SYLLABUS

(WITH EFFECT FROM 2018-19)

ಪಠ್ಯಕ್ರಮ

(ಶೈಕ್ಷಣಿಕವರ್ಷ 2018–19)

VII to VIII Semester

Bachelor Degree

in

Automobile Engineering

OUT COME BASED EDUCATION

WITH

CHOICE BASED CREDIT SYSTEM

P.E.S. College of Engineering
Mandya - 571 401, Karnataka
(An Autonomous Institution Affiliated to VTU, Belagavi)
Grant -in- Aid Institution
(Government of Karnataka)
Accredited by NBA, New Delhi
Approved by AICTE, New Delhi.

ಪಿ.ಇ.ಎಸ್. ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ
ಮಂಡ್ಯ–571 401, ಕರ್ನಾಟಕ
(ವಿ.ಟಿ.ಯು, ಬೆಳಗಾವಿ ಅಡಿಯಲ್ಲಿನ ಸ್ವಾಯತ್ತ ಸಂಸ್ಥೆ)
Ph : 08232- 220043, Fax : 08232 – 222075,Web : www.pescemandya.org

Preface

PES College of Engineering, Mandya, started in the year 1962, has become autonomous in the academic year 2008-09. Since, then it has been doing the academic and examination activities successfully. The college is running Eight undergraduate and Eight Postgraduate programs. It consists of Six M.Tech programs, which are affiliated to VTU. Other postgraduate programs are MBA and MCA.

India has recently become a Permanent Member by signing the Washington Accord. The accord was signed by the National Board of Accreditation (NBA) on behalf of India on 13th June 2014. It enables not only the mobility of our degree globally but also establishes equivalence to our degrees with that of the member nations such as Taiwan, Hong Kong, Ireland, Korea, Malaysia, New Zealand, Russia, Singapore, South Africa, Turkey, Australia, Canada and Japan. Among other signatories to the international agreement are the US and the UK. Implementation of Outcome Based Education (OBE) has been the core issue for enabling the equivalence and of Indian degrees and their mobility across the countries.

Our Higher Educational Institution has adopted the CBCS based semester structure with OBE scheme and grading system.

The credit based OBE semester system provides flexibility in designing curriculum and assigning credits based on the course content and hours of teaching.

The OBE, emphasize setting clear standards for observable, measurable outcomes of programs in stages. There lies a shift in thinking, teaching and learning processes moving towards Students Centric from Teacher Centric education. OBE standards focus on mathematics, language, science, attitudes, social skills & moral values.

The key features which may be used to judge, if a system has implemented an outcome based education system is mainly Standard based assessments that determines whether students have achieved the stated standard. Assessments may take any form, so long as the process actually measure whether the student knows the required information or can perform the required task. Outcome based education is a commitment that all students of all groups will ultimately reach the same minimum standards. Outcome Based Education is a method or means which begins with the end in mind and constantly emphasizes continuous improvement.

Choice Based Credit System (CBCS) provides choice for students to select from the prescribed courses (core, Foundation, Foundation Elective, elective, open elective and minor or soft skill courses). The CBCS provides a 'cafeteria' type approach in which the students can Choose electives from a wide range of courses of their choice, learn at their own pace, undergo additional courses and acquire more than the required credits, adopt an interdisciplinary approach to learning which enables integration of concepts, theories, techniques, and, perspectives from two or more disciplines to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline. These greatly enhance the skill/employability of students.

In order to increase the Industry/Corporate readiness, many Soft Skills and Personality Development modules have been added to the existing curriculum of the academic year 2015-16. Industry Interactions have been made compulsory to enhance the field experience. In order to enhance creativity and innovation Mini Project and Industrial visit & Interaction are included in all undergraduate programs.

Dr. Umesh D R
Deputy Dean (Academic)
Associate Professor,
Dept. of CS & Engg

Dr.R.Girisha
Dean (Academic)
Professor
Dept. of Computer Science Engg.

P.E.S. College of Engineering

VISION

PESCE shall be a leading institution imparting quality engineering and management education, developing creative and socially responsible professionals

MISSION

PEM1: Provide state of the art infrastructure, motivate the faculty to be proficient in their field of specialization and adopt best teaching -learning practices

PEM2: Impart engineering and managerial skills through competent and committed faculty using Outcome Based Educational curriculum

PEM3: Inculcate professional ethics, leadership qualities and entrepreneurial skills to meet the societal needs

PEM4: Promote research, product development and industry-institution interaction.

DEPARTMENT OF AUTOMOBILE ENGINEERING

The discipline Automobile Engineering was established in the year 1980, and now it has gained expertise and contributing vitally to the Automobile Engineering community. The focus is to consistently pursue in providing innovative and quality training to the talented and dedicated students, to empower them in engineering the development of national economy, specialized in transport sector. We are the pioneers in Karnataka to introduce the Department of Automobile Engineering to impart sound automotive knowledge to the students with a passion towards Automobiles. We take honor in being recognized as a 'research centre' in Karnataka by VTU and Mysore University. In addition to these regular programmes, this department is also actively involved in conducting Faculty Development Programmes, Technical talks, Training programmes and technical visits to various industries & regular industrial traiinings for the benefits of students. The department has well qualified and well experienced faculty members to meet the present day curriculum requirements both in theory and practical.

VISION

To be a distinguished centre for imparting quality education in automobile engineering to develop competent and socially responsible engineers and carryout research on continuous basis for the betterment of the society.

MISSION

AUM1: To give best learning experience through innovative teaching practices supported by excellent laboratory infrastructure and exposure to recent trends in the automotive industry.

AUM2: Provide in-depth knowledge in automobile engineering with equal emphasis on theoretical and practical aspects and interdisciplinary problem solving skills.

AUM3: Focus on Industry-institute interaction, for better understanding of the state of the art technologies, Promoting research and also to build the spirit of entrepreneurship.

AUM4: Inculcate societal responsibility and ethical values through personality development programs.

Programme Education Objectives (PEOs)

PEO1: To prepare Graduates to pursue a successful career in automotive and allied industries and/or to pursue higher education and/or to become entrepreneur.

PEO2: To develop expertise in the core area of automobile engineering such as design, manufacturing, and servicing with a focus on research and innovation for the benefit of the society.

PEO3: To enable graduates to apply interdisciplinary engineering knowledge to solve practical automobile engineering problems.

PEO4: To prepare graduates to demonstrate professionalism, team work, communication skills, ethical conduct, and societal responsibility and adapt to current trends by engaging in lifelong learning.

Programme Specific Outcomes (PSOs)

Specific skills enhanced in this programme can enable the Graduates to

PSO1. Apply the basic and advanced knowledge of automobile, manufacturing, materials and thermal engineering to analyze and solve a realistic/practical problem.

PSO2. Design basic automotive systems and make use of advanced automotive systems to improve the performance, safety, maintenance and management of automobiles.

PSO3. Use modern tools and carry out research in automotive domain for providing solutions to automotive and societal issues.

Programme Outcomes (PO)

Engineering program must demonstrate that their students attain the following outcomes:

1. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12**. Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Scheme of Teaching And Examination **VII Semester B.E.**

SL. No	Subject Code	Title of the Subject	Teaching Dept.	Hrs/ Week Pattern L : T : P:H	Total Credits	Examination Marks		
						CIE	SEE	Total
1	P18 AU 71	Mechanical Vibrations	AU	4 :0:0:	4	50	50	100
2	P18 AU 72	Vehicle body Engineering and safety	AU	4 :0:0:	4	50	50	100
3	P18 AU 73	Automotive air Pollution and control	AU	4 :0:0:	4	50	50	100
4	P18 AU 74X	Professional Elective-III	AU	2:1:0:	3	50	50	100
5	P18AUO75X	Open Elective–II	AU	3:0:0:	3	50	50	100
6	P18 AU L76	Automotive Testing and Servicing Lab	AU	0:0:3:	1.5	50	50	100
7	P18 AU L77	Diagnosis and Reconditioning Lab	AU	0:0:3:	1.5	50	50	100
8	P18 AU 78	Project Work Phase-I	AU	0:0:4:	2	100	--	100
Total					23	450	350	800

List of Electives					
	Professional Elective-III				**Open Elective-II**
Sl. No	**Course Code**	**Course Title**	**Sl No**	**Course Code**	**Course Code**
1	P18 AU 741	Electric Hybrid Vehicles	1	P18AUO751	Automotive Chassis & Transmission
2	P18 AU 742	Transport Management & Motor Vehicle Act			
3	P18 AU 743	Tyre Technology			
4	P18 AU 744	Finite Element Method			

Scheme of Teaching And Examination **VIII Semester B.E.**

	Subject Code	Title of the Subject	Teaching Dept.	Hrs/ Week Pattern L : T : P:H	Total Credits	Examination Marks		
						CIE	SEE	Total
1	P18 AU 81	Earthmoving Equipments and Tractors	AUTO	4:0:0:	4	50	50	100
2	P18 AU 82X	**Professional Elective-IV**	AUTO	2:1:0:	3	50	50	100
3	P18 AU 83	Internship	AUTO	0:0:0:	2	50	--	50
4	P18 AU 84	Project Work Phase-II	AUTO	0:0:0:	6	100	100	200
5	P18 AU 85	Self study course and seminar	AUTO	0:0:4:	2	50	--	50
Total					**17**	**300**	**200**	**500**

Professional Elective-IV		
Sl. No	**Course Code**	**Course Title**
1	P18 AU 821	Alternative Energy Sources for Automobiles
2	P18 AU 822	Automotive embedded systems
3	P18 AU 823	Control Engineering
4	P18 AU 824	Vehicle Dynamics

Course Title: MECHANICAL VIBRATION			
Course Code: P18AU71	**Semester: 7**	**L:T:P:H- 4:0:0:--**	**Credits:4**
Contact period : Lecture: 52 Hrs., Exam 3 Hrs.		**Weightage : CIE:50%; SEE:50%**	

Prerequisites:

The student should have undergone the course on Automotive Engines and Components, Automotive Chassis, Suspension and Transmission.

COURSE LEARNING OBJECTIVES (CLO):

The course aims to:

1. **Formulate** mathematical models of single degree of freedom, free, undamped and damped vibrating systems and **determine** their natural frequencies. **Formulate** mathematical models for damped free vibratory systems.(L5,L6)
2. **Determine** the response of simple single degree of freedom systems subjected to forced vibration.(L5)
3. **Explain** the working principle of vibration measuring instruments. **Determine** the whirling speed of shafts. **Compute** harmonics of general forcing functions using Fourier series.(L2,L5,L6)
4. **Formulate** mathematical models and **Solve** vibration problems related to Two degrees of freedom. **Determine** influence coefficients. (L3,L5,L6)
5. **Solve** multi degree of freedom systems using Rayleigh and Dunkerley, Stodola, Holzer and Matrix iteration methods. (L3).

Relevance of the course

Mechanical Vibrations is a foundation course in B.E Automobile engineering program that helps in understanding vibrations of various components in machines, vibrations due to unbalanced forces in a machine.

Further this course also helps in understanding, solving numerically various systems vibrating with multi degrees of freedom and method of damping the system.

COURSE CONTENT

UNIT – I

Undamped Free Vibrations: Introduction, basic concepts of vibration, Simple harmonic motion, types of vibration, elements of vibrating system, Single degree of freedom systems, determination of natural frequency using Newton's law and energy methods. **Damped Free Vibrations:** Introduction, types of damping, free vibrations with viscous damping, under-damped, over-damped and critically-damped systems, logarithmic decrement.

SSC: A vehicle as a single degree undamped and damped system. **12Hrs**

UNIT – II

Forced Vibrations: Introduction, forced vibration with constant harmonic excitation, steady state vibrations, forced vibration with rotating and reciprocating unbalance. Vibration isolation, force transmissibility. Forced vibrations due to excitation of the support: Absolute motion and relative motion.

SSC: Sources of vibration in automobile rider comfortable criteria **10Hrs**

UNIT – III

Vibration measuring instruments: Vibrometer, velocity pick-up and accelerometer**. Whirling of Shafts:** Introduction, critical speed of a light shaft having a single disc without damping, critical speed of a light shaft having a single disc with damping.

SSC: Fourier series and Harmonic Analysis: Analytical methods and numerical methods. **08Hrs**

UNIT – IV

Two Degrees of Freedom Systems: Introduction, undamped systems, principle and normal modes of vibration, co-ordinate coupling, generalized and principal co-ordinates, free vibration in terms of initial conditions, combined rectilinear and angular modes, undamped dynamic vibration absorber (No numerical on vibration absorber). Influence coefficients, Maxwell's reciprocal theorem.

SSC: A vehicle as two degree undamped system. **10 Hrs**

UNIT – V

Multi Degree Freedom Systems: Introduction, determination of natural frequencies, Rayleigh's method, Dunkerley's method, Stodola's method, Holzer's method. orthogonality principle, matrix iteration method.

SSC: Rayleigh's method, Dunkerley's method to find natural frequencies of multi degree freedom system. **12 Hrs**

TEXT BOOKS:

1 G.K. Grover, Nem Chand & brothers ,**Mechanical vibrations**:, Roorkee.

2 V.P. Singh, **Mechanical Vibrations** Dhanpat Rai & Company Pvt. Ltd.

REFERENCES:

1 S.S. Rao, **Mechanical Vibrations** Pearson Education Inc, 4th Edition, 2003.

2 S. Graham Kelly, Schaum's Outline Series, **Mechanical Vibrations** Tata McGraw Hill, Special Indian edition, 2007.

3 J.S. Rao & K. Gupta, **Theory & Practice of Mechanical vibrations** New Age International Publications, New Delhi, 2001.

4 Leonanrd Meirovitch, **Elements of Vibrations Analysis** Tata McGraw Hill, Special Indian edition, 2007.

5 Austin H Church, John Wiley & Sons. **Mechanical Vibrations**

COURSE OUTCOMES

1. Formulate mathematical models of single degree of freedom damped and undamped free vibratory systems and determine their natural frequencies.
2. Analyze the response of simple single degree of freedom systems subjected to forced vibration.
3. Explain the working principle of vibration measuring instruments. Determine the whirling speed of shafts and harmonics of general forcing functions using Fourier series.
4. Formulate mathematical models and determine natural frequencies and corresponding mode shapes of two degrees of freedom systems.

5. Use numerical methods to solve multi degree of freedom systems for their natural frequencies and mode shapes.

Course Articulation Matrix

Mapping of Course Outcomes (CO) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Sl. No.	Course Outcome	Programme Outcomes												Programme Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	Formulate mathematical models of single degree of freedom damped and undamped free vibratory systems and determine their natural frequencies.	3	3	2	-	-	-	-	-	-	-	-	-	3	1	1
2	Analyze the response of simple single degree of freedom systems subjected to forced vibration.	3	3	3	-	-	-	-	-	-	-	-	-	3	2	1
3	Explain the working principle of vibration measuring instruments. Determine the whirling speed of shafts and harmonics of general forcing functions using Fourier series.	3	2	3	-	-	-	-	-	-	-	-	-	2	2	1
4	Formulate mathematical models and determine natural frequencies and corresponding mode shapes of two degrees of freedom systems.	3	3	3	-	-	-	-	-	-	-	-	-	2	2	1
5	Use numerical methods to solve multi degree of freedom systems for their natural frequencies and mode shapes.	3	1	1	-	-	-	-	-	-	-	-	-	2	2	1

Course Title: Vehicle Body Engineering & safety			
Course Code: P18AU72	Semester: VII	L:T:P:H -4:0:0:4	Credits: 4
Contact Period-Lecturer: 52Hrs. Exam:3 Hrs		Weightage:CIE:50%; SEE:50%	

Prerequisites:

The student should have undergone the course on Automotive Engines and Components, Automotive Chassis, Suspension and Transmission.

Course Learning Objectives (CLOs)

This Course aims to

1. Explain the various constructional styles and shapes with respect to visibility, safety and interiors of car and bus bodies
2. Analyze the appropriate materials for body construction in view of safety, durability and aesthetics
3. Analyze the Aerodynamics profile of automobile body for optimum performance
4. Discuss the various requirements of automobile safety for passenger vehicles
5. Discuss the stress induced in vehicles for different load conditions the crash worthiness of vehicles

Course Content

UNIT- I

CAR BODY AND BUS BODY DETAILS Types of car bodies Constructional details of a passenger car. Visibility: Regulation, Driver's visibility, Methods of improving visibility.

CLASSIFICATION OF BUS BODIES – Based on distance traveled, Based on capacity of the bus and based on style & shape. Types of metal section used in the construction and regulations. Construction of conventional and integral type buses& comparison. Different types of seating arrangement.

SSC: Commercial vehicle body layouts & types **12Hrs**

UNIT -II

BODY MATERIALS, TRIM, MECHANISMS AND BODY REPAIR Types of materials used in body construction-Steel sheet, timber, plastics, GRP, properties of materials. Body trim items-body mechanisms. corrosion: Anticorrosion methods, Modern painting process procedure-paint problems. Hand tools-power tools-panel repair-repairing sheet metal-repairing.

SSC: Plastics-body fillers-passenger compartment service. **10Hrs**

UNIT -III

AERODYNAMICS Types of aerodynamic drag. Forces and moments influencing drag. Effects of forces and moments. Various body optimization techniques for minimum drag. Principle of wind tunnel technology. Testing with wind tunnel balance (scale models).

SSC: Flow visualization techniques **10Hrs**

UNIT -IV

DESIGN OF AUTOMOTIVE BODY AND SAFETY Introduction to automotive safety systems - Design of the body for safety - engine location - concept of crumble zone - safety sandwich construction - deformation behavior of vehicle body - speed and acceleration characteristics of passenger compartment on impact.

SSC: Collapsible steering column, tiltable steering wheel, air bags. **10 Hrs**

UNIT –V

Load Distribution: Types of load carrying structures -closed, integral, open, flat types. Calculation of loading cases- static, asymmetric, vertical loads. Load distribution, stress analysis of structure, body shell analysis.

CRASH WORTHINESS Definition – Requirements – Tests – component, sled and full-scale barrier impacts-Active safety: driving safety, conditional safety, perceptibility safety, operating safety.

SSC: Passive safety: exterior safety, interior safety. **10 Hrs**

Text Book

1. Heinz Heisler, "Advanced Vehicle Technology", 2 nd edition, Butterworth – Heinemann, 2002.
2. Wolf-Heinrich Hucho, "Aerodynamics of road vehicles", 4th edition, 2000.
3. Vivek D. "Ergonomics in the Automotive Design Process" Bhise publisher CRC press, Taylor and Francis group.

References

1. John Fenton, "Vehicle Body layout and analysis", Mechanical Engineering Publication Ltd., 1984
2. Hand book on vehicle body design – SAE publication
3. Vehicle Safety 2002, Cornwell press, Town Bridge, UK, ISBN 1356 -1448.
4. Redesign of bus bodies – part I & part II – CIRT, Pune (Report), 1983
5. Ed W.H. Hucho, Aerodynamics of Road Vehicles, 4th Edition, Butter worth's 1987

Course Outcomes

After learning all the units of the course, the student is able to

1. **Explain** the various constructional styles and shapes with respect to visibility, safety and interiors of car and bus bodies
2. **Analyze** the appropriate materials for body construction in view of safety, durability and aesthetics
3. **Analyze** the Aerodynamics profile of automobile body for optimum performance
4. **Discuss** the various requirements of automobile safety for passenger vehicles
5. **Discuss** the stress induced in vehicles for different load conditions the crash worthiness of vehicles

Course Articulation Matrix

Mapping of Course Outcomes (CO) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Sl. No.	Course Outcome	Programme Outcomes												Programme Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	**Explain** the various constructional styles and shapes with respect to visibility, safety and interiors of car and bus bodies	2	2	-	-	-	-	2	-	-	-	-	2	3	-	-
2	**Analyze** the appropriate materials for body construction in view of safety, durability and aesthetics	3	3	2	-	-	-	2	-	-	-	-	2	3	2	-
3	**Analyze** the Aerodynamics profile of automobile body for optimum performance	3	3	2	-	-	-	2	-	-	-	-	2	3	2	-
4	**Discuss** the various requirements of automobile safety for passenger vehicles	3	2	2	-	-	-	2	-	-	-	-	2	2	2	-
5	**Discuss** the stress induced in vehicles for different load conditions the crash worthiness of vehicles	3	3	2	-	-	-	2	-	-	-	-	2	3	3	-

Course Title: Automotive Air Pollution & Control			
Course Code: P18AU73	Semester: VII	L:T:P:H -4:0:0:4	Credits:4
Contact Period-Lecturer: 52Hrs. Exam: 3Hrs		Weightage:CIE:50%; SEE:50%	

Prerequisites:

Subject requires student to know about Students must have the back ground knowledge of combustion in S I engines and combustion in C I engine and also about measurement technology

Course Learning Objectives (CLOs):

At the end of the course the student should be able to

1. **Explain** the current Indian and European emission standards.(L2)
2. **Explain t**he mechanism of formation of HC,CO, particulate and Noxfrom SI and CI engines (L2)
3. D**escribe** about different pollution control techniques used in SI and CI engines(L2)
4. **Determine** the HC, CO, NOx and particulate using different gas analyzers (L5)
5. **Describe** about various post combustion treatments used in SI and CI engine (L2)

Course content

UNIT-I

Mechanism Of Pollutant Formation In Engines: Introduction, **NITROGEN OXIDES:** kinetics of NO formation in SI and CI engines, Formation of NO_2

CORBONMONOXIDE: UNBURNED HYDROCARBON EMISSIONS: Back ground, HC emissions from spark ignition engines, HC emission mechanisms in diesel engines Crankcase emissions, piston ring blow by, **PARTICULATE EMISSIONS:** Spark ignition engine particulates, characteristics of diesel particulates, soot formation fundamentals, soot oxidation.

SSC : evaporative emissions **11 Hrs**

UNIT-II

POLLUTION CONTROL TECHNIQUES:

SI engine emission control technology : engine design parameters like, compression ratio, cylinder size, equivalence ratio, ignition timing, residual gas dilution, engine speed, coolant temperature, combustion chamber shape, fueling system, variable valve timing and lift, variable swept volume and lean burn strategies.

positive crankcase ventilation system, evaporative emission control and exhaust gas recirculation

CI engine emission control technology : Design changes, compression ratio, in-cylinder air swirl, multi valves, engine load, engine speed, optimization of operating factors and Exhaust gas recirculation, fuel injection variables , electronic fuel injection systems and turbo charging.

SSC : on board diagnostic systems **11 Hrs**

UNIT-III

INFLUENCE OF FUEL PROPERTIES & EFFECT OF AIR POLLUTION

Motor gasoline properties, effect of gasoline properties on emissions and reformulated gasoline. Diesel Fuel properties, effect of diesel fuel properties on emissions, **Effect of air pollution:** on Human Health, on animals and on plants

SSC : effect of Alternative Fuels and lubricants on emissions. **10 Hrs**

UNIT- IV

INSTRUMENTATION FOR POLLUTION MEASUREMENTS

NDIR analyzers, Gas chromatograph, Thermal conductivity and flame ionization detectors, Analyzers for NO_x, Orsat apparatus, Smoke measurement, comparison method, obscuration method, ringelmann chart, Continuous filter type smoke meter, Bosch smoke meter, Hartridge smoke meter

Test cycles for light, medium and heavy duty vehicles engines

Emission standard for motor cycles, light duty and heavy duty vehicles

SSC: constant volume sampling **10 Hrs**

UNIT- V

POST COMBUSTION TREATMENTS

Available options, physical conditions & exhaust gas compositions before treatment,

SI engines : Thermal Reactors, catalytic exhaust after treatment catalyst, catalyst substrate, types of catalytic converter , oxidation and reducing catalytic converters and three way catalysts CI engines : catalytic exhaust gas after treatment, diesel oxidation catalysts, NOx storage reduction catalyst, selective catalytic reduction ,Installation of catalyst in exhaust lines, catalyst poisoning, catalyst light-off, particulate traps, Diesel Trap oxidizer.

SSC: Electronic fuel injection systems **10 Hrs**

Text Books

1. Automobiles and pollution, SAE transactions 1995
2. Internal combustion engine fundamentals, John B heywood, Mc Graw Hill CO 2011
3. Engine emissions, B P Pundir, Narosa publishing house, New Delhi, 2011
4. Air pollution and control, by pawl Degobert.

References:

1. Internal combustion engines, V Ganesan, Tata McGrawHill CO, 2014
2. Internal combustion engines, E F Obert,

Course Outcome

CO1. Distinguish between the different pollutants from SI and CI engines and their formation mechanism

CO2. Identify and analyze the different design parameters to control pollution from SI and CI engines

CO3. Interpret the different fuel properties on emission and also effect of automotive pollution on human, animals and plants

CO4. Distinguish between different methods of post combustion treatments

CO5. Measure pollutants emitted from SI and CI engines using different instruments

Course Articulation Matrix

Mapping of Course Outcomes (CO) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Sl. No.	Course Outcome	Programme Outcomes												Programme Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	Distinguish between the different pollutants from SI and CI engines and their formation mechanism	2			2		2			2			2			
2	Identify and analyze the different design parameters to control pollution from SI and CI engines	2	2		2	2		2		2	2	2	2			
3	Interpret the different fuel properties on emission and also effect of automotive pollution on human, animals and plants	2	2		2	2		2	2			2	2			
4	Distinguish between different methods of post combustion treatments				2			2	2							
5	Measure pollutants emitted from SI and CI engines using different instruments	2		2		2		2					1			

Course title: Electric Hybrid Vehicles			
Course code: P18AU741	Semester: VII	L – T – P -H:4-0-0-4	Credits: 3
Contact period-lecturer: 52hrs.	Exam:3 hrs	Weightage:CIE:50%; SEE:50%	

Prerequisites:
The student should have undergone the course on conventional vehicles propulsion and design

Course Learning Objectives (CLOs)

This Course aims to

1. Know Basic structure of the hybrid Electric vehicle and the performance of a hybrid vehicle.
2. Knowing the components of the Electric vehicle control of DC Motor drives and Energy storing technologies.
3. Understanding the Power train Modeling Techniques,
4. Know the concept of hybrid electric drive trains ,series configuration- locomotive drives
5. Describe the operation of braking system.

Course content

UNIT-1

Electric vehicles: Introduction: Limitations of IC Engines as prime mover, History of EVs, EV system, components of EV, Basic Structure-Electric vehicle drive train-advantages and limitations.

Configuration of electric vehicle, performance of electric vehicle, traction motor characteristics, tractive effort and transmission requirement , vehicle performance , tractive effort in normal driving ,energy consumption.

SSC: Study and list the Indian electric vehicle **10 Hrs**

UNIT-2

Electric Machines and Drives in EVs

Introduction to electric components used in electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Energy Storage Technology: Battery basics, different types of batteries (lead-acid battery / Lithium / Alkaline), High discharge capacitors, flywheels, battery parameters.

SSC: Study the motor fitted to any one electric vehicle **11 Hrs**

UNIT-3

Power train Optimization

Power train Modeling Techniques: Forward-Facing Vehicle Model Backward-Facing Vehicle Model. Comparison of Forward-Facing and Backward-Facing Models. Defining Performance Criteria: Tank-to-Wheel Emissions and Well-to-wheel Emissions. Modular Power train Structure: Framework of Proposed Toolbox, Modular Power train Structure. Optimizer.

Optimization Problem: Case Studies: Optimization of Power train Topology and Component Sizing

Case Study 1: Tank-to-Wheel versus Well-to-Wheel CO2. Lowest Well-to-Wheel CO2 Emissions, Lowest Tank-to-Wheel CO2 Emission, Multi objective Optimization

SSC: Study any one power train structure adopted in existing electric vehicle **10 Hrs**

UNIT-4

Hybrid Electric Vehicles - concept of hybrid electric drive trains

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. Different hybrid vehicles on the road; at least three modes.

SSC: Study the any one existing vehicle architecture **10 Hrs**

UNIT-5

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.

Fundamentals of Regenerative Braking

Braking Energy Consumed in Urban Driving, Braking Energy versus Vehicle Speed. Braking Energy, versus Braking Power, Braking Power versus Vehicle Speed Braking Energy versus Vehicle Deceleration Rat, Braking Energy on Front and Rear Axles, Brake System of EV, HEV, and FCV: Parallel Hybrid Brake System.

SSC: Study the braking system adopted in Indian electric vehicle **11 Hrs**

Text Books:

1. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Third Edition, CRC Press Taylor & Francis Group, 6000 ken Sound Parkway NW, Suite 300, Boca Raton, FL 33487-2742
2. Iqbal Husain "Electric and Hybrid Vehicles: Design fundamentals". CRC Press, 2011.

Reference Books:

1. Hybrid Electric Vehicle System Modeling and Control - Wei Liu, General Motors, USA, John Wiley & Sons, Inc., 2017.
2. Electric and Hybrid Vehicles, Tom Denton, Taylor & Francis, 2018.
3. James Laminie and John Lowry. "Electric Vehicle Technology – Explained', CRC Press 2010

Course Outcomes (CO)

After learning all the units of the course, the student is able to

1. Know Basic structure of the hybrid Electric vehicle and the performance of a hybrid vehicle.
2. Knowing the components of the Electric vehicle control of DC Motor drives and Energy storing technologies.
3. Understanding the Power train Modeling Techniques,
4. Know the concept of hybrid electric drive trains ,series configuration- locomotive drives
5. Describe the operation of braking system.

Course Articulation Matrix

Mapping of Course Outcomes (CO) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Sl. No.	Course Outcome	Programme Outcomes												Programme Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	Know Basic structure of the hybrid Electric vehicle and the performance of a hybrid vehicle.	3	2	1	-	-	2	2	-	-	-	-	2	3	1	1
2	Knowing the components of the Electric vehicle control of DC Motor drives and Energy storing technologies.	3	2	1	-	-	2	2	-	-	-	-	2	3	1	1
3	Understanding the Power train Modeling Techniques,	3	2	1	-	-	2	2	-	-	-	-	2	2	1	1
4	Know the concept of hybrid electric drive trains ,series configuration-locomotive drives	3	-	1	-	-	2	2	-	-	-	-	2	3	1	1
5	Describe the operation of braking system.	3	3	1	-	-	2	2	-	-	-	-	2	3	1	1

Course Title: Transport Management & Motor Vehicle Act			
Course Code: P18AU742	Semester: VII	L:T:P:H -4:0:0:4	Credits: 3
Contact Period-Lecturer: 52Hrs. Exam:3 Hrs		Weightage:CIE:50%; SEE:50%	

Prerequisites:
Understanding of transport management, Measures and systems for the effective transport management, transportation networks, operations & Motor Vehicle Act

Course Learning Objectives (CLOs):
At the end of the course the student will be able to –

1. **Describe** about a transport - management, infrastructure, -safe fleet operation, garage operation, Public transport vehicle design and maintenance.
2. **Explain** about Organization Management – ownership, Internal organization& public relations.
3. Explain about planning a Route Planning & Scheduling of the same. **Solve** problems pertaining to estimating traffic volumes for new route.
4. **Analyze and Compare** about Public Transport Fare collections, Fare structure, types of vehicle and calculation of Operating costs & types of vehicle.
5. **Understand** about recent Motor Vehicle Act, Taxation and insurance.

Course Content

UNIT-I

Transport Management

History of transport with special reference to Road Transport in India, Modes of Road Transport, organization, structure of fleet organization, Road worthiness requirement maintenance of records, prevention and analysis of road accident,[1] Emphasis of safe driving annual awards, Bonus encouragement, Platform layout, Safety devices. Infrastructure, road network, Bus priorities, Bus -stops, shelters, Bus stations facilities for passengers,[2]Garages, types of garage, location, layout, selection of site, garage organization, Function, requirement of facilities, legal provisions for depot. Layouts, inspection of faulty vehicle, estimation of repairs, test reports. [1,2]Vehicle Design, Design Considerations, Design Options, Standardization, Safety, Convenience, Comfort, Security, Environmental Standards, Raising Standards. Garage Stores. [1] **SSC**: Fleet Maintenance–Preventive, Breakdown, Maintenance Standards Schedules. **10Hrs.**

UNIT-II

Organization Management

Forms of Ownership, Principle of Transport, Management–Internal organization, Centralized & Decentralized condition (Engineering, Traffic, Secretarial), Administration. Personnel Management and Training, training& for drivers & conductors, Staffing Levels, Staff Selection, Recruitment and Training, Discipline and Incentives. Factors affecting punctuality. Public Relations Divisions Dissemination of information, maintaining of goodwill-handling of complaints, Co-operation with the press news and articles, Forms of publicity. [2,3]

SSC : Importance of quality, Inter departmental liaison advertisements, and Specialized publicity. **10Hrs.**

UNIT-III

Route Planning & Schedules

source of traffic, survey of route, preliminary schedule, test runs, factors affecting frequency, direction of traffic flow, community of interest, estimating, traffic volume, probable weekday travelers, passengers during various periods of the day, Estimation of traffic flow- frequency, estimated number of passengers, estimated traffic, possibility of single verses double deck and frequency. Timings, Bus workings and Schedules-Time table layout, uses of flat graph method of presentation, preparation of vehicle and crew schedule preparation of the duty roster, , duty arrangements Source of traffic, Town planning, turning points, Stopping places, Numerical Problems[2]

SSC: Cooperation with employers, use of the vehicle running numbering determination of vehicle efficiency checking efficiency of crew **11Hrs.**

UNIT-IV

Fare collections, Fare structure, Operating cost and types of vehicles

Need, Principles of collection, tickets and its types mechanical ticket machines, one-man operation, two stream boarding, pre-paid tickets, tickets exchanges, the fare box, electronic ticket machines, box system personal and common stock flat fare platform control.[2,3]Fare structure: Basis of fares, concession fares, straight and tapered scale elastic and inelastic demand co-ordination of fares, concessions fares for workman, standard layout of fare table, anomalies double booking inter availability through booking and summation, private hire charges. Operating cost and types of vehicles: Classification of costs, average speed, running costs, supplementary costs, depreciation obsolescence, factor affecting cost per vehicles mile incidence of wages and overheads.[2]

SSC: life of vehicles, sinking fund, types of vehicle, economic considerations **11Hrs.**

UNIT-V

Motor Vehicle Act

Short titles & definitions, Laws governing to use of motor vehicle & vehicle transport, Licensing of drivers & conductors, Registration of vehicle, State & interstate permits, Traffic rules, Signals & controls, Accidents, Causes & analysis, Liabilities & preventive measures, Design of road complex, Responsibility of driver, Public & public authorities, Offences, penalties & procedures, Personnel, Authorities & duties, Rules & regulations, Rules regarding construction of motor vehicles. **Taxation** and **Insurance of vehicle** [1].

SSC: Different types of forms. Government administration structure **10Hrs.**

Note: Numbers in Brackets [X] indicate Text book

Text Book:

1. V.S. Khilery, Dr. Satpal Sharma, Er.Shaman Gupta, Motor vehicle act and Transport Management, Ishan Publications, First Edition 2016-17
2. L D Kitchen ―Bus operation‖, ILIFFE & sons, London [Unit1-8]
3. Rex W. Faulks, Bus& coach operation, Butterworth Version Of 1988, London (**ISBN-10:** 0408028106, **ISBN-13:** 978-0408028103)

Reference Books:

1. P.G.Patankar, "Road Passenger Transport in India", CIRT, Pune.
2. Transport Management and Motor Vehicle act.-Dilip M kupade
3. Government Motor Vehicle Act –Publication on latest act to be used as on date

Course Outcomes:

After learning all the units of the course, the student is able to

1. **Describe** about a transport - management, infrastructure, -safe fleet operation, garage operation, Public transport vehicle design and maintenance. **L1**
2. **Explain** about Organization Management – ownership, Internal organization& public relations. **L2**
3. Explain about planning a Route Planning & Scheduling of the same. **Solve** problems pertaining to estimating traffic volumes for new route. **L3**
4. **Analyze and Compare** about Public Transport Fare collections, Fare structure, types of vehicle and calculation of Operating costs & types of vehicle. **L4**
5. **Understand** about recent Motor Vehicle Act, Taxation and insurance. **L2**

Course Articulation Matrix
Mapping of Course Outcomes (CO) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Sl. No.	Course Outcome	Programme Outcomes												Programme Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	**Describe** about a transport - management, infrastructure, -safe fleet operation, garage operation, Public transport vehicle design and maintenance. **L1**	3	-	-	-	-	2	2	1	-	2	-	2	3	-	-
2	**Explain** about Organization Management – ownership, Internal organization & public relations. **L2**	3	-	-	-	-	2	2	1	-	2	-	2	3	-	-
3	Explain about planning a Route Planning & Scheduling of the same. **Solve** problems pertaining to estimating traffic volumes for new route. **L3**	3	3	2	-	-	2	2	-	-	2	-	2	3	-	-
4	**Analyze and Compare** about Public Transport Fare collections, Fare structure, types of vehicle and calculation of Operating costs & types of vehicle. **L4**	3	-	-	-	-	2	2	-	-	2	-	2	3	-	-
5	**Understand** about recent Motor Vehicle Act, Taxation and insurance. **L2**	3	-	-	-	-	2	2	-	-	2	-	2	3	-	-

Course Title:- Tyre Technology			
Course Code: P18AU743	Semester: VII	L:T:P:H -4:0:0:4	Credits: 3
Contact Period-Lecturer: 52Hrs. Exam:3 Hrs		Weightage:CIE:50%; SEE:50%	

Prerequisite :

To learn about design and fabrication of tyres.

Course Learning Objectives (CLOs)

This Course aims to

1. To understand various components used and their function of tyres.
2. To design and suitable compounding formulation for various tyre components
3. To know the building & curing of tyres.
4. Understanding Tyre building specifications sequence of building.
5. Explain the green tyre preparation, curing, inspection and retreading

Course content

UNIT I

FABRIC PREPARATION Fabrics of the Tyre Industry: Cotton, Rayon, Nylon & steel cords – manufacture, construction – styles and presentations. Bonding methods: – Fabric bonding, necessities of stronger fabrics leading to bonding methods developments. Wet &dry bonding systems: – dip and hot stretch process for Nylon. REL-VP latex systems: –parameters for dip & hot stretch process for Nylon. Modified surface treatment needed for polyesters & glass fabric - Metal coating for steel cord. Recent developments in Radical Tyre fabrics – Aromatic Nylon (Kevlar) and other special fabric reinforcement systems and their use - Testing of dipped fabrics 'U', 'H' and other tests. Dip pick up and the relation to adhesion etc.

SSC: Types of tyres, tyre components and its role, tread patterns, outline of production of tires **11Hrs**

UNIT II

CALENDERING Calendering process: 3 and 4 roll calendars. Skimming & fractioning process preparation of bead wrapper and chaffer-on fabrics on 3 roll calendars. Topping process on calendar - Limitation of 3 roll calenders and advantages of 4 roll calendars-process control aspects – economics - Relation between ends per in chand calendering process. Inner, outer and breaker fabrics. Compound fabric ratios and compound design consideration for different styles of fabrics - Defects of calendered fabrics and their remedies. Parameters for scrap control in fabric processes in the tyre industry requirement of total quality control involving fabric supplier's dipping, calendering and bias cutting operations. Economics of fabric usage.

SSC: Requirements and function of tyres - Major departments of a Tyre Industry – An explanation of their function and relation to other departments. **11 Hrs**

UNIT III

THREAD EXTRUSION AND BEAD CONSTRUCTION Basic concepts of Extrusion. Die swell & shrinkage phenomenon – effect of compounding parameters on these phenomenon. Die design and theoretical calculation of tread weight. Effect of viscosity & temperature on

extrusion. Dimensions and weight control extusion operation parameters like feeding rate, screw speed, take off conveyor speed on tread extrusion. Extruded tread profile –critical dimensions. Duel extruder – Cap & base concept relation to tyre wear parameters like tread wear heat buildup etc. Cross head extruder wire coating process - Bias cutting and pocket making: Biasangle specification and the significance Horizontal and vertical laying of coated wore. Apex preparation on extruder and profile calendar Bead wrapping and flipping operations. Single and double bead concept and preliminary calculation of bead safety factors. Width and angle adjustments splicing and identification. Biasplies pocket 3-3-2 4-4-2 ply constructions Defects of pockets wrong identification over splicing wrinkles, parallel plies etc.

SSC: Factors influencing the performance of tyre: Compound design, degree of mixing (open mill & internal mixing) parameters (temperature, time, speed), degree of vulcanization **10 Hrs**

UNIT IV

TYRE BUILDING Tyre building inputs: Inner liners, plies, beads, tread, side wall and gum strips –their inspection Drum inspection for drum set, drum circumference Significance of parameters for tyre building. Size making on finished tyre and the relation to building specifications. Tyre building specifications sequence of building. Intermittent consolidation, use of various cements and gum strips. Importance of the state of the Art Technology. Appraisal of Tyre building as most crucial operation correlation of some of the cured tyre & service returned tyres to the lack of building skill. Green tyre inspection procedures weight tolerance techno-commercial importance of green tyre weight. Green tyre storage considerations.

SSC: Testing and dispatch of mixes, Basic quality control and mill room control Laboratory **10 Hrs**

UNIT V

GREEN TYRE PREPARATION & CURING Mold lubrication- Bladder assembly bead curing rings– Dimension criticality Services to the Bag-o-matic presses Curing cycle –shaping – HPS, and hot water circulation. Dome steam cold water & vacuum cycles. Determination of optimum cure of tyres by thermocouple built tyres. Economics of curing post cure inflation of Nylon tyres, cured tyre inspection. Defects of tyres – Tyre classification for defects – causes and discussions - Examination of: (i) returned tyres (ii) Tyres for retreading - Norm of tyre adjustments for fast wears, poor retreading Bead/casing failures. Hot and cold process, retreading concept of total price/km run increasing competition and future trends in the industry and open house discussion.

SSC: Internal and External painting – Awling – Bagging in case of Air bag cure Bag-o-matic and Air bag curing **10 Hrs**

Text Book

1. Tom French, Tyre technology, The University of Michigan, 1989.

References

1. Blow. C. M, Rubber Technology and Manufacture, Butterworth- Heinemann,London, 1982. ISBN 10: 0408005874 ISBN 13: 9780408005876
2. Maurice Morton, "Rubber Technology", Springer, 3rd edition, 1987. ISBN-13: 978-0412539503 ISBN-10: 0412539500
3. Claude Hepburn, "Rubber Technology and Manufacture", Third Edition,2005. ISBN-13: 978-0750610780 ISBN-10: 0750610786
4. Kovac. F. J, "Tyre Technology", Good Year Tire & Rubber Company, 5th edition 1978.

Course Outcomes (COs)

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

CO1. Explain the types of tyres and discuss the fabric preparation in the tyre Industry

CO2. Discuss the calendaring process and parameters for scrap control in fabric processes

CO3. Explain the thread extrusion, bead construction and effect of viscosity and temperature on extrusion

CO4. Describe the tyre building process

CO5. Explain the green tyre preparation, curing, inspection and retreading

Course Articulation Matrix

Mapping of Course Outcomes (CO) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Sl. No.	Course Outcome	Programme Outcomes												Programme Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	Explain the types of tyres and discuss the fabric preparation in the tyre Industry	3	2	1										2		1
2	Discuss the calendaring process and parameters for scrap control in fabric processes	3	2	1										2		1
3	Explain the thread extrusion, bead construction and effect of viscosity and temperature on extrusion	3	2	1										2		
4	Describe the tyre building process	3	2	1										2		
5	Explain the green tyre preparation, curing, inspection and retreading	3	2	1										2		1

Course Title: Finite Element Methods			
Course Code: P18AU744	Semester: VII	L:T:P:H- 4:0:0:4	Credits:3
Contact period : Lecture: 52 Hrs. Exam 3 Hrs.		Weightage : CIE:50%; SEE:50%	

Course objective: The course aims to provide an introductory approach to finite element method as a basic numerical tool for solving mechanical engineering problems.

Course Learning Objectives (CLOs)

This Course aims to

1. **Explain** the concept of finite element method as well as finite element discretization process. **Apply** Gauss elimination algorithm to **solve** linear algebraic equations and Gauss quadrature technique for numerical integration.
2. **Develop** interpolation models for different types of elements that satisfy convergence criteria and geometric isotropy. **Use** isoparametric concept in the finite element analysis.
3. **Formulate** element stiffness matrices and load vectors for different elements by **applying** variational principle.
4. **Use** developed finite element models in the **determination** of stresses, strains and reactions of axially loaded bars, trusses and transversely loaded beams.
5. **Formulate** finite element equations for heat transfer problems using Variational and Galerkin techniques and **apply** these models to conduction and convection heat transfer problems.

Course Content

Unit -1

INTRODUCTION TO FEM: Need for use of FEM, Advantages and disadvantages of FEM, Engineering Applications of FEM, Steps involved in FEM, Discretization process – types of elements (1D,2D,3D), size of the elements, location of nodes, node numbering scheme, Method of solution of linear algebraic equations – Gauss elimination method. Numerical integration by Gaussian quadrature (one point and two point formula). Basic elastic equations – body force and traction force, strain-displacement relations. Principle of minimum potential energy and derivation of potential energy functional for a 3D elastic body.

SSC: concept of plane stress and plane strain and their stress-strain relations. **10 Hrs**

Unit -2:

INTERPOLATION MODELS: Displacement function, selection of the order of displacement function, convergence criteria, geometric isotropy, Pascal's triangle for 2D polynomial, Different co-ordinate systems used in FEM, Interpolation or shape functions for 1D linear and quadratic bar elements and 2D linear triangular (CST) element in cartesian and natural co-ordinate systems. Lagrangian polynomial – Shape functions for linear quadrilateral element (QUAD 4) and quadratic quadrilateral element (9-noded), Iso-parametric, sub-parametric and super-parametric elements.

SSC: Concept of Jacobian matrix, Jacobian matrix for CST **12 Hrs**

Unit -3:

ELEMENT STIFFNESS MATRIX AND LOAD VECTORS: Strain displacement matrix, Stiffness matrix and load vector for linear and quadratic bar element and CST element. Assembly of elements by direct stiffness method, special characteristics of stiffness matrix, Treatment of boundary conditions- elimination and penalty methods.

SSC: Analysis of axially loaded uniformly tapered and stepped bars. **10 Hrs**

Unit -4:

ANALYSIS OF PLANE TRUSSES AND BEAMS: Local and global coordinate systems, stiffness matrix for plane truss element, analysis of truss members. Hermite shape function for beam element in Cartesian coordinates, Stiffness matrix and load vector for beam element, element shear force and bending moment.

SSC: analysis of beams & Planestreses **10 Hrs**

Unit -5

ANALYSIS OF HEAT TRANSFER PROBLEMS: Steady state heat transfer, 1D heat conduction- governing equation, boundary conditions, one-dimensional element, Galerkin's approach to heat conduction, heat flux boundary condition. 1D heat transfer in thin fins- Formulation of equations. Simple numerical of 1D heat transfer problems on composite walls and fins with conduction and convection.

SSC: Analysis of 2D heat transfer **10 Hrs**

Text Books:

1. Introduction to the Finite Element Method: C. S. Desai and J.F. Abel, EWP an East-West Edition
2. Introduction to Finite Elements in engineering: T R Chandrupatla and A D Belegundu, PHI.
3. The Finite Element Method in engineering: S S Rao, Elsevier. 5th edition 2010 **eBook ISBN:** 9780080952048 **Hardcover ISBN:** 9781856176613

References:

1. The FEM its basics and fundamentals: O.C.Zienkiewicz, Elsevier, 6e.2005. ISBN: 9780080472775
2. J.N.Reddy, Finite Element Method: McGraw –Hill International Edition.2004
3. Daryl. L. Logon, Finite Element Methods: Thomson Learning 6rd edition.2017 ISBN13: 9781305635111 ISBN10: 1305635116
4. David V. Hutton , Fundamentals of Finite Element Analysis:–Tata McGraw Hill Publishing Co. Ltd, New Delhi.2003

Course Outcomes

At the end of the course the students should be able to:

1. **Explain** the concept of finite element method as well as finite element discretization process. **Apply** Gauss elimination algorithm to **solve** linear algebraic equations and Gauss quadrature technique for numerical integration.

2. **Develop** interpolation models for different types of elements that satisfy convergence criteria and geometric isotropy. **Use** isoparametric concept in the finite element analysis.
3. **Formulate** element stiffness matrices and load vectors for different elements by **applying** variational principle.
4. **Use** developed finite element models in the **determination** of stresses, strains and reactions of axially loaded bars, trusses and transversely loaded beams.
5. **Formulate** finite element equations for heat transfer problems using Variational and Galerkin techniques and **apply** these models to conduction and convection heat transfer problems.

Course Articulation Matrix

Mapping of Course Outcomes (CO) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Sl. No.	Course Outcome	Programme Outcomes												Programme Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	**Explain** the concept of finite element method as well as finite element discretization process. **Apply** Gauss elimination algorithm to **solve** linear algebraic equations and Gauss quadrature technique for numerical integration.	3	-	-	-	-	-	-	-	-	3	-	-	2	-	1
2	**Develop** interpolation models for different types of elements that satisfy convergence criteria and geometric isotropy. **Use** isoparametric concept in the finite element analysis.	3	3	-	-	-	-	-	-	-	-	-	-	2	-	1
3	**Formulate** element stiffness matrices and load vectors for different elements by **applying** variational principle.	3	3	-	-	-	-	-	-	-	-	-	-	2	-	1
4	**Use** developed finite element models in the **determination** of stresses, strains and reactions of axially loaded bars, trusses and transversely loaded beams.	3	3	-	-	-	-	-	-	-	-	-	-	2	-	1
5	**Formulate** finite element equations for heat transfer problems using Variational and Galerkin techniques and **apply** these models to conduction and convection heat transfer problems.	3	3	-	-	-	-	-	-	-	-	-	-	2	-	1

Course Title: Automotive chassis and Transmission (Open Elective-II)			
Course Code: P18AUO751	Semester: VIII	L:T:P:H- 4:0:0:4	Credits:3
Contact period : Lecture: 52 Hrs. Exam 3 Hrs.		Weightage : CIE:50%; SEE:50%	

Prerequisite: This subject requires student to know about the back ground knowledge of different types of drives like belt drives, chain drives, and gear drives

Course Learning Objectives (CLOs)

At the end of the course the student should able to

1. Explain the need for transmission
2. Distinguish between positive and non positive drives
3. Explain the Constructional and working principles of different types of clutches
4. Explain the constructional and working principle of different types of gear box
5. Determine the gear ratio, speed of vehicle and number of teeth on driving and driven gears
6. Explain the working of different types of final drives and rear axles
7. Explain the working of different types of steering suspension systems used in automobiles
8. Explain the working of different types of brakes and their operating mechanisms

Course Content

UNIT – I

CLUTCHES :Necessity of clutch in an automobile, different types of clutches, friction clutches, namely single plate clutch, multi plate clutch, cone clutch, centrifugal clutch, electromagnetic clutch, hydraulic clutches, fluid coupling, torque converters, comparision between fluid coupling and torque converters, single stage , two stage and three stage torque converter,

SSC: 3 & 4 phase torque converters **11 Hrs**

UNIT II

GEAR BOX : Various Resistances to Motion of the Automobile, Traction, tractive effort, The need for transmission, Necessity of gear box, Calculation of gear ratios , Desirable ratios of 3speed & 4 speed gear boxes, Constructional details of Sliding-mesh gear box , Constant-mesh gear box, synchromesh gear box, epicyclic transmission, principle of operation, automatic transmission principle of operation

SSC: Continuously variable transmission **11 Hrs**

UNIT III

FINAL DRIVES AND REAR AXLE: introduction, single reduction, double reduction and planetary final drives, differential, differential lock, Hotchkiss drive, torque tube drive, construction of rear axle supporting .

Frames , types of frames , Materials, frame selections, cross members.

SSC: Skid reducing final drives **10Hrs**

UNIT IV

STEERING AND SUSPENSION :Steering mechanisms, steering geometry, steering linkages, steering gears, power steering, s**uspension system:** objects, types of suspension springs, coil springs, shock absorbers, air suspension system, hydrolastic suspension

SSC: Rack and pinion electric power assisted steering **10Hrs**

UNIT V

BRAKES: Necessity, types of brakes, drum brake, disc brake, hydraulic brake, air brake, servo brakes, power brake, vaccume brake, electric brake, ABS

SSC: Brake servos **10Hrs**

Text Books:

1. Kirpal Singh, "Automobile engineering –. Vol.1, Standard Pub. 2014
2. N.K Giri, 'Automotive Mechanics', Khanna Publication, New Delhi, 2014

Reference Books:

1. G.B.S.Narang "Automobile Engineering', Khanna publication, New Delhi, 2015
2. Heinz Heisler , Advanced vehicle technology , , 2002

Course Outcomes (COs)

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

1. **Understand** the basic principles of working of clutch and torque converter used in automobile
2. **Identify** the different types of manual and automatic transmission
3. **Understand** the basic principles of steering systems and suspension system
4. **Understand** the necessity of brakes and different types
5. **Understand** the different types of final drives and rear axles

Course Articulation Matrix

Mapping of Course Outcomes (CO) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Sl. No.	Course Outcome	Programme Outcomes												Programme Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	**Understand** the basic principles of working of clutch and torque converter used in automobile	2	2				2						2	2		
2	**Identify** the different types of manual and automatic transmission	2	2				2						2	2		
3	**Understand** the basic principles of steering systems and suspension system	2	2				2						2	2		
4	**Understand** the different types of final drives and rear axles	2	2				2						2	2		
5	**Understand** the necessity of brakes and different types	2	2				2						2	2		

Course Title: Automotive Testing and Servicing Lab			
Course Code: P18AUL76	Semester: VII	L:T:P:H -0:0:3:	Credits:1.5
Contact Period-Lecturer: 39Hrs. Exam: 3Hrs		Weightage:CIE:50%; SEE:50%	

Pre requisites: Subject requires student to know about IC engines performance characteristics Measurement of power, fuel consumption, air consumption and emission etc. Different dynamo meters and their working

Course content

1. Conduct performance test on single cylinder SI engine (Hero Honda, Bajaj)
2. Conduct performance test on multi cylinder SI engine(Fiat, Maruthi MPFI)
3. Conduct performance test on single cylinder CI engine (Kirloskar)
4. Conduct performance test on multi cylinder CI engine (TATA 407,Mahindra Maxima)
5. Conduct Morse test on SI engine to find FP, IP, indicated thermal efficiency and mechanical efficiency Fiat Engine
6. Conduct Morse test on CI engine to find FP, IP, indicated thermal efficiency and mechanical efficiency (Kirloskar)
7. Study of engine performance using alternate fuels like alcohol, bio diesel and LPG
8. Test the performance of single cylinder CI engine by varying compression ratio (VCR)
9. Optimizing the performance of SI engine by varying the ignition timing
10. Diagnose the engine using engine analyzer and advanced Engine diagnostic equipment.
11. Conduct performance test on universal test rig
12. Engine diagnosis by KTS-590
13. Gas Analyzer for petrol engine

Text books

1. Dr. N K Giri , automobile mechanics, khanna publishers, eight edition , 2014 ISBN 10: 8174092161 / ISBN 13: 9788174092168
2. Dr v Ganeshan , Internal combustion engines, Mc Graw hill, publication , fourth edition 2013 ISBN 10: 1259006190 / ISBN 13: 9781259006197
3. Auto lab manuals

Course outcomes(COs)

1. **Conduct** performance test on any given engine, and evaluate performance characteristics
2. **Analyze** the engine performance using alternative fuels
3. **Conduct** experiment to understand the effect of compression ratio on performance of the engine
4. **Optimize** the performance of the engine by varying the ignition timing, Diagnose the engine problem using engine analyzer

Course Articulation Matrix

Mapping of Course Outcomes (CO) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Sl. No.	Course Outcome	Programme Outcomes												Programme Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	**Conduct** performance test on any given engine, and evaluate performance characteristics	3	3	2	2	2	2	1	-	2	2	-	2	3	2	2
2	**Analyze** the engine performance using alternative fuels	3	3	-	2	-	-	1	-	1	-	-	1	3		2
3	**Conduct** experiment to understand the effect of compression ratio on performance of the engine	3	3	-	2	-	-	-	-	1	-	-	1	3	-	-
4	**Optimize** the performance of the engine by varying the ignition timing, Diagnose the engine problem using engine analyzer	3	3	-	2	-	-	-	-	1	-	-	1	3	-	-

Course Title: Diagnosis And Reconditioning Lab			
Course Code: P18AUL77	Semester: VII	L:T:P:H- 0:0:3	Credits: 1.5
Contact period : Lecture: 39 Hrs. Exam 3 Hrs.	Weightage : CIE:50%; SEE:50%		

Prerequisites:

The student should have undergone the course on: Auxiliary systems of Automotive vehicle and different operation in various machines and use of different measuring instruments.

Course Content

PART-A

1. Inspection of vehicles and preparation of test charts.
2. Tuning of Engines: Check for ignition timing, valve tappet clearance, Radiator flushing and check for leaks etc.,
3. Study and practice on :
   - Connecting rod alignment
   - Cylinder Reboring Machine
   - Valve Refacing Machine
   - Nozzle grinding Machine
   - Brake drum skimming Machine
4. Servicing of components like FIP, Carburetor, Fuel pump, Exhaust pipes and Silencer, Lubricating system, Air compressor, shock absorber, Calibrations of FIP.

PART – B

1. Study and practice of wheel alignment (Mechanical and computerized) and wheel balancing
2. Study of tyre retreading and vulcanizing (Using Tyre changer)
3. Study and practice on body repairs – tinkering and painting
4. Students have to visit at least three different automotive industries in which at least one automotive manufacturing unit. Report to be submitted on Industrial visit.

Text books

1. Mathur and Sharma - Internal combustion engines,
2. Auto service lab manuals

Course outcomes (COs)

At the end of the course the student should be able to

1. **Calculation** of Reboring, brake drum skimming, valve Refacing, connecting rod alignment tests and **conducting** experiments
2. **Practically** involving in different operation in **calibration** of FIP
3. **Practically** involving in principle and different operation of wheel alignment and wheel balancing
4. **Practically** involving in different operation in body repair and painting
5. To **visit** different automotive industries

Course Articulation Matrix

Mapping of Course Outcomes (CO) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Sl. No.	Course Outcome	Programme Outcomes												Programme Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	**Calculation** of reboring ,brake drum skimming, valve refacing, connecting rod alignment tests and **conducting** experiments	2	2	2	2	2	-	-	-	2	2	2	2	3	2	2
2	**Practically** involving in different operation in **calibration** of FIP	3	2	-	-	1	-	-	-	-	-	2	-	3	-	-
3	**Practically** involving in principle and different operation of wheel alignment and wheel balancing	3	2	-	-	2	-	-	-	-	-	2	-	3	-	-
4	**Practically** involving in different operation in body repair and painting	3	2	-	-	1	-	-	-	-	-	2	-	3	-	-
5	To **visit** different automotive industries	3	2	-	-	1	-	-	-	-	-	2	-	3	-	-

VIII Semester

Course Title: Earthmoving Equipments & Tractors			
Course Code: P18AU81	Semester: VIII	L:T:P:H -4:0:0:	Credits: 4
Contact Period-Lecturer: 52Hrs. Exam: 3Hrs		Weightage:CIE:50%; SEE:50%	

Prerequisites:

1. Subject requires student to know about
2. Basic automotive systems like
3. Engines, transmission and final drives
4. Brakes, steering, and suspension
5. Basic hydraulics

Course Learning Objectives (CLOs):

At the end of the course the student should be able to

1. **Explain** the construction, working principle and operation of different earth moving equipments and determine the operating capacity
2. **Discuss** different undercarriage and suspension systems used in earthmoving equipment and their advantages and limitations
3. **Describe** different transmission systems and final drive systems, their construction and working principle used in earth moving equipments
4. **Explain** the construction, working and selection of different types of pumps, valves and actuators used in hydraulic system
5. **Discuss** different steering and brake systems used in off and on high way vehicles and Explain their construction and working principle

Course Content

UNIT I

EQUIPMENTS, OPERATION& SELECTION: Different types of earth moving equipments and their applications. Dozers, Loaders, Shovels, Excavators, Scrapers, Motor graders, Rollers, Compactors, Tractors and Attachments and Methods of calculating operating capacity

SSC: Tractors and Attachments **10 Hrs**

UNIT-II

UNDER CARRIAGE AND TYRES: Tyre and tracked vehicles , advantages and disadvantages, under carriage components like , tracks, roller frames, drive sprockets, track rollers, track chains and track shoes.

Tyres: Defining tyre size, types of tyres-tubed, tubeless and studded tyres. tyre properties. tyre maintenance- tyre Application-factor influencing tyre cost

SSC: Hydroflatted tyres **10 Hrs**

UNIT -III

TRANSMISSIONS AND FINAL DRIVES: Splitter and range change gear boxes, Twin& triple counter shaft transmissions, transfer box power take-off (PTO) constructional and working principles, FINALDRIVES: types of reductions like, single reduction, double reduction final drives, Planetary final drives.

SSC: Inboard epicyclic double reduction final drive and two speed axles and PTO shaft.**12 Hrs**

UNIT-IV

HYDRAULICS: introduction, Basic components of hydraulic systems, construction and working of different types of positive displacement type and non positive displacement type of pumps hydraulic circuits.

HYDRAULIC VALVES: pressure control valves, flow control valves, directional control valves and limited travel valves, hydraulic motors and hydraulic cylinders. Depth & draft control systems.

SSC: Types of hydraulic valves **10 Hrs**

UNIT -V

STEERING AND BRAKES: Power steering types like, linkage type power steering, semi integral power steering & integral power steering.

STEERING OF TRACKED VEHICLES: Skid steering, articulated steering, clutch /brake steering system, controlled differential steering system and planetary steering system.

BRAKES: Types of brakes like, disc brake, engine brakes, retarders (exhaust compression retarder, hydraulic type retarder and engine compressed air type retarder) etc.

SSC: Different types of power steering **10 Hrs**

Text Books:

1. Erich J.schulz, Diesel equipment- volume I and II
2. S.C. Sharma, Construction equipment and its management
3. Heinz Heisler Advanced vehicle technology,

Reference Books:

1. Donald R. Hunt and L. W.Garner Farm machinery and mechanism
2. J.Y.Wong John Wiley and sons Theory of ground vehicles
3. Herbert Nicholas, Moving the earth
4. Jagman Singh, On and with the earth, W.Newman and Co. Culkatta

Course Outcomes

After learning all the units of the course, the student is able to

1. **Explain** the construction, working principle and operation of different earth moving equipments and determine the operating capacity
2. **Discuss** different undercarriage and suspension systems used in earthmoving equipment and their advantages and limitations
3. **Describe** different transmission systems and final drive systems, their construction and working principle used in earth moving equipments
4. **Explain** the construction, working and selection of different types of pumps, valves and actuators used in hydraulic system
5. **Discuss** different steering and brake systems used in off and on high way vehicles and Explain their construction and working principle

Course Articulation Matrix

Mapping of Course Outcomes (CO) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Sl. No.	Course Outcome	Programme Outcomes												Programme Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	**Explain** the construction, working principle and operation of different earth moving equipments and determine the operating capacity	3	2	-	-	-	-	-	-	-	-	-	-	3	-	-
2	**Discuss** different undercarriage and suspension systems used in earthmoving equipment and their advantages and limitations	3	2	-	-	-	-	-	-	-	-	-	-	3	-	-
3	**Describe** different transmission systems and final drive systems, their construction and working principle used in earth moving equipments	3	2	-	-	-	-	-	-	-	-	-	-	3	-	-
4	**Explain** the construction, working and selection of different types of pumps, valves and actuators used in hydraulic system	3	2	-	-	-	-	-	-	-	-	-	-	3	-	-
5	**Discuss** different steering and brake systems used in off and on high way vehicles and Explain their construction and working principle	3	2	-	-	-	-	-	-	-	-	-	-	3	-	-

Course title: Alternative Energy Sources for Automobiles			
Course code: P18AU821	Semester: VIII	L – T – P -H: 2-1-0-	Credits: 3
Contact period-lecturer: 52hrs	Exam:3 hrs	Weightage:CIE:50%; SEE:50%	

Prerequisites:

Basics of engineering chemistry, Automobile engineering and theory of fuels and combustion.

Relevance of the course

The subject **alternative energy sources for automobiles** is a core course in BE (automobile engineering) program that helps to understanding the various alternative fuels/energy sources for I.C. engines.

Further this course aims at developing and understanding future trends and development, including hydrogen as an internal combustion engine fuel.

Course Learning Objectives (CLO):

At the end of the course the student should be able to

1. **Identify** Non-conventional Energy Sources Analyze solar energy, and wind energy, Examine applications and limitations
2. **Analyze** Gaseous alternative fuels
3. **Analyze** biomass energy, Examine applications and limitations
4. **Analyze** Synthetic Alternative fuels, Examine applications and limitations
5. **Analyze** Reformulated conventional fuels, Future Alternative Fuels and alternative power trains, Examine applications and limitations

Course content

UNIT-1:

Introduction

Types of energy sources, their availability, need of alternative energy sources, Non-conventional energy sources, Classification of alternative fuels and drive trains. Technological up gradation required, Implementation barriers for alternative fuels, stakeholders of alternative fuels, roadmap for alternative fuels.

Solar energy and Wind energy

Introduction to solar energy, solar energy collectors, solar energy storage system, P. V. effect solar cells and characteristics, application of solar energy for automobiles.

Introduction to wind energy, principle of wind energy conversion, types of wind machines, applications of wind energy, Advantages and disadvantages of WEC systems.

SSC: Site selection considerations for wind Energy, Scenario of conventional auto fuels. **11 Hrs**

UNIT-II:

Gaseous alternative fuels.

Introduction,history,properties,production,storage,transportation,advantages,disadvantages and applications of hydrogen, liquid hydrogen(LH_2), compressed natural gas(CNG), liquefied natural gas(LNG), adsorbed and landfill gas(LFG).

SSC: Natural gas, liquefied petroleum gas(LPG) **10 Hrs**

UNIT-III:

Biomass Energy

Introduction, history, properties, production, storage, transportation, advantages, disadvantages and applications of Biogas or Bio methane, classification of biogas plants. Methanol, ethanol, butanol, straight vegetable oil (SVO) and biodiesel.

SSC: Khadi and Village Industries Commission (KVIC) janata model construction **10 Hrs**

UNIT-IV:

Synthetic Alternative fuels

Introduction, history, properties, production, storage, transportation, advantages, disadvantages and applications of HCNG and hythane, Di-Methyl Ether(DME), Diethyl Ether(DEE), Biomass to Liquid(BTL), Gas to Liquid(GTL), Coal to Liquid(CTL), Syngas, Producer gas or wood gas, P-series, Eco-Friendly Plastic Fuel(EPF), Wood Pyrolysis Oil(WPO), Magnegas and Tyre Pyrolysis Oil (TPO).

SSC: coal gasification & Natural gas reforming **10 Hrs**

UNIT-V:

Reformulated conventional fuels Introduction, history, properties, production, advantages, disadvantages and applications of coal water slurry (CWS), Reformulated Gasoline (RFG), Emulsified fuels and Hydrogen-enriched gasoline.

Future Alternative Fuels: Pulverized Metal Fuel (PMF), Ammonia, Liquid-Nitrogen, Boron, and Compressed Air.

Introduction to alternative power trains: Introduction, components of an EV, EV batteries, chargers, drives, transmission, controllers and power devices. Advantages and disadvantages of EVs. Hybrid electric vehicles, HEV drive train components, advantages of HV. History of dual fuel technology, Applications of DFT. Duel fuel engine operation, Advantages and disadvantages of duel fuel technology.

SSC: Advanced technology in Electric vehicles & Hybrid Electric vehicles **11 Hrs**

Text Books

1. S.S. Thipse “Alternative Fuels”, JAICO Publishing House, 2010. • **ISBN-10:** 8184950780 **ISBN-13:** 978-8184950786
2. G.D. Rai “Non-Conventional Energy Sources” Khanna Publishing New Delhi. 2011

References

1. M. Poulton- “Alternative fuels for vehicle book “1994. **ISBN-10:** 1562522256 **ISBN-13:** 978-1562522254
2. Richard L. Bechtold-“Automotive Fuels Guide Book”, SAE Publications, 1997.
3. T.N. Veziroglu-“Alternative energy sources”, McGraw Hill Publications.
4. A Primer on Hybrid Electric vehicles.

Course Outcomes

After learning all the units of the course, the student is able to

1. **Identify** Non-conventional Energy Sources Analyze solar energy, and wind energy, Examine applications and limitations
2. **Analyze** Gaseous alternative fuels
3. **Analyze** biomass energy, Examine applications and limitations
4. **Analyze** Synthetic Alternative fuels, Examine applications and limitations
5. **Analyze** Reformulated conventional fuels, Future Alternative Fuels and alternative power trains, Examine applications and limitations

Course Articulation Matrix

Mapping of Course Outcomes (CO) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Sl. No.	Course Outcome	Programme Outcomes												Programme Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	**Identify** Non-conventional Energy Sources Analyze solar energy, and wind energy, Examine applications and limitations	3	3	3	-	-	2	2	-	-	-	-	2	3	2	1
2	**Analyze** Gaseous alternative fuels	3	3	3	-	-	2	2	-	-	-	-	2	3	2	1
3	**Analyze** biomass energy, Examine applications and limitations	3	3	3	-	-	2	2	-	-	-	-	2	3	2	1
4	**Analyze** Synthetic Alternative fuels, Examine applications and limitations	3	3	3	-	-	2	2	-	-	-	-	2	3	2	1
5	**Analyze** Reformulated conventional fuels, Future Alternative Fuels and alternative power trains, Examine applications and limitations	3	3	3	-	-	2	2	-	-	-	-	2	3	2	1

Course Title: Automotive Embedded System			
Course Code: P18AU822	Semester: VIII	L:T:P:H -2:1:0:	Credits: 3
Contact Period-Lecturer: 52Hrs. Exam:3 Hrs		Weightage:CIE:50%; SEE:50%	

Course Learning Outcomes (CLOs):

1. Design and develop automotive embedded systems.
2. Analyze various embedded products used in automotive industry.
3. Evaluate the opportunities involving technology, a product or a service required for developing a startup idea used for automotive applications
4. Will be able to interface devices and build a complete system

Course Content

UNIT-I

ELECTRONICS IN THE AUTOMOBILE: 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.

SSC: Cross application technologies. 42V vehicle power supply system. **11Hrs**

UNIT-II

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-by-wire, shift by wire.

SSC: Future of Automotive Electronics **10Hrs**

UNIT-III

HARDWARE MODULES: Basic sensor arrangement, types of sensors such as- oxygen sensors, crank angle position sensors- Fuel metering vehicle speed sensors and destination sensors, Attitude sensor, Flow sensor, exhaust temperature, air mass flow sensors. Throttle position sensor

SSC: Solenoids, stepper motors, relays **11Hrs**

UNIT -IV

ELECTRONIC IGNITION SYSTEMS: Electronic ignition systems. Types of solid state ignition systems and their principle of operation Digital engine control system. Open loop and closed loop control system, Engine cranking and warm up control.

Acceleration enrichment. Deceleration learning and ideal speed control, Distributor less ignition – Integrated engine control system, Exhaust emission control engineering .

SSC: Exhaust emission control engineering **10 Hrs**

UNIT-V

AUTOMOTIVE EMBEDDED SYSTEM: Automotive Embedded systems. PIC, Free scale microcontroller based system. Recent advances like GLS, GPSS, GMS. Multiprocessor communication using CAN bus. Case study- cruise control of car.

SSC: Artificial Intelligence and engine management. **10 Hrs**

Text & References:

1. "Embedded System Design: A unified Hardware / Software Introduction" – Frank Valid and Tony Givargis, Wiley India Publishers. 2011
2. "A Practical Introduction to Hardware/Software Co-Design"- Patrick R. Schaumont, Springer Publishers. 2008

Course Outcomes

1 **Know** the safety electronics & active 4 passive safety s/m' s
2 **Know** the systems & design of steer by wire, brake by wire, gas by wire.
3 **Understand** the bas sensor types of sensor
4 **Analyze** the Electronic Ignition s/m
5 **Know** the Automotive embedded s/m micro controller based s/m

Course Articulation Matrix

Mapping of Course Outcomes (CO) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Sl. No.	Course Outcome	Programme Outcomes												Programme Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	**Know** the safety electronics & active 4 passive safety s/m' s	2	2					2					2	2	2	2
2	**Know** the systems & design of steer by wire, brake by wire, gas by wire.	2	2					2					2	2	2	2
3	**Understand** the bas sensor types of sensor	2	2						2	2	2		2	3	3	3
4	**Analyze** the Electronic Ignition s/m	2	2						2	2	2		2	3	3	3
5	**Know** the Automotive embedded s/m micro controller based s/m	2	2						2	2	2		2	3	3	3

Course Title: Control Engineering			
Course Code: P18AU823	Semester: VIII	L:T:P:H - 2:1:0:	Credits: 3
Contact Period-Lecturer: 52Hrs,: Exam:3 Hrs		Weightage:CIE:50%; SEE:50%	

Prerequisites: - Engineering Mathematics II, Engineering Mathematics III, Mechanical Vibrations

Course Learning Objectives (CLO):

At the end of the course the student should be able to

1. Identify and classify the different types of control systems. Develop mathematical model for the mechanical, electrical, servo mechanism and hydraulic systems.
2. Represent the systems consisting of number of components in the form of block diagrams and signal flow graphs and Develop mathematical models using reduction technique of these block diagrams and signal flow graphs.
3. Obtain the time response and steady-state error of the system. Determine stability of the various control systems by applying Routh's stability criterion.
4. Obtain frequency response and Determine stability of control system applying Nyquist stability criterion and using Bode plot.
5. Construct root loci from open loop transfer functions of control systems and Analyze the behavior of roots with system gain. Analyze complex systems having multi inputs and multi outputs using state-space method.

Course Content

UNIT - I

Introduction and Mathematical Models of Physical Systems: Concept of automatic controls, open and closed loop control systems, requirement of an ideal control system. Examples of control systems - Speed control system, Human body temperature control system, Home heating system, Traffic control system, Liquid level control system. Definition of Laplace transformation, Transfer function models, mathematical models of mechanical systems, models of electrical circuits, models of DC and AC motors, models of hydraulic systems and models of thermal systems. Analogous Systems- Force-voltage analogy and force-current analogy.

SSC: concepts of feedback control systems. **10 hrs**

UNIT- II

Block Diagrams & Signal Flow Graphs and Time Response Analysis: Transfer functions definition, block representation of system elements, reduction of block diagrams with single and multiple inputs. Signal flow graphs- Signal flow graph terminology, signal flow graph from block diagram, Manson's gain formula.

SSC: Signal flow graphs- Signal flow graph terminology **10 hrs**

UNIT -III

Time Response Analyses: Time response analysis - Introduction, transient and steady state response of control system, standard test inputs – step, ramp, parabolic and impulse inputs. First order system response to step and ramp inputs. Second order system response to step input, transient response specifications. Stability definition, mathematical concept of stability, characteristic root locations and stability, Routh's stability criterion, special cases of Routh's criterion. Steady-state error analysis- control system type, steady-state error constants- static position error constant, static velocity error constant and static acceleration error.

SSC: Concepts of time constant and its importance in speed of response. **10 hrs**

UNIT – IV

Frequency Response Analysis: Polar plots, relative stability- concepts phase margin and gain margin. Nyquist Stability Criterion, Stability analysis using Nyquist plot. Frequency response analysis using bode plot: Bode attenuation diagrams, stability analysis using Bode plots.

SSC: Frequency response analysis using bode plot **12 hrs**

UNIT –V

Root Locus and State-Space Analyses: Root locus analysis- Introduction, definition of root loci, general rules for constructing root loci, root locus analysis of control systems. State-space analysis- introduction, definitions, state-space equations, transformation matrix, controllability and observability.

SSC: general rules for constructing root loci, root locus analysis of control systems **10 hrs**

Text books

1. Katsuhiko Ogata, **Modern Control Engineering,** Phi Learning Pvt Ltd, 5th Edition, 2010, ISBN: 9788120340107.
2. Rao V Dukkipati, **Control Systems,** Narosa Publishing House, 2008, ISBN: 978-8173195549.
3. Joseph J. Distefano, Allen R. Stubberud and Avan J. Williams, **Feedback and Control Systems**, Schaum's Outlines series, Tata McGraw Hill, New Delhi, 2nd Edition, 2003, ISBN: 978-0070582880.

References

1. J. Nagarath & M. Gopal, **Control systems,** New age International publishers, 4th Edition, 2006, ISBN: 978-8122417753.
2. F. Golnaraghi and B.C. Kuo, **Automatic Control Systems**, John Wiley & Sons, 9th Edition, 2009, ISBN: 978-0470048962.
3. **Control Systems:** Ashfaq Husain and Haroon Ashfaq, Dhanpat Rai & Co., 2015, ISBN: 978-8177000276.

Course Outcomes

1. Identify and classify the different types of control systems. Develop mathematical model for the mechanical, electrical, servo mechanism and hydraulic systems.
2. Represent the systems consisting of number of components in the form of block diagrams and signal flow graphs and Develop mathematical models using reduction technique of these block diagrams and signal flow graphs.
3. Obtain the time response and steady-state error of the system. Determine stability of the various control systems by applying Routh's stability criterion.
4. Obtain frequency response and Determine stability of control system applying Nyquist stability criterion and using Bode plot.
5. Construct root loci from open loop transfer functions of control systems and Analyze the behavior of roots with system gain. Analyze complex systems having multi inputs and multi outputs using state-space method.

Course Articulation Matrix

Mapping of Course Outcomes (CO) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Sl. No.	Course Outcome	Programme Outcomes												Programme Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	Identify and classify the different types of control systems. Develop mathematical model for the mechanical, electrical, servo mechanism and hydraulic systems.	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
2	Represent the systems consisting of number of components in the form of block diagrams and signal flow graphs and Develop mathematical models using reduction technique of these block diagrams and signal flow graphs.	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
3	Obtain the time response and steady-state error of the system. Determine stability of the various control systems by applying Routh's stability criterion.	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
4	Obtain frequency response and Determine stability of control system applying Nyquist stability criterion and using Bode plot.	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
5	Construct root loci from open loop transfer functions of control systems and Analyze the behavior of roots with system gain. Analyze complex systems having multi inputs and multi outputs using state-space method.	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-

Course Title: Vehicle Dynamics			
Course Code: P18AU824	Semester: VIII	L:T:P:H -2:1:0:	Credits:3
Contact Period-Lecturer: 52Hrs. Exam:3 Hrs		Weightage:CIE:50%; SEE:50%	

Prerequisite: Subject requires student to know about, Mechanical Vibration, Automotive Technology, Theory of Machine

Course Learning Objectives (CLOs)

This Course aims to

1. Explain tyre forces and moment, summarize the construction of tyres(L1,L2)
2. Solve, illustrate stability of vehicle at different condition(L2,L3)
3. Describe, explain stability of vehicle during braking(L2,L3)
4. Describe, explain solve the stability of vehicle during steering(L2,L3)
5. Explain, solve the stability condition of vehicle during vertical vibration(L1,L2,L3)

Course Content

UNIT-I

Introduction: introduction to vehicle dynamics, the driver-vehicle-ground system, SAE vehicle coordinate system.

Tire fundamentals: desirable tire properties, tire force and movements, rolling resistance of tier, factors affecting the rolling resistance of tire. Tire construction, Bias-ply tire, and radial –ply tire, Performance of tyre of wet road, hydro planning, ride properties of tyres, static stiffness, non rolling dynamic stiffness, rolling dynamic stiffness, specification of tire, factors affecting tire life.

Acceleration performance: power for propulsion, air resistance, rolling resistance, grade resistance, traction and traction effort, road performance curve, calculation of equivalent weight, Numerical problems.

SSC: Calculate total resistance of any two Indian vehicle **10 Hrs.**

UNIT-II

Vehicle stability: stability on level ground, vehicle taking turn on level ground, stability on inclined ground, stability of vehicle running on a banked track, maximum achievable acceleration on level road and inclined road (Front, rear & four wheeldrive) determination of centre of gravity of a vehicle, transverse weight shift due to drive torque, effect of C.G position on maximum achievable acceleration, stability of two and three wheeler vehicles and Numerical problems.

SSC: Calculate maximum acceleration for Indian vehicle **10 Hrs.**

UNIT-III

Braking system and performance: braking requirements, construction and comparison of drum brake and disc brake, Energy of motion and frictional force, brake balance, stopping distance, brake fade, work done in brakes, braking efficiency, load transfer during braking, brake applied to rear wheels, max braking force and load distribution on level and inclined road (frank, rear & all wheel balanced) brake proportioning, behavior of vehicle when wheels locked conditions for wheel lockup, antilock brake system., Numerical problems.

SSC: Calculate maximum braking force for Indian vehicle **10 Hrs.**

UNIT-IV

Handling characteristics of road vehicles: steering geometry, effect of camber, kingpin inclination, castor, toe-in, toe-out, condition for true rolling, turning circle radius.
Ackerman linkage geometry – analytical and graphical solution, four wheel steering.
Cornering properties of tiers – cornering force, slip angle, self aligning torque,
Steady state handling characteristics: fundamental equation, neutral steer, under steer, over steer, steady state response to steering input, yaw velocity response, lateral acceleration response, curvature response, testing of handling characteristics and Numerical problems.
SSC: Construct steering error curve for any two Indian vehicle **11 Hrs**.

UNIT-V

Vehicle ride characteristics: Source of vibration in vehicle, human comfortable criteria vehicle ride models, two – degrees of freedom vehicle model for sprung and unsprung mass, two degrees of freedom vehicle model for pitch and bounce, introduction to random vibration, frequency response function, evolution of vehicle vibration.
Aerodynamics: mechanics of air flow around vehicles, pressure distribution on a vehicle, aerodynamics forces and moments. Effect of shape, angle of attack, operation parameters on drag and lift, aerodynamic aids.
SSC: study the various type of damping system provided to Indian vehicle. **11 Hrs.**

Text Books:

1. J.Y.Wong, "Theory of Ground Vehicles", Wiley publications-2008. ISBN: 978-0-470-17038-0

References:

1. Thomas D. Gillespie, "Fundamentals of Vehicle DynamicsSAE -2018. ISBN-13: 978-1560911999 ISBN-10: 1560911999
2. N.K.Giri, "Automobile Mechanics" Khanna publications-2014. ISBN 10: 8174092161 / ISBN 13: 9788174092168
3. Reza N.Jazar, "Vehicle Dynamics" springer publications-2014. ISBN: 978-1-4614-8544-5

Course Outcome:

After Learning all the units of the Course, the student is able to
1. Explain tyre forces and moment, summarize the construction of tyres(L1,L2)
2. Solve, illustrate stability of vehicle at different condition(L2,L3)
3. Describe, explain stability of vehicle during braking(L2,L3)
4. Describe, explain solve the stability of vehicle during steering(L2,L3)
5. Explain, solve the stability condition of vehicle during vertical vibration(L1,L2,L3)

Course Articulation Matrix

Mapping of Course Outcomes (CO) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Sl. No.	Course Outcome	Programme Outcomes												Programme Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	Explain tyre forces and moment, summarize the construction of tyres	3	2	2	-	-	-	-	-	-	-	-	-	2	-	-
2	Solve, illustrate stability of vehicle at different condition	3	2	2	-	-	-	-	-	-	-	-	-	2	-	-
3	Describe, explain stability of vehicle during braking	3	2	2	-	-	-	-	-	-	-	-	-	2	-	-
4	Describe, explain solve the stability of vehicle during steering	3	2	2	-	-	-	-	-	-	-	-	-	2	-	-
5	Explain, solve the stability condition of vehicle during vertical vibration	3	2	2	-	-	-	-	-	-	-	-	-	2	-	-

Course Title: Internship			
Course Code: P18AU83	Semester: VIII	L:T:P:H -0:0:0:	Credits:6
Contact Period-Lecturer: 52Hrs. Exam:3 Hrs		Weightage:CIE:50%; SEE:	

Internship: The internship shall be completed during the period scheme of teaching and examination

I. Internship of minimum 8 weeks duration to be completed between the vacation period of 6th 7th and 7th and 8th sem.
II. The internship can be carried out in any industry / R&D organization / Research / Institute Educational institute of repute/ Internashala (AICTE MoU Internship).
III. The department/ College shall nominate staff member/s to facilitate, guide and supervise students under internship.
IV. The Internal Guide has to visit place of Internship at least once during the student's Internship.
V. The students shall report the progress of the internship, students shall submit a report with completion and attendance certificates to the Head of the Department with the approval of both internal and external guides.
VI. After the completion of internship, students shall submit a areport with completion and attendance certificates to the Head of the department with the approval of both internal and external guides.
VII. There will be 50 marks for SEE (Seminar: 20, Internship report: 20 and Viva Voce: 10 marks). The minimum requirement of SEE marks shall be 50% of the maximum marks.
VIII. The Assessment marks (SEE) in the case of Internship, shall be based on the evaluation at the end of the 8th semester by a committee consisting of Head of the concerned department, two senior faculty members of the department, one of them may be the internal guide. The Internship may be evaluated by the committee for award of Assessment marks (SEE) based on an Internship Report, Presentation and Viva-Voce.
IX. The students are permitted to carry out the internship anywhere in India or abroad. The Institution will not provide any kind of financial assistance to any student for carrying out the Internship.
X. Failing to undergo Internship: Internship is one of the head of passing. Completion of internship is mandatory. If any student fails to undergo/complete the internship, he/she shall be considered as failed in that Course. The reappearance shall be considered as an attempt.

Course Title: Project work Phase I & II

Project Work: The Project Work (Phase I + Phase II) carries 8 credits (2 credits+6 credits) and spreads over TWO semesters, i.e. during 7th and 8th semesters.

I. Project Phase I and Project seminar Comprises of Literature Survey, Problem identification Objectives and Methodology CIE marks shall be based on the report covering Literature Survey, Problem identification, Objectives and Methodology and seminar presentation skill.

II. The Assessment marks (CIE) in the case of Project Work - Phase I, shall be based on the evaluation at the end of the 7th semester by a committee consisting of Head of the concerned department two senior faculty members of the department, one of them may be the internal guide. The work may be evaluated by the committee for award of Assessment marks (CIE) based on a Report [comprising of Synopsis, Introduction, Literature survey, Objective and Methodo1ogy presentation and viva voce.

III. The project work shall be carried out by candidate(s) independently/in a group (maximum of four) during the seventh and eighth semester under the guidance of one of the faculty members of the Department of study. If the project work is of inter-disciplinary nature, a co-guide shall be taken from the same or any other relevant Department. If a project work has to be carried out in any industry / factory / organization outside the campus, the permission for the same and the name of co-guide at any of these organizations shall be intimated to the authorities at the beginning of seventh semester by the Head of the Department.

IV. The weekly progress of the Project work shall be monitored and reviewed by the Project Guide assigned by DUGC. The method of evaluation, including intermediate assessment shall be evolved by the pertinent DUGC.

V. A candidate shall submit N+3 (No. of candidates+3) copies of the Report of the Project Work to Head, DUGC on or before the specified date. The report shall be in the format prescribed by the Institute. The candidate shall submit a report of the project work (dissertation) duly approved by the guide and co-guide. The project report shall be countersigned by the guide, co-guide (if any) and the Head of the Department

VI. The last date for the submission of Report shall be Two weeks before the closure of the semester in which the project work credits have been registered for and is expected to be completed or as announced by the COE. The date of submission of the dissertation may be extended up to a maximum of eight academic years, from the date of commencement of the first semester in which the candidate has taken admission to the course.

VII. The final evaluation (CIE & SEE) for Project Work - Phase II is done by a Project Work Evaluation Committee (PWEC) Constituted by the pertinent DUGC. There shall be an open seminar followed by a viva voce examination as part of the final evaluation. After the final evaluation, appropriate letter grade is awarded.

VIII. If in the Opinion of the PWEC, the Project Report is acceptable with minor modifications for the minimum passing grade ‘E’(Fair) in the case of project, the PWEC shall value and instruct the candidate suitably to incorporate the necessary modifications and to be submit it to

the Chairman PWEC. After such resubmission, the Chairman, PWEC will certify that the necessary modification has been incorporated

IX. The Assessment marks in case of Project Work - Phase II and seminar shall be based on the evaluation, as per the guidelines, at the end of the 8th semester by a committee consisting of Head of the concerned department, two senior faculty members of the department (one of them may be the internal guide).

X. The Assessment marks sheet shall bear the signature of all those concerned, along with the date and seal of the Principal.