VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI.

Scheme of Teaching and Examinations and Syllabus
M.Tech Automotive Engineering (MAU)
(Effective from Academic year 2020 - 21)

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2020 - 21
M.Tech Automotive Engineering (MAU)
Choice Based Credit System (CBCS) and Outcome Based Education(OBE)

I SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours per Week			Examination				Credits
				Theory	Practical	Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PCC	20MAU11	Advanced Mathematical Methods in Engineering	03	--	02	03	40	60	100	4
2	PCC	20MAU12	Advances in Automotive engines & systems	03	--	02	03	40	60	100	4
3	PCC	20MAU13	Noise Vibration Harshness	03	--	02	03	40	60	100	4
4	PCC	20MAU14	Automotive Chassis & power transmission	03	--	02	03	40	60	100	4
5	PCC	20MAU15	Alternative fuels, engine emission & emission control norms	03	--	02	03	40	60	100	4
6	PCC	20MAUL16	Automotive Engineering Laboratory-I	--	04	--	03	40	60	100	2
7	PCC	20RMI17	Research Methodology and IPR	01	--	02	03	40	60	100	2
			TOTAL	**17**	**04**	**12**	**21**	**280**	**420**	**700**	**24**

Note: PCC: Professional core.

Skill development activities:
Students and course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills.
The students should interact with industry (small, medium and large), understand their problems or foresee what can be undertaken for study in the form of research/ testing / projects, and for creative and innovative methods to solve the identified problem.
The students shall
(1) Gain confidence in modelling of systems and algorithms.
(2) Work on different software/s (tools) to Simulate, analyse and authenticate the output to interpret and conclude. Operate the simulated system under changed parameter conditions to study the system with respect to thermal study, transient and steady state operations, etc.
(3) Handle advanced instruments to enhance technical talent.
(4) Involve in case studies and field visits/ field work.
(5) Accustom with the use of standards/codes etc., to narrow the gap between academia and industry.
All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc.

Internship: All the students have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed internship credit shall be counted for the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

Note: (i) Four credit courses are designed for 50 hours Teaching – Learning process.
(ii) Three credit courses are designed for 40 hours Teaching – Learning process.
(iii) Two credit courses are designed for 25 hours Teaching – Learning process.

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II SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ Seminar	Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PCC	20MAU21	Vehicle dynamics	03	--	02	03	40	60	100	4
2	PCC	20MAU22	Autotronics	03	--	02	03	40	60	100	4
3	PCC	20MAU23	Automotive body	03	--	02	03	40	60	100	4
4	PEC	20MAU24X	Professional elective 1	04	--	--	03	40	60	100	4
5	PEC	20MAU25X	Professional elective 2	04	--	--	03	40	60	100	4
6	PCC	20MAUL26	Automotive Engineering Laboratory-II	--	04	--	03	40	60	100	2
7	PCC	20MAU27	Technical Seminar	--	02	--	--	100	--	100	2
TOTAL				**17**	**06**	**06**	**18**	**340**	**360**	**700**	**24**

Note: PCC: Professional core, PEC: Professional Elective.

Professional Elective 1		**Professional Elective 2**	
Course Code under 20MAU24X	**Course title**	**Course Code under 20MAU25X**	**Course title**
20MAU241	Driverless vehicles	20MAU251	Advanced Machine Design
20MAU242	Vehicle performance	20MAU252	SI and CI Engine Processes
20MAU243	Automotive control systems	20MAU253	Computational fluid dynamics
20MAU244	Engine management systems	20MAU254	Design of Heat Transfer Equipment

Note:
1. Technical Seminar: CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Participation in the seminar by all postgraduate students of the programme shall be mandatory.
The CIE marks awarded for Technical Seminar, shall be based on the evaluation of Seminar Report, Presentation skill and performance in Question and Answer session in the ratio 50:25:25.
2. Internship: All the students shall have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the

prescribed internship credit shall be counted in the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

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III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ Mini–Project/ Internship	Skill Development activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PCC	20MAU31	Hybrid and Electric vehicles	03	--	02	03	40	60	100	4
2	PEC	20MAU32X	Professional elective 3	03	--	--	03	40	60	100	3
3	PEC	20MAU33X	Professional elective 4	03	--	--	03	40	60	100	3
4	Project	20MAU34	Project Work phase -1	--	02	--	--	100	--	100	2
5	PCC	20MAU35	Mini-Project	--	02	--	--	100	--	100	2
6	Internship	20MAUI36	Internship	(Completed during the intervening vacation of I and II semesters and /or II and III semesters.)			03	40	60	100	6
TOTAL				**09**	**04**	**02**	**12**	**360**	**240**	**600**	**20**

Note: PCC: Professional core, PEC: Professional Elective.

Professional elective 3		**Professional elective 4**	
Course Code under	**Course title**	**Course Code under**	**Course title**
20MAU321	Automotive Embedded Systems	20MAU331	Machine Learning
20MAU322	Industry 4.0 And IIOT In Automotive Vehicles	20MAU332	Artificial Intelligence
20MAU323	Advanced Manufacturing Technology	20MAU333	Finite Element Method
20MAU324	Vehicle Aerodynamics & Ergonomics	20MAU334	Automotive Materials

Note:
1. Project Work Phase-1: Students in consultation with the guide/co-guide if any, shall pursue literature survey and

complete the preliminary requirements of selected Project work. Each student shall prepare relevant introductory project document, and present a seminar.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill and performance in Question and Answer session in the ratio 50:25:25.

SEE (University examination) shall be as per the University norms.

2. Internship: Those, who have not pursued /completed the internship shall be declared as fail in internship course and have to complete the same during subsequent University examinations after satisfying the internship requirements. Internship SEE (University examination) shall be as per the University norms.

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IV SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work	Duration in hours	CIE Marks	SEE Marks Viva voce	Total Marks	
				L	P					
1	Project	20MAU41	Project work phase -2	--	04	03	40	60	100	20
			TOTAL	--	**04**	**03**	**40**	**60**	**100**	**20**

Note:

1. Project Work Phase-2:

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a Senior faculty of the department. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report subjected to plagiarism check, Project Presentation skill and performance in Question and Answer session in the ratio 50:25:25.

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.

Advanced Mathematical Methods in Engineering

Course Code	20MAU11	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Errors and Simple Mathematical modelling: Error definition, round off errors and truncation errors. Mathematical modelling and Engineering problem solving: Simple mathematical model, Conservation Laws of Engineering. Engineering Applications on : Deflection of Beams, Whirling of shafts, Terminal velocity of a freely falling body.

Module-2

Roots of Equations by Numerical Methods: Newton- Raphson method, Horner's Method. Muller's method ,Barstow's (or Lin's method) , Graeffe's roots squaring method

(RBT Levels: **L1 & L2)**

Module-3

Ordinary Differential Equations: Solving ODE"s using: Picard's method, Runge-Kutta fourth order, Runge-Kutta Fehlberg method, Stiffness of ODE using shooting method, Boundary value problems.

(RBT Levels: **L1 & L2)**

Module-4

Partial Differential Equations: Classification of second order Partial Differential Equations. Solution of One dimensional wave equation,(Schmidt`s explicit formula), One dimensional heat equation by Schmidt method, Crank- Nicholson method, and Du Fort-Frankel method

(RBT Levels: **L1 & L2)**

Module-5

Sampling Theory: Testing of hypothesis using t and χ^2 test, Goodness of fit, F-test, Analysis of Variance: One – way with/without interactions, problems related to ANOVA, Design of experiments, RBD.

(RBT Levels: **L1,L2, L3&L4)**

Course outcomes:

At the end of the course the student will be able to:

CO1: Acquire the idea of significant figures, types of errors during numerical computation.

CO2: Develop the mathematical models of thermal system using ODE's and PDE's.

CO3: Learn the deterministic approach for statistical problems by using probability distributions.

CO4: Demonstrate the validity of the hypothesis for the given sampling distribution using standard tests and understand the randomization on design of experiments.

CO5: Classify and analyze mathematical tools applied to thermal engineering study cases

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

(1)M K Jain, S.R.K Iyengar, R K. Jain, Numerical methods for Scientific and engg computation, New Age International, 2003

(2) B.S. Grewal: Higher Engineering Mathematics, Khanna Publishers, 44th Ed., 2017

(3) 3. Steven C Chapra and Raymond P Canale, "Numerical Methods for Engineers," 7th Ed., cGraw-Hill Edition, 2015.

Reference Books

(1) William W.H., Douglas C.M., David M.G.and Connie M.B., "Probability and Statistics in Engineering, 4th Edition, Willey Student

(2) Dr. B.S. Grewal, "Numerical Methods in Engineering and Science", Khanna Publishers, 1999.

(3)K Shankar Rao, "Introduction to Partial Differential Equations" Prentice - Hall of India Pvt. Lt. , 1995 Edition.

(4) C. Ray Wylie and Louis C Barrett, "Advanced Engineering Mathematics". 6th edition, McGraw-Hill, 1995.

ADVANCES IN AUTOMOTIVE ENGINES & SYSTEMS

Course Code	20MAU12	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Fuel Supply and Injection Systems:

SI Engine: Types and Components of fuel injection systems, Continuous injection system, Timed injection system, Electronic Fuel Injection systems (EFIs), Merits and Demerits electronic , Multi point fuel injection system(MPFI), Functional divisions of MPFI system, Electronic control system, Injection timing, Group gasoline injection system

C.I. Engines: Fuel injection pump systems- Types, constructional features and operation, Factors influencing fuel spray atomization, penetration and dispersion of diesel, Fuel Injection Pumps (inline, rotary), Electronic diesel injection system, Electronic diesel injection control.

Module-2

Ignition system:
Energy requirements for ignition, Requirement of an ignition system, Battery ignition system, its operation and limitations, Dwell angle, 12V ignition system, 42 V ignition system, Magneto ignition system,
Modern ignition systems: Transistorized (TCI) and Capacitive Discharge (CDI), Firing order, Ignition timing and engine parameters, Spark advance mechanism, Ignition timing and exhaust emissions.
(RBT Levels: **L1 & L2)**

Module-3

Cooling and Lubrication System:

Cooling System: Necessity, variation of gas temperature, Areas of heat flow,heat transfer, piston and cylinder temperature, Heat rejected to coolant,quantity of water required, cooling system, air cooling, water cooling thermodynamics of forced circulation, thermostats, pressurized water cooling,regenerative cooling, comparison of air and water cooling, radiators types,cooling fan – power requirement, antifreeze solution.

Lubrication System: Lubricants, lubricating systems, Lubrication of piston rings, bearings, oil consumption, Oil cooling. Heat transfer coefficients, liquid and air cooled engines, coolants, additives and lubricity improvers, oil filters, pumps, and crankcase ventilation – types

(RBT Levels: **L1 & L2)**

Module-4

Engine Management System: Combined ignition and fuel managementsystems, Digital control techniques. Complete vehicle control systems. Artificial intelligence and engine management, Exhaust emission control in SI and CIengines Techniques.

(RBT Levels: **L1 & L2)**

Module-5

Supercharger and Turbo charger

Supercharger, Working Principle, Effect of Super charging, Types and Methods of Super charging, Turbo Charger, Working Principle , Turbo-lag,

Recent Developments in Automotive Engines:

VVT, V-TEC i-VTEC and IDTEC.ATFT, CRDI system- working Principle, Advantages and Effect of CRDI on emission reductions, Hybrid vehicles and fuel cells.

(RBT Levels: **L1 ,L2 & L3)**

Course outcomes:

At the end of the course the student will be able to:

CO 1: understand the working and analyse both the conventional & the modern fuel supply and injection systemsused in SI and CI engines.

CO 2: understand, differentiate and analyze the conventional and modern ignition systems.

CO 3:identify the vital components of cooling and lubricating system and do basic design calculations.

CO4: possess the knowledge of engine management system and apply the concept of artificial intelligence.

CO5: differentiate and analyse the turbocharger and supercharger working and update therecent advances in automotive engines.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) John B.Heywood, Internal Combustion Engine Fundamentals, McGraw- Hill Book Company(1988)
(2) Dr. K. K. Ramalingam, Introduction to Internal Combustion Engines, Scitech Publication, 2004
Reference Books
(1) Tom Denton, Automotive Electrical and Electronics, SAE, 2000
(2) Heinz Heisler, Advanced Engine Technology, SAE Publications, 1995
(3) Richard Van Basshuysen, Internal Combustion Engine Hand Book, Fred Schaefer, SAE(2004).

NOISE VIBRATION HARSHNESS			
Course Code	20MAU13	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Fundamentals of sound:

Definition of NVH, Vehicle noise - Direct sound generation mechanism: airborne sound; Indirect sound generation mechanism: structure borne sound; Subjective response sound, Acoustic variables, basic attributes of sound such as wavelength, period, frequency; speed of sound, Decibel scale, Wave equation, types of sound fields,

Measures of sound: Sound pressure, sound intensity and sound power, Combining sources: dB arithmetic, Standing wave, Beating, Impedance, Human hearing: frequency Versus sound pressure level, Loudness: phons and sones as noise descriptors; Weighting networks, Leqand various noise metrics for road noises.

(RBT Levels: **L1 & L2)**

Module-2

Noise measurements and Instrumentation:

Measuring microphones, Sound level meter, time and frequency weighting, Sound spectra – Octave band analysis, Order analysis and waterfall plot, Various types of acoustic testing chambers, Sound power measurement from Sound pressure: Two- microphone probe for measuring; Sound power measurement from Sound Intensity

(RBT Levels: **L1, L2 & L3)**

Module-3

Sound fields and Room Acoustics:

Characterizing sound sources; Directivity; Sound Fields; Various approaches to modelling sound sources; Transmission loss (TL) and Insertion loss (IL); Reverberation time and Acoustic Absorption Coefficient; Effects of leaks on barrier and TL of composite barriers; measurement Absorption Coefficient and Transmission loss (TL).

Vehicle Interior and Exterior noise:

Internal noise sources in vehicles such as engine noise; road noise; aerodynamic (wind) noise; brake noise; squeak, rattle and tizz noises; sound package solution to reduce the interior noise: acoustic isolation, acoustic absorption and damping material solutions; Exterior noise sources in vehicles. such as air intake systems and exhaust systems; Tyre noise.

(RBT Levels: **L1, L2 & L3)**

Module-4

Sources of Vehicle Vibration:

Power train and Engine vibrations; driveline vibrations; chassis and suspension vibrations; Control strategies; Human response to vehicle vibrations, concept of harshness; subjective and objective evaluation of vehicle harshness.

Vibration Isolation and Control:

Introduction; damping of vibrations; vibration isolation and absorption; design of a Vibration Absorbers, unconstrained and constrained layer damping treatment, add on dampers and stiffeners, Introduction to Active Vibration Control.

(RBT Levels: **L1, L2 & L3)**

Module-5
Vibration Measurement and Instrumentation: Definition of Modal Properties, Modal analysis theory, FE & Experimental modal analysis, Transducers and accelerometers Excitation sources Impact Excitation, Shaker excitation, Excitation signals, applications of Modal Analysis, laser based vibration measurements; analysis and presentation of vibration data. (RBT Levels: **L1, L2, L3& L4)**
Course outcomes: At the end of the course the student will be able to: CO1: understand and explain basics of Noise Vibration and Harshness. CO 2: use different instruments and analyse the data for identification of sources of noise and vibrations. CO3: understand /analyse, model and measure various sound and noise sources. CO 4: identify the sources of vibration analyse the problem and suggest remedies for vibration damping. **CO5:** posses the knowledge of vibration measurement and instrumentation.
Question paper pattern: The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60. • The question paper will have ten full questions carrying equal marks. • Each full question is for 20 marks. • There will be two full questions (with a maximum of four sub questions) from each module. • Each full question will have sub question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module.
Textbook/ Textbooks
(1) Bies D. A. and Hansen C. H., Engineering Noise Control: Theory and Practice-, Spon Press, Taylor &Francis, NYUSA, 2003.
(2) Mathew Harrison, Vehicle Refinement- Controlling Noise & Road, Elsevier Publication, IstEdition, 2004
Reference Books
(1) William W. Seto, Theory and Problems of Mechanical Vibrations, McGraw Hill International BookCo., Singapore, Illustrated Edition, 1964
(2) S. S. Rao, Mechanical Vibrations, Pearson Education Inc., 5th Edition, 2010
(3) S. Graham Kelly, Mechanical Vibrations, Schaum's Outline Series, Tata McGraw Hill Publishing Co.Ltd. SI Edition, 2000

AUTOMOTIVE CHASSIS & POWER TRANSMISSION			
Course Code	20MAU14	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60

Credits	04	Exam Hours	03

Module-1

Overview of Vehicle Chassis System:
General construction of chassis, Types of chassis layouts with respect tolocation of Power plant and drive arrangements and their comparison.Stability of vehicle on slope, weight distribution, numerical on above topics.

Frames:
Types of frames, loads acting of frame, cross sections and materials for frames,loading points, sub frames, calculation of cross section of frame members,Testing of frames numerical on above topics

(RBT Levels: **L1, L2 & L3)**

Module-2

Front axle and Steering Systems:

Front axle: Types of front axles and stub axles, Axle parts and materials, loads and stresses, Front wheel geometry- calculation of cross sections of front axles. **Steering Systems:** Condition for correct steering, types of steering gears, power steering, Types of linkages, Ackermann and Davis steering mechanisms, Reversible and Irreversible steering.

Suspension System:
Types of suspension system Constructional details of leaf spring, helper springs, coil springs, torsion bar, rubber springs, plastic springs, air bellows or pneumatic suspension, hydraulic suspension, constructional details of telescopic shock absorbers, independent suspension, front wheel independent suspension, rear wheel independent suspension, types, stabilizer, trouble shooting

(RBT Levels: **L1, L2 & L3)**

Module-3

Brakes:
Necessity and requirements of brakes, stopping distance and time, brake efficiency, weight transfer, brake shoe theory, determination of braking torque, Classification of brakes, constructional details- Drum brakes, Disc brakes Hydraulic brake system, Pneumatic brakes, Power assisted Braking system, Servo Brakes, Anti-lock Braking system, Retarders, Hill Holders, requirements of brake fluids, requirements and construction of brake shoes, trouble shooting.

Rear Axles:
Construction of rear axles, Types of loads acting on rear axle, Full floating, Three Quarter Floating and Semi – floating axles, Hotchkiss and torque tube drive

(RBT Levels: **L1, L2 & L3)**

Module-4

Overview of Vehicle Power Trains System:
Outlines of Power Trains, Power train functions, Power train layout and components, Main and Auxiliary functions, Requirements profile, Interrelations: Direction of rotation, Transmission Ratio and Torque, Road Profiles, Load Profiles, Typical Vehicle uses and Driver types, Performance features of Vehicle Transmissions. Design trends in Transmission, Kinematical relations of power trains, Numerical problems.

Matching Engine and Transmission:
Road loads and axle loads, Deriving condition diagram, Ideal transmission and engine-transmissions matching, Total ratio and overall gear ratio Selecting the largest power- train ratio, Selecting the smallest power- train ratio, Selecting the intermediate gears- saw tooth profile, Geometrical gear steps, Progressive gear steps, Numerical problems.

(RBT Levels: **L1, L2 & L3)**

Module-5

Manual Transmissions:
Manual Transmission Layouts and Components, Basic gear box construction, gear-sets with fixed axles, countershaft transmission and epicyclic gears, schemes for reverse gear. Transmission Power Flows, Numerical problems

Automatic Transmissions:
Level of automation, Gear shift mode, stepped and Continuously Variable Transmissions, synchronizer gear boxes, epi-cycloidal gear boxes, Design and analysis of planetary gear trains, Gear ratios and clutch engagement schedule, Clutch torques in steady state condition, Torque analysis in shifting process, Numerical problems

(RBT Levels: **L1, L2 & L3)**

Course outcomes:
At the end of the course the student will be able to:
CO 1: Differentiate various types of chassis layouts, frames, front axles, springs, rear axles arrangements and other chassis components
CO 2:Explain the construction and working of various chassis components.
CO 3: Design various chassis components.
CO 4:Understand the vehicle power train system, match the ideal and engine transmission and select the power train ratio.
CO 5: Acquire the basic skills required to design and analyse manual and automatic transmission system.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.■

Textbook/ Textbooks

(1) PP.M. Heldt, Automotive Chassis, Chilton & Co. **Edition, 1990**

(2) N.K. Giri, Automotive Mechanics, Khanna Publications, 8th Edition, 2008

Reference Books

Joseph I Heintner, Automotive mechanics, Affiliate d East West Press, New Delhi/Madras,1967

(2) J. Fenton, Handbook of Automotive Powertrain and Chassis Design Professional Engineering Publishing, London 1st Edition,1998

(3) Kirpal Singh, Automobile Engineering Vol. I, Standard publications, New Delhi.13th Edition, 2012

ALTERNATIVE FUELS, ENGINE EMISSION & EMISSION CONTROL NORMS			
Course Code	20MAU15	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction:

Types of energy sources, their availability, need of alternative energy sources, Non-conventional energy sources, Classification of alternative fuels, Scenario of conventional auto fuels, fuel quality aspects related to emission. Technological up gradation required, business driving factors for alternative fuels. Implementation barriers for alternative fuels.

Gaseous Alternative Fuels:

Hydrogen:

Introduction, properties and production of hydrogen. Storage, Advantages and disadvantages of hydrogen as fuel for S. I. and C. I. engines. Hazards and safety systems for hydrogen, hydrogen combustion. Performance and emission of from hydrogen.

Other Gaseous Fuels:

Properties, production, advantages and disadvantages of LPG, CNG, Methanol and Ethanol and their blends as Fuel for SI and CI engine.

(RBT Levels: **L1, L2 & L3)**

Module-2

Bio-Diesel:

Straight vegetable oil, Biodiesel-Production of Bio-Diesel, Bio-Diesel as Fuel for CI engine, Performance and emission of bio diesel.

Biogas or Bio-methane:

History, properties and production of Biogas, classification of biogas plants, biogas storage and dispensing system. Advantages of biogas, hazards and emissions of biogas.

Reformulated conventional fuels:

Introduction. Production of coal water slurry. Properties, as an engine fuel, emissions of CWS. RFG, Emulsified fuels. Hydrogen-enriched gasoline. Future Alternative Fuels, PMF, Ammonia, Liquid-Nitrogen.

(RBT Levels: **L1, L2)**

Module-3

Source of Emission from Automobiles:

Sources of Air Pollution. Various emissions from Automobiles-Formation-Effects of pollutants on environment and human beings.

S. I. Engine Emissions and its Control:

Emission formation in SI Engines- Carbon monoxide & Carbon dioxide -Unburned hydrocarbon, NOx, Smoke-Effects of design and operating variable son emission formation- controlling of pollutants - Catalytic converters, Charcoal Canister, CCS, Positive Crank case ventilation system, Secondary air injection, thermal reactor, Laser Assisted Combustion, etc.

(RBT Levels: **L1, L2 & L3)**

Module-4

C. I. Engine Emission and its Control:

Formation of White, Blue, and Black Smoke, NOx, soot, sulphur particulate and Intermediate Compounds - Physical and Chemical delay- Significance Effect of operating variables on Emission formation- Fumigation, Split injection, Add Blue, Catalytic Coating, EGR, HCCI, Particulate Traps, SCR.

Influence of Fuel Properties on Emission and Effect of Air Pollution:

Effect of petrol, Diesel Fuel, Alternative Fuels and lubricants on emissions, Effect of air pollution on Human Health, Effect of air pollution on animals, Effect of air pollution on plants

(RBT Levels: **L1, L2 & L3)**

Module-5

Test Procedures , Emission Measurements:

Constant Volume Sampling I and 3 (CVS-1&CVS-3) Systems, Sampling Procedures- Chassis dyno- Seven mode and thirteen mode cycles for Emission Sampling-Sampling problems -Emission analyzers - NDIR, FID, Chemi-luminesecent, Smoke meters.

Emission control Norms:

Emission norms – Euro: Euro 5 and Euro 6 Norms , Relative comparison ; & Bharat norm: Bharat Stage V and Bharat stage VI, Relative comparison of both

(RBT Levels: **L1, L2, L3 & L4)**

Course outcomes:

At the end of the course the student will be able to:

CO 1: Explain need for alternative fuels, various alternative fuels available and their suitability for automotive application.

CO 2: Explain sources of pollution from automobiles and effects of pollutants on living beings.

CO 3: Select suitable means for controlling pollution from automobiles.

CO 4: Select suitable method of sampling of pollutants and techniques for reduction of Pollution from Automobile.

CO 5: Analyse the existing pollution norms and identify the key areas and /components, for further improvements.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) S .S. Thipse., Alternative Fuels- JAICO Publishing House New Delhi 2nd Edition, 2019

(2) G. D. Rai , Non-Conventional Energy Sources, Khanna Publishing New Delhi 6thEdition, 2019

Reference Books

(1) V. Ganesan, Internal combustion Engines, Tata McGraw Hill Book Co, Eighth Reprint, 4th Edition, 2019

(2) D. J. Patterson and N. A. Henin ,Emission from Combustion Engine and their control Anna Arbor Science Publication, 2nd Edition , 1981

(3) Crouse and Anglin, Automotive Emission Control McGraw Hill Company., New York ,2nd Edition, 1977

AUTOMOTIVE ENGINEERING LABORATORY-I			
Course Code	20MAUL16	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	0:4:0	SEE Marks	60
Credits	02	Exam Hours	03

Sl. NO	Experiments
1	Linear Static (Stress) Analysis of Automotive Engine Components such as Connecting Rod, Piston, Cylinder wall, Crank Shaft using FEA software Such as ANSYS/MSC Patran / MSC Nastran and etc. (RBT Levels: **L1, L2, L3 & L4)**
2	Modal Analysis of Automotive Engine Components using FEA software. (RBT Levels: **L1, L2, L3 & L4)**
3	Dynamics Analysis of Automotive Engine Components using FEA Software (RBT Levels: **L1, L2, L3 & L4)**
4	Heat Transfer Analysis of Automotive Engine Components using FEA Software (RBT Levels: **L1, L2, L3 & L4)**
5	Study of Random Vibration analysis (RBT Levels: **L1, L2)**
6	Study latest emission norms: EURO V and BHARAT V and VI, Emission testing using conventional and unconventional fuels (RBT Levels: **L1, L2, L3)**
7	Morse test for finding FP, IP, Indicated thermal efficiency and Mechanical efficiency (RBT Levels: **L1, L2, L3 & L4)**
8	Study and tuning of CRDI engine. (RBT Levels: **L1, L2)**
9	Performance test on Variable Compression Ratio Engine to study effect of variation in compression ratio on engine performance. (RBT Levels: **L1, L2, L3 & L5)**

Course outcomes: At the end of the course the student will be able to: CO1: Posses the basic and essential knowledge of major software tools used in industries CO2: Design and analyse the static stress in vital automobile components CO3 Make the dynamic and thermal analysis of automotive engine components CO4: Understand and analyse the performance parameters of an IC Engine CO5: Apply the experimental concepts to do research in I.C Engines

RESEARCH METHODOLOGY AND IPR			
Course Code	20RMI17	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	1:0:2	SEE Marks	60
Credits	02	Exam Hours	03

Module-1

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India.

Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration.

(RBT Levels: **L1, L2, L3 & L4)**

Module-2

Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed.

Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs. ■

(RBT Levels: **L1, L2, L3 & L4)**

Module-3

Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs.

Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement Tools, Scaling, Scale Classification Bases, Scaling Techniques, Multidimensional Scaling, Deciding the Scale.

Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method. ■

(RBT Levels: **L1, L2, L3 & L4)**

Module-4

Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis.

Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi Square Tests. ■

(RBT Levels: **L1, L2, L3 & L4)**

Module-5

Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.
Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO. ■

(RBT Levels: **L1, L2)**

Course outcomes:

At the end of the course the student will be able to:

- Discuss research methodology and the technique of defining a research problem
- Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.
- Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.
- Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports
- Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR.■

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbooks

(1) Research Methodology: Methods and Techniques, C.R. Kothari, Gaurav Garg,New Age International,4th Edition, 2018.

(2) Research Methodology a step-by-step guide for beginners. (For the topic Reviewing the literature under module 2), Ranjit Kumar,SAGE Publications,3rd Edition, 2011.

(3) Study Material (For the topic Intellectual Property under module 5), Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013.

Reference Books

(1) Research Methods: the concise knowledge base, Trochim, Atomic Dog Publishing, 2005.

(2) Conducting Research Literature Reviews: From the Internet to Paper, Fink A, Sage Publications, 2009.

*** END OF I SEMESTER ***

VEHICLE DYNAMICS			
Course Code	20MAU21	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Basics of Vibration:
Definitions, Modelling and Simulation, Global and Vehicle Coordinate System, Free, Forced, Un-damped and Damped Vibration, Response Analysis of Single DOF, Two DOF, Multi DOF, Magnification factor, Transmissibility, Vibration absorber, Vibration measuring instruments, Torsional vibration, Critical speed. Modal analysis.
(RBT Levels: **L1, L2, L3 & L4)**

Module-2

Tyres:
Tyre forces and moments, Tyre structure, Longitudinal and Lateral force at various slip angles, rolling resistance, tractive and cornering property of tyre. Performance of tyre on wet surface. Ride property of tyres. Magic formulae tyre model, Estimation of tyre road friction. Test on Various road surfaces. Tyre
Vibration.
Braking Performance:
Basic equations, Braking forces, Brakes, Brake Proportioning, Antilock Brake system, Braking efficiency, Rear wheel lockup, Standards and Legislations, Numerical Examples
(RBT Levels: **L1, L2, L3)**

Module-3

Vertical Dynamics:
Human response to vibration, Sources of Vibration. Design, analysis and computer simulation of Passive, Semi-active and Active suspension using Quarter car, half car and full car model. Influence of suspension stiffness, suspension damping, and tyre stiffness. Control law for LQR, H-Infinite, Skyhook damping. Air suspension system and their properties.
Vehicle Aerodynamics:
Aerodynamic, Aerodynamic forces lift and drag components, Pitching, yawing, rolling moments, and Total road loads, Numerical Examples
(RBT Levels: **L1, L2, L3 & L4)**

Module-4

Steady State Handling Characteristics of Road Vehicles;
Steering Geometry, Derivation of fundamental equation governing the steady state handling behaviour of a road vehicle, Neutral Steer, Under steer and Over steer characteristics, characteristic and critical speeds, Neutral Steer Point, Static margin, Steady-State Response to Steering Input-Yaw Velocity Response, Lateral Acceleration Response, Sideslip Response and Curvature Response; Numerical Problems.
Performance Characteristics of Off-Road Vehicles:
Drawbar Performance - Drawbar Pull and Drawbar Power, Tractive Efficiency, Coefficient of Traction, Weight-to-Power Ratio for Off-Road Vehicles; Fuel Economy of Cross-country Operations Transport Productivity and Transport Efficiency, Mobility Map and Mobility Profile, Selection of Vehicle Configurations for Off-Road, Numerical Problems.
(RBT Levels: **L1, L2, L3 & L4)**

Module-5
Suspension Mechanisms: Solid Axle Suspension, Independent Suspension, Roll Center and Roll Axis, Car Tire Relative Angles, Toe, Caster Angle, Camber, Trust Angle, Suspension Requirements and Coordinate Frames, Kinematics Requirements, Dynamic Requirements, Wheel, wheel body, and tyre Coordinate Frames, Caster Theory,Numerical examples (RBT Levels: **L1, L2, L3)**
Course outcomes: At the end of the course the student will be able to: CO1: Explain basics of vibrations CO2:Analyze forces acting and the performance characteristics of tyres and brakes CO 3:Analyze vehicle dynamics and its influence on the vehicle handling characteristics CO 4: Explain principles of Steady State Handling Characteristics of Road Vehicles CO 5: Understand the suspension mechanisms, analyse and design
Question paper pattern: The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60. • The question paper will have ten full questions carrying equal marks. • Each full question is for 20 marks. • There will be two full questions (with a maximum of four sub questions) from each module. • Each full question will have sub question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module.■
Textbook/ Textbooks
(1) Reza N. Jazar, Vehicle Dynamics, Theory and Applications Springer Verlag. 2nd Edition, 2014
(2) J. Y. Wong, Theory of Ground Vehicles John Willey & Sons, NY 4th Edition, 2008
Reference Books
(1) Hans B. Pacejka Tyre and Vehicle Dynamics SAE 2nd Edition, 2006
(2) Giancarlo Genta , Motor Vehicle Dynamics: Modelling and Simulation World Scientific Publishing Co.; Singapore 3rd Edition, 2017
(3) Hucho W. H Aerodynamics of Road Vehicles SAE 4th Edition,

AUTOTRONICS			
Course Code	20MAU22	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Electrical and electronic principles: Safe working practices , Basic electrical principles, Electronic components and circuits, Digital electronics, Microprocessor systems , Measurement , Sensors and actuators , Diagnostics – electronics, sensors and actuators

Tools and test equipment: Basic equipment : Basic Hand Tools, accuracy of test equipment, : Multi-meters , Specialist equipment: Oscilloscope pressure testing, engine analysers scanner, Dedicated equipment-serial port communications Laser 2000 electronic systems tester, On-board diagnostics , Diagnostic procedures

(RBT Levels: **L1, L2, L3)**

Module-2

Electrical systems and circuits: The systems approach: vehicle system, open and closed loop systems; Electrical wiring, terminals and switching: cables, colour codes, printed circuits, fuses and circuit breakers, Terminators , switches , Multiplexed wiring systems , Circuit diagrams and symbols , Electromagnetic compatibility (EMC)

Batteries: Requirement, Construction, Principle of operation, Working of Lead acid, alkaline, Zebra, Sodium Sulphur, Swing batteries, Ratings, Charging, Maintenance & testing of Lead acid battery. Introduction to fuel cells, proton exchange membrane fuel cell, alkaline fuel cell.

(RBT Levels: **L1, L2, L3)**

Module-3

Charging systems: Requirements of the charging system, Charging system principles, Alternators and charging circuits, Diagnosing charging system faults

Starting systems: Requirements of the starting system, Starter motors and circuits , Types of starter motors: Inertia starters, pre engaged starters, permanent magnet starters, heavy vehicle starters, integrated starters, ,Diagnosing starting system faults

Module-4

Ignition systems: Electronic ignition: Introduction, constant dwell systems, constant energy systems, hall effect pulse generator, inductive pulse generator; programmed ignition, distributor less ignition.

Lighting: Lighting fundamentals, Lighting circuits, Gas discharge and LED lighting, Diagnosing lighting system faults

(RBT Levels: **L1, L2, L3& L4)**

Module-5

Chassis electrical systems: Anti-lock brakes ,Active suspension, Traction control , Automatic transmission ,Other chassis electrical systems , Diagnosing chassis electrical system faults

Auxiliaries: Windscreen washers and wipers: functional requirements, wiper blades, wiper linkages, wiper motor ; washer and wiper circuits, electronic control of wipers, microprocessor controlled wipers, Signalling circuits; Other auxiliary systems: electric horns, engine cooling fan motors

(RBT Levels: **L1, L2, L3)**

Course outcomes:

At the end of the course the student will be able to:

CO1: understand the basics of electrical and electronic components and identify them.

CO2: carry out the first hand diagnosis of faults in automotive systems

CO 3: identify the essential tools and test equipments and apply his knowledge to use them.

CO 4: understand and explain the requirements of electrical and electronic systems.

CO 5: apply the knowledge to analyse and modify an existing system /design a new system.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) Tom Denton. Automobile Electrical & Electronics Elsevier Butterworth-Heinemann 3rd Edition,2004

(2) William B.Ribbens Understanding Automotive Newnes, Elsevier Science Electronics 6th Edition,2003

Reference Books

(1) Ljubo Vlacic, Michel Parent, Fumio Intelligent Vehicle Technologies Butterworth-Heinemann 1st Edition,2001

(2) Ronald K. Jurgen ,Automotive Electronic Hand book McGraw Hill Professional 2nd Edition, 1999

(3) William Crouse and Anglin, Automotive Mechanics, Glencoe, 1993 10th Edition

AUTOMOTIVE BODY ENGINEERING & SAFETY			
Course Code	20MAU23	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction:
Types of car bodies, bus bodies and commercial vehicle bodies.
Interior Ergonomics:
Introduction, Seating dimensions, Interior ergonomics, ergonomics system design, seat comfort, requirements of drivers and passenger seats, suspension seats, split frame seating, back passion reducers, dash board instruments, electronic displays, commercial vehicle cabin ergonomics, mechanical package layout, goods vehicle layout. Visibility, regulations, drivers visibility, methods of improving visibility, Window winding and seat adjustment mechanisms.
(RBT Levels: **L1, L2, L3)**

Module-2

Aerodynamics:
Basics, Vehicle drag and types, Various types of forces and moments, effects of forces and moments, various body optimization techniques for minimum drag, Principle of wind tunnel technology, flow visualization techniques, tests with scale models, aerodynamic study for heavy vehicles.
Body Materials, Trim and Body Mechanisms:
Steel sheet, timber, plastic, glass, GRP, properties of materials - Corrosion - Anticorrosion methods – Selection of paint and painting process - Body trim items - Body mechanisms

(RBT Levels: **L1, L2, L3)**

Module-3

Car body details: Types: Saloon, hatchback, convertibles, Limousine, Estate Van, racing and sports car, etc. Car body construction types – frame and unitary (monocoque), various body panels and their constructional details
Bus body details: Types: Mini bus, single and double Decker, split level and articulated bus, Bus body lay out, Floor height, Engine location, Entrance and exit location, Seating dimensions, Constructional details: Frame construction, Double skin construction, Types of metal section used, Regulations, Conventional and integral type construction
(RBT Levels: **L1, L2, L3)**

Module-4

Body Loads and Design of Vehicle Bodies:
Idealized structure-structural surface, shear panel method, symmetric and asymmetrical vertical loads in car, longitudinal loads and different loading situations.
Vehicle Layout Design:
preliminary design, Load distribution on vehicle structure, stress analysis of bus body structure under bending and torsion, stress analysis in integral bus body, Design of chassis frame, Rules and regulations for body, Recent safety measures, Testing of body.
(RBT Levels: **L1, L2, L3)**

Module-5

Vehicle Safety:
Active and passive safety, Restraint systems used in automobiles: safety belts, Head restraints, Air bags, Knee bolsters, Importance of Bumpers and their design, Types of safety glass and their requirements, Importance of Ergonomics in Automotive safety- Locations of controls.

Vehicle Structures for Crash Worthiness:
Types of crash / roll over Tests, Regulatory requirements for crash testing, Instrumentation, high speed photography, Image Analysis.

(RBT Levels: **L1, L2, L3& L4)**

Course outcomes:
At the end of the course the student will be able to:
CO1: Reproduce chassis layouts of passenger and commercial vehicles.
CO 2: Understand the ergonomics of a vehicle and shall apply his skill to design and model vehicles as per ergonomic requirements.
CO3: Posses the knowledge of appropriate body material and choose.
CO 4: Choose suitable method for reduction in aerodynamic forces and moments in heavy vehicles.
CO 5: Identify the various safety aspects in a given vehicle and apply this knowledge while designing the vehicle for stability and safety.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Pawloski J, Vehicle Body Engineering Business Books Ltd. Illustrated Edition,1969

(2) Reimpell J The automotive chassis, Engineering principle 2nd Edition, 1983

Reference Books

(1) Watts, A. J., et al, Low speed Automobile Accidents, Lawyers and Judges , 3rd Edition, 1996

(2) Jullian Happian, An Introduction to Modern Vehicle Design SAE Illustrated Edition, 2002

(3) Braithwaite J.B. , "Vehicle Body building and drawing ", Heinemann Educational Heinemann Educational Books Ltd., London.

DRIVERLESS VEHICLES			
Course Code	20MAU241	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction to autonomous driving: autonomous driving technologies overview, autonomous driving algorithms: Sensing, Perception, Object Recognition and Tracking:

Autonomous driving client system: Robot Operating System, Hardware platform:

Autonomous driving cloud platform: Simulation, HD Map Production, Deep learning Model Training

(RBT Levels: **L1, L2, L3)**

Module-2

Autonomous vehicle localization:

Localization with GNSS: GNSS overview, GNSS error analysis, satellite based augmentation systems, real time kinematic and differential GPS, precise point positioning, GNSS INS integration Localization with LiDAR and HD maps

Visual Odometry: Stereo Visual Odometry, Monocular Visual Odometry, Visual Inertial Odometry, Dead Reckoning and Wheel Odometry; Sensor fusion

(RBT Levels: **L1, L2, L3)**

Module-3

Perceptions In Autonomous driving: Introduction, Datasets, Detection, Segmentation, Sterio, Optical flow and Scene flow

Deep learning in Autonomous Driving Perception: Convolutional Neural Networks, Detection, Semantic segmentation, Stereo and optical flow

(RBT Levels: **L1, L2, L3)**

Module-4

Prediction and Routing: Planning and control overview, Traffic prediction: Behaviour prediction as classification, Vehicle trajectory generation,

Lane level routing: Constructing a weighted directed graph for routing, typical routing algorithms, routing graph cost

(RBT Levels: **L1, L2, L3)**

Module-5

Decision planning and control: Behavioural decisions, Motion planning, Feedback control Reinforcement Learning Based Planning and Control,

Client systems for Autonomous Driving: Operating systems and computing platform

Cloud platform for Autonomous driving: Introduction, infrastructure , simulation

(RBT Levels: **L1, L2, L3& L4)**

Course outcomes:
At the end of the course the student will be able to:
CO1:Understand the Autonomous system's and its requirements
CO2:Explain algorithm, sensing, object recognition and tracking of an Autonomous system
CO3:Do the error analysis of Localization systems and use the tools and techniques
CO4:Explain, plan and control the traffic behaviour, and shall be able to do lane level routing and create simple algorithms
CO5:Explain Plan and control motion, choose proper client systems for automotive vehicles and understand the cloud platform

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.■

Textbook/ Textbooks

(1) Shaoshan Liu, Liyun Li, Jie Tang, Shuang Wu, Jean-Luc, Creating Autonomous Vehicle Systems Morgan & Claypool Publishers 1st Edition, 2018

(2) Ronald K. Jurgen Autonomous Vehicles for Safer Driving SAE International Edition , 2013

Reference Books

(1) Hod Lipson, Melba Kurman Driverless: Intelligent Cars and the Road ahead MIT Press. 1st Edition, 2016

(2) Markus Maurer, J. Christian Gerdes, Barbara Lenz Autonomous Driving: Technical, Legal and Social Aspects 1st Edition, 2016

(3) Hannah YeeFen Lim, Autonomous Vehicles and the Law: Technology, Algorithms and Ethics ,Edward Elgar Publishing. 1st Edition, 2018

VEHICLE PERFORMANCE

Course Code	20MAU242	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction to Vehicle System:
Morphology of vehicles, General layout of passenger cars and commercial vehicle, Type of power units, arrangement of power train, Vehicle controls
(RBT Levels: **L1, L2, L3)**

Module-2

Friction and Rolling Resistance of Pneumatic Tyres:
Aerodynamics forces and moments, Relationship between tractive effort and longitudinal slip of tyres, cornering properties of tyres, Equation of motion and maximum tractive effort
(RBT Levels: **L2, L3)**

Module-3

Vehicle Performance Estimation and Prediction:
Power plant characteristic and transmission related requirements, Vehicle acceleration, and max. Speed, Gradeability, Drive systems comparison.
(RBT Levels: **L1, L2, L3)**

Module-4

Vehicle Transmissions:
Characteristics and features friction clutches, mechanical geared transmission lay shaft and epicyclic gearbox, Synchronizers, Fluid coupling and torque converters. Drive lines, two wheel drive, four wheel drive, braking arrangement, safety in braking, weight transfer steering, and cornering power of tyres
(RBT Levels: **L1, L2, L3)**

Module-5

Handling Characteristics of Vehicles:
Steering geometry, steady state handling characteristics, steady state response to steering input. Directional stability of vehicle. Effect of shock and vibration on human being, comfort criteria
(RBT Levels: **L1, L2, L3& L4)**

Course outcomes:
At the end of the course the student will be able to:

Course outcomes:
At the end of the course the student will be able to:
CO1: Explain various parameters affecting the performance of a vehicle, estimate, analyse and predict them.
CO2: Explain significance of Friction and rolling resistance of pneumatic tyres.
CO3: To study the performance of different Vehicle transmissions.
CO4: Analyze Handling characteristics and stability of vehicles.
CO5: Understand the comfort criteria and apply them while designing

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Rao J.S. and Gupta. K.,, Theory and Practice of Mechanical Vibrations, Wiley Eastern Ltd., 2nd Edition,2002

(2) J. Y. Wong, Theory of ground vehicle, John Wiley and Sons Inc., New York, 1st Edition, 1978

Reference Books

(1) W. Steeds Mechanics of road vehicle Illiffe Books Ltd, London3rdEdition3rdEdition, 1992

(2) J. G. Giles, Steering, Suspension tyres llife Books Lid London London1st
Edition, 1975

(3) P. M.Heldt, Automotive chassis, Chilton Co,New York, 1st Edition,1982.

AUTOMOTIVE CONTROL SYSTEMS			
Course Code	20MAU243	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Chassis and Drive Line Control:
Components of chassis management system – role of various sensors and actuators pertaining to chassis system – construction – working principle of wheel speed sensor, steering position, tyre pressure, brake pressure, steering torque, fuel level, Engine and vehicle design data

Drive Line Control:
Speed control - cylinder cut - off technology, Gear shifting control – Traction / braking control, brake by wire -Adaptive cruise control, throttle by wire. Steering - power steering, collapsible and tiltable steering column, steer by wire

(RBT Levels: **L1, L2, L3)**

Module-2

Engine Management System:
Basic Engine Operations – Fuel Control, Ignition control, Lambda Control, Idle Speed Control, Knock Control , Open Loop and Closed Loop Control

Sensors:
Basic sensor arrangement; Types of sensors such as oxygen sensors, Crank angle position sensors, fuel metering/vehicle speed sensors and detonation sensors, altitude sensors, flow sensors, throttle position sensors, solenoids.

(RBT Levels: **L1, L2, L3)**

Module-3

Safety and Security Systems: Airbags, seat belt tightening system, collision warning systems, child Lock, anti-lock braking systems, Vision enhancement - Static and dynamic bending of Head light, road recognition system, Anti-theft technologies, smart card system, number plate coding, central locking system.

(RBT Levels: **L1, L2, L3)**

Module-4

Comfort and Vehicle Control System:
Active suspension systems, requirement and characteristics, different types, Vehicle Handling and Ride characteristics of road vehicle, pitch, yaw, bounce control, power windows, adaptive noise control. ABS Control System – Torque Balance at Wheels road contact – Control cycle of ABS System – Advantages – Traction control system-Combination of ABS with Traction control system

(RBT Levels: **L1, L2, L3)**

Module-5

Intelligent Transportation System:
Traffic routing system - Automated highway systems - Lane warning system - Driver Information System, driver assistance systems - Data communication within the car, Driver conditioning warning - Route Guidance and Navigation Systems-vision enhancement system, In-Vehicle Computing-Vehicle Diagnostics system. VANET usage in Automobiles

(RBT Levels: **L1, L2, L3& L4)**

Course outcomes:
At the end of the course the student will be able to:
CO1: Explain basics and different types of control system required for the Automotive vehicle for improvement of performance of vehicle.
CO2: identify the vital parameters of engine management, analyse and apply it for fuel economy.
CO3:understand the importance of safety and security systems
CO4: understand control system for improvement of comfort and apply the knowledge in system design.
CO5: learn effective utilization of fleet using Intelligent Transportation System.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) U. Kiencke, L. Nielsen, Automotive Control Systems, SAE and Springer-Verlag

(2) LjuboVlacic, Michel Parent, Fumio, Intelligent Vehicle Technologies, Butterworth- Heinemann publications, Oxford llustrated

Reference Books

(1) Crouse, W.H. &Anglin, D.L.,, Automotive Mechanics, Intl. Student edition, , TMH, New Delhi 9th edition**,**2002

(2) William B.Ribbens, Understanding Automotive Electronics, Butter worth, Heinemann Woburn, 5th edition, 1998

(3) Bosch, Automotive HandBook SAE 8th edition, 2007

ENGINE MANAGEMENT SYSTEMS			
Course Code	20MAU244	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Engine Input Sensors : Coolant & Intake Temperature, Crankshaft Position, Camshaft Position, Manifold Absolute Pressure, Throttle Position, Oxygen, Air/Fuel Ratio, Knock Speed & Distance, Battery & Switches

Output Devices: Relays, Injector Sequencing & Management, Ignition Operation, Idle Air Control, EGR, EVAP, Wastegate Solenoids, Torque Converter & Speed Control, Malfunction Indicator Light

(RBT Levels: **L1, L2, L3)**

Module-2

Speed Density/Mass Air Flow Fuel Management Strategies: Key ON Mode, Crank Mode, Open & Closed Loop, Wide-Open Throttle, Adaptive Memory Cells, Cruise &Deceleration, Wide-Open Throttle, Key OFF Mode

Fuel Injection Systems: Electronic Fuel Systems, Computer Self-Diagnostic Circuits, Electronic Throttle Actuator Control Systems, Fuel Control, Fuel Supply System Control, Injection System Inspection and Maintenance.

(RBT Levels: **L1, L2, L3)**

Module-3

Engine Diagnostic Procedures: Fuel System testing, On Board Diagnostics, Monitored & Non Monitored Circuits, Diagnostic Trouble Codes

Digital Engine Control System: Open loop and close loop control system, engine cooling and warm up control, idle speed control, acceleration and full load enrichment, deceleration fuel cut-off. Fuel control maps, open loop control of fuel injection and closed loop lambda control exhaust emission control, on-board diagnostics, diagnostics, future automotive electronic systems, Electronic dash board instruments – Onboard diagnosis system.

(RBT Levels: **L1, L2, L3)**

Module-4

SI Engine Management: Feedback carburettor system, throttle body injection and multi point fuel injection system, injection system controls, advantage of electronic ignition systems, three way catalytic converter, conversion efficiency versus lambda, Layout and working of SI engine management systems like Bosch Monojetronic

Group and sequential injection techniques. Working of the fuel system components. Advantages of electronic ignition systems. Types of solid state ignition systems and their principle of operation, Contactless electronic ignition system, Electronic spark timing control.

(RBT Levels: **L1, L2, L3)**

Module-5

CI Engine Management: Fuel injection system, parameters affecting combustion, noise and emissions in CI engines. Pilot, main, advanced, post injection and retarded post injection. Electronically controlled Unit Injection system. Layout of the common rail fuel injection system. Working of components like fuel injector, fuel pump, rail pressure limiter, flow limiter, EGR valve control in electronically controlled systems

Course outcomes:

At the end of the course the student will be able to:

CO1: Identify the modern automobile accessories and engine management systems.

CO2: Understand the computerized engine testing and diagnosis procedures and shall apply the concept to develop engine control systems.

CO3 :Explain the concept of various sensors and actuators and understand their working

CO4:Explain the SI and CI engine management systems, identify the key components and diagnose their working

CO5:Understand the principles and application of electronic fuel and ignition management systems in the modern automobile

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Halderman, J. & Linder, J. Automotive Fuel and Emissions Control Systems Upper Saddle River, NJ: Pearson Education 3rd Edition, 2012

(2) Halderman, J. D., Diagnosis &Troubleshooting of Automotive Electrical, Electronic, &Computer Systems, Upper Saddle River, NJ Pearson Education 6th Edition, 2011

Reference Books

(1) Robert Bosch, Diesel Engine Management, SAE Publications 3rd Edition, 2004

(2) Wiliam B. Ribbens, Understanding Automotive Electronics Newnes, Butterworth–Heinemann 5th Edition, 2001

(3) Young, Griffitns, Automobile Electrical & Electronic Equipments .,, Butterworths, London 6Th Edition (1980)

Advanced Machine Design			
Course Code	20MAU251	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction:
Role of failure prevention analysis in mechanical design, Modes of mechanical failure, Review of failure theories for ductile and brittle materials including Mohr's theory and modified Mohr's theory, Numerical examples.

Fatigue of Materials: Introductory concepts, High cycle and low cycle fatigue, Fatigue design models, Fatigue design methods, Fatigue design criteria, Fatigue testing, Test methods and standard test specimens, Fatigue fracture surfaces and macroscopic features, Fatigue mechanisms and microscopic features.

(RBT Levels: **L1, L2, L3)**

Module-2

Stress-Life (S-N) Approach:
S-N curves, Statistical nature of fatigue test data, General S-N behavior, Mean stress effects, Different factors influencing S-N behaviour, S-N curve representation and approximations, Constant life diagrams, Fatigue life estimation using SN approach.

Strain-Life (ε-N) approach:
Monotonic stress-strain behavior ,Strain controlled test methods ,Cyclic stress strain behavior ,Strain based approach to life estimation, Determination of strain life fatigue properties, Mean stress effects, Effect of surface finish, Life estimation by ε-N approach.

(RBT Levels: **L1, L2, L3)**

Module-3

LEFM Approach:
LEFM concepts, Crack tip plastic zone, Fracture toughness, Fatigue crack growth, Mean stress effects, Crack growth life estimation. Notches and their effects: Concentrations and gradients in stress and strain, S-N approach for notched membranes, mean stress effects and Haigh diagrams, Notch strain analysis and the strain – life approach, Neuber's rule, Glinka's rule, applications of fracture mechanics to crack growth at notches

(RBT Levels: **L1, L2, L3& L4)**

Module-4

Fatigue from Variable Amplitude Loading:
Spectrum loads and cumulative damage, Damage quantification and the concepts of damage fraction and accumulation, Cumulative damage theories, Load interaction and sequence effects, Cycle counting methods, Life estimation using stress life approach

(RBT Levels: **L1, L2, L3)**

Module-5

Surface Failure:
Introduction, Surface geometry, Mating surface, Friction, Adhesive wear, Abrasive wear, Corrosion wear, Surface fatigue spherical contact, Cylindrical contact, General contact, Dynamic contact stresses, Surface fatigue strength

(RBT Levels: **L1, L2, L3)**

Course outcomes:

At the end of the course the student will be able to:

CO1: Design machine components which are subjected to fluctuating loads.

CO2: Use LEFM approach for crack growth determination.

CO3: Design machine components/parts based on creep criterions. They areable to implement the concept of reliability for designing a machineparts or machine.

CO4: Explain the contact stresses and implementation of Hertz contactphenomenon to the real field problem. Identify failure modes and evolvedesign by analysis methodology.

CO5: Design against fatigue failure is given explicit attention.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Stephens, Ali Fatemi, Robert, Henry O.Fuchs, Metal Fatigue in Engineering Ralph I. John Wiley, NewYork, 2nd Edition, 2001

(2) Jack. A. Collins, Failure of Materials in Mechanical Design John Wiley, NewYork 2nd Edition, 1993

Reference Books

(1) S .Suresh, Fatigue of Materials Cambridge University Press 2nd Edition, 2006

(2) Julie .A. Benantine, Fundamentals of Metal Fatigue Analysis Prentice Hall, IllustratedEdition, 1990

(3) Steven R. Lampman, Nikki DiMateo Fatigue and Fracture ASM Hand Book IllustratedEdition, 1996

SI AND CI ENGINE PROCESSES SIMULATION			
Course Code	20MAU252	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Principle Of Computer Modelling and Simulation:
Monte Carlo simulation, Nature of computer modelling and simulation, advantages of simulation, limitations of simulation, and areas of application.

System and Environment:
Components of system-discrete and continuous systems. Model system-a variety of modelling approaches.

(RBT Levels: **L1, L2, L3)**

Module-2

Design and Evaluation of Simulation Experiments:
Variance reduction techniques-antithetic variables- variables verification and validation of simulation models

(RBT Levels: **L3, L4, L5)**

Module-3

S.I. Engine Simulation and Two Stroke Engine:
Simulation of Otto cycle at full throttle, part throttles and supercharged conditions. Progressive combustion, Exhaust and intake process analysis. Two Stroke Engine Simulation-Engine and Porting Geometry, Gas Flow, Scavenging.

(RBT Levels: **L1, L2, L3& L4)**

Module-4

C.I. Engine Simulation:
Simulation of ideal Diesel cycle and Diesel cycle at full throttle, part throttle and supercharged conditions. Zero dimensional combustion model, Progressive combustion, Exhaust and intake process analysis.

(RBT Levels: **L1, L2, L3& L4)**

Module-5

Simulation Exercises:
Case studies of Simulation for 2 stoke and 4 stroke engine. Simulation exercises using computers – MATLAB/SimuLink, Pro-E / ICEM, CFD Analysis, FE Analysis procedures, Advantages of FEA, Simple Exercise using MSC Nastran.

Multi-body Simulation Exercises:
Simple Multi-body Suspension, Four Bar mechanisms, Handling Analysis of simple Bogie using MSC Adams.

(RBT Levels: **L1, L2, L3& L4)**

Course outcomes:
At the end of the course the student will be able to:
CO1: Device various numeric techniques being used in the automotive system and sub system simulations.
CO 2: Design and do the evaluation of Simulation experiments.
CO 3: Simulate SI and CI engines combustion process and analyse the results
CO 4: Use the software tools; design, model and analyse the exhaust and intake process.
CO5:Understand, apply and create new models for system improvement.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) V. Ganesan, Simulation of Spark Ignition Engine Processes Universities Press 1st Edition,1996

(2) V. Ganesan, Computer Simulation of Compression Ignition Engine Universities Press1st Edition,1996

Reference Books

J. N. Mattavi and C. A. Amann ,Combustion Modelling in Reciprocating Engines Plenum Press 1stEdition,1980

(2) Horlock & Winterbone, The Thermodynamics and Gas Dynamics of Clarendon Press Illustrated edition 1982-1986.
Internal Combustion Engines

(3) J. I. Ramos, Internal Combustion Engine Modeling Hemisphere Publishing Corporation 1stEdition,1989

COMPUTATIONAL FLUID DYNAMICS			
Course Code	20MAU253	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction: History and Philosophy of computational fluid dynamics, CFD as a design and research tool, Applications of CFD in engineering, Programming fundamentals, MATLAB programming, Numerical Methods

Governing Equations: Models of the flow, The substantial derivative, Physical meaning of the divergence of velocity, The continuity equation, The momentum equation, The energy equation, Navier-Stokes equations for viscous flow, Euler equations for inviscid flow, Physical boundary conditions, Forms of the governing equations suited for CFD

(RBT Levels: **L1, L2, L3)**

Module-2

Partial differential equations: Classification of quasi-linear partial differential equations, Methods of determining the classification, General behaviour of Hyperbolic, Parabolic and Elliptic equations.

Basic aspects of discretization: Introduction to finite differences, Finite difference equations using Taylor series expansion and polynomials, Explicit and implicit approaches, Uniform and unequally spaced grid points

(RBT Levels: **L1, L2, L3& L4)**

Module-3

Grids with appropriate transformation: General transformation of the equations, Metrics and Jacobians, The transformed governing equations of the CFD, Boundary fitted coordinate systems, Algebraic and elliptic grid generation techniques, Adaptive grids.

Parabolic partial differential equations: Finite difference formulations, Explicit methods – FTCS, Richardson and DuFort-Frankel methods, Implicit methods – Crank-Nicolson and Beta formulation methods, Approximate factorization, Fractional step methods, Consistency analysis, Linearization

(RBT Levels: **L1, L2, L3)**

Module-4

Elliptic equations: Finite difference formulation, solution algorithms: Jacobi-iteration method, Gauss-Siedel iteration method, point- and line-successive over-relaxation methods, alternative direction implicit methods.

Hyperbolic equations: Explicit and implicit finite difference formulations, splitting methods, multi-step methods, applications to linear and nonlinear problems, linear damping, flux corrected transport, monotone and total variation diminishing schemes

(RBT Levels: **L2, L3& L4)**

Module-5

Stability analysis: Discrete Perturbation Stability analysis, von Neumann Stability analysis, Error analysis, Modified equations, Artificial dissipation and dispersion.

Grid generation: Algebraic Grid Generation, Elliptic Grid Generation, Hyperbolic Grid Generation, Parabolic Grid Generation

(RBT Levels: **L2, L3& L4)**

Course outcomes:

At the end of the course the student will be able to:

At the end of the course the student will be able to:

CO1: Understand the stepwise procedure to completely solve a fluid dynamics problem using computational methods

CO2:Derive the governing equations and understand the behaviour of the equations

CO3: Identify the boundary conditions and apply for the given problem.

CO4:Analyze the consistency, stability and convergence of various discretization schemes for parabolic, elliptic and hyperbolic partial differential equations.

CO5:Analyze methods of grid generation techniques and apply the finite difference and finite volume methods to solve the problems.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1) Anderson, J.D(Jr) Computational Fluid Dynamics McGraw-Hill Book Company 2nd **Edition,** 2017

2) Hoffman, K.A., and Chiang, S.T Computational Fluid Dynamics, Vol. I, II and III, Engineering Education System, Kansas, USA 2nd **Edition,** 2000

Reference

1) Chung, T.J Computational Fluid Dynamics, Cambridge University Press 2nd Edition, 2014

2) Versteeg, H.K. and Malalasekara, W., An Introduction to Computational Fluid Dynamics Pearson Education 2nd **Edition,** 2010

3) Anderson, D.A., Tannehill, J.C., and Pletcher, R.H., CRC Press 3rd Edition, 2013.

DESIGN OF HEAT TRANSFER EQUIPMENT			
Course Code	20MAU254	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction to Heat Exchangers: Definition, Applications, Various methods of classification of heat exchangers with examples, Governing Equation for heat exchangers: Derivation from steady-state steady-flow considerations.

Mathematical treatment of Heat Exchangers: Concept of Overall Heat Transfer Coefficient, Derivation of the concerned equations, Fouling, Fouling Factor, Factors contributing to fouling of a heat exchanger, Ill-Effects of fouling, Numerical Problems

(RBT Levels: **L1, L2, L3)**

Module-2

Concept of Logarithmic Mean Temperature Difference: Expression for single-pass parallel-flow and single-pass counter flow heat exchangers – Derivation from first principles, Special Cases, LMTD for a single-pass cross-flow heat exchanger – Nusselt‟s approach, Chart solutions of Bowman et al. pertaining to LMTD analysis for various kinds of heat exchangers, Numerical Problems,

Arithmetic Mean Temperature Difference [AMTD], Relation between AMTD and LMTD, Logical Contrast between AMTD and LMTD, LMTD of a single-pass heat exchanger with linearly varying overall heat transfer coefficient [U] along the length of the heat exchanger

(RBT Levels: **L1, L2, L3)**

Module-3

Concept of Effectiveness: Effectiveness-Number of Transfer Units Approach, Effectiveness of single-pass parallel-flow and counter-flow heat exchangers, Physical significance of NTU, Heat capacity ratio, Different special cases of the above approach, Chart solutions of Kays and London pertaining to Effectiveness-NTU approach, Numerical Problems.

(RBT Levels: **L1, L2, L3& L4)**

Module-4

Hair-Pin Heat Exchangers: Introduction to Counter-flow Double-pipe or Hair-Pin heat exchangers, Industrial versions of the same, Film coefficients in tubes and annuli, Pressure drop, Augmentation of performance of hair-pin heat exchangers, Series and Series-Parallel arrangements of hair-pin heat exchangers, Comprehensive Design Algorithm for hair-pin heat exchangers, Numerical Problems

(RBT Levels: **L1, L2, L3& L4)**

Module-5

Shell and Tube Heat Exchangers: Single-Pass, One shell-Two tube and other heat exchangers, Industrial versions of the same, Classification and Nomenclature, Baffle arrangement, Types of Baffles, Tube arrangement, Types of tube pitch lay-outs, Shell and Tube side film coefficients, Pressure drop calculations, Numerical Problems

(RBT Levels: **L1, L2, L3& L4)**

Course outcomes:
At the end of the course the student will be able to:
CO1: Understand the physics and the mathematical treatment of typical heat exchangers
CO2: Apply LMTD and Effectiveness - NTU methods in the analysis of heat exchangers
CO3:Design and analyze the shell and tube heat exchanger
CO4:Design and analyze the shell and tube heat exchanger
CO5:Choose the heat exchanger for the specific application

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Kays, W. M. and London, A. L., Compact Heat Exchangersm McGraw – Hill, New York 2nd Edition

(2) Donald Q. Kern Process Heat Transfer Echo Point Books and Media Illustrated, reprint,2019

Reference Books

(1) Incropera, F. P. and De Witt, D. P, Fundamentals of Heat and Mass Transfer John Wiley and Sons, New York 7th Edition,2013

(2) Yunus A Cengel; Afshin J. Ghajar, Mc Graw Hill education Heat and Mass Transfer: Fundamentals and Applications (SIE) 5th Edition, **2017**

(3) J Holman, Souvik Bhattacharyya, Mc Graw Hill education Heat Transfer – SIE 10th Edition, **2017**

AUTOMOTIVE ENGINEERING LABORATORY-II			
Course Code	20MAUL26	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	0:4:0	SEE Marks	60
Credits	02	Exam Hours	03

Sl. NO	Experiments
1	Study of common standards related to the automotive industry : IATF 16949, ISO 9001, ISO 14001, ISO 45001 (RBT Levels: **L1, L2, L3)**
2	Complete modelling of concept 2-wheeled and 4-wheeled vehicles (major systems) using any one of the Automotive Concept Design & Styling Software*. (RBT Levels: **L1, L2, L3& L4)**
3	Simulation of Suspension system using commercial software for LCV and HCV (RBT Levels: **L1, L2, L3& L4)**
4	Study of Driveline systems and Simulation using Commercial MBD software. (RBT Levels: **L1, L2, L3)**
5	Stress Analysis of Chassis Components using FE Software. (RBT Levels: **L1, L2, L3& L4)**
6	Testing Two Wheeled Vehicles on Chassis Dynamometer.
7	Study and practice of wheel alignment (computerized) and wheel balancing. (RBT Levels: **L1, L2, L3)**
8	Drawing electrical wiring layout for two, three and for wheeler vehicles (RBT Levels: **L1, L2, L3)**
9	Study of Vehicle aerodynamic forces and moments in Wind tunnel
10	Car - Clay modeling exercises (expertise from fine arts school may be availed) (RBT Levels: **L1, L2, L3)**
11	Impact Analysis of Automotive Vehicle System using FE Software. (RBT Levels: **L1, L2, L3& L4)**

Course outcomes:

At the end of the course the student will be able to:

CO1: Understand the suspension systems used in automotive vehicles, model them and simulate their working

CO2: Design and analyze the driveline systems

CO3:Prepare the layout of wiring system and analyze for fault

CO4: Perform testing and analysis of forces using dynamometer.

CO5: Analyze the impact of automotive vehicle system and suggest remedial actions/design improvements.

Software:*Romax concept, Autodesk- Alias / 3DS Max, Blender (Open source software), Rhino 3D, Creo Parametric, Sold works, Solid Edge, Inventor, CATIA (any one software),

TECHNICAL SEMINAR			
Course Code	20MAU27	CIE Marks	100
Number of contact Hours/week	0:0:2	SEE Marks	--
Credits	02	Exam Hours	--

Course objectives:

The objective of the seminar is to inculcate self-learning, face audience confidently, enhance communication skill, involve in group discussion and present and exchange ideas.

Each student, under the guidance of a Faculty, is required to

- Choose, preferably through peer reviewed journals, a recent topic of his/her interest relevant to the Course of Specialization.
- Carryout literature survey, organize the Course topics in a systematic order.
- Prepare the report with own sentences.
- Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities.
- Present the seminar topic orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

The CIE marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill, participation in the question and answer session and quality of report) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculties from the department with the senior most acting as the Chairperson.

Marks distribution for CIE of the course 20MAU27 seminar:

Seminar Report: 30 marks

Presentation skill:50 marks

Question and Answer:20 marks

*** END OF II SEMESTER***

HYBRID AND ELECTRIC VEHICLES			
Course Code	20MAU31	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Hybrid Vehicles:
Introduction to HVs, Performance characteristics of road vehicles; calculation of road load, predicting fuel economy, grid -connected hybrids.

Hybrid architecture:
Series configuration- locomotive drives, series parallel switching, load tracking architecture. Pre transmission parallel and combined configurations-Mild hybrid, power assist, dual mode, power split, power split with shift, Continuously Variable transmission (CVT), wheel motors

(RBT Levels: **L1, L2, L3)**

Module-2

Propulsion methods:
DC motors-series wound, shunt wound, compound wound and separately excited motors AC motors-Induction, synchronous, brushless DC motor, switched reluctance motors.

(RBT Levels: **L1, L2, L3)**

Module-3

Hybrid power plant specifications:
Grade and cruise targets, launching and boosting, braking and energy recuperation, drive cycle implications, engine fraction-engine downsizing and range and performance, usage requirements.

Sizing the drive system:
Matching electric drive and ICE, sizing the propulsion motor; sizing power electronics

(RBT Levels: **L1, L2, L3)**

Module-4

Energy storage technology:
Battery basics; lead-acid battery; different types of batteries; battery parameters, Battery Recycling.

Fuel cells:
Fuel cell characteristics, fuel cell types – alkaline fuel cell, proton exchange Membrane; direct methanol fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, hydrogen storage systems, reformers, fuel cell EV, super and ultra capacitors.

(RBT Levels: **L1, L2, L3)**

Module-5

Electric vehicles: Introduction: Limitations of IC Engines as prime mover, History of EVs, EV system, components of EV-DC and AC electric machines: Introduction and basic structure-Electric vehicle drive train-advantages and limitations, Permanent magnet and switched reluctance motors-EV motor sizing: Initial acceleration, rated vehicle velocity, Maximum velocity and maximum grade ability

(RBT Levels: **L1, L2, L3& L4)**

Course outcomes:
At the end of the course the student will be able to:

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Mike Westbrook, M H Westbrook , Development & Future of Battery The Institution of Electrical Engineers, UK and SAE, USA1st Edition, reprint 2005

(2) Robin Hardy, Iqbal Husain Electric and Hybrid Vehicles CRC Press, 1st Edition 2003

Reference Books

(1) International Energy Agency, France Energy Technology Analysis Prospects for Hydrogen and Fuel Cells OECD, 2005 1stEddition

(2) Hamid A Toliyat, Gerald B Kliman Handbook of Electric Motors Marcel Decker Inc. 2nd Edition, 2004

AUTOMOTIVE EMBEDDED SYSTEMS			
Course Code	20MAU321	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Electronics in Automotive:
Introduction Body and convenience electronics: vehicle power supply controllers and lighting modules, door control modules, Safety electronics: active safety systems: ABS, ASR, ESP passive safety systems: Restraint systems and their associated sensors in an automobile.
Powertrain Electronics: Gasoline engine management, Infotainment electronics: Dashboard/instrument cluster, car audio, telematic systems, navigation systems, multimedia systems, cross application technologies. 42V vehicle power supply system
(RBT Levels: **L1, L2, L3)**

Module-2

Drive by Wire:
Challenges and opportunities of X-by-wire: system & design requirements steer-by-wire, brake-by-wire, suspension-by-wire, gas-by-wire, power-bywire, shift by-wire. Future of Automotive Electronics.
(RBT Levels: **L1, L2, L3)**

Module-3

Hardware Modules:
MC9S12XD family features-Modes of operation-functional block diagram overview-programming model. Memory Map Overview Pulse Width Modulator (PWM)-On-chip ADC Serial Communication Protocol: SCI, SPI,IIC, CAN.
(RBT Levels: **L1, L2, L3)**

Module-4

Software Development Tools:
Introduction to HCS12XDT512 Student Learning Kit & PBMCU (Project Board) –Introduction to Code Warrior IDE-Editing-Debugging-Simulating simple programs. Flashing code into HCS12XDT512 SLK board and testing
(RBT Levels: **L1, L2, L3& L4)**

Module-5

Integration of Software and Hardware:
Downloading the Software from Host Machine to Target Machine. Implementing application prototype: Power Window and Automotive Lighting System
(RBT Levels: **L3& L4)**

Course outcomes:
At the end of the course the student will be able to:
CO1: Explain basics of Automotive Embedded system concepts
CO2: Select embedded system in automobiles
CO3. Use hardware and usage software in Automotive Embedded System
CO4: Use different software development tools.
CO5: Integrate Software and Hardware

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Werner Klingenstein ;Semiconductors-Technical Information Technologies and characteristic data Publicis Corporate Publishing, 2nd revised edition 2004

(2) Ronald K Jurgen, Automotive Electronics Handbook; McGraw Hill, 2nd edition 1999

Reference Books

(1) Werner Klingenstein & Team, Technical Information, Technologies and Characteristic Data- Publicis Corporate Publishing 2nd edition 2004

(2) LjuboVlacic, Michel Parent &Furnio Harshima, Intelligent Vehicle Technologies: Theory and Applications Butterworth-Heinemann publications2001

INDUSTRY 4.0 AND IIOT IN AUTOMOTIVE VEHICLES			
Course Code	20MAU322	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Introduction to Industry 4.0: Industry 4.0: Globalization and Emerging Issues, The Fourth Revolution, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories,
Industry 4.0: Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis
(RBT Levels: **L1, L2, L3)**

Module-2

Introduction to IIoT: Architectural Overview, Design principles and needed capabilities, IoT Applications, Sensing, Actuation, Basics of Networking, M2M and IoT Technology Fundamentals Devices and gateways, Data management, Business processes in IoT, Everything as a Service(XaaS), Role of Cloud in IoT, Security aspects in IoT.
(RBT Levels: **L1, L2, L3)**

Module-3

Elements of IIoT: Hardware Components- Computing (Arduino, Raspberry Pi), Communication, Sensing, Actuation, I/O interfaces. Software Components- Programming API‟s (using Python/Node.js/Arduino) for Communication Protocols-MQTT, ZigBee, Bluetooth, CoAP, UDP, TCP.
(RBT Levels: **L1, L2, L3)**

Module-4

IIoT Application Development : Solution framework for IoT applications- Implementation of Device integration, Data acquisition and integration, Device data storage- Unstructured data storage on cloud/local server, Authentication, authorization of devices
(RBT Levels: **L1, L2, L3& L4)**

Module-5

Case Studies: IoT case studies and mini projects based on Industrial automation, Transportation, Agriculture, Healthcare, Home Automation
(RBT Levels: **L3, L4&L5)**

Course outcomes:
At the end of the course the student will be able to:
CO1: Explore how Industry 4.0 will change the current manufacturing technologies and processes by digitizing the value chain.
CO2: Understand the drivers and enablers of Industry 4.0.
CO3:Learn about various IIoT-related protocols.
CO4: Build simple IIoT Systems using Arduino and Raspberry Pi.
CO5: Analyse and implement the concept in real life applications

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Arshdeep Bahga,Vijay Madisetti Ïnternet of Things, "A Hands on Approach University Press 1st **Edition,** 2015

(2) Pethuru Raj and Anupama C. Raman, The Internet of Things: Enabling Technologies, Platforms, and Use Cases , CRC Press, **1stEddition,** 2017.

Reference Books

(1) SRN Reddy, RachitThukral and Manasi Mishra, Introduction to Internet of Things: A practical Approach ETI Labs, **Edition,** 2017

(2) Adrian McEwen , Designing the Internet of Things, Wiley**1st Edition,** 2013.

(3) Raj Kamal Internet of Things : Architecture and Design McGraw Hill **1st Edition,** 2017

ADVANCED MANUFACTURING TECHNOLOGY			
Course Code	20MAU323	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Sheet Metal Forming:
Introduction, Forming methods, shearing and Blanking, Bending, stretch forming, Deep drawing, redrawing operations, Defects in formed products.

High Energy Rate Forming:
Explosive forming, Electro-hydraulic forming, Electro-magnetic forming, Super Plastic Forming - Process principles, Equipment, Process variables, Merits and Limitations

(RBT Levels: **L1, L2, L3)**

Module-2

Forging:
Classification, various stages during forging, Forging equipment, brief description, deformation in compression, forging defects. Residual stresses in forging.

Special Casting processes:
Different casting techniques for manufacturing of automotive components like cylinder block, piston, flywheel, bearing liners, etc.

Joining of Plastics:
Heated tool welding or hot bar welding, Hot gas welding or pendulum welding, High frequency welding, Ultrasonic welding, Friction welding, Induction welding

(RBT Levels: **L1, L2, L3)**

Module-3

Powder Metallurgy Processing:
Process details and special characteristics of Powder Metallurgy process, Powder making methods, Characteristics of Powders, Process flow chart, Process steps and Process variables.
Compaction techniques like CIP & HIP (Cold Iso-static and Hot Iso-static pressing), Product design considerations, Applications of Powder metallurgy

(RBT Levels: **L1, L2, L3)**

Module-4

Agile Manufacturing Technologies: Introduction, Developing agile manufacturing, Integration of Product/Process Development, Application of IT/IS concepts, Agile supply chain management, Design of skill and knowledge and Computer control of Agile manufacturing. Flexible manufacturing systems

(RBT Levels: **L1, L2, L3)**

Module-5

Plastics Injection Mould Design : General arrangement of an injection mould, Basic systems of the mould – Feeding system, cooling system and ejection systems, Concepts of three plate molds and tooling for moulding articles with undercuts, Concepts of split moulds, hot runner systems – Their advantages and limitation over conventional systems. Basic concepts of mould standardization and innovative mould components

(RBT Levels: **L1, L2, L3& L4)**

Course outcomes:

At the end of the course the student will be able to:

CO1: Understand the sheet metal forming and forging processes and shall use the appropriate one.

CO2: Choose suitable Forging process production of automotive components.

CO3: understand the advanced manufacturing technologies and systems and apply his skill to develop the technique.

CO4: Select suitable metal joining methods used in automobiles.

CO5: Use plastic joining methods

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Sach G., Fundamentals of Working of Metals, Pergamum Press **2nd Edition, 2008**

(2) R. A. Flinn & P. K. Trojan, Engineering Materials & their applications, 4th edition, Jaico Publishing House**1stEdition, 1999**

Reference Books

(1) P.M. Heldt , High speed combustion engines , Oxford and IBH Publishing Co, New York **2nd Edition,** 1990

(2) AGunasekharan, Agile Manufacturing The 21st Century Competitive strategy, Elsevier Press, India **1stEddition, 2001**

(3) Flham D.T &Dinjoy, Rapid Manufacturing S.S Verlog London **2nd Edition, 2001**

VEHICLE AERODYNAMICS & ERGONOMICS			
Course Code	20MAU324	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Fundamentals of Aerodynamics:
Scope- concept of bluff body, Generic Shapes, relevance of these shapes to ground vehicles. Pressure drag and viscous drag, flow phenomenon related to vehicles- External and Internal flows, Resistance to vehicle motion, flow field around car, aerodynamic development of cars, Optimization of car bodies for lower drag
(RBT Levels: **L1, L2, L3& L4)**

Module-2

Stability, Safety and Comfort:
The origin of forces and moments- effects- vehicle dynamics, under side wind forces and moment coefficients- safety limits, design stage measures, important factors affecting aerodynamics like rear slant, cross winds, engine cooling air flow, under body flow, wheel rotation, air flow around individual components, high performance vehicles, very long
(RBT Levels: **L2, L3& L4)**

Module-3

Wind Tunnels and Test Techniques:
Principles of wind technology- limitations of simulation- simulation based optimization of geometrics, drag reduction technologies- surface shaping, scaled models. Wind tunnel experiments- measurement of pressure coefficients, drag force, wind tunnel limitations and corrections- boundary layer control, wind tunnel blockage, climatic tunnels, measuring equipment
and transducers-pressure measurement, velocity measurement, flow visualization techniques, Wind noise measurement.
(RBT Levels: **L1, L2, L3& L4)**

Module-4

Application of CFD:
Methods to solve Navier – stoke equations, forces acting on fluid element, compressibility effect in a flow field, inviscid flow, governing equations, irritation flow field and consequences, potential flow, boundary layer methods. Important requirements of CFD solvers, Geometric/ Dynamic similarity, robust flow solver. Turbulence models, Numerical modelling of fluid flow around vehicle body.
(RBT Levels: **L1, L2, L3& L4)**

Module-5

Aerodynamic Design:
Development and simulation of cars, buses, trucks, surface motion, surface permeability, mass addition, energizing flow around the vehicle
(RBT Levels: **L1, L2, L3)**

Course outcomes:
At the end of the course the student will be able to:
CO1:Analyse the stability of vehicle and comfort to occupants
CO2:Conduct wind tunnel testing for flow visualization ,analyse and interpret the results
CO3: Calculate different aerodynamic forces
CO4:Choose the appropriate CFD solvers and do numerical modelling of fluid flow
CO5:Create aerodynamically designed vehicle body using CFD

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) W. H. Hucho, Aerodynamics of Road vehicles , Butterworth and Co Ist Edition1987

(2) Schlichting H, Boundary Layer Theory Mc. Graw Hill, New York 7thEddition 1975

Reference Books

(1) Pope A , Low speed Wind tunnel Testing, John Wiley and Sons, New York3 rd Edition, 1999

(2) Society of Automotive Engineers , SAE Vehicle Aerodynamics Packet Society of Automotive Engineers, Edition ,2006

MACHINE LEARNING			
Course Code	20MAU331	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Introduction: Well posed learning problems, Designing a Learning system, Perspective and Issues in Machine Learning.
Concept Learning: Concept learning task, Concept learning as search, Find-S algorithm, Version space, Candidate Elimination algorithm, Inductive Bias.
(RBT Levels: **L1, L2, L3)**

Module-2

Decision Tree Learning: Decision tree representation, Appropriate problems for decision tree learning, Basic decision tree learning algorithm, hypothesis space search in decision tree learning, Inductive bias in decision tree learning, Issues in decision tree learning
(RBT Levels: **L1, L2, L3)**

Module-3

Artificial Neural Networks: Introduction, Neural Network representation, Appropriate problems, Perceptrons, Back propagation algorithm
(RBT Levels: **L1, L2, L3)**

Module-4

Bayesian Learning: Introduction, Bayes theorem, Bayes theorem and concept learning, ML and LS error hypothesis, ML for predicting probabilities, MDL principle, Naive Bayes classifier, Bayesian belief networks, EM algorithm
(RBT Levels: **L1, L2, L3)**

Module-5

Evaluating Hypothesis: Motivation, Estimating hypothesis accuracy, Basics of sampling theorem, General approach for deriving confidence intervals, Difference in error of two hypotheses, Comparing learning algorithms.
Instance Based Learning: Introduction, k-nearest neighbour learning, locally weighted regression, radial basis function, cased-based reasoning,
Reinforcement Learning: Introduction, Learning Task, Q Learning
(RBT Levels: **L1, L2, L3)**

Course outcomes:
At the end of the course the student will be able to:
CO1: Understand the concept of machine learning and able to apply it to the real world
CO2: Recall the problems for machine learning and select the either supervised, unsupervised or reinforcement learning.
CO3: Understand theory of probability and statistics related to machine learning
CO4: Illustrate concept instance based learning and evaluate the hypothesis
CO5:

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Tom M. Mitchell, Machine Learning , McGraw Hill Education. India Edition 2013

(2) Oliver Theobald, Machine Learning For Absolute Beginners: A Plain English Introduction Scatter plot Press 2nd Edition, 2013

Reference Books

(1) Trevor Hastie, Robert Tibshirani, Jerome, The Elements of Statistical Learning Springer series in statistics.

(2) Andy Grey , Machine Learning: The Ultimate Guide for Beginners and Starters , Amazon Asia-Pacific Holdings Private Limited, Kindle Edition

(3) Ethem Alpaydın,, Introduction to machine learning,, MIT press. 3rd Edition, 2014

Note: In case expertise is not available in the parent department, CSE or ECE department faculty shall handle this course

ARTIFICIAL INTELLIGENCE			
Course Code	20MAU332	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Introduction: Overview of AI problems, examples of successful recent AI applications. The Turing test, Rational versus non-rational reasoning.

Search Strategies: Problem spaces (states, goals and operators), problem solving by search. Uninformed search (breadth-first, depth-first, depth first with iterative deepening). Heuristics and informed search (hill-climbing, generic best-first, A*). Minimax Search, Alpha-beta pruning

(RBT Levels: **L1, L2, L3)**

Module-2

Knowledge representation and reasoning: Review of propositional and predicate logic, First order logic, Resolution and theorem proving, Forward chaining, Backward chaining, Temporal and spatial reasoning. Review of probabilistic reasoning, Bayes theorem. Totally-ordered and partially-ordered Planning

(RBT Levels: **L1, L2, L3)**

Module-3

Planning-The blocks world, Components of Planning Systems, Goal stack planning, Nonlinear planning, Hierarchical planning. Learning-Learning from example, Learning by advice, Explanation based learning, Learning in problem solving, Definition and examples of broad variety of machine learning tasks, Classification, Inductive learning, Simple statistical-based learning such as Naive Bayesian Classifier, decision trees.

(RBT Levels: **L1, L2, L3)**

Module-4

Natural Language Processing: Language models, n-grams, Vector space models, Bag of words, Text classification, Information retrieval, Pagerank, Information extraction, Question-answering

(RBT Levels: **L1, L2, L3)**

Module-5

Agents: Definition of agents, Agent architectures (e.g., reactive, layered, cognitive), Multi-agent systems- Collaborating agents, Competitive agents, Swarm systems and biologically inspired models. Expert Systems: Representing and Using Domain Knowledge, Expert System Shells, Explanation, Knowledge Acquisition.

(RBT Levels: **L1, L2, L3)**

Course outcomes:

At the end of the course the student will be able to:

CO1: Understand, identify and apply the artificial learning concepts in automotive Vehicles

CO2:Differentiate search strategies and able to choose the one based on application

CO3:Explain different reasoning and planning technique and able to use them appropriately

CO4:Describe natural language processing and do information retrieval

CO5: Explain the expert systemand able to represent and use domain knowledge

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Elaine Rich, Kevin Knight and Shivashankar BNair, Artificial Intelligence Tata McGraw Hill3rd Edition 2009

(2) Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems Pearson Education1st Edition, 2015

Reference Books

(1) S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach Prentice Hall, 3rd Edition 2009

(2) Melanie Mitchel, Artificial Intelligence: A Guide for Thinking Humans Farrar, Straus and Giroux ,1st Edition, 2019

(3) Masoud Yazdani, Artificial Intelligence: Principles and Applications, Chapman and Hall, 1986 Digital Edition,2008

Note: In case expertise is not available in the parent department, CSE or ECE department faculty shall handle this course

FINITE ELEMENT METHOD			
Course Code	20MAU333	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Introduction to Finite Element Methods:
Engineering analysis, History, advantages and disadvantages, classification, basic concepts, convergence criteria. Role of finite element analysis in computer aided design, mathematical preliminaries, and differential equation formulation. Variational formulations, weighted residual methods

(RBT Levels: **L1, L2, L3)**

Module-2

One Dimensional Elements:
Analysis of bars and trusses, basic equations and Potential Energy functional. 1D Bar Element, Admissible displacement function, strain matrix, stress recovery, Element equation, stiffness matrix. Consistent nodal force vectors: Body force, initial strain, assembly procedure, Boundary and constraint conditions, single point constraint, multi point constraint, truss element , shape functions for higher order elements, C0, C-1 elements

(RBT Levels: **L1, L2, L3)**

Module-3

Two Dimensional Elements:
Analysis of Plane Elasticity Problems: Triangular element, four noded quadrilateral Element(QUAD4), shape functions for higher order elements (LST and QUAD 8), Lagrange element, stain –displacement matrix, stiffness matrix and Jacobian of CST and QUAD4 elements.

Axi-symmetric Solid elements:
Analysis of Bodies of revolution under axi-symmetric loading, Axi-symmetric Triangular and Quadrilateral Ring Elements, Strain-Displacement matrix, stiffness matrix

(RBT Levels: **L1, L2, L3)**

Module-4

Three dimensional elements:
Applications to Solid mechanics Problems: Basic Equations and Potential Energy Functional, Four Noded Tetrahdral Element, Eight - Noded Hexahedral Element, LaGrange family, Shape Functions for Higher Order Elements.

Beam elements
Analysis of beam and frames: 1-D Beam element Problems.

(RBT Levels: **L1, L2, L3& L4)**

Module-5

Dynamic Considerations: Formulation of point mass and distributed mass, Consistent element mass matrix of one dimensional bar element, truss element, beam element , Lumped mass matrix, Evaluation of eigen values and eigen vectors. Applications to bars and beam element

Heat Transfer:
Steady state heat transfer, 1D heat conduction governing quations. Functional approach for heat conduction. Galerkin's approach for heat conduction. 1D heat transfer in thin fins

(RBT Levels: **L1, L2, L3& L4)**

Course outcomes:
At the end of the course the student will be able to:
CO1:Understand and explain the fundamentals of structural mechanics and finite elementmethod
CO2: Develop element stiffness matrix for different elements using variousmethods.
CO3: Illustrate different methods of deriving shape functions for variouselements.
CO4: Design, analyse and create simple structural elements,
CO5:Design,analyse and create simple heat transfer conduction problems

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

T. R. Chandrupatla, A. D. Belegundu, Finite Elements in Engineering , 3rd Ed PHI. 3rd Edition

S. S. Rao, Finite Elements in Engineering, 4th Edition, Elsevier, 6th Edition,

Reference Books

(1) U.S. Dixit, Finite Element Methods for Engineers, Cengage Learning, 1st Edition 2009

(2) R. D. Cook, D. S Maltus, M. E. Plesha, R. J. Witt,, Concepts and applications of Finite Element Analysis Wiley 4th Ed 4th Edition 2001

(3) 4th Edition 2001, Finite Element Methods, Thomson Learning 3rdedition, 5th Edition 2012

J. N. Reddy,, Finite Element Method, McGraw -Hill , 3rd Edition 2006International Edition.

AUTOMOTIVE MATERIALS			
Course Code	20MAU334	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Aluminium Alloys & Lightweight Magnesium for Automotive Applications: Introduction; Wrought aluminium alloys; Cast aluminium processes Technologies; Cast aluminium metallurgy and properties; New Lightweight alloys; Process technologies; mechanical and physical properties; Case studies of applications.

Testing Automotive Materials:

Evaluation of materials under realistic loading and environmental conditions; different test methods for evaluation of properties for specific applications.

(RBT Levels: **L1, L2, L3& L4)**

Module-2

Composite Materials for Automotive Applications:

Definition, Classification, Types of matrices & reinforcements, characteristics & selection, Fiber composites, laminated composites, particulate composites, prepegs, sandwich construction.

Manufacturing Composite Materials:

Lay up and curing – open and closed mould processing – Hand lay –up techniques – Bag moulding and filament winding. Pultrusion, pulforming, Thermoforming, Injection moulding, Cutting, Machining and joining, tooling, Quality assurance – Introduction, material qualification, types of defects, NDT methods.

(RBT Levels: **L1, L2, L3& L4)**

Module-3

Metal Matrix Composites:

Reinforcement materials, types, Characteristics & selection, base metals, selection, applications in automotive engineering

(RBT Levels: **L1, L2, L3& L4)**

Module-4

Micro Mechanical analysis of a Lamina:

Introduction, Evaluation of the four elastic modules – Rule of mixture, ultimate strengths of unidirectional lamina.

Macro mechanics of a Lamina:

Hooke's law for different types of materials, number of elastic constants; Two – dimensional relationship of compliance & stiffness matrix. Hooke's law for two dimensional angle lamina, engineering constants – angle lamina, Invariants, Theories of failure.

(RBT Levels: **L1, L2, L3)**

Module-5

Macro Mechanics of Laminates:

Laminates Coding, ABD Matrices, Classical Laminates Theory, Special cases of Laminates, Strength Theories of Laminates.

(RBT Levels: **L1, L2, L3)**

Course outcomes:

At the end of the course the student will be able to:

CO1: Explain properties of various light metals used for vehicle body construction.

CO2: Select suitable materials for making composite materials.

CO3: Apply basics of strength of materials and theories of failure for analysis of laminates.

CO4: Analyse failure of materials by using NDT techniques

CO5: Understand , analyse and apply laminates coding and macro mechanics

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) James M Boileau, Developments in Lightweight Alloys for Automotive Applications, SAE, 1st Eddition,2006

(2) Thomes Ruden, Lightweight Magnesium Technology, SAE illustrated edition, 2006

Reference Books

(1) Donald H Wright, Testing Automotive Materials & Components, SAE 1st Eddition, 1993

(2) Krishan K. Chawla, Composite material science and Engineering, Springer, 3rd Edition 2012

(3) P. C. Mallik, Marcel Decker, Fibre reinforced composites, 3rd Edition 2007

PROJECT WORK PHASE – 1			
Course Code	20MAU34	CIE Marks	100
Number of contact Hours/Week	2	SEE Marks	--
Credits	02	Exam Hours	--

Course objectives:

- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organisation, time management, and presentation skills.
- Impart flexibility and adaptability.
- Inspire independent and team working.
- Expand intellectual capacity, credibility, judgement, intuition.
- Adhere to punctuality, setting and meeting deadlines.
- Instil responsibilities to oneself and others.
- Train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Phase-1 Students in consultation with the guide/s shall carry out literature survey/ visit industries to finalize the topic of the Project. Subsequently, the students shall collect the material required for the selected project, prepare synopsis and narrate the methodology to carry out the project work.

Seminar: Each student, under the guidance of a Faculty, is required to

- Present the seminar on the selected project orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Course outcomes:

At the end of the course the student will be able to:

- Demonstrate a sound technical knowledge of their selected project topic.
- Undertake problem identification, formulation, and solution.
- Design engineering solutions to complex problems utilising a systems approach.
- Communicate with engineers and the community at large in written an oral forms.
- Demonstrate the knowledge, skills and attitudes of a professional engineer.

Continuous Internal Evaluation

CIE marks for the project report (50 marks), seminar (30 marks) and question and answer (20 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

MINI PROJECT			
Course Code	20MAU35	CIE Marks	40
Number of contact Hours/Week	2	SEE Marks	60
Credits	02	Exam Hours/Batch	03

Course objectives:

- To support independent learning and innovative attitude.
- To guide to select and utilize adequate information from varied resources upholding ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Mini-Project: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

Course outcomes:

At the end of the course the student will be able to:

- Present the mini-project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills.
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it.

CIE procedure for Mini - Project:

The CIE marks awarded for Mini - Project, shall be based on the evaluation of Mini - Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.The marks awarded for Mini - Project report shall be the same for all the batch mates.

Semester End Examination

SEE marks for the mini-project shall be awarded based on the evaluation of Mini-Project Report, Presentation skill and Question and Answer session in the ratio 50:25:25 by the examiners appointed by the University.

INTERNSHIP / PROFESSIONAL PRACTICE			
Course Code	20MAUI36	CIE Marks	40
Number of contact Hours/Week	2	SEE Marks	60
Credits	06	Exam Hours	03

Course objectives:

Internship/Professional practice provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc. The objective are further,

To put theory into practice.

To expand thinking and broaden the knowledge and skills acquired through course work in the field.

To relate to, interact with, and learn from current professionals in the field.

To gain a greater understanding of the duties and responsibilities of a professional.

To understand and adhere to professional standards in the field.

To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality.

To identify personal strengths and weaknesses.

To develop the initiative and motivation to be a self-starter and work independently. ■

Internship/Professional practice: Students under the guidance of internal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.

Seminar: Each student, is required to

- Present the seminar on the internship orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit the report duly certified by the external guide.
- The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident. ■

Course outcomes:

At the end of the course the student will be able to:

- Gain practical experience within industry in which the internship is done.
- Acquire knowledge of the industry in which the internship is done.
- Apply knowledge and skills learned to classroom work.
- Develop a greater understanding about career options while more clearly defining personal career goals.
- Experience the activities and functions of professionals.
- Develop and refine oral and written communication skills.
- Identify areas for future knowledge and skill development.
- Expand intellectual capacity, credibility, judgment, intuition.
- Acquire the knowledge of administration, marketing, finance and economics. ■

Continuous Internal Evaluation CIE marks for the Internship/Professional practice report (20 marks), seminar (10 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with
Semester End Examination SEE marks for the internship report (30 marks), seminar (20 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University. ■

PROJECT WORK PHASE -2			
Course Code	20MAU41	CIE Marks	40
Number of contact Hours/Week	4	SEE Marks	60
Credits	20	Exam Hours	03

Course objectives:

- To support independent learning.
- To guide to select and utilize adequate information from varied resources maintaining ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas. ■

Project Work Phase - II: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism. ■

Course outcomes:

At the end of the course the student will be able to:

- Present the project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it. ■

Continuous Internal Evaluation:

Project Report: 20 marks. The basis for awarding the marks shall be the involvement of the student in the project and in the preparation of project report. To be awarded by the internal guide in consultation with external guide if any.

Project Presentation: 10 marks.

The Project Presentation marks of the Project Work Phase -II shall be awarded by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

Question and Answer: 10 marks.

The student shall be evaluated based on the ability in the Question and Answer session for 10 marks.

Semester End Examination

SEE marks for the project report (30 marks), seminar (20 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University. ■