UG Curriculum-2020
of
B. Tech. in Automobile Engineering

School of Technology

Pandit Deendayal Energy University

Program Educational Objectives (PEOs)

1. To prepare the graduates with strong foundation in science and engineering for successful careers in core mechanical and interdisciplinary industries, higher education and research.
2. To prepare graduates who can become entrepreneur/innovators to design and develop system/process/product/service to address social and industrial challenges.
3. To prepare graduates with leadership qualities, strong communication skills, professional and ethical values.
4. To prepare lifelong learners graduates to excel in their professional career as well as to pursue higher education.

Program Outcomes (POs)

1. **Engineering knowledge:** An ability to apply knowledge of mathematics, science, and engineering in solving/analyzing problems in industries, research and development institutions, public sector units, higher education and in academia.
2. **Problem Analysis:** An ability to design and conduct experiments, as well as to analyze and interpret data in mechanical engineering theory and practice at various industrial work-places.
3. **Design/ Development of solutions:** An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, health and safety, manufacturability, and sustainability.
4. **Multidisciplinary Approach:** An ability to function on multidisciplinary teams.
5. **Modern tool usage:** An ability to identify, formulate, and solve engineering problems using modern tools and techniques.
6. **Communication:** An ability to communicate effectively.
7. **The Engineer and Society:** The broad education necessary to understand the impact of mechanical engineering solutions in a local, global, economic, environmental, and societal context.
8. **Life-long learning:** A recognition of the need for, and an ability to engage in life-long learning.
9. **Investigations of complex problem:** Use of Applied research including design of experiments, analysis and interpretation of data, synthesis of the information to provide valid solutions with the knowledge of contemporary issues.
10. **Project Management:** An ability to apply engineering knowledge and management principles skills to manage engineering projects.
11. **Environment and Sustainability:** An ability to design sub-systems, systems, components and processes to fulfil demand of environmental sustainability.
12. **Ethics:** Apply engineering principles toward the professional values and ethics.

Program Specific Outcomes (PSOs)

1. To **analyze the problems** and **create solution** by applying engineering knowledge with a multidisciplinary approach in the area of vehicle function, vehicle design and vehicle performance.
2. To analyze, interpret and provide solutions for the technical challenges faced by the Automobile Industry **using engineering software/tools.**
3. **To work effectively in a team** to address **complex issues** by engaging in **lifelong learning** and following **ethical and environmental** practices.

COURSE STRUCTURE FOR B.TECH. FIRST YEAR (Automobile Engineering)

SEMESTER I (Subjects)				B.TECH. FIRST YEAR (Automobile Engineering)											
Sr. No.	Category Code	Course Code	Course Name	Teaching Scheme					Exam Scheme						
				L	T	P	C	Hrs/wk	Theory			Practical		Total Marks
									CE	MS	ES	CE	ES	
1	BSC	20MA101T	Mathematics – I	3	1	0	4	4	25	25	50	-	-	100
2	BSC	20CH101T	Engineering Chemistry	3	0	0	3	3	25	25	50	-	-	100
3	BSC	20CH101P	Engineering Chemistry Lab	0	0	2	1	2	-	-	-	50	50	100
4	ESC	20ME102T	Elements of Mechanical Engineering	3	0	0	3	3	25	25	50	-	-	100
5	ESC	20ME102P	Elements of Mechanical Engineering-Lab	0	0	2	1	2	-	-	-	25	25	50
6	ESC	20IC101T	Basic Electronics	2	0	0	2	2	25	25	50	-	-	100
7	ESC	20IC101P	Basic Electronics Lab	0	0	2	1	2	-	-	-	25	25	50
8	ESC	20ME101P	Engineering Graphics – Lab	0	0	4	2	4	-	-	-	25	25	50
9	ESC	20CP101T	Programming with C	1	0	0	1	1	25	25	50	-	-	100
10	ESC	20CP101P	Programming with C - Lab	0	0	2	1	2	-	-	-	25	25	50
11	HSC	20HS102T	Environmental Studies	3	0	0	3	3	25	25	50	-	-	100
12	HSC	16SP101	NCC-I	0	0	2	1	2	-	-	-	-	-	100
		16SP102	NSS-I											
		16SP103	Sports-I											
Total				**15**	**1**	**14**	**23**	**30**						

CE = Continuous Evaluation MS = Mid Semester Exam ES = End Semester Exam

20MA101T					MATHEMATICS-I					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

- To be able to evaluate problems related to differential and integral calculus of complex functions.
- To be able to obtain area, volume using integral calculus.
- To be able to formulate and solve various engineering problems using calculus.
- To study the properties of Matrix algebra and apply them to solve the system of algebraic equations.

UNIT 1 DIFFERENTIAL CALCULUS AND ITS APPLICATIONS **08 Hrs.**

Partial derivative and its application, - Euler's theorem - Total derivatives - Jacobians – Maxima and Minima of two variables using Lagrange's multipliers. Convergence of infinite series.

UNIT 2 INTEGRAL CALCULUS AND ITS APPLICATIONS **12 Hrs.**

Definition Evaluation of double integral (Cartesian – Polar form) – Change of orders - Change of variables – Evaluation of triple integral, change of variables (Cartesian to spherical – and cylindrical) – Applications, area – volume – center of mass – center of gravity by double and triple integral.

UNIT 3 MATRIX ALGEBRA AND ITS APPLICATIONS **10 Hrs.**

Solution of system of algebraic equation - Rank of a matrix, consistency of system of equation - Characteristic equation of a square matrix- Eigen values and Eigenvectors of a real matrix - Properties of eigen values and eigen vectors - Cayley-Hamilton theorem (without proof) - finding inverse of a matrix - Diagonalisation of a matrix using orthogonal transformation.

UNIT 4 VECTOR CALCULUS **10 Hrs.**

Gradient, divergence and curl – Directional derivative – Irrotational and Solenoidal vector fields – Vector Integration – Simple problems on line, surface and volume integrals – Green's theorem in a plane, Gauss divergence theorem and Stokes' theorem (without proofs) – Simple application involving cubes and rectangular parallelepipeds.

40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – **Identify** the use of convergence of infinite series in engineering aspects.
CO2 – **Understand** the concept of Directional derivative, Irrotational, and Solenoidal vector fields.
CO3 – **Apply** appropriate tool/method to extract the solutions of engineering problems.
CO4 – **Analyze** the obtained solution in context with theory.
CO5 – **Appraise** mathematical problems from real to complex domain.
CO6 – **Evaluate** problems on Green's, Stokes' and Divergence theorems.

TEXT/REFERENCE BOOKS

1. B. S Grewal, Higher Engineering Mathematics, (43rd Edition), Khanna Pub., Delhi (2014).
2. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Alpha Science, 3rd Ed., 2007.
3. Erwin Kreyszig, Advanced Engineering mathematics, John Wiley, 10th Ed., 2015.
4. G. Strang, Linear Algebra and its applications, 4th Edition, Cengage Learning, 2005.
5. K. Hoffman and R. A. Kunze, Linear Algebra, Prentice Hall of India, 2002.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs.**
Part A: 10 questions 3 marks each	30 Marks (40 min)
Part B: 5 questions 6 marks each	30 Marks (50 min)
Part C: 5 questions 8 marks each	40 Marks (90 min)

20CH101T					Engineering Chemistry					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	0	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To develop the fundamental understanding about atomic structure and interatomic bonding.
- To provide the knowledge about structural features, synthesis, properties of various categories of materials.
- To develop the skills for phase, microstructural and elemental characterisation of materials.
- To provide the knowledge about the role of chemistry in modern engineering applications.

UNIT 1 Atomic structure and interatomic bonding **12h**

Electrons in atoms, Bohr atomic model, wave mechanical model, introduction to quantum chemistry, wave functions and probability densities, quantum numbers, orbital shapes - *s,p,d,f*- LCAO-MO of H_2, covalent, ionic and metallic bonding, bonding forces and energies, lattice energy and Madelung constant, metallic crystal structure, ceramic crystal structure and influencing factors.

UNIT 2: Chemistry of materials **10 h**

Introduction and classification of materials; structural features, synthesis, properties of metallic (e.g. noble metal), polymeric (e.g. thermoplastic and thermosetting), glass-ceramic (e.g. silicates, metal oxides) carbonaceous materials (e.g. fullerene, carbon nanotube, graphene); Introduction to nanomaterials, surface area to volume ratio and aspect ratio of nanomaterials, quantum confinement, top-down and bottom up chemical/physical approaches for synthesis of nanomaterials.

UNIT 3: Chemistry of Fuels and energy devices **10 h**

Fuels – Classification of fuels; Determination of calorific values of solid fuels by bomb calorimeter – Manufacture of synthetic petrol by Fischer-Tropsch method – Knocking in IC engines – Octane and cetane rating of fuels; Petrol and Diesel Engine, chemistry for alternative source and storage of energy (supercapacitor, fuel cell, battery); role of chemistry on in photo-voltaic devices (solar cell).

UNIT 4: Instrumental methods of chemical analysis **12 h**

Characterization of materials using X-ray diffraction (XRD), thermal Analysis (TGA-DTA-DSC), basics and application of Microwave spectroscopy, FTIR, UV-visible spectroscopy; NMR spectroscopy; Chromatographic techniques (GC, HPLC).

Max. 44 h

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the fundamental concept about atomic structure and interatomic bonding.

CO2 - Acquire knowledge about metallic and ceramic crystal structure.

CO3 - Acquire knowledge about structural features, properties of different classes of materials including nanomaterials.

CO4 - Explain the methodologies for the synthesis of different categories of materials.

CO5 - Develop the skill for phase, microstructural and elemental characterisation of materials.

CO6 - Develop the knowledge on the role of chemistry in various modern engineering applications.

TEXT/REFERENCE BOOKS

1. An Introduction to Materials Science & Engineering, W.D. Callister, John Wiley & Sons (2007).
2. Fundamental of Ceramics, MW Barsoum, IOP publishing (2003).
3. Text book of Nanoscience and Nanotechnology, T. Pradeep, Mc. Graw Hill Education (2003).
4. Textbook of Nanoscience and Nanotechnology, Murty, Shankar, B Raj, Rath, Murday, Springer (2013).
5. Materials Science and Engineering, V. Raghavan, Prentice-Hall of India Private Limited (2003).
6. Principles of Instrumental Analysis, Douglas A. Skoog, Donald M.West, 6th Edition, Cengage (2014)

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 h**

Part A/Question: 3 Questions from each unit, each carrying 3 marks 36 Marks

Part B/Question: 2 Questions from each unit, each carrying 8 marks 64 Marks

20CH101P					Engineering Chemistry Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

- To enhance and develop scientific and analytical skills
- To relate concepts learned in chemistry and engineering to the real-world situations.
- To acquire skills to perform laboratory experiments.
- To demonstrate safe and proper use of standard chemistry glassware and equipment.

LIST OF EXPERIMENTS

1. **External Indicator**–To determine the strength of given solution of ferrous ammonium sulphate by titrating against standard N/40 $K_2Cr_2O_7$ using potassium ferricyanide as an external indicator
2. **Iodometry**– To determine the strength of given copper sulphate solution by titrating against N/20 sodium thiosulphate (hypo) solution
3. **Iodimetry**– To determine the strength of given ascorbic acid by titrating against standard N/10 iodine solution
4. **Complexometric Titration**– To determine the total, permanent and temporary hardness of given water by complexometric titration using standard 0.01M EDTA solution
5. **pH metric titration**– To determine the strength of given HCl solution using a standard NaOH solution by performing a pH-metric titration
6. **Conductometric titration**– To determine the strength of given HCl solution using a standard NaOH solution by performing a conductometric titration
7. **Potentiometric titration**– To determine the strength of given HCl solution potentiometrically
8. **Chemical Kinetics**– To study the kinetics of decomposition of sodium thiosulphate by a mineral acid
9. **Chloride in Water**– Determination of Chloride in the given water sample by Mohr Method
10. **Polymerization**– To prepare a polymer (Nylon 6,10), identify the functional groups by FT-IR
11. **Spectrophotometry**– To determine the λmax and concentration of given unknown potassium permanganate using UV-Visible Spectroscopy technique

Max. <28> Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Apply the concepts learned in chemistry and engineering to the real-world situations.

CO2 - Enhanced ability to identify, analyse and interpret the results from the experiments

CO3- Carry out quantitative analysis by instrumental method using Conductometer.

CO4- Analyse compounds by titrimetric, gravimetric and instrumental methods

CO5- Determine the concentration of unknown solutions by Spectrophotometric method.

CO6- Investigate the reaction rate and predict the order and rate constant

TEXT/REFERENCE BOOKS

1. College Practical Chemistry, VK Ahluwalia, S Dhingra, A Gulati, Universities Press
2. Foundations of Experimental Chemistry, JB Baruah, P Gogoi, PharmaMed Press.
3. A Text Book of Chemistry Practicals Vol I & II, SS Sawhney, M S Jassal, SP Mittal, APH Publishing Corp.>

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3Hrs**

Part A : Lab Work – Continuous Assessment 50 Marks

Part B : Lab Exam and Viva 50 Marks

20ME102T					Elements of Mechanical Engineering					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To introduce and define the basics concept of mechanical engineering.
- To familiarize the working principles of IC engines and industrial robotics systems.
- To enable the students to understand the details about the energy systems and its components.
- To demonstrate the various machine elements, materials and its function.
- To help the students acquire knowledge about the various manufacturing process.

UNIT 1 Introduction to Thermodynamics **10 Hrs.**

Definition and applications, systems and control volumes, thermodynamic properties, thermodynamic systems, state and equilibrium processes and cycles, temperature and Zeroth law of thermodynamics, forms of Energy, energy transfer by work and heat, law of conservation of energy, energy conversion efficiencies.

Properties of Pure substances - Definition, examples and phases, phase change of pure substances, property diagrams and property tables. Solution of Numerical Problems through EES Software.

UNIT 2 Law of degradation of Energy and Internal Combustion Engines **10 Hrs.**

Limitations of First Law, Thermal Energy reservoirs, heat engines, Refrigerators and Heat pumps, Kelvin Plank and Clausius statement and their equivalence.

Introduction, classification and brief description of I.C. engines mechanism, 4-Stroke and 2-Stroke cycles and engines. Otto, Diesel and dual cycles; MEP and air standard efficiencies.

UNIT 3 Engineering materials and Introduction to Manufacturing Processes **10 Hrs.**

Stresses, strains and material properties.

Conventional manufacturing process: Lathe Machines, CNC machines, drilling machines, universal Milling machines. Non-conventional manufacturing processes: Additive Manufacturing, 3D printing.

UNIT 4 Introduction to industrial robotics and Industry 4.0 **10 Hrs.**

Introduction, Industrial and Non-industrial robots, Anatomy and configuration of Industrial Robots, Robot Components, Robot Applications.

Max. 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Define the "fundamentals' and "terminologies" used in Engineering Thermodynamics.
CO2: Explain the energy conservation principles applicable for ideal gas and pure substance applications
CO3: Analyse the performance of thermodynamic cycles.
CO4: Evaluate the performance of power cycles
CO5: Identify the principles of different machining techniques and material properties.
CO6: Understand the anatomy, applications of robots and introduction to industry 4.0.

TEXT/REFERENCE BOOKS

1. Cengel, Yunus A., and Michael A. Boles. Thermodynamics: An Engineering Approach 6th Editon (SI Units). The McGraw-Hill Companies, Inc., New York, 2013.
2. Sharma, Pramod C. A textbook of production engineering. S. Chand Publishing, 2019.
3. Nag, P. K. Engineering thermodynamics. Tata McGraw-Hill Education, Sixth Edition, 2017.
4. Groover, Mikell P., Mitchell Weiss, and Roger N. Nagel. Industrial robotics: technology, programming and application. McGraw-Hill Higher Education, 2015

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Unit 1 and 2: Two question from each unit (Total 4 question with subparts) 40 Marks
Unit 3 and 4: Two question from each unit (Total 4 question with subparts) 60 Marks

20ME102P					Elements of Mechanical Engineering Lab.		
Teaching Scheme					Examination Scheme		
L	T	P	C	Hrs/Week	Practical		Total Marks
					Continuous Evaluation	End Semester LE/Viva	
0	0	2	1	2	25	25	50

COURSE OBJECTIVES:

- To Perform experiments and collect experimental data on thermal and mechanical systems to validate theoretical principles.
- **To analyse, differentiate** and **evaluate** Law of conservation of energy on thermal systems.
- **To evaluate** performance of heat engine and heat pumps.
- **To calculate and compare** the components, application of the conventional manufacturing machines, non-conventional manufacturing machines and industrial robotic systems.
- **To demonstrate** the working principle of heat engine and additive manufacturing process.

List of Experiments:

1. To understand and perform fluid property evaluation using property tables and engineering equation solver software.
2. To perform experimental study and verify 1st law of thermodynamics by energy balance of heat exchanger.
3. To evaluate thermodynamic systems using Engineering Equation Solver.
4. To determine Performance of Heat pump and evaluate its coefficient of performance.
5. To understand and demonstrate components and working cycle of Internal Combustion engine.
6. To understand and demonstrate construction and working of conventional manufacturing machine.
7. To understand and demonstrate construction and working of non-conventional manufacturing machine.
8. To study additive manufacturing process applied for 3D printing.
9. To develop a working model of a simple robotic system.

Course Outcomes (COs):

On completion of the course, students will be able to

CO1 - Understand and **evaluate** conservation law of thermodynamics through experimentation.
CO2 - Understand and **analyse** thermal systems data using engineering equation solver.
CO3 – Measure the coefficient of performance of heat pump.
CO4 - Examine the internal combustion engine components and its working.
CO5 - Demonstrate the various components of convention and non-conventional manufacturing machines and elaborate their applications.
CO6 – Classify the components in industrial robots and **develop** a simple robotic system.

Resources/Text/Reference books

1. Sukhatme, Suhas P., and J. K. Nayak. Solar energy. McGraw-Hill Education, 2017
2. Cengel, Yunus. Heat and mass transfer: fundamentals and applications. McGraw-Hill Higher Education, 2014
3. Groover, Mikell P., Mitchell Weiss, and Roger N. Nagel. Industrial robotics: technology, programming and application. McGraw-Hill Higher Education, 2015

END SEMESTER LAB EXAMINATION

Max. Marks: 50 **Exam Duration: 2 hrs**

Quiz/Experiment	20 Marks
Viva	30 Marks

20IC101T					Basic Electronics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	0	0	100

COURSE OBJECTIVES

- To understand rectification through p-n junction diode and applications of diode
- To learn different configurations and static characteristics of bipolar junction transistor and MOSFET
- To illustrate the OPAMP application in different real life circuits
- To introduce basic concepts of digital electronics

UNIT 1: DIODES AND RECTIFIERS **8 Hrs.**

Review of p-n junction diode, 1-phase half wave, full wave and bridge rectifier using diode. Calculation of average & rms value, PIV, efficiency, transformer utilization factor and ripple for different diode rectifier circuit. Use of Capacitor Filter for ripple reduction, voltage multipliers, Zener diode in load and line regulation.

UNIT 2: BJT, FET AND MOSFET **07 Hrs.**

Working of a BJT, transistor biasing, different transient circuit configuration (CB, CE and CC), static characteristic for BJT, transistor as switch, amplifier, concept of feedback amplifier and oscillator. Classification of FET, static characteristics of FET, FET biasing and load line, MOSFET, static characteristic of MOSFET and biasing

UNIT 3: OPAMP **04Hrs.**

Introduction, Block Diagram and Characteristics of Ideal Op-Amp, Parameters of an Op-Amp, Inverting and Non- Inverting Amplifier, Virtual Ground, Adder, Subtractor, Comparator, Integrator and Differentiator.

UNIT 4: DIGITAL ELECTRONICS **07Hrs.**

Number system, Binary arithmetic, logic gates and combinational logic, Boolean algebra, DeMorgan's Theorems, Logic minimization and Karnaugh maps, full adder, multiplier, multiplexing, Flip Flops, Introductory Sequential Logic, Counters, Registers

Total 26 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 –Demonstrate application of different diode in circuits
CO2 – Evaluate zener diode as voltage regulator
CO3- Apply BJT, FET and MOSFET in different circuits
CO4–Understand static characteristics OPAMP
CO5–Illustrate basic concepts and theorem of digital systems
CO6–Build digital circuits using logic gates and flip flops

TEXT/REFERENCE BOOKS

1. Boylestad and Nashlesky, "Electronic Devices and Circuit Theory", PHI
2. N.N. Bhargava, S.C. Gupta, and D.C. Kulshreshtha, "Basic Electronics And Linear Circuits", McGraw Hill Education (India)
3. R. A. Gaikwad, "Operational Amplfier and Linear Integrated Circuits", PHI
4. Morris Mano, "Digital Design", PHI
5. J. Millman, C. Halkias and C. Parikh, "Integrated Electronics", Tata McGraw Hill.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc.(10 to 20 marks each)	80 to 60 Marks

20IC101P					Basic Electronics Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	0	0	0	25	25	50

COURSE OBJECTIVES

- To understand the characteristics of PN junction diodes and their applications
- To Observe properties of BJT, FET and MOSFET
- To illustrate the OPAMP application in different real life circuits
- To introduce basic concepts of digital electronics

Experiment Sessions would be simulation based covering but not limited to following topics:

1. To study the simulation tool and its features for analog circuit simulation
2. To study the VI characteristic of silicon and germanium diodes.
3. To study reverse characteristics of zener diode.
4. To study half wave, full wave and bridge rectifiers
5. To study BJT as switch
6. To study common emitter amplifier
7. To study different biasing circuits of BJT
8. To study transfer and drain characteristic of FET and MOSFET
9. To study the simulation of digital circuits
10. To study and verify logic gates
11. To implement X-OR and X-NOR gates using basic gates
12. To study and design adder and subtracter circuits
13. To study and design flip flops
14. To study OPAMP and its properties
15. To study ADC and DAC
16. Design of mini project in a group of 4-5 students

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Study the fundamentals of electronic components
CO2: Understand the working principle of semiconductor devices
CO3: Apply the analog and digital concept in building real time circuits
CO4: Analyze the behaviour of semiconductor devices, OPAMP, ADC and DAC
CO5: Evaluate different circuit for different device parameters
CO6: Build analog and digital sub-system

TEXT/REFERENCE BOOKS

1. Boylestad and Nashlesky, “Electronic Devices and Circuit Theory”, PHI
2. N.N. Bhargava, S.C. Gupta, and D.C. Kulshreshtha, “Basic Electronics And Linear Circuits”, McGraw Hill Education (India)
3. R. A. Gaikwad, “Operational Amplfier and Linear Integrated Circuits”, PHI
4. Morris Mano, “Digital Design”, PHI
5. J. Millman, C. Halkias and C. Parikh, “Integrated Electronics”, Tata McGraw Hill.

COURSE OBJECTIVES

- To learn fundamental of engineering drawing and standards used in drawing
- To enable the students with various concepts of projections and standards related to technical drawings.

20ME101P					Engineering Graphics - Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	4	2	4	-	-	-	25	25	50

- To demonstrate and communicate ideas using orthographic (2D) & isometric projection (3D) methods
- To help students to use CAD software to solve engineering problems

UNIT 1 Introduction **10 Hrs.**

Introduction to Engineering Graphics – Importance and applications, drawing instruments & accessories, lettering, types of lines, dimensioning methods, basic geometric drawing.

Computer Aided Engineering Drawing: Introduction to CAD, use of softwares in drawing, CAD software user interface, commands, menus and toolbars.

UNIT 2 Orthographic Projection **14 Hrs.**

Introduction to projection, types of projection, 1st angle and 3rd angle projection, 2D sketch, sketch entities and tools – origin, points, lines, arcs, polygons, fillets and chamfer, trim, extend and offset, projections from pictorial view, orientation of views, sections and sectional views.

UNIT 3 Isometric Projection and Projection of Solids **14 Hrs.**

Construction of isometric views from orthographic projections, approach to modelling, moving from 2D to 3D, creating 3D models using CAD features, assembly of components and exploded views.

Classification of solids, projections of solids like cylinder, cone, pyramid and prism with its inclination to reference plane, concept of development of lateral surfaces, intersection of solids.

UNIT 4 Computer aided drafting **14 Hrs.**

Drafting – Drafting standards, drawing views, alignment of drawing views, dimensions and tolerances, symbols, comments and annotations, computer aided drafting, drawing sheet and title block.

Tolerance - Introduction to limits, fits and tolerances, standardized representation of threads, fasteners, welds, bearings and springs, dimensional and geometric tolerances, surface finish symbols.

Total 52 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the fundamentals of engineering graphics and **remember** the basic rules of dimensioning and labelling.

CO2 - **Develop** the ability to learn fundamental of CAD software and its use to solve engineering problems.

CO3 - **Comprehend** the concept of projection and use it to **represent** the views on reference planes.

CO4 - **Apply** the technical communication skill for 3-dimensional geometries in the form of 3D models using isometric projection.

CO5 - **Analyze** the orientation of geometrical bodies with respect to reference planes and **evaluate** the intricate details of solid using sectioning and development of lateral surfaces.

CO6 - **Create** drawing sheet by **organizing** drawing views and **applying** necessary dimensions and tolerances.

TEXT/REFERENCE BOOKS

1. R Hanifan, “Perfecting Engineering and Technical Drawing”, Springer International Publishing Switzerland
2. Bethune, J. D., “Engineering Design and Graphics with SolidWorks 2019, 1st edition”, Macromedia Press
3. K Morling, “Geometric and Engineering Drawing”, Elseveir Insights
4. DM Kulkarni, “Engineering Graphics with AutoCAD”, Easter Economy Edition
5. Agrawal, B. & Agrawal C. M., “Engineering Drawing”, Tata McGraw Hill Publishers
6. P.J. Shah, “Engineering Graphics”, S. Chand Publishing
7. David C Planchard, “Engineering Graphics with SOLIDWORKS 2019: A Step-by-Step Project Based Approach’’, SDC Publications.

Max. Marks: 50 **Exam Duration: 2 Hrs**

Continuous evaluation	25 marks
End semester examination and Viva-voce	25 marks

20CP101T					Programming with C					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
1	0	0	1	1	25	25	50	-	-	100

COURSE OBJECTIVES

- To develop a greater understanding of the issues involved in programming language, design and implementation
- To inculcate functional and logical problem-solving skills through programming.
- To understand the basic concepts of C programming

UNIT 1 BASICS OF C PROGRAMMING **4 Hrs.**

Input, Output constructs, different data types, types of Operators, Precedence and associativity of Operators, Control Structure and Loop Structure

UNIT 2 ARRAY AND STRINGS **4 Hrs.**

1-dimensional, 2-dimensional and 3-dimensional arrays, different types of user defined functions, String operations in form of Character arrays, In-built String functions

UNIT 3 POINTERS **4 Hrs.**

Basic pointer arithmetic, arrays and String using Pointer, call the functions using Call-by reference property

UNIT 4 FILE HANDLING **2 Hrs.**

open the file in write mode and write the data into it, open the file in read mode and read from the file, Open the file in append mode and append the contents in the file, handle the File operations using seek function.

Max. 14 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Understand functional and logical problem-solving skills through programming
CO2 - Write, compile and debug programs in C language
CO3 – Use basic and derived data types in C and Operators in C.
CO4 - Design programs involving decision structures, loops, and functions in C.
CO5 - Implement Programs to perform pointer arithmetic and array handling with Pointers.
CO6 - Perform File-handling operations in C.

TEXT/REFERENCE BOOKS

1. E.Balaguruswamy, Programming in ANSI C, McGraw-Hill
2. Jeri R. Hanly and Elli B.Koffman, Problem Solving and Program Design in C.
3. Brain W.Kernighan & Dennis Ritchie, C Programming Language, PHI

SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Short Questions (such as: MCQ, fill-in-the-gaps, objective or short one-line questions, match the following etc. (1 or 2 marks each)	20 to 40 Marks
Large Questions (such as: problem analysis, numerical solutions, logical/analytical steps and methods, derivations, descriptive answers, tabular solutions, graphical solutions, etc. (10 to 20 marks each)	80 to 60 Marks

20CP101P					Programming with C - Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	-	-	-	25	25	50

COURSE OBJECTIVES

- To understand the basic concepts of C programming
- To understand design and implementation issues involved with variable allocation and binding, control flow, types, subroutines, parameter passing
- To develop understanding of Compilation process.

LIST OF EXPERIMENTS:

Practical list should be prepared based on the content of the subject and following guidelines should be useful. - Computer Programming covering all constructs of C language.

Following list gives some programming examples. Faculty can prepare their own list in same manner keeping above guidelines and syllabus in mind.

1. Add, substract, multiply, divide two numbers.
2. Convert hours into minutes, minute to hours, etc.
3. Convertion related programs dollars into Rs. Where 1 $ = 48 Rs. , grams to KG, KileBytes to Megabytes, etc.
4. Convert celcius into Fahrenheit. F = (9/5 * C) + 32 and Fahrenheit into celcius. C = 5/9 * (F – 32)
5. Calculate simple and compound interest where I = PRN/100.
6. Calculate area & perimeter of a square, rectangle, circle, triangle.
7. Program to sort N numbers. (Ascending and Descending)
8. Program to calculate string length, reverse the string, etc.
9. Program to check the string and number is palindrome or not.
10. Program to generate sine, cosine, tan series.
11. Program to generate fibonnaci series.
12. Program to calculate factorial using recursion.
13. Program to create a database using array of structures.
14. Programs related to pointers.
15. Programs related to file.

Design based Problems (DP)/Open Ended Problem:

1. Develop a game/Puzzle in C language.
2. Use interrupts to develop programs related to basic operations.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Understand functional and logical problem-solving skills through programming
CO2 - Write, compile and debug programs in C language
CO3 – Use basic and derived data types in C and Operators in C.
CO4 - Design programs involving decision structures, loops, and functions in C.
CO5 - Implement Programs to perform pointer arithmetic and array handling with Pointers.
CO6 - Perform File-handling operations in C.

TEXT/REFERENCE BOOKS

1. E.Balaguruswamy, Programming in ANSI C, McGraw-Hill
2. Jeri R. Hanly and Elli B.Koffman, Problem Solving and Program Design in C.
3. Brain W.Kernighan & Dennis Ritchie, C Programming Language, PHI

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 50 **Exam Duration: 2 Hrs**

Part A/Question: <QUIZ/VIVA> <25> Marks
Part B/Question: <PRACTICAL PERFORMANCE> <25> Marks

20HS102T					ENVIRONMENTAL STUDIES					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- Understanding about Bird's eye view of Environment,
- Understanding of multidisciplinary aspect of environment
- Understanding of pollutions and their effects on environment
- Understanding about various environment pollution control strategies

UNIT 1 Bird's Eye view to Environment 08Hrs.

Environmental Studies – Its importance and Multidisciplinary nature; Ecosystem and its various types, factors affecting the functioning of an ecosystem; Biodiversity – its importance, threats and conservation; Natural Resources – Forest, Water, Mineral, Energy, Minerals, Food; Review of State of India's Environment.

UNIT 2 Multi-scale Environmental Pollution 10 Hrs.

Concept of Clean Environment, Introduction to various environmental standards – air, water, soil, noise, heat. Causes and Effects of Air Pollution, Water Pollution, Soil Pollution, Solid Waste (organic and Inorganic) Pollution, Hazardous Waste Pollution, Marine Pollution, Noise Pollution, Thermal Pollution, Radioactive Pollution; Pollution across Indian cities – case studies; Introduction to man-made disasters like floods, heat waves, landslides, etc.

UNIT 3 Environmental Pollution Control Strategies 12 Hrs.

Multi-approaches (role of research, technology, policy, planning & implementation, legislation & judiciary, incentives & business) for reducing various types of pollution; Case studies of Pollution control strategies; Review of the Central and State Government's policies and mechanisms for managing various natural resources and controlling the various types of pollutions (including Swacch Bharat Abhiyan), Global Initiatives for environmental management; Indian Culture and Traditional Wisdom for managing environment

UNIT 4 Social Issues and the Environment 09 Hrs.

Concept of sustainability and Sustainable Development, Environmental Sustainability Index, Environmental Ethics, Public awareness and people's participation (bottlenecks and solutions), Consumerism and Waste products, Introduction to Carbon Footprint & Water Footprint, Green Buildings, Green Business (profitability in managing environment)

TOTAL 39 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1- Understand the various facets of environment,
CO2- Understand of multidisciplinary aspects of environment
CO3- Understand about the different types of pollutions
CO4- Understand the effects of pollution on human health, plants, materials and environment
CO5- Understand about the various environment pollution control strategies
CO6- Understand about various concepts of sustainable development

TEXT/REFERENCE BOOKS:

1. Bharucha Erach, Textbook for Environmental Studies, UGC New Delhi
2. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd, Ahmedabad 380013, India
3. Clark, R. S., Marine Pollution, Clanderson Press Oxford
4. Daniel B. Botkin & Edwards A. Keller, Environmental Science, Wiley INDIA edition.
5. Hawkins R. E., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay
6. Miller T. G. Jr., 2006. Environmental Science, Clengage Learning, India
7. Odum E. P. 1971. Fundamentals of Ecology, W. B. Saunders Co, USA
8. Wagner K. D., 1998. Environmental Management, W. B. Saunders Co, USA

END SEMESTER EXAM PAPER SCHEME (Max Marks: 100)

Max. Marks: 100 (Left aligned)		**Exam Duration: 3 Hrs**
Part A	4 Questions of 10 Marks each. 1 Question from every unit.	40
Part B	6 Questions of 10 Marks each. 3 Questions from Unit 3 & 4 each	60

16SP101/16SP102/16SP103					NCC-I/NSS-I/SPORTS-I					
Teaching Scheme					Examination Scheme					
					Theory			Practical		
L	T	P	C	Hrs/Week	MS	ES	IA	LW	*Participation and Attendance	Total Marks
0	0	2	1	2	* Continuous Evaluation			--	100	100

COURSE OBJECTIVES

- To develop discipline, character, brotherhood, the spirit of adventure and ideals of selfless service amongst young citizens
- To develop youth leadership in the students.
- To induce social consciousness among students through various camps and 'Shibir' activities.
- To develop skills and physical fitness among students through indoor & outdoor sports, field & track events.

National Cadet Corps (NCC):

Introduction to NCC, Aims and objectives, Structure and organization, NCC Song, Incentives, National Integration and Awareness, Drill, saluting, Personality Development & Leadership, Disaster Management, Social Awareness & Community Development, Health & Hygiene, Adventure camps, Environment Awareness and Conservation, Obstacle Training, Armed forces, Map reading, Field Craft & Battle Craft, Introduction to Infantry Weapons & Equipment, Weapon Training (During camps), Participation into Republic and Independence day ceremonial parades,

National Service Scheme (NSS):

Importance and role of youth leadership, Life competencies, Youth development programmes and youth 'shibir', Health, hygiene and sanitation, Youth health, lifestyle, first aid, youth and yoga

Sports:

Importance of sports/games in life, Physical fitness, Introduction to various games and sports, field and track events, Physical training, exercises, running, walking, jogging, Teaching of different sports/games, track & field events , demonstration, practice, skills and correction, Introduction to Yoga & Meditation.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – **Understand** the importance of Nation building and individual contribution to the same.
CO2 – **Integrate** physical fitness and mental wellbeing
CO3 – **Discover** grassroots challenges of community
CO4 – **Creating** societal impact
CO5 – **Maintain** discipline and team spirit
CO6 – **Upholding** the value of one for all and all for one

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: --**

* All registered students will be evaluated based on his/her attendance during the NCC/NSS/Sports sessions and participation to camps and other activities.

COURSE STRUCTURE FOR B.TECH. FIRST YEAR (Automobile Engineering)

SEMESTER II (Subjects)				B.TECH. FIRST YEAR (Automobile Engineering)											
Sr. No.	Category code	Course Code	Course Name	Teaching Scheme					Exam Scheme					
				L	T	P	C	Hrs/wk	Theory			Practical		Total Marks
									CE	MS	ES	CE	ES	
1	BSC	20MA103T	Mathematics - II	3	1	0	4	4	25	25	50	-	-	100
2	ESC	20CE101T	Element of Civil Engineering & Solid Mechanics	4	0	0	4	4	25	25	50	-	-	100
3	ESC	20CE101P	Element of Civil Engineering & Solid Mechanics - Lab	0	0	2	1	2	-	-	-	25	25	50
4	ESC	20EE101T	Elements of Electrical Engineering	3	0	0	3	3	25	25	50	-	-	100
5	ESC	20EE101P	Elements of Electrical Engineering - Lab	0	0	2	1	2	-	-	-	25	25	50
6	BSC	20PH101T	Engineering Physics	3	0	0	3	3	25	25	50			100
7	BSC	20PH101P	Engineering Physics Lab	0	0	2	1	2	-	-	-	25	25	50
8	ESC	20ME103P	Workshop Practice	0	0	2	1	2	-	-	-	25	25	50
9	ESC	20CP102P	Fundamentals of Python Programming	0	0	2	1	2	-	-	-	25	25	50
10	HSC	20HS101P	Communication Skills - I	0	0	2	1	2	-	-	-	25	25	50
11	HSC	16HS109T	Professional Ethics & Human Values	1	0	0	1	1	25	25	50	-	-	100
12	HSC	16SP101	NCC - II	0	0	2	1	2	-	-	-	-	-	100
		16SP102	NSS - II											
		16SP103	Sports - II											
13	HSC	16TP110	Civic Services & Social Internship	0	0	0	1	0	-	-	-	-	-	100
			Total	**14**	**1**	**14**	**23**	**29**						

CE = Continuous Evaluation MS = Mid Semester Exam ES = End Semester Exam

20MA103T					MATHEMATICS - II					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

- To be able to apply the calculus of complex functions to construct analytic functions.
- To be able to compute residues and apply them to evaluate contour integrals.
- To be able to formulate and solve various engineering problems using the methods of solving ODEs.
- To study the properties of Laplace transforms and apply them to solve ODEs.

UNIT 1 COMPLEX DIFFERENTIATION **10 Hrs.**

Limit, Continuity, Differentiability of function of complex variable, Analytic function, Cauchy-Euler equation (in Cartesian and polar coordinates), Harmonic function and its significance, Singularities, Taylor's series, Mapping (translation, rotation and inversion), bilinear transformation, Conformal mapping, Applications of Conformal mapping.

UNIT 2 COMPLEX INTEGRATION AND APPLICATIONS **10 Hrs.**

Definition of a Complex line integral, Contour integrals, Cauchy- Goursat theorem, Cauchy integral theorem, Cauchy Integral formula (CIF), CIF for derivatives, Calculation of residues, Cauchy Residue theorem, Applications of residues to evaluate real definite integrals.

UNIT 3 ORDINARY DIFFERENTIAL EQUATIONS WITH APPLICATIONS **10 Hrs.**

Differential equations of first order and higher degree, Higher order differential equations with constant coefficients, Rules for finding C.F. and P.I., Method of variation of parameters, Cauchy and Legendre's linear equations, Linear differential equations of second order with variable coefficients; Simultaneous linear equations with constant coefficients, Applications of higher order differential equations in solving engineering problems.

UNIT 4 LAPLACE TRANSFORMS **10 Hrs.**

Piecewise continuous functions and exponential functions, Definition, Existence and Properties of Laplace transforms, Heaviside function, Inverse Laplace transform, Properties of inverse Laplace transforms, Convolution theorem, Applications of Laplace Transforms in solving differential equations.

40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Identify the use of various special functions in engineering aspects.
CO2 – Illustrate the ability to handle mathematical models, to describe physical phenomena, using suitable techniques.
CO3 – Apply appropriate tool/method to extract the solutions of engineering problems.
CO4 – Analyze the obtained solution in context with theory.
CO5 – Appraise mathematical problems from real to complex domain.
CO6 – Create a mathematical model of engineering interest.

TEXT/REFERENCE BOOKS

1. R.V. Churchill and J. W. Brown, Complex variables and applications, McGraw-Hill, 7th Ed., 2003
2. J. M. Howie, Complex analysis, Springer-Verlag, 1st Ed., 2003.
3. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Alpha Science, 3rd Ed., 2007.
4. Erwin Kreyszig, Advanced Engineering mathematics, John Wiley, 10th Ed., 2015.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs.**
Part A: 10 questions 3 marks each	30 Marks (40 min)
Part B: 5 questions 6 marks each	30 Marks (50 min)
Part C: 5 questions 8 marks each	40 Marks (90 min)

20CE101T					Element of Civil Engineering and Solid Mechanics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
4	-	-	4	4	25	50	25	--	--	100

COURSE OBJECTIVES.

- To introduce and explain the basic scope of engineering.
- To understand different types of force systems and apply them to practical engineering applications.
- To develop an understanding of the basic concepts related to tensile, compressive and shear stresses in engineering components.
- To discuss the basic principles of torsion in shafts, shear force and bending moment in beams, Deflection in springs, Columns and Struts.

UNIT 1 INTRODUCTION TO CIVIL ENGINEERING & MECHANICS **14 Hrs.**

Basics and scope of Civil Engineering- Introduction to Civil Engineering- Branches of Civil Engineering- Application of Civil Engineering in other domain different types residential of buildings- green building and smart building.
Introduction to Engineering Mechanics- Resolution of forces- Varignon's – couples- Lami's theorem-
Centroid and Moment of Inertia- Determination of moment of inertia of simple planar laminas like rectangle- triangle-quarter-semi-circle and circle. Theorems of perpendicular and parallel axis-polar moment of inertia- radius of gyration.

UNIT 2. SIMPLE AND COMPOUND STRESSES AND STRAIN **14 Hrs.**

Introduction to stresses and strain – Stress-strain diagram- Elastic constants -relationship between elastic constants and Poisson's ratio – Generalised Hook's law – Strain energy – Deformation of simple and compound bars – thermal stresses. Biaxial state of stress – Stress at a point – stresses on inclined planes – Principal stresses and Principal strains and Mohr's circle of stress, Theories of failure

UNIT 3 SFD- BMD AND STRESSES IN BEAM **12 Hrs.**

Types of beams- Cantilever, Simply supported, Overhanging: Shear Force and Bending Moment Diagrams Theory of simple bending – bending stress and shear stress in beams.
Deflection of beams by Double integration method – Macaulay's method – Area moment theorems for computation of slopes and deflections in beams – Conjugate beam method.

UNIT 4 TORSION AND COLUMNS **12 Hrs.**

Introduction to Torsion – derivation of shear strain – Torsion formula – stresses and deformations in circular and hollow shafts – Stepped shafts – shafts fixed at the both ends – Stresses in helical springs. Theory of columns – Long column and short column – Euler's formula – Rankine's formula - Secant formula - beam column.

Total 52 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 –**Describe** the basics and scope of civil engineering, role of civil engineer and sub branches of civil engineering.

CO2 -**Compute** the stress and strain developed due to applied load in any structural member and solve the principal stress & strain at a point of stressed member.

CO3 – **Calculate** the shear force & bending moment diagram under various loading & support condition.

CO4 - **Analyze** bending and shear stresses in the different layers of the beam for various loadings.

CO5 - **Determine** the torsion equation & pure torsion

CO6 - **Explain** the loaded structural members for deflection.

TEXT/REFERENCE BOOKS

1. N.H Dubey, Engineering Mechanics-Statics and Dynamics, Tata McGraw Hill Private limited
2. R. S. Khurmi, Engineering Mechanics, S. Chand Publication
3. S.S. Bhavikatti Elements of Civil Engineering (IV Edition) , Vikas Publishing House Pvt. Ltd., New Delhi.
4. Ferdinand P Beer and E Russel Johnson , Mechanics for Engineers (Statics & Dynamics) McGraw Hill book company, New York
5. Timoshenko and Gere, Mechanics of Materials, CBS Publishers, New Delhi, 1996
6. S. B. Junarkar and Dr. H. J. Shah, Mechanics of Structures, 27th Revised and Enlarged, Charotar Publication.
7. Beer and Johnston, Mechanics of Materials, McGraw Hill International

END SEMESTER EXAMINATION QUESTION PATTERN

Max. Marks: 100 **Exam Duration 3 Hrs.**

Part A: 4 Question from unit-1 – 5 Marks Each 20 Marks

Part B: 8 Numerical Questions from unit 2 to unit 4 – 10 Marks Each 80 Marks

20CE101P					Elements of Civil Engineering & Solid Mechanics Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
-	-	2	1	2	-	-	-	25	25	50

COURSE OBJECTIVES

- To conduct standard tests on construction steel under static load.
- To conduct standard tests on metals under impact load
- To conduct standard tests of flexure and compression on wooden items.
- To conduct standard tests of crushing, impact and abrasion on bricks and tiles.

LIST OF EXPERIMENTS

2. Tension test on mild steel
3. Compression test of ms bar/cost iron
4. Bending test on wooden beam / Steel bars
5. Shear test on steel bar
6. Hardness test
7. Charpy impact test
8. Izod impact test
9. Compression test of on bricks
10. Flexural test on clay roof tiles

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – **Define** the standard tests of mild steel under tension, compression & shear.
CO2 – **Compute** and use the Charpy impact testing machine to evaluate the performance of metal under impact load.
CO3 – **Compute** Rockwell hardness testing machine to determine the hardness of metals
CO4 – **Illustrate** modulus of rupture of timber and steel bar.
CO5 – **Determine** the compressive and bending strength of clay items.
CO6 – **Explain** the crushing, impact and abrasion values of bricks.

R**EFERENCES:**

1. S. B. Junarkar and Dr. H. J. Shah, Mechanics of Structures, 27th Revised and Enlarged, Charotar Publication.
2. Beer and Johnston, Mechanics of Materials, McGraw Hill International

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3Hrs**

Part A : Lab Work – Continuous Assessment 50 Marks
Part B : Lab Exam and Viva 50 Marks

20EE101T					Elements of Electrical Engineering					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To impart knowledge on DC and AC circuits.
- To learn construction, working principles and characteristics of transformer and induction machines.
- To introduce students to various means for electrical safety and protection of electrical installations.
- To impart knowledge on electric wiring and illumination for domestic and industrial applications.

UNIT 1: DC CIRCUITS **10 Hrs.**

Electrical circuit elements (R, L and C), voltage and current sources, dependent and independent sources, Ohms Law, temperature co-efficient of resistance, Kirchhoff current and voltage laws, voltage and current divider circuit, Thevenin and Norton Theorems and their equivalents, maximum power transfer and superposition theorems, nodal and mesh analysis, star-delta transformation, Time domain analysis/natural response of first order RL and RC Circuit

UNIT 2: AC CIRCUITS **10 Hrs.**

Generation of AC voltage, representation of sinusoidal waveforms, rms values of different sinusoidal waveforms, Rectangular and Polar representation of phasor, Sinusoid representation in time and frequency domain. of Analysis of single-phase ac series circuits consisting of R, L, C, RL, RC, RLC combinations, instantaneous, average power and reactive power, complex power and power factor. AC parallel circuit and its solution in admittance form, resonance in AC series circuit and parallel circuit. Polyphase circuits, star and delta representation of polyphase circuit, power measurement in polyphase circuit

UNIT 3: TRANSFORMERS AND INDUCTION MACHINES **10 Hrs.**

Magnetic material and its B-H characteristic, Faraday's Law of Electromagnetic Induction **Transformers:** ideal transformer, emf equation for transformer, working of practical transformer on no-load and load **Induction Machine:** Types of induction motor, production of rotating magnetic field from 3-phase supply, operation of three phase induction motor, starting and running torque, Torque-slip characteristics of induction motor, Power Stages in IM

UNIT 4: ELECTRICAL INSTALLATION, SAFETY AND PROTECTION **10 Hrs.**

Fuse, MCB, ELCB, MCCB, underground cables. Domestic and Industrial Wiring. Types of lamps, illumination schemes and lumen requirement for domestic and industrial applications, Earthing and it schemes. Electrical safety rules, electric shock and first aid, energy conservation methods, elementary calculation of energy consumptions, tariffs

Max Hrs: 40

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Analyze electrical circuits using network theorems.
CO2 – Compare the behavior of R, L and C and their combinations in AC circuits.
CO3 – Analyze balanced polyphase systems in star and delta configuration
CO4 – Understand the construction, working and basic characteristics of transformer and induction machines
CO5 – Recognize the importance of protective devices and electrical safety measures
CO6 – Carry out domestic and industrial electrification

TEXT/REFERENCE BOOKS

1. J. Bird, "Electrical Circuit Theory and Technology", Routledge, Tailor and Francis Group, Sixth Edition, 2017.
2. D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
3. B. L. Theraja, "Electrical Technology", Vol. 1, S. Chand Publication, New Delhi
4. Surjit Singh, "Electrical Estimating and Costing", Dhanpat Rai and Co.

20EE101P					Elements of Electrical Engineering - Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	-	-	-	25	25	50

COURSE OBJECTIVES

- To gain practical knowledge on DC and AC circuits
- To learn operation of electrical instruments and electrical machines
- To develop skills to implement electric wiring

LIST OF EXPERIMENTS

1. Introduction to elements of electrical engineering laboratory and to study different electrical measuring instruments
2. To validate Ohm's law with linear resistors and find power dissipation in resistor
3. To implement voltage divider and current divider circuit
4. To validate Thevenin and Norton theorem for DC circuit
5. To validate Superposition and Maximum Power Transfer theorem for DC circuit
6. To obtain transient response of RL and RC circuit
7. To evaluate performance of AC series circuit
8. To evaluate performance of AC parallel circuit
9. To analyse resonance condition in AC circuit
10. To establish relation between line and phase quantities in star and delta connected polyphase system
11. To measure power in polyphase system
12. To perform load test on 1-phase transformer
13. To perform load test on 3-phase transformer
14. To obtain current time characteristic for domestic protective devices
15. To carry out domestic electric wiring

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Operate basic electrical measuring instruments

CO2 – Simulate the basic electrical circuits and obtain results based on electrical laws and network theorem

CO3 – Understand the performance of AC circuit with different connection of R, L and C

CO4 – Formulate star and delta configuration of polyphase system and measure power in polyphase system

CO5 – Operate transformer and induction machines and evaluate its performance

CO6 – Understand the basic wiring and operation of protective devices for domestic application

20PH101T					Engineering Physics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To understand basic concepts of quantum mechanics and solve the Schrödinger equation for various cases.
- To understand basics concepts of electric and magnetic properties of solids.
- To develop the fundamental understanding of optoelectronic devices.
- To understand the heat transfer mechanism in solids and fluids.

UNIT 1 Introduction to Quantum Mechanics **12 Hrs.**

Inadequacies in Classical Physics, Wave Nature of Matter, Heisenberg's Uncertainty Principle and its applications, zero point energy, Basic Postulates and Formalism of QM: Energy, Momentum and Hamiltonian Operators. Time-independent Schrodinger Wave Equation for Stationary States. Properties and interpretation of Wave Function. Probability Density and Probability. Conditions for Physical Acceptability of Wave Functions, Application of time-independent Schrödinger equation for various potentials.

UNIT 2 Electronic theory of Solids **10 Hrs.**

Elements of crystallography; lattice vibrations of solids; Bloch Theorem and Origin of energy bands, band structure of conductors, type of semiconductors, Free Electron Theory of metals, Wiede-mann Franz Law, Kronig-Penny model, Hall effect. Magnetism and its origin, magnetization and susceptibility, dia-para-ferro-magnetism. Ferromagnetism, Nano magnets and magneto resistance, hard disk drive storage technology. Phenomenology of Superconductors, Meissner effect, BCS theory - high temperature superconductors.

UNIT 3 OPTICS, LASER AND OPTO-ELECTRONICS **08 Hrs.**

Optics: Introduction, division of amplitude, thin film interference, Applications of interference, Laser: The Einstein coefficients, Spontaneous and stimulated emission, Optical amplification and population inversion, meta stable state, optical resonator, the principle of pumping scheme, laser beam characteristics. Types of LASER, Injection Laser Diode (ILD). Quantum Cascade Laser, Comparison between ILD and QCL. Applications of lasers.

UNIT 4 THERMAL PHYSICS **10 Hrs.**

Laws of thermodynamics-basic concepts, closed and open systems-first law. Heat transfer-thermal expansion of solids and liquids –Conduction in solids – thermal conductivity- Forbe's method, Lees' disc method, conduction through compound media, formation of ice on ponds, thermal insulation and its applications. Thermal Convection - properties of radiant heat, sea and land breeze. Thermal Radiation – emission and absorption radiation, emissive power, black body radiation – Kirchoff's, Stefan's laws, wien's law, Newton's law of cooling.

Max. 40 Hrs.

COURSE OUTCOMES

CO1 – Identify and understand the experimental results which require conceptualization of quantum theory.
CO2 – Interpret the solution of Schrödinger equation to obtain physical information about the system.
CO3 - Identify basic concepts in semiconductors, superconductors and magnetism and apply it in engineering applications.
CO4 - To understand concepts of optical interference and LASER, analyse the lasing characteristics to apply in different laser diodes and other applications
CO5 - To understand concepts of thermal physics in terms of laws and modes of heat transfer.
CO6 - To apply knowledge of concepts of engineering physics to solve real world problems.

TEXT/REFERENCE BOOKS

1. N. Zettili, Quantum Mechanics: Concepts and applications, Willey Publications
2. Kittel, Charles. Introduction to Solid State Physics. John Wiley and Sons.
3. W.D. Callister and David Rethwisch, Materials Science & Engineering -An Introduction, 9th edn.,
4. Heat and Thermodynamics BrijLal, N. Subrahmanyam, S. Chand, Limited, 2001.
5. Optics by Ajay Ghatak, Tata macgraw hill publishing.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part A/Question: 3 Questions from each unit, each carrying 3 marks	36 Marks
Part B/Question: 2 Questions from each unit, each carrying 8 marks	64 Marks

20PH101P					Engineering Physics - Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	Viva	
0	0	2	1	2	-	-	-	50	50	100

COURSE OBJECTIVES

- To understand the working of various electrical, mechanical and optical instruments in the laboratory.
- To gain practical knowledge in Physics through experiments.
- To understand basics concepts of Physics and be able to apply in performing the experiments.

List of Experiments

1. Introduction to Oscilloscope.
2. Study of Interference using Newton's Ring experiment.
3. Determination of thermal conductivity of different solids.
4. Experiment with solar collector.
5. Experimental to determine linear thermal expansion coefficient of solid bodies.
6. Experiment on reflection of Ultrasonic waves.
7. Experiments with heat pump.
8. Determining Plank's constant and Inverse square law.
9. Experiments on diffraction with He-Ne Laser Kit.
10. Study of Hall Effect.
11. Determining semiconductor energy band gap using four probe method.
12. Experiment to study forced oscillations.
13. Study of charging and discharging of capacitive plates.
14. Study of Bio-Savart's Law
15. Experiments on Fiber Optics.
16. Study of Photoconductivity.
17. Determining e/m by Thomson's method.
18. Study of Polarization of light using LASER.
19. Millikan's oil drop experiment.
20. Study of Holography.

** Any 10 experiments will be conducted relevant to theory course.

COURSE OUTCOMES

On completion of the course, the students will be able to

CO1 - Apply and analyze the concepts of electricity and magnetism.
CO2 - Understand the interaction of light waves and its propagation in different media.
CO3 - Demonstrate and implement the phenomenon of resonance
CO4 - Investigate the electrical properties of a given semiconductor device
CO5 - Examine the charge transport mechanism in different conductors
CO6 - Design and analyze the light propagation for communication application using fibre optics

TEXT/REFERENCE BOOKS

1. Ghatak, Optics, 3rd edition, Tata McGraw Hill (2005).
2. Kittel, Knight and Ruderman, Mechanics - Berkeley Physics Course, Vol. 1, Tata McGraw-Hill.
3. Avadhanulu, A text book of engineering Physics, S. Chand & Company, Ltd.
4. Brij Lal, N. Subrahmanyam, Heat and Thermodynamics, S. Chand & Company, Ltd
5. Halliday, Resnick, Walker, Fundamentals of Physics (Wiley)

Evaluation Pattern

Max. Marks: 100

Continuous evaluation	50 marks
End semester examination and Viva-voce	50 marks

16ME103P					Workshop Practice		
Teaching Scheme					Examination Scheme		
L	T	P	C	Hrs/Week	Practical		Total Marks
					Continuous Evaluation	End Semester	
-	-	2	1	2	25	25	50

COURSE OBJECTIVES

- To impart the machining skills in students
- To develop a skills in precision, safety at work place, team working with right attitude
- To prepare a job by using ability to design and model different prototypes.

Metrology

Semi-Precision tools: Rules and scales, try square. Inside/Outside Calipers, Depth gages etc. Precision Tools: Micrometers, Vernier calipers, Bevel Protractor, Dial indicator, Gage blocks, Surface plates etc.

Carpentry Shop

Timber, Seasoning and Preservation, Plywood and Ply boards, Carpentry Tools, Engineering applications. Different Joints

Bench work and Fitting

Introduction to the familiarization with tools and their uses, Hammers, Hacksaws, choice of blades & sawing techniques, Files with their classification; According to their longitudinal shape & cross section, classification based on cuts; teeth; length of the file, Care of files and hand tool safety rules Vices & their classification, Other hand tools; scribers, chisels, scrapers, center, punch, surface gauge, Universal cribbing block, Trammel, Screw drivers, Drills, Spanners, Pliers, Taps, Dies, Reamers, Screw drivers etc, Fitting Processes : Marking, Chipping, Sawing, Filing, Scrapping, Drilling, Internal Threading (or Trapping), External Threading (or Dieing), Reaming, welding, soldering, brazing

Tin Smithy – Surface development

Shearing and Bending of sheets, Making simple products by Tin Smithy practice.

List of Experiments:

1. Introduction to Workshop and safety.
2. Experiment on measurement of linear, angular and curved dimensions of the object.
3. Fitting job: Detailed drawing of work piece, use of fitting tools and job preparation.
4. Hands on experience on welding, brazing and soldering.
5. Carpentry job: Detailed drawing of work piece, use of carpentry tools and job preparation.
6. Sheet metal job: Detailed drawing of work piece, use of sheet metal working tools and job preparation.
7. Plumbing job: Internal/External threading, piping network using Tees, Elbows, Reducer, Bends etc

COURSE OUTCOMES

CO1: Define fundamentals and principles cutting and enhance the machining skills in students

CO2: Apply principles of machining and develop a skills in dignity of labour, precision, safety at work place, team working and development of right attitude

CO3: Analyse the effect design and model different prototypes in carpentry

CO4: Examine the effect and create and develop ability to design and model different basic prototypes in trade of fitting

CO5: Determine the effect and create and develop ability to design and model different basic prototypes in trade of tin smithy

CO6: Evaluate the performance of different machining and cutting processes such as fitting, carpentry, plumbing etc.

Evaluation Pattern

Max. Marks: 50	**Exam Duration: 2 Hrs**
Continuous evaluation	25 marks
End semester examination and Viva-voce	25 marks

20CP102P					Fundamentals of Python Programming					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

- To impart the basic concepts of Python Programming language
- To be familiar with data structures available in Python
- To understand testing and debugging in Python
- To draw different kinds of plots using for scientific research

INTRODUCTION TO PYTHON

The basic elements of Python, Branching programs, Strings and Input, Iteration

FUNCTION, SCOPING AND ABSTRACTION

Functions and Scoping, Specifications, Recursion, Global variables, Modules, Files

TESTING AND DEBUGGING

Testing, Debugging

STRUCTURED TYPES, MUTABILITY AND HIGHER-ORDER FUNCTIONS

Tuples, Lists and Mutability, Functions as Objects, Strings, Tuples and Lists, Dictionaries

EXCEPTIONS AND ASSERTIONS

Handling exceptions, Exceptions as a control flow mechanism, Assertions

SOME SIMPLE ALGORITHMS AND DATA STRUCTURES

Search Algorithms, Sorting Algorithms, Hashtables

PLOTTING

Plotting using PyLab and extended examples

COURSE OUTCOMES

On completion of the course, student will be able to

CO1- Understand the basic concept of programming with python.
CO2- Understand the basics of creating applications.
CO3- Apply various data structures available in Python in solving computational problems.
CO4- Create robust applications for solving computational problems using the Python.
CO5- Test and debug applications written using the Python.
CO6- Draw different kinds of plots using PyLab and generating series.

TEXT/REFERENCE BOOKS

1. John V Guttag. “Introduction to Computation and Programming Using Python”, Prentice Hall of India.
2. Allen Downey, Jeffrey Elkner and Chris Meyers "How to think like a Computer Scientist, Learning with Python", Green Tea Press.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 50 **Exam Duration: 2 Hrs**

Part A/Question: QUIZ/VIVA 25 Marks
Part B/Question: PRACTICAL PERFORMANCE 25 Marks

20HS101P					Communication Skills – I (Semester I/II) (First Year)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	0	2 hours per week	--	--	--	50	50	100

COURSE OBJECTIVES

- Understand of the fundamental elements of communication in English language.
- Know and understand different practices of verbal and non-verbal communication with inputs to improve basic language skills.
- Students are expected to be better equipped in the following areas:
  - **Listening:** Understanding basic content in lectures and common everyday situations
  - **Speaking:** Correct expression in the English language at a basic level
  - **Reading:** Understanding, retaining, and critically analyzing technical/non-technical content
  - **Writing:** Using appropriate vocabulary, grammar, effective paragraph construction, writing in day-to-day scenarios, including digital platforms

UNIT 1 **21 hrs**

- Structure of English Language, Academic, Research and Technical Vocabulary, Phonetics and Accent

UNIT 2 **3 hrs**

- Listening Skills, Note Taking and Note Making, Collective note-taking and note-making on digital platforms

UNIT 3 **3 hrs**

- Reading: Reading Comprehension, Speed Reading

UNIT 4 **3 hrs**

- The art of introducing oneself, Public speaking and articulation

Max. 30 hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

- CO1 Confidence to listen, speak, read and write in English
- CO2 Being able to produce something new with the help of inputs
- CO3 Learning to critically analyze
- CO4 Preparing reports/critique with the help of collected data
- CO 5 Having a multi-dimensional/disciplinary perspective and approach
- CO6 Better improved and sharpened skills to present, convince and persuade to be an effective and successful professional

TEXT/REFERENCE BOOKS

1. Harmer, Jeremy. The Practice of English Language Teaching. Harlow: Pearson Longman, 2007.
2. Kaul, Asha. Business Communication. Delhi: Prentice-Hall of India, 2006.
3. Maley, A. 'Literature in the Language Classroom', The Cambridge Guide to Teaching ESOL, Cambridge University Press, 2001.
4. Richards, Jack C., and Willy A. Renandya, eds. Methodology in Language Teaching: An Anthology of Current Practice. Cambridge University Press, 2002.
5. Sharma, Sangeeta and Binod Mishra. Communication Skills for Engineers and Scientists. New Delhi: PHI Learning Pvt. Ltd., 2009.

Assessment Tool	Marks	Assignments
Lab Work	50	• Listening and Questionnaire – 15 • Grammar Worksheet – 20 • Short Story/Essay (750 – 1000 words) – 05 • Reading Comprehension – 10 • Wordsworth – 10
Lab Exam/Viva	50	• Narrating a Story along with Self Introduction/Speech – 15 • Reading Aloud – 05 • Vocabulary/Phonetics – 20

16HS109T					Professional Ethics and Human Values					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
1	0	0	1	1	25	50	25	--	--	100

COURSE OBJECTIVES

- Identify the core values that shape the ethical behaviour of an Engineer
- Awareness on professional ethics and human values
- To know their role in technological development
- To appreciate the rights of others
- Improved communication and learn to work in group
- Learn to understand and discuss on issues of social interest

Unit 1: Human Values [5 hrs]

Morals, Values and Ethics - Integrity - work Ethic - Service Learning - Civic Virtue - Respect for others - Living peacefully - Caring - Sharing - Honesty - Courage - Valuing time - Co-operation - Commitment - Empathy - Self-Confidence - Character - Spirituality

Unit 2: Engineering Ethics [4 hrs]

Sense of 'Engineering Ethics' - Variety of moral issued - types of inquiry - moral dilemmas - moral autonomy - Kohlberg's theory - Gilligan's theory - Consensus and controversy - Models of Professional Roles & Professionalism - theories about right action - Self-interest - customs and religion - uses of ethical theories.

Unit 3: Engineering as experimentation [4 hrs]

Engineers as responsible experimenters - Research ethics -Codes of ethics - Industrial Standard - Balanced outlook on law - the challenger case study.

Unit 4: Safety, risk and Global issues [5 hrs]

Safety and risk - assessment of safety and risk - Risk benefit analysis and reducing risk - Threat of Nuclear power - Collegiality and loyalty - respect for authority - Confidentiality - conflicts of interest - professional rights - employees' rights - Intellectual Property rights (IPR) - discrimination. Multinational corporations - Business ethics - Environmental ethics - Role in Technological Development - Weapons development - consulting engineers - engineers as expert witnesses and advisors-Ethics.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Find the core values that shape the ethical behaviour of an Engineer
CO2: Students will get aware of the professional ethics and human values
CO3: Develop and understand their role in technological development
CO4: Simplify to the rights of others
CO5: Perceive improved communication with activities and learning to work in group
CO6: Discuss on issues of social interest and make opinions based on logical reasoning

TEXT/REFERENCE BOOKS

1. A Textbook on Professional Ethics and Human Value by Prof. R. S. Nagaarazan, New Age International Limited Publisher, Chennai. 2006
2. A Text book on Professional Ethics and Human Values by M. Govindarajan, S. Natarajan, V. S. Senthilkumar, PHI Learning Pvt. Ltd., 2013.
3. A Text book on Professional Ethics and Human Values by Dinesh Babu, Firewall Media, 2007

16TP110					Civic Services & Social Internship					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
			01	21 days	--	--	--	--	--	100

COURSE OBJECTIVES

- To develop a holistic view of social work and social welfare in the community, with special emphasis on the role of different agencies like Govt. departments and NGOs in human services.
- To enlighten and sensitize students on various types of problems of the people and their diversified cultural background.
- To understand the agency as an organization, its structure, functions, activities and sources of funding.
- To understand and make a commitment to the basic humanistic values and principles of social work practice in a secular democratic society.
- To develop an understanding of the application of the methods of social work practice in the field.
- To develop an understanding of the opportunities in working with diverse populations.
- To develop the self –awareness necessary to assess one's own values, attitudes, feelings, strengths, limitations, and interests and performance.
- To inspire young technocrats to become change makers

UNIT 1: Overview of Civic and Social Service Sector

UNIT 2: Understanding of NGO/Civic Body/Government Body Management and their functioning

UNIT 3: Study of Individual organizational and government projects and schemes where students are interning

UNIT 4: Field visits

COURSE OUTCOMES

On completion of the course, student will be able to

CO1- Become sensitized workforce of enlightened Engineers and Managers who are socially concerned and willing to positively contribute to the society

CO2- Acquire desired work habits and attitudes with the sense of social responsibility and think innovatively to find solutions

CO3- Understand the role of different NGO/civic/government bodies in the service of citizens

CO4- Imbibe basic humanistic values and principles of social work practice in a secular democratic society

CO5- To assess one's own values, attitudes, feelings, strengths, limitations, interests and performance through opportunities of working with diverse populations

CO6- Obtain experiential learning via internship and be sensitive towards issues of modern-day citizenship and democracy

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100

Part A: NGO evaluation 50 Marks

Part B: Internal faculty 50 Marks

UG Curriculum-2020
of
B. Tech. in Automobile Engineering

School of Technology

Pandit Deendayal Energy University

Program Educational Objectives (PEOs)

1. To prepare the graduates with strong foundation in science and engineering for successful careers in core mechanical and interdisciplinary industries, higher education and research.
2. To prepare graduates who can become entrepreneur/innovators to design and develop system/process/product/service to address social and industrial challenges.
3. To prepare graduates with leadership qualities, strong communication skills, professional and ethical values.
4. To prepare lifelong learners graduates to excel in their professional career as well as to pursue higher education.

Program Outcomes (POs)

13. **Engineering knowledge:** An ability to apply knowledge of mathematics, science, and engineering in solving/analyzing problems in industries, research and development institutions, public sector units, higher education and in academia.
14. **Problem Analysis:** An ability to design and conduct experiments, as well as to analyze and interpret data in mechanical engineering theory and practice at various industrial work-places.
15. **Design/ Development of solutions:** An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, health and safety, manufacturability, and sustainability.
16. **Multidisciplinary Approach:** An ability to function on multidisciplinary teams.
17. **Modern tool usage:** An ability to identify, formulate, and solve engineering problems using modern tools and techniques.
18. **Communication:** An ability to communicate effectively.
19. **The Engineer and Society:** The broad education necessary to understand the impact of mechanical engineering solutions in a local, global, economic, environmental, and societal context.
20. **Life-long learning:** A recognition of the need for, and an ability to engage in life-long learning.
21. **Investigations of complex problem:** Use of Applied research including design of experiments, analysis and interpretation of data, synthesis of the information to provide valid solutions with the knowledge of contemporary issues.
22. **Project Management:** An ability to apply engineering knowledge and management principles skills to manage engineering projects.
23. **Environment and Sustainability:** An ability to design sub-systems, systems, components and processes to fulfil demand of environmental sustainability.
24. **Ethics:** Apply engineering principles toward the professional values and ethics.

Program Specific Outcomes (PSOs)

4. To **analyze the problems** and **create solution** by applying engineering knowledge with a multidisciplinary approach in the area of vehicle function, vehicle design and vehicle performance.
5. To analyze, interpret and provide solutions for the technical challenges faced by the Automobile Industry **using engineering software/tools.**
6. **To work effectively in a team** to address **complex issues** by engaging in **lifelong learning** and following **ethical and environmental** practices.

Proposed Course Structure of B. Tech. in Automobile Engineering

COURSE STRUCTURE FOR B.TECH. SECOND YEAR (Automobile Engineering)

SEMESTER III (Subjects)				B.TECH. SECOND YEAR (Automobile Engineering)											
Sr. No.	Category Code	Course Code	Course Name	Teaching Scheme					Exam Scheme						
									Theory			Practical		Total Marks
				L	T	P	C	Hrs/wk	CE	MS	ES	CE	ES	
1	BSC	20MA202T	Mathematics-III	3	1	0	4	4	25	25	50	-	-	100
2	PCC	20AE201T	Thermodynamics and Fluid Flow	3	0	0	3	3	25	25	50	-	-	100
3	PCC	20AE201P	Thermodynamics and Fluid Flow- Lab	0	0	2	1	2	-	-	-	25	25	50
4	PCC	20ME202T	Strength of Material	3	0	0	3	3	25	25	50	-	-	100
5	PCC	20ME202P	Strength of Material - Lab	0	0	2	1	2	-	-	-	25	25	50
6	PCC	20ME203T	Mechanical Measurements and Metrology	3	0	0	3	3	25	25	50	-	-	100
7	PCC	20ME203P	Mechanical Measurements and Metrology - Lab	0	0	2	1	2	-	-	-	25	25	50
8	PCC	20AE202P	Geometric Modelling Lab	0	0	4	2	4	-	-	-	25	25	50
9	OE	20AE203T	Open Elective – I: Automotive Chassis and Components	3	0	0	3	3	25	25	50	-	-	100
10	HSC	20HS201P	Communication Skills - II	0	0	2	1	2	-	-	-	50	50	100
			Total	**15**	**1**	**12**	**22**	**28**						

CE = Continuous Evaluation MS = Mid Semester Exam ES = End Semester Exam

20MA202T					Mathematics-III					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

- To apply Fourier analysis for solving applications in mechanical and other engineering branches.
- To familiarize students with a variety of engineering problems that can be handled by special functions where the analytical methods fail.
- To provide a broad coverage of various mathematical techniques that are widely used for solving and to get analytical solutions to partial differential equations of first and second order.
- To introduce different techniques to develop first or second order partial differential equations and their solution in variety of Mechanical fields.

UNIT 1 FOURIER SERIES AND APPLICATIONS IN MECHANICAL ENGINEERING **10 Hrs.**

Periodic functions, odd and even functions, Euler's formulae for Fourier series in an interval of length 2 pi, change of interval, Dirichlet's conditions, half range Sine and Cosine series, complex Fourier series, Parseval's identity and its applications in Mechanical Oscillations, Applications of Fourier Series in Periodic variation of gas pressure in a 4-stroke internal combustion engine Or the study of Crank rotation in respect of Fourier Series.

UNIT 2 SPECIAL FUNCTIONS **10 Hrs.**

Power series method to solve the differential equation, Frobenius method for solution near regular-singular points, Legendre's equation, Legendre Polynomials, Rodrigue's formula, Bessel's equation, orthogonality conditions and generating functions for Legendre and Bessel's equations.

UNIT 3 PARTIAL DIFFERENTIAL EQUATIONS OF FIRST ORDER **10 Hrs.**

Formation of Partial Differential Equations (PDEs), Solutions of PDEs of first order, Cauchy problem for first order PDEs, Lagrange's method, Charpit and Jacobi methods for solving first order nonlinear PDEs

UNIT 4 PARTTIAL DIFFERENTIAL EQUATIONS OF SECOND ORDER WITH APPLICATIONS **10 Hrs.**

Classification of second order PDEs, method of separation of variables, Fourier series solutions of one-dimensional wave equation, one dimensional heat equation, steady state solution of two-dimensional heat equation, applications of PDEs to string and rod problems pertaining to Mechanical Systems

40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – **Identify** the role of periodic functions in real world problems.
CO2 – **Understand** the various techniques to analyze the behavior of different Mechanical periodic systems such as 4 – stroke engines.
CO3 – **Solve** the differential equations which are not solvable by analytical methods known so far and thus develop a skill to look for alternatives.
CO4 – **Discuss** the role of partial derivatives in engineering problems where multiple factors affect the system.
CO5 – **Evaluate** physical problems involving partial derivatives.
CO6 – **Develop** the ability to model the physical systems in terms of the methods learnt in this course and then solve accordingly.

TEXT/REFERENCE BOOKS

1. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons 10th Edition, (2016)
2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers 44th Edition, (2017)
3. R.K. Jain & S.R.K. Iyengar, Advanced Engineering Mathematics, 3rd Ed., Narosa Publishing House, (2002).
4. Tai-Ran Hsu, Applied Engineering Analysis, John Wiley & Sons, (2018)
5. K. S. Rao: Introduction to Partial Differential Equations, PHI Learning Pvt Ltd, New Delhi, (2010)
6. T. Amaranath: An Elementary Course in Partial Differential Equations, Narosa Publishing House, New Delhi, (2003)

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs.**
Part A: 6 questions 5 marks each	30 Marks (60 min)
Part B: 5 questions 8 marks each	40 Marks (80 min)
Part C: 2 questions 15 marks each	30 Marks (40 min)

20AE201T					Thermodynamics & Fluid Flow					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
4	0	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

- **To introduce and define the basics concept of thermodynamics.**
- **To familiarize the concepts of entropy, reversibility, irreversibility and thermodynamic relations.**
- **To enable the students to understand the details about the properties of steams, vapour processes and vapour cycles.**
- **To understand the fluid properties and principles of fluid statics.**

UNIT 1 Entropy and Fuels & Combustion **14 Hrs.**

Review of the basics of Thermodynamics: Review of Zeroth, First and Second Law of Thermodynamics. Concept of Reversibility & reversible cycle. Entropy, Clausius inequality, principle of increase of Entropy.

Fuels and Combustion**:** Combustion theory, Combustion Equations Theoretical, excess air and equivalence ratio. Analysis of products of combustion Calorific value – HCV & LCV., Enthalpy of formation and enthalpy of combustion, first and second law analysis of reacting systems.

UNIT 2 Exergy analysis and Thermodynamic relations **14 Hrs.**

Availability: Available and unavailable energy, concept of availability, availability of heat source at constant temperature and variable temperature (Numerical) Availability of non-flow and steady flow systems, Helmholtz and Gibbs function, irreversibility and second law efficiency.

Thermodynamic Relations: Different relationship for systems of constant composition, Helmholz and Gibb's function, variable specific heat, Joule-Kelvin coefficient, Clausius- Clapeyron equation Ideal Gas mixtures.

UNIT 3 Power generation Cycles **16 Hrs.**

Properties of Steam and Vapor Processes: Formation of steam, Properties of steam, Use of Steam Tables and Mollier diagram for steam. Study of steam calorimeters (Separating, Throttling and combined).

Vapour Power Cycles: Comparison of Carnot cycle and Rankine cycle, Efficiency of Rankine cycle, Relative efficiency, Effect of superheat, boiler and condenser pressure on performance of Rankine cycle. Reheat & Regenerative cycle (no numerical).

Gas power cycles: Introduction to Carnot cycle, Otto cycle, Diesel cycle, Dual cycle, Brayton, Ericssion, and Stirling cycle**.**

UNIT 4 Fluid Statics **16 Hrs.**

Introduction to Continuum, Force, Stress, Strain, Types of fluids, Fluid Properties, Newton's law of viscosity, Compressibility and vapor pressure, Fundamental Concepts: Fluid flow definition (Eulerian vs. Langrangian). Fluid Statics: Hydrostatic law, Pascal's law, Pressure at a point, Total Pressure, Centre of pressure, Pressure on a plane (Horizontal, Vertical, Inclined) & Curved surfaces, Archimedes Principle , Buoyancy and stability of floating and submerged bodies, Meta-centric height

Max. 60 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Define the different laws of thermodynamics and illustrate the concepts of fuels and combustions.
CO2: Explain the concept of exergy and energy analysis of systems.
CO3: Apply the thermodynamics relations for different gases.
CO4: Analyze the thermodynamic processes using steam tables and Mollier diagrams.
CO5: Evaluate different types of gas power cycles and assess the performance of Rankine power cycle.
CO6: Discuss the properties of fluids, principles of buoyancy, stability conditions and principles of fluid statics

TEXT/REFERENCE BOOKS

1. Yunus A. Cengel & Bole, Thermodynamics- Engineering Approach by Tata Mcgraw Hill, 9th edition, 2019.
2. P. K. Nag, Engineering Thermodynamics, Tata Mcgraw Hill, New Delhi.
3. F. White, Fluid Mechanics, Tata-McGraw Hill publishers, 7th edition, 2011.
4. Yunus A. Cengel & John Cimbala, Fluid Mechanics: Fundamentals and Applications by Tata Mcgraw Hill, 4th edition, 2017.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part A/Question: 6 Questions from all units, each carrying 10 marks 60 Marks
Part B/Question: 4 Numerical Questions from all units, each carrying 10 marks 40 Marks

20AE201P					Thermodynamics and Fluid Flow Lab.					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES

- **To understand the working principle and operations of reciprocating compressor and bomb calorimeter.**
- **To use engineering equation solver for problem solving and analysis.**
- **To understand the working principle and operations of diesel engine**
- **To study different types of calorimeter and principles of steam power plants.**
- **To understand the principle of Bernoulli's theorem**

List of Experiment

1. Introduction to reciprocating air compressor.
2. Performance test on Reciprocating air compressor.
3. To calculate the calorific value of a liquid fuel by bomb calorimeter.
4. To study the working of single cylinder diesel engine and analyze by Engineering Equation Solver (EES).
5. Load test on four stroke single cylinder diesel engine.
6. Heat balance test on four stroke single cylinder diesel engine.
7. Measurement of dryness fraction by Separating Calorimeter, Throttling Calorimeter, Separating and Throttling Calorimete
8. To study a steam power plant cycle.
9. To verify the Bernoulli's theorem.
10. To determine the meta-centric height of a floating body.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Define working principle of reciprocating air compressor and summarize the performance characteristics of reciprocating air compressor.

CO2: Identify the calorific value of a substance by using bomb calorimeter.

CO3: Analyze the performance of single cylinder diesel engine using Engineering Equation solver.

CO4: Examine the performance characteristic of single cylinder four stroke diesel engine and determine the performance of heat balance sheet.

CO5: Discuss the steam power plant cycle and separating and throttling calorimeters.

CO6: Evaluate the validity of Bernoulli's theorem.

TEXT/REFERENCE BOOKS

1. Yunus A. Cengel & Bole, Thermodynamics- Engineering Approach by Tata Mcgraw Hill, 9th edition, 2019.
2. P. K. Nag, Engineering Thermodynamics, Tata Mcgraw Hill, New Delhi, 2nd edition, 2013.
3. F. White, Fluid Mechanics, Tata-McGraw Hill publishers, 7th edition, 2011.
4. Yunus A. Cengel & John Cimbala, Fluid Mechanics: Fundamentals and Applications by Tata Mcgraw Hill, 4th edition, 2017.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Lab work	50 Marks
Lab viva/ exam	50 Marks

20ME202T					Strength of Material					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs. / Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To impart the knowledge of fundamental concepts of stresses and strains.
- To obtain the analytical and graphical solutions of principle stress and strain.
- To get acquainted with the theories on flexural stresses and bean deflections.
- To get accustomed to the torsional forces in solid and hollow shafts.

UNIT 1 SIMPLE STRESSES AND STRAINS **11 Hrs.**

Elasticity and plasticity, Types of stresses and strains, Hooke's law, stress, strain diagram for mild steel, Working stress, Factor of safety, Lateral strain, Poisson's ratio and volumetric strain, Elastic moduli and the relationship between them, Bars of varying section, composite bars, Temperature stresses.

UNIT 2 PRINCIPAL STRESSES and SHEAR FORCE BENDING MOMENT **12 Hrs.**

Stresses on an inclined section of a Bar under axial loading, compound stresses: normal and tangential stresses on an inclined plane for biaxial stresses. Mohr's circle stresses- Principle stresses and strains- analytical and graphical solutions. Various theories of failures for ductile and brittle material. Graphical representation of theories of failure. Definition of beam, Types of beams, S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, u.d.l., uniformly varying loads and combination of loads.

UNIT 3 FLEXURAL STRESSES and DEFLECTION OF BEAMS **11 Hrs.**

Theory of simple bending, Neutral axis, Determination of bending stresses and section modulus of rectangular, circular sections and other sections, Design of simple beam sections. Deflection and radius of curvature, Differential equation for the elastic line of a beam, Double integration and Macaulay's methods, Determination of slope and deflection for cantilever and simply supported beams subjected to point loads, - U.D.L. Uniformly varying load.-Mohr's theorems.

UNIT 4 TORSION and COLUMNS STRUTS **11 Hrs.**

Derivation of torque equation, Shear stress diagram for solid and hollow circular shafts, Comparison between solid and hollow shaft with regard to their strength and weight, Power transmitted by shaft. Buckling and Stability, Columns with Pinned ends, Columns with other support conditions, Limitations of Euler's Formula, Rankine's Formula, Columns with eccentric Axial Loads, Secant formula.

45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Define the fundamental concepts of stresses and strains in one dimensional and two dimensional states
CO2: Draw shear force and bending moment diagram for different types of beams with various loading conditions
CO3: Estimate the slope and deflection of beam subjected to various loading conditions
CO4: Interpret the bending and shear stresses in beams of different shapes
CO5: Estimate the power required for the shaft
CO6: Estimate the effective length of columns with different support conditions.

TEXT / REFERENCE BOOKS

1. James M Gere, Mechanics of Materials, 9th Edition, Cengage publication, 2018.
2. Beer and Johnston ,Mechanics of Materials,6th Edition,Tata Mc Graw Hill 2017.
3. R. C. Hibbeler, Mechanics of Materials., 9th Edition, Prentice Hall, Pearson,2013
4. S. S. Ratan ,Strength of Materials , 2nd Edition, Tata Mc Graw Hill, 2013.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs**
Part A: 8 Questions of 2 Marks each	16 Marks (40 mins.)
Part B: 6 Questions of 14 Marks each	84 Marks (140 mins.)

20ME202P					Strength of Material (Lab)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs. / Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	-	-	-	25	25	50

COURSE OBJECTIVES

- To find the strength of mechanical elements subjected to various types of loadings.
- To Identify, formulate and solve the engineering problems exist in mechanical element under damage.
- To understand the failure behavior of structural element and impact of usage of material in various application.
- To learn about the physical aspect related to hardness, toughness, stress, impact, fatigue, tension, compression, torsion and fatigue.

List of Practicals

1. To study the stress-strain characteristics of mild steel, aluminum by conducting tensile test on UTM.
2. To determine the Young's modulus of the material by conducting deflection test on a simply supported beam.
3. To determine the Modulus of rigidity by conducting Torsion test on Solid shaft
4. To find the Brinnell's hardness numbers of (a) Steel (b) Brass (c) Aluminum (d) Copper by conducting hardness test.
5. To find the Rockwell hardness numbers of (a) Steel (b) Brass (c) Aluminum (d) Copper by conducting hardness test.
6. To find compressive strength of wood and concrete by conducting compression test.
7. To find impact strength of (a) steel (b) aluminum by conducting izod impact test
8. To find impact strength of (a) steel (b) aluminum by conducting charpy impact test

On completion of the course, student will be able to
CO1: Illustrate the behaviour of material under impact condition
CO2: Understand the deflection of different sections at different loading conditions
CO3: Sketch stress- strain curve of ductile material under tensile loading
CO4: Compare compression strength between wood and concrete
CO5: Evaluate hardness of metals
CO6: Evaluate elastic constants using flexural and torsion test

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 50	**Exam Duration: 2 Hrs**
Part A: Lab Examination	60 mins
Part B: Viva	60 mins

COURSE OBJECTIVES

- To introduce and familiarize the different industrial terminology for measurements systems and metrology.
- To familiarize different techniques for measurement of physical quantities such as pressure, force, torque etc.

20ME203T					Mechanical Measurements and Metrology					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

- To introduce the concept of quality control and assurance and the role of measurement in it.
- To demonstrate the technique of automated inspection and machine vision for measurements.

UNIT 1 **10 Hrs.**

Fundamentals of measurement systems: Principal of measurements, metrology: introduction and types, methods of measurements, basic terminology of measurements. **Standard of measurement:** Roles of standards in measurement, material standards, types of standard, subdivision of standards, calibrations. **Transducers for Measurement:** Introduction to Transducers, its classification, Quality Attributes.

UNIT 2 **13 Hrs.**

Limits, Fits, Tolerance and Limit gauging: Principle of Interchangeability, selective assembly, Tolerances, allowance, Maximum and Minimum Metal Conditions, Fits, System of Limits and Fits, Hole basis and shaft basis systems, Design of Limit gauging: Taylor's Principle, Wear allowance in limit gauge, Plain Plug Gauges, Snap Gauges. **Measurements of Force, Torque, and Pressure:** Measurement of Force: platform balance, load cell, proving ring; Measurement of Torque: dynamometer; Pressure Measurement Scales, Method of Pressure Measurement, Ring Balance, Inverted Bell Manometer, Dead-weight Pressure Gauge, Measurement of Vacuum, High Pressure Measurement. **Measurements of Strain, Speed, and Temperature:** Techniques of Measurement of Strain, Strain Gauge Material, Backing or Carrier Materials, Adhesives, Protective Coatings, Bonding of Gauges. Different techniques of Measurement of speed such as tachometers & Speedometers. , Different techniques of temperature measurement such as thermometer.

UNIT 3 **12 Hrs.**

Linear and Angular metrology: Linear measurements instruments: verniers and micrometres; Angle measurement instruments: bevel protector, sine bar and centre, clinometers, collimator; Calibrations of the instruments, slip gauges. **Comparators:** Need for comparators, characteristics of comparators and its classifications. **Measurement of surface roughness and texture:** Significance of surface finish, terminology of surface texture, influencing factors for surface finish, symbolic representation of surface finish, surface roughness measurement techniques.

UNIT 4 **10 Hrs.**

Inspection and quality control: Introduction to Inspection and Quality Control, Quality Control and Quality Assurance, Statistical Quality Control, Total Quality Management, Six Sigma, Quality Standards.

Miscellaneous Metrology: Precision Instrumentation Based on Laser Principles, Coordinate Measuring Machines, Machine Tool Metrology, Automated Inspection, Machine Vision.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: **Understand** the fundamentals of measuring systems, its terminology and roles of standards and Transducers
CO2: **Analyse** the measurement techniques for force, pressure, torque, strain, speed and temperature systems.
CO3: **Apply** the principles of limits, fits and tolerance for designing of industrial gauges.
CO4: **Apply** the concepts of Linear and angular metrology and to study the functioning of different comparators.
CO5: **Understand** the measurement system for roughness measurement and texture and advanced principle of automated inspection.
CO6: **Evaluate** the different aspects of quality assurance and control and the role of measurement in it.

TEXT/REFERENCE BOOKS

1. D S Kumar Mechanical Measurements and Control, Metropolian publisher.
2. R K Jain , Engineering Metrology, Khanna Publisher.
3. A K Sawhney, Mechanical Measurement and Instrumentation, Dhanpat Rai Publication.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part A/Question: 10 Questions from each unit, each carrying 2 marks	20 Marks
Part B/Question: 2 Questions from each unit with internal choice, each carrying 16 marks	80 Marks

COURSE OBJECTIVES

- To learn the working principles of different measuring devices and their precision.

20ME203P					Mechanical Measurements and Metrology – Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
-	-	2	1	2	-	-	-	25	25	50

- To familiarize with various types of measurements, methods, errors, and their limitations.
- To develop an ability to validly use measuring instruments.
- To appreciate the importance of measurements and metrology on the quality of a product/component.

List of Experiments:

1. To measure the various dimensions of the given work piece by various measuring Instruments.
2. Introduction to generalized measurement system and Terminology.
3. To study the working of following instruments and Analysis of environmental parameters at different locations.
4. Feature recognition using optical method, selection and counting.
5. To study and calibrate the precision measuring instruments like Vernier calliper, Micrometre, and Dial gauge.
6. To get acquainted with sine bar.
7. Surface analysis of various manufacturing processes.
8. To measure the fundamental dimensions of a gear using contour (profile) projector.
9. To study different types of the comparators.
10. To demonstrate different types of Limit Gauges.
11. Add Screw and Gear parameter measurement

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the working principles and operations of various instruments.
CO2 - Analyse the effect of different parameters on the measurements and methodologies.
CO3 - Demonstrate the significance of different instruments for different measurements.
CO4 - Judge the uses of appropriate techniques for different measurement applications in practical life.
CO5 - Appraise the limitations of each measurement technique and methodologies followed.
CO6 – Explain the qualitative significance of the quantitative results obtained.

TEXT/REFERENCE BOOKS

1. Lab Manual, PDPU
2. Alan S. Morris, Measurement and Instrumentation Principles, Elsevier
3. D S Kumar Mechanical Measurements and Control, Metropolian publisher.
4. R K Jain , Engineering Metrology, Khanna Publisher.
5. A K Sawhney, Mechanical Measurement and Instrumentation, Dhanpat Rai Publication.

END SEMESTER EXAMINATION PATTERN

Max. Marks: 50

Viva (oral examination)	25 Marks
Lab exam	25 Marks

COURSE OBJECTIVES

20AE202P					Geometric Modeling Lab.		
Teaching Scheme					Examination Scheme		
L	T	P	C	Hrs/Week	Practical		Total Marks
					Continuous Evaluation	End Semester	
-	-	4	2	4	50	50	100

- To apply knowledge of advanced CAD concepts and techniques by using contemporary CAD software.
- To apply basic knowledge of CAD geometric entities to model IC engine parts, create assemblies, sheet-metal
- To apply the basic knowledge of geometric dimensioning and tolerances

List of Experiments:

1. Recapitulate concepts of sketch entities and tools, 3D features
2. Use of advanced 3D features like lofted base, revolved base, sweep, draft, wrap and mirroring features
3. To create different types of mechanical springs – compression, torsional and extension strings
4. To create 3D assembly of mechanical systems and edit parts in the assembly
5. Create and edit Bill of Materials (BOM)
6. Introduction to Production Drawings, Tolerance – Limit tolerance, angular tolerance, geometric tolerances.
7. Fit Tolerances – Clearance fits, hole basis & shaft basis, Interference fits
8. Part and Assembly drawings of Engine Parts, Machine Tool Parts, Engine Cross Head, Screw Jack
9. Part and Assembly drawings of Automotive Components namely: Rocker Arm Assembly, Plummer block assembly, IC Engine Connecting rod, Piston, Piston Pin and Piston Rings, inlet and exhaust valves.
10. Generation of various sectional views from solid models and assemblies and vice-a-versa
11. Introduction to Sheetmetal drawings, basic commands like Edge flange, Hem, Jog, Cosmetic blend, Corners etc

COURSE OUTCOMES

On completion of the course, student will be able to
CO-1: Demonstrate competency in engineering drawing using a commercial CAD package
CO-2: Create 3D solid models and assemblies from solid models
CO-3: Create views from 3D models, assemblies and vice a versa
CO-4: Apply industry standards in the preparation of technical mechanical drawings
CO-5: Make use of concepts of geometric tolerances and demonstrate them in CAD drawings
CO-6: Model sheet-metal parts using commercial CAD package

RESOURCES/TEXT/REFERENCE BOOKS

1. Geometric Modeling Lab Manual
2. http://www.solidworkstutorials.com/introduction-to-solidworks/
3. Ajeet Singh, Machine Drawing, Tata McGraw- Hill Publishing Company Ltd, New Delhi, 2017
4. Machine Drawing by K. L. Narayan and Co, 3rd Edition, New Age International Publishers, New Delhi, 2016
5. N D Junnarkar, Machine Drawing, Pearson Education Pvt Ltd; 1 edition, Singapore, 2007

END SEMESTER LAB EXAMINATION

Max. Marks: 100	**Exam Duration: 2 Hrs**
Create surface models/generation of views	15 Marks (80 mins.)
Create engineering drawings with geometric tolerances	10 Marks (40 mins.)

COURSE OBJECTIVES

20AE203T					Open Elective: I Automotive Chassis and Components					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

- To understand the need and role of chassis construction in the function of an Automobile.
- To analyse the effect of different steering geometries on vehicle performance.
- To understand the function of various components and sub-systems in the working of an Automobile.
- To corelate the tandem working of various components and their interdependence.

UNIT 1 **10 Hrs.**

Vehicle Chassis: Introduction, Automotive Assembly-Chassis and Body, Chassis Components, Layout of Chassis for different vehicles, Chassis Frame, Frame Types, Frame materials, Frame Loads, Frame Defects and its mitigation. Chassis for two wheelers, three wheelers, pick-up vehicles and heavy duty vehicles.
Vehicle Body: Need and Function, Types, Aerodynamic considerations in body profiling, Body Defects.

UNIT 2 **11 Hrs.**

Front Axle: Function, Types of front axles, Constructional features.
Steering System: Function, Various steering geometries and their importance on vehicle performance, Condition for correct steering, Steering mechanisms, Steering linkages, Steering gears, Power Assisted Steering.

UNIT 3 **11 Hrs.**

Driveline: Driveline components and their function. Final drive and its types.
Rear Axle: Loads, Types, Constructional features.
Suspension System: Need and Function, Types, Solid-Axle Suspension, Independent suspensions, Rubber suspension, Pneumatic Suspensions, Shock absorbers, Active Suspensions.

UNIT 4 **10 Hrs.**

Braking System: Need and Function, Types, Disc and Drum brakes, Mechanical brakes, Constructional features of Pneumatic, Hydraulic and Servo Brakes, Anti-lock Braking Systems, Emergency brakes.
Wheels and Tyres: Wheel function, Dimensions, Wheel types and their relative features, Tyre function, Tyre types, materials, designation, Tubeless tyres, Cross ply tyres, Radial ply tyres.

Max. 42 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1 – Classify the chassis layout based on type of vehicle.
CO2 – Examine the role of steering geometries and system on the vehicle stability.
CO3 – Explain the role of various driveline components in a vehicle.
CO4 – Analyse various suspension systems and their effect on vehicle ride and handling.
CO5 – Compare the function and features of different braking systems for an automobile.
CO6 – Identify the function of wheels and tyres on vehicle performance.

TEXT/REFERENCE BOOKS

1. Tim Gilles, “Automotive Chassis-Brakes, Steering and Suspension”, Thomson Delmer Learning, 2005.
2. Jornsen Reimpell, Helmut Stoll, “Automotive Chassis: Engineering Principles”, Elsevier, 2nd edition, 2001.
3. Banga T. R. & Nathu Singh, Automobile Engineering, Khanna Publishers, 2007.
4. Rajput R. K., Automobile Engineering, Laxmi Publications (P) Ltd, 2008.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

6 questions 5 marks each	30 Marks
7 questions 10 marks each	70 Marks

COURSE OBJECTIVES

- To understand communication and its process and effect on giving and receiving information.
- To learn and apply communication skills in different public and interpersonal contexts.
- To develop analytical, research, and organizational skills through communication skills for a fulfilling career.

UNIT 1 **7 hrs**

20HS201P					Communication Skills – II (Semester – III/IV) (Second Year)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	0	2 hours per week	--	--	--	50	50	100

- Technical Writing
  - ✓ Report Writing
  - ✓ Creating Lab Journals and Manuals
- Portfolio of Critical Writing and Creative Writing
  - ✓ Essay, Story-writing, etc.

UNIT 2 **7 hrs**

- Summarizing
- Writing Reviews (Books/Articles/Movies/websites)
- Reading Skills (Advanced)

UNIT 3 **7 hrs**

- Digital Literacy
  - ✓ Emails
  - ✓ Creating e-content
  - ✓ Editing and proofreading online
  - ✓ Using grammar and spell check software
  - ✓ Using plagiarism checkers

UNIT 4 **9 hrs**

- Group Discussion
- Resume Writing
- Interview Skills

Max. 30 hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO 1 Apply current technology for effective communication leading to better dissemination of knowledge and expertise.
CO 2 Demonstrate relevant knowledge of communication skills in different settings to cater to different purposes and audiences.
CO 3 A sound understanding of communication theory, practice and application to optimize career opportunities.
CO 4 Dynamic communication skills to build and maintain robust and effective professional relationships.
CO5 Augmented communication skills to prepare and present messages, reports and documents in intent and to integrate different sources of information and knowledge.
CO 6 Monitoring and critical reflection on communication skills for the adoption of appropriate strategy required in achieving the desired outcomes.

TEXT/REFERENCE BOOKS

1. Harmer, Jeremy. The Practice of English Language Teaching. Harlow: Pearson Longman, 2007.
2. Kaul, Asha. Business Communication. Delhi: Prentice-Hall of India, 2006.
3. Maley, A. 'Literature in the Language Classroom', The Cambridge Guide to Teaching ESOL, Cambridge University Press, 2001.
4. Richards, Jack C., and Willy A. Renandya, eds. Methodology in Language Teaching: An Anthology of Current Practice. Cambridge University Press, 2002.
5. Sharma, Sangeeta and Binod Mishra. Communication Skills for Engineers and Scientists. New Delhi: PHI Learning Pvt. Ltd., 2009.

Assessment Tool	Marks	Assignments
Lab Work	50	Essay/Journal Writing – 10; Report Writing – 10; Creating e-content – 10; Blog Writing – 10; Review Writing - 10
Lab Exam/Viva	50	Mock Interview – 15; Group Discussion – 15; Cover Letter/Curriculum - 20

Proposed Course Structure of B. Tech. in Automobile Engineering

COURSE STRUCTURE FOR B.TECH. SECOND YEAR (Automobile Engineering)

SEMESTER IV (Subjects)				B.TECH. SECOND YEAR (Automobile Engineering)											
Sr. No.	Category Code	Course Code	Course Name	Teaching Scheme					Exam Scheme						
				L	T	P	C	Hrs/wk	Theory			Practical		Total Marks
									CE	MS	ES	CE	ES	
1	PCC	20AE204T	Theory of Machines	3	0	0	3	3	25	25	50	-	-	100
2	PCC	20AE204P	Theory of Machines - Lab	0	0	2	1	2	-	-	-	25	25	50
3	PCC	20AE205T	Materials Technology	3	0	0	3	3	25	25	50	-	-	100
4	PCC	20AE205P	Materials Technology - Lab	0	0	2	1	2	-	-	-	25	25	50
5	PCC	20AE206T	Automotive Chassis and Components	3	0	0	3	3	25	25	50	-	-	100
6	PCC	20AE206P	Automotive Chassis and Components - Lab	0	0	2	1	2	-	-	-	25	25	50
7	PCE		Professional Core Elective - I	3	0	0	3	3	25	25	50	-	-	100
8	OE	20AE209T	Open Elective – II: Connected Cars and Recent Advancements	3	0	0	3	3	25	25	50	-	-	100
9	IND	20IF201T	Industry 4.0	2	0	0	2	2	25	25	50	-	-	100
10	IND	20IF201P	Industry 4.0 Lab	0	0	2	1	2	-	-	-	50	50	100
12	Project	20TP210	Industrial Orientation (3 weeks-summer break)	0	0	0	1	0	-	-	-	-	-	-
			Total	**17**	**0**	**8**	**22**	**25**						

CE = Continuous Evaluation MS = Mid Semester Exam ES = End Semester Exam

Professional Core Elective – I:

Course Code	Course Name		Course Code	Corse Name		Course Code	Course Name
20AE207T	Automotive Fuels and Lubricants		20AE208T	IC Engine Emissions & Control			

20AE204T					Theory of Machines					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	--	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To learn the theory of kinematics and dynamics
- To perform the analysis of several mechanical components such as cams, gears, gyroscope etc.
- To carry out balancing of rotating and reciprocating machine elements.

UNIT 1 Introduction to Kinematics and velocity analysis **8 Hrs.**

Introduction: Fundamentals of kinematics and mechanisms, kinematic link, types, kinematic pair, types of motions, kinematic pairs and chain, types of joints, mechanism, machine, degree of freedom (mobility), inversions of simple mechanisms, Grashoff's law. Velocity analysis: Introduction, velocity of point in mechanism, relative velocity method, velocities in four bar mechanism, instantaneous center. Steering mechanisms and equation of correct steering.

UNIT 2 Acceleration analysis and Cams **7 Hrs.**

Acceleration analysis: Introduction, acceleration of a point on a link, acceleration diagram, Coriolis's component of acceleration, crank and slotted lever mechanism. Introduction, classification of cams and followers, cam profiles for knife edge, roller and flat faced followers for uniform velocity, uniform acceleration.

UNIT 3 Force analysis of link and gears **13 Hrs.**

Static and dynamic Force Analysis: Static equilibrium, equilibrium for two force and three force members, Free body diagrams, D'Alembert's Principle, Dynamic analysis of four link and slider crank mechanism. Velocity and acceleration of automobile components. Gears: Laws of gearing, gears terminology, tooth form, standard interchangeable tooth profile, minimum number of teeth on pinion in contact with a gear, interference and under cutting, bevel, helical and spiral gears, Simple, compound, reverted and epicyclic gear trains, analytical and tabular methods, differential gear box.

UNIT 4 Gyroscope and Balancing **11 Hrs.**

Gyroscope: Angular velocity, angular acceleration, gyroscopic torque, gyroscopic effect on naval ships and aeroplanes, stability of an automobile, two-wheel vehicle. Balancing: Balancing of rotating masses in single and multiple planes.

Balancing of Reciprocating Masses: Primary and secondary balancing of reciprocating masses. Unbalanced forces and couples examination of "V", multi cylinder in line and radial engines for primary and secondary balancing.

Max. 39 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Recall the fundamentals of mathematics and kinematics.
CO2 - Explain the functioning of various mechanical components such as gears, gyroscope, cams etc.
CO3- Apply the various kinematic and dynamic principles to design various mechanical components.
CO4- Analyse the motion and forces in various machine elements.
CO5- Evaluate various machine elements based on the kinematic and dynamic analysis.
CO6- Formulate a real life problem considering the kinematics and dynamics of the system.

TEXT/REFERENCE BOOKS

1. S. S. Rattan, Theory of Machines, 5th Edition, Tata Mc Graw-Hill publications, New Delhi, 2019.
2. Amitabha Ghosh, Theory of Mechanisms and Machines, East West Press., 2008.
3. J.E. Shigley and J.J. Uicker, Theory of Machines and Mechanisms, 3rd Edition, Oxford University Press, 2003.
4. B.V.R. Gupta, Theory of Machines: Kinematics and Dynamics, 1st Edition, Dreamtech Press, 2019.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

6 Questions of 5 marks each-No choice	30 Marks
7 Questions of 10 marks each-No choice	70 Marks

20AE204P					Theory of Machines Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	--	2	1	--	--	--	50	50	100

COURSE OBJECTIVES

- To learn the theory of design and kinematics
- To statically and dynamically balance an unbalanced rotating system.
- To calculate Gyroscopic Torques in a Gyroscope apparatus.
- To compare the behavior of various configurations of Governors.
- To analyze and interpret data across all practical.

Experiment No.	Title
1	To study various types of Kinematics links, pairs, chains and Mechanism.
2	To study inversion of a four bar mechanism, single and double crank slider mechanism.
3	To study various types of cam and follower arrangements.
4	To study various types of gears: Spur, Helical, worm and Bevel gears.
5	To study various types of gear trains: Simple, Compound, Reverted, Epicyclic and differential gear trains
6	To determine the Gyroscopic couple and its effect on a rotating disc
7	To demonstrate the effect of static and dynamic unbalance in a rotating system of masses.
8	To completely balance a system of rotating masses.
9	To determine the characteristics of governors
10	To determine the jump speed of a Cam-follower system.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Recall the fundamentals mechanism, kinematics and dynamics.

CO2 – Explain and give examples for various mechanisms and their inversions.

CO3- Apply the various mechanical design and kinematics principles to design various mechanical components.

CO4- Analyse the design of motion of machines and their components.

CO5- Compare and assess the dynamic behaviour of various mechanisms.

CO6- Formulate and design cams, governors and various mechanisms.

RESOURCES/TEXT/REFERENCE BOOKS

1. Theory of Machines Lab Manual.
2. S. S. Rattan, Theory of Machines, 5th Edition, Tata Mc Graw-Hill publications, New Delhi, 2019.
3. J.E. Shigley and J.J. Uicker, Theory of Machines and Mechanisms, 3rd Edition, Oxford University Press, 2003.

LAB EXAMINATION PATTERN

Max. Marks: 100	Exam duration: 2 Hrs
Continuous Evaluation	50 Marks
Lab Exam	50 Marks

20AE205T					Materials Technology					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- **To know materials with their applications in automotive industry.**
- **To understand different properties of various materials.**
- **To comprehend the development of modern materials manufacturing technologies.**
- **To study different types of material manufacturing techniques.**

UNIT 1 MATERIALS AND THEIR APPLICATIONS **09 Hrs.**

Metallic materials: ferrous and non-ferrous alloys, Non-metallic materials: polymer and ceramic, Composites. Super alloys, Superplastic alloy, SMART materials, advanced materials: SMA, FRP and their properties. Material selection on the basis of cost, strength, formability and machinability.

UNIT 2 MATERIAL PROPERTIES AND TESTING **09 Hrs.**

Mechanical properties and testing: strength, hardness, ductility, fatigue, creep, toughness. Metallography, microstructure and analysis. Non-destructive testing: dye penetrant, ultrasonic, magnetic particle, radiography tests. Tribology in automotive industry: wear and corrosion. ASTM standards for mechanical testing.

UNIT 3 AUTOMOTIVE MATERIALS **09 Hrs.**

Lightweight materials and their metallurgy: aluminum alloys, magnesium alloys, titanium alloys. Steel and cast iron. Structure-property relations, Heat treatment: role, importance and types.

UNIT 4 MATERIALS MANUFACTURING **12 Hrs.**

Foundry: Introduction to casting, foundries, types of castings-patterns-allowances-moulding sand and ingredients-gating system-cores-chaplets-crucibles. Making of-Patterns-Cores-Casting design. Solidification of casting. Casting of metals-plastics. Casting Types-Casting defects and remedies. Classification and concepts of metal working processes. **Forging**-Principles-Classifications-Tools-Dies-Defects. **Rolling**-Fundamentals-Theory-Tools-Types-Defects.**Extrusion**-Classifications-Tools-Dies-Operations-Defects.**Drawing**-Wires-Bars-Tubes-Forces.
Sheet metal forming-Bending- Deep drawing-Roll forming- Stamping-Spinning. **Powder metallurgy**-Introduction, working principle and applications.

Max. 39 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – List automotive materials and their applications.
CO2 – Define properties of the automotive materials.
CO3 – Distinguish Ferrous and non-ferrous materials.
CO4 – Evaluate relation between structure and properties.
CO5 – Understand the working principles of various casting processes.
CO6 – Identify the importance of metal forming in manufacturing.

TEXT/REFERENCE BOOKS

1. Mikell P. Groover, Fundamentals of Modern Manufacturing-Materials, Processes and Systems, Wiley.
2. W. D. Callister, Material Science and Engineering, Wiley.
3. P.N. Rao, Manufacturing Technology Vol 1, Mc Graw Hill India.
4. M.P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, 7th edition, Willey.
5. S. Kalpakjian and S.Schmid, Manufacturing Processes for Engineering Materials, 6th Edition, Pearson.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part A/Question: 3 Questions from each unit - each carrying 5 marks	60 Marks
Part B/Question: 1 Question from each unit- each carrying 10 marks	40 Marks

20AE205P					Materials Technology Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	-	-	-	25	25	50

COURSE OBJECTIVES

- **To analyse and understand various material properties.**
- **To understand different microstructure of different materials.**
- **To test mechanical properties and understand the deformation behaviour.**
- **To understand the working principle and operations of casting and forming technology.**

LIST OF EXPERIMENTS:

1. To study the safety aspects of mechanical testing, casting and metal forming operations.
2. Demonstration of sand casting operations & manufacturing of various cast products.
3. Generate both Engineering and True Stress Vs Strain curves and measure the tensile properties of the materials including modulus of resilience, and interpret the importance of each property.
4. Correlate the tensile strength with hardness data and understand the variability of material properties.
5. Hardness measurements - Micro and Macro, including Knoop hardness test, and study the variations in micro and macro hardness using Vickers hardness test.
6. Correlate the Impact energy to the temperate and understand the importance of Ductile-to-Brittle Transition behaviour of the materials.
7. Develop S-N curves for steels and determine their fatigue life & fatigue strength.
8. Over view of Metallography procedures, and Metallurgical microscopes their construction, applications and limitations.
9. Metallographic examination of steels and alloys, their phase analysis, application of lever rule in phase analysis and correlating to the phase diagrams.
10. Number Familiarize with ASTM Grain size chart and determine the ASTM Grain Size.
11. Metallographic examination of Ferrous Metals including Stainless Steels.
12. Metallographic examination of Non Ferrous Metals - Aluminium and Copper.
13. Fractrographay of different materials (Tensile, Brittle, Fatigue and Creep)
14. Wear Testing of Metallic Samples (ASTM G65).
15. Super plasticity of metallic materials and elevated temperature tensile tests of metallic materials (ASTM E 21).
16. Practical demonstration of various NDT methods.
17. Effect of heat treatments on microstructures.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 : Understand various mechanical testing methods.

CO2 : Develop skill for specimen preparation to observe microstructure.

CO3: Produce sand cast component.

CO4: Define fundamentals and principles of metal forming to practical applications.

CO5: Examine stress-strain behaviour for different lightweight materials.

CO6: Judge the uses of different testing techniques for different applications in practical life.

TEXT/REFERENCE BOOKS

1. Mikell P. Groover, Fundamentals of Modern Manufacturing-Materials, Processes and Systems, Wiley.
2. W. D. Callister, Material Science and Engineering, Wiley.
3. P.N. Rao, Manufacturing Technology Vol 1, Mc Graw Hill India.
4. M.P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, 7th edition, Willey.
5. S. Kalpakjian and S.Schmid, Manufacturing Processes for Engineering Materials, 6th Edition, Pearson.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 25	**Exam Duration: 2 Hrs**
Quiz	10 Marks
Experiment	15 Marks

20AE206T					Automotive Chassis and Components					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To understand the need and role of chassis construction in the function of an Automobile.
- To analyse the effect of different steering geometries on vehicle performance.
- To understand the function of various components and sub-systems in the working of an Automobile.
- To corelate the tandem working of various components and their interdependence.

UNIT 1 **10 Hrs.**

Vehicle Chassis: Introduction, Automotive Assembly-Chassis and Body, Chassis Components, Layout of Chassis for different vehicles, Chassis Frame, Frame Types, Frame materials, Frame Loads, Frame Defects and its mitigation. Chassis for two wheelers, three wheelers, pick-up vehicles and heavy duty vehicles.
Vehicle Body: Need and Function, Types, Aerodynamic considerations in body profiling, Body Defects.

UNIT 2 **11 Hrs.**

Front Axle: Function, Types of front axles, Constructional features.
Steering System: Function, Various steering geometries and their importance on vehicle performance, Condition for correct steering, Steering mechanisms, Steering linkages, Steering gears, Power Assisted Steering.

UNIT 3 **11 Hrs.**

Driveline: Driveline components and their function. Final drive and its types.
Rear Axle: Loads, Types, Constructional features.
Suspension System: Need and Function, Types, Solid-Axle Suspension, Independent suspensions, Rubber suspension, Pneumatic Suspensions, Shock absorbers, Active Suspensions.

UNIT 4 **10 Hrs.**

Braking System: Need and Function, Types, Disc and Drum brakes, Mechanical brakes, Constructional features of Pneumatic, Hydraulic and Servo Brakes, Anti-lock Braking Systems, Emergency brakes.
Wheels and Tyres: Wheel function, Dimensions, Wheel types and their relative features, Tyre function, Tyre types, materials, designation, Tubeless tyres, Cross ply tyres, Radial ply tyres.

Max. 42 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1 – Classify the chassis layout based on type of vehicle.
CO2 – Examine the role of steering geometries and system on the vehicle stability.
CO3 – Explain the role of various driveline components in a vehicle.
CO4 – Analyse various suspension systems and their effect on vehicle ride and handling.
CO5 – Compare the function and features of different braking systems for an automobile.
CO6 – Identify the function of wheels and tyres on vehicle performance.

TEXT/REFERENCE BOOKS

1. Tim Gilles, “Automotive Chassis-Brakes, Steering and Suspension”, Thomson Delmer Learning, 2005.
2. Jornsen Reimpell, Helmut Stoll, “Automotive Chassis: Engineering Principles”, Elsevier, 2nd edition, 2001.
3. Banga T. R. & Nathu Singh, Automobile Engineering, Khanna Publishers, 2007.
4. Rajput R. K., Automobile Engineering, Laxmi Publications (P) Ltd, 2008.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

6 questions 5 marks each	30 Marks
7 questions 10 marks each	70 Marks

20AE206P					Automotive Chassis and Components Lab		
Teaching Scheme					Examination Scheme		
L	T	P	C	Hrs/Week	Practical		Total Marks
					Continuous Evaluation	End Semester	
-	-	2	1	2	25	25	50

COURSE OBJECTIVES

- To understand the construction and layout of Automotive Chassis.
- To have a hands-on experience on the overhaul of various components of Automotive Chassis.
- To understand the working of various subassemblies and accessories of an automobile.
- To appreciate the importance of synergistic working of Automotive components.

List of Experiments

1. Study the layout of chassis in different types on vehicles.
2. Overhaul of a Clutch.
3. Overhaul of a Gearbox.
4. Overhaul of Final Drive and Differential.
5. Overhaul of braking system.
6. Overhaul of steering system.
7. Overhaul of electrical system.
8. Overhaul of some vehicle accessories like horn, wiper etc.
9. Overhaul of wheel and tyres.
10. Overhaul of car body.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Explain the basic layout an automotive chassis.

CO2 – Develop a basic understanding on operation of various driveline components of the automotive chassis.

CO3 – Illustrate the working of an understanding on braking system used in an automobile.

CO4 – Analyze the working of steering system for vehicle control.

CO5 – Illustrate the operation and importance of various accessories in the function an automobile.

CO6 – Develop a basic know-how regarding the installation, inspection and maintenance of automotive components

RESOURCES/TEXT/REFERENCE BOOKS

1. Automotive Chassis and Components Lab Manual.
2. Kirpal Singh, Automobile Engineering Vol I and II, Standard publishers, 2014.
3. Crouse, W. H., and Anglin D. L., Automotive Mechanics, 10th Edition, McGraw-Hill, 2017.

END SEMESTER LAB EXAMINATION

Max. Marks: 25 **Exam Duration: 2 Hrs**

Quiz/Experiment 10 Marks

Viva-Voce 15 Marks

20AE207T					Automotive Fuels and Lubricants					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- **To understand the extraction process of automotive fuels from fossil fuels and renewable energy sources.**
- **To analyse the quality of the fuel by understanding fuel properties and testing.**
- **To understand the underlying concepts for automobile lubrication.**
- **To develop an understanding for selection of lubricants and lubrication systems for automobiles.**

UNIT 1 MANUFACTURE OF FUELS AND LUBRICANTS **12 Hrs.**

Structure of Petroleum, refining process, fuels, thermal cracking, catalytic cracking, polymerization, alkylation, isomerisation, blending, products of refining process. Manufacture of lubricating oil base stocks, manufacture of finished automotive lubricants.
Manufacture of Gasoline and Diesel Fuel from Renewable Sources

UNIT 2 PROPERTIES AND TESTING OF FUELS **12 Hrs.**

Thermo-chemistry of fuels, properties and testing of fuels, relative density, calorific value, flash point, fire point, distillation, vapour pressure, spontaneous ignition temperature, viscosity, pour point, flammability, ignitability, diesel index, API gravity, aniline point, carbon residue, copper strip corrosion etc.

UNIT 3 Fundamentals of Lubrication: **12 Hrs.**

Stribeck Curve: Lubrication Regimes, Function of automotive lubricant, Types of lubricants, Characteristics of lubricating oils, Viscosity, Factors affecting viscosity and viscosity index, additives in lubricant, Grades of lubricating oils and their designation, Laboratory Methods for Testing Lubricants: Viscosity meter, Four-ball Apparatus, FZG Gear oil-test Rig, Fourier transform infrared spectroscopy, and ASTM D2272 rotating bomb oxidation test.

UNIT 4 Automotive Lubrication: **12 Hrs.**

Components of lubrication system: Oil strainer, Oil pumps, Oil filters, sensors and indicators etc., Automotive Lubrication System: Splash lubrication, Pressure feed lubrication, Mist lubrication, semi-pressurized lubrication system, Dry sump lubrication, Cooling of lubricating oils, Crankcase ventilation and Chassis lubrication.

Max. 48 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Knowledge of various methods of manufacturing fuels and lubrication from fossil fuels and renewable sources.
CO2 – Analyze the properties of the automotive fuels
CO3 – Examine the fuels with various testing parameters.
CO4 – Build an understanding on the fundamentals and principles of Lubrication.
CO5 – Study and Analyze different methods used for testing lubricants used in automotive industry.
CO6 – Develop an ability to select lubrication system for a different assemblies of automobiles.

TEXT/REFERENCE BOOKS

1. Paul Richards "Automotive Fuels Reference Book", 3rd Edition, SAE international, 2014
2. Sajid Zaman, “Practical Handbook on Fuel Properties and Testing”, Lambert Academic Publishing, 2014.
3. M.M Khonsari and E.R., Booser, “Applied tribology: bearing design and lubrication”, John Wiley & Sons, 2017.
4. K.K. Jain, and R.B. Asthana, “Automobile engineering”, Tata McGraw-HILL, 2002.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

6 questions 5 marks each 30 Marks
7 questions 10 marks each 70 Marks

20AE208T					IC Engine Emissions & Control					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To impart the knowledge automotive pollution control
- To teach concept of formation and control techniques of pollutants like UBHC, CO, NOx, particulate matter and smoke for both SI and CI engine
- To introduce the instruments for measurement of pollutants and emission standards

UNIT 1: Introduction **(06)**

Pollutants - sources - formation - effects of pollution on environment - human - transient operational effects on pollution - Regulated - Unregulated emissions - Emission Standards.

UNIT 2: Emission from SI Engine and their Control **(12)**

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

UNIT 3: Emission from CI Engine and their Control **(12)**

Emission formation in CI engines (HC, CO, NOx, aldehydes, smoke and particulates) - Effect of design and operating variables on emission formation - Control techniques, exhaust gas recirculation, NOx selective catalytic reduction, diesel oxidation catalytic convertor - Diesel particulate filter, NOx versus particulates –trade off

UNIT 4 Test Procedure, Instrumentation & Emission measurement **(12)**

Test procedures CVS1, CVS3 - Test cycles - IDC - ECE Test cycle - FTP Test cycle - NDIR analyzer - Flame ionization detectors - Chemiluminescent analyzer - Dilution tunnel - Gas chromatograph - Smoke meters -SHED test.

Max : 42 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Understand the formation of various emission from SI engine and control techniques.
CO2: Understand the formation of various emission from CI engine and control techniques.
CO3: Acquire knowledge about emission measuring instruments and test procedures.
CO4: Gain knowledge about various alcohol and gaseous fuels and their use in SI and CI engines.
CO5: Acquire knowledge about various vegetable oils (Bio Diesel) and their use in CI engines.
CO6: Recognize the need and ability to engage in lifelong learning for further developments in this field.

TEXT/REFERENCE BOOKS

1. B.P. Pundir, B.P., 2007. Engine Emissions: Pollutant Formation and Advances in Control Technology, Alpha Science International Limited
2. G. Amba Prasad Rao, T. Karthikeya Sharma, 2020, Engine Emission Control Technologies: Design Modifications and Pollution Mitigation Techniques, CRC Press
3. Hiroshi Nakamura, Masayuki Adachi, 2014, Engine Emissions Measurement Handbook, SAE International and Horiba Ltd.
4. Automobiles and Pollution SAE Transaction, 1995

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part A/Question: 10 Questions from each unit, each carrying 2 marks 20 Marks
Part B/Question: 2 Questions from each unit with internal choice, each carrying 16 marks 80 Marks

20AE209T					Open Elective: II Connected Cars and Recent Advancements					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	-	-	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- **To understand working of Connected, automated and Intelligent cars**
- **To provide knowledge related to Sensor Technology for Advanced Driver Assistance Systems**
- **To study fundamentals of Wireless Technology**
- **To know about recent driver assistance system technology and recent development in automated technology**

UNIT 1 INTRODUCTION TO CONNECTED, AUTOMATED AND INTELLIGENT CARS **10 Hrs.**

Introduction to Connected, automated and Intelligent cars: Automotive Electronics Overview, Advanced Driver Assistance Electronic Systems, Connected Car Technology: Connectivity Fundamentals, Navigation and Other Applications, Connected Car Display Technology, Connected and Autonomous Vehicle Technology: Basic Control System Theory applied to Automobiles, Overview of the Operation of ECUs, Basic Cyber-Physical System Theory and Autonomous Vehicles **Autonomous Vehicles:** Driverless Car Technology, Moral, Legal, Roadblock Issues, Technical Issues, Security Issues

UNIT 2 SENSOR TECHNOLOGY **9 Hrs.**

Sensor Technology for Advanced Driver Assistance Systems: Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology, **Impaired Driver Technology:** Driver Impairment Sensor Technology, Sensor Technology for Driver Impairment Detection, Transfer of Control Technology

UNIT 3 WIRELESS TECHNOLOGY **10 Hrs.**

Overview of Wireless Technology: Wireless System Block Diagram and Overview of Components, Transmission Systems – Modulation/Encoding, Receiver System Concepts – Demodulation/Decoding, Signal Propagation Physics, Basic Transmission Line and Antenna Theory, **Wireless System Standards and Standards Organizations: Wireless Networking and Applications to Vehicle Autonomy:** Basics of Computer Networking – the Internet of Things, Wireless Networking Fundamentals, Integration of Wireless Networking and On-Board Vehicle Networks

UNIT 4 RECENT DRIVER ASSISTANCE SYSTEM AND VEHICLES **9 Hrs.**

Recent Driver Assistance System Technology: Basics of Theory of Operation, Applications – Legacy, Applications – New, Applications – Future, Integration of ADAS Technology into Vehicle Electronics, System Examples, Role of Sensor Data Fusion, Recent Driver Assistance System Technology applied in various automobile companies dealing with Non-Passenger Car, mini project to apply knowledge of various technologies related to connected vehicles.

Max. 38 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Understand technology applied in connected Cars
CO2: Explain basics and advancement in and Automated and intelligent Cars
CO3: Explore basics related to sensor technology in automated vehicles
CO4: Learn fundaments related to wireless technology in connected vehicles
CO5: Understand recent driver assistance system technology associated with automated vehicles
CO6: Apply knowledge of sensor and wireless technology to execute mini projects for connected cars

TEXT/REFERENCE BOOKS

1. G. Mullett, Wireless Telecommunications Systems and Networks, Thomson – Delmar Learning, ISNB#1-4018-8659-0, 2006
2. G. Mullett, Basic Telecommunications: The Physical Layer, Thomson – Delmar Learning, ISBN#1-4018-4339-5, 2003
3. Dietmar P.F. Möller, Roland E. Haas, Guide to Automotive Connectivity and Cybersecurity: Trends, Technologies
4. Tom Denton, Automobile Electrical and Electronic Systems

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part A/Question: 4 Questions from each unit, each carrying 10 marks 40 Marks
Part B/Question: 4 Questions from each unit each carrying 15 marks 60 Marks

20IF201T					Industry 4.0					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- To interpret the core elements and basic technologies of Industry 4.0
- To understand how the core elements and technologies of Industry 4.0 are interconnected
- To develop a holistic approach to improve processes and products with Industry 4.0

UNIT I: INDUSTRY 4.0 – CONCEPTS & TERMINOLOGIES **08 Hrs.**

Industry 4.0, Smart business model, Technology road-map, Sensing & actuation, Communication, Internet of things (IoT), Cyber Physical Systems and Next Generation Sensors, Visualization, Cloud Computing.

UNIT II: SMART WORLD & SUSTAINABLE ENVIRONMENT **08 Hrs.**

Sensors and their integration, Renewable Energy System, Hybrid Energy System, Smart Grid, Smart Metering, Communication Protocols, 5G Technology, Smart Agriculture, Smart Infrastructure, Physiological Sensors, Human Machine Interface.

UNIT III: SMART MANUFACTURING **08 Hrs.**

Automation Systems, Additive Manufacturing, Micro-Electro-Mechanical Systems (MEMS), Smart Factories and Interconnection, Advanced Robotics – Autonomous and Swarm, Self-Propelled Vehicles, Drones–Unmanned Aerial Vehicle (UAV), 3d Printing, Spacecrafts.

UNIT IV: TRANSFORMING TECHNOLOGIES IN BIOENGINEERING **08 Hrs.**

Establishment of Smart Biotechnology Factory, Artificial Intelligence in Bioprocess Technology, 3D Bio Printing for Tissue Engineering, Simulation Tools, RSM and Box Model, Cyber Physical System based Telemedicine, Real Time Biosensors, Bio nanotechnology, biofuel.

Total Hours 32 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Understand the core elements and basic technologies for Industry 4.0
CO2 – Apply the different computational techniques and algorithms for realizing Industry 4.0
CO3 – Transform the traditional business approach by integrating the data and intelligence
CO4 – Develop the traditional industries with intelligent and automated machines
CO5 – Utilize data and intelligence for the development of Smart World
CO6 – Understand the concept, significance and means to achieve sustainable development

TEXT/REFERENCE BOOKS

1. Ustundag Alp, and Emre Cevikcan, Industry 4.0: Managing the Digital Transformation, Springer,First Edition, 2018
2. Kaushik Kumar, Divya Zindani, and J. Paulo Davim, Digital Manufacturing and Assembly Systems in Industry 4.0., CRC Press, Taylor & Francis First Edition, 2019.
3. Antonella Petrillo, Raffaele Cioffi, and Fabio De Felice, Digital Transformation in Smart Manufacturing., IntechOpen Publisher, First Edition, 2018.
4. J. Ekanayake, K. Liyanage, J. Wu, A. Yokoyama and N. Jenkins, Smart Grid: Technology and Applications, John Wiley and Sons Ltd., First Edition, 2012
5. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, First Edition, 2016
6. Ibrahim Garbie, Sustainability in Manufacturing Enterprises: Concepts, Analyses and Assessments for Industry 4.0, Springer, First Edition, 2016

20IF201P					Industry 4.0 Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

List of Experiments

1. Basic computations using Python programming.
2. Use simulations to understand the performance/behavior of a system by (i) creating a computational environment that mimics the real world, (ii) generating (synthetic) or loading data from sources, and (iii) testing the hypothesis
3. Introduction to MATLAB programming and SIMULINK
4. 3D printing of Airfoil through rapid prototyping 3D printer
5. Dynamic simulation of drone (unmanned air vehicle) through MATLAB/SIMULINK
6. ANSYS simulation of bending of a beam in an earthquake resist-building
7. Introduction to Arduino Embedded platform.
8. Design of line follower autonomous vehicle.
9. Design of smart meter for recording the electricity consumption
10. Design of smart lighting with the help of proximity sensors.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Understand the concept of Industry 4.0 and its significance
CO2 – Understand the resource requirements for the implementation of Industry 4.0
CO3 – Learn the Simulation Packages for Industry 4.0
CO4 – Explore the concept of Smart Infrastructure through simulation studies
CO5 – Inspect embedded platform applications for Industry 4.0
CO6 – Synthesise the solution for the given Industry 4.0 related problem

TEXT/REFERENCE BOOKS

1. Ustundag Alp, and Emre Cevikcan, Industry 4.0: Managing the Digital Transformation, Springer,First Edition, 2018
2. Kaushik Kumar, Divya Zindani, and J. Paulo Davim, Digital Manufacturing and Assembly Systems in Industry 4.0., CRC Press, Taylor & Francis First Edition, 2019.
3. Antonella Petrillo, Raffaele Cioffi, and Fabio De Felice, Digital Transformation in Smart Manufacturing., IntechOpen Publisher, First Edition, 2018.
4. J. Ekanayake, K. Liyanage, J. Wu, A. Yokoyama and N. Jenkins, Smart Grid: Technology and Applications, John Wiley and Sons Ltd., First Edition, 2012
5. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, First Edition, 2016
6. Ibrahim Garbie, Sustainability in Manufacturing Enterprises: Concepts, Analyses and Assessments for Industry 4.0, Springer, First Edition, 2016

20TP210					Industrial Orientation					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs. / Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
-	-	-	3	-	-	-	-	50	50	100

COURSE OBJECTIVES

- **To visit automobile industries to observe real world engineering activities**
- **To understand the applications of theoretical concepts**
- **To relate the fundamentals of engineering to the real world**
- **To identify the challenges of industries**

As a part of better exposure to industry practices we recommend our students to visit reputed organizations and interact with people to understand the real world problems and prepare themselves accordingly. Students of 4th semester visit different industries and get a better outlook of the practical scenario of the subjects taught to them in classroom

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – To bridge the gap between classroom teaching and industrial experience.
CO2 – To understand and co-relate the industrial skills required.
CO3 – To learn real word engineering as an individual and to work in a team.
CO4 – To give a good perception of their tasks and responsibilities within a professional environment
CO5 – Become updated with all the latest changes in technological world.
CO6 – Assess and evaluate challenges faced in industry

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: NA**
Part A: Viva	50 Marks
Part B: Report	50 Marks

Proposed Course Structure of B. Tech. in Automobile Engineering

COURSE STRUCTURE FOR B.TECH. THIRD YEAR (Automobile Engineering)

SEMESTER V (Subjects)				B.TECH. THIRD YEAR (Automobile Engineering)											
Sr. No.	Category Code	Course Code	Course Name	Teaching Scheme					Exam Scheme						
									Theory			Practical		Total Marks
				L	T	P	C	Hrs/wk	CE	MS	ES	CE	ES	
1	PCC	20AE301T	Manufacturing Technology	3	0	0	3	3	25	25	50	-	-	100
2	PCC	20AE301P	Manufacturing Technology - Lab	0	0	2	1	2	-	-	-	25	25	50
3	PCC	20AE302T	Design of Machine Elements	3	0	0	3	3	25	25	50	-	-	100
4	PCC	20AE302P	Design of Machine Elements -Lab	0	0	2	1	2	-	-	-	25	25	50
5	PCC	20AE303T	Automotive Power Train Systems	3	0	0	3	3	25	25	50	-	-	100
6	PCC	20AE303P	Automotive Power Train Systems- Lab	0	0	2	1	2	-	-	-	25	25	50
7	PCE		Professional Core Elective - II	3	0	0	3	3	25	25	50	-	-	100
8	OE	20AE306T	Open Elective – III Vehicle Manufacturing	3	0	0	3	3	25	25	50	-	-	100
9	HSC	20HS301P	Communication Skills - III	0	0	2	1	2	-	-	-	50	50	100
			Total	**15**	**0**	**8**	**19**	**23**						

CE = Continuous Evaluation MS = Mid Semester Exam ES = End Semester Exam

Professional Core Elective – II:

Course Code	Course Name		Course Code	Corse Name		Course Code	Course Name
20AE304T	Automotive HVAC						
20AE305T	Special Vehicles						

20AE301T					Manufacturing Technology					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To provide the basics & advances in manufacturing processes, their classification, advantages & disadvantages.
- To provide the fundamentals and working principles of casting, welding, and metal working processes.
- To provide the basics of manufacturing of plastics and powder materials.
- To provide fundamentals of machining and Machine tools.
- To understand role of finishing processes in manufacturing.

UNIT 1 **08 Hrs.**

Introduction-Welding-Soldering-Brazing. Classification of welding-fluxes. Gas welding-ARC-MIG-TIG-Resistance-Spot-Thermite-Plasma-Induction-Explosive-Forge-Friction-Frictional Stir-Laser-E-beam-Plasma. Weld joints-Weldability-Metallurgical Characteristics-Defects-Causes-Remedies. Destructive and NDT of welds.

UNIT 2 **08 Hrs.**

High energy rate forming processes-under water explosions-spark discharge, Pneumatic mechanical means, internal combustion of gases, and rapid force magnetic fields. Powder Forming-Techniques-Classifications-Applications. Processing of Plastics-Moulding

UNIT 3 **12 Hrs.**

Single point cutting tool: Tool geometry–concept of rake and clearance angles–different systems of tool geometry–mechanism of chip formation-essential properties and types of cutting fluids, machinability–failure, life and materials of cutting tools. **Lathe**: Principle of working. Various lathe operations–accessories–classification and specification of lathe machines-Tool and job holders in lathes. **Shaping, slotting, planning and broaching machines**: Kinematic systems–principle of working–classifications, specification and operations performed

UNIT 4 **12 Hrs.**

Milling, Drilling and boring machines: Kinematic system–principle of working–classifications–specifications–operations performed–accessories–milling cutter–classifications of cutters. Introduction to indexing–methods of indexing–gear cutting methods– twist drill–deep hole drilling machines. Numerical and experimental study-effect of process parameters. **Grinding and super finishing:** Classifications of grinding machines–specifications grinding wheels–mechanism of grinding–different bonds and abrasives–truing and dressing. Super abrasive wheels and their bonds. Super finishing methods–characteristics and applications.

Max. 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – **Understand** the working principles of various casting processes
CO2 – **Choose** the appropriate manufacturing process of powder forming and processing of plastics.
CO3 – Classify various types welding processes and their significance.
CO4 – **Analyze** single point cutting tool geometry with role of different tool angels.
CO5 – **Understand** fundaments of Lathe, Milling, drilling and Boring machines and **evaluate** machining performance.
CO6 – **Selection** of appropriate super finishing processes

TEXT/REFERENCE BOOKS

1. Serope Kalpakjian, Manufacturing engineering and Technology, Wesley Publishing Co.
2. Lindberg R.A, Processes and Materials of Manufacture, Prentice Hall of India (P) Ltd.
3. P.N.Rao, Manufacturing & Technology: Foundry Forming and Welding, Tata McGraw Hill Publications.
4. Chee Kai Chua, Kah Fai Leong, Chu Sing Lim, Rapid prototyping: Principles and applications, World scientific publications.
5. A. B. Chattopadhyay, Machining and Machine Tools, John Wiley & Sons publisher.
6. Geoffrey Boothroyd, Fundamentals of Metal Machining and Machine Tools, CRC press.
7. R.K. Jain and S.C. Gupta, Production Technology.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part A/Question: 4 Questions from all units together - each carrying 5 marks	20 Marks
Part B/Question: 2 Questions from each unit each carrying 10 marks	80 Marks

20AE301P					Manufacturing Technology Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	-	-	-	25	25	50

COURSE OBJECTIVES

- To analyse and understand various welding techniques.
- To understand moulding process
- To understand the working principle and operations of conventional machining techniques such as Lathe, Milling, Drilling, Grinding, Shaper and Grinding Machines and prepare job using these machines
- To understand the working principle and operations of non-conventional machining techniques such as EDM, WEDM and ECM processes and prepare job using these non-conventional techniques

List of Experiments:

1. To study the safety aspects of welding, casting and metal forming operations
2. Shielded metal arc welding & effects of variables on bead geometry
3. Gas metal arc welding & effects of variables on bead geometry
4. Gas tungsten arc welding & effects of variables on bead geometry
5. Gas welding, Gas cutting & effects of variables on cutting quality
6. Plasma cutting & effects of variables on cutting quality
7. Solid state welding - Friction stir welding
8. Resistance welding, Butt welding and Spot and Projection welding
9. Soldering and Brazing
10. Injection moulding of plastics
11. Prepare a Job of required shape and size on Lathe Machine and analyse the effect of process parameters.
12. Prepare a Job of required shape and size on Milling Machine and analyse the effect of process parameters.
13. Prepare a Job of required shape and size on Grinding Machine and analyse effect of process parameters.
14. Prepare a Job of required shape and size on shaping machine and analyse effect of process parameters
15. Non- Conventional machining by using RAM-EDM and effect of process parameters
16. Non- Conventional machining by using Wire-EDM and effect of process parameters
17. Non- Conventional machining by using Electrochemical Machining (ECM) and effect of process parameters.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Understand various metal joining techniques
CO2 – Analyse the effect of process parameters on weld quality
CO3 – Produce sand cast mould and cast a component
CO4: Define fundamentals and principles of metal cutting to practical applications using conventional machining processes of lathe machines
CO5: Apply principles of metal cutting to practical applications using conventional machining processes of milling machines.
CO6: Evaluate the performance of different non-conventional machining processes such as EDM, WEDM and ECM.

TEXT/REFERENCE BOOKS

1. P. N. Rao, Manufacturing & Technology: Foundry Forming and Welding, Tata McGraw Hill Publications.
2. Serope Kalpakjian, Manufacturing engineering and Technology, Wesley Publishing Co.
3. Lindberg R.A, Processes and Materials of Manufacture, Prentice Hall of India (P) Ltd.
4. Roy A Lindberg, Process and Materials of Manufacturing, Pearson Edu.
5. Serope Kalpakjian & Steuen. R. Sechmid, Manufacturing Technology, Pearson Education Asia.
6. Taylor H.F Flemings M.C & Wulff J., Foundry Engineering, Wiley Eastern Limited.
7. Sharma PC. A Textbook of Production Enginerring. S. Chand Publishing.
8. Hmt, H.M.T. Production technology. Tata McGraw-Hill Education.

END SEMESTER LAB EXAMINATION

Max. Marks: 25	**Exam Duration: 2 Hrs**
Quiz/Experiment	10 Marks
Viva-Voce	15 Marks

20AE302T					Design of Machine Elements					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To learn the theory of design of machine elements.
- To be able to design rivets, welded joints, shafts, couplings, screws, nuts and springs
- To develop an ability to design a system, component, or process to meet desired needs within realistic constraints.

UNIT I : Introduction to machine design and Design of simple machine parts **11 Hrs.**

Introduction to machine design, design procedure, Selection of materials, Properties and coding of various materials, manufacturing considerations in design

Design against static loading: factors of safety, Types of stresses, Design of Cotter joint, Knuckle joint, Theories of elastic failure

UNIT II : Design of Joints **11 Hrs.**

Introduction to Permanent and temporary joints, Advantages and disadvantages of joints.

Riveted Joint: Terminology of a riveted joint, types of rivets and riveted joints, Materials for rivets, Stresses in rivets and design of a riveted joint, Joint Efficiency, Eccentrically loaded riveted joint.

Welded Joint: Types of welded joints, Weld Materials, Stresses in welded joints and design of welded joints, Welded joint subjected to eccentric loading.

UNIT III : Design of Shafts, Keys and Couplings **11 Hrs.**

Design of Shafts: Shaft Material, Design of solid and hollow shafts for strength and rigidity, Design of shafts for combined bending and axial loads, Design of keys

Design of Shaft Couplings: Types of couplings, Rigid vs. flexible couplings, Design of flange coupling,

UNIT IV : Design of Power screw and Springs **12 Hrs.**

Design of Power Screws: Types of power screw threads, design of screw with different types of threads used in practice, self-locking screw, Design of nuts, Design of clamp, Screw jack, toggle jack

Design of Mechanical Springs: Types of springs, Materials for Springs, Stresses, deflection and buckling of helical springs, Helical Springs of non-circular cross-sections, Helical Tension spring, Energy storage capacity, Helical torsion springs, Co-axial springs, leaf springs

Max. <45> Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Recall the fundamentals of design procedure of machine components.
CO2: Use theories of failure for safe designing of components
CO3: Explain the various mechanical components such as rivets, welded joints, shafts and couplings
CO4: Analyze the shafts based on strength and rigidity criterion
CO5: Estimate the dimensions of various mechanical components
CO6: Formulate and design rivets, welded joints, shafts, couplings, springs and screws

TEXT/REFERENCE BOOKS

1. V. Bhandari, Design of Machine Elements, Tata Mc-Graw hill Publishers
2. J.Shingley, C. Mischke, R. Budynas, Mechanical Engineering Design, Tata Mc-Graw hill Publishers
3. R. Norton, Machine Design: An Integrated Approach, Pearson Education Publishers.
4. Khurmi and Gupta, The textbook of Machine Design, S Chand & Co Ltd

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part A/Question: 8 questions of 2 marks each 16 Marks

Part B/Question: 6 questions of 14 marks each 84 Marks

20AE302P					Design of Machine Elements Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	--	2	1	--	--	--	50	50	100

COURSE OBJECTIVES

- To learn the theory of design of machine elements.
- To be able to design rivets, welded joints, shafts, couplings, screws, nuts and springs
- To develop an ability to design a system, component, or process to meet desired needs within realistic constraints.

Experiment No.	Title	Hrs.
1	Design and Drawing of Power screw	2
2	Design of Screw jack and Toggle jack.	2
3	Design of shafts, keys and Couplings.	2
4	Problems for design of joints using welding, riveting and fasteners.	2
5	Practice on applying different machining symbols, roughness symbols and manufacturing symbols in assembly/detail drawings.	2
6	Introduction to parametric modeling software.	4
7	Prepare 3D solid model using base features, Extrude/Protrude/Revolve.	4
8	Prepare 3D solid models that include engineering features.	4
9	Mini Project on Parametric Software includes: a) Prepare solid models of dismantled parts of an assembly (selected as student activity 1). b) Assemble the parts. c) Get orthographic production drawings of solid models prepared at "a" above. d) Get orthographic production drawings of assembly model prepared at "b" above. e) Prepare the bill of material (BOM). f) Present the project.	8

Max. 30 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Recall the fundamentals of design procedure of machine components.
CO2: Use theories of failure for safe designing of components
CO3: Formulate and design rivets, welded joints, shafts, couplings, springs and screws.
CO4: **Design, develop** and **model** the given part using various CAD software.
CO5: Prepare solid models & assembly of mechanical parts.
CO6: Prepare the production drawing and BOM using the CAD software.

TEXT/REFERENCE BOOKS

1. K.C.Jhon, Machine Design, PHI
2. Ajeet singh, Machine drawing including AutoCAD, Tata-McGraw Hill Publishers.
3. Alex kruleski, Fundamental of Geometric dimensioning & tolerancing, Cengage publication
4. K.L.Narayan, Production drawing, New age publication

LAB EXAMINATION PATTERN

Max. Marks: 100

Continuous Evaluation	50 Marks
Lab Exam	50 Marks

20AE303T					Automotive Power Train systems					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- **To classify and analyse various transmission components, SI and CI engine components, cycle with combustion phenomenon.**
- **To evaluate the performance parameters of SI and CI engines and transmission losses and efficiency.**
- **To Classify, Analyse and evaluate Powertrain functions, Powertrain layout and components, Main and Auxiliary functions.**
- **To estimate Interrelations: Direction of rotation, Transmission Ratio and Torque.**

UNIT 1: INTERNAL COMBUSTION ENGINE AND FUEL SYSTEMS 10 Hrs.

Introduction to IC engines: Engine Classification. Air standard cycles and fuel air cycles. Engine performance parameters, valve timing diagram. Fuel supply systems in SI and CI engines, Direct injection and Common rail injection.

UNIT 2: FUNDAMENTALS OF COMBUSTION AND VEHICLE TRANSMISSION 10 Hrs.

Combustion in CI and SI engines, abnormal combustion and knock in engines,

Basic Elements of Vehicle and Transmission Engineering, Need of Gearboxes, Functions of Vehicle Transmissions, and Fundamental Performance Features of Vehicle Transmissions, Trends in Transmission Design, Transmission Losses and Efficiency.

UNIT 3: POWER TRAIN SYSTEMS 10 Hrs.

Development of Vehicles & Drive Units, Stages in the Development of Automotive Transmissions, Development of Gear-Tooth Systems and other, Transmission Components. Outlines of Power Trains, Powertrain functions, Powertrain layout and components, Main and Auxiliary functions, Requirements profile, Interrelations: Direction of rotation, Transmission Ratio and Torque, Road Profiles, Load Profiles, Typical Vehicle uses and Driver types, Performance features of Vehicle Transmissions.

UNIT 4: AUTOMATIC AND ELECTRONICALLY CONTROLLED TRANSMISSION SYSTEMS 10 Hrs.

Automatic transmission systems, hydromantic and CVT systems, torque converters, hydraulic control systems, Ford Hydromantic transmission systems, Electronically controlled automatic transmission systems, Hydrostatic drive systems, different pumps and motors for hydrostatic drive systems.

COURSE OUTCOMES:

on completion of the course, students will be able to

CO1: Understand and analyse various transmission components SI and CI engine cycle with combustion phenomenon
CO2: Understand and analyse the systems for CI and Si engines
CO3: Evaluate the performance parameters of SI and CI engines and transmission losses and efficiency.
CO4: Analyse and evaluate Interrelations: Direction of rotation, Transmission Ratio and Torque.
CO5: Classify and analyse the various Automatic transmission systems.
CO6: Understand and analyse Electronically controlled automatic transmission systems

TEXT AND REFERENCE BOOKS:

1. V. Ganesan, Internal Combustion Engines, 4th edition, The Tata McGraw-Hill publications, 2017.
2. Jack Erkavec, Automotive Engineering- Automatic Transmission & transaxles, classroom and shop manual, Cengage learning India Pvt Ltd, India Edition, 2011.
3. W.H., Anglin. D.L., "Automotive Transmission and Power Trains construction ", McGraw-Hill, 5th edition, 1976.
4. John Heywood, 'Internal Combustion engine fundamentals", McGraw Hill Education; 1 edition 2017.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part A: 4 Question form each unit – 10 marks each 40 Marks

Part B: 6 Numerical Questions – 10 marks each 60 Marks

20AE303P					Automotive Power train systems - Lab		
Teaching Scheme					Examination Scheme		
L	T	P	C	Hrs/Week	Practical		Total Marks
					Continuous Evaluation	End Semester	
-	-	2	0	2	50	50	100

COURSE OBJECTIVES

- **To understand and classify various transmission components, SI and CI engine components.**
- **To have a hands-on experience on the overhaul of various components of power train systems.**
- **To appreciate the importance of synergistic working of electronically controlled power train components.**

LIST OF EXPERIMENTS

Experiment 1: To study the various parts and systems of IC engines and transmission system
Experiment 2: Overhaul of automotive power train system
Experiment 3: Performance test on 4Stroke-4 Cylinder SI engine under constant load and variable speed conditions.
Experiment 4: Performance test on 4Stroke-4 Cylinder SI engine under variable load and constant speed conditions.
Experiment 5: Performance test on single cylinder 4Stroke CI engine under variable load conditions.
Experiment 6: Performance of Morse test on Muti-cylinder engine.
Experiment 7: To analyse heat loses in CI engine with the help of heat balance sheet.
Experiment 8: overhaul of automatic power train system
Experiment 9: Overhaul of Electronically controlled power train system.
Experiment 10: To study and demonstrate the working of turbo-charged BMW engine.
Experiment 11: To study and demonstrate the working of ignition, lubrication and cooling in a Ford engine.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Recognize and understand various parts and systems of IC engines and transmission system
CO2: Plan, conduct and perform performance test on IC engines power train.
CO3: Perform experiments and analysis on load transmission for various IC engines under variable loading condition.
CO4: Perform experimental study on IC engines to obtain the indicator diagram and prepare heat-balance sheet and different efficiencies.
CO5: Develop a basic know-how regarding automatic transmission systems; CVT and DCT
CO6: Develop a basic know-how regarding electronically controlled automatic transmission system

TEXT AND REFERENCE BOOKS:

1. V. Ganesan, Internal Combustion Engines, 4th edition, The Tata McGraw-Hill publications, 2017.
2. Jack Erkavec, Automotive Engineering- Automatic Transmission & transaxles, classroom and shop manual, Cengage learning India Pvt Ltd, India Edition, 2011.
3. W.H., Anglin. D.L., "Automotive Transmission and Power Trains construction ", McGraw-Hill, 5th edition, 1976.
4. John Heywood, 'Internal Combustion engine fundamentals", McGraw Hill Education; 1 edition 2017.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 2 Hrs**

Part A: Quiz/Experiment - Manual 50 Marks
Part B: Viva 50 Marks

20AE304T					Automotive HVAC					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	-	-	3	4	25	50	25	--	--	100

COURSE OBJECTIVES

- To impart knowledge on basics of HVAC, its necessity for automobiles and provide exposure of the same
- To skill students to carry out performance evaluation and analyse different components of HVAC systems
- To provide knowledge on testing and troubleshooting procedures in case of breakdown of automobile HVAC system
- To provide knowledge of the environmental impacts and methods to minimise the same

UNIT 1: FUNDAMENTALS OF AIR CONDITIONING SYSTEMS (10 Hrs)

Basic Definitions: Ton of Refrigeration, COP, Energy Efficiency Ratio, Seasonal Energy Efficiency Ratio, Heat Exchanger And Its Types; Air Conditioning Components: Compressor, Condenser, Evaporator, Expansion Valve; Air conditioning for passengers, isolated vehicles and transport vehicles; Refrigerants: Types of refrigerants, Properties and selection of refrigerants

UNIT 2: PSYCHROMETRY AND LOAD CALCULATIONS (12 Hrs)

Properties of moist air, Psychrometric properties, tables, charts, Psychrometric processes in air conditioning equipment, Summer and winter air conditioning, Comfort charts, Factor affecting comfort, Ventilation requirements

Load Calculation: Solar Radiation – Internal Heat Gains, Humidity and Air-flow, Heating Load Estimate and Cooling Load Estimate, Load calculations for automobiles, Effect of air conditioning load on engine performance

UNIT 3: AIR CONDITIONING SYSTEMS (8 Hrs)

Basic Air Conditioning System: Classification, Layout, Central and unitary air conditioning systems, Location of Air Conditioning components in a Car, Refrigerants used in automobile air conditioning, Eco-friendly refrigerants, Thermoelectric cooling and Thermo-acoustic refrigeration.

UNIT 4: DISTRIBUTION SYSTEMS AND CONTROL DEVICES (10 Hrs)

Fan Arrangements, Indoor Air Distribution; Total, Static and Velocity Pressures; Air Flow through Simple Duct System, Layout of duct systems for automobiles, Dynamic loss in ducts and their impact on load calculation.

Air Quality control, Temperature regulation through automatic control, Humidity control, Recent trends used in Modern Automobile Air Conditioning.

[Total : 40 Hrs]

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: **Define** different terminologies of HVAC and cooling needs of different automobiles
CO2: **Understand** the principles of Psychrometry and load calculation for an automotive vehicle
CO3: **Develop** knowledge and functioning of a HVAC system
CO4: **Analyse** heating, cooling and air conditioning system, carry out inspection, maintenance, adjustments, and repair
CO5: **Interpret** and **assess** the required heating/ cooling, distribution system and controls
CO6: **Develop** proficiency in HVAC system selection and devise methods to reduce environmental impact

TEXT/REFERENCE BOOKS

1. Steven Daly, “Automotive Air Conditioning and Climate Control Systems”, Butterworth-Heinemann; 1 edition, 2006
2. Paul Lung, "Automotive Air Conditioning", C.B.S. Publisher & Distributor, Delhi, 1991
3. Paul Weiser, “*Automotive Air Conditioning*” - Reston Publishing Co., Inc., 1990
4. William H. Crouse and Donald I. Anglin, “*Automotive Air conditioning*”, McGraw Hill, 1983
5. MacDonald, K.I., “Automotive Air Conditioning”, Theodore Audel series, 1978

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Unit 1/Question: <Question 1 with subsections(with internal choice)>	<20> Marks
Unit 2/Question: < Question 2 with subsections(with internal choice)>	<20> Marks
Unit 3/Question: <Question 3 with subsections(with internal choice)>	<30> Marks
Unit 4/Question: < Question 4 with subsections(with internal choice)>	<30> Marks

COURSE OBJECTIVES

20AE305T					Special Vehicles					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

- **To classify and analyse various Earth moving vehicles**
- **To Classify, Analyse and evaluate engine capacity and design consideration for rail, motorbike and special vessel.**
- **To Classify and analyse the eco vehicle technologies.**

UNIT 1: EARTH MOVING VEHICLES **10 Hrs**

Earth Moving machineries: Classification of the various earth movers; Loader, excavator dozer, design considerations; Power train system;

UNIT 2: HEAVY DUTY VEHICLES **10 Hrs**

Vessel Engineering and Rail engineering; Heavy duty vehicles and trucks: Classification; Engine requirements; Design consideration, Applications

Unit 3: ECO Vehicle Technologies **10 Hrs**

Eco- Vehicle Technology: Classification; Engine requirements; Classification of alternate power sources; Design consideration, Applications

UNIT 4: MOTOR SPORT VEHICLES **10 Hrs**

Motor-Sport Engineering; Motor cycles and motor bikes: Classification; Engine requirements; Design consideration, Applications

COURSE OUTCOMES

on completion of the course, students will be able to

CO1: Understand the various component of heavy equipment machines
CO2: Understand the working of various earth moving vehicles
CO3: Analyse the eco vehicle technologies and its applications
CO4: Analyse engine requirement for heavy duty truck and vehicles
CO5: Classify and analyse moto sport vehicles.
CO6: Understand and analyse application and relevant design consideration for special vehicles.

TEXT AND REFERENCE BOOKS:

1. V. Ganesan, *Internal Combustion Engines*, 3rd edition, The Tata McGraw-Hill publications, 2017
2. Jack Erkavec, Automotive Engineering- Automatic Transmission & transaxles, classroom and shop manual, Cengage learning India Pvt Ltd, India Edition, 2011.
3. W.H., Anglin. D.L., "Automotive Transmission and Power Trains construction ", McGraw-Hill, 5th edition, 1976.
4. John Heywood, 'Internal Combustion engine fundamentals", McGraw Hill Education; 1 edition 2017.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part A: 4 Question form each unit – 10 marks each 40 Marks

Part B: 6 Numerical Questions – 10 marks each 60 Marks

20AE306T					Open Elective: III Vehicle Manufacturing					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	-	-	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- **To introduce basic engine components and its manufacturing process**
- **To introduce manufacturing of air filters and catalytic converter of spark plugs**
- **To explain the manufacturing and processing of glass components in automobile**
- **To provide understanding on sheet metal joining processing involved in automotive body manufacturing**

UNIT 1: INTRODUCTION TO AUTOMOTIVE ENGINE COMPONENTS-I: 10 Hrs.

Introduction to automotive Engines-overview of parts, Their function requirement, Material used in the automotive sector. Manufacturing of an engine block of cylinder head- Functional requirement of an engine block & cylinder head-Materials used in engine block casting. Manufacturing process – Low pressure die casting, High pressures die casting, expendable pattern casting. Machining – Cutting, Milling, Drilling, Boring, Honing, Reaming-Manufacturing of Camshaft-Functional requirement of Camshaft, Materials used in Camshaft, Production requirement-Process requirement–Closed die forging, Impression die forging-Finishing operations. Heat treatment. Manufacturing of crankshaft-Materials used in crankshaft manufacturing, Production requirement-Process requirement – Forging, Precision machining - Heat treatment

UNIT 2: MANUFACTURING OF AUTOMOTIVE ENGINE COMPONENTS–II: 10 Hrs.

Manufacturing of main bearing – Description, Purpose, Consistent wall thickness, Precise crush height, process requirement – Centrifugal casting, Mold material, Surface finishing for main bearing. Manufacturing of main bearing cap-Special treatment materials for cap-Hot & Cold chamber die casting-Precision drilling operation. Vibration damper-Functional requirement-Production requirement, Process description. Vacuum casting- Piston ring & pin-Description - types-Functional requirement- Material-Production requirement-Valves, Types of valves –Process – Cutting, Friction welding (Bimetal Special purpose), Upsetting, Forging, Stellied welding, Heat treatment, Grinding. Automotive springs-Manufacturing process–Hot rolling, oil tempering, cold oiling, stress relieving, nitriding, Strain aging. Inlet Manifold-Description, Injection molding. Exhaust manifold Description, Process – Welded tubular, Investment casting.

UNIT 3: MANUFACTURING OF AIR FILTERS AND CATALYTIC CONVERTER OF SPARK PLUGS 09 Hrs.

Manufacturing of Air filters-Description of Air filters, Core materials, sealing agents. Manufacturing of oil filters-Description of oil filters, Materials-Production-Manufacturing of ceramic catalytic convertor-Functional requirement-Material properties-Processing–Shaping, sintering, finishing. Manufacturing of metallic catalytic convertor-Description-Material properties- -Methods of forming honey comb-Manufacturing of spark plug-Functional requirement- Manufacturing process – Processing of ceramic, forming of electrode, bonding.

UNIT 4: MANUFACTURING OF GLASS, RUBBER PROCESSING TECHNOLOGY & AUTOMOTIVE BODY 10 Hrs.

Raw material preparation & melting-Properties of glass -Classification of glass for automotive application-Glass melting furnace-Pot furnace, Day tank, Continuous tank, Electric furnace-Shaping of Glass- Spinning, blowing-Shaping of flat glass – Rolling, float, Drawing of glass tubs-Forming of glass fibers-Centrifugal spraying-Drawing of continuous filaments-Heat treatment & finishing-Annealing, Tempered glass. Manufacturing of tyre-Component-Preparation, tyre building, curing and inspection.

Automotive materials-Automotive steel grades–Automotive stamping process & die-die operations-Deep drawing-Coating-Advances in metal forming-Hydro forming & extrusion-Automotive TIG welding-Robotic spot welders-Adhesive bonding-Advances in automotive welding-Friction welding-Automotive joining -Joining an automotive frame, Set assembling automotive doors-Final assembly-Installation of trim assembly-Installation of the chassis-Final assembly & testing-Ergonomics of the final assembly-Mechanical fastening & bolting

Max. 39 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Understand the functional requirement of automotive component for the required manufacturing process
CO2 – Design considerations for the manufacturing process for various automotive components
CO3 – Select the materials for the components based on its functionality
CO4 – Understand primary & secondary machining operation. Also special heat treatment & surface coating techniques
CO5 – Understand automotive welding technique for vehicle chassis
CO6 – The final assembly and ergonomics of automotive body

TEXT/REFERENCE BOOKS

1. Serope Kalpakjian, "Manufacturing Engineering and Technology", 6th Edition, Addison-Wesley Publishing Co., Boston, 2010.
2. Mikell P. Groover "Fundamentals of Modern Manufacturing", 4th Edition,John Wiley & Sons Inc, 2010
3. Mohammed A. Omar, "The Automotive Body Manufacturing System and Processes"1st Edition, John Wiley & Sons Inc, USA, 2011.
4. Helmi A Youssef, Hassan E El-Holfy, Mahmoud H Ahmed, "Manufacturing Technology", CRC Press, 2010
5. Benjamin W Niebel,"Modern Manufacturing Process Engineering", Mc Graw- HILL international editions, April 1989

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part A/Question: 8 Questions covering all Units, carrying 2.5 marks 20 Marks

Part B/Question: 2 Questions from each unit each carrying 10 marks 80 Marks

20HS301P					Communication Skills – III (Semester V/VI) (Third Year)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	0	2 hours per week	--	--	--	50	50	100

COURSE OBJECTIVES

- To strengthen the communication skills of professionals to make them ready for the modern workplace.
- To fine tune their professional skills and expertise using communication skills.
- To participate in the life long learning process with confidence and certainty.

UNIT 1 **10 hrs**

- Writing research proposals
- Writing technical projects

UNIT 2 **15 hrs**

- The Art of Presentation
  - *Sapiens: A Brief History of Humankind* (2011), Yuval Noah Harari
  - *Thank You for Being Late: An Optimist's Guide to Thriving in the Age of Accelerations* (2016), Thomas L. Friedman
  - (Presentation in teams of 4 students each, not more than two from the same branch, with a view to promote cross-disciplinary research)

UNIT 3 **5 hrs**

- Uploading portfolios on SlideShare
  - ✓ Uploading Video modules

Max. 30 hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

- CO 1 Demonstrate enhanced communications skills for enhanced team work for a better result.
- CO 2 Apply critical analysis for innovative thinking and well-rounded perspectives in different settings and contexts.
- CO 3 Analysis of situations to identify opportunities for professional and career growth through strong communication skills.
- CO 4 High competence of oral, written and visual communication skills for a workplace ready professional.
- CO 5 Realization and application of communication skills and language processes for multiple perspectives and interdisciplinary approach in profession.
- CO 6Improved communication skills for improved research, organizational, and critical thinking and perspective.

TEXT/REFERENCE BOOKS

1. Kaul, Asha. Business Communication. Delhi: Prentice-Hall of India, 2006.
2. Maley, A. 'Literature in the Language Classroom', The Cambridge Guide to Teaching ESOL, Cambridge University Press, 2001.
3. Richards, Jack C., and Willy A. Renandya, eds. Methodology in Language Teaching: An Anthology of Current Practice. Cambridge University Press, 2002.
4. Sharma, Sangeeta and Binod Mishra. Communication Skills for Engineers and Scientists. New Delhi: PHI Learning Pvt. Ltd., 2009.

Assessment Tool	Marks	Assignments
Lab Work	50	• Business Proposal – 15 • Research Project Proposal – 15 • Reviews on the two books – 20
Lab Exam/Viva	50	• Presentation on the reviews of the two books (Intra Branch) – 15 • Presentation on a technical topic (Inter Branch) – 15 • Slideshare/Video Modules (Prescribed Texts) – 20

Proposed Course Structure of B.Tech. in Automobile Engineering
COURSE STRUCTURE FOR B.TECH. THIRD YEAR (Automobile Engineering)

SEMESTER VI (Subjects)				B.TECH. THIRD YEAR (Automobile Engineering)											
Sr. No.	Category Code	Course Code	Course Name	Teaching Scheme					Exam Scheme						
									Theory			Practical		Total Marks
				L	T	P	C	Hrs/wk	CE	MS	ES	CE	ES	
1	PCC	20AE307T	Automotive Transmission	3	0	0	3	3	25	25	50	-	-	100
2	PCC	20AE307P	Automotive Transmission - Lab	0	0	2	1	2	-	-	-	25	25	50
3	PCC	20AE308T	Vehicle Dynamics	3	0	0	3	3	25	25	50	-	-	100
4	PCC	20AE308P	Vehicle Dynamics Lab	0	0	2	1	2	-	-	-	25	25	50
5	PCC	20AE309T	Finite Element Analysis	3	0	0	3	3	25	25	50	-	-	100
6	PCC	20AE309P	Finite Element Analysis Lab	0	0	2	1	2	-	-	-	25	25	50
7	PCE		Professional Core Elective - III	3	0	0	3	3	25	25	50	-	-	100
8	OE	20AE316T	Open Elective – IV Special Vehicles	3	0	0	3	3	25	25	50	-	-	100
9	PCC	20AE310P	Automotive Design Lab	0	0	4	2	4	-	-	-	25	25	50
10	Project	20TP310	Industrial Training/ IEP (6 weeks-summer break)	0	0	0	2	0	-	-	-	50	50	100
			Total	**15**	**0**	**10**	22	25						

CE = Continuous Evaluation MS = Mid Semester Exam ES = End Semester Exam

Professional Core Elective – III:

Course Code	Course Name		Course Code	Corse Name		Course Code	Course Name
20AE311T	Electric and Hybrid Vehicles		20AE315T	Wheel and Tyre Technology			
20AE312T	Ergonomics and Styling						
20AE313T	Connected Cars and Recent Advancements						
20AE314T	Two and Three Wheeler Technology						

20AE307T					Automotive Transmission					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To understand the need and role of transmission in the function of an Automobile.
- To analyse the effect of using different transmission systems on vehicle performance.
- To understand various allied technologies associated with Automotive transmission.
- To enable development of better technologies for innovative transmission.

UNIT 1 **14 Hrs.**

Introduction: Necessity and components of a Transmission system, layouts of Transmission system. Road loads and Power required for propulsion, Tractive resistance and tractive effort, Reactions for different wheel drives
Clutch: Constructional features and working of different types of clutch (like single plate, multi plate, cone, semi−centrifugal, fully, centrifugal, wet etc.) used in automobiles, calculation of surface area and number of driving and driven plates, nature of wear and tear of each component, effect of misalignment and mis−adjustment of components, fluid coupling, trouble shooting in clutch systems.

UNIT 2 **11 Hrs.**

Manual Transmission: Types, Sliding Mesh and Constant Mesh Gear Box, Synchromesh gear boxes and synchronizers. Performance characteristics.
Automated Manual Transmission: Types, Working and Constructional features, Performance Characteristics

UNIT 3 **12 Hrs.**

Hydrodynamic and Hydro Kinetic Drives: Fluid coupling, Torque converters, Multi-stage torque converters, Performance characteristics.
Automatic Transmission: Planetary Gear Trains, Wilson Gear Box, CVTs, Dual Clutch Transmission, Hydraulic control systems. Electronic Control.
Hydrostatic Drives and Electric Drives: Introduction, Features and performance characteristics.

UNIT 4 **08 Hrs.**

Propeller Shaft: Propeller shafts and their types, fluid drive and fluid flywheel, universal joints, hotchkiss drive, torque tube drive, whirling of propeller shaft.
Differential: Principle of the differential, locking differential, limited slip differential
Final Drive and Rear Axle: Final drives and its types, hypoid type final drive, rear axle, rear axle drives, rear axle shaft supporting, rear axle casing, axle breather, oil retention

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1 – Estimate power requirements for automobiles.
CO2 – Design clutch systems for automobiles.
CO3 – Examine various manual transmission systems and determine their performance characteristics.
CO4 – Analyse various automatic transmission systems and their support systems.
CO5 – Explain the function of hydrostatic drives and electric drives.
CO6 – Outline the function of other auxiliary components of a transmission system.

TEXT/REFERENCE BOOKS

1. Harald Naunheimer , Bernd Bertsche , Joachim Ryborz , Wolfgang Novak "Automotive Transmission: Fundamentals, Selection, Design and Application", 2nd Edition, Springer, 2011.
2. Kenneth Garrett, Kenneth Newton, W steeds, The motor vehicle, (13e), Butterworth-Heinemann Ltd, London, 2005.
3. Kirpal Singh, Automobile Engineering Vol− I & II, Standard Pub.& Dist.
4. Jack Erkavec, Automotive Technology- Manual transmission, Cengage learning India Pvt Ltd, 2011.
5. Heldt P.M, "Torque converters", Chilton Book Co., 1992.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

6 questions 5 marks each	30 Marks
7 questions 10 marks each	70 Marks

20AE307P					Automotive Transmission Lab.		
Teaching Scheme					Examination Scheme		
L	T	P	C	Hrs/Week	Practical		Total Marks
					Continuous Evaluation	End Semester	
-	-	2	1	2	25	25	50

COURSE OBJECTIVES

- To understand the construction and layout of major sub-assemblies in automotive transmission line.
- To develop a know-how and know-why regarding operational details of automotive transmission system.
- To develop a basic knowledge about how to install, inspect and maintain automotive transmission line during assembly of an automobile.

List of Experiments

1. To study layout of transmission system for a front wheel drive, rear wheel drive and a four-wheel drive arrangement.
2. Demonstrate construction and working of different types of friction clutches.
3. Demonstrate construction and working of manual gearbox for a two wheel and four-wheel automobile.
4. Study of layout and constructional details of an automatic gearbox.
5. Demonstrate functions of propeller shaft and universal joint.
6. Study and demonstrate working principle of overdrive mechanism.
7. Demonstrate working of a manual and electric transfer case.
8. Study of an electric drive in an Electric vehicle.
9. Demonstrate working and function of a differential mechanisms with differential lock and non-slip differential.
10. Demonstrate construction and operation of manual steering and power steering mechanism.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – **Understand** the basic layout an automotive transmission system.
CO2 – **Develop** a basic understanding on operation an automotive transmission system.
CO3 – **Establish** an understanding on types of gear boxes and steering mechanisms used in an automobile.
CO4 – **Analyze** the working of various types of frictional clutches used in an automotive industry.
CO5 – **Illustrate** the operation and importance of components such as propeller shafts, universal joint, transfer case, differential mechanism etc. for power transmission in an automobile.
CO6 – **Develop** a basic know-how regarding the installation, inspection and maintenance of automotive power transmission system of an automobile.

RESOURCES/TEXT/REFERENCE BOOKS

1. Automotive Transmission Lab Manual.
2. Naunheimer, H., Bertsche, B., Ryborz, J. and Novak, W., 2011. Automotive Transmission: Fundamentals, Selection, Design and Application. Springer.
3. Crouse, W. H., and Anglin D. L., 1976. Automotive Transmission and Power Trains construction. McGraw-Hill.
4. Jack Erkavec, Automotive Technology- Manual transmission, Cengage learning India Pvt Ltd, 2011.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 50 **Exam Duration: 2 Hrs**

Part A: Experiment/Quiz 20 Marks

Part B: Viva-Voce 30 Marks

20AE308T					Vehicle Dynamics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To understand the modelling approach for multibody systems like vehicles.
- To analyse the dynamic behaviour of a vehicle in different real-world scenarios.
- To understand the influence of sub-systems of a vehicle on its performance.
- To enable development of better technologies for superior vehicle performance.

UNIT 1 **11 Hrs.**

Multibody Systems: System definition and modeling, elements of multibody systems, equations of motion for multibody systems, fundamental approach to modeling.
One dimensional Dynamics of Vehicles: Various vehicle scenarios- Parked Car on a Level Road, Parked Car on an Inclined Road, Accelerating Car on a Level Road, Accelerating Car on an Inclined Road, Parked Car on a Banked Road, Vehicles on a Crest and Dip

UNIT 2 **12 Hrs.**

Road Loads: Aerodynamic Loads and its mitigation. Rolling resistance and their mechanisms.
Acceleration Performance: Power limited acceleration and traction limited acceleration.
Braking Performance of a vehicle: Basic equation for deceleration, braking forces, brakes and Anti-lock Braking System
Steering dynamics: Kinematics of steering, steering mechanisms, four-wheel steering, steering mechanism optimization, roll dynamics and rollover prevention: one DOF, four DOF roll dynamics, rollover dynamics, rollover index, Steady state cornering.

UNIT 3 **11 Hrs.**

Suspensions: Solid axles, Independent suspensions, anti-squat and anti – pitch suspension geometry, design and analysis of passive suspension, full half and quarter car models, model decoupling, verification of models, Active automotive suspensions, Active control, Active system asymptotes, trade - offs, Semi active suspensions, model analysis and optimal semi active suspension, suspension optimization.

UNIT 4 **8 Hrs.**

Tires: Tire stiffness, tire forces, rolling resistance, tire vibrations, Basic tire modeling considerations, semi – empirical type models, single contact point transient tire models, Longitudinal vehicle dynamics.

Max. 42 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1 – Demonstrate the modelling approach for multi-body systems.
CO2 – Build models for one-dimensional dynamics of vehicles.
CO3 – Examine various road loads along with the acceleration and braking performance of a vehicle.
CO4 – Analyse the steering dynamics of a vehicle.
CO5 – Analyse the effect of suspension systems on the performance of a vehicle.
CO6 – Determine the effect of tire characteristics on the performance of a vehicle.

TEXT/REFERENCE BOOKS

1. Thomas Gillespie, Fundamentals of Vehicle Dynamics, Society of Automotive Engineers, 1992.
2. Rajesh Rajamani, Vehicle Dynamics and Control, 2nd Edition, Springer publication, 2012.
3. Hans B Pacejka, Tire and Vehicle Dynamics, 3rd Edition, SAE International, 2012.
4. Karl Popp and Werner Schiehlen, Ground Vehicle Dynamics, Springer publication, 2010.
5. Raza Jazor, Vehicle Dynamics: Theory and Applications, 2nd Edition, Springer Publication, 2014.
6. Vehicle Dynamics: Theory and Applications by Raza Jazor, Springer Publication

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

4 questions 10 marks each	40 Marks
4 questions 15 marks each	60 Marks

20AE308P					Vehicle Dynamics Lab		
Teaching Scheme					Examination Scheme		
L	T	P	C	Hrs/Week	Practical		Total Marks
					Continuous Evaluation	End Semester	
-	-	2	1	2	25	25	50

COURSE OBJECTIVES

- To understand the fundamentals of computer simulation tools.
- To have a hands-on experience on the dynamic analysis for different car models.
- To develop multibody model for simulation of a vehicle.
- To simulate various vehicle components for their real time working.

List of Experiments

1. Simulation tools for Vehicle Dynamics-1
2. Simulation tools for Vehicle Dynamics-2
3. Simulation for suspension parameter optimization
4. Multi-body Dynamic simulation for quarter car model
5. Multi-body Dynamic simulation for half car model
6. Simulation of Steering systems-1
7. Simulation of Steering systems-2
8. Simulation for Braking Systems-1
9. Simulation for Braking Systems-2

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Develop basic skills for simulation using a computer.
CO2 – Determine the effect of various suspension parameters on the effective working of the suspension.
CO3 – Construct multi-body dynamic model for a quarter car.
CO4 – Construct multi-body dynamic model for a half car.
CO5 – Build simulation models for steering systems of an automobile.
CO6 – Build simulation models for braking systems of an automobile.

RESOURCES/TEXT/REFERENCE BOOKS

1. Vehicle Dynamics Lab Manual.
2. Gillespie T, “Fundamentals of Vehicle Dynamics”, Society of Automotive Engineers (SAE)”, 1992.

END SEMESTER LAB EXAMINATION

Max. Marks: 25 **Exam Duration: 2 Hrs**

Quiz/Experiment 10 Marks
Viva-Voce 15 Marks

20ME309T					Finite Element Analysis					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	-	-	3	3	50	100	25	--	--	100

COURSE OBJECTIVES

- To learn the theory and characteristics of finite element methods.
- To formulate the stiffness matrix for linear, quadratic and higher order elements for 1D, 2D and 3D cases.
- To learn and solve problems of beam, truss, frame, grid, plates, dynamic, thermal and fluid using variational and displacement methods.

UNIT 1 INTRODUCTION **12 Hrs.**

Introduction to Finite Element Method, Basic Concepts and Steps in FEM formulations, Discretization, General Applications of the Method, Comparison with other numerical methods, Integral formulations and Variation methods: Need of weighted Integral forms, Differential equations and Functional forms, Galerkin Methods, Point Collocation methods, Weak Formulations, Rayligh-Ritz Methods, Concept of Interpolation

UNIT 2 FINITE ELEMENT ANALYSIS OF ONE DIMENSIONAL PROBLEMS **10 Hrs.**

Linear, Quadratic and Higher order Elements, Beam Elements, Truss, and Grid Elements

UNIT 3 FINITE ELEMENT ANALYSIS OF TWO AND THREE DIMENSIONAL PROBLEMS **15 Hrs.**

Triangular, Quadrilateral and rectangular element, Natural Coordinates and Coordinates transformations, Connectivity of Elements, Introduction to 3D problems and its theoretical formulation

UNIT 4 APPLICATIONS OF FINITE ELEMENT ANALYSIS **5 Hrs.**

Solution of Dynamic Analysis, Plane Elasticity and Thermal Problems using Finite Elements Analysis

Max. 42 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – **Recall** the fundamental theory of FEM and concepts behind formulation methods in FEM.

CO2 – **Explain** the role and significance of variational methods considering linear, quadratic, and cubic shape functions.

CO3 - **Modify** the real world problems to 1D, 2D and 3D cases of finite element analysis by applying various FEA elements such as bars, beams, plane and iso-parametric elements.

CO4 – **Analyse** the bars, trusses, beams, heat transfer, fluid flow, and dynamic problems using suitable boundary conditions to a local as well as global equations.

CO5 – **Estimate** the deflections, stresses, and strains induced during failure of various components.

CO6 – **Formulate** and **simulate** various mechanical components subjected to different loading conditions using FEM.

TEXT/REFERENCE BOOKS

1. J.N. Reddy, An Introduction to Finite Element Method, McGraw Hill Publication(2003)
2. L.S. Segerlind, Applied Finite Element Analysis, John Wiley & Sons
3. S.S. Rao, The Finite Element Method in Engineering, Pergamon
4. D.L. Logan, A First Course in the Finite Element Method, Cengage Learning

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs**
5 Questions of 2 marks each-No choice	10 Marks
4 Questions of 5 marks each-No choice	20 Marks
5 Questions of 10 marks each-one choice and 1 question of 20 marks	70 Marks

20ME309P					Finite Element Analysis Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	-	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

- To learn the theory and characteristics of finite element methods.
- To solve problems of 1D, 2D, and 3D using FEA.
- To learn and solve problems of static, thermal, and dynamic problems.

Experiment No	Content
1	An introduction to software, stages of analysis, user interface, convergence testing, saving/restoring jobs, and importing/exporting.
2	Analysis of one dimensions problems
3	Analysis of Two Dimensional Problems: Plane stress and Plane strain
4	Analysis of Three Dimensional Problems: Static Analysis
5	Analysis of thermal Problems
7	Post Processing and interpretation
8	Major Project

Max. 30 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – **Recall** the fundamental theory of FEM and concepts behind formulation methods in FEM.

CO2 – **Explain** the role and significance of various elements/mesh used in FEA.

CO3 - **Modify** the real world problems to 1D, 2D and 3D cases of finite element analysis by applying various FEA elements such as bars, beams, plane, iso-parametric elements and solid elements.

CO4 – **Analyse** the bars, trusses, beams, heat transfer, fluid flow, and dynamic problems using suitable boundary conditions to a local as well as global equations.

CO5 – **Estimate** the deflections, stresses, and strains induced during failure of various components.

CO6 – **Formulate** and **simulate** various mechanical components subjected to different loading conditions using FEM.

TEXT/REFERENCE BOOKS

1. J.N. Reddy, An Introduction to Finite Element Method, McGraw Hill Publication(2003)
2. L.S. Segerlind, Applied Finite Element Analysis, John Wiley & Sons
3. S.S. Rao, The Finite Element Method in Engineering, Pergamon

LAB EXAMINATION PATTERN

Max. Marks: 100

Lab work	50 Marks
Lab Exam	50 Marks

20AE310P					Automotive Design Lab		
Teaching Scheme					Examination Scheme		
L	T	P	C	Hrs/Week	Practical		Total Marks
					Continuous Evaluation	End Semester	
-	-	4	2	4	25	25	50

COURSE OBJECTIVES

- To understand the fundamentals of Automotive Design.
- To gain proficiency in using engineering analysis tool.
- To perform analysis for various facets of an automobile.
- To perform crash analysis for a vehicle.

List of Experiments

1. To study the fundamentals of design.
2. To study the fundamentals of ANSYS, as a tool for analysis.
3. To perform structural analysis using 1D and 2D elements.
4. To perform structural analysis using 3D elements.
5. To perform thermal analysis for automotive systems-1.
6. To perform thermal analysis for automotive systems-2.
7. To perform structural analysis for Chassis frame-1.
8. To perform structural analysis for Chassis frame-2.
9. To perform aerodynamic analysis for a vehicle-1.
10. To perform aerodynamic analysis for a vehicle-2.
11. To perform Crash Analysis for a vehicle-1.
12. To perform Crash Analysis for a vehicle-2.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Outline the fundamentals of design and tool for analysis.
CO2 – Analyse structures in 1D, 2D and 3D modes.
CO3 – Analyse thermal aspects of an automobile.
CO4 – Analyse structural integrity of chassis frames.
CO5 – Analyse aerodynamics of a vehicle and thereby design better structures.
CO6 – Predict safety of a vehicle in a crash.

RESOURCES/TEXT/REFERENCE BOOKS

1. Automotive Design Lab Manual.
2. Esam M. A., Finite element simulation using ANSYS, Taylor & Francis Publication, 2010

END SEMESTER LAB EXAMINATION

Max. Marks: 25 **Exam Duration: 2 Hrs**

Quiz/Experiment 10 Marks
Viva-Voce 15 Marks

20AE311T					Electric and Hybrid Vehicles					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3		25	50	25	--	--	100

COURSE OBJECTIVES

- To understand the dynamic requirements of automobile sector/market and need of electric and hybrid vehicles.
- To compare, design and integrate the two power sources of hybrid vehicle.
- To classify and analyse various SI and CI engine components and thermodynamic cycles with combustion phenomenon.
- To perform the motor torque calculations and design the electrical drive and controller unit.
- To study and compare different types of hybrid/electrical vehicle architecture.

UNIT 1 Introduction to Conventional and Hybrid Electric Vehicles **10Hrs.**

Introduction to the power train in conventional or Internal combustion based automobile, electrical vehicles and hybrid electric vehicles, different energy sources for hybrid vehicles. **Electric/Hybrid Vehicle Architecture Design:** Types of Electric Vehicle and components, Electrical protection and system requirement, Photovoltaic solar based EV design, Battery Electric vehicle (BEV), Hybrid electric vehicle (HEV), Plug-in hybrid vehicle (PHEV), Fuel cell electric vehicle (FCEV), Electrification Level of EV, Comparison of fuel vs Electric and solar power, Solar Power operated Electric vehicles. **Engine** classifications, basic engine components and terminology, working principles of engines, four-stroke (4S) and two-stroke (2S) SI and CI engines, cooling system, exaust system, lubrication system.

UNIT 2 IC Engine and its performance characteristics **10 Hrs.**

Supercharging and turbo-charging, Two-stroke engines, Alternative engines. Performance and Testing: performance parameters, speed measurements, fuel consumption, brake power, friction power, indicator diagram measurements, heat balance sheet, performance comparison of SI and CI engines Alternative fuels for IC engines.

UNIT 3 Electric Drive and controller **10 Hrs.**

Types of power electricle, drive,Types of Motors and there performance characteristics, Selection and sizing of Motor, RPM and Torque calculation of motor, Motor Controllers. Function of Control Unit, Development Process, Software Hardware, Data Management and GUI/HMI. Technology Scenario, Market Scenario, Policies and Regulations, Payback and commercial model, Payback and commercial model, Polices in India.

UNIT 4 Battery & energy Management System and Charging systems/stations **10 Hrs.**

Need of BMS,Rule based control and optimization based control, Software-based high level supervisory control, Mode of power, Behavior of motor. Challenges of themal management of Batteries (both while charging and discharging, PCM bases cooling stratergies, next generation thermal managemnt systems. Type of Charging station, Selection and Sizing of charging station, Components of charging station, line diagram of charging station.

Max. 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Identify, choose and alter different types of **Electric/Hybrid Vehicle Architecture Design** based on the requirement

CO2 – To specify the specifications of IC engine/Electrical power drive.

CO3 - To design/specify the Battery management system and propose the type and specifications of charging stations

CO4 – To perform the heat balance sheet and performance analysis of IC engine

CO5 – To specify appropriate electric drive and perform RPM and Torque calculation of motor

CO6 – To present a comprehensive overview of Electric and Hybrid Electric Vehicles for current and futuristic market scenarios.

TEXT/REFERENCE BOOKS

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003
3. Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
4. M. Ehsani, Y. Gao, S. Gay and Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, CRC Press, 2005

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part A: 4 Question 40 Marks

Part B: 3 Question 60 Marks

20AE312T					Ergonomics and Styling					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	-	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To impart knowledge on Ergonomics in design of Automotive Vehicles
- To provide the knowledge of safety and styling in Automotive Vehicles

UNIT 1: Introduction to Automotive Ergonomics and Biomechanics 12 Hrs.

Ergonomics in Vehicle Design and its Approach its Origin of Ergonomics and Human Factors Engineering, Human Characteristics and Capabilities, Implementing Ergonomics, Anthropometry and Biomechanics: Anthropometry, Applications of Biomechanics. Driving Posture and Healthy Design, Driving Simulators.

UNIT 2: Occupant Packaging, Driver Information Acquisition and Processing 12 Hrs.

Vehicle Packaging, Sequence in Development of Vehicle Package, Definition of Key Vehicle Dimensions and Reference Points, Driver Package Development Procedures. Digital Human Modelling (DHM). Importance of Time, Understanding Driver Vision Considerations, Information Processing, Human Errors, Psychophysics, Visual Capabilities, Information Acquired through Other Sensory Modalities, Applications of Information Processing for Vehicle Design

UNIT 3: Design and Styling of Automobile Interiors 12 Hrs.

Design considerations of Controls, Displays, and Interior Layouts, methods to evaluate controls and displays, Field of view, Forward-Field-of-View Evaluations, Mirror Design Issues, Methods to measure.
Fields of View. Automotive Lighting, Design considerations of Lighting equipment like Headlight, Signal Light, Photometric measurements of Lamp outputs, headlamp evaluation. Entry and Exit of vehicles, Features and Dimensions related to Entry and Exit and methods to evaluate.

Unit 4: Design and Styling of Automobile exteriors 14 Hrs.

Study of Exterior Interfaces, design and their issues. Automotive Craftmanship, its importance, attributes, measurement methods. Human response to Vibration, thermal environments.
Design Exercises: Implementation of the ergonomics and styling to help build a package of a vehicle.

Max. 50 Hrs.

COURSE OUTCOMES:

On completion of the course, student will be able to
CO1 - **Develop** fundamental concepts related to Ergonomics in Automotive Design
CO2 - **Demonstrate** the fundamentals of Biomechanics in Automotive Design
CO3 - **Design** for Occupant packaging and safety
CO4 - **Estimate** design constraints while styling Automobile Interiors
CO5 - **Estimate** design constraints while styling Automobile Exteriors
CO6 - **Design** an automobile based on Ergonomics and Styling

TEXT/REFERENCE BOOKS

1. Bhise, V.D. Ergonomics in the automotive design process. CRC Press, 2016
2. Harvey, C. and Stanton, N.A., Usability evaluation for in-vehicle systems. CRC Press, 2016
3. Stuart, M. and H-Point: The fundamentals of car design and packaging. Art Center College of Design, 2009

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs**
Part A: 4 questions of 10 marks each	40 Marks (120 mins.)
Part B: 5 questions of 12 marks each	60 Marks (180 mins.)

20AE313T					Connected Cars and Recent Advancements					
Teaching Scheme					**Examination Scheme**					
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**			**Practical**		**Total Marks**
					MS	**ES**	**IA**	**LW**	**LE/Viva**	
3	**-**	**-**	**3**	**3**	**25**	**50**	**25**	**--**	**--**	**100**

COURSE OBJECTIVES

- **To understand working of Connected, automated and Intelligent cars**
- **To provide knowledge related to Sensor Technology for Advanced Driver Assistance Systems**
- **To study fundamentals of Wireless Technology**
- **To know about recent driver assistance system technology and recent development in automated technology**

UNIT 1 INTRODUCTION TO CONNECTED, AUTOMATED AND INTELLIGENT CARS 10 Hrs.

Introduction to Connected, automated and Intelligent cars: Automotive Electronics Overview, Advanced Driver Assistance Electronic Systems, Connected Car Technology: Connectivity Fundamentals, Navigation and Other Applications, Connected Car Display Technology, Connected and Autonomous Vehicle Technology: Basic Control System Theory applied to Automobiles, Overview of the Operation of ECUs, Basic Cyber-Physical System Theory and Autonomous Vehicles **Autonomous Vehicles:** Driverless Car Technology, Moral, Legal, Roadblock Issues, Technical Issues, Security Issues

UNIT 2 SENSOR TECHNOLOGY 9 Hrs.

Sensor Technology for Advanced Driver Assistance Systems: Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology, **Impaired Driver Technology:** Driver Impairment Sensor Technology, Sensor Technology for Driver Impairment Detection, Transfer of Control Technology

UNIT 3 WIRELESS TECHNOLOGY 10 Hrs.

Overview of Wireless Technology: Wireless System Block Diagram and Overview of Components, Transmission Systems – Modulation/Encoding, Receiver System Concepts – Demodulation/Decoding, Signal Propagation Physics, Basic Transmission Line and Antenna Theory, **Wireless System Standards and Standards Organizations: Wireless Networking and Applications to Vehicle Autonomy:** Basics of Computer Networking – the Internet of Things, Wireless Networking Fundamentals, Integration of Wireless Networking and On-Board Vehicle Networks

UNIT 4 RECENT DRIVER ASSISTANCE SYSTEM AND VEHICLES 9 Hrs.

Recent Driver Assistance System Technology: Basics of Theory of Operation, Applications – Legacy, Applications – New, Applications – Future, Integration of ADAS Technology into Vehicle Electronics, System Examples, Role of Sensor Data Fusion, Recent Driver Assistance System Technology applied in various automobile companies dealing with Non-Passenger Car, mini project to apply knowledge of various technologies related to connected vehicles.

Max. 38 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Understand technology applied in connected Cars
CO2: Explain basics and advancement in and Automated and intelligent Cars
CO3: Explore basics related to sensor technology in automated vehicles
CO4: Learn fundaments related to wireless technology in connected vehicles
CO5: Understand recent driver assistance system technology associated with automated vehicles
CO6: Apply knowledge of sensor and wireless technology to execute mini projects for connected cars

TEXT/REFERENCE BOOKS

1. G. Mullett, Wireless Telecommunications Systems and Networks, Thomson – Delmar Learning, ISNB#1-4018-8659-0, 2006
2. G. Mullett, Basic Telecommunications: The Physical Layer, Thomson – Delmar Learning, ISBN#1-4018-4339-5, 2003
3. Dietmar P.F. Möller, Roland E. Haas, Guide to Automotive Connectivity and Cybersecurity: Trends, Technologies
4. Tom Denton, Automobile Electrical and Electronic Systems

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part A/Question: 4 Questions from each unit, each carrying 10 marks	40 Marks
Part B/Question: 4 Questions from each unit each carrying 15 marks	60 Marks

20AE314T					Two and Three Wheeler Technology					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	-	-	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- **To present a problem oriented in depth knowledge of two and three wheeler technology.**
- **To address the underlying concepts and methods behind two and three wheeler technology.**
- **Understand special parts and their importance and working in two and three wheelers.**
- **Identify and locate different frames, suspension system and transmission unit used on various two and three wheeler vehicles.**

UNIT 1 Introduction **06 Hrs.**

Development, Classification & layouts of two wheelers (motorcycles, scooters, mopeds) and Three wheelers, applications & capacity – goods & passengers, study of technical specification of Two & Three wheelers

UNIT 2 Engine technology and Transmission Systems **14 Hrs.**

2 stoke and 4 stoke engines. Design criteria for engines – design of cylinders, cylinder head, cooling fins, crank case, connecting rod and crank shaft. Carburetor types and design. Battery coil ignition, magneto ignition and electronic ignition. Lighting and other electrical systems kick starter system. Clutch – special requirements, different types used in two & three wheelers, need of primary reduction, belt and chain drive, selection of transmission - gear transmission, gear shift mechanism, belt transmission, automatic transmission (Continuous Variable Transmission - CVT, Epicyclic), final drive & differential for three wheeler, wheel drive.

UNIT 3 Steering, Suspension and sub system **12 Hrs.**

Steering system arrangement for two & three wheelers, steering column construction, steering geometry, Suspension requirements, design considerations, trailing & leading link, swinging arm, springs & shock absorbers. Design consideration of brake, types of brakes – disc, drum, braking mechanism – mechanical, hydraulic & servo, wheel types - spokes, disc, split, construction of tube type tyre and tubeless tyres, it's advantages & comparison – methods vulcanizing of tubes & tyres for tubeless tyres, special tyre requirements for two & three wheelers.

UNIT 4 Frames and Maintenance **08 Hrs.**

Types of frame, construction, loads, design consideration, materials, Types of three wheeler bodies, layout, RTO regulations, aerodynamic, aesthetic & ergonomics considerations for body work, side car. Preventive & breakdown maintenance, factors affecting fuel economy & emission. Helmets: Types & purpose. Safety standards related to helmets.

40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - To understand the various subsystem of two and three wheeler.
CO2 - Discuss about the two-wheeler types, frames and transmission system.
CO3 - Describe about the three wheeler types, frames and design aspects
CO4 - Explain about steering systems, suspension system and brake systems.
CO5 - Discuss about cooling systems, lubrication systems, wheels and tires.
CO6 - Explain about the Power transmission Electric two and three wheelers.

TEXT/REFERENCE BOOKS

1. Newton Steed, "The Motor Vehicle", McGraw Hill Book Co. Ltd., New Delhi,2010
2. Siegfried Herrmann, "The Motor Vehicle", Asia Publishing House, Bombay,2011.
3. Dhruv U Panchal, "Two and three wheelers", Pearson Publications, 2007.
4. G.B.S. Narang, "Automobile Engineering", 5th Edition, Kh anna Publishers, Delhi,2010.
5. K.K. Ramalingam., "Two wheelers", Scitech Publications (India) Pvt. Ltd., Chennai 2012.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

4 Questions of 5 marks each –no choice 20 Marks

20AE315T					Wheel and Tyre Technology					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

6 Questions of 10 marks each –no choice 60 Marks
1 Questions of 20 marks each –no choice 20 Marks

COURSE OBJECTIVES

- To understand the rudimentary elements of Wheels and Tyres with reference to vehicles.
- To determine the influence of wheel assembly in vehicle performance.
- To understand the influence of wheels and tires on vehicle performance.
- To enable development of better technologies for superior tyre performance.

UNIT 1 **11 Hrs.**

Wheels: Wheel Terminology, Steel Wheels, Light Metal Wheels, Synthetic and Carbon Wheels, Wheel Development, Quality Assurance, Wheel Bolt and Wheel Assembly

UNIT 2 **12 Hrs.**

Tires: Tire fundamentals, Tire Manufacturing, Tire Development Process, Tire Project Management, Testing and Validation, Tire Characteristics

UNIT 3 **11 Hrs.**

Wheel Assembly: Valve Assembly, Wheel Uniformity, Wheel Mounting, Matching, Filling and Tire Inflation Pressure, Bead Seat Optimization, Tire Uniformity, Balancing Process, Quality Assurance

UNIT 4 **8 Hrs.**

Tire Models and Simulation: Tire stiffness, tire forces, rolling resistance, tire vibrations, Basic tire modeling considerations, Tire Models

Max. 42 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1 – Outline the fundamentals of wheel technologies for a vehicle.
CO2 – Summarize the tire technologies associated with vehicles.
CO3 – Analyse the tire characteristics for superior vehicle performance.
CO4 – Demonstrate the importance of wheel assembly for vehicle safety and stability.
CO5 – Analyse the balancing of wheels for safe vehicle operation.
CO6 – Develop models for tires for desired vehicle performance.

TEXT/REFERENCE BOOKS

1. Gunter Leister, Passenger Car Tires and Wheels, Springer, 2018.
2. Thomas Gillespie, Fundamentals of Vehicle Dynamics, Society of Automotive Engineers, 1992.
3. Hans B Pacejka, Tire and Vehicle Dynamics, 3rd Edition, SAE International, 2012.
4. Karl Popp and Werner Schiehlen, Ground Vehicle Dynamics, Springer publication, 2010.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**
4 questions 10 marks each 40 Marks
4 questions 15 marks each 60 Marks

20AE316T					Open Elective: IV Special Vehicles					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- **To classify and analyse various Earth moving vehicles**
- **To Classify, Analyse and evaluate engine capacity and design consideration for rail, motorbike and special vessel.**
- **To Classify and analyse the eco vehicle technologies.**

UNIT 1: EARTH MOVING VEHICLES **10 Hrs**

Earth Moving machineries: Classification of the various earth movers; Loader, excavator dozer, design considerations; Power train system;

UNIT 2: HEAVY DUTY VEHICLES **10 Hrs**

Vessel Engineering and Rail engineering; Heavy duty vehicles and trucks: Classification; Engine requirements; Design consideration, Applications

Unit 3: ECO Vehicle Technologies **10 Hrs**

Eco- Vehicle Technology: Classification; Engine requirements; Classification of alternate power sources; Design consideration, Applications

UNIT 4: MOTOR SPORT VEHICLES **10 Hrs**

Motor-Sport Engineering; Motor cycles and motor bikes: Classification; Engine requirements; Design consideration, Applications

COURSE OUTCOMES

on completion of the course, students will be able to

CO1: Understand the various component of heavy equipment machines
CO2: Understand the working of various earth moving vehicles
CO3: Analyse the eco vehicle technologies and its applications
CO4: Analyse engine requirement for heavy duty truck and vehicles
CO5: Classify and analyse moto sport vehicles.
CO6: Understand and analyse application and relevant design consideration for special vehicles.

TEXT AND REFERENCE BOOKS:

1. V. Ganesan, *Internal Combustion Engines*, 3rd edition, The Tata McGraw-Hill publications, 2017
2. Jack Erkavec, Automotive Engineering- Automatic Transmission & transaxles, classroom and shop manual, Cengage learning India Pvt Ltd, India Edition, 2011.
3. W.H., Anglin. D.L., "Automotive Transmission and Power Trains construction ", McGraw-Hill, 5th edition, 1976.
4. John Heywood, 'Internal Combustion engine fundamentals", McGraw Hill Education; 1 edition 2017.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part A: 4 Question form each unit – 10 marks each 40 Marks
Part B: 6 Numerical Questions – 10 marks each 60 Marks

20TP310					Industrial Training					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs. / Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
-	-	-	6	-	-	-	-	50	50	100

COURSE OBJECTIVES

- **To undertake six weeks of industrial training**
- **To understand the applications of theoretical concepts**
- **To relate the fundamentals of engineering to the real world engineering**
- **To identify the challenges of industries and propose a solution for it**

During Industrial training, students undergo six weeks of summer internship to identify and understand the problems and challenges faced in the industry and try to develop a methodology/solution for the same.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - To use acquired knowledge and skills in an industrial environment different from that of the home university.
CO2 - Become updated with all the latest changes in technological world.
CO3 –To bridge the gap between classroom teaching and industrial experience.
CO4 - To be a multi-skilled engineer with good technical knowledge, management, leadership, entrepreneurship skills and life-long learning.
CO5 - To identify, formulate and model problems and find engineering solution based on a systems approach.
CO6 – To be able to adapt self-improvement through continuous professional development.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: NA**
Part A: Viva	50 Marks
Part B: Report	50 Marks

Proposed Course Structure of B. Tech. in Automobile Engineering
COURSE STRUCTURE FOR B.TECH. FOURTH YEAR (Automobile Engineering)

SEMESTER VII (Subjects)				B.TECH. FOURTH YEAR (Automobile Engineering)											
Sr. No.	Category Code	Course Code	Course Name	Teaching Scheme					Exam Scheme					
				L	T	P	C	Hrs/wk	Theory			Practical		Total Marks
									CE	MS	ES	CE	ES	
1	PCC	20AE401T	Automotive Electricals and Electronics	3	0	0	3	3	25	25	50	-	-	100
2	PCC	20AE401P	Automotive Electricals and Electronics Lab	0	0	2	1	2	-	-	-	25	25	50
3	PCC	20AE402T	Vehicle Safety	3	0	0	3	3	25	25	50	-	-	100
4	PCC	20AE402P	Vehicle Safety Lab	0	0	2	1	2	-	-	-	25	25	50
5	PCE		Professional Core Elective - IV	3	0	0	3	3	25	25	50	-	-	100
6	PCE		Professional Core Elective - IV Lab	0	0	2	1	2	-	-	-	25	25	50
7	PCE		Professional Core Elective - V	3	0	0	3	3	25	25	50	-	-	100
8	PCE		Professional Core Elective – V Lab	0	0	2	1	2	-	-	-	25	25	50
9	PCE		Professional Core Elective - VI	3	0	0	3	3	25	25	50	-	-	100
10	Project	20TP410	Seminar and Technical Writing	0	0	4	2	4	-	-	-	25	25	50
			Total	**15**	**0**	**12**	21	27						

CE = Continuous Evaluation MS = Mid Semester Exam ES = End Semester Exam

Professional Core Elective – IV:

Course Code	Course Name		Course Code	Corse Name		Course Code	Course Name
20AE403	Computer Aided Design & Manufacturing						
20AE404	Advanced Manufacturing Technology						
20AE405	Heat and Mass Transfer						

Professional Core Elective – V:

Course Code	Course Name		Course Code	Corse Name		Course Code	Course Name
20AE406	Machine Design						
20AE407	Vehicle Testing and Automotive Standards						

Professional Core Elective – VI:

Course Code	Course Name		Course Code	Corse Name		Course Code	Course Name
20AE408T	Operations Research		20AE411T	Automotive Control Engineering			
20AE409T	Vehicle Aerodynamics		20AE412T	Automotive Manufacturing and Marketing			
20AE410T	Noise, Vibration and Harshness						

20AE401T					Automotive Electricals and Electronics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To understand the role of electrical systems in an automobile.
- To analyse the working of electronic control systems and their effect on vehicle performance.
- To understand various techniques of Vehicle motion control.
- To enable development of better technologies for superior vehicle performance.

UNIT 1 **11 Hrs.**

Batteries: Ratings and Designation, Types, Construction, Charging and Testing
Charging System: Alternator: construction and working, Circuits and rectification, DC Generator, Voltage Regulator.
Starting System: Requirements, Construction and Working, Starter Drive Mechanisms

UNIT 2 **12 Hrs.**

Lighting: Fundamentals, Circuits, Headlights, Other lights and auxiliaries like Wiper system, Signalling and Warning system.
Accessories: Power Windows, Boot lid, Sunroof, HVAC etc.
Engine Management Systems: Fuel Injection, Conventional Ignition System, Electronic Ignition System, Programmed Ignition System, Distributor-less ignition system, Engine Control Modes, Variable Valve Timing, Ignition Controlling

UNIT 3 **11 Hrs.**

Vehicle Motion Control: Cruise Control and Adaptive Cruise Control, Principle, Construction and Working. Anti-lock Braking System, Construction, Working and control. ESP and EBD. Electronic and Active Suspension systems, Electric Power Assisted Steering, construction and working, Steer-by-wire

UNIT 4 **8 Hrs.**

Vehicle Diagnostics: Electronic Control System Diagnostics, On-Board Diagnostics II, Fault Codes, Model based sensor failure detection.
Connected Cars: Concept and allied technologies, Navigation systems, communication protocols, models.

Max. 42 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1 – Appraise the role of battery and starting systems in the working of an automobile.
CO2 – Illustrate the working of lighting systems and various accessories in an automobile.
CO3 – Examine the function of Engine Management system and its effect on automobile performance.
CO4 – Summarize the technologies available for vehicle motion control.
CO5 – Analyse the diagnostics systems available for fault detection in an automobile.
CO6 – Explain various concurrent connected car technologies and the benefits offered by them.

TEXT/REFERENCE BOOKS

1. William. B. Ribbens, “Understanding Automotive Electronics” 7th edition Butterworth-Heinemann publications, 2012.
2. Tom Denton “Automobile Electrical and Electronic Systems” 3rd edition, Elsevier Butterworth-Heinemann, 2004.
3. Robert Bosch Gmbh “Bosch Automotive Electric and Electronics” 5th edition Springer-Vieweg, 2007

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

6 questions 5 marks each	30 Marks
7 questions 10 marks each	70 Marks

20AE401P					Automotive Electricals and Electronics Lab		
Teaching Scheme					Examination Scheme		
L	T	P	C	Hrs/Week	Practical		Total Marks
					Continuous Evaluation	End Semester	
-	-	2	1	2	25	25	50

COURSE OBJECTIVES

- To understand the fundamentals of automotive electrical and electronics systems.
- To have a hands-on experience on testing and overhauling various electrical and electronic systems of an automobile.
- To be acquainted with working and interfacing of sensors for modern day automobiles.
- To be acquainted with PWM for signal generation.

List of Experiments

1. To study the layout of Automotive Electrical system.
2. To test the battery using Hydrometer, Load test, etc.
3. To understand and demonstrate jump-start of a vehicle.
4. To understand and test starter motor working.
5. To understand and test alternator working.
6. To perform fault diagnostics using OBD.
7. To study the interfacing of sensors.
8. To study PWM signal generation.
9. To study the working of parking sensors.
10. To study the working of navigation systems.
11. To study the Instrument Cluster and communication protocols.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Develop basic skills for overhaul and testing of electrical and battery systems.
CO2 – Identify various testing methods for starters and alternators.
CO3 – Determine the role of On-board diagnostics in vehicle function.
CO4 – Demonstrate interfacing and working of various sensors in an automobile.
CO5 – Explain the PWM signal generation technique.
CO6 – Identify the function of instrument cluster and communication protocols thereof.

RESOURCES/TEXT/REFERENCE BOOKS

1. Automotive Electricals and Electronics Lab Manual.
2. Tom Denton “Automobile Electrical and Electronic Systems” 3rd edition, Elsevier Butterworth-Heinemann 2004.

END SEMESTER LAB EXAMINATION

Max. Marks: 25	**Exam Duration: 2 Hrs**
Quiz/Experiment	10 Marks
Viva-Voce	15 Marks

20AE402T					Vehicle Safety					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To understand the importance of vehicle safety.
- To analyse the crashworthiness of a vehicle.
- To understand various safety concepts in automobiles.
- To understand concurrent vehicle safety equipment and system.

UNIT 1 **12 Hrs.**

Introduction: Vehicle Safety, Instances of catastrophe and hazards, Design of Body for safety, Energy equations, Engine location. Effect of deceleration. Deceleration on impact. Crumble zone, Safety sandwich structure. Active and Passive Safety

UNIT 2 **11 Hrs.**

Safety Concepts: Active Safety-Driving and Conditional, Perceptibility safety, Operating Safety, Passive Safety-Exterior Safety, Interior Safety. Deformation behaviour, Pedestrian safety, Severity Index, Study of comparative tolerance, study of crash dummies.

UNIT 3 **11 Hrs.**

Safety Equipment: Seat belts and protection, types of seat belts, Airbags-operation and control, Frontal design for safety, collision warning system, Rear collision, Object detection and emergency braking, ABS, ESP, EBD, Lane-assist, Lane-watch and other safety provisions in modern vehicles.

UNIT 4 **8 Hrs.**

Crashworthiness: Introduction, Goals, Techniques to achieve Crashworthiness, Tests, Models Requirements, Design Practice, Comparison Between LMS and FE-Based Crashworthiness Processes, Lumped Mass-Spring Models, Limitations of LMS Models, Crash/Crush Design Techniques for Front Structures. Optimization of Vehicle Structures for Crash Worthiness. Types of Crash, Roll Over Tests, Regulatory requirements for Crash Testing

Max. 42 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Analyse the vehicle safety dynamics owing to sudden decelerations and impact.
CO2 – Illustrate various safety concepts from the perspective of vehicle and occupants.
CO3 – Explain various safety systems and protocols for pedestrian safety.
CO4 – Examine the function of various safety equipment and systems.
CO5 – Analyse the crashworthiness of a vehicle during impact.
CO6 – Design vehicle components for safety against impact and crash.

TEXT/REFERENCE BOOKS

1. Daniel J Helt, Recent development in Automotive Safety Technology, SAE International Publication, 2013.
2. Jullian Happian-Smith "An Introduction to Modern Vehicle Design" SAE, 2002
3. Paul Du Bois Clifford C. Chou Bahig B. Fileta Tawfik B. Khalil Albert I. King Hikmat F. Mahmood Harold J. Mertz Jac Wismans, Vehicle Crashworthiness and Occupant Protection, Automotive Applications Committee American Iron and Steel Institute Southfield, Michigan, 2004.
4. CAE Methods for Vehicle Crashworthiness and Occupant Safety, and Safety-critical Systems, SAE special publication: Society of Automotive Engineers, 2004.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

6 questions 5 marks each 30 Marks
7 questions 10 marks each 70 Marks

20AE402P					Vehicle Safety Lab		
Teaching Scheme					Examination Scheme		
L	T	P	C	Hrs/Week	Practical		Total Marks
					Continuous Evaluation	End Semester	
-	-	2	1	2	25	25	50

COURSE OBJECTIVES

- To understand the importance of vehicle safety.
- To analyse the crashworthiness of a vehicle.
- To study various safety equipment and features in different types of vehicles.
- To determine the crashworthiness of a vehicle.

List of Experiments

1. To study the types of hazards and accidents that a vehicle can face.
2. To study the vehicle safety features in two-wheelers.
3. To study the safety features in heavy duty vehicles.
4. To study the construction and working of different safety belts.
5. To study the construction and working of different types of SRS.
6. To study the factors affecting vehicle safety in times of crash.
7. To analyze the crashworthiness of a vehicle.
8. To develop models for crashworthiness of a vehicle.
9. To develop optimum solutions for safety against crash and impact.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Analyse the vehicle safety dynamics owing to sudden decelerations and impact.
CO2 – Determine various safety features in two wheelers.
CO3 – Determine various safety features in heavy duty vehicles.
CO4 – Explain the construction and working of various safety equipment in vehicles.
CO5 – Analyse the crashworthiness of a vehicle.
CO6 – Design solutions of ensuring and increasing safety in vehicles.

RESOURCES/TEXT/REFERENCE BOOKS

1. Vehicle Safety Lab Manual.
2. Daniel J Helt, Recent development in Automotive Safety Technology, SAE International Publication, 2013.

END SEMESTER LAB EXAMINATION

Max. Marks: 25	**Exam Duration: 2 Hrs**
Quiz/Experiment	10 Marks
Viva-Voce	15 Marks

20AE403T					Computer Aided Design & Manufacturing					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	-	2	5	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To gain knowledge of CAD/CAM/CAE in Automotive Design
- To gain knowledge of use of FMS and robotic technology in Automotive Design

UNIT 1: CAD FUNDAMENTALS AND GRAPHICS **12 Hrs.**

Evolution of CAD/CAM and CIM, computers and workstation, elements of interactive graphics, input/ out put display, storage devices in CAD, – networking of CAD systems - 2D Graphics: line drawing algorithms, DDA line algorithm – circle drawing, Bresenham`s circle drawing algorithm– 2D Transformation: translation, rotation, scaling, reflection – clipping -3D Graphics (basic only).

UNIT 2: GEOMETRIC MODELING AND NUMERICAL CONTROL **10 Hrs.**

Wire frame, surface and solid modeling - Engineering analysis; design review and evaluation, automated drafting. Numerical control: Need - advantages and disadvantages – classifications – Point to point, straight cut and contouring positioning - incremental and absolute systems – open loop and closed loop systems – DDA integrator and Interpolators – resolution – CNC and DNC.

UNIT 3: COMPUTER AIDED PROCESS PLANNING AND FMS **12 Hrs.**

Concepts; traditional and CAPP; automated process planning: process planning, general methodology of group technology, code structures of variant and generative process planning methods, AI in process planning, process planning software. Flexible Manufacturing Systems (FMS): Introduction, types, concepts, need and advantages of FMS - cellular and FMS - JIT and GT applied to FMS.

UNIT 4: ROBOTIC TECHNOLOGY **14 Hrs.**

Overview, basic components - robot end effectors – sensors in robotics – control of actuators in robotic mechanisms (basic only) – control of robot joint, stepper motor, direct drive actuators – hydraulic and pneumatic systems (basic only) – robot arm kinematics, direct and inverse kinematics solution robot arm dynamics – robot applications: material transfer, machine loading and unloading, pre cutting operations, assembly, inspection and welding.

48 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - **Build** the fundamental concepts related to CAD
CO2 - **Apply** algorithms to build CAD entities using Computer Graphics
CO3 - **Build** the fundamentals of numerical controls used in CNC and DNC
CO4 - **Apply** the concepts of Process planning using CAD tools
CO5 - **Build** the understanding of FMS system in Automotive industries
CO6 - **Develop** the fundamentals of Robotic Technology

TEXT/REFERENCE BOOKS

1. Yoram Koren - Numerical control of machine tools, McGraw-Hill.
2. M Groover and E Zimmers, Computer Aided Design And Manufacturing, 1st Ed, Pearson Education, New Delhi, 2003
3. G. E. Thyer, Computer Numerical Control of Machine Tools, Butterworth Heinemann, Butterworth-Heinemann, 1991
4. David F Rogers and J. Adams, Mathematical elements for computer graphics, 2nd Ed, TMH, 1990
5. Ibrahim Zeid, Mastering CAD/CAM, 2nd Edition, Tata Mc Graw Hill, New Delhi, 2003

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs**
Part A: 4 questions of 10 marks each	40 Marks (120 mins.)
Part B: 5 questions of 12 marks each	60 Marks (180 mins.)

Pandit Deendayal Energy University **School of Technology**

20AE403P					Computer Aided Design & Manufacturing Lab.		
Teaching Scheme					Examination Scheme		
L	T	P	C	Hrs/Week	Practical		Total Marks
					Continuous Evaluation	End Semester	
-	-	2	1	2	50	50	50

Pre-requisites: Geometric Modeling Lab

COURSE OBJECTIVES

- To apply knowledge of advanced CAD concepts and techniques by using contemporary CAD software.
- To create surfaces using synthetic curves
- To enable path programming for AGVs using commercial softwares

List of Experiments:

1. Recapitulate concepts of sketch entities and tools, Part Modeling
2. Recapitulate concepts of Assembly, Views
3. Recapitulate concepts of Sheetmetal drawing
4. Modeling using cosmetic curves like Bezier, B-Spline, T-Spline, NURBS
5. Introduction to Part programming using NC and CNC codes
6. Path programming for AGVs

COURSE OUTCOMES

On completion of the course, student will be able to
CO-1: Demonstrate competency in engineering drawing using a commercial CAD package
CO-2: Create 3D solid models, assemble using commercial CAD Packages
CO-3: Create 3D surface models using commercial CAD Packages
CO-4: Create views from 3D models, assemblies and vice a versa
CO-5: Simulate the machining operation using Part programming
CO-6: Programming using a commercial software package for path planning for AGVs

RESOURCES/TEXT/REFERENCE BOOKS

1. Geometric Modeling Lab Manual
2. http://www.solidworkstutorials.com/introduction-to-solidworks/
3. Machine Drawing by K. L. Narayan and Co, 3rd Edition, New Age International Publishers, New Delhi, 2016
4. Machine Drawing by Ajeet Singh, Tata McGraw- Hill Publishing Company Ltd, New Delhi, 2009
5. N D Junnarkar, Machine Drawing, Pearson Education Pvt Ltd; 1 edition, Singapore, 2007
6. MTAB path programming user manual

END SEMESTER LAB EXAMINATION

Max. Marks: 100	**Exam Duration: 2 Hrs**
Create surface models/generation of views	15 Marks (80 mins.)
Programming for pick and place of parts	10 Marks (40 mins.)

20AE404T					Advanced Manufacturing Technology					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	-	-	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- **To introduce various non-conventional/advanced machining techniques**
- **To introduce advanced welding techniques**
- **To explain the application of micro wave processing in manufacturing domain**
- **To provide basic understanding on advanced casting processes**

UNIT 1: ADVANCED MATERIAL REMOVAL PROCESSES (MECHANICAL): 10 Hrs.

Need for advanced material removal processes, Classification of advanced machining/material Removal processes, considerations in process selection and applications-Ultrasonic Machining Process–Mechanism of material removal, ultrasonic Machine and its process Parameters, Modeling of MRR in USM, economic considerations-Abrasive Flow Machining- Principle, AFM technology, process parameters in AFM, Ultrasonic flow polishing, Orbital AFM, Magneto abrasive flow machining, Centrifugal force assisted AFM-Abrasive jet machining–Principle, Components and process parameters, modeling of MRR in AJM for brittle material-Water jet and abrasive Water Jet Machining–Process principles, modeling of mixing process, modeling of MRR in WJM & AWJM

UNIT 2: ADVANCED MATERIAL REMOVAL PROCESSES (THERMAL, ELECTROCHEMICAL AND CHEMICAL): 12 Hrs.

Electrical Discharge Machining – EDM principle, Mechanism of material removal in EDM-Die sink EDM, wire cut EDM, Powder mixed EDM, overcut, ovality, taper ratio, taper angle in EDM, modeling of MRR in EDM, Micro-EDM (Introduction)-Laser Beam Machining–Principle of Laser, solid state lasers, gas state lasers, Classification of laser beams, Types of laser, Mechanism of Material Removal using laser beam, Process parameters, modeling of MRR in LBM-Electron beam machining–removal mechanism-Electrochemical Machining–Mechanism of Material Removal in ECM, The Subsystems of Electro-Chemical Machining, ECM process parameters, MRR of alloy in ECM, Dynamics of ECM (no feed condition and with feed condition. Economic aspects of ECM-Chemical machining: Important steps in chemical machining, etchants in chemical machining, Ultrasonic-Assisted Electrochemical Machining–Abrasive Electro-discharge Grinding, EDM with Ultrasonic Assistance-Electrostream drilling.

UNIT 3: ADVANCED WELDING PROCESSES 10 Hrs.

Cold metal transfer welding – Working principle, CMT pulse, Advanced CMT, application-Pulse arc welding – Pulse gas tungsten arc welding and pulse gas metal arc welding (P-GMAW)-Ultrasonic welding – Introduction of different types of ultrasonic welding (Ultrasonic seam welding, ultrasonic torsion welding, Ring welding, line welding), application-Electron Beam Welding – EBW Equipment, process parameters, process capabilities, advantages, limitation, application-Hybrid welding processes – Hybrid Laser Arc Welding, TIG-MIG hybrid welding, hybrid friction stir welding

UNIT 4: MICRO WAVE AND ADVANCED CASTING PROCESSES 07 Hrs.

Microwave Processing of Materials – The electromagnetic spectrum, Conventional and microwave heating, Polarization and Conduction, Unique benefits and distinctive features of Microwave Processing, Microwave Applications, Sintering using microwaves, Microwave Joining of non-metallic materials, Microwave coating and cladding-Advances in casting processes – Evaporative Pattern Casting, Hybrid Evaporative Pattern Casting Process, Vacuum Sealed Moulding Process, Ceramic Shell Investment Casting Process

Max. 39 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Understand various non-conventional/advanced manufacturing techniques
CO2 – Judge the energy source responsible for removing material in advanced machining techniques
CO3 – Analyse the influence of parameters on various advanced machining performance
CO4 – Select appropriate machining techniques for a given material
CO5 – Understand advanced welding methods
CO6 – Application of micro wave processing in manufacturing and Understand advanced casting processes

TEXT/REFERENCE BOOKS

1. Hassan El-Hofy, Advanced machining processes, Non traditional and hybrid machining processes, Tata Mcgraw Hill, 2005.
2. Mehta K., Advanced Joining and Welding Techniques: An Overview, Springer, 2017.
3. V. K. Jain, Advanced Machining Processes, Allied Publishers, 2009.
4. Serope Kalpakjian, Manufacturing Processes for Engineering Materials, Pearson Education India, 1984

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs**
Part A/Question: 8 Questions covering all Units, carrying 2.5 marks	20 Marks
Part B/Question: 2 Questions from each unit each carrying 10 marks	80 Marks

20AE404P					Advanced Manufacturing Technology Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	25	25	50

COURSE OBJECTIVES

- **To understand the working principle and operations of non-conventional machining techniques such as EDM, WEDM, ECM and ECDM processes.**
- **To familiarize additive manufacturing processes.**
- **To understand solid state cladding using friction surfacing**
- **To understand various advanced welding processes**

LIST OF EXPERIMENTS

1. Introduction to the safety aspects of conventional and non-conventional machining operations and Study of specification of machines through different catalogs.
2. Non- Conventional machining by using RAM-EDM and effect of process parameters
3. Non- Conventional machining by using Wire-EDM and effect of process parameters
4. Non- Conventional machining by using Electrochemical Machining (ECM) and effect of process parameters.
5. Non- Conventional machining by using Electrochemical Discharge Machining (ECDM) and effect of process parameters.
6. Demo on additive manufacturing of plastic components
7. Demo on Ultrasonic machining
8. Effect of ultrasonic welding variables on similar and dissimilar metal combinations
9. Effect of pulse parameters on weld bead profile
10. Solid state cladding using Fiction surfacing of Aluminium on steel
11. Arc Welding processes for Wire arc additive manufacturing

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Understanding various non-traditional machining processes

CO2: Analyse the effect of various parameters on machining performance of EDM and WEDM process

CO3: Analyse the effect of various parameters on machining performance of EDM and WEDM process

CO4: Appraise the influence of various parameters on ultrasonic welding process

CO5: Judge the uses of different welding techniques for surfacing and additive manufacturing applications.

CO6: Evaluate the performance of different non-conventional machining processes such as EDM, WEDM ECM and ECDM.

TEXT/REFERENCE BOOKS

1. Sharma PC. A Textbook of Production Enginerring. S. Chand Publishing, 1999.
2. Hmt, H.M.T. Production technology. Tata McGraw-Hill Education, 2001.
3. Nasir Ahmed ,New Development in Advance Welding, publishers, Wood head publishing Limited, England, 2007
4. Welding Hand Book Eight edition, Vol. 1, American Welding Society
5. J Vora, V J Badheka, Advances in Welding Technologies for Process Development, CRC Press, 2019.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 25 **Exam Duration: 2 Hrs**

Quiz/Experiment 10 Marks

Viva-Voce 15 Marks

20AE405T					Heat and Mass Transfer					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- **To understand the basic principles of heat transfer.**
- **To introduce real world engineering examples in engineering practice.**
- **To develop an intuitive understanding of heat transfer by emphasizing the physics.**
- **To understand the basics of mass transfer.**

UNIT 1 CONDUCTION **12 Hrs.**

Introduction: modes, mechanisms and basic concepts of heat transfer; Fourier's law, effect of thermal conductivity, thermal diffusivity; Industrial applications. Heat Conduction: Generalized (3D) heat conduction equation in the Cartesian, cylindrical and spherical co-ordinates; One dimensional steady state solution; temperature profile and heat transfer equations; Boundary conditions; wall, cylinder, sphere and composites; electrical analogy; overall heat transfer coefficient; Variable thermal conductivity; critical radius of insulation. Extended surfaces: fin performance parameters. Numerical calculation. Transient heat conduction: lumped system analysis; approximate analytical and graphical solutions for plane walls and semi-infinite solids.

UNIT 2 CONVECTION **12 Hrs.**

Heat Convection: Classification, physical mechanism and dimensional analysis applied to forced and free convection; local and average heat transfer coefficients and dimensionless numbers; Thermal and hydrodynamic boundary layers; Analogies between momentum and heat transfer; laminar and turbulent heat flow correlations for external flow. Internal forced convection: concept of average velocity and temperature; entrance region; General thermal analysis for laminar flow in a tube; heat transfer correlations for laminar and turbulent flow. Free convection: Equation of motion and the Grashof number; natural convection over surfaces and inside enclosures; combined natural and forced convection. Boiling and Condensation: Boiling regimes and the boiling curve; Film and drop wise condensation; correlations. flow boiling.

UNIT 3 RADIATION **10 Hrs.**

Thermal Radiation: Industrial applications, Concept of radiation, absorptivity, reflectivity & transmissivity, blackbody, grey surfaces, emissive power & emissivity. Laws of radiation – Planck, Stefan – Boltzman, Wein's displacement, Kirchoff. Intensity of radiation & solid angle, Lambert's cosine law, shape factor. Radiation heat exchange between black bodies, geometric configuration factor, heat exchange between diffuse-grey bodies-radiation shield, heat exchange between enclosed grey surfaces, electrical analogy to simple problems and non-luminous gas radiation.

UNIT 4 HEAT EXCHANGER **8 Hrs.**

Heat Exchangers: Industrial applications, classification, heat exchange performance analysis, LMTD for parallel & counter flow heat exchanger, overall heat transfer coefficient, fouling, correction factor for multi-pass arrangement, effectiveness and number of transfer unit for parallel and counter flow heat exchanger, cross flow, TEMA standards. Introduction to Mass Transfer: Fick's law; Analogy between heat and mass transfer; Mass diffusion: mass and molar basis; Diffusion through a stationary and moving medium; mass convection and analogies.

40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Comprehend modes of heat transfer and apply principles of heat transfer to solve engineering problems.
CO2 - Analyze and Solve problems involving steady and unsteady heat conduction.
CO3 - Evaluate convection heat transfer problems for a variety of flow conditions using convection correlations.
CO4 - Analyze heat exchanger performance using LMTD and NTU methods.
CO5 - Evaluate radiative heat exchange between two or more surfaces of different geometries
CO6 - Understand the basic principles of mass transfer.

TEXT/REFERENCE BOOKS

1. Yunus A. Cengel and Afshin J. Ghajar, Heat and Mass Transfer: Fundamentals and Applications, McGraw Hill Education. 5th Edition, 2017.
2. F. P. Incropera and D. P. DeWitt, Introduction to Heat Transfer, Wiley, , New York, 5th edition, 2006.
3. J. P. Holman, Heat Transfer, Tata McGraw Hill Education, 10th Edition, 2017.
4. F. White, Heat and Mass Transfer, Pearson Education (US), 1988.
5. S. P. Sukhatme, A Textbook of Heat Transfer, Universities Press, 4th Edition, 2005.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3Hrs**

Part A: 5 questions of 10 marks each 50 Marks (90 mins.)
Part B: 5 questions of 10 marks each 50 Marks (90 mins.)

20AE405P					Heat Transfer and Mass Transfer LAB					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	-	-	-	25	25	50

COURSE OBJECTIVES

- **To analyse, differentiate and evaluate different modes of heat transfer through various mediums.**
- **To evaluate steady and transient state properties of heat transfer mediums.**
- **To calculate and compare the performance of heat exchangers.**
- **To evaluate several characteristics of the conduction, convection and radiation.**

List of Experiments:

1. To identify the thermal Conductivity of a Metal Rod.
2. To identify the thermal Conductivity of Insulating Powder.
3. To identify the convective heat transfer of air in natural convection mode.
4. To identify the convective heat transfer of air in force convection mode.
5. To identify the effect of orientation in natural convection heat transfer.
6. To find out the performance parameter of concentric tube heat exchanger.
7. To verify the Stefan Boltzmann constant.
8. To identify the emissivity of a test material.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the engineering examples of different modes of heat transfer
CO2 - Evaluate and verify heat transfer modelling through experimentation
CO3 - Understand and analyse emissivity of a given materials.
CO4 - Understand and analyse thermal conductivity of a given insulating powder
CO5 - Examine the performance of heat exchangers.
CO6 - Compile and interpret the experimental data at steady state condition

TEXT/REFERENCE BOOKS

1. Yunus A. Cengel and Afshin J. Ghajar, Heat and Mass Transfer: Fundamentals and Applications, McGraw Hill Education. 5th Edition, 2017.
2. F. P. Incropera and D. P. DeWitt, Introduction to Heat Transfer, Wiley, , New York, 5th edition, 2006.
3. J. P. Holman, Heat Transfer, Tata McGraw Hill Education, 10th Edition, 2017.
4. F. White, Heat and Mass Transfer, Pearson Education (US), 1988.
5. S. P. Sukhatme, A Textbook of Heat Transfer, Universities Press, 4th Edition, 2005.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Quiz/Experiment	50 Marks
Viva	50 Marks

20AE406T					Machine Design					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	-	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To provide basic knowledge on the design considerations of various automotive components
- To impart knowledge on design to various force transmission elements like gears and bearings
- To provide the knowledge of design of an industrial gear box, brakes and clutches

UNIT 1: Design of Clutches and Brakes **11 Hrs.**

Clutches - Design requirements of friction Clutches, Selection criterion, Torque transmission Capacity, Lining Materials, Design of multiple disc clutches, cone clutch and centrifugal clutch. Brakes- Design of band and block brake, internal expanding shoe brake and disc brake, Thermal considerations for brakes and clutches.

UNIT 2: Design of Gear Drives **10 Hrs.**

Gear terminology, Standard system of gear tooth, Gear materials, Selection of type of Gears, Force analysis, Beam & Wear Strength, and Effective load on gear tooth for Spur Gears, Helical Gears, Bevel Gears. Terminology and force analysis, wear rating of Worm Gears, Heat dissipation in gears.

UNIT 3: Design Of Gear Box **09 Hrs.**

Geometric progression- standard step ratio, vehicle motion resistance, sliding mesh gear box, constant mesh gear box, synchromesh gearbox, multi speed gear box

UNIT 4: Design of Bearings **10 Hrs.**

Materials and selection of bearings, Working conditions for the bearings, Hydrodynamic lubrication theory for journal bearings, Design factors, Design procedure. Sliding Contact Bearings, Journal bearings, Rolling Contact Bearings-Types of the ball and roller bearings, Life rating, Basic capacities, Equivalent load, Loading ratio. Special bearings.

Max. 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Recall the fundamentals of mechanics of solid and kinematics.
CO2 - Explain the functioning of various mechanical components such as brakes, clutches, bearings and gears.
CO3- Apply the various kinematic and dynamic principles to design various mechanical components.
CO4- Analyse the forces and stresses in various machine elements.
CO5- Evaluate various machine elements based on the strength consideration.
CO6- Formulate a real life problem considering and Evaluate the various design and failure criterion as per the industry standards

TEXT/REFERENCE BOOKS

1. V.B. Bhandari, Design of Machine Elements, 4th Ed., Tata-McGraw Hill Publishers, 2017.
2. R. Norton, Machine Design: An Integrated Approach, 5th Ed., Pearson Education Publishers, 2013.
3. J. Shigley, C. Mischke, R. Budynas, Mechanical Engineering Design, 10th Ed., Tata-McGraw Hill, 2015.
4. U. C. Jindal, Machine Design, 1st Ed., Pearson, 2010.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs**
Part A/Question: 4 Questions (10 Marks Each)	40 Marks
Part B/Question: 5 Questions (12 Marks Each)	60 Marks

20AE406P					Machine Design Practical		
Teaching Scheme					Examination Scheme		
L	T	P	C	Hrs/Week	Practical		Total Marks
					Continuous Evaluation	End Semester	
--	--	2	1	2	**25**	**25**	**50**

COURSE OBJECTIVES

- To define mechanical problem and learn mathematical formulation.
- To learn Matlab coding, CAD modelling and ANSYS software.
- To perform analysis and interpret the results.

PART A: Minor Project

List of Design Problems: Manual design, Computer program and solid model using CREO

1. Design exercise for Brakes
2. Design exercise for Clutches
3. Design exercise for Spur/Helical gears
4. Design exercise for Bevel/Worm gears
5. Design exercise for Bearings
6. Design exercise for Gear boxes

PART B: Major Project

Consist of:

1. Conduct FEA analysis and understand the results. Visit of any one industry identified
2. Manual Design of the major design
3. Preparation of the Computer program for the design (for parametric analysis and optimization)
4. Preparation of the solid model, detail and assembly drawings using software
5. Analysis of the parts using FEA software
6. Preparation of the report

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Recall and List the programming, modelling and analysis software.

CO2 - Classify different types of analysis that can be performed on mechanical components.

CO3 - Prepare problem and Solve mathematical equations for simple interdisciplinary problem.

CO4 - Conduct FEA analysis and analyze the findings obtain through Matlab and FEA.

CO5 - Compare the results obtain using Matlab and ANSYS.

CO6 - Design and Develop Matlab code, CAD model and perform analysis for a real life problem of society.

TEXT/REFERENCE BOOKS

1. Rudra Pratap, Getting Started with MATLAB: A Quick Introduction for Scientists & Engineers, 1st Edition, Oxford University Press, 2010.
2. Steven C. Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientists, 3rd Edition, Tata McGraw-Hill Education, 2011.
3. Mary K. Thompson & John M. Thompson, ANSYS Mechanical APDL for Finite Element Analysis, 1st Edition, Butterworth-Heinemann, 2017.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 50 **Exam Duration: 2 Hrs**

Part A : Presentation based on Project 25 Marks

Part B : Viva 25 Marks

20AE407T					Vehicle Testing and Automotive Standards					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To understand the various facets of vehicle performance.
- To diagnose the factors affecting engine performance.
- To diagnose the factors affecting operations of a vehicle.
- To understand the various processes of Vehicle Testing.

UNIT 1 **11 Hrs.**

Engine Performance Diagnosis: Engine leak and noise Diagnosis, Exhaust, Oil consumption and Temperature tests, Cooling System Diagnosis, Power balance tests and Compression tests, Valve timing and clearance tests.

UNIT 2 **12 Hrs.**

Operational Performance: Engine Performance & Operating Characteristics, Operation at Full Load and Part Load Conditions, Effect of Vehicle Condition, Tire and Road Condition, Traffic Condition.

UNIT 3 **11 Hrs.**

Vehicle Testing: NVH, Power and Fuel Consumption, Testing on Chassis Dynamometer, Road and Track Testing, Initial Inspection, Run-in, Durability and Extensive Driving, Maximum Speed and Acceleration, Brake Testing.

UNIT 4 **8 Hrs.**

Automotive Standards: Vehicle Pollution Norms, Bharat Stage Standards, NCAP Standards for Vehicle Crash testing. Vehicle Standardization

Max. 42 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Outline the factors affecting Engine performance.

CO2 – Examine the function of various Engine components by appropriate testing.

CO3 – Analyse the engine performance and operating characteristics.

CO4 – Determine the effect of various operating factors on the performance of the vehicle.

CO5 – Design tests for testing vehicles for various operating conditions.

CO6 – Summarize various standards available for vehicles.

TEXT/REFERENCE BOOKS

1. Martyr A. J, Plint M. A, “Engine Testing Theory and Practice”, 3rd edition, Butterworth-Heinemann, 2007.
2. Crouse. W. H, Anglin. D. L, “Motor Vehicle Inspection”, McGraw Hill, 1978.
3. Giles J. G, Vehicle Operation & Performance, Illife Books Ltd., 1989.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

4 questions 10 marks each 40 Marks

4 questions 15 marks each 60 Marks

20AE407P					Vehicle Testing and Automotive Standards Lab		
Teaching Scheme					Examination Scheme		
L	T	P	C	Hrs/Week	Practical		Total Marks
					Continuous Evaluation	End Semester	
-	-	2	1	2	25	25	50

COURSE OBJECTIVES

- To understand the testing process for determining Engine Performance.
- To have a hands-on experience on testing and overhauling various components of an automobile.
- To be acquainted with Emission testing and analysis for modern day automobiles.
- To determine efficiencies of various sub-systems of a vehicle.

List of Experiments

1. To perform Morse Test on Petrol Engine.
2. To study the Valve Timing Diagram for 2S and 4S Engines.
3. To conduct performance test on Petrol Engines.
4. To conduct performance test on Diesel Engines.
5. To perform testing of four-wheeler using Chassis Dynamometer.
6. To perform Wheel Balancing.
7. To perform Wheel Alignment.
8. To measure the emissions from a vehicle using Gas Analyser.
9. To study the performance of two-wheeler vehicles.
10. To study the suspension efficiency of a vehicle.
11. To study the Braking efficiency of a vehicle.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Develop basic skills for overhaul and testing of vehicle systems.
CO2 – Identify various testing methods for Engine Performance Testing.
CO3 – Demonstrate wheel balancing and alignment.
CO4 – Test the emissions from a Vehicle.
CO5 – Determine the performance of two-wheeler vehicle.
CO6 – Analyze the suspension and braking efficiencies of a vehicle.

RESOURCES/TEXT/REFERENCE BOOKS

1. Vehicle Testing and Automotive Standards Lab Manual.
2. Martyr A. J, Plint M. A, “Engine Testing Theory and Practice”, 3rd edition, Butterworth-Heinemann, 2007.
3. Crouse. W. H, Anglin. D. L, “Motor Vehicle Inspection”, McGraw Hill, 1978.

END SEMESTER LAB EXAMINATION

Max. Marks: 25	**Exam Duration: 2 Hrs**
Quiz/Experiment	10 Marks
Viva-Voce	15 Marks

COURSE OBJECTIVES

- To know importance of operation research and their relative characteristics.
- To develop operation research strategy of a product/ process.
- To address the various operation research techniques for different processes.
- To study the concepts of game theory in industrial applications.

UNIT 1 **(10L)**

20AE408T					Operations Research					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	-	-	3	3	25	50	25	--	--	100

Introduction to operation Research and model building**,** review of basic linear algebra, concept of convexity, Introduction to linear programming, formulation of linear programming, the graphical method, the simplex method, feasibility, Un-boundness, alternative optima, degeneracy, the Big-M method, the Two phase method.

UNIT 2 **(10L)**

Duality in linear programming, sensitivity analysis, Goal programming, The transportation and transmission problems, solution methods, optimality test, degeneracy in TP. Assignment problem, Hungarian method, the Travelling Salesman Problem.

UNIT 3 **(10L)**

Introduction to integer programming, formulation of typical IP problems, the Branch and Bound method for solving pure and mixed IP, the cutting plane algorithm.

UNIT 4 **(10L)**

Introduction to game theory, two person zero sum games, saddle points, graphical solution, LP based solution, application of game theory, use of modelling software in operations research.

Max : 40 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to

- **CO 1.** **Define** the scope and importance of operation Research
- **CO 2.** **Analyse** the importance of operation research for design/manufacturing.
- **CO 3.** **Develop** the operation research technique for product/ process
- **CO 4.** **Summarize** the operation techniques allied with design/Manufacturing
- **CO 5.** **Apply** the principal of operation research for designing the process/ product.
- **CO 6.** **Examine** the various operation research guidelines for different processes.

TEXT/REFERENCE BOOKS

1. Winston, W., Operation Research: Applications and Algorithms, 4th Edition, Pearson publication, 2003.
2. Hiller and Lieberaman, Introduction to Operation Research, Tata McGraw Hill, 2005.
3. Taha, H., Operation Research: An Introduction, 8th Edition, Pearson publication, 2007.
4. Render, Stair, Hanna and Badri, Quantitative Analysis for Management, 12th Edition, Pearson Education, 2016.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part A/Question: 10 Questions from each unit, each carrying 2 marks	20 Marks
Part B/Question: 2 Questions from each unit with internal choice, each carrying 16 marks	80 Marks

COURSE OBJECTIVES

- To learn the theory and characteristics of vehicle aerodynamics.
- To learn Aerodynamic drag produced in ground vehicles and understand recent needs.
- To learn experimental Aerodynamics for ground vehicles.

20AE409T					Vehicle Aerodynamics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	-	-	3	3	50	100	25	--	--	100

UNIT 1 INTRODUCTION TO VEHICLE AERODYNAMICS **12 Hrs.**

Scope, History of Vehicle Aerodynamics, Present and Future Trends, Flow Phenomena Related to Vehicles, Effects of Viscosity, Aerodynamic Noise, Body to Body Interference, Resistance to vehicle motion, Fuel consumption and performance: Impact of aerodynamics

UNIT 2 AERODYNAMIC DRAG OF PASSENGER CARS **10 Hrs.**

General Concept of Drag, High Reynolds Number Flow versus Low Reynolds Number Flow, Lift, Drag, Side Force, and Moment, General Aerofoil Flow Behaviour, Sources of Drag in Ground Vehicles, The passenger car as a bluff body, Flow field around a passenger car, Introduction to Drag Fractions and Their Local Origins: Front End, Windshield and A-Pillar, Front Spoiler and Rear Spoiler etc.

UNIT 3 EXPERIMENTAL AERODYNAMICS FOR GROUND VEHICLES **10 Hrs.**

Requirements for a Vehicle Wind Tunnel, Fundamentals of Wind Tunnel Technique, Equipment, Limitations of Simulation, Tests with Reduced-Scale Models, Existing Automobile Wind Tunnels

UNIT 4 STRATEGIES FOR BODY SHAPE DEVELOPMENT AND RECENT RESEARCH **12 Hrs.**

Shape Optimization, Adaptation of Attachments, Facelift, Drag of Passenger Cars in Production, Drag Coefficients of Production Cars, Research: Concept Vehicles, Record Vehicles, Introduction to Computational Aerodynamics for Ground Vehicles

Max. 44 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – **Recall** the fundamental theory of Aerodynamics and flow phenomenon related to vehicles.
CO2 – **Explain** the role and significance of Drag and Computational aerodynamics applied to ground vehicles.
CO3- **Apply** the Wind tunnel to experimental aerodynamics of vehicles.
CO4 - **Solve** the problems of drags induced in various components of vehicle.
CO5 – **Analyse** the aerodynamics problems exist in components of ground vehicle.
CO6 – **Recommend** strategies for body development and optimization.

TEXT/REFERENCE BOOKS

1. Hucho W. H., Aerodynamics of Road Vehicles, SAE International Publications, 2006.
2. Yomi Obidi, Theory and Applications of Aerodynamics for Ground Vehicles, SAE International Publications.
3. Barnard R. H., Road Vehicles aerodynamics Desing - an introduction, MechAero publishing, 2009.
4. Mark Gleason, Vehicle aerodynamics design and technology, Society of Automotive Engineers, Incorporated, 2001.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

5 Questions of 2 marks each-No choice	10 Marks
4 Questions of 5 marks each-No choice	20 Marks
5 Questions of 10 marks each-one choice and 1 question of 20 marks	70 Marks

20AE410T	Noise Vibration and Harshness
Teaching Scheme	Examination Scheme

L	T	P	C	Hrs. / Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

To impart the knowledge of fundamental concepts of sound and vibration.
To determine the sources of noise and vibration.
To get acquainted with the concept of Harshness and NVH control.
To carry out vibration and sound measurement for various components of automobile.

UNIT 1 Fundamentals of Sound **11 Hrs.**

Definition of NVH, Vehicle noise - Direct and Indirect sound generation mechanism: structure borne sound; Subjective response sound, Acoustic variables, basic attributes of sound such as wavelength, period, frequency; speed of sound, Decibel scale, Wave equation, types of sound fields, Measures of sound: Sound pressure, sound intensity and sound power, Combining sources: dB arithmetic, Standing wave, Beating, Impedance, Human hearing: frequency Versus sound pressure level, Loudness: phons and sones as noise descriptors; Weighting networks, Leqand various noise metrics for road noises.

UNIT 2 Vehicle Vibration and Control **12 Hrs.**

Power train and Engine vibrations; driveline vibrations; chassis and suspension vibrations; Control strategies; Human response to vehicle vibrations, concept of harshness; subjective and objective evaluation of vehicle harshness. Introduction; damping of vibrations; vibration isolation and absorption; design of a Vibration absorbers, add on dampers and stiffeners, Introduction to Active Vibration Control.

UNIT 3 Harshness and NVH Control **11 Hrs.**

Definition of Harshness and acceptable degree of Harshness. Perception of Ride comfort i.e. psychological effects of Noise & Vibrations. Study of NVH - Legislations applicable for vehicles in India Source ranking, noise path analysis, modal analysis, design of experiments, Optimization of dynamic characteristics, vibration absorbers and Helmholtz resonators, active control techniques.

UNIT 4 Vibration and Sound Measurement **11 Hrs.**

Transducers and accelerometers, Excitation sources, Impact Excitation, Shaker excitation, Excitation signals, applications of Modal Analysis, laser based vibration measurements; analysis and presentation of vibration data. Noise specifications and mandatory standards regulations. Internal and External Sources of noise in vehicle. Noise Measuring Instruments: Microphone, Sound intensity probes, Acoustic Holography, Statistical Energy Analysis

45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to
CO 1: Describe the various sources of sound generation in automotive industry to control NVH.
CO2: Explain the sources of vehicle vibration.
CO3: Identify various types of dampers for vibration control.
CO4: Understand the concept of harshness and learn various control techniques.
CO 5: Describe the strategies to control Noise, Vibration and Harshness for the comfort of the passengers.
CO 6: Understand vibration and sound measurement techniques.

TEXT / REFERENCE BOOKS

1. Norton, Fundamental of Noise and Vibration, **2nd Edition** Cambridge University Press, 2003
2. B.M. Munjal, Acoustic Ducts and Mufflers, 2nd Edition ,John Wiley,2014
3. Sheng, Vehicle Noise, Vibration and Sound Quality, 1st Edition, SAE International,2012
4. Silva, Vibration Damping, Control, and Design,1st Edition, CRC Press,2007.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs**
Part A: 8 Questions of 2 Marks each	16 Marks (40 mins.)
Part B: 6 Questions of 14 Marks each	84 Marks (140 mins.)

COURSE OBJECTIVES

- To get the basic understanding of Controllers and their design

20AE411T					Automotive Control Engineering					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

- To obtain the mathematical modelling and dynamic response of mechanical, electrical, fluid and thermal systems and obtain results using MATLAB and Simulink.
- To utilize the knowledge of system transfer function and frequency response to design closed loop controls.

UNIT 1 Control system and mathematical modelling **8 Hrs.**

Introduction to Control systems-Basic components and applications, Classification of Control system, Feedback control system. Mechanical, electrical, thermal and hydraulic systems, Block diagram and signal flow graph analysis, Transfer function. Problem solving using MATLAB and Simulink.

UNIT 2 Time and frequency domain analysis **12 Hrs.**

Time Domain Analysis: Time domain specifications, Test signals, Transient response of First, Second and Higher order system, Effect of pole locations, Concept of stability, Relative stability, Routh's stability criterion. Frequency domain analysis: Time & frequency response relationship, Polar plots, Bode's plot, Stability in frequency domain, Nyquist plots, Nyquist stability criterion, Performance specifications in frequency-domain, Stability analysis and Relative Stability, Lead and lag compensation, Problem solving using MATLAB and Simulink.

UNIT 3 Root locus analysis and Controller Design **10 Hrs.**

Root locus method of analysis and design, Lead and lag compensation. Introduction to controllers, Types of control action, proportional, derivative and integral control, Controller Design (P, PD, PI, PID), Hydraulic controllers, Introduction to electronic controllers, Pneumatic controllers, Introduction to thermal controllers. Problem solving using MATLAB and Simulink.

UNIT 4 State Variable Analysis **10 Hrs.**

Block Diagram, Transfer functions and State Diagrams, Solution of state equations, Decomposition of Transfer functions, Concepts of controllability and observability, Pole placement, Proportional, Integral and Derivative feedback, Design of Servo systems, Design of Regulator system with observers, Design of Magnetic-Ball suspension system.

Max. 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Recall the basics of controllers, transfer function and block diagram.

CO2 - Classify the various types of control system and their applications.

CO3 - Explain the mathematical modelling and dynamic response of Physical systems.

CO4 – Distinguish and compare the time domain and frequency domain analysis.

CO5 – Evaluate different types of controllers based on time and frequency domain.

CO6 - Utilize system transfer function and frequency response to design closed loop controls.

TEXT/REFERENCE BOOKS

1. Kuo, Golnaraghi, Sridhar, Automatic Control Systems, 9th edition, Wiley India, 2009.
2. Katsuhiko Ogata, Modern Control Engineering, 5th Edition, PHI Learning Pvt Ltd, 2011.
3. Norman S. Nise, Control Systems Engineering, John Wiley & Sons, India, 5th Edition, 2008.
4. I. J. Nagrath, M. Gopal, Control Systems Engineering, Anshan, 8th Edition, 2008.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part A/Question: 6 Questions (10 Marks Each)	60 Marks
Part B/Question: 2 Questions (20 Marks Each)	40 Marks

COURSE OBJECTIVES

- To provide the basics in the automotive components and their manufacturing processes.
- To provide the fundamentals and working principles of automotive manufacturing technologies.

20AE412T					Automotive Manufacturing and Marketing					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	-	3	3	25	50	25	--	--	100

- To provide the advances in the automotive designs and manufacturing processes.
- To provide the basic understanding of automotive marketing.

15 Hrs.

UNIT 1 Introduction to Manufacturing of Automotive Engine Components

Introduction to automotive parts and their functional requirements-design considerations-materials selection-manufacturing of engine block, cylinder head, camshaft & crank shaft, main bearing and cap, damper, piston ring and pin, valves, springs, inlet & exhaust manifolds-production and process requirements for all-low & high pressure die casting, expendable pattern casting, centrifugal casting, hot & cold chamber die casting, vacuum casting, cold chamber die casting, forging, closed die forging, impression die forging, precision machining, monometallic, bimetal, stellied welded, chrome plate, hot rolling, heat treatment, oil tempering, cold oiling, nitriding, stress relieving, slot peering, strain aging, Injection molding, Injection molding, investment casting, process machining: cutting, milling, drilling, boring, honing, reaming, and finishing operations-quality consideration-manufacturing defects and remedies.

UNIT 2 Manufacturing of Air Filters And Catalytic Converter of Spark Plugs **5 Hrs.**

Air and oil filters, functionality, designs, filter materials, sealing agents, core materials, ceramic and metallic catalytic converters, functionalities, materials & components required, spark plug, design and materials used, shaping, sintering & manufacturing.

UNIT 3 Manufacturing of Glass &Rubber Processing Technology and Automotive Body **15 Hrs.**

Glass and types, properties, applications, design considerations-melting, furnaces & tanks, shaping, spinning, blowing, rolling, drawing, forming, centrifugal spraying, glass fibres, filaments & tubes, heat treatment, annealing, tempering & finishing-Tyres, functionality, materials selection, compound & mixing, manufacturing, tyre building, curing & inspection. Automotive materials, steels, grades, high strength & ultra-strength-stamping Al sheet, die operations & tooling, blank & sharing, dies, deep drawing, coating & lubrication, hydro forming & extrusion, industrial origami: metal folding, forming, flexible stamping, TIG welding-Robotic spot welders-adhesive bonding-friction welding, weld bonding-joining automotive frame-set assembling doors- trim assembly-chassis installation-final assembly & testing- ergonomic: mechanical fastening & bolting.

UNIT 4 Automotive Marketing **5 Hrs.**

Automation-Mass Production and Mass Marketing- Metamorphosis of the Automotive Market- Globalisation-New Model of Creating Value- Disruptive technologies and market disruption- Innovation and Digital Transformation in the Automotive Industry-Secrets of Success. **Max. 40 Hrs.**

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the fundamentals, design and functional aspects of automotive components

CO2 - Understand the design considerations and manufacturing processes used for automotive components

CO3 - Explain the basics of equipment and tools used in different automotive manufacturing technologies

CO4 - Analyse various types of designs/forces/energy/power used in automotive manufacturing processes

CO5 - Evaluate the challenges and innovations in the automotive marketing.

CO6 - Formulate the variations in selecting the automotive manufacturing processes for advanced designs.

TEXT/REFERENCE BOOKS

1. Serope Kalpakjian, Manufacturing engineering and Technology, Wesley Publishing Co.
2. Mikell P. Groover "Fundamentals of Modern Manufacturing", 4th Edition, John Wiley & Sons Inc., 2010
3. Mohammed A. Omar, "The Automotive Body Manufacturing System and Processes"1st Edition, John Wiley & Sons Inc, USA, 2011.
4. Candelo, Elena, Marketing Innovations in the Automotive Industry, Springer publications

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part A/Question: 8 Questions from all units together - each carrying 2.5 marks 20 Marks

Part B/Question: 2 Questions from each unit each carrying 10 marks 80 Marks

COURSE OBJECTIVES

20TP410					Seminar and Technical Writing					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	4	2	04	-	-	-	-	-	50

- Students can gain skills of group interaction, skills of integrative discussion, critical evaluation and exploring and mining a text through seminar.
- Students can develop the technical writing skill

Seminar

Each student must present any technical topic for 15 mins followed by an evaluation by a teacher for 10 minutes using evaluation criteria. All other students must attend and can give suggestions. Each student must give minimum two presentations per semester.

Technical writing

1	Definitions, structure and types of reports	6Hrs
2	Importance of references, glossary and bibliography. How to write and insert them in reports.	6 Hrs
3	Use and types of charts and illustrations in report writing	6 Hrs
4	Various report writing techniques	6 Hrs
5	Computer aided report writing practices	6 Hrs
		30 Hrs

COURSE OUTCOMES

On outcome of the course would be as follows:
CO-1: Shy or reserved students find voice.
CO-2: Students are highly motivated to research and prepare for discussion
CO-3: Group sharing provides a more in-depth understanding of the text
CO-4: Students develop the skills for report writing.
CO-5: Students learn the standard process to write a publication quality report or research article
CO-6: Familiarization of various software tools for report writing

References:

1. Malcolm Goodale, Professional Presentations, Cambridge University Press (2009)
2. MK Rampal and S L Gupta, Project report writing, Galgotia Publishing Company, New Delhi (2010)

END SEMESTER EXAMINATION PATTERN

Max. Marks: 50

Part A: Writing skill 25 marks
Part B: Presentation 25 Marks

Proposed Course Structure of B.Tech. in Automobile Engineering

COURSE STRUCTURE FOR B.TECH. FOURTH YEAR (Automobile Engineering)

SEMESTER VIII (Subjects)				B.TECH. FOURTH YEAR (Automobile Engineering)											
Sr. No.	Category Code	Course Code	Course Name	Teaching Scheme					Exam Scheme						
				L	T	P	C	Hrs/wk	Theory			Practical		Total Marks
									CE	MS	ES	CE	ES	
1	Project	20TP420	Major Project/ Comprehensive Project	-	-	-	13	-	-	-	-	50	50	100
Total				**-**	**-**	**-**	13	-						

CE = Continuous Evaluation MS = Mid Semester Exam ES = End Semester Exam

20TP420					Major Project					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs. / Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
			13	13				50	50	100

COURSE OBJECTIVES

- To demonstrate a sound technical knowledge of their selected project topic.
- To study the problems of industry/society and apply engineering knowledge to solve the problem.
- Ability to solve complex problems and find engineering solution based on a systems approach.
- To communicate with engineers and the community at large in written an oral form.
- Become updated with all the latest changes in technological world and capability and enthusiasm for self-improvement through continuous professional development

COURSE OUTCOMES

On completion of the course, student will be able to

CO1- Define the relevance of project topic selected for the study with the help of studied techniques/principles.

CO2- Summarize the problem statement with the help of literature survey, analytical and documentation skills.

CO3- Apply the data/information gathered for problem to construct the project planning.

CO4- Analyze and solve the problems using latest tools/techniques and experimental observations/theoretical modelling through critical investigation.

CO5- Develop effective report writing, presentation and communication skills.

CO6- Practice the acquired knowledge, skills and attitudes for becoming a professional engineer

20TP420					Comprehensive Project					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	0	13	13	--	--	--	--	--	--

COURSE OBJECTIVES

- To demonstrate a sound technical knowledge of their selected project topic.
- To study the problems of industry/society and apply engineering knowledge to solve the problem.
- Ability to solve complex problems and find engineering solution based on a systems approach.
- To communicate with engineers and the community at large in written an oral form.
- Become updated with all the latest changes in technological world and capability and enthusiasm for self-improvement through continuous professional development

COURSE OUTCOMES

On completion of the course, student will be able to

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CO4 – Analyze and solve the problems using latest tools/techniques and experimental observations/theoretical modelling through critical investigation.

CO5 – Develop effective report writing, presentation and communication skills.

CO6 – Practice the acquired knowledge, skills and attitudes for becoming a professional engineer.