# 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*<br>2. *Yunus. Acengel., Michael A Boles, Thermodynamics – An Engineering Approach, 8th ed., Tata McGraw Hill- Education, 2015*<br>3. *Nag. P.K, Engineering Thermodynamics, 5th edition, Tata McGraw Hill Education, 2013* | 4. *R. Rudramoorthy, Thermal Engineering, 4th ed., Tata McGraw-Hill, 2007*<br>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.*<br>2. *Rajput R. K, "A textbook of Internal Combustion Engines", 2nd edition, Laxmi Publications (P) Ltd, 2007.*<br>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*<br>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.*<br>2. *P.N. Rao, Manufacturing technology – Machining and MachineTools, Vol. 2, 3rd ed., Tata Mc Graw Hill, 2017*<br>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.*<br>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*<br>2. *Radhakrishnan. P "CAD / CAM / CIM" New age international,2018*<br>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.*<br>5. *Bhandari V, "Design of Machine Elements", Tata McGraw-Hill Education,2010.*<br>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<br>2. Introducing solidworks "Dassault systems", 2014<br>3. Matt Loambard, "Mastering Solidworks", 201 | 4. Nitin.S. Gokhale, "Practical finite element analysis", Hyperworks, 2020<br>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.*<br>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.*<br>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.*<br>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*<br>4. *Allan.W.M.Bonnick "Automotive Computer Controlled System2001,Butterworth- Heinemann*<br>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*<br>2. *Ahmed A Shabana., "Computational Dynamics ", Wiley &Sons. thirdedition 2017* | 3. *Bhavikatti S.S., "Finite Element Analysis", New Age InternationalPublishers, New Delhi, 2008.*<br>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.*<br>*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.*<br>*Practice 3: Magic Formula Tire model – Simulation of longitudinal and lateral forces.*<br>*Practice 4: Simulation and analysis of Quarter Car model using Simulink / Simscape / Modelica.*<br>*Case study to be offered by Volvo – Fundamental Equation of Motion for longitudinal dynamics of a truck*<br>*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.*<br>*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.*<br>*Practice 5: Shock absorber testing – Characterizing the shock absorber and formulating simple models for shock absorber using curve fitting.*<br>*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.*<br>*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.*<br>*Practice 7: Active Suspension system study using Quanser active suspension test rig. Practice 8:*<br>*Control strategy for a basic ABS implementation using Simulink.*<br>*Case study to be offered by Volvo – Bicycle model formulation for a truck system.*<br>*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.*<br>*Practice 9: Plotting longitudinal, lateral and vertical forces involved in vehicle motion using Carmaker software. Practice 10:*<br>*Single Track model simulation and analysis using Simulink / Simscape.*<br>*Practice 11: Basic kinematic Simulation with Motion Solve*<br>*Case study to be offered by Volvo - Basic ABS system design for trucks*<br>*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.*<br>2. *Thomas D Gillespie, Fundamentals of Vehicle Dynamics, 2nd Revised Edition, SAE International, Warrendale, 2021.*<br>3. *Reza N Jazar "Vehicle Dynamics: Theory and Application", 3rd Edition, Springer International Publishing AG, Switzerland, 2017.*<br>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.*<br>6. *Ellis.J.R - "Vehicle Dynamics"- Business Books Ltd., London- 1991..*<br>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.*<br>***Practice:***<br>*9. Measurement of HC, CO, CO2, and O2 Using Exhaust Gas Analyzer and Smoke Density Measurement*<br>*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.*<br>***Practice:***<br>*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*<br>*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*<br>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*<br>4. *James M. Gere, Mechanics of Materials, 8th ed., Brooks/Cole, USA, 2013*<br>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*<br>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*<br>4. *Kazimi S. M. A, Solid Mechanics, 2nd ed.,Tata McGraw Hill, 2017*<br>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*<br>2. *Dieter.G.E, Mechanical Metallurgy, McGraw Hill, Singapore, 2017*<br>3. *Budinski.K.G, Budinski.M.K, Engineering Materials Properties and selection,Edition 9, Pearson Publication, 2010*<br>4. *ASM Hand book, Failure analysis and prevention, Vol: 11, 2021*<br>5. *Reza Abbaschian, Lara Abbaschian& Robert E. Reed-Hill, Principles of Physical Metallurgy, Cengage Learning, 2013*<br>6. *Chaudhery Mustansar Hussain,,"Smart Materials and New Technologies", Springer, 2022*<br>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.*<br>9. *William D. Callister, David G. Rethwisch, Materials Science and Engineering: An Introduction,10th ed., Wiley publication, 2018*<br>10. *Donald R. Askeland, Wendelin J. Wright, Essentials of Materials Science & Engineering, 4th ed., Cengage, 2018*<br>11. *Raghavan V. Physical Metallurgy: Principles and Practice, PHI Learning, 2015.*<br>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*<br>2. *Bansal.R.K, A text book of Fluid Mechanics and Hydraulics Machines, Laxmi publications (P) Ltd., 9th ed., 2015*<br>3. *Modi P.N, Seth S.M, Hydraulics and Fluid Mechanics, Standard Book House, 15th ed., 2002*<br>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*<br>6. *Cengel, Y.A. and Cimbala, J.M. (2018) FluidMechanics. Fundamentals and Applications. 4th Edition. McGraw-Hill, New York.*<br>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*<br>2. *Thomas Bevan, Theory of Machines, 3rd Edition – P*<br>3. *Education Limited – 2005 – 3rd Edition* | 4. *Robert L. Norton, Kinematics and Dynamics of Machinery, 2nd Edition, McGraw Hill, 2013.*<br>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* | |

# ACADEMIC CURRICULA

# UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume – 7A
(Syllabi for Automobile Engineering Programme Courses)

## SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

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

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

# ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021

## SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

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

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

| Course Code | 21AUE221T | Course Name | AUTOMOTIVE COMPONENTS MANUFACTURING | 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 knowledge in understanding the manufacturing processes of automotive components |
| CLR-2: | understanding the professional and ethical responsibility |
| CLR-3: | understand The process to meet desired needs within realistic |

| Course Outcomes (CO): | At the end of this course, learners will be able to: | Program Outcomes (PO) | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 Engineering Knowledge | 2 Problem Analysis | 3 Design/development of solutions | 4 Conduct investigations of complex problems | 5 Modern Tool Usage | 6 The engineer and society | 7 Environment & Sustainability | 8 Ethics | 9 Individual & Team Work | 10 Communication | 11 Project Mgt. & Finance | 12 Life Long Learning | PSO-1 | PSO-2 | PSO-3 |
| CO-1: | understand the automotive component to be manufactured | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 3 | - | - |
| CO-2: | acquire knowledge in Complete Transmission system Production | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 3 | - | - |
| CO-3: | identify the suitable manufacturing process Vehicle components | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 3 | - | - |
| CO-4: | examine the primary & secondary Process in Vehicle Structure manufacturing | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 3 | - | - |
| CO-5: | identify the possible defects and suggest suitable remedies | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 3 | - | - |

***Unit-1 - Manufacturing of Automotive Engine Components*** **9 Hour**

*Manufacturing of main bearing – Description, Purpose, Material-Production requirement – Consistent wall thickness, Precise crush height, process requirement - Centrifugal casting Meld material, Consideration for main bearing in centrifugal casting.-Surface finishing for main bearing -Manufacturingof main bearing cap-Functional requirement - Material requirement – Special treatment materials for cap - Production requirement-Process requirement –Hot chamber die casting - Cold chamber die casting-Precision drilling operation - Vibration damper-Functional requirement, Description of vibration, Material requirement, Production requirement - Process description.-Vacuum casting Consideration for casting damper-Why vacuum casting & its advantages - Piston ring & pin-Description - types-Functional requirement.*

***Unit-2 - Manufacturing of Transmission Components*** **9 Hour**

*Overview - Material selection and Manufacturing methods for transmission system. Flywheel - Casting and Machining. Clutch - Friction plate, clutch housing, pressure plate conventional and fine blanking, composite friction lining. Methods of Gear manufacture – Gear hobbing and gear Shaping machines - gear generation - gear finishing and shaving – Grinding and lapping of hobs and shaping cutters –gear honing –gear broaching. Gearbox -Casting, precision forging, powder metallurgy, heat treatment and finishing. Propeller shaft -Continuous casting, extrusion, dies heat treatment and surface hardening. Axle-Differential –Axle Shaft –Bearing –fasteners-Forging, casting and machining. Leaf and coil spring -Forging and machining, composite leaf spring and wrap forming of coil spring.*

***Unit-3 - Manufacturing Process of Chassis Components*** **9 Hour**

*Material selection and manufacturing methods for Vehicle Frame Manufacturing, Wheel drum, Brake drum, Brake shoes, wheel rim and wheel housing manufacturing. Steering systems, shock absorbers, dead axle – casting, forging, machining and finishing operation- Heat treatment procedures for chassis components.*

***Unit-4 - Manufacturing of Body Components*** **9 Hour**

*Surface treatment –Plastics – Plastics in Automobile vehicles –Processing of plastics - Body Panel -Thermoforming and hydro forming, press forming, stretchforming. Emission control system –catalytic converter – Hydro forming of exhaust manifold and lamp housing. Welding – Resistance welding and other weldingprocesses with the use of Robots in Body weldment. Instrument Panel -Principle of injection molding, injection molding of instrument panel. Bumpers - Molding of bumpers, reinforced reaction injection molding, Manufacture of polymer panels.*

| ***Unit-5 – Manufacturing of Tyres and Advance Materials Manufacturing*** | ***9 Hour*** |
|---|---|
| *Tire and tube manufacturing, spray painting, powder coating, Prototype Manufacturing -RPT,3-D Printing, chemical vapour deposition, physical vapourdeposition, cryogenic grinding of powders, sealants, sound proof materials, structural adhesives, MMC liners – Selection of materials for Auto components.* | |

| **Learning Resources** | | |
|---|---|---|
| | 1. *Heldt P M, "High Speed Combustion Engines", Oxford IBHpublishing Co., Calcutta, 1996.*<br>2. *B.P. Bhardwaj, "The Complete Book on Production of Automobile Components & Allied Products", NIIR Project Consultancy Services, 2014.* | 3. *Kalpakjian, "Manufacturing Engineering and Technology",Pearson Education, 2005*<br>4. *Degarmo E P, "Materials and process in Manufacturing", MacmillanPublishing Co, 1997.*<br>5. *John A S, "Introduction to Manufacturing Processes", Tata McGraw -Hill, 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* | *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.Madhan Kumar, SRMIST* |
| 2. *Mr.S.Ravi Kumar Raisunsoft Solutions, mymail2ravi@ymail.com* | 2. *Dr.R.Elansezhian, Pondicherry Engineering College,elansezhianr@gmail.com* | 2. *Dr.J.Chandradass, SRMIST* |

| Course Code | 21AUE222T | Course Name | WELDING AND JOINING TECHNIQUES | 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 knowledge of fusion welding processes and weld joints* |
| ***CLR-2:*** | *select various welding processes based on applications* |
| ***CLR-3:*** | *list welding parameters and filler metals for various welding processes* |
| ***CLR-4:*** | *understand advanced welding techniques and their applications* |
| ***CLR-5:*** | *acquire knowledge in high-energy welding process* |

| 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:*** | *categorize the various types of welding processes* | 2 | - | - | 1 | - | - | - | - | - | - | - | - | 3 | - | - |
| ***CO-2:*** | *explain various arc welding techniques and their applications* | 3 | - | 2 | - | - | - | - | - | - | - | - | - | 3 | - | - |
| ***CO-3:*** | *determine welding parameters for different types of materials* | - | 1 | - | 2 | - | - | - | - | - | - | - | - | 3 | - | - |
| ***CO-4:*** | *predict the welding process suitable for automotive applications* | 3 | - | - | - | 2 | - | - | - | - | - | - | - | 3 | - | - |
| ***CO-5:*** | *compare advanced welding with conventional welding techniques* | - | - | - | 3 | 2 | - | - | - | - | - | - | - | 3 | - | - |

| ***Unit-1 - Fundamentals of Welding*** | ***9 Hour*** |
|---|---|
| *Fundamentals of welding and joining process - Classification of fusion welding processes, Heat source intensity, Heat Input rates, Shielding methods,Metallurgical effect of weld thermal cycle, Residual stresses, Formation and Relieving, Types of weld joints, cleaning of edges, Edge preparation, cleaning of edges, Tack welding.* | |
| ***Unit-2 - Arc Welding Process*** | ***9 Hour*** |
| *Introduction to Arc Welding, Carbon arc welding, Gas tungsten arc welding, Gas Metal Arc Welding, Plasma arc welding, Submerged arc welding, Electroslag welding, Metal transfer in welding, Arc welding applications, Arc welding advantages and disadvantages.* | |
| ***Unit-3 - Gas Welding Process*** | ***9 Hour*** |
| *Oxygen cutting, Flame cut ability of metals, effect of cutting on structure and properties of steel, Gas welding, fuel gases and flames Oxygen lancing machine cutting,Powder cutting, Welding of different types of materials - carbon and alloy steels. Welding of different types of materials - Cast iron non-ferrous metals and alloys, and aluminium. Soldering and Brazing: Capillary and welding action, Soldering and Brazing-Temperature Range, Filler Metals and Fluxes Processes and application, welding & joining of non-metals.* | |
| ***Unit-4 - Advanced Welding Process*** | ***9 Hour*** |
| *Spot welding and types of equipment, Rocker arm press type welding and it's applications, Seam welding and its applications, Projection welding and its applications, Flash and butt welding applications, Torches, Filler metal and Fluxes, Backward and Forward welding and filler rod diameter, Thermit welding.* | |
| ***Unit-5 - Solid State Welding Process*** | ***9 Hour*** |
| *Introduction to solid state welding process, Friction welding & friction stir welding, Forge welding. Ultra-Sonic welding, Explosive welding, Laser welding, Electron beam welding -types of electron gun, Electron beam welding- spot size beam power Operating voltage, pulse technique, deep penetration and applications, Operating voltage, pulse technique, deep penetration and applications, Micro joining, Nano joining Techniques and other joining for automotive applications* | |

| | | |
|---|---|---|
| **Learning Resources** | 1. *Nadkarni. S. V, "Modern Arc Welding Technology", AdorWelding Ltd. Oxford and IBH Publishing, 2008.*<br>2. *William A. Bowditch, Kevin E. Bowditch, Mark A. Bowditch, "Welding Technology Fundamentals",Goodheart-WillcoxPublisher, 4 edition, 2009* | 3. *Richard L. Little, "Welding and welding Technology", TATA McGraw HillPublishing Company Ltd, 2013*<br>4. *Parmar. R. S, "Welding Engineering and Technology", Khanna Publishers,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* | *50%* | - | *20%* | - | *20%* | - |
| Level 2 | *Understand* | *30%* | - | *30%* | - | *30%* | - |
| Level 3 | *Apply* | *20%* | - | *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.N.Vijayakumar, Head Test labs, Mahindra andMahindra, vijayakumar.n@mahindra.com.* | 1. *Prof. M.Balasubramanian, Professor, IIT Madras,mbala@iitm.ac.in* | 1. *Mr. S. Palanisamy, ,SRMIST* |
| 2. *Mr.N.Vijayakumar, Head Test labs, Mahindra andMahindra, vijayakumar.n@mahindra.com.* | 2. *Prof. M.Balasubramanian, Professor, IIT Madras,mbala@iitm.ac.in* | 2. *Dr. Chandradass J ,SRMIST* |

| Course Code | 21AUE321T | Course Name | AUTOMOTIVE SURFACE ENGINEERING | Course Category | E | PROFESSIONAL ELECTIVE | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

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

| Course Learning Rationale (CLR): | The purpose of learning this course is to: |
|---|---|
| CLR-1: | describe the surface preparation techniques |
| CLR-2: | interpret the knowledge on thermal spraying technology for surface coating applications |
| CLR-3: | understand the process of Hot dip and diffusion coating |
| CLR-4: | illustrate the testing procedure for surface coating |
| CLR-5: | understand the testing and selection of coating |

| 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: | select the various techniques of surface preparation | 1 | 2 | 3 | - | - | - | - | - | - | - | - | - | 3 | - | - |
| CO-2: | identify the thermal spraying process and electrodeposited coating | 1 | 2 | - | 3 | - | - | - | - | - | - | - | - | 3 | 2 | - |
| CO-3: | distinguish the process of Hot dip and diffusion coating | 1 | 2 | 3 | - | - | - | - | - | - | - | - | - | 3 | - | - |
| CO-4: | perform the testing procedure for surface coating | 3 | 1 | - | 2 | - | - | - | - | - | - | - | - | 3 | 2 | - |
| CO-5: | analyze and select the coating for application | 2 | 1 | 3 | - | - | - | - | - | - | - | - | - | 3 | 2 | - |

***Unit-1 - Need and Relevance of Surface Engineering*** — ***9 Hour***

*Introduction and Need of Surface Friction Behavior, Advantages, Limitations, and Applications. General cleaning process for ferrous metals and non-ferrous metals.*

***Unit-2 - Surface Wear Assessment*** — ***9 Hour***

*Causes and Mechanisms, Types of Wear and Mechanisms and Classical Governing Laws, Techniques to Evaluate Damage of Wear Surfaces, AdhesiveWear - Pin-on-Disk Unidirectional Sliding Adhesive Wear Test, Reciprocating Wear Test, Abrasive Wear Test. Principle of Corrosion-Classification of corrosion-Types of corrosion-Factors influencing corrosion Corrosion Testing*

***Unit-3 - Surface Strengthening Process*** — ***9 Hour***

*Surface Engineering by Changing the Surface Metallurgy, Approach, Transformation Hardening Methods -Flame Hardening, Induction Hardening, Laser BeamHardening, Plastic Deformation-Based Approaches - Shot Peening, Burnishing and Contour Rolling, Friction Stir Processing Surface Engineering by Changing the Composition , Approach, Carburizing, Nitriding, Boronizing, Aluminizing, Plasma Carburizing and Plasma Nitriding, Surface Modification Using Diffusion-Based Processes (PVD, CVD),*

***Unit-4 - Surface Modification Process*** — ***9 Hour***

*Surface Modification by Developing Coating and Cladding Approach, Technical Factor Affecting Performance, Weld Surfacing- Gas Welding, Gas Metal Arc Welding, Laser Cladding, Thermal Spraying -Flame Spraying Process, High-Velocity Oxy-Fuel Thermal Spraying, Electric Arc Wire Spray Process, Plasma Arc Spray, Electroplating, Electroless Process*

***Unit-5 - Characterization of Engineered Surfaces*** — ***9 Hour***

*Characterization of Surface Properties -Surface Roughness, Thickness of Coatings and Films, Bond Strength of Coating–Substrate, Non-destructive Testing (NDT) and Destructive Testing of Modified Surfaces X-Ray Diffraction (XRD) Analysis, Scanning Electron Microscopy (SEM), Compositional Analysis, Energy Dispersive X-Ray (EDAX) Analysis, Macroscopic Observation, Metallographic Examination*

| | | |
|---|---|---|
| **Learning Resources** | 1. *DeGarmo's "Materials and Processes in Manufacturing" J.T.Black, Ronald A. Kohser Wiley, 2011.*<br>2. *S.K.Basu, S.N.Sengupta & B.B.Ahuja ,"Fundamentals of Tribology", Prentice –Hall of India Pvt Ltd, New Delhi, 2005*<br>3. *George Dieter "Mechanical Metallurgy", McGraw Hill Education; 2012* | 4. *G.W.Stachowiak& A.W .Batchelor , "Engineering Tribology",worth-Heinemann, UK, 2005*<br>5. *Stand Grainger engineering coatings – design and application jaico publishingHouse, 1994. Parthasarathy. N.V., Electroplating Handbooks, Prentice Hall, 2010*<br>6. *Rabinowicz.E, "Friction and Wear of materials", Second Edition:John Willey &Sons, 2013* |

**Learning Assessment**

| | *Bloom's Level of Thinking* | *Continuous Learning Assessment (CLA)* | | | | *Summative Final Examination (40% weightage)* | |
|---|---|---|---|---|---|---|---|
| | | *Formative CLA-1 Average of unit test (50%)* | | *Life-Long Learning CLA-2 (10%)* | | | |
| | | *Theory* | *Practice* | *Theory* | *Practice* | *Theory* | *Practice* |
| Level 1 | *Remember* | *20%* | *-* | *20%* | *-* | *15%* | *-* |
| Level 2 | *Understand* | *30%* | *-* | *30%* | *-* | *25%* | *-* |
| Level 3 | *Apply* | *50%* | *-* | *50%* | *-* | *30%* | *-* |
| Level 4 | *Analyze* | *-* | *-* | *-* | *-* | *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. Silambarasan Ramadoss, Renault NissanTechnology & Business Centre India, silambarasan.ramadoss@rntbci.com* | 1. *Dr. A.Siddharthan, Madras Institute ofTechnology, sidharth@mitindia.edu* | 1. *Dr.J.Chandradass, SRMIST,* |
| 2. *Mr. Prasad Arun Kumar, Mahindra Research Valley, prasad.arunkumar@mahindra.com* | 2. *Dr. S. Renold Elsen, Vellore Institute of Technology,renoldelsen.s@vit.ac.in* | 2. *Mr.M.Palanivendhan, SRMIST* |

| Course Code | 21AUE322T | Course Name | AGILE MANUFACTURING | 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:*** | *interpret the manufacturing system and operation in terms of economic and technology* |
| ***CLR-2:*** | *learn the manufacturing categories, material handling and manufacturing product* |
| ***CLR-3:*** | *expertise in industrial automation levels and its functional requirement* |

| 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:*** | *illustrate the lean manufacturing tools and their potential applications* | *3* | *2* | *-* | *2* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *3* | *-* | *-* |
| ***CO-2:*** | *recite the usage of visual management in Manufacturing System* | *3* | *2* | *-* | *2* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *3* | *-* | *-* |
| ***CO-3:*** | *contrast the appropriate techniques of agile manufacturing* | *3* | *2* | *-* | *3* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *3* | *-* | *-* |
| ***CO-4:*** | *articulate professional engineering solutions to eliminate wastes* | *3* | *2* | *-* | *3* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *3* | *-* | *-* |
| ***CO-5:*** | *compare the complex technology drivers of agile manufacturing* | *3* | *2* | *-* | *1* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *3* | *-* | *-* |

| ***Unit-1 - Introduction to Manufacturing Operations*** | ***9 Hour*** |
|---|---|
| *Introduction to Manufacturing Operations - Definition of Manufacturing - Alternate Definition of Manufacturing system as Technological - Economic Process Comments – Remarks - Manufacturing Industries & Products Manufacturing Categories –Primary – Secondary – Territory - Continuous & BatchProduction – Discrete manufacturing industry. Manufacturing Products – Materials, Typical Product - Manufacturing Operation-Processing & Assembly Operations-Material handling - Inspection & testing-Coordination & testing- Process, Objective, Working & Stages of operations -Product & Production Relationship - Production quantity & product variety* | |
| ***Unit-2 - Manufacturing System*** | ***9 Hour*** |
| *Manufacturing System- Definition - Material Handling- Definition - Human Resource Manufacturing system in large production system - Components ofa manufacturing system - Various components- Production machines - Tools, fixtures & material handling system - Computer systems to coordinate the manufacturing system - Human Workers - Classification of Manufacturing systems - Factors - types of operation performed* | |
| ***Unit-3 - Supply Chain Management, Production Planning and Control System*** | ***9 Hour*** |
| *Supply Chain Management - Importance of supply chain-Definition - competitive industrial revolution - Relying on Suppliers-downside and upside - Supply chain management-Physical supply chain - management philosophy - Purchasing-changing roles - requirement specifications - suppliers, assessment, selection & contracting - managing supplier relationship* | |
| ***Unit-4 - Lean Production: JIT, Value Added and Waste Elimination*** | ***9 Hour*** |
| *Agile Manufacturing - Introduction-Definition-Organize to master change - leverage the impact of People & information - cooperate to enhance competitiveness-enrich the customers - Market force & agility - Intensifying competition-fragmentation of mass market - cooperative business relationship - Changing customer expectation - Reorganizing the production system for agility-design - Reorganizing the production system for agility-product* | |

| ***Unit-5 - Agile Manufacturing*** | ***9 Hour*** |
|---|---|
| *Agile Manufacturing - Introduction-Definition-Organize to master change - leverage the impact of People & information - cooperate to enhance competitiveness-enrich the customers - Market force & agility - Intensifying competition-fragmentation of mass market - cooperative business relationship - Changing customer expectation - Reorganizing the production system for agility-design - Reorganizing the production system for agility-product* | |

| | | |
|---|---|---|
| **Learning Resources** | 1. *Mikell P. Groover "Automation, Production System & Computer Integrated Manufacturing", Prentice Hall; 3 edition (August 3, 2007).*<br>2. *John M. Nicholas "Competitive Manufacturing Management" 9th Edition, TATA McGraw Hill editions.2010* | 3. *S.R.K. Prasad, R. Prabhakar, S. Dhandapani, V. Selladurai " Intelligent Flexible Autonomous Manufacturing Systems", TATA McGraw- Hill Publishing Company Limited, 2010.*<br>4. *M. P. Chowdiah, Gopinath Gargesa, V. Arun Kumar, "Agile Manufacturing, TATA McGraw-Hill Publishing Company Limited, 2006.* |

**Learning Assessment**

| | *Bloom's Level of Thinking* | *Continuous Learning Assessment (CLA)* | | | | *Summative Final Examination (40% weightage)* | |
|---|---|---|---|---|---|---|---|
| | | *Formative CLA-1 Average of unit test (50%)* | | *Life-Long Learning CLA-2 (10%)* | | | |
| | | *Theory* | *Practice* | *Theory* | *Practice* | *Theory* | *Practice* |
| Level 1 | *Remember* | *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. *Dr K Venkateswaran, Bimetal Bearings Limited,drvenki@bimite.co.in* | 1. *Dr.R.Elansezhian, PondicherryEngineering College,elansezhianr@gmail.com* | 1. *Mr.S.Madhan Kumar SRMIST* |
| 2. *Dr.G.Saravanan Caterpillar, gsaravanan@cat.com* | 2. *Mr. N.Ravikumar, Crescent Institute of Science andTechnology, ravikumar@crescent.education* | 2. *Dr.J.Chandradass, SRMIST* |

| Course Code | 21AUE323T | Course Name | MANUFACTURING SYSTEMS AND SIMULATION | 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 simulation modelling can aid in effective decision-making* |
| ***CLR-2:*** | *create Simulation model building aspects of discrete systems (such as Queuing, Inventory and manufacturing) in detail* |
| ***CLR-3:*** | *demonstrate how computer simulation can be used to successfully model, analyze and improve systems under study* |
| ***CLR-4:*** | *perform the statistical analysis of simulation model output* |
| ***CLR-5:*** | *selection of the appropriate simulation software for the different cases* |

| 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 simulation* | *3* | *-* | *1* | *2* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *3* | *-* | *-* |
| ***CO-2:*** | *simulation software* | *2* | *-* | *-* | *3* | *1* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *3* | *-* | *-* |
| ***CO-3:*** | *interpret simulation output using valid statistical methods and make appropriate recommendations* | *2* | *1* | *3* | *-* | *1* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *3* | *-* | *-* |
| ***CO-4:*** | *analyze data to determine appropriate input distributions using valid statistical methods* | *3* | *1* | *-* | *2* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *3* | *-* | *-* |
| ***CO-5:*** | *apply the simulation software for various manufacturing system/process* | *2* | *-* | *-* | *1* | *3* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *3* | *-* | *-* |

| ***Unit-1 - Manufacturing Systems and System Design*** | ***9 Hour*** |
|---|---|
| *Basic concepts and problems concerning systems Components of Manufacturing systems and System design: Decision making procedures Classificationsof Manufacturing systems Structural, Transformational and procedural aspects of manufacturing. Modes of production- Batch Production, Cellular, Flexible Manufacturing. Process systems for manufacturing. Logistics systems- Product-Production Relationship, Material flow & technological information flow Management and information systems for manufacturing. Managerial information flow in manufacturing systems.* | |
| ***Unit-2 - Probability*** | ***9 Hour*** |
| *Basic concepts of probability-Discrete versus Continuous Variables, Probability distribution for discrete variables Probability distribution for continuous variables Binominal Distribution- to test hypothesis Statistical Models- Queueing Systems, Inventory and Supply chain system Spread Sheet simulations Queueing simulation in a spread sheet Simulating a single server queue Discrete and Continuous Systems Concepts in Discrete- Event system simulation.* | |
| ***Unit-3 - Random Number Generation Techniques*** | ***9 Hour*** |
| *Properties of random numbers Techniques for generating random numbers- Linear Congruential Method Techniques for generating random numbers- Combined Linear Congruential Generator. Techniques for generating random numbers- Random- Number streams Tests for random numbers- Frequency Test. Tests for random numbers- Test for Autocorrelation. Direct transformation for acceptance and rejection techniques- Poisson Distribution Inverse Transform Techniques- Exponential Distribution, Uniform Distribution Inverse Transform Techniques- Emphatical continuous distributions.* | |
| ***Unit-4 - Data Collection Methods*** | ***9 Hour*** |
| *Input modeling, Data collection Histograms, Selecting the family distribution, selecting input distributions with data Quantile-Quantile plot Parameter estimation- sample mean and sample variance Goodness-of-fit tests Kolmogorov-smirnov goodness of fit test Selecting input models without data Multivariate and time series input models Time-series input models experimental layout and validation.* | |

| ***Unit-5 - Simulation Processes*** | ***9 Hour*** |
|---|---|
| *Programming for discrete event system simulation in GPSS-GPSS- Single Server Queue simulation, Simulation of Production systems- Models of Material Handling system. Simulation of Production systems- Models of Material Handling Equipment. Queueing Systems- Characteristics Queueing Systems- Notations Project networks Maintenance and replacement systems Investment Analysis.* | |

| **Learning Resources** | | |
|---|---|---|
| | 1. *Jerry Banks and John S Carson, Barry L Nelson, David M Nicol,'Discrete event system simulation',5th editionPearson Education, 2017, ISBN 13: 9789332518759.*<br>2. *David Bedworth& James Bailey, Integrated production control system management, analysis & design, 5th ed., John Wiley & Sons Ltd, 2005, ISBN 13: 9780471821793* | 3. *Carrle A, "Simulation of Manufacturing Systems", John Wiley and SonsInc., New York, 2007, ISBN 13: 9780471915744*<br>4. *Gordon G, "Systems Simulation", Pearson Education, 2002.ISBN 13:788120301405 arsingh Deo, "System Simulation with Digital Computer", Prentice Hall ofIndia, New Delhi, 2001.ISBN 13: 9780138817893* |

**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. *Mr.N.Vijayakumar, Head Test labs, Mahindra andMahindra, vijayakumar.n@mahindra.com.* | 1. *Dr. A.Siddharthan, Madras Institute ofTechnology, sidharth@mitindia.edu* | 1. *Dr.J.Chandradass, SRMIST* |
| 2. *Mr.S. Senthil Kumar, Deputy Manager, RenaultNissan Technology & Business Centre India, senthilkumar.subramanian@rntbci.com* | 2. *Dr. A.Siddharthan, Madras Institute ofTechnology, sidharth@mitindia.edu* | 2. *Mr.S.Palanisamy,, SRMIST,* |

| Course Code | 21AUE324T | Course Name | ADVANCED MANUFACTURING PROCESS | 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 knowledge of various advanced manufacturing processes used in industries |
| CLR-2: | understand the various manufacturing process of composite, plastics and glass\ |
| CLR-3: | acquaint students with the concept of Additive Manufacturing (AM), various AMtechnologies, selection of materials for AM, modelling of AM processes, and their applications in various fields |
| CLR-4: | acquire knowledge in low temperature joining process |
| CLR-5: | understand the advanced manufacturing by Rapid prototyping method |

| 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: | identify the advanced metal forming process and its current role in the industries | 3 | - | - | 2 | - | - | - | - | - | - | - | - | 3 | 1 | - |
| CO-2: | choose the manufacturing process for the fabrication of composite, plastics and glass depending on the applications | 2 | - | 3 | - | 1 | - | - | - | - | - | - | - | 3 | 1 | - |
| CO-3: | integrate microelectronic devices for Automotive application | 2 | - | 3 | 1 | - | - | - | - | - | - | - | - | 3 | - | - |
| CO-4: | list the low-temperature joining and surface treatment process | 3 | 1 | - | 2 | - | - | - | - | - | - | - | - | 3 | - | - |
| CO-5: | select economically viable manufacturing processes of highly complex parts alternative to conventional manufacturing technologies | 2 | - | - | 1 | 3 | - | - | - | - | - | - | - | 3 | 2 | - |

**Unit-1 - Advanced Manufacturing Process – Introduction** **9 Hour**

*Introduction – why do we need an advanced manufacturing process? Introduction to powder metallurgy technique, Need and role of powder metallurgy inAutomotive industry, Powder Metallurgy Applications – Automotive parts and components. Production and properties of metal powders. Particle size, distribution and shape of metal powders. Blending of metal powders and purpose. Hazards in Blending, Compaction of Metal powders. Purpose of Isotacticpressing. Hot & Cold Shaping Process. Metal injection moulding, Spray Deposition. Sintering – process, Coining, Forging. Mechanism and Properties ofSintered Parts Secondary & Finishing Operations. Heat treating, Impregnation, Infiltration & Plating. Dent Resistance of Sheet metals – dent formation &automotive application. Fabrication of Honey Comb Structure for Catalytic Converter. Superplastic Forming – Super plasticity process, advantages and Properties. Diffusion bonding – process – advantages.*

**Unit-2 - Composite Materials** **9 Hour**

*Introduction to Composites, Composites properties and structures. Processing of Polymer Matrix composites- Compression molding, injection molding, hand lay-up method, filament winding. Processing of Metal Matrix composites. Processing of Ceramic Matrix Composites. Composites in Automotive applications. Shaping of plastics Injection Molding process. Blow Molding process. Rotational Molding process. Thermoforming process. Compression molding process, Transfer Molding process. Economics of Processing Plastics & Composites. Forming & shaping of Glass- piece ware glass- spinning pressing, press and blow, blow & blow and casting Flat and tubular glass- float process, rolling of flat plate, Danner process Forming of glass fiber- centrifugal spraying, drawing Strengthening Techniques for Glass.*

**Unit-3 - Role of Electronics in Manufacturing** **9 Hour**

*Role of Electronics in the Industrial Revolution. Integration of Semiconductors & Silicon- Structure, Physical Properties. Semiconductors – working and types. Semiconductors – advantages. Wafer Formation & preparation. Single Crystal growing, Slicing of wafers Geometry of wafers. Film Deposition & Oxidation techniques. Physical Vapor Deposition, Chemical Vapor Deposition, Photolithography – Principle and Process. Photolithography - Types & working. Etching –Need, Types, Principle. Etching - Process & Working. Diffusion- Principle, Process & Working, Ion Implantation - Principle, Process & Working. A brief outline of Wire Bonding, Packaging, Yield, Reliability.*

| ***Unit-4 - Joining process and Heat Treatment Process*** | ***9 Hour*** |
|---|---|
| *Introduction to joining process. Brazing & Soldering methods- torch, furnace, induction, resistance, dip, infrared and applications. Adhesion bonding – types ofadhesives and adhesives system – Applications Joining of Plastics Joining of ceramics Joining of glass. Surface Treatment- need, surface structure. Mechanical surface treatment – shot peening, laser shot peening Water jet peening, Ultrasonic peening. Surface rolling - operation explosive hardening - operation Cladding - process & working. Case hardening - process & working Hard facing - objective, process & working. Spark hardening - objective, process & working. Thermal spraying – need, materials Thermal spraying – types. Thermal spraying –process- combustion, electrical and cold spraying.* | |
| ***Unit-5 - Additive Manufacturing*** | ***9 Hour*** |
| *Introduction to additive manufacturing. Importance of Rapid prototyping. RPT – classification based on materials, Advantages Liquid-based techniques-overview Stereolithography. Solid Ground Curing technique. Multi Jet Modeling, Ballistic particle. Shape deposition Manufacturing Powder-based techniques-overview Selective laser sintering. Laser-engineered net shaping.3D printing – introduction 3D printing- working and application. Solid based technique-overview. Fused Deposition Modeling, Paper Lamination Technology, Laminated object modeling – process.* | |

| **Learning Resources** | 1. *SeropeKalpakjian, "Manufacturing Engineering and Technology", 6th Edition, Addison-Wesley publishingCo., Boston, 2014.* | 2. *Helmi A Youssef, Hassan E El-Holfy, Mahmoud H Ahmed,"Manufacturing Technology", CRC Press. 2010*<br>3. *Mikell P. Groover "Fundamentals of Modern Manufacturing", 4thEdition, John Wiley & Sons Inc, 2015* |
|---|---|---|

**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* | *50%* | - | *20%* | - | *20%* | - |
| Level 2 | *Understand* | *30%* | - | *30%* | - | *30%* | - |
| Level 3 | *Apply* | *20%* | - | *50%* | - | *50%* | - |
| Level 4 | *Analyze* | - | - | - | - | - | - |
| 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.N.Vijayakumar, Head Test labs, Mahindra andMahindra, vijayakumar.n@mahindra.com.* | 1. *Prof. M.Balasubramanian, Professor, IITMadras, mbala@iitm.ac.in* | 1. *Dr.J.Chandradass, SRMIST,* |
| 2. *Mr.S. Senthil Kumar, Deputy Manager, RenaultNissan Technology & Business Centre India, senthilkumar.subramanian@rntbci.com* | 2. *Dr.P.Jawahar, Assistant Professor, NITAgartala, drjawahar.me@nita.ac.in* | 2. *Mr.S.Palanisamy, SRMIST,* |

| Course Code | 21AUE325T | Course Name | COMPUTER INTEGRATED MANUFACTURING | 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: | identify the capability in students to understand and use CIM in industry |
| CLR-2: | prepare planning and scheduling of process equipment fabrication using various CAPP |
| CLR-3: | demonstrate and use automated assembly lines, FMS and Industrial Robots |
| CLR-4: | formulate the Advanced knowledge in NC and CNC machining |

| 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: | extract the concepts/components of computer integrated manufacturing | 3 | 2 | - | - | 1 | - | - | - | - | - | - | - | 3 | - | - |
| CO-2: | illustrate the knowledge of computer aided process planning | 3 | 2 | - | - | 1 | - | - | - | - | - | - | - | 3 | - | - |
| CO-3: | develop knowledge about Group Technology and Flexible Manufacturing System | 3 | 2 | - | - | 1 | - | - | - | - | - | - | - | 3 | - | - |
| CO-4: | articulate themselves familiar with AGVs and Robotics | 3 | 2 | - | - | 1 | - | - | - | - | - | - | - | 3 | - | - |
| CO-5: | familiarize with NC and CNC machining | 3 | 2 | - | - | 1 | - | - | - | - | - | - | - | 3 | - | - |

**Unit-1 - Introduction To CIM** — **9 Hour**

*Brief introduction to CAD and CAM - Manufacturing Planning, Manufacturing control - Concurrent Engineering - CIM concepts - Computerized elements of CIM system - Types of production - Manufacturing models and Metrics - Mathematical models of Production Performance - Model problems I - Model problems II - Marketing engineering - Problems I - Problems II - Basic Elements of an Automated system - Levels of Automation - Five Levels of Automation*

**Unit-2 - Production Planning and Control and Computerized Process Planning** — **9 Hour**

*Process planning - Computer Aided Process Planning (CAPP) - Retrieval Computer Aided Process Planning - Generative Computer Aided Process Planning - Aggregate Production Planning - Aggregate Plan Strategies - Master Production Schedule - Main Functions of Master Production Scheduling -Material Requirement planning - Demand driven MRP - Capacity Planning - Control Systems - Shop Floor Control - Inventory Control - Introduction on Manufacturing Resource Planning - II (MRP-II) - Enterprise Resource Planning (ERP)*

**Unit-3 - Group Technology and Flexible Manufacturing System** — **9 Hour**

*Part families - Parts Classification /Parts coding - Opitz Part Coding system - Production flow Analysis - Cellular Manufacturing - Composite part concept - Individual features of Composite part concept - Machine cell design and layout - Applications of GT - Types of Flexibility - Flexible Manufacturing System - FMS Components - FMS Application - FMS Benefits - FMS Planning*

**Unit-4 - Automated Guided Vehicle System /Industrial Robotics** — **9 Hour**

*Automated Guided Vehicle System (AGVS) - AGV System management - AGVS Application - Vehicle Guidance technology - Vehicle Guidance technology benefits - Vehicle Management & Safety - Robot Anatomy - Related Attributes - Classification of Robots - Robot Control systems - End Effectors - Sensors in Robotics -Industrial Robot Applications - Material Handling Applications - Process Operations - Assembly and Inspection*

**Unit-5 - NC/CNC Machine Tools** — **9 Hour**

*Types, Classification - Specification and components - Construction Details - Controllers, Sensors and Actuators, - CNC hardware - -circulating ball screw - anti friction sideways - step/servo motors - NC/CNC tooling - Fundamentals of Part programming - Fundamentals of Part programming Programming for drilling, lathe and milling machine operations, - Robot Programming languages - Types of formats, Part subroutines, do loops, - Robot Accuracy*

| | | |
|---|---|---|
| **Learning Resources** | 1. *Mikell.P.Groover "Automation, Production Systems and computer integrated manufacturing", 4th edition Pearson Education 2016.*<br>2. *Kant Vajpayee. S., 'Principles of Computer Integrated Manufacturing', Prentice Hall of India, 2009*<br>3. *P.Radhakrishnan, Computer Numerical Control Machines and Computer Aided Manufacture, New Age International, 2018* | 4. *Mikell.P.Groover and Emory Zimmers Jr., "CAD/CAM", Prentice Hall ofIndia Pvt. Ltd., New Delhi-1, 2008*<br>5. *P.Radhakrishnan, CNC Machines New Central Agency, 2013*<br>6. *Yorem Koren, Computer Control of Manufacturing Systems, Mc Graw HillEducation 2017* |

**Learning Assessment**

| | *Bloom's Level of Thinking* | *Continuous Learning Assessment (CLA)* | | | | *Summative Final Examination (40% weightage)* | |
|---|---|---|---|---|---|---|---|
| | | *Formative CLA-1 Average of unit test (50%)* | | *Life-Long Learning CLA-2 (10%)* | | | |
| | | *Theory* | *Practice* | *Theory* | *Practice* | *Theory* | *Practice* |
| Level 1 | *Remember* | *20%* | *-* | *20%* | *-* | *15%* | *-* |
| Level 2 | *Understand* | *30%* | *-* | *30%* | *-* | *25%* | *-* |
| Level 3 | *Apply* | *50%* | *-* | *50%* | *-* | *30%* | *-* |
| Level 4 | *Analyze* | *-* | *-* | *-* | *-* | *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. Silambarasan Ramadoss, Renault Nissan Technology & Business Centre India,* | 1. *Dr. A.Siddharthan, Madras Institute of Technology, sidharth@mitindia.edu* | 1. *Mr.S.Madhan Kumar, SRMIST* |
| 2. *Mr. Prasad Arunkumar, MRV* | 2. *Dr. S.Renold Elsen, VIT* | 2. *Dr. J. Chandradass, SRMIST* |

| Course Code | 21AUE326T | Course Name | PROCESS PLANNING AND COST ESTIMATION | 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:*** | *impart basic knowledge about process planning and cost estimation* |
| ***CLR-2:*** | *retrieve the basic idea to estimate different cost* |
| ***CLR-3:*** | *study about cost estimation* |
| ***CLR-4:*** | *understand the importance of production cost* |
| ***CLR-5:*** | *acquaint knowledge to estimate machining time and cost* |

| 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:*** | *interpreting knowledge about work study and ergonomics* | *1* | *3* | *2* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *3* | *-* | *-* |
| ***CO-2:*** | *execute the process planning concepts* | *1* | *2* | *-* | *3* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *2* | *-* | *-* |
| ***CO-3:*** | *predict various cost estimation* | *1* | *2* | *3* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *2* | *-* | *-* |
| ***CO-4:*** | *calculate the production cost* | *3* | *1* | *-* | *2* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *3* | *-* | *-* |
| ***CO-5:*** | *solve machining time and cost* | *2* | *1* | *3* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *2* | *-* | *-* |

| ***Unit-1 - Methods of Process Planning*** | ***9 Hour*** |
|---|---|
| *Methods of process planning -steps in process selection-Objectives of Work study, Method Study-Basic Procedure for Method -Recording Techniquesused in Method Study-Work Measurements-Objectives of work Measurements-Work Sampling, Analytical Estimating-Ergonomics-Ergonomics Principles Applied to Instrument Design and Control-Ergonomics Principles Applied to Machines and Controls* | |
| ***Unit-2 - Production Process Planning*** | ***9 Hour*** |
| *Process parameters calculation for various production processes--Details of process plan, process charts and route sheets-Process planning methods- manual and computer aided process planning & its approaches-Manual process planning-Basic procedure, merits & demerits, applications and comparisons-Case study-Preparation of manual process plan for four stroke petrol engine assembly-Computer aided process planning-Types, Basic procedure, merits, demerits and applications -process analysis-Break even analysis* | |
| ***Unit-3 - Cost Estimation for Process Planning*** | ***9 Hour*** |
| *Objectives of cost estimation- Types of cost estimation- Fundamentals of costing and cost accounting methods- Components of a Cost Estimate- Classification ofCosting- Elements of Cost, Cost of Product- Estimation labor cost, material cost- allocation of overhead charges- Methods of Cost Estimates- Data Requirements and Sources of information* | |
| ***Unit- 4 - Foundry Shop Cost Estimation*** | ***9 Hour*** |
| *Foundry shop basics, various types of casting, Types of patterns -Casting tools and accessories-Cost estimation in foundry shop- pattern cost, casting cost-Welding, Types of weld joints, Gas Welding-Estimation of Gas welding cost, Gas cutting-Arc welding: Equipment, Cost Estimation-Cost estimation in Welding shop* | |
| ***Unit- 5 - Machining Time cost Estimation*** | ***9 Hour*** |
| *Estimation of Machining Time - Importance of Machine Time Calculation- Calculation of Machining Time for Different Lathe Operations, Drilling and Boring - Machining Time Calculation for Milling, Shaping and Planning -Machining Time Calculation for Grinding.* | |

| | | |
|---|---|---|
| **Learning Resources** | 1. *Chitale, A.K., and Gupta, R.C., "Product Design and Manufacturing", Prentice Hall of India, New Delhi, 2011.*<br>2. *Adithan,M, "Process planning and cost estimation", New Age International(P) Limited,2011* | 3. *Nanua Singh, "System Approach to computer Integrated Design andmanufacturing", John Wiley & Sons, New York, 2010*<br>4. *Sinha.B.P., "Mechanical Estimation and Costing", Tata McGraw-Hill,Publishing Co.,2018*<br>5. *Narang, G.B.S. and Kumar. "Production and planning", Khana Publishers, New Delhi,2015* |

**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. *Mr. Silambarasan Ramadoss, Renault Nissan Technology & Business Centre India, silambarasan.ramadoss@rntbci.com* | 1. *Dr. A.Siddharthan, Madras Institute ofTechnology, sidharth@mitindia.edu* | 1. *.Dr.J.Chandradass, SRMIST* |
| 2. *Mr. Prasad Arun Kumar, Mahindra Research Valley, prasad.arunkumar@mahindra.com* | 2. *Dr. S. Renold Elsen, Vellore Institute of Technology,renoldelsen.s@vit.ac.in* | 2. *Mr.M.Palanivendh, SRMIST* |

| Course Code | 21AUE421T | Course Name | AUTOMOTIVE QUALITY SYSTEMS | Course Category | E | PROFESSIONAL ELECTIVE | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

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

| Course Learning Rationale (CLR): | The purpose of learning this course is to: |
|---|---|
| CLR-1: | impart the knowledge of quality concepts and quality management systems |
| CLR-2: | implement the knowledge of tool and techniques in automotive industries |
| CLR-3: | integrate the idea to work with professional cost accountants to obtain realistic cost estimates |
| CLR-4: | collaborate on international quality systems and modern management systems for quality |

| 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: | relate the quality concepts and quality production | 1 | 2 | 3 | - | - | - | - | - | - | - | - | - | 2 | - | - |
| CO-2: | explain quality Management system and different dimensions of quality | 1 | 2 | - | 3 | - | - | - | - | - | - | - | - | 2 | - | - |
| CO-3: | implement the application of management tools and techniques for process improvement | 1 | 2 | 3 | - | - | - | - | - | - | - | - | - | 2 | - | - |
| CO-4: | assess Automotive TS16949 quality system practices | 3 | 1 | - | 2 | - | - | - | - | - | - | - | - | 2 | - | - |
| CO-5: | validate various system analysis measurement and data collection | 2 | 1 | 3 | - | - | - | - | - | - | - | - | - | 2 | - | - |

| **Unit-1 - Basic Concepts of Quality** | **9 Hour** |
|---|---|
| classification of quality and services-Quality systems overview-Product Quality Design-Quality engineering in design of production processes-Quality Characteristics-Reliability-Safety-Quality engineering in production-Quality engineering in service | |
| **Unit-2 - Quality Management Systems** | **9 Hour** |
| A conceptual Frame Work-Dimensions of Quality-Costs of Quality-Quality System Standards-ISO 9000 clauses-ISO 9000 interpretations-ISO TS16949 clauses -ISO TS16949 interpretation | |
| **Unit-3 - Modern Management Tools and Techniques** | **9 Hour** |
| Introduction to Modern Management Techniques-5s concepts-Kaizen Techniques-Six sigma methodologies-Quality circles-Taguchi loss function-Theory-Taguchi loss function-Applications-POKE –YOKE Techniques | |
| **Unit-4 - ISO Standards of Automotive Quality Systems** | **9 Hour** |
| ISO TS16949 Scope, application and quality management system-Requirements of quality management system-Advanced Product Quality Planning (APQP)-Focus and benefits -Advanced Product Quality Planning (APQP)- Different Phases -Design of Failure Mode Effects Analysis-Types -Design of Failure Mode Effects Analysis-Advantages and Limitations -Process Failure Mode Effects Analysis-Production Part Approval Process (PPAP)-Single and Multiple Regression | |
| **Unit-5 - Quality Tools and Measurement Systems Analysis** | **9 Hour** |
| concepts of SPC detection vs. prevention-Data collection methods-Statistical Tools-Understanding of measurement systems-Variable Gauge R&R- Introduction to Hypothesis Testing-ANOVA-Correlation Analysis | |

| | | |
|---|---|---|
| **Learning Resources** | 1. *Chitale, A.K., and Gupta, R.C., "Product Design and Manufacturing", Prentice Hall of India, New Delhi, 2011.*<br>2. *Adithan,M, "Process planning and cost estimation", New Age International(P) Limited,2011* | 3. *Nanua Singh, "System Approach to computer Integrated Design andmanufacturing", John Wiley & Sons, New York, 1996.*<br>4. *Sinha.B.P., "Mechanical Estimation and Costing", Tata McGraw-Hill,Publishing Co.,1995*<br>5. *Narang, G.B.S. and Kumar. "Production and planning", Khana Publishers, New Delhi, 1995.* |

**Learning Assessment**

| | *Bloom's Level of Thinking* | *Continuous Learning Assessment (CLA)* | | | | *Summative Final Examination (40% weightage)* | |
|---|---|---|---|---|---|---|---|
| | | *Formative CLA-1 Average of unit test (50%)* | | *Life-Long Learning CLA-2 (10%)* | | | |
| | | *Theory* | *Practice* | *Theory* | *Practice* | *Theory* | *Practice* |
| Level 1 | *Remember* | *20%* | - | *20%* | - | *20%* | - |
| Level 2 | *Understand* | *30%* | - | *30%* | - | *30%* | - |
| Level 3 | *Apply* | *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. *Mr. Silambarasan Ramadoss, Renault NissanTechnology & Business Centre India, silambarasan.ramadoss@rntbci.com* | 1. *Dr. A.Siddharthan, Madras Institute ofTechnology, sidharth@mitindia.edu* | 1. *Dr. J.Chandradass, SRMIST* |
| 2. *Mr. Prasad Arun Kumar, Mahindra Research Valley, prasad.arunkumar@mahindra.com* | 2. *Dr. S. Renold Elsen, Vellore Institute of Technology,renoldelsen.s@vit.ac.in* | 2. *Mr. M.Palanivendhan,SRMIST* |

| Course Code | 21AUE422T | Course Name | INDUSTRIAL ENGINEERING AND OPERATIONAL RESEARCH | 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 the concepts of industrial engineering and organization* |
| ***CLR-2:*** | *develop a diverse group of professionals and leaders in industrial engineering* |
| ***CLR-3:*** | *enhance the scientific awareness of the society in the field of operation research* |

| 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 impact of industrial engineering solutions in a global and social context* | *3* | *2* | *-* | *1* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *3* | *-* | *-* |
| ***CO-2:*** | *relate the technology and skills of industrial engineering to model and analyze problems* | *3* | *2* | *-* | *1* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *3* | *2* | *-* |
| ***CO-3:*** | *articulate the Effective utilization of men, equipment and space* | *3* | *2* | *-* | *2* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *2* | *3* | *-* |
| ***CO-4:*** | *ensure optimal use of resources with modern technology to create a place of higher learning in the fields of Operation Research* | *3* | *3* | *-* | *3* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *1* | *3* | *-* |
| ***CO-5:*** | *analyze the PERT/CPM for a constraint-based problem of service/manufacturing* | *3* | *3* | *-* | *3* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *3* | *-* |

| ***Unit-1 - Industrial Engineering and Management Science*** | ***9 Hour*** |
|---|---|
| *Introduction to Industrial Engineering, Concepts - History and Development of Industrial Engineering - Scientific management - Roles of an Industrial Engineer - Applications of Industrial Engineer - Functions of Industrial Engineering department and its organization - Production Management - Production Management Versus Industrial Engineer - Operations Management - Management science - Historical Development - Tools of management science - Simulation model - Managerial economics - Managerial Techniques - Managerial Accounting - Analysis and performance* | |
| ***Unit-2 - Production and Productivity*** | ***9 Hour*** |
| *Production Concept - Production function - Production system - Analysis of Production system - Input output model - Productivity - Productivity modelproblem - Factors affecting productivity – Product design - Increasing productivity of Resources - Work productivity - Model Problem I - Model Problem II - Productivity measures - Development of Productivity Measures - Productivity Measurement system - Components of Productivity Measurement system* | |
| ***Unit-3 - Plant Location and Layout*** | ***9 Hour*** |
| *Factors Governing on plant location - Locational Economics - Rural V/S Urban plant sites - Plant layout - Principles of Plant layout - Process layout - Process layout Merits and demerits - Product layout - Product layout Merits and demerits - Combination layout - Fixed position layout - Flow pattern layout - Flow pattern layout types - Work station - Work station design - Model Problem I - Model Problem II.* | |
| ***Unit-4 - Work Study*** | ***9 Hour*** |
| *Definition concept and need for work study - Method Study - Method Study Procedure - Process chart symbols - Flow process charts - Process charts types - Flow diagram - Steps in flow diagram - Man type flow process chart - String diagram - String diagram construction - Multiple Activity chart - Multiple Activity chart Construction - Operational analysis - Example Operational chart - Analysis of motion - Steps in motion analysis* | |

| ***Unit-5 - Operational Research*** | ***9 Hour*** |
|---|---|
| *Operational Research concept and definition - Methods of Operational Research - Linear Programming - Graphical method - Model problem in Graphical method - Transportation problem - Transportation problem types - Vogels approximate method - Model problem in Vogels approximate method - North west corner method - Model problem I - Cost matrix - Profit matrix -Profit matrix with equal supply and demand - Profit matrix withunequal supply and demand – Degeneracy - Degeneracy Problem* | |

| | | |
|---|---|---|
| **Learning Resources** | 1. *O.P. Khanna,"Industrial Engineering and management",17thEdition,Dhanpat Rai PublishingCoPvt Ltd, 2018.*<br>2. *Martand Telsang,"Industrial Engineerinand Productionmanagement", 2nd edition, S. Chand publisher, 2014.* | 3. *Hamdy A Taha, "Operations Research: An Introduction" 10th Edition, Pearson, 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* | *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. *Mr.N.Vijayakumar, Head Test labs, Mahindra and Mahindra,vijayakumar.n@mahindra.com.* | 1. *Prof. M.Balasubramanian, Professor, IIT Madras, mbala@iitm.ac.in* | 1. *Mr.S.Madhan Kumar, SRMIST* |
| 2. *Mr.S. Senthil Kumar, Deputy Manager, RenaultNissan Technology & amp; Business* | 2. *Dr.P.Jawahar, Assistant Professor, NITAgartala, drjawahar.me@nita.ac.in* | 2. *Dr.J.Chandradass, SRMIST* |

| Course Code | 21AUE231T | Course Name | HEAT VENTILATION AND AIR CONDITIONING | 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: | describe the working of Refrigeration system |
| CLR-2: | interpret the knowledge on Psychrometry process |
| CLR-3: | understand the refrigerant properties |
| CLR-4: | illustrate the Load calculation |
| CLR-5: | understand the function of air distribution 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: | select the various refrigeration system | 3 | - | - | - | - | - | 1 | - | - | - | - | - | 3 | - | - |
| CO-2: | identify the thermal condition of Psychrometry process | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 3 | - | - |
| CO-3: | distinguish the refrigerant properties | 2 | - | - | - | - | - | 1 | - | - | - | - | - | 3 | - | - |
| CO-4: | perform the Load calculation | 3 | - | 1 | - | - | - | - | - | - | - | - | - | 3 | 2 | - |
| CO-5: | analyze and select the air distribution system | 2 | - | 2 | - | - | - | - | - | - | - | - | - | 3 | 2 | - |

**Unit-1 - Fundamentals – Automotive Air Conditioning System** — **9 Hour**

*Introduction to air conditioning system, location of air conditioning system in a car, schematic layout of refrigeration system, terminologies in HVAC: tr, cop, eer, seer, heat exchanger and its types, direct-contact heat exchangers, storage type exchangers, tubular heat exchangers, shell-and-tube exchangers, double-pipe heat exchangers, spiral tube heat exchangers, air conditioning components: compressor, condenser, evaporator expansion valve. Systems operation and safety devices – refrigerant pressure switch, pressure control valve, thermal protection switch, and anti – defrost relays, fusible plug (pressure relief valve), relays and sensors.*

**Unit-2 - Psychrometry** — **9 Hour**

*properties of moist air, Dalton's law of partial pressure, psychrometric properties: dry bulb temperature, wet bulb temperature, specific humidity, dew point temperature, relative humidity, psychrometric processes: sensible cooling, sensible heating, humidifying, dehumidifying, heating and humidifying, coolingand dehumidifying, cooling and humidifying, heating and dehumidifying, comfort charts, factors affecting comfort, effective temperature, ventilation requirements.*

**Unit-3 - Refrigerant** — **9 Hour**

*Working of Refrigerant in refrigeration system, Desirable Properties of Refrigerant, Selection of Refrigerants, Thermodynamic Requirements, Freezing Point, Critical Temperature and Pressure, Flammability, Toxicity, action of refrigerant with water, action of refrigerant with oil, eco – friendly refrigerants, refrigerants used in automobile air conditioning, Global Warming Potential, Ozone Depletion Potential, Classification of Refrigerant Mixtures, Lubricant in Refrigeration system.*

**Unit-4 - Distribution System** — **9 Hour**

*Fan Characteristics, Centrifugal Fans, Axial Fans, Fan Arrangements: Fan in Series, Fan in parallel, Types of Ducts: Air Flow Through Simple Duct System, Duct Fittings, Friction Loss in Duct, Dynamic Loss In Ducts, Indoor Air Distribution, Diffusers, Ventilation, Air noise level.*

| ***Unit-5 - Load Calculation*** | ***9 Hour*** |
|---|---|
| *Internal Heat gains, Occupancy Load, Lighting Load, Appliances Load, Product Load, System Heat Gains, Supply air duct heat gain and Leakage loss, Heat gain from Air Conditioning fan, Safety factor, Cooling Load Estimate, Room Sensible Heat, Room Latent Heat, Grand total load on Airconditioning system, layout of duct systems for automobiles and their impact on load calculations, Tutorials.* | |

| **Learning Resources** | | |
|---|---|---|
| | 1. *C. P. Arora "Refrigeration and Air conditioning" – Fourth edition McGraw Hill Education (India) Private Limited, New Delhi, 2020.*<br>2. *Joseph Wagner, Kirk VanGelder - "Automotive Heating, Ventilation and Air Conditioning" – Jones & Bartlett Learning, 2018.*<br>3. *Schnubel, Mark "Automotive Heating and Air Conditioning" 6thedition, Cengage Learning, 2016* | 4. *Bill Whitman, Bill Johnson, John Tomczyk, Eugene Silberstein "Refrigeration & Air Conditioning Technology" – Cengage Learning –2012.*<br>5. *Birch, Tom; Duvic, Martin "Automotive heating and Air conditioning" –Prentice Hall, 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* | *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. S. Ashok kumar, ETA, ashoks@eta-engg.com* | 1. *Prof. Shaligram Tiwari, IIT Madras, shaligt@iitm.ac.in* | 1. *Mr. S. Logeshwaran, SRMIST* |
| 2. *Mr. D Rajasekaran, Freeze India Manufacturing Pvt Limited, rajakd@fim.com* | 2. *Dr. P. Balachander, CEG campus, Anna University, p_balachander@annauniv.edu* | 2. *Dr. C. Prabhu, SRMIST* |

| Course Code | 21AUE232T | Course Name | ENGINE TESTING AND VALIDATION | 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:*** | *employ various instruments for measuring engine parameters* |
| ***CLR-2:*** | *create insight on the fundamental considerations for engine test facility* |
| ***CLR-3:*** | *analyze the various engine operating parameters* |
| ***CLR-4:*** | *analyze the data acquired from the engine* |
| ***CLR-5:*** | *validate the data acquired from the engine* |

| 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 knowledge of basic principle of measuring instruments* | *3* | *1* | *2* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *3* | *-* | *-* |
| ***CO-2:*** | *measure the various engine operating parameters of I.C engine* | *2* | *-* | *-* | *3* | *-* | *-* | *-* | *-* | *1* | *-* | *-* | *-* | *3* | *2* | *-* |
| ***CO-3:*** | *develop an engine test rig with necessary instrumentation* | *3* | *-* | *2* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *1* | *-* | *3* | *2* | *-* |
| ***CO-4:*** | *evaluate the performance parameters in IC engines* | *2* | *-* | *3* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *1* | *-* | *3* | *2* | *-* |
| ***CO-5:*** | *analyze and validate various engine test results* | *3* | *-* | *-* | *3* | *-* | *-* | *-* | *-* | *-* | *-* | *1* | *-* | *3* | *2* | *-* |

| ***Unit-1 - Instrumentation and Data Acquisition*** | ***9 Hour*** |
|---|---|
| *Classification of data acquisition devices- High speed Data Acquisition, Sensors :- Pressure measurement-The Hall-effect sensor-Shielded-field sensor- Crankshaft position sensor- Types- Throttle position sensor-Temperature sensors - flow sensor- Sensors for Feedback control- Exhaust gas oxygen sensor-EGO characteristics-Switching characteristics- Knock sensor- Pressure sensor -Noise and vibration sensors-measuring spark plugs - control systems (EDACS)- Post processing of data- Tutorial session (Strain Gauges)* | |
| ***Unit-2 - Engine Parameters*** | ***9 Hour*** |
| *Indicated power measurement - Frictional power measurement-Tutorial session- Brake power measurements-Torque and speed measurements- –Engine dynamometers- Factors considered for dynamometer selection - Electrical Dynamometer-Eddy Current Dynamometer - Measurement of speed- Fuel consumption measurement- Air consumption measurement- Smoke and particulate measurement- Measurement of exhaust emissions – HC, CO, NOx and CO2 – hot, cold cycle and thermal shock tests* | |
| ***Unit-3 - Test Facility Layout Considerations*** | ***9 Hour*** |
| *Basics of test cell and control room design - Conditioning systems - intake Air , Fuel Conditioning , Oil Conditioning , Coolant Conditioning - Test cell noise control- Cooling circuit requirements- Installation- Exhaust gas system- Installation- Exhaust Back Pressure-Electrical system considerations- Layout-Fuel storage requirements-Fuel supply requirements- Fuel treatment systems-Temperature compensation - Engine and Dynamometer Cooling - Input parameters for engine testing-Maintenance of engine test facility-Troubleshooting of engine instruments – health and safety management* | |
| ***Unit-4 - Specific System Testing*** | ***9 Hour*** |
| *On-line piston temperature measurements - Turbocharger testing - Combustion failure detection (engine knock) - Oil consumption measurement (cylinder selective and transient) - Attributes of the existing test facility and engine compatibility and requirements for hydrogen engines - Comparison with e drive test systems and traction motor testing* | |

| ***Unit-5 - Validation of Data and Test Results*** | ***9 Hour*** |
|---|---|
| *Introduction-General principles for data validation in engine testing- Error types-Error Sources-Combination of errors- Experiment repeatability- Instrument Sensitivity-Experimental precision- Absolute and relative accuracy-Traceability- Uncertainty- calibration –definition, importance-Calibration – definition- importance- Calibration techniques for pressure- Calibration techniques for temperature-Gaussian distribution as a statistical tool- Erroranalysis-Tutorial session* | |

| | | |
|---|---|---|
| **Learning Resources** | 1. *A.J.Martyr, M.A. Plint, Engine Testing and Theory and Practice,3rd edition,-SAE International, 2007*<br>2. *Dietrich,C.F. "Uncertainty, Calibration and Probability", The Statisticsof Scientific and Industrial Measurement, 1st edition, 2017* | 3. *Jyotindra S. Killedar, Dynamometer: Theory and application to engine testing,Xlibris Corporation LLC, 2012*<br>4. *A.J.Martyr, M.A. Plint, Engine testing: The design, building, modification anduse of powertrain test facilities, 4th edition,- Elsevier, 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* | *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.Kaushik Aithal, Senior Engineer, Tata Elxsi,koushikaithal97@ gmail.com* | 1. *Dr. V. Edwin Geo, Professor, Mechanical Engineering,İstinye Universitesi Turkey, edwin.varuvel@istinye.edu.t* | 1. *Dr. C.Prabhu, SRMIST* |
| 2. *Mr.R. Govindarajan, Royal Enfield* | 2. *Dr. M. Arul Prakash Jothi, Vel Tech.* | 2. *Mr. Jerome stanley, SRMIST* |

| Course Code | 21AUE331T | Course Name | FUEL TESTING AND STANDARDS | 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 the sources, composition and properties of automotive fuels |
| CLR-2: | gain knowledge on reference and commercial fuels and road map to quality improvement |
| CLR-3: | acquire knowledge on the significance of different fuel properties with respect to engine application |
| CLR-4: | make the students familiarize with BIS testing standards for gasoline and diesel |
| CLR-5: | conceive idea on the testing methods for LPG, CNG and biodiesels |

| 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 sources, composition and properties of automotive fuels and significance of testing fuels | 3 | 2 | 1 | 3 | 1 | - | 3 | 3 | 2 | - | - | - | 3 | - | - |
| CO-2: | acquire knowledge on the specification of reference fuels for testing vehicles, road map and bottle necks in quality improvement | 3 | 2 | 1 | 3 | 1 | - | 3 | 3 | 2 | - | - | - | 3 | - | - |
| CO-3: | identify the significant fuel properties and its implication in engine application | 3 | 2 | 1 | 3 | 1 | - | 3 | 3 | 2 | - | - | - | 3 | - | - |
| CO-4: | gain knowledge on commercial gasoline and diesel fuel testing procedures as specified in BIS | 3 | 2 | 1 | 3 | 1 | - | 3 | 3 | 2 | - | - | - | 3 | - | - |
| CO-5: | gain knowledge on CNG, LPG and biodiesel testing | 3 | 2 | 1 | 3 | 1 | - | 3 | 3 | 2 | - | - | - | 3 | - | - |

| | |
|---|---|
| **Unit-1 - Automotive Fuels** | **9 Hour** |
| Petroleum - sources and composition- Gasoline, Diesel, CNG, LPG, Alcohols, Biodiesels - Reformulated fuels -Types and Use, Additives-Types and Use, Hydrogen as IC engine fuel- Comparison of LPG, CNG, Hydrogen- Importance of fuel testing- Need for fuel testing Standards- An overview of the different standards available for fuel testing-EN, ASTM, ISO, JIS BIS | |
| **Unit-2 - Reference and Commercial Fuels** | **9 Hour** |
| Technical specification of fuels – significance- Technical Specification of Reference fuel for testing vehicles – Gasoline – Diesel–CNG- LPG – Hydrogen - Biodiesel – Alcohol - Blended fuels- Comparison of the specification of Commercial Gasoline and commercial diesel for different Bharat stage norms – Fuel quality improvement accomplished in India- Fuel quality compliance issues- Fuel testing- Presumptive liability- Fuel registration and tracking - A comparison in India, USA and Japan- Inhibiting factors in fuel quality improvement in India | |
| **Unit-3 - Fuel Properties** | **9 Hour** |
| Properties of different fuels-Volatility- Oxidation stability- Octane rating- Cetane rating- Calorific Value- Density- Viscosity- Carbon Residue Etc.- Characteristic requirements of different fuels in IC engines- Availability - Fuel economy- Performance- Gasoline quality effects on vehicle emissions- Diesel quality effects on vehicle emissions- Ultra low sulphur fuels- Lubricity characteristics- Flame characteristics- burning velocity, flame temperature and flammability limit | |
| **Unit-4 - Commercial Gasoline and Diesel Fuel Testing Methods as Specified in BIS** | **9 Hour** |
| Method to determine Distillation temperatures- Research Octane Number (RON), Motor Octane Number (MON)- Calorific value, Oxidation Stability- Sulphur content- Reid Vapour Pressure- Benzene, Aromatic- Olefin and oxygen content- Method to determine Ash content- Carbon residue- Cetane number and Index- Flash point, Kinematic viscosity- Density, calorific value- Test for sulphur and water content, sulphated ash- Cold filter plug point , Cloud point- Copper strip corrosion - Polycyclic Aromatic Hydrocarbon | |

| ***Unit-5 - CNG, LPG, Hydrogen and Biodiesels Testing*** | ***9 Hour*** |
|---|---|
| *Method to determine methane and Ethane content- C3 and C4 content- Motor Octane number- Hydrogen sulphide content (LPG)- Odour, Copper strip corrosion- Wobbe Index(CNG)- Oxidation Stability- Low temperature flow properties- Kinematic viscosity- Cetane number - Ester content, Mono, Di and Tri- glycerides- Density, Iodine Number- Structure indices- Liquid chromatography technique- Gas chromatography- Mass Spectrometry analysis- Photo spectrometry analysis* | |

| **Learning Resources** | | |
|---|---|---|
| | 1. *Automotive Fuels Reference Book, Third Edition R-297, PaulRichards- Society of Automotive Engineers Inc.,2014*<br>2. *ALTERNATIVE FUELS Concepts, Technologies and Developments S.S. Thipse, Jaico Publishing House, 2010*<br>3. *Biodiesel Production and Properties by AmitSarin, RSC Publishing ,2012* | 4. *Motor Vehicles Act ,2019, India ARAI Tap Document –Document on Test Method, Testing Equipments and Related Procedures for Testing Type approval and Conformity of Production (COP),Ministry of Road Transport and High ways*<br>5. *Practical Handbook on Fuel Properties and Testing by SajidZaman, Lambert Academic Publishing, 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* | *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.Gunabalan,Manager, R&D Turbo Energy,Chennai,* | 1. *Dr..M. Parthasarathy, Associate Professor, Department of Automobile Engineering, Vel Tech Rangarajan* | 1. *Dr. C. Prabhu, SRMIST* |
| 2. *Mr.Shantha Kumar, Lead Engineer, Royal Enfield* | 2. *Dr. Elumalai P.V, Associate Professor, Aditya Engineering College, Surampalem, Andhrapradesh. Email: elumalai@aec.edu.in* | 2. *Mr. D. Boopathi, SRMIST* |

| Course Code | 21AUE332T | Course Name | AUTOMOTIVE EXHAUST SYSTEM DEVELOPMENT | 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 and understanding about automotive exhaust systems* |
| ***CLR-2:*** | *understand various emission norms and control methods* |
| ***CLR-3:*** | *gain knowledge about noise pollutions and control methods* |
| ***CLR-4:*** | *enlighten the knowledge in Computational analysis* |
| ***CLR-5:*** | *understand various fuel testing and validation techniques* |

| 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 History and evolution of Automobile Exhaust System* | *3* | *2* | *1* | *2* | - | - | *3* | - | - | - | - | - | *3* | - | - |
| ***CO-2:*** | *gain familiarity on the emission norms and emission reduction techniques* | *3* | *3* | *1* | *2* | - | - | *2* | - | - | - | - | - | *3* | - | - |
| ***CO-3:*** | *get familiarized with the basics of acoustics, muffler types and characteristic design of mufflers* | *3* | *3* | *1* | *2* | - | - | *2* | - | - | - | - | - | *3* | - | - |
| ***CO-4:*** | *understand the procedures and fundamentals involved in computational fluid dynamic, thermal and structural analysis of vehicle exhaust system* | *3* | *3* | *1* | *2* | - | - | *3* | - | - | - | - | - | *3* | - | - |
| ***CO-5:*** | *understand the fundamentals involved in testing and validation of automotive exhaust system* | *3* | *3* | *1* | *2* | - | - | *2* | - | - | - | - | - | *3* | - | - |

***Unit-1 - Introduction to Engine Exhaust*** ***9 Hour***

*Engine Exhaust Technology Evolution – India automotive emission regulation – Noise limits for vehicles at manufacturing stage – Basics of Exhaust System from Engine head face to tail pipe – Components of exhaust system – Exhaust catalytic converter – Silencer (Muffler) – System integration.*

***Unit-2 - Emission Control Systems Overview*** ***9 Hour***

*Understanding of Gasoline and diesel engine out pollutants – Emission Norms – Air to Air – Converter Hot end components – TWC – Manifold – Cone Profiles Substrate: Types of Substrate – Wash coat – Mat – Types of Mats – Shell – Canning – Types of Canning– GBD (Gap Bulk Density) – Temperature Sensor – Oxygen Sensor – Thermal Management – Insulators – Heat Shields – (Gasoline / Diesel) – Advancement in substrates – Technology for gasoline engine – Three way converter (TWC) – Gasoline particulate filter (GPF) – Lean NOx Trap (LNT) – Technology for diesel engine – Exhaust gas recirculation (EGR) – Diesel oxidation catalyst (DOC) – Partial flow filter (PFF) – Diesel particulate filter (DPF) – Selective catalytic reduction (SCR) – Selective catalytic reduction filter (SCRF) Global regulations and testing protocols – System integration. GENERAL DESIGN CONSIDERATIONS: Size and volume of the emission control devices – Air-Fuel ratio and cylinder volume of the engine – effect of temperature – Space velocity – L/D ratio for pressure drop study – Location and mounting methods – effect of exhaust flow pattern*

***Unit-3 - Noise Control Systems*** ***9 Hour***

*Basics of Acoustics – Fundamentals of sound – Terminologies– Destructive & Constructive interferences – Engine exhaust noise introduction – Gasoline & Diesel engine operation & exhaust noise characteristics – Vehicle Pass by Noise – Exhaust noise measurement standards – Types of exhaust noises – Passive noise reduction techniques – Types of mufflers – Muffler design constrains – Muffler internal design – Helmholtz resonator – Internal resonators – Baffle plates – Perforations –shells – End Plates – Pipe diameters – Absorptive materials – Development methodologies – Muffler performance parameters – Sound transmission loss – Insertion loss – Noise reduction – Tail pipe noise level – back pressure– Advanced muffler technologies – Cat con integrated muffler – Active noise cancellation – Sporty sound mufflers – Sound engineering, Off Road – On Road – Non Road muffler applications Examples – Manufacturing Processes – Roll & Spot welding – Lockseaming – Double seaming – Web forming – Clinching – Cold metal transfer – Hydro forming – Piercing – Stamping – Muffler examples.*

| **Unit-4 - Computational Analysis (CFD and FEA)** | **9 Hour** |
|---|---|
| *CFD for vehicle exhaust system – Governing equation of fluid flow and heat transfer – Flow Uniformity – Pressure loss through exhaust system – Flow Eccentricity – HEGO Index – Conjugate Heat Transfer Analysis – Introduction to finite element analysis. Present, Past, Future FEA – Introduction to Pre-processing ID, 2D,3D Elements – Meshing, Processing Techniques – Statics of strength of materials – Types of Analysis – Modal Analysis – Linear Static Analysis – Introduction to Non-linear Analysis – Dynamic Analysis – Thermal Analysis – RLDA & Fatigue Analysis – Post processing techniques of different Analysis – Process Flows and Targets – Case Study 1-2-3* | |
| **Unit-5 - Testing and Validation** | **9 Hour** |
| *Vehicle noise measurement – Operational vibration analysis – Experimental modal analysis – Air leak test Thermal Shock Tests – Thermal fatigue test –Back pressure measurement test – Hot end system: Hot Vibration Test – Cold vibration test – Flow noise measurement – Shell deformation test – Cold end: Biaxial fatigue test – Uni-axial fatigue test – Salt spray test – Condensate Water Noise Test – Transmission loss measurement – Shell stiffness measurement – Glass wool endurance test – Resonance frequency measurement – Shell radiation noise measurement – Tail pipe noise measurement – Water drainage ability test. Self-Study: Latest instruments used for measurement of exhaust noise / pollutants and various parameter and its reduction techniques as per EURO VI and BS VI norms* | |

| | | |
|---|---|---|
| **Learning Resources** | 1. *Philip ii smith and John Morrison "The scientific design of exhaust and intake systems engineering and performance"., 3rdedition, publisher: Bentley (Robert) inc., USA*<br>2. *Istvan I. Ver and leol.Beranek "Noise and vibration controlengineering ( principles and applications)"., 2 ndedition 2006, publisher : john wiley& sons inc.* | 3. *M.L. Munjal "Acoustics of ducts and mufflers"., 2nd edition, publisher:wiley, 2014*<br>4. *Engine Emissions: Pollutant Formation and Advances in Control Technology,Alpha science publisher, 2015* |

**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.KrishnamoorthyNallappan, Renault NissanTechnology and Business Centre, krishnamoorthy.nallappan@rntbci.com.* | 1. *Dr.V GANESH, Sri Venkateswara College ofEngineering , vinaganesh@svce.ac.in* | 1. *Dr. C. Prabhu, SRMIST* |
| 2. *Mr. Ram Prasanth A, Caterpillar India Pvt Ltd, anjaneyulu_ram_p@cat.com* | 2. *Dr.Parthasarathy M,Vel Tech RangarajanDr.SagunthalaR&D Institute of Science and Technology, nparthasararhy@veltech.edu.in.* | 2. *Mr. D. Boopathi, SRMIST* |

| Course Code | 21AUE333T | Course Name | ENGINE AUXILIARY SYSTEMS | Course Category | E | PROFESSIONAL ELECTIVE | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

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

| Course Learning Rationale (CLR): | *The purpose of learning this course is to:* |
|---|---|
| ***CLR-1:*** | *impart knowledge about Super charging & Turbocharging their mapping procedure and thermodynamic issues related to their operation* |
| ***CLR-2:*** | *provide a fundamental knowledge on Engine Thermal Management* |

| 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 | PSO-1 | PSO-2 | PSO-3 |
| | | 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 | | | |
| ***CO-1:*** | *acquire knowledge about Supercharging and compressor mapping* | *3* | - | - | *3* | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-2:*** | *gain knowledge about Flow maps of supercharging systems* | *3* | - | - | *3* | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-3:*** | *analyze Thermodynamic issues with Turbocharging* | *3* | *3* | - | - | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-4:*** | *understand the Modern design features of exhaust turbocharger features* | *3* | - | - | *3* | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-5:*** | *acquire knowledge about Engine thermal management* | *3* | - | *3* | - | - | - | - | - | - | - | - | - | *3* | - | - |

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

*Introduction to super charging Definitions, survey of supercharging methods Petrol engines Diesel engines Exhaust turbo charging. Fundamentals of compressor mapping compressor power Air consumption Types of compressors Compressor characteristics Relationship between air consumption and power Numerical problems-calculate air consumption and power Volumetric efficiency of supercharged four stroke engines Numerical problems-calculate volumetric efficiency Computations of gas exchange process*

***Unit-2 - Super Charging and Turbo Charging*** — ***9 Hour***

*Introduction to flow maps of supercharging systems Two stroke engines Four stroke engines Interaction between turbocharger and engine. Mechanical supercharging, Exhaust turbo charging -operational differences. Equivalent nozzle area of turbine Pulse turbocharging, Diagram for determination of operating condition of a single stage turbocharger system. Examples of computed results Tutorials on supercharging systems*

***Unit-3 - Performance Characteristics*** — ***9 Hour***

*Introduction to thermodynamic issues with turbocharging Cylinder release temperature Mean exhaust temperature Theoretical aspects of complete extraction of work Expanding from release pressure to ambient pressure Complete conversion into kinetic energy at ambient pressure Compressor power in terms of mean piston pressure Numerical -compressor power in terms of mean piston pressure Difference in fuel consumption between mechanical and exhaust superchargers Effect of cooling the charge air. Exhaust turbocharger as a means to increase efficiency Numerical Problem-Exhaust turbocharger as a means to increase efficiency.*

***Unit-4 - Feature Characteristics*** — ***9 Hour***

*Introduction to particular features of exhaust turbocharging Exhaust manifold arrangements for various firing sequences of engines Constant pressure vs pulse turbocharging Modified forms of pulse turbocharging Transient response Torque characteristics of engines with exhaust turbochargers Measures to improve acceleration Measures to improve torque characteristics of exhaust turbocharged engines. Altitude de-rating Effect of supercharging on exhaust emissions of SI engines Effect of supercharging on exhaust emissions of CI engines*

| ***Unit-5 - Heat Management*** | ***9 Hour*** |
|---|---|
| *Charge boosting, exhaust pre-release, turbo-cooling miller, two stage, complex, hyper-bar, rotor designs Types of impellers, bearing arrangements types and lubrication on bearings Examples of supercharged engines of road vehicles (cases), introduction to engine cooling systems, engine coolants Heat exchangers, in- vehicle installation, performance curves Pressurized engine cooling systems: filling, de- aeration & drawdown accessories. On-highway cooling system test code, engine cooling systems field test (air-to-boil) Heat exchanger thermal & pressure cycle durability. Cooling fans Fan laws, fan characteristics, and system resistance curve Cooling flow measurement techniques Cooling system inspection, trouble diagnosis & service. Radiator field failures. Introduction to EGR (exhaust gas recirculation) coolers significance in reduction of vehicle emissions* | |

| | | |
|---|---|---|
| **Learning Resources** | 1. *Zinner, K, "Auxillary Engine Systems by Supercharging of Internal CombustionEngines"., Springer, 1978.*<br>2. *Watson and M.S. Janota, "Turbocharging the Internal CombustionEngines", Macmillan Press, London 1982*<br>3. *BOSCH, "Automotive Handbook", 8 th Edition, Bentley RobertIncorporated, 2011*<br>4. *Lilly, L.C.R, "Diesel Engine Reference Book", Butterworths, London,1984* | 5. *Benson, R.S, Whitehouse N.D, "Internal Combustion Engines", Vol 1 and 2,Pergamon Press Ltd. Oxford UK.1980*<br>6. *Tom Birch, "Automotive Heating & Air Conditioning", 6th edition, PrenticeHall PTR, 2011*<br>7. *Hermann Hiereth, Peter Prenninger, "Charging the Internal CombustionEngine", Springer, 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* | *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. Jayaraman R. BLG* | 1. *Dr. M. Parthasarathty, Vel Tech* | 1. *Dr. T. Prakash, SRMIST* |
| 2. *Mr. Shanmugasundarm, RNTBCI* | 2. *Dr. P. NandhaKumar, Amirtha School Engineering,* | 2. *Dr. C. Prabhu, SRMIST* |

| Course Code | 21AUE334T | Course Name | DESIGN OF AUTOMOTIVE THERMAL SYSTEM | Course Category | E | PROFESSIONAL ELECTIVE | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

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

| Course Learning Rationale (CLR): | The purpose of learning this course is to: |
|---|---|
| CLR-1: | understand various heat transfer concepts and formulation of thermal design |
| CLR-2: | solve heat balance equation and energy, exergy analysis |
| CLR-3: | understand the concepts of automotive climate control |
| CLR-4: | familiarize with the applications of heat exchangers |
| CLR-5: | understand the concepts to thermal management in power electronics and controllers |

| 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 the knowledge of heat transfer concepts for design formulation | - | - | 3 | - | - | - | - | - | - | - | - | - | 3 | - | - |
| CO-2: | analyze the energy quantity and quantity | - | - | - | 3 | - | - | - | - | - | - | - | - | - | 3 | - |
| CO-3: | identify different compressor systems and its applications and able to calculate its efficiencies | 1 | - | - | - | - | - | - | - | - | - | - | - | 3 | - | - |
| CO-4: | list the basic components and analyze the working of heat exchangers | 1 | - | - | - | - | - | - | - | - | - | - | - | 3 | - | - |
| CO-5: | apply the thermal management methods in power electronics and controllers | - | - | - | - | 2 | - | - | - | - | - | - | - | 3 | - | - |

**Unit-1 - Fundamentals and Systematic Approach to Heat Transfer Concepts** — **9 Hour**

*Energy, Heat & Work, First Law of Thermodynamics, Heat Engines, Refrigerators, and Heat Pumps, Second Law of Thermodynamics, Carnot Cycle, Conduction, Convection-Parallel flow on a Isothermal Plate, A cylinder in cross flow, Flow in Ducts, Free Convection, Radiation. Formulation of Thermal System Design- Requirement and Specifications, Design Variables, Constraints. Designing a workable system, Optimization methods -overview and significance*

**Unit-2 - Automotive Engine Thermal Management** — **9 Hour**

*Fundamentals of First & Second Law of Thermodynamics to the engine performance (Volumetric efficiency and Thermal Efficiency), heat balance equation, Fundamentals of Exergy, Energy analysis, Thermal Models and Operating Strategy- smart valve, variable speed pump, variable speed fan. Applications of Thermoelectric generators and Thermoelectric coolers, Applications of heat pipes and heat sink.*

**Unit-3 - Fundamentals of Automotive Climate Control** — **9 Hour**

*Psychrometric properties, Use of psychrometric chart, coefficient of performance, Refrigerants – Types of refrigerants, Properties and Selection of refrigerants,Factors affecting the air flow, Types of fans, Axial and Centrifugal fans, Load calculations, Winter air-conditioning, Two-phase flow effects in the Evaporator and Condenser, air side heat transfer on the Evaporator and Condenser, System mass effects, Simplified cabin thermal model. Convective thermal interaction-cabin air and atmosphere.*

**Unit-4 - Fundamentals- Heat Exchangers** — **9 Hour**

*Functions of radiator, compressor, Functions of condenser, evaporator, expansion valve, Classification of heat exchangers – According to transfer process, Number of fluids, surface compactness, Construction features, flow arrangements, heat transfer mechanisms, Selection and design of heat exchangers based on – Types, heat transfer rate, cost, pumping power, size and materials. Coolant- function, types, and required properties. Advanced cooling system with smart valve, variable speed pump, variable speed fan, engine block, radiator, and sensors (temperature, mass flow rate and power).*

**Unit-5 - Thermal management in EV systems** — **9 Hour**

*Temperature sensitivity and heat generation of batteries- electrothermal, Internal heat generation, Rate of Discharge, Battery ageing, Thermal runaway, battery heat transfer medium. Role of thermal management in power electronics and controllers, heat sink design and configuration, Application of microfluidics and nano fluids.*

| | | |
|---|---|---|
| **Learning Resources** | 1. *Yunus A Cengel, Afshin J Ghajar, "Heat and Mass Transfer".,Tat McGraw Hill Education Private Limited, New Delhi,2018*<br>2. *HoSung Lee "Thermal Design: Heat Sinks, Thermoelectrics, Heat Pipes, Compact Heat Exchangers, and Solar Cells" 2011 JohnWiley & Sons, Inc*<br>3. *Jaluria, Yogesh.Design and optimization of thermal systems 2ndEdition CRC Press, Taylor & Francis Group 2018.* | 4. *W. F. Stoecker Design of Thermal Systems Third Edition,McGraw – Hill, New york, 1989*<br>5. *Quansheng Zhang "Automotive Air Conditioning Optimization, Controland Diagnosis" Springer International Publishing AG 2016*<br>6. *James Larminie, John Lowry, Electric Vehicle Technology Explained,Wiley, 2012.*<br>7. *Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRCPress, 2003*<br>8. *"Bosch' Automotive Handbook", 8thEdition* |

**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. *Dr. R. Krishnamurthy, Group Director,DesignGroup, DRDL- DRDO, Hyderabad, rkmurthy@drdl.drdo.in* | 1. *Dr. K. M. Parammasivam., Ph.D., Post-doc(Japan), Professor, Department of Aerospace Engineering Madras Institute OfTechnology Campus, Anna University, Chennai, Indiamparams@mitindia.edu* | 1. *Mr. Jerome Stanley, SRMIST* |
| 2. *Dr. A Sakthivel, Scientist 'G', Regional Director RCMA (Helicopters), CEMILAC, DRDO, Bengaluru* | 2. *Dr.S. Nadaraja pillai, Professor, Department of Mechanical Engineering,Sastra university Thanjavur, nadarajapillai@mech.sastra.edu* | 2. *Dr. C Prabhu, SRMIST* |

| Course Code | 21AUE335T | Course Name | SIMULATION OF INTERNAL COMBUSTION ENGINES | 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:*** | *gain Knowledge about various engine design parameters* |
| ***CLR-2:*** | *understand engine numerical modeling* |
| ***CLR-3:*** | *enlighten the knowledge about simulation of various performance parameters for different type engine* |

| Course Outcomes (CO): | *At the end of this course, learners will be able to:* | Program Outcomes (PO) | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 Engineering Knowledge | 2 Problem Analysis | 3 Design/development of solutions | 4 Conduct investigations of complex problems | 5 Modern Tool Usage | 6 The engineer and society | 7 Environment & Sustainability | 8 Ethics | 9 Individual & Team Work | 10 Communication | 11 Project Mgt. & Finance | 12 Life Long Learning | PSO-1 | PSO-2 | PSO-3 |
| ***CO-1:*** | *understand the Various Combustion Parameters* | *3* | *2* | *-* | *2* | *3* | *-* | *1* | *-* | *-* | *-* | *-* | *-* | *3* | *-* | *-* |
| ***CO-2:*** | *analyze the various idle cycles* | *3* | *2* | *-* | *3* | *3* | *-* | *1* | *-* | *-* | *-* | *-* | *-* | *-* | *3* | *-* |
| ***CO-3:*** | *understand Various Combustion Simulations* | *3* | *2* | *-* | *3* | *3* | *-* | *1* | *-* | *-* | *-* | *-* | *-* | *-* | *3* | *-* |
| ***CO-4:*** | *gain knowledge about two Stroke engine simulations* | *3* | *2* | *-* | *3* | *3* | *-* | *1* | *-* | *-* | *-* | *-* | *-* | *-* | *3* | *-* |
| ***CO-5:*** | *understand Diesel engine numerical modeling* | *3* | *2* | *-* | *3* | *3* | *-* | *1* | *-* | *-* | *-* | *-* | *-* | *-* | *3* | *-* |

| ***Unit-1 - Introduction to Combustion*** | ***9 Hour*** |
|---|---|
| *Introduction to combustion- Heat of reaction- Measurement of URP- Measurement of HRP- Adiabatic flame temperature- Complete combustion in C/H/O/NSystems- Constant volume adiabatic combustion- Constant pressure adiabatic combustion- Calculation of adiabatic flame temperature- Isentropic changes of state* | |
| ***Unit-2 - SI Engine Simulation with Air as Working Medium*** | ***9 Hour*** |
| *Ideal Cycles in SI Engine- Actual working cycle in SI Engine- Deviation Between Actual and Ideal Cycle – Problems- SI Engine Simulation withAdiabatic Combustion- SI Engine Temperature Drop Due to Fuel Vaporization- Full Throttle Operation - Efficiency Calculation- SI Engine Part-Throttle Operation- SI Engine Part-Throttle Efficiency Calculation- Super Charged Operation* | |
| ***Unit-3 - Progressive Combustion*** | ***9 Hour*** |
| *SI Engines Simulation with Progressive Combustion- SI Engines Simulation with Gas Exchange- Heat Transfer Process- Friction Calculation- Compression of Simulated Values- Validation Of The Computer Code- Engine Performance Simulation- Pressure Crank Angle Diagram- Other Engine Performance* | |
| ***Unit-4 - Gasoline Engine Simulation*** | ***9 Hour*** |
| *Thermodynamics of the gas exchange process- Flows in engine manifolds- One dimensional models- multi-dimensional models- Flow around valves and through ports- Models for scavenging in two stroke engines- Isothermal models- non-Isothermal models- Heat transfer and friction* | |
| ***Unit-5 - Diesel Engine Simulation*** | ***9 Hour*** |
| *Combustion in CI engines Single zone models- Premixed-Diffusive models- Wiebe' model- Whitehouse way model- Two zone models- Multizone models- Meguerdichian and Watson's model- Hiroyasu's model- Lyn's model- Flow chart preparation-* | |

| | | |
|---|---|---|
| **Learning Resources** | 1. *Jerald A. Caton. "An Introduction to Thermodynamic CycleSimulations for Internal Combustion Engines"., John Wiley &Sons, 2015*<br>2. *Lino Guzzella , Christopher H. Onder .," Introduction to Modeling and Control of Internal Combustion Engine Systems".,Springer, 2010*<br>3. *Ganesan.V, "Computer Simulation of Compression IgnitionEngines"., Orient Longman, 2000* | 4. *Ganesan. V. "Computer Simulation of spark ignition engine process".,Universities Press (I) Ltd, Hyderabad, 1996.*<br>5. *Ramoss. A. L, "Modelling of Internal Combustion Engines Processes".,McGraw Hill Publishing Co., 1992*<br>6. *Gordon P.Blair, The Basic Design of two-stroke engines, SAE Publicatin, 1990* |

**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. *Mr.KrishnamoorthyNallappan, Renault NissanTechnology and Business Centre, krishnamoorthy.nallappan @rntbci.com* | 1. *Dr.J.Venkatesan, S Sri VenkateswaraCollege of Engineering, jvenkat@svce.ac.in* | 1. *Dr. C. Prabhu, SRMIST* |
| 2. *Mr.P.MohamedAzarudeen,Renault Nissan Technologyand Business Centre, mohamedazarudeen.pakkirmohideen@rntbci.com* | 2. *Dr.S.RamKumar, Vel Tech RangarajanDr.Sagunthala R&D Institute ofScience and Technology ,* | 2. *Mr. D. Boopathi, SRMIST* |

| Course Code | 21AUE431T | Course Name | AUTOMOTIVE EMISSION FORMATION AND CONTROLS | 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 SI engine emission formation |
| CLR-2: | provide an insight CI engine emission formation |
| CLR-3: | familiarize with the basics of noise pollution |
| CLR-4: | create insight on emission measuring instruments |
| CLR-5: | learn about noise and vibration measurement |

| 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: | comprehend the various emissions from SI engine and its control techniques | 2 | - | - | 3 | - | - | 1 | - | - | - | - | - | 3 | 3 | - |
| CO-2: | understand the various emission reduction techniques for CI engine | 2 | - | - | 3 | - | - | 1 | - | - | - | - | - | 3 | 2 | - |
| CO-3: | understand and evaluate the noise pollution formation | 2 | - | - | 3 | - | - | 1 | - | - | - | - | - | 3 | - | - |
| CO-4: | apply the knowledge on measuring emissions through instruments | 1 | - | 2 | - | - | - | 3 | - | - | - | - | - | 3 | 2 | - |
| CO-5: | understand and compare the significance of driving cycles and the influencing factors | 1 | - | - | 2 | - | - | 3 | - | - | - | - | - | 3 | 1 | - |

**Unit-1 - Emission Formation in SI Engines** — **9 Hour**

*Emission formation in SI engines (CO, HC, CO2, NOx). Effect of design variables on emission formation in SI engines- Effect of operating variables on emission formation in SI engines- Control techniques - Thermal reactor - Control techniques - exhaust gas recirculation- Three-way catalytic convertor- Charcoal canister control for evaporative emission- Positive crank case ventilation for blow by gas control.*

**Unit-2 - Emission Formation in CI Engines** — **9 Hour**

*Emission formation in CI engines (NOx, particulates, aldehydes, HC, CO, CO2)- Effect of design variables on emission formation in CI engines- Effect of operating variables on emission formation in CI engines- Control techniques, exhaust gas recirculation- selective catalytic reduction (SCR) ,– Ammonia slip - coated SCR – Lean NOx trap (LNT) – Role of zeolite in NOx reduction - Diesel oxidation catalyst- catalytic convertor- Diesel particulate filter (DPF) - Catalyzed particulate filter (CPF) - NOx versus particulates –trade off.*

**Unit-3 - Sources of Noise** — **9 Hour**

*Basics of acoustics: Introduction to sound – Intermittent- continuous-low frequency - impulsive- terminologies–Noise cancellation– destructive & constructiveinterferences- Engine noise : introduction–gasoline & diesel engine operation- Exhaust noise characteristics –vehicle pass by noise – exhaust noise measurementstandards- Types of exhaust noises: pulsation noises–flow noises–booming noises- Shell radiation noises–passive noise reduction techniques- vehicle interior noise levels- vehicle structural Noise, aerodynamics noise, Exhaust Noise. Noise reduction in Automobiles —Encapsulation technique for noise reduction – Vehicular noise pollution and its implication on the ecosystem*

**Unit-4 - Emission Measurement** — **9 Hour**

*Principle of operation of emission measuring instruments used in SI and CI engines. - Measurement of CO2 and CO by NDIR- Hydrocarbon emission by FID-Chemiluminescent Analyser for NOx-Gas Chromatograph- Spot sampling- Continuous indication type smoke meters (Bosch, AVL and Hartridge smoke meters)- Emission test procedures and requirements for different vehicle categories (An overview) – FTP– SHED- Euro and Bharat stage norms*

| ***Unit-5 - Driving Cycles, Emission and Factors*** | ***9 Hour*** |
|---|---|
| *Indian driving cycle (IDC) - Modified Indian driving cycle (MIDC)- International Driving Cycle - Real world emissions - Time, Average speed, maximum speed and maximum acceleration - Fuel economy and emissions - Other influencing factors (driving behavior, influence of air conditioning systems etc.,)* | |

| **Learning Resources** | | |
|---|---|---|
| | 1. *Ganesan V, "Internal combustion engines"., 4th edition, TataMcGraw Hill Education, 2012*<br>2. *John B Heywood. "Internal Combustion Engine Fundamentals"., Tata McGraw-Hill 1988, Reprint 2012.*<br>3. *Automotive Fuel and Emissions Control Systems (Automotive Systems Books), Halderman, James, ISBN 10: 0133799492 / ISBN 13:9780133799491,Pearson, 2015* | 4. *Simulating Combustion: Simulation of combustion and pollutant formation for engine-development - Günter P. Merker · Christian Schwarz,Gunnar Stiesch · Frank Otto - Springer-Verlag Berlin Heidelberg 2006*<br>5. *https://www.araiindia.com/pdf/Indian_Emission_Regulation_Booklet.pdf* |

**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.N. Senthil, Manager, TAFE, senthil.n@tafe.com* | 1. *Dr. N. Balaji, Sri Krishna College of* | 1. *Dr. C. Prabhu, SRMIST* |
| 2. *Mr R. Govindarajan, Royal Enfield, ashoks@eta- engg.com* | 2. *Dr.R.Sakthivel, Sri Venkateswara College of Engineering, rsakthivel@svce.ac.in* | 2. *Mr. M.Jeromestanley, SRMIST* |

| Course Code | 21AUE432T | Course Name | ALTERNATIVE FUELS AND ENERGY SYSTEMS | Course Category | E | PROFESSIONAL ELECTIVE | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

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

| Course Learning Rationale (CLR): | The purpose of learning this course is to: |
|---|---|
| CLR-1: | evaluate the use of alcohol in SI and CI engine |
| CLR-2: | create insight on use of vegetable oil as fuel in CI engine |
| CLR-3: | evaluate the use of hydrogen as fuel in SI and CI engine |
| CLR-4: | analyze the other gaseous fuels utilization in SI and CI engine |
| CLR-5: | create insight on hybrid, solar and electric based vehicles |

| Course Outcomes (CO): | At the end of this course, learners will be able to: | Program Outcomes (PO) | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | | | |
| | | Engineering Knowledge | Problem Analysis | Design/development of solutions | Conduct investigations of complex problems | Modern Tool Usage | The engineer and society | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO-1 | PSO-2 | PSO-3 |
| CO-1: | apply the knowledge of using alcohol as fuel | 2 | 1 | - | - | - | - | 3 | - | - | - | - | - | 2 | - | - |
| CO-2: | list the techniques employed to use vegetable oil in CI engine | 2 | 1 | - | - | - | - | 3 | - | - | - | - | - | 2 | - | - |
| CO-3: | develop system for using hydrogen in engines | 2 | 1 | - | - | - | - | 3 | - | - | - | - | - | 3 | - | - |
| CO-4: | understand the concepts of biogas, LPG and CNG as fuels in IC engines | 2 | 1 | - | - | - | - | 3 | - | - | - | - | - | 3 | - | - |
| CO-5: | demonstrate the working of hybrid, solar and electric vehicles | 2 | 1 | - | - | - | - | 3 | - | - | - | - | - | 3 | - | - |

**Unit-1 - Alcohol Fuels** — **9 Hour**

*Need for Alternate Fuel - Alternate Fuel Properties – Alcohol production techniques - use of alcohol as a fuel in CI and SI engines–Modifications andmethods to use alcohol in SI and CI engines —Gasohol, Flexible Fuel system, Reformed Alcohol - Dual fuel combustion- Spark assisted diesel engine - Surface ignition- ignition accelerators — Performance, emission and combustion characteristics*

**Unit-2 - Vegetable Oil and Other Sources as Fuel** — **9 Hour**

*Various vegetable oils and their properties – First to fourth generation biofuels – Well to wheel analysis Problems of using vegetable oil in CI engine - Techniques to overcome problems of using vegetable oil in CI engine - Trans-esterification – Reaction and Process, optimization –Biodiesel properties- Blending of different fuels and effect in SI and CI engine on performance, emission and combustion – Diesel, ether based fuels Blending Waste to energy: Waste plastics, Waste tire, used lubricant oil, solid waste, Waste cooking oil, food waste, agricultural waste –Various techniques for conversion of waste to fuel - Performance and emission and combustion characteristics - Comparison of , fuel derived from different types of waste with biodiesel and diesel*

**Unit-3 - Hydrogen Based Fuels** — **9 Hour**

*Hydrogen as fuel in IC engine, hydrogen properties -Hydrogen as fuel in IC engine- Hydrogen production techniques –storage methods - Problems associated with hydrogen as fuel and its solution -Different methods of using hydrogen in SI and CI engine- Performance, emission and combustion characteristics – Scope for use of hydrogen in rail, sea and air transportation – Global hydrogen demand - Fuel cell -Concept with hydrogen and methanol Fuel cell - Power rating, performance and heat dissipation Layout of fuel cell vehicle*

**Unit-4 - Other Gaseous Fuels** — **9 Hour**

*Biogas – Introduction-sources Biogas production -Factors affecting biogas production -Biogas usage in CI and SI engine-Properties of LPG and CNG as fuel in IC engine -Properties of LPG and CNG as fuel in IC engine-Fuel metering system -Combustion characteristics- Effect on performance and emission characteristics of LPG and CNG vehicle- LPG and CNG vehicle layout _- Dual fuel Characteristics of other gaseous fuels with hydrogen.*

| ***Unit-5 - Hybrid, Solar and Electric Vehicles*** | ***9 Hour*** |
|---|---|
| *General layout of an Electric vehicles - Advantages and limitations-in comparison to the conventional IC engine Types of hybrid vehicles and configuration - Source of power for electric and hybrid vehicles - Layout of solar powered vehicles- Overview of energy storage devices. – Types,advantages and limitations.* | |

| | | |
|---|---|---|
| **Learning Resources** | 1. *M.K. Gajendra Babu & K.A. Subramanian, Alternate Transportation Fuels: Utilization in combustion engine, CRC press,2017* | 2. *Dr. S. S. Thipse, Alternate fuels , Jaico Publishing house , 2010*<br>3. *Paul Richards, SAE -Automotive Fuels Reference Book, Third Edition R-297, 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. S. Sivaramakrishnan, Volvo Cars, sivaramakrishnan.swaminathan@volvocars.com* | 1. *Dr. K. Balasubramanian, Sri Krishna College of Engineering, balasubramanian@skcet.ac.in* | 1. *Dr. C. Prabhu, SRMIST* |
| 2. *Mr.SarathRamakannan, Aston Martin, sharath.ramakrishnan@astonmartin.com* | 2. *Dr. S. Premnath, Sri Venkateswara College of Engineering, prem@svcce.ac.in* | 2. *Dr. T.Prakash, SRMIST* |

| Course Code | 21AUE241T | Course Name | AUTOMOTIVE DRIVELINE DESIGN | Course Category | E | PROFESSIONAL ELECTIVE | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

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

| Course Learning Rationale (CLR): | ***The purpose of learning this course is to:*** |
|---|---|
| ***CLR-1:*** | *design the driveline systems and its components* |
| ***CLR-2:*** | *distinguish the design of various flywheel and clutches* |
| ***CLR-3:*** | *analyze the stresses and design various gears* |
| ***CLR-4:*** | *compare and design different gearboxes* |
| ***CLR-5:*** | *design the different braking systems and axles* |

| 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:*** | *identify the different types of power transmission drives* | *2* | *1* | *3* | - | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-2:*** | *infer the design of various flywheel and clutches* | *1* | *2* | *3* | - | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-3:*** | *classify and design different gears used in transmission systems* | *3* | *2* | *1* | - | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-4:*** | *categorize and design different gearbox and shafts* | *1* | *2* | *3* | - | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-5:*** | *interpret the design of various braking systems and axles* | *1* | *2* | *3* | - | - | - | - | - | - | - | - | - | *3* | - | - |

| ***Unit-1 - Design of Flexible Drives*** | ***9 Hour*** |
|---|---|
| *Flexible drives - Introduction - Comparison of flexible drives with rigid drives - Belt drives types and construction - Geometrical relationship - Analysis of belt tensions - Condition for maximum power - Pulley design for belt drives - Tutorial on belt drives - Introduction of chain drives - Advantages of chain drives over belt drives - Roller chains - Geometrical relationship - Polygonal effect - Power rating for roller chains - Design of sprocket wheels - Design of chain drive - Chain lubrication - Tutorial on chain drives* | |
| ***Unit-2 - Design of Flywheel and Clutches*** | ***9 Hour*** |
| *Flywheel and governor - flywheel materials - Torque analysis - Stresses in Solid disc flywheel - Rimmed flywheel - Stresses in rimmed flywheel - Tutorialon flywheel design - Design considerations of clutches - Torque Transmission Capacity, uniform pressure theory - Uniform wear theory - Design of singleplate clutch - Design of multidisc clutch - Friction materials - Design of Cone clutches - Solving problems - Design of centrifugal clutches – Energy equation for clutches - Thermal consideration in clutch design* | |
| ***Unit-3 -Design of Spur Gear and Helical Gear*** | ***9 Hour*** |
| *Gears-Introduction - Gear terminology and gear trains - Design of spur gear, Selection of material - Beam strength for gear tooth - Permissible bending stress -Effective load on gear tooth - Estimation of module based on beam strength - Wear strength of Spur gear - Solving problems - Solving problems - Terminology ofhelical gears - Force analysis of helical gears - Force analysis of helical gears - Beam strength of helical gears - Effective load on gear tooth - Wear strength of helical gear - Estimation of module based on wear strength - Solving problems* | |
| ***Unit-4 - Design of Gearbox, Propeller Shaft*** | ***9 Hour*** |
| *Gear box, components, requirements, Gear matching - Requirements to obtain optimum design - Ray diagram, geometric progression and standard step ratio - kinematic layout - Design of sliding mesh gear box - Design of gearbox - Solving problems - Constant mesh gearbox - Speed reducer unit - Design of propeller shaft for bending and torsion - Design of propeller shaft for bending and torsion - Design of propeller shaft for rigidity - Solving problems - Design of universal joints - Design of CV joints - Slip joint design Solving problems* | |

| ***Unit-5 - Design of Final Drive*** | ***9 Hour*** |
|---|---|
| *Axles-Types, materials - Design requirements of front axle - Loads on axles - Steering Knuckle - King pin - Rear Axle (drive Axle) tube - Design of front axle - Design of front axle - Solving problems - Solving problems - Design of rear axle - Design of rear axle - Solving problems - Solving problems - Design of fully floating axle - Design of half floating axle - Design of dead axle - Design of Final drive and differential* | |

| | | |
|---|---|---|
| **Learning Resources** | 1. *Bhandari. V. B., "Design of Machine Elements", Tata McGraw-Hill Publishing Company Ltd, 2010.*<br>2. *Gian Carlo Genta, Lorenzo lorello "The Automotive Chassis system design" published by Springer,2009* | 3. *Joseph E. Shigley & Larry D. Mitchell, "Mechanical Engineering Design",10th Edition, McGraw-Hill International book company,2014*<br>4. *Julian Hapian Smith, "An Introduction to Modern Vehicle Design", Society of Automotive Engineers Inc,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* | *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. *Mr. T.R.Karthikeyan, TAFE, vasucar@gmail.com* | 1. *Dr..A.Samuel Raja, Thiyagarajar college of Engineering Madurai, samuel1973@tce.edu* | 1. *Dr. J. Chandradass, SRMIST* |
| 2. *Mr. R. Srikanth, Altair, srikanth.r@altair.com* | 2. *Mr. N.Ravikumar, Crescent Institute of Science and Technology, ravikumar@crescent.education* | 2. *Mr. P. Baskara Sethupathi, SRMIST* |

| Course Code | 21AUE242T | Course Name | AUTOMOTIVE CHASSIS COMPONENT DESIGN | Course Category | E | PROFESSIONAL ELECTIVE | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

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

| Course Learning Rationale (CLR): | *The purpose of learning this course is to:* |
|---|---|
| ***CLR-1:*** | *design the chassis and its components* |
| ***CLR-2:*** | *design the steering and braking system and its components* |
| ***CLR-3:*** | *compare and classify different transmission system* |
| ***CLR-4:*** | *distinguish various suspension systems and designing it* |
| ***CLR-5:*** | *gain knowledge about tire and its performance characteristics* |

| 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 different types of frames and loads acting on it* | *3* | *1* | *2* | - | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-2:*** | *interpret different steering and braking system components* | *3* | *2* | *1* | - | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-3:*** | *evaluate the transmission components and their design procedures* | *1* | *2* | *3* | - | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-4:*** | *classify and design different suspension system and its components* | *1* | *2* | *3* | - | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-5:*** | *infer about tires and their performance characteristics* | *3* | *2* | *1* | - | - | - | - | - | - | - | - | - | *3* | - | - |

***Unit-1 - Frames*** ***9 Hour***

*Study of loads - Bending case - Torsion case - Combined bending and torsion - Lateral loading - Fore and aft loading - Frame materials - Design of frames - Moment of inertia of rectangular section - Moment of Inertia of a Hollow Rectangular Section - Moment of Inertia of a Hollow Rectangular Section -Moment of Inertia of a Circular Section - Chassis types, introduction -Ladder frames - Cruciform frames - Torque tube backbone frames- Space frames - Integral structures - Underbody, Sub-frame - Industrial vehicle frames - Structural tasks Structural design - Structural testing*

***Unit-2 - Design of Steering*** ***9 Hour***

*Introduction Steering mechanism - Steering mechanism and applications - Rack and pinion steering box - Screw and sector steering box - Design Steeringcolumn - Design Steering column - Steering column calculations - Recirculation ball steering diagnosis and service - Principles of conventional column -Tilt column systems - Collapsible steering column - Conventional steering linkage mechanism - Rack and pinion steering linkage mechanism – Manual And Power Steering Theory - Manual steering - Power steering - Power steering pump operation - Rack and pinion - steering diagnosis and service*

***Unit-3 - Design of Brakes*** ***9 Hour***

*The fundamentals of braking - Brake system components and configurations - Weight transfer during braking & effect of vehicle parameters - Disc brakes / Discbrake – types, advantages & disadvantages - Mechanical brake systems - components and configurations - Hydraulic brake systems - components and configurations - Air brake systems - components and configurations - Parking brake systems - Brake Friction materials – Brake pads & Brake Liner Composition and friction - Thermal effects in friction brakes - Wheel lock and vehicle stability during braking - Electronic braking system - Brake system legislation - Brake testing - Brake NVH - Stopping distance calculation - Brake factor calculation for a drum brake / Disc brake - Brake torque calculation in a hydraulic system*

***Unit-4 - Suspension System Design*** ***9 Hour***

*Introduction - Design of leaf Springs - Design of Helical Springs - Helical Springs in Series and Parallel and design of torsion bar - Independent suspensions McPherson suspension - McPherson suspensions for rear axle - Double wishbone suspension - Virtual centres suspensions - Trailing arm suspensions- Semi- trailing arms suspension - Multilink suspensions Semi-independent suspensions - Twist beam suspension - Rigid axle suspensions - Rigid axles with leaf springs - Rigid guided axles - Industrial vehicles suspensions - Pneumatic springs - Front suspension Rear suspensions - Design and testing*

| ***Unit-5 - Wheels and Tires System Design*** | ***9 Hour*** |
|---|---|
| *Description Rim characteristics - Tire characteristics Wheel reference system - Tire operation - On-road driving - Off-road driving - Rolling radius -Rolling radius - Rolling resistance Effect of speed, material nature and structure, tread wear - Effect of operating temperature, inflation pressure andvertical load, tire size, road - wheel sideslip angle - Static Forces - Static Forces - Longitudinal Force - Longitudinal Force - Cornering forces - Interaction between longitudinal and side forces - Outline on dynamic behavior - Outline on dynamic behavior - Testing of tires -* | |

| | | |
|---|---|---|
| **Learning Resources** | 1. *The Automotive Chassis Volume 1: Components Design Genta,Giancarlo, Morello, L., Springer, Netherlands 2009.*<br>2. *Introduction to Modern Vehicle Design Julian Happian-Smith,Butterworth- Heinemann 2001.*<br>3. *Vector Mechanics for Engineers: Statics and Dynamics Beer, Johnston, McGraw Hill Education; Tenth edition 2017* | 4. *Advanced Vehicle Technology Heinz Heisler, Butterworth-Heinemann; 2 edition 2002.*<br>5. *The Motor Vehicle Kenneth Newton, T.K. Garrett, W. Steeds,Butterworth -Heinemann 12 Revised edition 1997* |

**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. *Mr.N. Vijayakumar Mahindra & Mahindra, vijayakumar.n@mahindra.com* | 1. *Mr. B.Vasanthan, Madras Institute of technology, Anna University, bvasanthan@mitindia.edu* | 1. *Dr. J. Chandradass, SRMIST* |
| 2. *Mr..R.Srikanth, Altair, srikanth.r@altair.com* | 2. *Mr.N.Ravikumar, Crescent Institute ofScience and Technology,ravikumar@crescent.education* | 2. *Mr. P. Baskara Sethupathi, SRMIST* |

| Course Code | 21AUE341T | Course Name | VEHICLE DESIGN DATA CHARACTERISTICS | Course Category | E | PROFESSIONAL ELECTIVE | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

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

| Course Learning Rationale (CLR): | *The purpose of learning this course is to:* |
|---|---|
| ***CLR-1:*** | *understand the basic knowledge of vehicle design specifications* |
| ***CLR-2:*** | *provide knowledge of vehicle frame, body and suspension design* |
| ***CLR-3:*** | *provide knowledge on performance curves at various vehicle speeds* |
| ***CLR-4:*** | *provides the knowledge on steering and axle design* |
| ***CLR-5:*** | *familiarize the design procedure for types of brakes* |

| 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:*** | *generalize the selection of vehicle specifications on the basis of various forces and resistance* | *2* | *3* | *2* | - | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-2:*** | *choose a suitable vehicle frames and suspension systems by calculating different type of loads and moment* | *3* | *3* | *3* | - | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-3:*** | *select the suitable power requirement for the given vehicle specifications* | *3* | *3* | *3* | - | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-4:*** | *calculate the loads and moment on steering, final drive, front and rear axle systems in a vehicle* | *3* | *3* | *3* | - | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-5:*** | *choose a suitable brake system for the given vehicle specification* | *3* | *3* | *3* | - | - | - | - | - | - | - | - | - | *3* | - | - |

***Unit-1 - Introduction*** ***9 Hour***

*Study and Selection of Vehicle Specifications - Choice of Cycle, Fuel, Speed, Method of Cooling, Material, Design Variables and Operating Variables Affecting Performance and Emission, Benchmarking. Calculation and Plotting the Curves of Air, Rolling and Gradient Resistances, Driving Force – Engine Power, Speed, Differential Ratio, Rear Axle Ratio, Torque and Mechanical Efficiency at Different Vehicle Speeds. Vehicle Interior and Exterior Design. Ergonomics and Styling. Assumptions to be made in designing a vehicle, Range of values for Gross Vehicle Weight, Frontal Area, maximum speed, maximum acceleration, gradability in different gears, Basics of Automobile Design.*

***Unit-2 - Suspension System*** ***9 Hour***

*Design of Frame Members: Longitudinal, Cross and Support Members for Heavy and Light Vehicles. Load, Moment and Stress Calculations. Design of Vehicle Body. Design of Springs: Leaf, Coil and Torsion Bar. Design of Hydraulic, Pneumatic and Rubber Suspension. Calculation, Tabulation and Plotting of Curves for Air and Rolling Resistances at various vehicle speeds, Calculation and Plotting of Driving force, Power requirement for different loads and acceleration, Maximum Power calculation.*

***Unit-3 - Performance Curves*** ***9 Hour***

*Calculation, Tabulation and Plotting of Curves for Air and Rolling Resistances at various vehicle speeds, Calculation and Plotting of Driving force, Power requirement for different loads and acceleration, Maximum Power calculation. Connecting rod length to Crank Radius Ratio, Plotting of Piston Velocity and Acceleration against Crank Angle, Plotting Gas force, inertia force and Resultant force against Crank Angle, Turning Moment and Side Thrust against Crank Angle.*

| ***Unit-4 - Gear Ratios*** | ***9 Hour*** |
|---|---|
| *Speed ratios and number of teeth-Force analysis -Tooth stresses – Dynamic effects – Fatigue strength – Factor of safety – Gear materials – Design of straight tooth spur & helical gears, Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears. Worm Gears: terminology, Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair. Geometric progression –Standard step ratio – Ray diagram, kinematics layout -Design of sliding mesh gear box – Design of multi speed gear box for machine tool applications – Constantmesh gear box – Speed reducer unit. – Variable speed gear box, Fluid Couplings, Torque Converters for automotive applications. Determination of Gear Ratios, Acceleration and Gradability, Typical Problems on Vehicle performance.* | |
| ***Unit-5 - Brake System*** | ***9 Hour*** |
| *Braking fundamentals, Energy of motion and frictional force, brake balance, stopping distance, brake fade, brake torque, work done during braking, braking efficiency numerical, Brake booster functions, Braking of vehicle, brakes applied to the rear wheels, front wheels, all four wheel and numerical, braking of vehicle moving in a curved path, internal expanding (drum)brake with explanation of leading and trailing shoe and numerical, concept of self-energizing, disc brake principle, Comparison of disc brake over drum brakes..* | |

| **Learning Resources** | |
|---|---|
| 1. *R.S.Khurmi J.K. Gupta 'A Textbook of Machine Design' EurasiaPublishing House (Pvt.) Ltd, New Delhi- 2005*<br>2. *iri.N.K- "Automobile Mechanics"- Khanna Publisher, NewDelhi- 2012.*<br>3. *Newton Steeds & Garret- "Motor Vehicle"- Wildlife Books Ltd.,London – 2001* | 4. *Heldt.P.M - "Automotive Chassis"- Chilton Co., New York- 1992.*<br>5. *Steeds. W -"Mechanics of Road Vehicles"- Illiffe Books Ltd., London- 1990.*<br>6. *Giles.K.G - Steering, Suspension andTires"- Wildlife Books Ltd., London –1988.* |

**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.C. Saravanan, Anna university, BITCampus, csaran_auto@rediffmail.com* | 1. *Dr. J.Chandradass, SRMIST* |
| 2. *Mr.S.Vengatesan, RNTBCI, vengatesan.subramanian@rntbci.com* | 2. *Prof. (Dr) A V Waghmare, AISSMSCollege of Engineering, avwaghmare@aissmscoe.com* | 2. *Mr.G.Naresh, SRMIST* |

| Course Code | 21AUE342T | Course Name | CONCEPTS OF ENGINEERING DESIGN | Course Category | E | PROFESSIONAL ELECTIVE | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

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

| Course Learning Rationale (CLR): | The purpose of learning this course is to: |
|---|---|
| CLR-1: | familiarize the students with the design process |
| CLR-2: | give insights into the various tools used in Design Methods |
| CLR-3: | acquaint students with material selection and design strategies |
| CLR-4: | familiarize the students with the Engineering statistics and reliability in design |
| CLR-5: | give insights into legal and ethical issues in Designing and to various tools involved in Quality Engineering |

| 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 design processes | 2 | - | 2 | 1 | - | - | - | - | - | - | - | - | 3 | - | - |
| CO-2: | demonstrate various tools used in Design Methods | 2 | - | 3 | - | 2 | - | - | - | - | - | - | - | 3 | - | - |
| CO-3: | understand the process of material selection and can interpret various techniques involved in Design | 3 | - | 2 | 2 | - | - | - | - | - | - | - | - | 3 | - | - |
| CO-4: | implement various Engineering statistics methods in design | 3 | 2 | 2 | - | - | - | - | - | - | - | - | - | 3 | - | - |
| CO-5: | understand the legal and ethical issues in Designing and apply various tools used in Quality Engineering | 2 | - | 2 | 2 | - | - | - | - | - | - | - | - | 3 | - | - |

| Unit-1 - Design Process | 9 Hour |
|---|---|
| The Design Process, Morphology of Design, Design Drawings, Computer Aided Engineering, Designing of Standards, Concurrent Engineering, ProductLife Cycle, Technological Forecasting, Market Identification, Competition Bench Marking, Systems Engineering, Life Cycle Engineering, Human Factors in Design, Industrial Design. | |
| **Unit-2 - Design Methods** | **9 Hour** |
| Creativity and Problem Solving, Product Design Specifications, Conceptual Design, Decision Theory, Decision Tree, Embodiment Design, Detail Design,Mathematical Modeling, Simulation, Geometric Modeling, Finite Element Modeling, Optimization, Search Methods, Geometric Programming, Structural Optimization, Shape Optimization. | |
| **Unit-3 - Material Selection Processing and Design** | **9 Hour** |
| Material Selection Process, Economics, Cost vs Performance, Weighted Property Index, Value Analysis, Role of Processing in Design, Classification of Manufacturing Process, Design for Manufacture, Design for Assembly, Designing for Castings, Forging, Metal Forming, Machining and Welding, Residual Stresses, Fatigue, Fracture and Failure | |
| **Unit-4 - Engineering Statistics and Reliability** | **9 Hour** |
| Introduction to statistics and Reliability, Probability and Distributions, Test of Hypothesis, Design Of Experiments, Reliability Theory, Design for Reliability, Reliability Centered Maintenance, Tutorial. | |
| **Unit-5 - Legal and Ethical Issues in Design and Quality Engineering** | **9 Hour** |
| Introduction to Ethics, The Origin of Laws, Contracts, Liability, Tort Law, Product Liability, Protecting Intellectual Property, Legal and Ethical Domains, Solving Ethical Conflicts, Total Quality Concept, – Quality Assurance, Taguchi Methods, Failure Mode Effect Analysis | |

| | | |
|---|---|---|
| **Learning Resources** | 1. *Dieter, George E., Engineering Design - "A Materials and Processing Approach", McGraw Hill International Editions, Singapore, 4th Edition, 2008*<br>2. *Karl T. Ulrich and Steven D. Eppinger "Product Design and Development" McGraw Hill Edition 6th edition 2015* | 3. *Pahl, G, and Beitz, W.," Engineering Design: A Systematic Approach",Springer London, 2014*<br>4. *Ray, M.S., "Elements of Engg. Design", Prentice Hall Inc. 2007*<br>5. *Suh, N.P., "The principles of Design", Oxford University Press, NY.2015* |

**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. *Mr.R Siva GMMCO, rsiva@gmmco.com* | 1. *Dr. K.Chandrasekaran, RMK Engg. College, dean.mech@rmkec.ac.in* | 1. *Dr.J.Chandradoss, SRMIST* |
| 2. *Mr.Prasad MP AGNITO INSIGHTS, prasad@agnito.in* | 2. *Dr.Uma Maheshwar ,OsmaniaUniversitymahesh.v@uceou.edu,* | 2. *Mr.G.Naresh, SRMIST* |

| Course Code | 21AUE343T | Course Name | RAPID PROTOTYPING AND TOOLING | Course Category | E | PROFESSIONAL ELECTIVE | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

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

| Course Learning Rationale (CLR): | The purpose of learning this course is to: |
|---|---|
| CLR-1: | understand and use techniques for processing of CAD models for rapid prototyping |
| CLR-2: | understand and apply fundamentals of rapid prototyping techniques |
| CLR-3: | use appropriate tooling for rapid prototyping process |
| CLR-4: | use rapid prototyping techniques for reverse engineering |
| CLR-5: | examine the cases relevant to mass customization and some of the important research challenges associated with AM and its data processing 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 history, concepts and terminology of additive manufacturing | 3 | - | 2 | 2 | - | - | - | - | - | - | - | - | - | 3 | 2 |
| CO-2: | apply the reverse engineering concepts for design development | 2 | - | 3 | 2 | - | - | - | - | - | - | - | - | 3 | - | - |
| CO-3: | understand the variety of additive manufacturing techniques | 2 | - | 1 | 1 | - | - | - | - | - | - | - | - | 3 | - | - |
| CO-4: | design and develop newer tooling models | 3 | 2 | 3 | - | - | - | - | - | - | - | - | - | 3 | - | - |
| CO-5: | analyze the cases relevant to mass customization and some of the important research challenges associated with AM and its data processing tools | 3 | 3 | - | 3 | - | - | - | - | - | - | - | - | 3 | 2 | - |

**Unit-1 - Introduction to Rapid Prototyping** — **9 Hour**

*Overview of subtraction and additive manufacturing, History, Need-Classification of additive manufacturing, cost and effects of design changes during conceptual modeling, detail designing, prototyping, manufacturing and product release, Reverse Engineering, Bench marking, 3D scanning, 3D digitizingand Data fitting, CAD for RPT: CAD model preparation, Part Orientation and support generation, Model Slicing –Tool path Generation, Materials for Additive Manufacturing Technology and its classification based on materials, RPT and its role in modern manufacturing mechanical design-Economics of RP techniques.*

**Unit-2 - Liquid Based Additive Manufacturing System** — **9 Hour**

*Methods in liquid based process and material used for fabrication, Stereo lithography Apparatus (SLA)- Principle, process, advantages, disadvantages andlimitations, Digital light processing, principal Process, Advantages, disadvantages and Limitations, Solid ground curing principle, Process Advantages, disadvantages and Limitations, Continuous Liquid Interface, Production Shape deposition modelling.*

**Unit-3 - Solid Based Additive Manufacturing System** — **9 Hour**

*Introduction to solid based additive Manufacturing system, Methods in solid based process and material used for fabrication, Fused deposition modeling (FDM :principle, Process, Advantages disadvantages and Limitation, Multi jet modelling- Principle, process, advantages, disadvantages and limitations, Laminated object modeling (LOM)- Principle, process, advantages, disadvantages and limitations, Electron-beam freeform fabrication, Case studies.*

**Unit-4 - Powder Based Additive Manufacturing System** — **9 Hour**

*Methods in powder based process and material used for fabrication, Selective Laser Sintering : Principles of SLS, Process, advantages and Applications, Selective Laser Melting : Principles of SLM, Process, advantages and applications, Selective heat sintering, Laser Engineered Net Shaping (LENS) -,Principle, process, advantages, disadvantages and limitations, Three Dimensional Printing - Principle, process, advantages and applications-Electron Beam Melting- Principle, process, advantages, disadvantages and limitations.*

| ***Unit-5 - Additive Manufacturing Application and Case Studies*** | ***9 Hour*** |
|---|---|
| *Special materials, medical and bio-additive manufacturing, Customized implants and prosthesis: Design and production, Bio-Additive Manufacturing- Computer Aided Tissue Engineering (CATE), Advantages, disadvantages and Applications of RP techniques in Automotive components, 3D printed brake caliper, 3D printed food, need and its limitation, zero-gravity 3D printer, Application of RP in Art and jewelry Challenges in implementation of RP techniques, Case Studies.* | |

| **Learning Resources** | | |
|---|---|---|
| | 1. *Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", second edition, World Scientific Publishers, 2010* | 3. *Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer,2010.* |
| | 2. *Gebhardt, A., "Rapid prototyping", Hanser Gardener Publications,2003.* | 4. *Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and IndustrialApplications, CRC press, 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* | *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.K Suresh, HAL, Sureshhal82@gmail.com* | 1. *Dr.P.D.Jeyakumar, Crescent University,pdjeyakumar@crescent.edu* | 1. *Dr.J.Chandradoss, SRMIST* |
| 2. *Mr.Ajeesh Varghese Halla,Ajeeshvarghese@halla.com* | 2. *Dr.K Prabu VIT, Prabu.k@vit.ac.in* | 2. *Mr.G.Naresh, SRMIST* |

| Course Code | 21AUE344T | Course Name | MODELING AND CONTROL OF VIBRATION IN MECHANICAL SYSTEMS | Course Category | E | PROFESSIONAL ELECTIVE | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

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

| Course Learning Rationale (CLR): | *The purpose of learning this course is to:* |
|---|---|
| ***CLR-1:*** | *impart knowledge on fundamentals of vibrations* |
| ***CLR-2:*** | *know the concept of two degree of freedom systems and continuous systems* |
| ***CLR-3:*** | *analyze different methods of modeling multi degree of freedom systems* |
| ***CLR-4:*** | *understand the concept of Vibration control techniques* |
| ***CLR-5:*** | *gain knowledge on vibration measurement devices* |

| Course Outcomes (CO): | *At the end of this course, learners will be able to:* | Program Outcomes (PO) | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | | | |
| | | Engineering Knowledge | Problem Analysis | Design/development of solutions | Conduct investigations of complex problems | Modern Tool Usage | The engineer and society | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO-1 | PSO-2 | PSO-3 |
| ***CO-1:*** | *understand the fundamentals of vibration and single degree of freedom system* | *3* | *3* | - | - | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-2:*** | *implement two degree of freedom systems in any application* | - | *3* | *3* | - | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-3:*** | *classify the different modeling methods in multi degree of freedom systems* | *3* | - | *3* | - | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-4:*** | *interpret different vibration control techniques* | - | *3* | - | *3* | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-5:*** | *implement the vibration measurement devices in real time application* | - | *3* | - | *3* | - | - | - | - | - | - | - | - | *3* | - | - |

***Unit-1 - Fundamentals of Vibration and Modelling SDOF Systems*** — ***9 Hour***

*Concept of vibration - Classification of vibration - Vibration analysis procedure and elements - Harmonic and periodic motions - vibration terminology - Modelling of single degree of freedom systems - Vibration model, Equation of motion-Natural Frequency - Energy method, Rayleigh method - Principle of virtual work, Damping models - Viscously damped free vibration - Special cases: oscillatory, non-oscillatory and critically damped motions - Logarithmic decrement, Experimental determination of damping coefficient -Forced harmonic vibration, Magnification factor - Rotor unbalance, Transmissibility - Vibration Isolation - Equivalent viscous damping, Sharpness of resonance.*

***Unit-2 - Two Degree of Freedom Systems and Continuous Systems*** — ***9 Hour***

*Two DOF - Modelling of Two Degree of freedom systems - Modelling ofTwo Degree of freedom systems - Free Vibration Analysis of an Un damped System - Free Vibration Analysis of damped System - Equations of Motion for Forced Vibration - Forced Vibration with Harmonic Excitation System - Forced Vibration with Harmonic Excitation System - Coordinate Couplings and Principal Coordinates - Vibration of continuous systems - Vibrating string - Longitudinal vibration of rods - Torsional vibration of rods - Vibration of suspension bridges - Euler equation for beams*

***Unit-3 - Modelling of Multi-Degree of Freedom Systems*** — ***9 Hour***

*Multi Degree Freedom System - Modeling of Continuous Systems as Multi-degree of Freedom Systems - Influence Coefficients stiffness coefficients - Flexibility and inertia influence coefficients - Flexibility Matrix and Stiffness Matrix - Flexibility Matrix and Stiffness Matrix - Eigen Valuesand Eigen Vectors - Eigen Values and Eigen Vectors - Matrix Iteration Method – Approximate Methods - Dunkerley, Rayleigh's, and Holzer Method - Geared Systems - Eigen Values & Eigenvectors for large system of equations using sub space - Solving problems*

***Unit-4 - Vibration Control*** — ***9 Hour***

*Introduction to vibration control - Specification of Vibration Limits - Static and dynamic balancing - Balancing of Rotating Machines - Field balancing - Whirling of Rotating Shafts - Critical Speeds, Stability Analysis - Balancing of Reciprocating Engines - Control of Natural Frequencies - Vibration Isolation - Vibration Isolation methods - Vibration Absorbers - Dynamic vibration absorbers - torsional and pendulum type absorbers - Damped vibration absorbers*

| ***Unit-5 - Vibration Measurement and Applications*** | ***9 Hour*** |
|---|---|
| *Transducers - Transducers types and applications - Vibration pickups – Vibrometer – Accelerometer – Velometer - Phase Distortion – Frequency Measuring Instruments - Vibration Exciters - Signal Analysis - Dynamic Testing of Machines and Structures - Experimental Modal Analysis - Measurement of Mode Shapes - Machine Condition Monitoring and Diagnosis – Machine Condition Monitoring and Diagnosis* | |

| **Learning Resources** | | |
|---|---|---|
| | 1. *Ramamurti. V, "Mechanical Vibration Practice with BasicTheory", Narosa, New Delhi, 2010*<br>2. *S. Graham Kelly & Shashidar K. Kudari, "Mechanical Vibrations", TataMcGraw–Hill publishing Com. Ltd New Delhi, 2007* | 3. *Rao, S.S.," Mechanical Vibrations," Addison Wesley Longman, 6th Edition 2018.*<br>4. *Thomson, W.T. – "Theory of Vibration with Applications", CBS Publishersand Distributors, New Delhi, 2006* |

**Learning Assessment**

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

**Course Designers**

| **Experts from Industry** | **Experts from Higher Technical Institutions** | **Internal Experts** |
|---|---|---|
| 1. *Mr. Dhanraj domala, Design Engineer, Xitadel Dhanraj.domala@xitadel.com* | 1. *Dr.M.Subramanian , Associate Professor, PSG Tech, msn.auto@psgtech.ac.in* | 1. *Dr.J. Chandradass, SRMIST* |
| 2. *Mr.GopalDhanasekar, System Engineer,Automotive Testing System. Gopal.dhanasekar@ats_india.com* | 2. *Dr. R Kannan, Professor, PSNA CET* | 2. *Mr .P. Baskara Sethupathi, SRMIST* |

| Course Code | 21AUE441T | Course Name | DESIGN FOR MANUFACTURE | 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:*** | *describe design of manufacturing process for casting and forming* |
| ***CLR-2:*** | *illustrate design of manufacturing process for extrusion* |
| ***CLR-3:*** | *discuss design of manufacturing process for machining* |
| ***CLR-4:*** | *illustrate design of manufacturing process for joining* |
| ***CLR-5:*** | *devise assembly process of manufactured 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:*** | *compare various manufacturing process and design processes for casting and forming process* | *2* | - | *2* | *3* | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-2:*** | *interpret various manufacturing process and design processes for Extrusion process* | *2* | - | *2* | *3* | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-3:*** | *interpret various manufacturing process and design processes for Extrusion process* | *2* | - | *2* | *3* | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-4:*** | *interpret various manufacturing process and design processes for Joining process* | *2* | - | *2* | *3* | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-5:*** | *design various assembly process of automotive components* | *3* | - | *3* | *3* | - | - | - | - | - | - | - | - | *3* | - | - |

| ***Unit-1 - Design for Manufacture and Casting*** | ***9 Hour*** |
|---|---|
| *Economics of process selection, Introduction to materials and material selection, Mechanical properties of materials, General design principles formanufacturability, Design considerations for Sand cast, Design considerations for Die cast, Design considerations for Permanent mould cast parts, Design considerations for Centrifugal cast parts, Design considerations for Investment cast parts, Design for powder metal casting. Case studies* | |
| ***Unit-2 - Design for Extrusion, Forming and Forging*** | ***9 Hour*** |
| *Various extrusion process, Comparison of Various extrusion process, Design considerations for Hot extruded parts, Design considerations for Impact/Coldextruded parts, Design considerations for Stamped parts, Design considerations for Forged parts, Design considerations for Forming, Design considerations for Fine blanked parts, Design considerations for Metal injection molded parts. Case studies* | |
| ***Unit-3 - Design for Machining*** | ***9 Hour*** |
| *Design considerations for turning operation, Design for machining round holes, Parts produced by milling, Design considerations for milling, Parts produced byplanning, Design considerations for planning, Parts produced by shaping, Design considerations for shaping, Parts produced by slotting, Design considerations for slotting, Design considerations for Polishing and Plating. Case studies* | |
| ***Unit-4 - Design for Joining Process*** | ***9 Hour*** |
| *Design Recommendation for Solder and Brazed Assembly, Design Recommendation for Adhesively Bonded Assemblies, Design Recommendation for Welding, Cost reduction and Minimizing distortion, Design considerations for Weld strength, Design considerations for Weldment & heat treatment, Parts joined by resistance welding, Design considerations for resistance welding, Parts joined by spot welding, Design considerations for spot welding, Parts joined by seam welding, Design considerations for seam welding, Parts joined by Projection welding, Design considerations for Projection welding, Parts joined by Flash & Upset weldment, Design considerations for Flash & Upset weldment. Case studies* | |
| ***Unit-5 - Design for Assembly*** | ***9 Hour*** |
| *General assembly recommendations, Minimizing the number of parts in Assembly, Design considerations for Rivets, Screw fasteners ,Gasket & Seals, Press fits, Snap fits and Automatic assembly. Case studies* | |

| | | |
|---|---|---|
| **Learning Resources** | 1. *Corradopoli, "Design for Manufacture – A structured approach",CRC Press, 2001.*<br>2. *O. Molloy, E.A. Warman, S. Tilley, Design for Manufacturing andAssembly: Concepts, Architectures and Implementation, Springer, 2010* | 3. *Erik Tempelman, Hugh Shercliff, Bruno Ninaber van Eyben, Manufacturing and Design: Understanding the Principles of How Things Are Made, Elsevier, 2014.*<br>4. *Henry Peck, "Designing for Manufacture", Sir Isaac Pitman & Sons Ltd., 1973.* |

**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.N.Vijayakumar, Head Test labs, Mahindra andMahindra, VIJAYAKUMAR.N@mahindra.com.* | 1. *Prof. M.Balasubramanian, Professor, IITMadras, mbala@iitm.ac.in* | 1. *Dr. J.Chandradoss, SRMIST* |
| 2. *Mr.Prasad Arun Kumar, Mahindra Research Valley, prasad.arunkumar@mahindra.com* | 2. *Dr. P.Jawahar, Assistant Professor, NITAgartala, drjawahar.me@nita.ac.in* | 2. *Mr.G.Naresh, SRMIST* |

| Course Code | 21AUE442T | Course Name | GEOMETRICAL DIMENSIONING AND TOLERANCE | 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:*** | *apply the standard dimensioning practices for mechanical drawings* |
| ***CLR-2:*** | *gain knowledge on tolerance in part diagrams* |
| ***CLR-3:*** | *use the concept of geometric tolerance in part diagrams* |
| ***CLR-4:*** | *interpret the Form and orientation control with GD&T* |
| ***CLR-5:*** | *interpret the Profile and location control with GD&T* |

| 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:*** | *sketch a part diagram with proper dimensioning according to the standards* | *1* | *3* | *2* | - | - | - | - | - | - | - | - | - | - | *3* | - |
| ***CO-2:*** | *connect the tolerance with dimensioning and its implementation* | *3* | *2* | *1* | - | - | - | - | - | - | - | - | - | *3* | *3* | - |
| ***CO-3:*** | *drew a part diagram with GD&T symbols* | *1* | *3* | *2* | - | - | - | - | - | - | - | - | - | - | *3* | - |
| ***CO-4:*** | *recognize its important and usage in manufacturing* | *3* | *2* | *1* | - | - | - | - | - | - | - | - | - | *3* | - | - |

***Unit-1 - Dimensioning Overview*** ***9 Hour***

*Basic Concepts - Terminologies used in dimensioning - Location and Orientation Dimensions - Symbols for Drilling Operations, dimensioning a Blind Hole - Placement, Spacing, Extension Lines - Grouping and Staggering - Reading Direction, View Dimensioning - Repetitive Features, Detail Dimensioning - Dimensioning Concentric Circles - Detail Dimensioning - Diameter versus Radius - Dimensioning Guidelines - Principles of Good Dimensioning - Importance of dimensioning - Example with 2D drawings*

***Unit-2 - Tolerances and Its Implementation*** ***9 Hour***

*Tolerance Representation - General Tolerances - Limit Dimensions - Plus and Minus Dimensions - Single Limit Dimensions - Important Terms in tolerance - Allowances - Different between tolerance and allowances - Fit Types - Clearance fit - Interference fit - Transition fit - Clearance and Interference Fits between Two Shafts and a Hole Transition Fit between a Shaft and a Hole - Basic Hole System - Basic Shaft System - Example with Thread Notes.*

***Unit-3 - T Symbols and Datum*** ***9 Hour***

*GD: Need for GD&T - Benefits of GD&T - Technical standards - GD&T symbols - How to read a feature control frame - Datums – introduction - Datum vs. datum feature - The datum reference frame - 3-2-1 locating principle - Uncertainties in datum establishment - Common misconceptions in datum - Profile of a line, surface - Maximum material condition Least material condition - Regardless of feature size - The Tylor principle - Virtual boundaries - Problem on finding wall thickness*

***Unit-4 - Form and Orientation Controls*** ***9 Hour***

*Flatness – verification techniques - Straightness - Surface and mid-plane control - Circularity - Circularity verification techniques - Circularity on cylinder and cone - Theory vs reality in measuring circularity - Evaluation of roundness - Cylindricity - Method of measuring deviation from cylindricity - Angularity and its measurement method - Perpendicularity - Perpendicularity verification techniques - Shifting vs growing - Parallelism and its measuring techniques - Free state inspection of flexible parts - Restrained state control of flexible parts*

| ***Unit-5 - Profile and Location Controls*** | ***9 Hour*** |
|---|---|
| *Profile of a line, surface - Inspecting profile of a line, surface - Planer Coplanarity - Conicity - Runout – circular runout and total runout - Inspection of runouts - Concentricity - Position - Projected tolerance zone - Positional co-axiality - Zero tolerancing -Composite tolerancing - A logical approach to part tolerancing - Refining functional geometric controls to be more cost effective - Push pin gages – advantages - Push pin gages – tolerance distribution - Tolerance on the work - Tolerance on the work- cont.* | |

| **Learning Resources** | 1. *Alex Krulikowski, Fundamentals of Geometric Dimensioningand Tolerancing,Delmar Cengage Learning 2E, 1997* | 2. *James D. Meadows, Geometric Dimensioning and Tolerancing:Applications and Techniques for Use in Design: Manufacturing, and Inspection,CRC Press,1995*<br>3. *Gary R.Bertoline , Introduction to graphics communications forengineers, McGraw-Hill, 4th edition.* |
|---|---|---|

**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.Dalpat Singh, M & M, singh.dalpat@mahindra.com* | 1. *Mr. J. MahasharAli, Crescent Institute of Science andTechnology,* | 1. *Dr. J. Chandradass, SRMIST* |
| 2. *Mr. Nirmal Kumar, Hubell India, nirmal06kumar@gmail.coml* | 2. *Dr. K. Kalaichelvan, Anna University kalaichelvan@annauniv.edul* | 2. *Mr. P. Baskara Sethupathi, SRMIST* |

| Course Code | 21AUE251T | Course Name | AUXILIARY VEHICLE SYSTEMS | Course Category | E | PROFESSIONAL ELECTIVE | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

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

| Course Learning Rationale (CLR): | The purpose of learning this course is to: |
|---|---|
| CLR-1: | recognize the vehicle motion control and stabilization system |
| CLR-2: | identify the importance of Driver assistance, security and warning system |
| CLR-3: | build the knowledge of Safety and comfort system |
| CLR-4: | understand the auxiliary systems of chassis |
| CLR-5: | assess the automotive Safety 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: | assess the vehicle's motion control and stabilization system | 3 | 3 | - | - | - | 3 | - | - | - | - | - | - | 3 | 2 | - |
| CO-2: | aware of the significance of the driver assistance, security, and warning systems | 3 | 3 | - | - | - | 3 | - | - | - | - | - | - | 3 | 2 | - |
| CO-3: | get familiar with the vehicle behavior in dynamic condition | 3 | 3 | - | - | - | 3 | - | - | - | - | - | - | 3 | 2 | - |
| CO-4: | recognize the chassis auxiliary systems | 3 | 3 | - | - | - | 3 | - | - | - | - | - | - | 3 | 2 | - |
| CO-5: | learn about the several sorts of safety measures, including active and passive safety | 3 | 3 | - | - | - | 3 | - | - | - | - | - | - | 3 | 2 | - |

| | |
|---|---|
| **Unit-1 - Vehicle Motion Control and Stabilization System** | **9 Hours** |
| Stability Control Adaptive cruise control Lane Keep Assist System Electronic Stability Program Blind Spot Detection system, Driver alertness detection system Electronic Transmission Control System Electronic Brake Force Distribution System | |
| **Unit-2 - Information, Security and Warning System** | **9 Hours** |
| Collision warning system Vehicle Navigation System. Looking in, Looking-out sensor Intelligent vision system, Vehicle Integration system. GlobalPositioning system Road Network Onboard Diagnosis System Immobilizer Anti-Theft Alarm System Voice Warning System Keyless Entry System Central Locking System Tire Pressure Monitoring System | |
| **Unit-3 - Comfort Systems** | **9 Hours** |
| Heating, Ventilation Air Conditioning Systems Principles and working Electronic Outside Rear View Mirror (ORVM) Rain Sensing Wiper System EnvironmentInformation System Tilt Able Steering Wheel, Garage Door Opening System Automatic Climate Control Adaptive Head Light Night Vision Assist, Traffic Jam Assist Hill Start Assist Need for Active suspension Construction of active suspension Working of active suspension | |
| **Unit-4 - Chassis Auxiliary System** | **9 Hours** |
| Needs for Auxiliary systems Power Assisted Steering System Working Principle Regenerative Braking System Principle and operation Servo Brake Vehicle RetardersElectrical Retarders Hydrodynamic Retarders Advantages of retarders Hydro Elastic Suspension System Rubber Suspension Pneumatic Suspension Drive by Wire System Brake by wire | |
| **Unit-5 - Safety System** | **9 Hours** |
| Seat belt, Seat belt tightener system and importance Collapsible Steering Column Air Bags Deployment System Designing aspects of automotivebumpers Materials for bumpers Steering and mirror adjustment, Frontal Object Detection Rear Vehicle Object Detection System Anti-roll bar Emergency Brake Assist, Emergency Response Child Lock System Central locking system | |

| | | | |
|---|---|---|---|
| **Learning Resources** | 1. William B. Ribbens, "Understanding Automotive Electronics",6th Edition, Newnes, 2003<br>2. BOSCH, Automotive Handbook, 11th Edition, Bentley publishers | 3. Dr. Kirpal Singh, "Automobile Engineering" Volume – 1, 12th Edition,Standard Publishers<br>4. Robert Bosch GmbH -"Safety, Comfort and Convenience Systems"- Wiley; 3rd edition, 2007. | |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (CLA) | | | | Summative Final Examination (40% weightage) | |
|---|---|---|---|---|---|---|---|
| | | Formative CLA-1 Average of unit test (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.MyilavanPalanivel, WABCO India limited ,myilavan@gmail.com | 1. Dr.R.Ben Ruben, Sri Krishna College of Engineeringand Technology, benrubenr@skcet.ac.in | 1. Mr. S. Yokeshwaran, SRMIST |
| | 2. Dr.S.Ramkumar, Vel Tech, drsramkumar@veltech.edu | 2. Dr. K. Kamalakkannan, SRMIST |

| Course Code | 21AUE252T | Course Name | TWO AND THREE WHEELER 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: | provide wide knowledge about the working principles of Two Wheelers Systems, parts identification, assembling, dismantling, maintenance and repairing |
| CLR-2: | distinguish the components of Power storage, chassis and transmission systems for conventional and EVs |

| 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: | classify the different power plants and systems arrangement of petrol and electric vehicles | 3 | - | - | - | - | - | 3- | - | - | - | - | - | 3 | - | - |
| CO-2: | distinguish the components of chassis and transmission systems in two wheelers | 3 | - | 3 | - | - | - | - | - | - | - | - | - | 3 | - | - |
| CO-3: | classify different types of brakes and tires used in two wheelers and their applications | 3 | - | 3 | - | - | - | - | - | - | - | - | - | 3 | - | - |
| CO-4: | describe Dynamic characteristics of two wheelers | 3 | 3 | 3 | - | - | - | - | - | - | - | - | - | 3 | - | - |
| CO-5: | infer the types of three-wheeler constructions for various applications | 3 | - | - | - | - | - | 3 | - | - | - | - | - | 3 | - | - |

**Unit-1 - Power Plant** — **9 Hour**

Power plant components Two stroke and four stroke SI engines - Fuel systems Carburetion, gasoline fuel injection systems. Lubrication systems Ignitionsystem – magneto coil spark ignition system battery coil spark ignition system, electronic ignition system Starting systems Kick starter and electrical systems. Case Study Electric scooter power plant Different types of batteries for electric scooters Different traction motors - Maintenance and Service

**Unit-2 - Chassis and Sub Systems** — **9 Hour**

Chassis and sub systems-components Types of main frames. Drive from engine to rear wheel chain drive – shaft drive Clutch requirements Single plate –multiple plates – centrifugal clutch. Transmission (gear box) gear controls and gear change mechanism CVT for two wheelers - Suspension for front wheels Suspension – for rear wheels Telescopic and gas charged suspension Shock absorbers Panel meters and controls on handle bar

**Unit-3 - Brakes and Wheels** — **9 Hour**

Brakes-introduction Drum brakes-principle, construction and working Disc brakes-principle, construction and working Brake links layout – for front wheels – for rear wheels Brake adjustment Need for ABS in two wheelers Single channel and dual channel ABS Wheels spokes wheel – cast wheel – disc wheel Tires Tube and tubeless tires Radial ply and cross ply tires Tubes – vulcanizing. Tire requirements of electric vehicles

**Unit-4 - Two-wheeler Dynamics** — **9 Hour**

Geometric Consideration – Balance and Steering Gyroscopic Effect with tyre camber and steer force Tyre force – Body Lean- load transfer during squat and dive- Effect of CoG during braking

**Unit-5 - Three Wheelers** — **9 Hour**

Three wheelers-types Case study of Indian model's Front engine auto rickshaws Rear engine auto rickshaws Pickup vans Delivery vans Trailers frames and transmission wheel type's wheel mountings attachment Tyre types. Brake systems. Case Study Electric Three Wheelers – Power storage Traction motors

| | | |
|---|---|---|
| **Learning Resources** | 1. *K.K. Ramalingam., "Two wheelers", Scitech Publications (India)Pvt. Ltd., Chennai 2012.*<br>2. *William H crouse, "Automotive Mechanics", McGraw Hill Education; 10 editions 2017* | 3. *Edward Abdo, Modern motor cycle technology by 3rd Edition, 2015* |

**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. Siva R GMMCO* | 1. *Dr. K. Prabhu, VIT* | 1. *Mr.S.Yokeshwaran SRMIST* |
| 2. *Mr. R. Ravindran GMMCO* | 2. *Mr. S. Sunil MIT* | 2. *Dr.K.Kamalakkannan SRMIST* |

| Course Code | 21AUE351T | Course Name | VEHICLE PERFORMANCE 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:*** | *understand the fundamental of vehicle performance variables* |
| ***CLR-2:*** | *familiarize with the engine sub-systems and engine performance* |
| ***CLR-3:*** | *understand the principles of transmissions, braking and suspension system* |
| ***CLR-4:*** | *understand the principles of transmissions, braking and suspension system* |
| ***CLR-5:*** | *understand the concepts of various vehicle 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:*** | *determine the parameters influencing vehicle performance and predict the performance* | - | - | 2 | - | - | - | - | - | - | - | - | - | 3 | - | - |
| ***CO-2:*** | *diagnose the various engine sub systems for improving engine performance* | - | - | - | 2 | - | - | - | - | - | - | - | - | 3 | - | - |
| ***CO-3:*** | *understand the principles of transmissions, braking and suspension system* | - | - | - | 3 | - | - | - | - | - | - | - | - | 3 | - | - |
| ***CO-4:*** | *familiarize with the operational characteristic of vehicle performance* | 1 | - | - | - | - | - | - | - | - | - | - | - | 3 | - | - |
| ***CO-5:*** | *understand the concepts of various vehicle testing methods* | - | - | - | - | 3 | - | - | - | - | - | - | - | 3 | - | - |

***Unit-1 - Vehicle Performance Estimation and Prediction*** ***9 Hour***

*Aerodynamic drag of road vehicles, methods of estimation of resistance to vehicle motion, power required for propulsion, power plant characteristics withthe requirements of transmission system of vehicles, vehicle controls, arrangements in power train configuration, vehicle acceleration and Vehicle maximum speed Calculation, grade ability performance of vehicles, various drive systems for vehicle requirements, hill climbing requirements, vehicle power requirements for hill climbing, ride characteristics of vehicles on different road surfaces, effect of pressure temperature and humidity on power output, power output.*

***Unit-2 - Engine Performance Analysis*** ***9 Hour***

*Engine compression test, cylinder leakage test, sources of engine noise, methods to reduce noise from the various sources, engine oil issues that affect engine performance, effect of ambient temperature/pressure and its measurement on engine performance, cooling system failure, diagnose the cooling system, power balance test, valve timing test, clearance test, intake system performance, exhaust system performance, boost pressure available from a turbocharger, effect of waste gate on boost pressure, steps in no start diagnosis, scope testing of ignition systems.*

***Unit-3 - Vehicle Transmission Performance*** ***9 Hour***

*Clutch slippage and drag, causes of clutch vibration, performance of automatic transmission systems, power bands in automatic transmission system, performance of transmission fluids, solenoid valve testing method, diagnostic procedure for testing of driveline components, various braking arrangements, performance and characteristics of braking systems effect of weight transfer in vehicles, various steering system arrangements, performance of rigid suspension system, characteristics of rigid suspension system, the performance of independent suspension system, characteristics of independent suspension system, performance characteristics of torsion bar, stabilize*

***Unit-4 - Operational Performance*** ***9 Hour***

*Engine performance parameters- the operating characteristics of engine, operation of engine at full load conditions, operation of engine at part load conditions, various parameters influencing fuel economy, influence of various parameters influencing fuel economy, various conditions of vehicle running, effects of vehicleconditions on fuel economy, effect of various tire and road conditions on fuel economy, effect of various traffic conditions and driving habits on fuel economy, definition of turning circle radius of a vehicle, turning circle radius test of a vehicle, testing of vehicles in a four wheeler chassis dynamometer, performance of vehicles in a four-wheeler chassis dynamometer*

| ***Unit-5 - Vehicle Testing*** | ***9 Hour*** |
|---|---|
| *Fundamentals of acoustics - human response to sound, testing procedure for vehicle power, testing procedure for evaluating fuel consumption, head lightalignment testing, light intensity testing, road testing of vehicles, different test tracks for vehicle testing, initial inspection procedure in vehicle testing, PDI procedure in vehicle testing, maximum speed estimation procedure, maximum acceleration estimation procedure, brake testing of road vehicles, procedure of brake testing of road vehicles, handling characteristics of vehicles on different road surfaces, side slip determination method.* | |

| | | |
|---|---|---|
| **Learning Resources** | 1. *William F.Milliken and Douglas L.Milliken, "Race car vehicle dynamics", 11th edition, SAE, 2018*<br>2. *Peter Wright, "Formula 1Technology", 2001. MartyrA.J,Plint M.A,*<br>3. *EngineTestingTheoryandPractice"3rdedition, Butterworth-Heinemann, 2007.Butter worth Heinemann, 2007.*<br>4. *Ken Pickerill, "Automotive Engineering Engine Performance Shop Manual", Cengage Learning, 2010* | 5. *Thomas D. Gillespie, "Fundamental of Vehicle Dynamics, Society of Automotive Engineers", USA 11th edition, 2006*<br>6. *Wolf-Heinrich Hucho, "Aerodynamics of road vehicles", 4th edition, 2000*<br>7. *Gousha H. M, "Engine Performance Diagnosis & Tune up Shop Manual".*<br>8. *Crouse. W. H, Anglin. D. L, "Motor Vehicle Inspection", McGraw Hill, 2018* |

**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. *Alisha Abdullaha, RACING Academy fo women, AlishaAbdullaha24@gmail.com* | 1. *Dr.R.Jagadeeshwaran, BIT, profresearch@bitsathy.ac.in* | 1. *Jerome Stanley M, SRMIST* |
| 2. *Mr.N.Yogesh, RNTBCI,Yogesh.nagendiran@rntbci.com* | 2. *Mr.R.Ragavendran ITS,Motorsports@hindustanuniv.ac.in* | 2. *Dr.K.Kamalakkannan SRMIST* |

| Course Code | 21AUE352T | Course Name | TYRE 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:*** | *provide a broad overview of the design aspects, materials and application of pneumatic vehicle tyres* |
| ***CLR-2:*** | *impart knowledge on Industrial geometric standards and measurement techniques of 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:*** | *infer the Concepts of Tyre Design* | *3* | *3* | *3* | *3* | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-2:*** | *interpret the applications of pneumatic tyres appropriate to the types of vehicles* | *3* | - | - | - | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-3:*** | *illustrate the Mechanics of Pneumatic tyres* | *3* | *3* | - | *3* | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-4:*** | *determine various parameters such as Load capacity, Deflection, Wear and Durability of Tyres* | *3* | *3* | - | *3* | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-5:*** | *describe the Tyre geometry and its measuring techniques* | *3* | - | *3* | *3* | *3* | - | - | - | - | - | - | - | *3* | - | - |

| ***Unit-1 - Overview of Tyre Technology*** | ***9 Hour*** |
|---|---|
| *Types- Industry Standards - Tyre components –Tyre Design Process - Tyre performance criteria outdoor test - Tyre performance criteria indoor test - Technical Test-Tyre Manufacturing Process Tyre Assembly and Curing* | |
| ***Unit-2 - Applications of Pneumatic Tyres*** | ***9 Hour*** |
| *Two-Wheeler Tyres Castoring Trail for Motor cycle - Internal heat generation - Passenger Car Tyres - ground Contact area – distribution of ground contactPressure - deflation – effects of run flat Truck Tyres - Design Tread patterns Tread compounds Agricultural and Earth Movers Tyres Military Vehicle Tyres, Electric Vehicles specific tyres.* | |
| ***Unit-3 - Mechanics of Tyres*** | ***9 Hour*** |
| *Tyre Axis system Rolling Resistance - Variation of Rolling resistance coefficient of bias ply and radial ply tyres with speed variation with surface textures Effect of Tyre diameter Effect of Tractive and Braking effort Tractive Effort and Longitudinal Slip Behaviour of Tyre under driving torque Variation of Tractive effort with longitudinal Slip Behaviour of Tyre under braking torque Variation of braking effort with longitudinal Slip Cornering Properties slip angle and cornering forcecornering characteristics of bias and radial ply tyres for cars and trucks Self aligning torque Variation of Self aligning torque with slip angle for bias and radial ply tyres Camber and Camber Thrust Variation of Camber thrust with normal load and camber angle for car tyres Models for Cornering Behavior of tires Stretched String model Beam on Elastic foundation model* | |
| ***Unit-4 - Tyre Analysis*** | ***9 Hour*** |
| *Tyre Load Capacity TRA Formula, Basic Formula Constant, Pressure exponent, Section Diameter. Deflection Analysis: Sliding Abraration, Tyre Stiffness and Tyre wear Failure Analysis: Structural Failures In service failure modes Tyre durability, Servicing, maintenance and safety* | |
| ***Unit-5 - Tyre Measurement Techniques*** | ***9 Hour*** |
| *Tyre component Profilometer- Thickness control On roll profile thickness measurement Dimension control – length measurement Width measurement Tyre piece weight measurement Tyre colour inspection Tyre Geometry inspection Tyre Mark Inspection Retrofit- Tyre Geometry line Tyre Uniformityline Tyre balancing line Non Destructive Testing Methods X-ray Examination Shearography Eddy Current* | |

| | | |
|---|---|---|
| **Learning Resources** | 1. US Department of Transportation., "The Pneumatic Tire",February2006<br>2. Tom French, "Tyre Technology" Taylor and Francis 2007 | 3. J. Y. Wong, "Theory of Ground Vehicles", 4th Edition "2008<br>4. H. B. Pacejka "Tyre and vehicle dynamics", Second Edition 2006 |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (CLA) | | | | Summative Final Examination (40% weightage) | |
|---|---|---|---|---|---|---|---|
| | | Formative CLA-1 Average of unit test (50%) | | Life-Long Learning CLA-2 (10%) | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember | 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. Mr. P. Poongumaran, TICEL | 1. Dr.V M Murugesan Vnm.auto@psgtech.ac.in | 1. Mr.S.Yokeshwaran SRMIST |
| 2. Mr. G. Thanigaiarasu, RNTBCI | 2. Dr.K.Prabu VIT Prabu.k@vit.ac.in | 2. Dr.K.Kamalakkannan SRMIST |

| Course Code | 21AUE353T | Course Name | MOTORSPORT 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: | understand the fundamental of race car, system, concept, and design |
| CLR-2: | familiarize with the aerodynamics employed in racing cars |
| CLR-3: | understand the principles of Primary, Secondary Chassis Set-ups |
| CLR-4: | familiarize with the suspension geometry, design and dampers in racing cars |
| CLR-5: | understand the structure and design of final drives and braking system in racing cars |

| 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: | demonstrate their knowledge on the fundamentals of race car design and development | 3 | 1 | 2 | - | - | - | - | - | - | - | - | - | 3 | - | - |
| CO-2: | asses Aerodynamics employed in racing cars | 3 | 3 | - | 2 | - | - | - | - | - | - | - | - | 3 | - | - |
| CO-3: | interpret the effects of various dynamic conditions on a race car chassis | 3 | 3 | - | 2 | - | - | - | - | - | - | - | - | 3 | - | - |
| CO-4: | compare and classify the different types of suspension systems used in racing | 3 | - | 1 | - | - | - | - | - | - | - | - | - | 3 | - | - |
| CO-5: | identify the appropriate drives and braking systems for the required racing applications | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 3 | - | - |

**Unit-1 - Race Car Design and Development** — **9 Hour**

*Problems Imposed by Racing- Racing Objectives, Rule book and Regulations, "g-g" Diagram- Road car vs race car, Constraints and Specifications – Performance and Handling, Structure, Weight distribution, Driver Accommodation and Safety, Tire and Adjustable feature, Preliminary Design and Analysis, Driver-Vehicle Relationship, Desirable Vehicle Characteristics. Fundamentals of Testing- Track Test Program Planning, Test Methodology, Circular Skid Pad Testing. Case study- 1955 Mercedes W196 Grand Prix car. Case study- 1998 Ferrari F300 Grand Prix car*

**Unit-2 - Race Car Aerodynamics** — **9 Hour**

*Aerodynamic Forces and Moments, Race car drag components, Drag Estimation and Drag Improvement, Ground Effects in a race car, Ground Plane Simulation in Race Car Applications, Spoilers, Dams, Wings, Effectiveness of Wings in Steady State Cornering, High Lift Devices- Flaps and Slats. Flow Control Devices- Dams, Fences, Vanes, Skirts, Spoilers. Vortex Creating Devices- Ledges, Edge, Cusps, Lips. Pressure Change Creation Devices-Perforations, Vents, Bleeds, Scoops, Seals. Active Flow Control Devices- Internal Airflow, RAM Air Ducted Radiator, Air Entrance Scoop. Full size wind tunnel testing, Case study: Chaparral wings, Case study: Formula Benetton's pressurized, half-scale wind tunnel. Case study: Moving ground plane Benetton's wind tunnel*

**Unit-3 - Race Car Chassis** — **9 Hour**

*Conditions for Traversing a 90° Corner, Chassis Tuning Set-ups, Effects of High-Speed Braking, Effects of High-Speed Cornering, Effects of Combined Braking Cornering, Steady State Cornering, Acceleration Out of a Corner, Straight Line Acceleration, Throttle Behaviour, Steering Wheel Force and Kick back, Moving CG Position, Ballasts. Effect of engine weight reduction on longitudinal CG position. Roll Center Position Changing Anti-Pitch geometry, Chassis Steering Axis Geometry, changing camber, Chassis Ride Roll Characteristics, Chassis Track Width, Chassis Ride Spring Rate, Tires and Rims, Adjusting Roll Stiffness and Roll Stiffness distribution. Case Study: Development of Monocoque chassis by Colin Chapman, LOTUS; Case Study: Evolution of Carbon Fiber Materials in F1 racing history*

| | |
|---|---|
| ***Unit-4 - Race Car Suspension System*** | ***9 Hour*** |
| *Front Suspension- General Design Consideration and performance features, Camber Effects- McPherson Struts, SLA Suspension, SLA suspension geometry, Instant Axis Concept. Rear Suspension-SLA Rear Suspension, Beam Axle Rear Suspensions, Decoupled Rear Axle Suspension, and F1 car suspension: Double wishbone and outboard spring, Top rocker and Inboard spring, pull-rod and inboard spring, Push rod and vertical coil spring, push rod and horizontal coil spring and damper, Push rod and Vertical torsion bar with horizontal damper. Suspension Springs- Torsion Springs, Coil Springs, Progressive Rate Coil Springs. Installation Consideration, Damping in Racing- Ride/Handling Compromise, Steering Activity, Transient Maneuvering, Bump Damping and Rebound Damping, Racing damper schematic.* | |
| ***Unit-5 - Race Car Drives and Braking Systems*** | ***9 Hour*** |
| *Merits of Front and Rear wheel drive in racing, Four-Wheel Drive in Racing, Differentials used in Racing- Open Differentials, Locked (Spool) Differentials. Limited Slip Differential, Traction Control and Other Electronic Improvements in Racing, Mechanical Components in Braking System, Limitations and Considerations of Braking in Racing, Brake Boost in racing, Effects of "g" Force on Brake Fluids, Brake Hydraulics, Brake Ventilation, Brake Distribution, ABS in Racing, Carbon-Carbon discs. Case study: Ferrari F300 two-pedal arrangement for braking.* | |

| | | |
|---|---|---|
| **Learning Resources** | 1. *William F.Milliken and Douglas L.Milliken, "Race car vehicledynamics", 11th edition, SAE, 2018*<br>2. *Peter Wright, "Formula 1Technology", 2001.* | 3. *Thomas D. Gillespie, "Fundamental of Vehicle Dynamics, Society ofAutomotive Engineers", USA 11th edition, 2006*<br>4. *Wolf-Heinrich Hucho, "Aerodynamics of road vehicles", 4th edition, 2001* |

**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. *Ms. Alisha Abdullaha, RACING Academy for women, AlishaAbdullaha24@gmail.com* | 1. *Dr.R.Jagadeeshwaran, BIT, profresearch@bitsathy.ac.in* | 1. *Mr. Jerome Stanley M, SRMIST* |
| 2. *Mr.N.Yogesh, RNTBCI,Yogesh.nagendiran@rntbci.com* | 2. *Dr. Ganesh P, SVCE* | 2. *Dr.K.Kamalakkannan SRMIST* |

| Course Code | 21AUE354T | Course Name | AUTOMOTIVE NVH | 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 NVH concepts in automotive context* |
| ***CLR-2:*** | *learn the sources of noise and vibration in automotive vehicles* |
| ***CLR-3:*** | *learn the noise and vibration control techniques for automotive vehicles* |
| ***CLR-4:*** | *know the importance of vehicle body NVH* |
| ***CLR-5:*** | *familiarize with the NVH issues in hybrid and electric vehicles* |

| 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:*** | *comprehend the creation, propagation and measurement of noise* | *3* | *3* | - | - | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-2:*** | *classify and interpret the various sources of noise and vibration in automotive vehicles* | *3* | *3* | - | - | - | - | - | - | - | - | - | - | *3* | 2 | - |
| ***CO-3:*** | *select the appropriate noise and vibration control technique in automotive vehicles* | *3* | *3* | - | - | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-4:*** | *emphasize the importance of modal analysis of vehicle bodies in vibration control* | *3* | *3* | - | - | - | - | - | - | - | - | - | - | *3* | 2 | - |
| ***CO-5:*** | *differentiate the NVH issues in conventional IC engine vehicles and Electric vehicles* | *3* | *3* | - | - | - | - | - | - | - | - | - | - | *3* | - | - |

***Unit-1 - NVH and Vehicle Refinement*** — ***9 Hour***

*NVH – Meaning of Noise, Vibration and Harshness in automotive context. Vehicle Refinement – Purpose, History, Targets of vehicle refinement. Acoustics – Creation and Propagation of sound, Decibel scale. Physical concepts - relationship among sound power, intensity and pressure level, Octaveband analysis. Noise measurement – Instrumentation, Reference quantities, Decibel scale. Human hearing – Anatomy of human ear, Mechanism of hearing.*

***Unit-2 - Noise and Vibration Sources*** — ***9 Hour***

*Noise Control – Control at source, Control along the path/Noise path analysis. Structure borne noise and vibration control through damping– Damping phenomenon, Material damping, friction damping, Surface damping treatments. Structure borne noise and vibration control through stiffness – Mechanism,Stiffness tuning, Vibration control - isolation and absorption techniques, Vibration absorber, isolation of masses, isolation at high frequencies. Engine and related systems – Engine balancing, Engine mounts, Tuned absorbers. Wind Noise – Control techniques and Methods. Squeak / Rattle – Control strategy during vehicle development, design integration of body structure, Material friction pair matching,*

***Unit-3 - Noise and Vibration Control*** — ***9 Hour***

*Noise Control – Control at source, Control along the path/Noise path analysis. Structure borne noise and vibration control through damping– Damping phenomenon, Material damping, friction damping, Surface damping treatments. Structure borne noise and vibration control through stiffness – Mechanism, Stiffness tuning, Vibration control - isolation and absorption techniques, Vibration absorber, isolation of masses, isolation at high frequencies. Engine and related systems – Engine balancing, Engine mounts, Tuned absorbers. Wind Noise – Control techniques and Methods. Squeak / Rattle – Control strategy during vehicle development, design integration of body structure, Material friction pair matching,*

***Unit-4 - Whole Body Vibration and Sound Packaging*** — ***9 Hour***

*Whole body vibration – Scope for study, Body stiffness, Modes and Modal analysis. Overall body stiffness – Body bending stiffness, Body Torsional stiffness, Testing and Analysis, Stiffness control, Effect of body cross section. Modal shape and frequency – Whole body modes, frequency, Modal testing, Control of body modes. Sound packaging – Necessity and scope, Body sealing. Sound absorption – Mechanism and materials for sound absorption coefficient, Insulation materials and structures. Application of sound packaging – Sound absorptive materials and structures, Sound baffle material.*

| ***Unit-5 - NVH in Hybrid and Electric Vehicles*** | ***9 Hour*** |
|---|---|
| *NV causes and sources in Electric Vehicles. Electromagnetic causes – Electromagnetic vibration, Magnetostrictive noise, Vibration and Noise control, Power electronics noise and its control. Mechanical causes – Bearings, Rotor imbalance, Bent shaft. Aerodynamic noise – Aerodynamic noise in Electricmotors and their cause. Battery System – Low frequency vibrations of battery pack, Driveline vibrations on battery pack, Vibration control. Noise Control of Electric Motors – Whistling Noise, Pole shape optimization of motors, Active regulation of current.* | |

| | | |
|---|---|---|
| **Learning Resources** | 1. *Mathew Harrison, "Vehicle Refinement Controlling Noise and Vibration in Road Vehicles", SAE International, USA. First Edition, 2004. ISBN: 0 7680 1505 7*<br>2. *Jian Pang., "Noise and Vibration Control in Automotive Bodies)", Dwiley China Machine Pres, 2019, ISBN: 9781119515494.* | 3. *Xu Wang., "Vehicle Noise and Vibration Refinement", Woodhead Publishing India Pvt. Ltd. New Delhi, 2010. ISBN: 978-1-84569-497-5.* |

**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. *Mr. Siva R GMMCO* | 1. *Dr. K. Prabhu, VIT* | 1. *Dr.K. Kamalakkannan, SRMIST* |
| 2. *Mr. R. Ravindran GMMCO* | 2. *Mr. S. Sunil MIT* | 2. *Dr.A.J.D. Nanthakumar, SRMIST* |

| Course Code | 21AUE355T | Course Name | ADVANCED VEHICLE 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:*** | *understand electric and hybrid vehicle operation and architectures* |
| ***CLR-2:*** | *analyze the suspension system used in automobiles* |
| ***CLR-3:*** | *understand various emissions and noise pollution control techniques* |
| ***CLR-4:*** | *understand the fundamentals of modern sensors, actuators, ignition and injection systems* |
| ***CLR-5:*** | *understand the basics of control system used in automobiles* |

| 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:*** | *recognize various trends in automotive power plants* | *3* | *3* | *1* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *3* | *-* | *-* |
| ***CO-2:*** | *gain knowledge about various modern suspension and braking systems* | *3* | *3* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *3* | *-* | *-* |
| ***CO-3:*** | *identify suitable methods to reduce the noise emission and categorize the emission norms* | *3* | *3* | *-* | *2* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *3* | *-* | *-* |
| ***CO-4:*** | *apply the function, construction and operation of various sensors and actuators* | *3* | *3* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *3* | *-* | *-* |
| ***CO-5:*** | *acquire knowledge about automated tracks for safe and fast travel* | *3* | *3* | *2* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *3* | *-* | *-* |

| ***Unit-1 - Trends in Automotive Power Plants*** | ***9 Hour*** |
|---|---|
| *Introduction to power plant Lean Burn Engines Stratified Charged Hydrogen Engines Hybrid Vehicles Electric Vehicles Fuel Cell Vehicles Magnetic Track Vehicles* | |
| ***Unit-2 - Suspension and Brakes*** | ***9 Hour*** |
| *Interconnected Air and Liquid Suspensions Hydro Elastic Suspension System Hydro Gas Suspension Closed Loop Suspension Active Suspension Modern Rear Wheel Brake Self-Energizing Disc Brake Indirect Floating Caliper Disc Brake Limiting Device Power–Assisted Braking System Anti-Skid System Regenerative Braking* | |
| ***Unit-3 - Emission and Noise Pollution Control*** | ***9 Hour*** |
| *Sources of Pollution. Various emissions from Automobiles Formation — Effects of pollutants on environment human beings Emission control techniques Emission standards Engine Emissions, Types of Catalytic Conversion Charcoal Canister CI engine emission and its control Formation — Smokes, NOx, soot, sulphur particulate Control Techniques-Fumigation, EGR, HCCI, Particulate Traps, SCR sources of Noise Engine Noise, Transmission Noise, vehicle Structural Noise, aerodynamics noise Exhaust Noise. Noise reduction in Automobiles Noise Control Techniques Silencer Design. Noise Control Techniques.* | |
| ***Unit-4 - Vehicle Operation and Control*** | ***9 Hour*** |
| *Automotive Electronics Sensors: Position, speed Acceleration/Vibrational, Force/Torque, Flow meters, Automotive Actuators Electromechanical Actuators Fluid-mechanical actuators Computer Control for pollution, noise and for fuel economy Basics of networks Examples of networked Vehicles - Bus system Control area network in vehicle Electronic Fuel Injection Electronic Ignition system* | |
| ***Unit-5 – Vehicle Automated Tracks*** | ***9 Hour*** |
| *automated tracks Road network Preparation Maintenance of Proper Road Network Traffic survey road priority index Automated highway system National Highway Network with Automated Roads and Vehicles Satellite Control of Vehicle Operation for Safe and Fast Travel Intelligent transportation systems Transducers and Operation Of The Vehicle Like Optimum Speed And Direction* | |

| | | |
|---|---|---|
| **Learning Resources** | 1. *T. K. Garrett "The Motor Vechicle"., 13th edition 2009.*<br>2. *Dr. N.K. Giri, "Automobile Mechanic", Khanna Publishers, 2006 Beranek. L.L. "Noise Reduction"., McGraw-Hill Book Co., Inc,Newyork, 199* | 3. *Heinz Heisler, "Advanced vehicle technology"., elsevier Store.2002 Crouse/Anglin "Automotive Mechanics" Career Education; 10th editionJanuary 13, 1993*<br>4. *Bosch Hand Book"., 3rd Edition, SAE,1993* |

**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. MyilavanPalanivel, WABCO india limited,myliavan@gmail.com* | 1. *Dr.P D Jeyakumar, Cresent University, pdjeyakumar@cresent.education.* | 1. *Mr. S. Yokeshwaran, SRMIST* |
| | | 2. *Dr K. Kamalakkannan SRMIST* |

| Course Code | 21AUE451T | Course Name | AUTOMOTIVE SAFETY AND ERGONOMICS | 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:*** | *impart knowledge on basics of vehicle construction details and its effects* |
| ***CLR-2:*** | *know the various safety concepts used in passenger cars* |
| ***CLR-3:*** | *gain knowledge about various safety systems and its equipment* |
| ***CLR-4:*** | *understand the concepts of vehicle ergonomics* |
| ***CLR-5:*** | *interpret the various automotive comfort feature* |

| Course Outcomes (CO): | *At the end of this course, learners will be able to:* | Program Outcomes (PO) | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 Engineering Knowledge | 2 Problem Analysis | 3 Design/development of solutions | 4 Conduct investigations of complex problems | 5 Modern Tool Usage | 6 The engineer and society | 7 Environment & Sustainability | 8 Ethics | 9 Individual & Team Work | 10 Communication | 11 Project Mgt. & Finance | 12 Life Long Learning | PSO-1 | PSO-2 | PSO-3 |
| ***CO-1:*** | *understand the fundamentals of design and construction of vehicle body* | *3* | - | - | *2* | - | - | *2* | - | - | - | - | - | *3* | - | - |
| ***CO-2:*** | *classify the various safety parameters such as interior and exterior safety concepts* | *3* | - | *2* | - | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-3:*** | *understand the concepts of active and passive safety systems for real time application* | *3* | - | - | - | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-4:*** | *implement the vehicle ergonomics for enhancing the comfort level* | *3* | - | *2* | - | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-5:*** | *describe the different types of comfort and convenience systems* | *3* | - | - | *1* | - | - | - | - | - | - | - | - | *3* | - | - |

***Unit-1 - Design and Construction of Vehicle Body*** — ***9 Hour***

*Introduction to design and construction of vehicle body - Design of the body for Safety. Energy equations, Engine location - Effects of deceleration insidepassenger compartment - Deceleration on impact with stationary and movable obstacle - Concept of crumble zone and safety sandwich construction - Characteristics of vehicle structures - Optimization of vehicle structures for crash worthiness - Types of crash / Rolls over tests - Regulatory requirements for crash testing - Instrumentation, High speed photography – Image analysis.*

***Unit-2 - Interior and Exterior Safety Concepts*** — ***9 Hour***

*Safety concepts- Introduction - Active safety, Driving safety, Conditional safety - Perceptibility safety - Operating safety - Passive safety – Exterior andInterior safety systems - Deformation behaviour of vehicle body - Speed and acceleration characteristics of passenger compartment on impact – Pedestrian safety - Human impact tolerance- Determination Of injury thresholds - Severity index, Study of comparative tolerance - Study of crash dummies.*

***Unit-3 - Active and Passive Safety Systems*** — ***9 Hour***

*Introduction to safety systems - Seat belt, Automatic seat belt fastening system - Collapsible steering column - Tiltable steering wheel - Air bags - Electronic systems for activating air bags - Frontal design for safety - Collision warning system - Causes of rear end collision, frontal and rear object detection - Object detection system with braking system interactions - Anti-lock braking system - ESP And EBD Systems - Adaptive Cruise Control (ACC) - Navigation systems, traffic telematics -Infrared night vision system.*

***Unit-4 - Vehicle Ergonomics*** — ***9 Hour***

*Introduction to human body - Anthropometrics and its application to vehicle ergonomics - Cockpit design - Driver comfort – seating, visibility - Driver comfort –Seat pan, Back rest, Steering wheel, Head rest and mirrors - Man-Machine system - Psychological factors – stress, attention - Passenger comfort - Ingress and Egress – Spaciousness – Ventilation, Temperature control - Dust and fume prevention - Interior features and conveniences - Placement of vehicle controls and use of modern technologies.*

| ***Unit-5 - Comfort and Convenience Systems*** | ***9 Hour*** |
|---|---|
| *Comfort and Convenience Systems- Introduction - Cabin comfort - In-Car air conditioning – overall energy efficiency - Air Management, Central and unitary systems, Air flow circuits - Air Cleaning, Ventilation, Air space diffusion - Compact heat exchanger design, Controls and Instrumentation - Steering and mirror adjustment – Central locking system – Garage door opening system – Tire pressure control system – Rain sensing systems – Environment information system – Automotive lamps and its types, design, construction and performance – Light signaling devices – stop lamp, Rearposition lamp, Direction indicator, Reverse lamp, Reflex indicator - Gas discharge lamp, LED - Adoptive Front Lighting System (AFLS) – Daylight Running Lamps (DRL) - Role of MCU in security and safety features.* | |

| **Learning Resources** | | |
|---|---|---|
| | 1. *Prasad, Priya and Belwafa Jamel, "Vehicles Crashworthiness and Occupant Protection", American Iron and Steel Institute, USA. 2017*<br>2. *JullianHappian-Smith "An Introduction to Modern Vehicle Design"SAE, 2002* | 3. *Bosch - "Automotive Handbook" - 10th edition - SAE publication - 2018.4."Recent development in Automotive Safety Technology", SAE International Publication. Editor: Daniel J Helt, 2013.*<br>4. *Keitz H.A.E. "Light Calculations and Measurements", Macmillan 4th edition 2019.* |

**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. Dhanraj domalaXitadel, Dhanraj.domala@xitadel.com* | 1. *Dr.V. Uma Maheshwar, Osmania University,mahesh.v@uceou.edu,* | 1. *Dr.K.Kamalakkannan SRMIST* |
| 2. *Mr.GopalDhanasekar, ATS Gopal.dhanasekar@ats_india.com* | 2. *Mr.A.Muthuvel, Sairam Engineering College, Muthuvel.mech@sairamce.edu.in* | 2. *Mr.S. Kiran, SRMIST* |

| Course Code | 21AUE452T | Course Name | VEHICLE BODY ENGINEERING AND AERODYNAMICS | 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:*** | *identify different types of vehicle body structures and their details* |
| ***CLR-2:*** | *know the details of bus bodies, classification and its regulations* |
| ***CLR-3:*** | *impart knowledge on the concept of car aerodynamics and testing of scale models* |
| ***CLR-4:*** | *classify different types of commercial vehicles and its types* |
| ***CLR-5:*** | *understand the various concepts of commercial vehicle aerodynamics* |

| 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 fundamentals of various automotive body construction details* | *3* | - | - | - | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-2:*** | *classify the various types of bus body construction and able to identify the body layout* | *3* | - | *2* | - | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-3:*** | *understand the concepts of car aerodynamics in body engineering for better style and low drag* | *3* | - | - | - | - | - | *2* | - | - | - | - | - | *3* | - | - |
| ***CO-4:*** | *select a suitable body optimization technique to minimize drag and able to describe the wind tunnel testing procedure* | *3* | - | *2* | *1* | - | - | - | - | - | - | - | - | *3* | - | - |
| ***CO-5:*** | *describe the different types of commercial vehicles and its design Apply the concept of commercial vehicle aerodynamics for reducing the drag* | *3* | - | - | *2* | - | - | - | - | - | - | - | - | *3* | - | - |

***Unit-1 - Car Body Details and its Safety Features*** ***9 Hour***

*History - Evolution of vehicle body, Importance of vehicle body - Car Body Terminologies & types of car bodies - Visibility - Forward visibility - Forwardvision measurement and Regulations - Driver's Visibility, All round visibility of the vehicle – sensors and its functions - Methods of improving visibility.- Safety - factors influencing safety in traffic - Classification - Active & Passive safety - Active safety - Driving, Conditional, Perceptibility & Operational safety - Passive safety - Interior & Exterior safety - Safety aspects in design - Bumper end, front and rear end - Active Safety devices - Passive Safety devices - Air bag - Telescopic/Collapsible Steering column - Modern Painting process of a passenger car body - Selection of paint and painting process - Corrosion and Anti corrosion methods.*

***Unit-2 - Public Transport Vehicles and its Details*** ***9 Hour***

*Introduction to bus bodies - Bus body panels & terminologies - Classification of bus body - Based on distance travelled by the vehicle - Based on capacityof the vehicle - Based on shape and style of the vehicle - Based on types of metal section used - Bus body regulations - Sequence of bus building operation - Construction of conventional type of bus body - Construction of Integral type of bus body - Comparison of test results of integral and conventional bus. – Frame construction and Double skin construction.*

***Unit-3 - Commercial Vehicle Details*** ***9 Hour***

*Car Aerodynamics – Introduction - Importance of Aerodynamics – Types of Aerodynamic drag - Various Aerodynamic forces and moments and its effects - Various body optimization techniques for minimum drag - Wind tunnel technology - Principle & Construction details – Types of wind tunnels - Flow visualization techniques – Smoke method, Tuft method, Oil coating method - Testing with wind tunnel balance (scale models)*

***Unit-4 - Commercial Vehicle Details*** ***9 Hour***

*Commercial vehicles – Introduction - Classification of Commercial vehicle bodies - LCV – Light commercial vehicles and its types – Pickups and delivery vans -HCV - Heavy commercial vehicles and its types - Dimensions of commercial vehicle driver's seat in relation to various controls - Constructional details of Tanker body - Constructional details of Tipper body - Various tipping methods and mechanisms - Flat platform and drop side body construction - Segmental design of driver's cab - Compactness of Driver's cab.*

| ***Unit-5 - Commercial Vehicle Aerodynamics*** | ***9 Hour*** |
|---|---|
| *Commercial vehicle aerodynamics – Introduction - Importance of Commercial vehicle Aerodynamics - Effects of rounding sharp front body edges - Effects of various cabs on trailer body - Fore body pressure distribution - Effect of Cab to trailer body roof height - Effects of a cab to trailer body gap seals - Commercial vehicle drag reducing devices - Cab roof deflectors & Corner Vanes - Vortex generators and Diffusers - Tractor and Trailer Skirting - Effect of Trailer load position on vehicle's drag resistance.* | |

| | | |
|---|---|---|
| **Learning Resources** | 1. *Pawloski J, " Vehicle Body Engineering" - Business Books Ltd.,*<br>2. *Wolf-Heinrich Hucho, "Aerodynamics of road vehicles", 4th edition,2000.* | 3. *John Fenton, "Vehicle Body layout and analysis", Mechanical EngineeringPublication Ltd., 2004*<br>4. *Heinz Heisler, "Advanced Vehicle Technology", 2nd edition,Butterworth – Heinemann, 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* | *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** |
|---|---|---|
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| 2. *Mr.V.Raja Raman Altair, rajarav@asiapac.altair.com* | 2. *Mr.A.Muthuvel, Sairam College of Engioneering, muthuvel.mech@sairamce.edu.in* | 2. *Mr.S.Kiran ,SRMIST* |

# SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

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