RAJALAKSHMI ENGINEERING COLLEGE

An AUTONOMOUS Institution
Affiliated to ANNA UNIVERSITY, Chennai

REGULATIONS R2019

Curriculum and Syllabus

for

B.E. AUTOMOBILE ENGINEERING

Choice Based Credit System

(For students admitted in
The academic years 2021-22 & 2022-23)

RAJALAKSHMI ENGINEERING COLLEGE

(An Autonomous Institution Affiliated to Anna University Chennai)

Choice Based Credit System

DEPARTMENT OF AUTOMOBILE ENGINEERING

CURRICULUM AND SYLLABUS REGULATIONS – 2019

B.E. AUTOMOBILE ENGINEERING

VISION:

To be a department of excellence in the domain of Automotive Engineering and develop competent engineers imbibed with entrepreneurial and innovative skills with a concern for the society.

MISSION:

- To provide accessible quality education well grounding the students in the fundamental principles of Automotive Engineering and humane values.
- To provide a conducive environment for the students to get transformed themselves into professionals who can design, develop and effectuate automotive systems for industry and societal needs.
- To explore, develop and create innovations in Automotive Engineering thereby furthering research activities resulting in products satisfying industrial and social needs.

PROGRAMME EDUCATIONAL OBJECTIVES (PEO'S)

1. To provide students with sound foundation in the mathematical, scientific and engineering fundamentals necessary to formulate, analyze and solve engineering problems and to prepare them for higher studies and for successful careers in automobile industry.

2. To impart students with knowledge, innovation and skills towards research, design and development of Automotive Systems and allied integrated systems of global standards for betterment of society. To impart knowledge in usage of alternate fuels and emission control in IC engines.

3. To instill the values, skills, leadership, team spirit and professional ethics for comprehensive and wholesome personality and to promote entrepreneurial interest among students so that they can compete globally in the field and to create a fervor for use of Engineering in addressing societal concerns.

PROGRAM OUTCOMES (PO)

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSO's)

PSO1. Will be able to design and develop power plant and chassis systems in a view to meet the dynamic needs of the society by harnessing the potential of electronic systems and modern software tools.

PSO2. Will be able to explore possibilities of viable alternate fuels and to develop emission control technologies and safety systems

PSO3. Will be able to work in an industry as a team member as well as an individual with professional qualities and evolve oneself for lifelong learning.

CURRICULUM AND SYLLABUS

CURRICULUM

Semester I							
Course Code	**Course Title**	**L**	**T**	**P**	**Total**	**C**	**CAT**
HS19151	Technical English	2	1	0	3	3	HS
MA19151	Algebra and Calculus	3	1	0	4	4	BS
PH19141	Physics of Materials	3	0	2	5	4	BS
GE19101	Engineering Graphics	2	2	0	4	4	ES
GE19121	Engineering Practices – Civil and Mechanical	0	0	2	2	1	ES
MC19101	Environmental Science and Engineering (Non Credit course)	3	0	0	3		MC
	Total	**13**	**4**	**4**	**21**	**16**	

Semester II							
Course Code	**Course Title**	**L**	**T**	**P**	**Total**	**C**	**CAT**
MA19251	Differential Equations and Vector Calculus	3	1	0	4	4	BS
CY19241	Engineering Chemistry	3	0	2	5	4	BS
EE19241	Basic Electrical Engineering	3	0	2	5	4	ES
GE19211	Problem solving and programming in Python	1	0	4	5	3	ES
GE19201	Engineering Mechanics	2	1	0	3	3	ES
GE19122	Engineering Practices - Electrical and Electronics	0	0	2	2	1	ES
MC19102	Indian Constitution and Freedom Movement (Non Credit course)	3	0	0	3		MC
	Total	**15**	**2**	**10**	**27**	**19**	

Semester III							
Course Code	**Course Title**	**L**	**T**	**P**	**Total**	**C**	**CAT**
GE19304	Fundamentals of Management for Engineers	3	0	0	3	3	HS
MA19351	Transforms and Statistics	3	1	0	4	4	BS
AT19341	Applied Thermodynamics	2	1	3	6	4.5	ES
AT19342	Automotive Engines	3	0	3	6	4.5	PC
AT19343	Strength of Materials for Automobile Engineers	2	1	3	6	4.5	PC
EC19351	Basic Electronics Engineering	3	0	0	3	3	ES
AT19311	Computer Aided Machine Drawing Laboratory	0	0	3	3	1.5	PC
MC19301	Essence of Indian Traditional Knowledge (Non Credit course)	3	0	0	3		MC
	Total	**19**	**3**	**12**	**34**	**25**	

Semester IV							
Course Code	**Course Title**	**L**	**T**	**P**	**Total**	**C**	**CAT**
AT19401	Engineering Materials and Metallurgy	3	0	0	3	3	ES
AT19402	Production Technology - I	3	0	0	3	3	PC
AT19441	Fluid Mechanics and Machinery for Automobile Engineers	2	1	2	5	4	PC
AT19442	Automotive Drive Line and Chassis	4	0	2	6	5	PC
AT19443	Theory of Machines	2	1	2	5	4	PC
GE19421	Soft Skills - I	0	0	2	2	1	EEC
CS19411	Python Programming for Machine Learning	1	0	4	5	3	ES
	Total	**15**	**2**	**12**	**29**	**23**	

Semester V							
Course Code	**Course Title**	**L**	**T**	**P**	**Total**	**C**	**CAT**
AT19501	Machine Design	2	1	0	3	3	PC
AT19502	Electric and Hybrid Vehicles - I	3	0	0	3	3	PC
AT19541	Automotive Electrical and Electronics	3	0	3	6	4.5	PC
AT19542	Production Technology - II	3	0	3	6	4.5	PC
	Open Elective - I	3	0	0	3	3	OE
	Professional Elective - I	3	0	0	3	3	PE
AT19521	Two and Three wheelers Laboratory	0	0	2	2	1	PC
AT19522	Computer Aided Vehicle Design Data Characteristics Laboratory	0	0	2	2	1	PC
GE19521	Soft Skills - II	0	0	2	2	1	EEC
	Total	**17**	**1**	**12**	**30**	**24**	

Semester VI							
Course Code	**Course Title**	**L**	**T**	**P**	**Total**	**C**	**CAT**
AT19601	Electric and Hybrid Vehicles - II	3	0	0	3	3	PC
AT19602	Automotive Pollution and Control	3	0	0	3	3	PC
AT19641	Automotive System Design	2	1	3	6	4.5	PC
AT19642	Automotive Fuels and Lubricants	3	0	2	5	4	PC
AT19643	Vehicle Dynamics	2	1	3	6	4.5	PC
	Open Elective - II	3	0	0	3	3	OE
GE19621	Problem solving techniques	0	0	2	2	1	EEC
AT19611	Design Thinking and Innovation for Automobile Engineers	0	0	4	4	2	EEC
	Total	**16**	**2**	**14**	**32**	**25**	

Semester VII							
Course Code	**Course Title**	**L**	**T**	**P**	**Total**	**C**	**CAT**
AT19701	Vehicle Management System	3	0	0	3	3	PC
AT19702	Intelligent Vehicle System	3	0	0	3	3	PC
	Professional Elective – II	3	0	0	3	3	PE
	Professional Elective – III	3	0	0	3	3	PE
AT19721	Vehicle Maintenance Laboratory	0	0	2	2	1	PC
AT19722	Computer Aided Analysis laboratory	0	0	2	2	1	PC
AT19723	Technical Seminar / Industrial Training / Comprehension	0	0	2	2	1	EEC
AT19711	AI and ML for Automobile Engineers	0	0	6	6	3	PE
AT19713	Project - Phase I	0	0	4	4	2	EEC
	Total	**12**	**0**	**16**	**28**	**20**	

Semester VIII							
Course Code	**Course Title**	**L**	**T**	**P**	**Total**	**C**	**CAT**
	Professional Elective – IV	3	0	0	3	3	PE
	Professional Elective – V	3	0	0	3	3	PE
AT19811	Project – Phase II	0	0	12	12	6	EEC
	Total	**6**	**0**	**12**	**18**	**12**	

Professional Elective - I							
Course Code	**Course Title**	**L**	**T**	**P**	**Total**	**C**	**CAT**
AT19P51	Automotive Transmission	3	0	0	3	3	PE
AT19P52	Automotive Heat Transfer	3	0	0	3	3	PE
AT19P53	Two and Three Wheelers	3	0	0	3	3	PE
AT19P54	Control Engineering	3	0	0	3	3	PE
MA19451	Numerical Methods	3	0	0	3	3	PE

Professional Elective - II							
Course Code	**Course Title**	**L**	**T**	**P**	**Total**	**C**	**CAT**
AT19P71	Automotive Sensors	3	0	0	3	3	PE
AT19P72	Tractors and Farm Equipment	3	0	0	3	3	PE
AT19P73	Automotive Safety	3	0	0	3	3	PE
AT19P74	Instrumentation and Metrology	3	0	0	3	3	PE
ME19P81	Operations Research	3	0	0	3	3	PE
ME19P68	Geometric Dimensioning and Tolerances	3	0	0	3	3	PE

Professional Elective - III							
Course Code	**Course Title**	**L**	**T**	**P**	**Total**	**C**	**CAT**
AT19P75	Finite Element Analysis for Automobile Engineers	3	0	0	3	3	PE
AT19P76	Vehicle Maintenance	3	0	0	3	3	PE
AT19P77	Noise, Vibration and Harshness Control	3	0	0	3	3	PE
ME19P72	Additive Manufacturing	3	0	0	3	3	PE
ME19603	Total Quality Management	3	0	0	3	3	PE

Professional Elective - IV							
Course Code	**Course Title**	**L**	**T**	**P**	**Total**	**C**	**CAT**
AT19P81	Vehicle Body Engineering	3	0	0	3	3	PE
AT19P82	Off road vehicles	3	0	0	3	3	PE
AT19P83	Production of Automotive Components	3	0	0	3	3	PE
ME19P74	Hydraulics and Pneumatics	3	0	0	3	3	PE
ME19P84	Computational Fluid Dynamics	3	0	0	3	3	PE

Professional Elective - V							
Course Code	**Course Title**	**L**	**T**	**P**	**Total**	**C**	**CAT**
AT19P84	Automotive Testing	3	0	0	3	3	PE
AT19P85	Automotive Air-Conditioning	3	0	0	3	3	PE
AT19P86	Automotive Aerodynamics	3	0	0	3	3	PE
AT19P87	Transport Management	3	0	0	3	3	PE
GE19P72	Entrepreneurship Development	3	0	0	3	3	PE

Open Elective (Offered to other branches)							
Course Code	**Course Title**	**L**	**T**	**P**	**Total**	**C**	**CAT**
AT19O31	Automotive Systems	3	0	0	3	3	OE
AT19O32	Automotive Sensors and Actuators	3	0	0	3	3	OE
AT19O33	Elements of Electric and Hybrid Vehicles	3	0	0	3	3	OE
AT19O34	Fundamentals of Automotive Electronics	3	0	0	3	3	OE

SUMMARY

SEM	HSMC	BS	ES	PC	OE	PE	EEC	Credit
I	3	8	5					16
II		8	11					20
III	3	4	7.5	10.5				25
IV			6	16			1	23
V				17	3	3	1	24
VI				19	3		3	25
VII				8		9	3	20
VIII						6	6	12
Total	6	20	29.5	70.5	6	18	14	164
%	3.66%	12.20%	17.99%	42.99%	3.66%	10.98%	8.54%	100%

I SEMESTER

Subject Code	Subject Name	Category	L	T	P	C
HS19151	TECHNICAL ENGLISH	HS	2	1	0	3
Common to all branches of B.E./ B.Tech programmes – I semester						

Objectives:	
●	To enable learners to acquire basic proficiency in English reading and listening.
●	To write in English precisely and effectively.
●	To speak flawlessly in all kinds of communicative contexts.

UNIT-I	VOCABULARY BUILDING	9
The concept of word formation - Root words from foreign languages and their use in English - Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives - Synonyms, antonyms, and standard abbreviations. Compound words – abbreviation – single word substitution – **Listening:** Listening comprehension, listening to motivational speeches, podcasts and poetry. **Speaking:** Short talks on incidents - place of visit – admiring personalities, etc.		
UNIT-II	**BASIC WRITING SKILLS**	**9**
Sentence structures - Use of phrases and clauses in sentences - punctuation - coherence - Organizing principles of paragraphs in documents - Techniques for writing precisely. **Reading & Writing** – Free writing – paragraphs - article reading and writing criticism - change of tense forms in short text or story – inferential reading – rewrite or interpret text - prepare questions based on the text. **Speaking:** Everyday situations – conversations and dialogues, speaking for and against.		
UNIT-III	**GRAMMAR AND LANGUAGE DEVELOPMENT**	**9**
Subject-verb agreement- Noun-pronoun agreement - Articles – Prepositions – Redundancies. **Reading & Writing:** Read from innovation and ideas that changed the world, newspaper column writing – **Speaking:** Demonstrative speaking practice using visual aids (charts, graphs, maps, pictures, etc.).		
UNIT-IV	**WRITING FOR FORMAL PRESENTATION**	**9**
Nature and Style of sensible Writing - Describing – Defining – Classifying - Providing examples		

or evidence - Writing introduction and conclusion. **Reading & Writing –** Read from Literary pieces – identify different parts text – difference between print and digital writing. Writing: Recommendations - Foreword - Review of book. **Speaking-** Formal Presentations – Debate on social issues/taboos and solutions.			
UNIT-V	**EXTENDED WRITING AND SPEAKING**		**9**
Writing: Précis writing – Essay writing – workplace communication: Resume – Business letters and emails – Proposals. **Speaking:** Panel discussion – reporting an event – mock interview – Master Ceremony.			
	Total Contact Hours	**:**	**45**

Course Outcomes: On completion of course students will be able to	
●	Discuss and respond to the listening content.
●	Read and comprehend different texts and appreciate them
●	Understand structures and techniques of precise writing
●	Analyse different genres of communication and get familiarized with new words, phrases, and sentence structures.
●	Write and speak appropriately in varied formal and informal contexts.

Text Books:	
1	English for Technologists & Engineers, Orient BlackSwan Publications, Chennai 2012.
Reference Books / Web links:	
1	Technical Communication, Meenakshi Raman &Sangeeta Sharma, Oxford University Press
2	Effective Communication Skills, Kulbushan Kumar, Khanna Publishing House, Delhi
3	Communication Skills, Pushplata, Sanjay Kumar, Oxford University Press
4	Practical English Usage. Michael Swan. OUP. 1995.
5	Remedial English Grammar. F.T. Wood. Macmillan.2007
6	On Writing Well. William Zinsser. Harper Resource Book. 2001
7	Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
8	Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

Subject Code	Subject Name	Category	L	T	P	C
MA19151	ALGEBRA AND CALCULUS	BS	3	1	0	4
Common to I sem. B.E. – Aeronautical Engineering ,Automobile Engineering, Civil Engineering, Mechatronics & Mechanical Engineering						

Objectives:	
•	To gain knowledge in using matrix algebra techniques and the limitations of using infinite series approximations for those problems arising in mathematical modelling.
•	To understand the techniques of calculus which are applied in the Engineering problems.

UNIT-I	MATRICES	12
Symmetric and skew – symmetric matrices , orthogonal matrices – Eigen values and Eigen vectors - Cayley – Hamilton theorem (without proof) and applications - orthogonal transformation and quadratic forms to canonical forms - Nature of quadratic forms.		
UNIT-II	**SEQUENCES AND SERIES**	**12**
Convergence of sequence and series – Test for convergence: Comparison Test, D'Alembert Ratio Test, Leibnitz Test, Integral test – Binomial series, Exponential series and logarithmic series: Summations and approximations.		
UNIT-III	**APPLICATIONS OF DIFFERENTIAL CALCULUS**	**12**
Curvature in Cartesian co-ordinates – Centre and radius of curvature – Circle of curvature – Evolutes – Envelopes - Evolute as envelope of normals.		
UNIT-IV	**FUNCTIONS OF SEVERAL VARIABLES**	**12**
Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Maxima and minima of functions of two variables – Lagrange's method of undetermined multipliers.		
UNIT-V	**APPLICATION OF INTEGRATION**	**12**
Centre of Gravity – Moment of inertia - Double integrals in Cartesian and polar coordinates – Change of order of integration - Area of a curved surface - Triple integrals – Volume of Solids.		
	Total Contact Hours : 60	

Course Outcomes: On completion of the course students will be able to	
•	Apply the concept of Eigenvalues and eigenvectors, diagonalization of a matrix for solving problems.
•	Develop skills in solving problems involving sequences and series.
•	Analyze, sketch and study the properties of different curves.
•	Analyze, sketch and study the properties of different curves and to handle functions of several variables and problems of maxima and minima.
•	Obtain the centre of gravity, moment of inertia for rigid bodies and also surface area and volume using multiple integrals.

Text Books:	
1	Grewal B.S., " Higher Engineering Mathematics ", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2	T Veerarajan, Engineering Mathematics –I , McGraw Hill Education, 2014

Reference Books / Web links:	
1	Ramana. B.V., " Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
2	Erwin Kreyszig ," Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.
3	Bali, N.P. and Manish Goyal, A Text Book of Engineering Mathematics, Lakshmi Publications Pvt. Ltd., New Delhi, 2006.

Subject Code	Subject Name	Category	L	T	P	C
PH19141	**PHYSICS OF MATERIALS**	BS	**3**	**0**	**2**	**4**
Common to I sem. B.E. – Aeronautical Engineering, Automobile Engineering, Civil Engineering, Mechanical Engineering & Mechatronics						

Objectives:	
•	To enhance the fundamental knowledge in Physics and its applications relevant to mechanical engineering streams.
•	To familiarize students in various experimental setups and instruments that are used to study / determine the various properties of materials.

UNIT-I	**MECHANICS & PROPERTIES OF MATTER**	**9**
Basic definitions - Newton's laws – forces -solving Newton's equations - constraints and friction - cylindrical and spherical coordinates - potential energy function - conservative and non-conservative forces - central forces - conservation of angular momentum - non-inertial frames of reference - rotating coordinate system - centripetal and Coriolis accelerations – Elasticity - stress-strain diagram - bending of beams - cantilever depression - Young's modulus determination - I-shape girders.		
UNIT-II	**CRYSTAL PHYSICS**	**9**
Basis – lattices - symmetry operations and crystal systems -Bravaislattics - atomic radius and packing fraction - SC, BCC, FCC, HCP lattices - Miller indices - diffraction by crystals - reciprocal lattice - interpreting diffraction patterns - crystal growth techniques-Czochralski and Bridgmann, crystal defects.		
UNIT-III	**PHYSICS OF MATERIALS**	**9**
Solid solutions - Hume-Rothery's rules –Gibb's phase rule - binary phase diagrams –isomporhous systems - tie-line and lever rule - eutectic, eutectoid, peritectic, peritectoid, monotectic and syntectic systems - formation of microstructures - homogeneous and non-homogenous cooling – nucleation - iron-carbon phase diagram - eutectoid steel - hypo and hypereutectoid steel – diffusion - Fick's laws – T-T-T diagrams.		
UNIT-IV	**ENGINEERING MATERIALS & TESTING**	**9**

Metallic glasses – preparation and properties - Ceramics – types, manufacturing methods and properties - Composites – types and properties - Shape memory alloys – properties and applications - Nano-materials – top down and bottom up approaches – properties - Tensile strength – Hardness – Fatigue - Impact strength – Creep - Fracture – types of fracture.		
UNIT-V	**QUANTUM PHYSICS**	**9**
Blackbody problem -Planck's radiation law - duality of light -De Broglie hypothesis - properties of matter waves - wave packets –Schrodinger's equations (time dependent and time independent) - Born interpretation (physical significance of wave function) - probability current - operator formalism (qualitative) - expectation values - uncertainty principle - particle in a box -eigen function and eigen values -Dirac notation (qualitative).		
	Contact Hours :	**45**

List of Experiments			
1	Determination of Laser characteristics (wavelength and angular spread).		
2	Determination of Young's modulus by non-uniform bending method		
3	Determination of thermal conductivity of a bad conductor – Lee's Disc method.		
4	Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer		
5	Coupled oscillators - Two compound pendulums;		
6	Experiment on moment of inertia measurement- Torsional pendulum by resonance,		
7	LC circuit, LCR circuit and Resonance phenomena in LCR circuits;		
8	Experiments on electromagnetic induction – BH-Curve experiment		
9	Determination of thickness of a thin wire – Air wedge method		
10	Determination of solar cell characteristics.		
11	Measurement of hysteresis loss: B -H curve.		
12	Determination of creep characteristics of a metallic wire		
	Contact Hours	:	**30**
	Total Contact Hours	:	**75**

Course Outcomes: On completion of the course students will be able to	
●	Understand foundational mechanics and elastic nature of materials and determine the elastic moduli of materials.
●	Apply the basic knowledge of crystallography in materials preparation and treatments.
●	Create binary phase diagrams and TTT charts and use them to analyse and measure the properties of alloys.
●	Understand various engineering materials, test or measure their properties and use them in suitable applications.
●	Understand the concepts of quantum theory and the nature of light and determine the characteristics of a given laser source.

Text Books:	
1	Bhattacharya, D.K. &Poonam, T. *"Engineering Physics".* Oxford University Press, 2018.
2	Raghavan, V. *"Physical Metallurgy: Principles and Practice"*. PHI Learning, 2019.

Reference Books / Web links:	
1	Balasubramaniam, R. *"Callister's Materials Science and Engineering".* Wiley India Pvt. Ltd., 2017.
2	Raghavan, V. *"Materials Science and Engineering: A First course"*. PHI Learning, 2019.
3	Resnick, R., Halliday, D., & Walker, J. *"Principles of Physics*", Wiley India Pvt., 2018.
4	Gaur, R.K. & Gupta, S.L. *"Engineering Physics".*DhanpatRai Publishers, 2018.

Subject Code	Subject Name	Category	L	T	P	C
GE19101	ENGINEERING GRAPHICS	ES	2	2	0	4

Objectives:

- To understand the importance of the drawing in engineering applications
- To develop graphic skills for communication of concepts, ideas and design of engineering products
- To expose them to existing national standards related to technical drawings.
- To improve their visualization skills so that they can apply these skills in developing new products.
- To improve their technical communication skill in the form of communicative drawings

CONCEPTS AND CONVENTIONS (Not for Examination)		1
Importance of graphics in engineering applications–Use Drafting Instruments– BIS conventions and specifications–Size, layout and folding of drawing sheets– Lettering and dimensioning. Basic Geometrical constructions.		
UNIT-I	**PLANE CURVES AND FREE HAND SKETCH**	11
Curves used in engineering practices: Conics–Construction of ellipse, parabola and hyperbola by eccentricity method– Construction of cycloids, Construction of involutes of square and circle drawing of tangents and normal to the above curves. Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three Dimensional objects – Layout of views- Freehand sketching of multiple views from pictorial views of objects		
UNIT-II	**PROJECTION OF POINTS, LINESAND PLANESURFACE**	12
Orthographic projection- principles-Principal planes- projection of points. First angle projection - Projection of straight lines inclined to both the principal planes – Determination of true lengths and true inclinations by rotating line method- Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.		
UNIT- III	**PROJECTION OF SOLIDS**	**12**
Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one of the principal planes by rotating object method.		
UNIT-IV	**PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES**	**12**
Sectioning of solids in simple vertical position when the cutting plane is inclined to the one of the		

principal planes and perpendicular to the other – obtaining true shape of the section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones.		
UNIT-V	**ISOMETRIC AND PERSPECTIVE PROJECTIONS**	**12**
Principles of isometric projection–isometric scale–Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders and cones. Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method.		
	Total Contact Hours : 60	

Course Outcomes: After learning the course, the students should be able	
●	To construct different plane curves and free hand sketching of multiple views from pictorial objects.
●	To comprehend the theory of projection and to draw the basic views related to projection of points, lines and planes
●	To draw the projection of solids in different views
●	To draw the projection of Sectioned solids and development of surfaces of solids
●	To visualize and prepare Isometric and Perspective view of simple solids
Text Book (s):	
1	Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50th Edition, 2010.
2	Natarajan K.V., "A text book of Engineering Graphics", DhanalakshmiPublishers, Chennai, 2017.
Reference Books(s) / Web links:	
1	Varghese P I., "Engineering Graphics", McGraw Hill Education (I) Pvt.Ltd., 2013.
2	Venugopal K. and PrabhuRaja V., "Engineering Graphics", New Age International (P)Limited, 2008.
3	Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 2017.
4	Basant Agarwal and Agarwal C.M., "Engineering Drawing", McGraw Hill Publishing Company Limited, New Delhi, 2018.
5	Robi, P.S. Department of Mechanical Engineering, IITG. https://nptel.ac.in/courses/112103019/

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
GE19121	ENGINEERING PRACTICES – Civil & Mechanical	ES	0	0	2	1

Objectives:

To provide exposure to the students with hands on experience on various basic engineering practices in Civil and Mechanical Engineering.

List of Experiments

CIVIL ENGINEERING PRACTICE	
1.	Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, and elbows in household fittings.
2.	Preparation of basic plumbing line sketches for wash basins, water heaters, etc.
3.	Hands-on-exercise: Basic pipe connections –Pipe connections with different joining components.
Carpentry Works:	
4.	Study of joints in roofs, doors, windows and furniture.
5.	Hands-on-exercise: Woodwork, joints by sawing, planning and chiselling.
MECHANICAL ENGINEERING PRACTICE	
6.	Preparation of butt joints, lap joints and T- joints by Shielded metal arc welding.
7	Gas welding practice.
Basic Machining:	
8	Simple Turning and Taper turning
9	Drilling Practice
Sheet Metal Work:	
10	Forming & Bending:
11	Model making – Trays and funnels
12	Different type of joints.
Machine Assembly Practice:	
13	Study of centrifugal pump

14	Study of air conditioner		
	Total Contact Hours	**:**	**30**

Course Outcomes:	
●	Able to perform plumbing activities for residential and industrial buildings considering safety aspects while gaining clear understanding on pipeline location and functions of joints like valves, taps, couplings, unions, reducers, elbows, etc.
●	Able to perform wood working carpentry activities like sawing, planning, cutting, etc. while having clear understanding of the joints in roofs, doors, windows and furniture.
●	Able to produce joints like L joint, T joint, Lap joint, Butt joint, etc. through arc welding process while acquiring in depth knowledge in the principle of operation of welding and other accessories
●	Able to perform operations like Turning, Step turning, Taper turning, etc. in lathe and Drilling operation in drilling machine
●	Able to perform sheet metal operations like Forming, Bending, etc. and fabricating models like Trays, funnels, etc.

Subject Code	Subject Name	Category	L	T	P	C
MC19101	**ENVIRONMENTAL SCIENCE AND ENGINEERING**	MC	**3**	**0**	**0**	**0**

Common to I sem. B.E. – Aeronautical Engineering, Automobile Engineering, Biomedical Engineering, Civil Engineering, Mechanical Engineering & Mechatronics And B.Tech. – Biotechnology, Chemical Engineering & Food Technology
and
Common to II sem. B.E. – Computer Science and Engineering, Electrical and Communication Engineering & Electrical and Electronics Engineering and B.Tech. – Information Technology

Objectives:	
●	To understand the importance of natural resources, pollution control and waste management.
●	To provide the students about the current social issues and environmental legislations.

UNIT-I	**NATURAL RESOURCES**	**9**

Environment -definition - scope and importance - forest resources -use and overexploitation -water resources -use and over utilization - dams - benefits and problems - water conservation -energy resources - growing energy needs - renewable and non-renewable energy sources - use of alternate energy sources -land resources -land degradation - role of an individual in conservation of natural resources.

UNIT-II	**ENVIRONMENTAL POLLUTION**	**9**

Definition - causes, effects and control measures of air pollution -chemical and photochemical reactions in the atmosphere - formation of smog, PAN, acid rain, and ozone depletion- noise pollution -mitigation procedures - control of particulate and gaseous emission (Control of SO_2, NO_X, CO and HC).
Water pollution - definition-causes-effects of water pollutants–marine pollution-thermal pollution-radioactive pollution-control of water pollution by physical, chemical and biological processes–waste water treatment-primary, secondary and tertiary treatment.
Soil pollution : definition-causes-effects and control of soil pollution.

UNIT-III	**SOLID WASTE MANAGEMENT**	**9**

Solid wastes - sources and classification of solid wastes -solid waste management options - sanitary landfill, recycling, composting, incineration, energy recovery options from wastes
Hazardous waste -definition -sources of hazardous waste-classification (biomedical waste,

radioactive waste, chemical waste, household hazardous waste)-characteristics of hazardous waste ignitability (flammable) reactivity, corrosivity, toxicity -effects of hazardous waste -case study-bhopal gas tragedy - disposal of hazardous waste-recycling , neutralization, incineration, pyrolysis, secured landfill - E-waste management -definition-sources-effects -electronic waste recycling technology.		
UNIT-IV	**SOCIAL ISSUES AND THE ENVIRONMENT**	**9**
Sustainable development -concept, components and strategies - social impact of growing human population and affluence, food security, hunger, poverty, malnutrition, famine - consumerism and waste products - environment and human health - role of information technology in environment and human health -disaster management– floods, earthquake, cyclone and landslide.		
UNIT-V	**TOOLS FOR ENVIRONMENTAL MANAGEMENT**	**9**
Environmental impact assessment (EIA) structure -strategies for risk assessment–EIS-environmental audit-ISO 14000-precautionary principle and polluter pays principle- constitutional provisions- - pollution control boards and pollution control acts- environmental protection act1986- role of non-government organisations- international conventions and protocols.		

	Contact Hours	**:**	**45**

Course Outcomes:

On completion of the course students will be able to

●	Be conversant to utilize resources in a sustainable manner.
●	Find ways to protect the environment and play proactive roles.
●	Apply the strategies to handle different wastes
●	Develop and improve the standard of better living.
●	Be conversant with tools of EIA and environmental legislation.

Text Books:

1	Benny Joseph, "Environmental Science and Engineering", 2nd edition, Tata McGraw-Hill, New Delhi,2008.
2	Gilbert M.Masters, "Introduction to Environmental Engineering and Science", 2nd edition, Pearson Education, 2004.

Reference Books / Web links:	
1	Dharmendra S. Sengar, “Environmental law”, Prentice hall of India Pvt Ltd, New Delhi,2007.
2	ErachBharucha, “Textbook of Environmental Studies”, 3rd edition, Universities Press(I) Pvt Ltd, Hydrabad, 2015.,
3	G. Tyler Miller and Scott E. Spoolman, “Environmental Science”, 15th edition, CengageLearning India PVT, LTD, Delhi, 2014.
4	Rajagopalan, R, “Environmental Studies-From Crisis to Cure”, 3rd edition,Oxford University Press,2015.
5	De. A.K., “Environmental Chemistry”, New Age International, New Delhi,1996.
6	K. D. Wager, Environmental Management, W. B. Saunders Co., Philadelphia, USA, 1998.

II SEMESTER

Subject Code	Subject Name	Category	L	T	P	C
MA19251	DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS	BS	3	1	0	4

Common to II sem.B.E. – Aeronautical Engineering, Automobile Engineering, Civil Engineering, Mechatronics & Mechanical Engineering
and
B. Tech. - Biotechnology, Food Technology & Chemical Engineering

Objectives:

- To handle practical problems arising in the field of engineering and technology using differential equations.
- To solve problems using the concept of Vectors calculus, Complex analysis, Laplace transforms.

UNIT-I	SECOND AND HIGHER ORDER DIFFERENTIAL EQUATIONS	12

Second and higher order Linear differential equations with constant coefficients - Method of variation of parameters – Cauchy's and Legendre's linear equations - Simultaneous first order linear equations with constant coefficients.

UNIT-II	PARTIAL DIFFERENTIAL EQUATIONS	12

Formation of partial differential equations - Solutions of standard types of first order partial differential equations - Lagrange's linear equation -- Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNIT-III	VECTOR CALCULUS	12

Gradient, divergence and curl – Directional derivative – Irrotational and solenoidal vector fields – Vector integration – Green's theorem in a plane, Gauss divergence theorem and Stokes' theorem (excluding proofs) – Simple applications involving cubes and rectangular parallelopipeds.

UNIT-IV	ANALYTIC FUNCTIONS	12

Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates - Properties – Harmonic conjugates – Construction of analytic function - Conformal mapping and Bilinear transformation-Cauchy's integral theorem and Cauchy's integral formula (proof excluded) – Taylor's series and Laurent's series – Singularities – Residues – Residue theorem (without proof), simple problems.

UNIT-V	LAPLACE TRANSFORM	12
Laplace transform – Sufficient condition for existence – Transform of elementary functions – Basic properties – Transforms of derivatives and integrals of functions - Derivatives and integrals of transforms - Transforms of unit step function and impulse functions, periodic functions. Inverse Laplace transform – Problems using Convolution theorem – Initial and final value theorems – Solution of linear ODE of second order with constant coefficients using Laplace transformation techniques.		
	Total Contact Hours : 60	

Course Outcomes:
On completion of course students will be able to

●	Apply various techniques in solving ordinary differential equations.
●	Develop skills to solve different types of partial differential equations
●	Use the concept of Gradient, divergence and curl to evaluate line, surface and volume integrals.
●	Use the concept of Analytic functions, conformal mapping and complex integration for solving Engineering problems.
●	Use Laplace transform and inverse transform techniques in solving differential equations.

Text Books:

1	Grewal B.S., "Higher Engineering Mathematics ", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2	T Veerarajan, Engineering Mathematics –II , McGraw Hill Education, 2018

Reference Books / Web links:

1	Ramana. B.V., " Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
2	Erwin Kreyszig ," Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.
3	Bali, N.P. and Manish Goyal, A Text Book of Engineering Mathematics, Lakshmi Publications Pvt. Ltd., New Delhi, 2006.
4	T Veerarajan, Transforms and Partial Differential Equations, Third Edition, 2018.

Subject Code	Subject Name	Category	L	T	P	C
CY19241	ENGINEERING CHEMISTRY	BS	3	0	2	4

Common to II sem. B.E. – Aeronautical Engineering, Automobile Engineering, Mechanical Engineering and Mechatronics

Objectives:

- To understand the theoretical and practical principles of corrosion and its control
- To familiarise the fundamentals of chemical energy conversions in batteries and fuels
- To acquaint knowledge on alloys and analytical techniques

UNIT-I	CORROSION AND PROTECTIVE COATINGS	9

Cause and effects of corrosion - theories of chemical and electrochemical corrosion –emf series- types of corrosion: Galvanic, water-line , intergranular and pitting corrosion – passivity - factors affecting rate of corrosion - corrosion control methods- cathodic protection -sacrificial anode and impressed current cathodic methods - corrosion inhibitors - metal cladding - anodizing - electroplating - electroless plating - factors influencing electroplating - polarisation - decomposition potential - over voltage - current density - electrolyte concentration- additives - organic coatings - paints - constituents - functions - special paints - fire retardant - water repellent - temperature indicating and luminous paints.

UNIT-II	ENERGY STORAGE DEVICES	9

Batteries - primary battery - alkaline battery - secondary battery (Lead acid storage battery, Nickel - Cadmium battery and Lithium – ion battery) -flow battery -components, working principle and applications of hydrogen-oxygen, solid oxide, direct methanol and proton exchange membrane fuel cells.

UNIT-III	PHASE RULE AND ALLOYS	9

Phase rule - definition of terms - one component system -water system - reduced phase rule - thermal analysis - two component system- eutectic system - lead silver system - safety fuses and solders.

Alloys - purpose of alloying - function and effects of alloying elements - properties of alloys - classification of alloys - Ferrous alloys - nichrome and stainless steel - Non-ferrous alloys - brass and bronze - heat treatment of alloys (annealing, hardening, tempering, normalising, carburizing and nitriding)

UNIT-IV	FUNDAMENTAL SPECTROSCOPIC TECHNIQUES AND THERMAL ANALYSIS	9

Principles of spectroscopy - UV,visible and IR spectroscopy principle - instrumentation (block diagram) - applications. Principles, block diagram, instrumentation and applications of TGA,

DTA, DSC and Flame photometry			
UNIT-V	**FUELS AND COMBUSTION**		**9**
Fuels- classification -coal-ranking of coal- proximate and ultimate analysis metallurgical coke - manufacture by Otto-Hoffmann method - Petroleum processing and fractions -knocking - octane number and cetane number - synthetic petrol - Fischer Tropsch and Bergius processes -power alcohol,biodiesel- Gaseous fuels CNG and LPG. Combustion-calorific value- Dulongs formula-problems- flue gas analysis – Orsat apparatus– theoretical air for combustion – problems			
	Contact Hours	**:**	**45**
List of Experiments			
1	Determination of corrosion rate on mild steel by weight loss method		
2	Estimation of DO by winkler's method		
3	Determination of total, temporary and permanent hardness by EDTA method.		
4	Estimation of alkalinity by indicator method.		
5	Estimation of chloride by argentometric method		
6	Estimation of extent of corrosion of Iron pieces by potentiometry		
7	Estimation of mixture of acids by conductometry.		
8	Estimation of acid by pH metry		
9	Estimation of copper / ferrous ions by spectrophotometry.		
10	Estimation of sodium and potassium in water by flame photometry.		
11	Determination of flash and fire point of lubricating oil		
12	Determination of cloud and pour point of lubricating oil		
13	Determination of phase change temperature of a solid.		
	Contact Hours	**:**	**30**
	Total Contact Hours	**:**	**75**

Course Outcomes: On completion of the course students will be able to	
●	Analyze type of corrosion and identify suitable corrosion control method
●	Construct electrochemical cells and measure its potential
●	Modify metal properties by alloying
●	Characterize various material systems
●	Understand the role of fuels in day to day applications

Text Books:	
1	P. C. Jain and Monika Jain, "Engineering Chemistry", DhanpatRai Publishing Company (P) Ltd,New Delhi, 2015.
2	O.G.Palanna, "Engineering Chemistry", McGraw Hill Education (India) PVT, Ltd,New Delhi, 2017.

Reference Books / Web links:	
1	C. N. Banwell and E.M. McCash, "Fundamentals of Molecular Spectroscopy", 4th Edn, Tata McGraw-Hill Edition, 1995
2	ShashiChawla, "A Text Book of Engineering Chemistry", DhanpatRai& Co, New Delhi, 2017.
3	Sharma Y.R., "Elementary Organic Spectroscopy", Sultan Chand & Sons, New Delhi, 2014.
4	Sharma B. K.,"AnalyticalChemistry",Krishna Prakashan Media (P) Ltd., Meerut, 2005.

Subject Code	Subject Name	Category	L	T	P	C
EE 19241	BASIC ELECTRICAL ENGINEERING	ES	3	0	2	4
(Common to AUTO, ECE, MECH, and MCT)						

Objectives:

- To introduce electric circuits and provide knowledge on the analysis of circuits using network theorems.
- To impart knowledge on the phenomenon of resonance in series and parallel circuits and also to obtain the transient response of RC, RL and RLC circuits.
- To provide knowledge on the principles of electrical machines.
- To learn the concepts of different types of power converter and batteries.
- To teach methods of experimentally analyzing electrical circuits and machines

UNIT-I	**DC CIRCUITS**	9

Electrical circuit elements (R, L and C), voltage and current sources, Kirchhoff's current and voltage laws, analysis of simple circuits with dc excitation. Superposition, The venin and Norton Theorems.

UNIT-II	**AC CIRCUITS**	9

Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three phase balanced circuits, voltage and current relations in star and delta connections

UNIT-III	**DC MOTORS AND TRANSFORMERS**	9

Construction, working, torque-speed characteristic and speed control of DC motors Construction and principle of operation- EMF Equation- regulation, losses and efficiency of Single Phase Transformers - Auto-transformer.

UNIT-IV	**AC ROTATING MACHINES**	9

Construction and working of Synchronous Generators-EMF Equation - Construction and working-torque-slip characteristic- starting methods of three phase induction motors-Single-phase induction motors- Construction and Working of Permanent Magnet Brushless DC Motors and Stepper Motors.

UNIT-V	**BATTERIES AND POWER CONVERTERS**	9

Types of Batteries, Important Characteristics for Batteries -DC-DC buck and boost converters-duty ratio control -Single-phase and three-phase voltage source inverters – Sinusoidal modulation			
	Total Contact Hours	**:**	**45**

List of Experiments			
1	Experimental verification of Kirchhoff's voltage and current laws.		
2	Experimental verification of network theorems (The venin and, Norton Theorems).		
3	Load test on DC shunt motor.		
4	Speed control of DC shunt motor.		
5	Load test on single-phase transformer.		
6	Open circuit and short circuit tests on single phase transformer.		
7	Speed control of chopper fed DC motor.		
8	Speed control of 3Φ Induction motor.		
	Contact Hours	**:**	**30**
	Total Contact Hours	**:**	**75**

Course Outcomes:	
On completion of the course, the students will be able to	
•	analyse DC and AC circuits and apply circuit theorems.
•	realize series and parallel resonant circuits.
•	understand the principles of electrical machines.
•	understand the principles of different types of power converter and batteries.
•	experimentally analyze the electric circuits and machines.

Text Book(s):	
1	D. P. Kothari and I. J. Nagrath, “Basic Electrical Engineering”, Tata McGraw Hill, 2010.
2	M.H.Rashid, “Power Electronics: Circuits, Devices and Applications”, Pearson Education, PHI Third Edition, New Delhi, 2014.
3	David Linden and Thomas B. Reddy, “ Handbook of Batteries” McGraw-Hill Professional,2001

Reference Books(s) / Web links:	
1	D. C. Kulshreshtha, “Basic Electrical Engineering”, McGraw Hill, 2009.
2	E. Hughes, “Electrical and Electronics Technology”, Pearson, 2010.
3	D. Toro, “Electrical Engineering Fundamentals”, Prentice Hall India, 1989.
4	L. S. Bobrow, “Fundamentals of Electrical Engineering”, Oxford University Press, 2011.
5	P.S.Bimbra “Power Electronics”, Khanna Publishers, 4th Edition, 2007.

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
GE19211	**PROBLEM SOLVING AND PROGRAMMING IN PYTHON** (with effect from 2021 batch onwards) (Common to AERO, AUTO, BME, BT, CHEMICAL, CIVIL, EEE, ECE, FT, MECH, MCT, R&A)	**ES**	**1**	**0**	**4**	**3**

Course Objectives:

- To understand computers, programming languages and their generations and essential skills for a logical thinking for
- problem solving.
- To write, test, and debug simple Python programs with conditionals, and loops and functions
- To develop Python programs with defining functions and calling them
- To understand and write python programs with compound data- lists, tuples, dictionaries
- To search, sort, read and write data from/to files in Python.

List of Experiments

1. Study of algorithms, flowcharts and pseudocodes.
2. Introduction to Python Programming and Demo on Python IDLE / Anaconda distribution.
3. Experiments based on Variables, Datatypes and Operators in Python.
4. Coding Standards and Formatting Output.
5. Algorithmic Approach: Selection control structures.
6. Algorithmic Approach: Iteration control structures.
7. Experiments based on Strings and its operations.
8. Experiments based on Lists and its operations.
9. Experiments based on Tuples and its operations.
10. Experiments based on Sets and its operations.
11. Experiments based on Dictionary and its operations.
12. Functions: Built-in functions.
13. Functions: User-defined functions.
14. Functions: Recursive functions.
15. Searching techniques: Linear and Binary.
16. Sorting techniques: Bubble and Merge Sort.
17. Experiments based on files and its operations.

Contact Hours : 75

Course Outcomes:

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

- Understand the working principle of a computer and identify the purpose of a computer programming language and
- ability to identify an appropriate approach to solve the problem.
- Write, test, and debug simple Python programs with conditionals and loops.
- Develop Python programs step-wise by defining functions and calling them.
- Use Python lists, tuples, dictionaries for representing compound data.
- Apply searching, sorting on data and efficiently handle data using flat files.

Text Books:	
1.	Allen B. Downey, Think Python: How to Think Like a Computer Scientist, Second edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)
2.	Guido Van Rossum and Fred L. Drake Jr, An Introduction to Python - Revised and updated for Python 3.2, NetworkTheory Ltd., 2011.
Reference Books:	
1.	John V Guttag, Introduction to Computation and Programming Using Python, Revised and expanded Edition, MIT Press , 2013.
2.	Robert Sedgewick, Kevin Wayne, Robert Dondero, Introduction to Programming inPython: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.
3.	Timothy A. Budd, Exploring Python, Mc-Graw Hill Education (India) Private Ltd., 2015.
4.	Kenneth A. Lambert, Fundamentals of Python: First Programs, Cengage Learning, 2012.
5.	Charles Dierbach, Introduction to Computer Science using Python: A Computational ProblemSolving Focus, Wiley India Edition, 2013.
6.	Paul Gries, Jennifer Campbell and Jason Montojo, Practical Programming: An Introduction to Computer Scienceusing Python 3, Second edition, Pragmatic Programmers, LLC, 2013.

Subject Code	Subject Name	Category	L	T	P	C
GE19201	**Engineering Mechanics**	ES	2	1	0	3
	(Common to Mech, Aero, Auto Civil and MCT)					

Objectives:	
●	To understand the basics of mechanics and apply the concept of equilibrium to solve problems of concurrent forces.
●	To understand the concept of equilibrium and to solve problems of rigid bodies.
●	To learn about the center of gravity and moment of inertia of surfaces and solids.
●	To learn the basic concepts of friction.
●	To learn the concepts in kinematics and kinetics of rigid bodies in plane motion.

UNIT-I	**STATICS OF PARTICLES**	9
Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces – Vectorial representation of forces – Vector operations of forces - additions, subtraction, dot product, cross product – Coplanar Forces – rectangular components – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility.		
UNIT-II	**EQUILIBRIUM OF RIGID BODIES**	9
Free body diagram – Types of supports –Action and reaction forces –stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon's theorem – Single equivalent force -Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions – (Descriptive treatment only)		
UNIT-III	**PROPERTIES OF SURFACES AND SOLIDS**	9
Centroids and centre of mass – Centroids of lines and areas - Rectangular, circular, triangular areas by integration – T section, I section, - Angle section, Hollow section by using standard formula –Theorems of Pappus - Area moments of inertia of plane areas – Rectangular, circular, triangular areas by integration – T section, I section, Angle section, Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem – Principal moments of inertia of plane areas – Principal axes of inertia-Mass moment of inertia –mass moment of inertia for prismatic, cylindrical and spherical solids from first principle – Relation to		

area moments of inertia.		
UNIT-IV	**DYNAMICS OF PARTICLES**	**9**
Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion - Newton's laws of motion – Work Energy Equation– Impulse and Momentum – Impact of elastic bodies.		
UNIT-V	**FRICTION AND RIGID BODY DYNAMICS**	**9**
Friction force – Laws of sliding friction – equilibrium analysis of simple systems with sliding friction –wedge friction, Ladder friction, Rolling resistance -Translation and Rotation of Rigid Bodies – Velocity and acceleration – General Plane motion of simple rigid bodies such as cylinder, disc/wheel and sphere.		
	Total Contact Hours :	**45**

Course Outcomes: On the successful completion of the course, students will be able to	
●	Comprehend and analysis the forces in the system.
●	Solve problems in engineering systems using the concept of static equilibrium.
●	Determine the centroid of objects such as areas and volumes, center of mass of body and moment of inertia of composite areas.
●	Solve problems involving kinematics and kinetics of rigid bodies in plane motion.
●	Solve problems involving frictional phenomena in machines.

Text Book (s):	
1	Beer, F.P and Johnston Jr. E.R, Cornwell and Sanghi ., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 11thEdition, McGraw-Hill Publishing company, New Delhi (2017).
2	Rajasekaran S and Sankarasubramanian G., "Engineering Mechanics Statics and Dynamics", 3rd Edition, Vikas Publishing House Pvt. Ltd., 2005.

Reference Books(s) / Web links:	
1	Meriam J.L. and Kraige L.G., " Engineering Mechanics- Statics - Volume 1, Dynamics- Volume 2", Third Edition, Wiley India,2017.
2	Hibbeller, R.C and Ashok Gupta, "Engineering Mechanics: Statics and Dynamics", 11th

	Edition, Pearson Education 2010.
3	Irving H. Shames and Krishna MohanaRao. G., "Engineering Mechanics – Statics and Dynamics" 4thEdition, Pearson Education 2006.
4	S SBhavikatti, Engineering Mechanics, New Age International Publishers, 2016
5	Vela Murali, "Engineering Mechanics", Oxford University Press (2010)

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
GE19122	ENGINEERING PRACTICES - ELECTRICAL & ELECTRONICS	ES	0	0	2	1

Objectives:

- To provide hands on experience on various basic engineering practices in Electrical Engineering.
- To impart hands on experience on various basic engineering practices in Electronics Engineering.

List of Experiments

A. ELECTRICAL ENGINEERING PRACTICE

1	Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2	Fluorescent lamp wiring.
3	Stair case wiring.
4	Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.
5	Measurement of resistance to earth of an electrical equipment.

B. ELECTRONICS ENGINEERING PRACTICE

1	Study of Electronic components and equipments – Resistor, colour coding, measurement of AC signal parameter (peak-peak, rms period, frequency) using CRO.
2	Study of logic gates AND, OR, EX-OR and NOT.
3	Generation of Clock Signal.
4	Soldering practice – Components Devices and Circuits – Using general purpose PCB.
5	Measurement of ripple factor of HWR and FWR.

	Total Contact Hours	**:**	**30**

Course Outcomes:

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

- fabricate electrical and electronic circuits

●	formulate the house wiring
●	design the AC-DC converter using diode and passive components
REFERENCE	
1	Bawa H.S., "Workshop Practice", Tata McGraw – Hill Publishing Company Limited, 2007.
2	Jeyachandran K., Natarajan S. &Balasubramanian S., "A Primer on Engineering Practices Laboratory", Anuradha Publications, 2007.
3	Jeyapoovan T., Saravanapandian M. &Pranitha S., "Engineering Practices Lab Manual",Vikas Publishing House Pvt.Ltd, 2006.
4	Rajendra Prasad A. &Sarma P.M.M.S., "Workshop Practice", Shree Sai Publication, 2002.

MC19102	INDIAN CONSTITUTION AND FREEDOM MOVEMENT	Category	L	T	P	C
	(Common to Mech, Aero, Auto Civil and MCT)	**MC**	**3**	0	0	0

Objectives:

•	To inculcate the values enshrined in the Indian constitution
•	To create a sense of responsible and active citizenship
•	To know about Constitutional and Non- Constitutional bodies
•	To understand sacrifices made by the freedom fighters

UNIT-I	INTRODUCTION	9
Historical Background – Constituent Assembly of India – Philosophical foundations of the Indian Constitution – Preamble – Fundamental Rights – Directive Principles of State Policy – Fundamental Duties – Citizenship – Constitutional Remedies for citizens. Constitution' meaning of the term, Indian Constitution: Sources and constitutional history, Features: Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy		
UNIT-II	**STRUCTURE AND FUNCTION OF CENTRAL GOVERNMENT**	9
Union Government – Structures of the Union Government and Functions – President – Vice President – Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review.		
UNIT-III	**STRUCTURE AND FUNCTION OF STATE GOVERNMENT AND LOCAL BODY**	9
State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts- Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, Pachayati Raj: Introduction, Elected officials and their roles, ,Village level: Role of Elected and Appointed officials.		
UNIT-IV	**CONSTITUTIONAL FUNCTIONS AND BODIES**	**9**
Indian Federal System – Center – State Relations – President's Rule – Constitutional Functionaries – Assessment of working of the Parliamentary System in India- CAG, Election Commission, UPSC, GST Council and other Constitutional bodies-. NITI Aayog, Lokpal, National Development Council and other Non –Constitutional bodies		

UNIT-V	INDIAN FREEDOM MOVEMENT		9
British Colonialism in India-Colonial administration till 1857- Revolt of 1857- Early Resistance to British Rule-Rise of Nationalism in India-Indian Freedom Struggle under Mahatma Gandhi-Non-Cooperation Movement-Civil Disobedience Movement- Quit India Movement-British Official response to National movement- Independence of India Act 1947-Freedom and Partition			
	Total Contact Hours	**:**	**45**

Course Outcomes: On the successful completion of the course, students will be able to	
•	Understand the functions of the Indian government
•	Understand and abide the rules of the Indian constitution.
•	Gain knowledge on functions of state Government and Local bodies
•	Gain Knowledge on constitution functions and role of constitutional bodies and non constitutional bodies
•	Understand the sacrifices made by freedom fighters during freedom movement

Text Book (s):	
•	Durga Das Basu, "Introduction to the Constitution of India ", Lexis Nexis, New Delhi., 21st Ed 2013
•	Bipan Chandra, History of Modern India, Orient Black Swan, 2009
•	Bipan Chandra, India's Struggle for Independence, Penguin Books, 2016
•	Maciver and Page, " Society: An Introduction Analysis ", Mac Milan India Ltd., New Delhi.2nd ed, 2014
•	P K Agarwal and K N Chaturvedi , Prabhat Prakashan, New Delhi, 1st ed , 2017

Reference Books(s) / Web links:	
•	Sharma, Brij Kishore, "Introduction to the Constitution of India:, Prentice Hall of India, New Delhi.
•	U.R.Gahai, "Indian Political System ", New Academic Publishing House, Jalaendhar.

SEMESTER III

Subject Code	Subject Name	Category	L	T	P	C
GE19304	FUNDAMENTALS OF MANAGEMENT FOR ENGINEERS	HS	3	0	0	3

OBJECTIVES	
1	To expose the students to the basic concepts of management in order to aid in understanding how an organization functions, and in understanding the complexity and wide variety of issues managers face in today's business firms.

UNIT-I	INTRODUCTION TO MANAGEMENT	9
Definition, Nature and Scope, Functions, Managerial Roles, Levels of Management, Managerial Skills, Challenges of Management; Evolution of management thought. Organization: Types and environmental factors.		
UNIT-II	**PLANNING AND DECISION MAKING**	**9**
General Framework for Planning – Planning Process, Types of Plans, Management by Objectives; Decision making and Problem Solving - Steps in Problem Solving and Decision Making.		
UNIT-III	**ORGANIZATION AND HRM**	**9**
Principles of Organization: Organizational Design & Organizational Structures; Departmentalization, Delegation; Empowerment, Centralization, Decentralization. Human Resource Management & Business Strategy: Talent Management and Strategic Human Resource Planning; Recruitment and Selection; Training and Development; Performance Appraisal.		
UNIT-IV	**LEADING AND MOTIVATION**	**9**
Leadership, Power and Authority, Leadership Styles, Leadership Skills, Leader as Mentor and Coach, Team Leadership. Motivation – Types of Motivation; Relationship between Motivation, Performance and Engagement, Content Motivational Theories – Needs Hierarchy Theory, Two Factor Theory, Theory X and Theory Y.		

UNIT-V	CONTROLLING	9
Control, Types and Strategies for Control, Steps in Control Process, Budgetary and Non-Budgetary Controls. Characteristics of Effective Controls, Establishing control systems. Managing productivity- Cost control- Purchase control- Maintenance control- Quality control- Planning operations. Managing globally- Strategies for International business.		
	Total Contact Hours :	**45**

Course Outcomes: After completing the course, the Learners should be able to:	
1	Understand and apply the basic principles of management.
2	Understand and apply the planning, organizing and control processes
3	Will be able to understand and design organization as well as manage and develop human resource
4	Understand various theories related to the development of leadership skills, motivation techniques and team work
5	Will be able to understand and apply controlling practices in all applications.

Text Books:	
1	Principles of Management, Prakash Chandra Tripathi, Tata McGraw-Hill Education, 2008
2	Fundamentals of Management, Stephen P. Robbins, Pearson Education, 2009.
Reference Books / Web links:	
1	Essentials of Management, Koontz Kleihrich, Tata Mc – Graw Hill.
2	Management Essentials, Andrew DuBrin, 9e, Cengage Learning, 2012.

Subject Code	Subject Name	Category	L	T	P	C
MA19351	**TRANSFORMS AND STATISTICS**	BS	**3**	**1**	**0**	**4**
Common to III sem. B.E. Aeronautical Engineering, Automobile Engineering and B.Tech. Chemical Engineering						

Objectives:	
●	To acquaint the student with different transform techniques used in wide variety of situations.
●	To provide required skills to apply different statistical tools to analyze Engineering problems.

UNIT-I	**FOURIER SERIES**	**12**
Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Parseval's identity – Harmonic analysis.		
UNIT-II	**BOUNDARY VALUE PROBLEMS**	**12**
Classification of PDE – Solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction (excluding insulated edges).		
UNIT-III	**Z - TRANSFORMS AND DIFFERENCE EQUATIONS**	**12**
Z- transforms - Elementary properties – Inverse Z - transform (using partial fraction and residues) –Convolution theorem - Formation of difference equations – Solution of difference equations using Z- transform.		
UNIT-IV	**TESTING OF HYPOTHESIS**	**12**
Statistical hypothesis - Large sample test based on Normal distribution for single mean and difference of means -Tests based on t, F and Chi-square test for single sample standard deviation. Chi-square tests for independence of attributes and goodness of fit.		
UNIT-V	**DESIGN OF EXPERIMENTS**	**12**
One way and two way classifications - Completely randomized design – Randomized block design –Latin square design - 2^2factorial design.		
	Total Contact Hours :	**60**

Course Outcomes: On completion of course students will be able to	
●	develop skills to construct Fourier series for different periodic functions and to evaluate infinite series.
●	classify different types of PDE and solve boundary value problems.
●	solve difference equations using Z – transforms that arise in discrete time systems.
●	obtain statistical data from experiments and also analyze the same using statistical test.
●	design experiments using suitable ANOVA techniques and draw conclusions.

Text Books:	
1	Grewal B.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, Delhi, 2020.
2	Veerarajan. T., "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt.Ltd.,New Delhi, Second reprint, 2016.
3	Veerarajan T., 'Probability, Statistics and Random Processes with Queueing Theory and Queueing Networks' , Mc Graw Hill, 2018.

Reference Books / Web links:	
1	Glyn James, "Advanced Modern Engineering Mathematics", 5th Edition, Pearson Education, 2018.
2	Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India, 2011.
3	Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company Limited, New Delhi, 2017.
4	Ross S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 5th Edition, Elsevier, 2014.
5	Spiegel M.R., Schiller. J. and Srinivasan. R.A., "Schaum's Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition, 2004.
6	Johnson R.A. and Gupta. C.B., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 7th Edition, 2007.
7	Design and Analysis of Experiments, 8ed, ISV (WSE)" by Douglas C. Montgomery, Wiley; Eighth edition (2013)

Subject Code	Subject Name (Lab oriented Theory Courses)	Category	L	T	P	C
AT19341	**APPLIED THERMODYNAMICS**	**ES**	**2**	**1**	**3**	**4.5**
(Use of Standard and approved Steam Table, Mollier Chart, Compressibility Chart Refrigeration Tables, Psychrometric Chart and HMT Data Book are permitted)						

OBJECTIVES:		
• To illustrate the thermodynamic laws and their applications		
• To make the students understand the second law of thermodynamics and availability.		
• To make the student understand the basics of ideal and real gases and properties of steam and steam power cycles.		
• To explain the various refrigeration systems and air compressors used in practice.		
• To make the students to understand the basics of heat transfer		
UNIT I	**FIRST LAW OF THERMODYNAMICS**	**9**
Macroscopic and microscopic aspects – thermodynamic system and surrounding – forms of energy– properties of a system – state - equilibrium– Quasi static process – Zeroth law of Thermodynamics – Heat – Work –First law of Thermodynamics - PMM I –Application of First law to non flow system– Thermodynamic analysis of control volume– Steady flow energy equation– Applications.		
UNIT II	**SECOND LAW OF THERMODYNAMICS**	**9**
Limitations of first law – cyclic heat engine - heat pump – refrigerator - second law of thermodynamics – equivalence of Kelvin-Planck and Clausius statements - PMM II - Reversibility and irreversibility – causes of Irreversibility - Carnot cycle - reversed Carnot cycle - Carnot theorem – absolute thermodynamic temperature scale – Clausius theorem - Clausius inequality - concept of entropy – principle of increase of entropy - Applications of Second Law.		
UNIT III	**IDEAL & REAL GASES AND STEAM POWER CYCLE**	**9**
Properties of ideal and real gases - equation of state for ideal and real gases - Vander Waal's equation of states, compressibility factor and compressibility chart, Gas Mixtures Pure substance - thermodynamic properties of steam - Use of Steam Table and Mollier Chart - Determination of dryness fraction - StandardRankine cycle and Reheat cycle.		

UNIT IV	REFRIGERATION AND AIR COMPRESSORS	8
Psychrometry – Property calculations of air vapour mixtures by using chart and expressions – basic psychrometric processes - Refrigeration - vapour compression refrigeration cycle – p-H Charts – Working principle of vapour absorption system – comparison between vapour compression and absorption systems - Air conditioning systems Air Compressors : Classification and working principle Reciprocating and rotary air compressors. **(Descriptive treatment only)**		
UNIT V	**HEAT TRANSFER**	**10**
Heat transfer through conduction - Fourier's law of conduction - Problems on one dimensional heat conduction through plain walls, composite walls and cylinder walls. Heat transfer through convection – Natural and Forced Convection, Problems on pin fin and Heat Exchangers. Introduction to Heat transfer through radiation, Stefan Boltzman Law, black body and grey body. **(Descriptive treatment only)**		
	TOTAL :	**45 PERIODS**

APPLIED THERMODYNAMICS LAB	
LIST OF EXPERIMENTS	
1.	Study on Steam Power Plant
2.	Performance test on a reciprocating air compressor
3.	Performance test in Air Conditioning System
4.	Performance test on refrigeration system
5.	Determination of Thermal conductivity of composite wall.
6.	Effectiveness of Parallel /counter flow heat exchanger.
7.	Heat transfer from pin-fin apparatus (natural & forced convection modes)
8.	Determination of emissivity of a grey surface.
	Total : 45 Periods

COURSE OUTCOMES: On completion of the course students will be able to **:**
1. Explain the basic concepts in thermodynamics and solve problems in first law of thermodynamics
2. Apply the second law of thermodynamics and availability to calculate the efficiency of Heat engine and COP of Heat pump
3. Calculate properties of real gas, ideal gases, gas mixture, explain the basic operation of a steam power plant, calculate efficiency, steam rate and heat rate of the steam power cycles.
4. Calculate psychrometric properties, Explain VCR system, VAR system, conduct performance test on AC, refrigeration system, explain working of various air compressors and examine performance test on reciprocating air compressor.
5. Explain basic laws pertaining to heat transfer, calculate heat transfer through various modes, calculate heat transfer coefficient, design basic heat exchanger, conduct experiment to find thermal conductivity of a composite wall, and find out emissivity of a grey surface.

TEXT BOOKS:	
1	Nag. P. K., 'Basic and Applied Thermodynamics', Tata McGraw-Hill Education Pvt. Ltd., 2010.
2	S. Domkundwar, C.P. Kothandaraman and A.V. Domkundwar., "A Course in Thermal Engineering", DhanpatRai and Co, 2004.
REFERENCE BOOKS:	
1	Ramalingam K.K. 'Thermodynamics', Sci-Tech Publications, 2006.
2	P.Chattopadhyay, "Engineering Thermodynamics", Oxford University Press, 2010.
3	Rathakrishnan E, "Fundamentals of Engineering Thermodynamics", PHI Learning P. Ltd. New Delhi, 2009.
4	Holman. J.P., "Thermodynamics", 3rd Ed. Tata McGraw-Hill Education Pvt. Ltd., 2007.
5	Arora C.P, 'Thermodynamics', Tata McGraw-Hill Education Pvt. Ltd., 2004.
6	Merala C, Pother, Craig W, Somerton, 'Thermodynamics for Engineers', Schaum Outline Series, Tata McGraw-Hill Education Pvt. Ltd., New Delhi, 2004.
7	Rajput R.K., "Thermal Engineering", Laxmi Publications (P) Limited, New Delhi, 2010

Subject Code	Subject Name (Lab oriented Theory Courses)	Category	L	T	P	C
AT19342	AUTOMOTIVE ENGINES	PC	3	0	3	4.5

OBJECTIVES:

- To understand the basic principles, construction and working of IC engines
- To understand the concept & working of various fuels systems employed in IC engines
- To understand the combustion and combustion chamber types in IC engines.
- To understand the concept of turbocharging, supercharging, and engine testing
- To understand the requirements and types of cooling and lubrication systems in IC engines

UNIT I	CONSTRUCTION AND OPERATION	9

Classification of IC engines, Constructional details of spark ignition (SI) and compression ignition (CI) engines. Working principles. Two stroke SI and CI engines – construction and working. Comparison of SI and CI engines and four stroke and two stroke engines. Firing order. Cam shaft and Valve train actuation mechanisms, Variable valve timing (VVT). Air Standard Otto, diesel, dual and brayton cycles.

UNIT II	FUEL SYSTEMS	9

Air fuel ratio requirements of SI engines, Air fuel ratio and emissions, Working of a simple carburetor, Throttle body injection, MPFI and GDI system. Diesel fuel injection systems-Jerk pumps, distributor pumps, pintle and multi-hole nozzles, Unit injector and common rail injection systems. Injection pumps calibration. Need for a governor for diesel engines. Description of a simple diesel engine governor.

UNIT III	COMBUSTION AND COMBUSTION CHAMBERS	9

Introduction to combustion in SI and diesel engines and stages of combustion. Dependence of ignition timing on load and speed. Knock in SI and CI engines. Combustion chambers for SI and CI engines. Direct and indirect injection combustion chambers for CI engines. Importance of Swirl, squish and turbulence. Factors controlling combustion chamber design.

UNIT IV	SUPERCHARGING, TURBOCHARGING AND ENGINE TESTING	9

Supercharging and Turbocharging, Different methods of turbocharging, Inter-cooling, Turbocharger controls including, waster gate, variable geometry, variable nozzle types. Measurement of Brake Power, Frictional Power and Cylinder pressure. Indicated thermal, brake thermal and volumetric efficiencies. Engine performance maps, Engine testing standards.

UNIT V	COOLING AND LUBRICATION SYSTEMS		9
Need for cooling, types of cooling systems- air and liquid cooling systems. Thermo syphon and forced circulation and pressurized cooling systems. Radiator construction and Types. Properties of coolants. Requirements of lubrication systems. Types-mist, pressure feed, dry and wet sump systems. Properties of lubricants.			
	TOTAL :	**45**	**PERIODS**

AUTOMOTIVE ENGINES LAB	
LIST OF EXPERIMENTS	
1.	Dismantling and Assembling of Multi-cylinder Petrol Engine
2.	Dismantling and Assembling of Multi-cylinder Diesel Engine
3.	Valve timing and port timing diagram
4.	Study of Petrol engine fuel system
5.	Study of Diesel engine fuel system
6.	Determination of p-θ and p-V diagrams for IC engine with piezo-electric pick up, charge amplifier, angle encoder and PC
7.	Performance and emission test on multi cylinder CI engine
8.	Performance and emission test on multi cylinder SI engine.
9.	Heat balance test on multi-cylinder SI engine
10.	Heat balance test on multi-cylinder CI engine
11.	Study of cooling system used in automotive engines
12.	Study of lubrication system used in automotive engines
	Total : 45 Periods

COURSE OUTCOMES:

On completion of the course the students will be able to

1. Explain basic construction, working of IC engines, operating cycles, perform dismantling and assembly of engines, draw valve and port timing diagrams.
2. Identify and demonstrate various fuel systems employed in automobiles.
3. Explain the stages of combustion, types of chambers and various parameters affecting combustion, conduct experiments using combustion analyser to find combustion characteristics.
4. Explain turbocharging, supercharging, engine testing, and test a variety of engines to draw their performance and emission characteristics.
5. Students will be able to explain the requirements of cooling and lubrication and different types of cooling and lubrication systems employed in IC engines

TEXT BOOKS:	
1	Ganesan V., "Internal Combustion Engines", Tata McGraw Hill, 4th edition, 2012.
2	R.P. Sharma and M.L. Mathur"Internal Combustion Engines"DhanpatRai Publications, 2013
REFERENCE BOOKS:	
1	B. P. Pundir, "IC Engines: Combustion and Emissions" Narosa Publication, 2017
2	Ramalingam K.K., "Internal Combustion Engines", Sci-Tech Publications, 3rd edition, 2016.
3	Devaradjane. Dr. G., Dr. M. Kumaresan, "Automobile Engineering", AMK Publishers, 2013
4	Heinz Heisler, "Advanced Engine Technology", Butterworth Heinemann Publications, 1995
5	John B. Heywood, "Fundamentals of Internal Combustion Engines", McGraw Hill, 1988
6	Gupta. H.N. "Fundamentals of Internal Combustion Engines", reprint, PHI Learning Pvt. Ltd. 2006

Subject Code	Subject Name	Category	L	T	P	C
AT19343	Strength of Materials for Automobile Engineering	PC	2	1	3	4.5

OBJECTIVES:

- To understand the fundamental concepts of stress, strain and elastic constants of solids under external loading
- To acquire knowledge about the transverse and bending loads acting on structural components.
- To learn the deformation of shafts subjected to torsion and various methods for calculating deflection of beams
- To study the various stresses acting on thin, thick cylinders and spheres due to internal pressure of fluid.
- To conduct tensile, impact and hardness tests on materials, compression test on spring, wood and brick.

UNIT I	STRESS, STRAIN AND DEFORMATION OF SOLIDS	9

Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of simple and compound bars – Thermal stresses – Elastic constants – Volumetric strains –Stresses on inclined planes – principal stresses and principal planes – Mohr's circle of stress, failure theories.

UNIT II	TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM	9

Beams – types transverse loading on beams – Shear force and bending moment in beams – Cantilevers – Simply supported beams and over – hanging beams. Theory of simple bending– bending stress distribution – Load carrying capacity – Proportioning of sections – Flitched beams – Shear stress distribution.

UNIT III	TORSION	9

Torsion formulation stresses and deformation in circular and hollows shafts – Stepped shafts– Deflection in shafts fixed at the both ends – Stresses in helical springs – Deflection of helical springs, carriage springs.

UNIT IV	DEFLECTION OF BEAMS	9

Double Integration method – Macaulay's method for computation of slopes and deflections in beams - Conjugate beam and strain energy.
Columns – end conditions – equivalent length of a column – Euler equation – slenderness

ratio – Rankine formula for columns.			
UNIT V	**THIN CYLINDERS, SPHERES AND THICK CYLINDERS**		**9**
Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses and deformation in thin and thick cylinders – spherical shells subjected to internal pressure –Deformation in spherical shells – Lame's theorem.			
	TOTAL :	**45**	**PERIODS**

List of Experiments
1. Tension test on a mild steel rod
2. Torsion test on mild steel rod
3. Impact test on metal specimen (IZOD AND CHARPY)
4. Hardness test on metals – Brinell and Rockwell Hardness Number
5. Deflection test on beams
6. Compression test on helical springs
7. Hardness and impact strength of hardened, hardened and tempered steel.
8. Effect of Tempering and quenching – Comparison of Improvement Mechanical properties and Microscopic Examination of (i) Unhardened specimen (ii) Quenched Specimen and **(iii)** Quenched and tempered specimen.
9. Double Shear test on Mild Steel rod
10. Compression test on Wood & Brick
Total : 45 Periods

COURSE OUTCOMES:
1. The students will be able to explain tension, compression and shear stresses and construct the Mohr‘s circle for the given stress condition. The students will be able to conduct tensile, compression, hardness and impact tests. 2. The students will be able to draw the shear force diagram and bending moment diagram for beams subjected to different loading conditions. The students will be able to perform torsion and double shear tests. 3. The students will be able to calculate the deformation of shafts subjected to torsional loads. The students will be able to demonstrate a compression test on wood. 4. The students will be able to calculate the deflection of beams using Macaulay‘s method and their strain energy. The students will be able to examine a deflection test on beams. 5. The students will be able to determine the stresses acting on thin cylinders, thick cylinders and spheres.

TEXT BOOKS:	
1.	Bansal, R.K ,"Strength of Materials", Laxmi Publications (P) Ltd, Sixth Edition-2017
2.	Jindal U.C., "Strength of Materials by Pearson", Publisher: Education Pearson; Second edition (2017).
REFERENCE BOOKS:	
1.	Egor. P.Popov “Engineering Mechanics of Solids” Publisher: Phi Learning, 2nd Edition-2009
2.	Subramanian R., "Strength of Materials", Oxford University Press, Oxford Higher Education Series, 2016
3.	Hibbeler, R.C., "Mechanics of Materials", Pearson Education, Low Price Edition, 2018
4.	Ferdinand P. Been, Russell Johnson, J.r. and John J. Dewole "Mechanics of Materials", Tata McGraw Hill Publishing co. Ltd., New Delhi, 2016.
5.	Suraj Prakash harsha, “Strength of materials” Department of mechanical and industrial engineering, IITR. https://nptel.ac.in/courses/112107147/

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
EC19351	Basic Electronics Engineering	ES	3	0	0	3

Objectives:

- To study the operation of semiconductor devices and their characteristics.
- To understand the concepts of operational amplifiers with its applications.
- To acquire knowledge about the operation of timing circuits and Oscillators.
- To gain knowledge about digital logic circuits.
- To introduce the basics of electronic communication systems.

UNIT-I	SEMICONDUCTOR DEVICES AND APPLICATIONS	9

Introduction to P-N junction Diode and V-I characteristics, Half wave and Full-wave rectifiers. Zener diode and its characteristics, Zener diode as voltage regulator. Introduction to BJT and its input and output characteristics, BJT as a single stage CE amplifier.

UNIT-II	OPERATIONAL AMPLIFIER AND APPLICATIONS	9

Introduction to operational amplifiers, Op-amp input modes and parameters, Op-amp in open loop configuration, Op-amp with negative feedback, study of practical Op-amp IC 741, inverting and non-inverting amplifier applications: summing and difference amplifier, unity gain buffer, comparator, integrator and differentiator.

UNIT-III	TIMING CIRCUITS AND OSCILLATORS	9

RC-timing circuits, IC 555 and its applications as astable and mono-stable multi-vibrators, positive feedback, Barkhausen criteria for oscillation, R-C phase shift and Wein bridge oscillator.

UNIT-IV	DIGITAL ELECTRONICS FUNDAMENTALS	9

Boolean algebra, Basic and Universal Gates, Symbols, Truth tables, logic expressions, Logic simplification using K- map, half and full adder/subtractor, multiplexers, de-multiplexers, flip-flops, shift registers, counters, Block diagram of 8086 microprocessor and 8051 microcontroller and their applications.

UNIT-V	ELECTRONIC COMMUNICATION SYSTEMS	9

The elements of communication system, Transmission media: wired and wireless, need of modulation, AM and FM modulation schemes, Mobile communication systems: cellular concept and block diagram of GSM system.

	Total Contact Hours	:	45

Course Outcomes:	
•	Demonstrate the characteristics of the diode and transistors.
•	Design suitable amplifiers for simple applications.
•	Analyze the timing circuits and design oscillators.
•	Construct simple digital logic circuits.
•	Develop a high degree of familiarity with the Electronic Communication Systems.

Text Book(s):	
1	Floyd, “Electronic Devices” Pearson Education, 9th edition, 2012.
2	R.P. Jain, “Modern Digital Electronics”, Tata Mc Graw Hill, 3rd Edition, 2007.
3	Frenzel, “Communication Electronics: Principles and Applications”, Tata Mc Graw Hill, 3rd Edition, 2001.

Reference Books(s) / Web links:	
1	Donald .A. Neamen, Electronic Circuit Analysis and Design – 2nd Edition, Tata McGraw Hill, 2009.
2	David A., “Bell Electronic Devices and Circuits”, Oxford Higher Education Press, 5th Edition, 2010
3	M. Morris Mano, “Digital Design”, 4th Edition, Prentice Hall of India Pvt. Ltd., 2008 / Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2003.
4	Simon Haykin, Communication Systems, John Wiley & sons, NY, 4th Edition, 2001.
5	Salivahanan. S, Suresh Kumar. N, Vallavaraj.A, “Electronic Devices and circuits”, Third Edition, Tata McGraw- Hill, 2008

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
AT19311	Computer Aided Machine Drawing Laboratory	PC	0	0	3	1.5

Objectives:
• To learn about the BIS specifications and symbols for welding joints, riveted joints, keys and fasteners.
• To learn the concepts of fits and tolerances and to know about geometric dimensioning and tolerance
• To enable the students to interpret the production drawings and understand part drawings and assembly drawings.
• To learn the commands and steps involved in creating two dimensional sketches of mechanical components
• To learn the steps involved to draw and assembly drawing using part drawing of mechanical components.

List of Experiments			
1.	Study on drawing standards		
2.	Study of fits, limits and tolerances		
3.	Drafting various views of flange coupling		
4.	Drafting various views of flange coupling		
5.	Drafting various views of universal joint		
6.	Drafting assembly view of screw jack		
7	Drafting assembly view of piston		
8	Drafting assembly view of connecting rod		
9	Drafting assembly view of knuckle joint assembly		
10	Drafting assembly view of screw clutch assembly		
	Total Contact Periods	**:**	**45**

Course Outcomes:

1. Students will be able to explain BIS specifications and symbols for welding joints, riveted joints, keys and fasteners.
2. Students will be to describe the fits, tolerances and geometric dimensioning.
3. Students will be able to construct the production drawings, part drawings and assembly drawings.
4. Students will be able to draw two-dimensional sketches for mechanical components.
5. Students will be able to generate assembly drawings for mechanical components using a CAD package.

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
MC19301	**Essence Of Indian Traditional Knowledge**	MC	3	0	0	0

Objectives:	
•	This course aims at imparting basic principles of thought process, reasoning and inference. Sustainability is the core of Indian traditional knowledge system connecting society and nature. Holistic life style of yogic science and wisdom are important in modern society with rapid technological advancements and societal disruptions. The course mainly focuses on introduction to Indian knowledge system, Indian perspective of modern science, basic principles of Yoga and holistic healthcare system, Indian philosophical, linguistic and artistic traditions.

Pedagogy: Problem based learning, group discussions, collaborative mini projects.

UNIT-I	**INTRODUCTION TO INDIAN KNOWLEDGE SYSTEM**	6
Basic structure of the Indian Knowledge System –Veda – Upaveda - Ayurveda, Dhanurveda- Gandharvaveda, Sthapathyaveda and Arthasasthra. Vedanga (Six forms of Veda) – Shiksha, Kalpa, Nirukta, Vyakarana, Jyothisha and Chandas- Four Shasthras - Dharmashastra, Mimamsa, Purana and Tharkashastra.		
UNIT-II	**MODERN SCIENCE AND YOGA**	6
Modern Science and the Indian Knowledge System – a comparison - Merits and demerits of Modern Science and the Indian Knowledge System - the science of Yoga-different styles of Yoga – types of Yogaasana, Pranayam, Mudras, Meditation techniques and their health benefits – Yoga and holistic healthcare – Case studies.		
UNIT-III	**INDIAN PHILOSOPHICAL TRADITION**	**6**
Sarvadharshan/Sadhdharshan – Six systems (dharshans) of Indian philosophy - Nyaya, Vaisheshika, Sankhya, Yoga, Vedanta-Other systems- Chavarka, Jain (Jainism), Boudh (Buddhism) – Case Studies.		
UNIT-IV	**INDIAN LINGUISTIC TRADITION**	6
Introduction to Linguistics in ancient India – history – Phonetics and Phonology – Morphology – Syntax and Semantics-Case Studies.		

UNIT-V	**INDIAN ARTISTIC TRADITION**	6
Introduction to traditional Indian art forms – Chitrakala (Painting), Murthikala / Shilpakala (Sculptures), Vaasthukala, Sthaapathya kala (Architecture), Sangeeth (Music), Nruthya (Dance) and Sahithya (Literature) – Case Studies.		

	Total Contact Hours	**:**	**30**

Course Outcomes: On completion of the course students will be able to	
1	Understand basic structure of the Indian Knowledge System
2	Apply the basic knowledge of modern science and Indian knowledge system in practise
3	Understand the importance Indian Philosophical tradition
4	Appreciate the Indian Linguistic Tradition.
5	Understand the concepts of traditional Indian art forms
Text Book (s):	
1	V. Sivaramakrishnan (Ed.), *Cultural Heritage of India-course material*, Bharatiya Vidya Bhavan, Mumbai. 5th Edition, 2014.
2	Swami Jitatmanand, *Modern Physics and Vedant*, Bharatiya Vidya Bhavan.
3	Swami Jitatmanand, *Holistic Science and Vedant*, Bharatiya Vidya Bhavan.
4	Fritzof Capra, Tao of Physics.
5	Fritzof Capra, The Wave of life.
Reference Books(s) / Web links:	
1	VN Jha (Eng. Trans.), *Tarkasangraha of Annam Bhatta*, International Chinmay Foundation, Velliarnad, Arnakulam.
2	Yoga Sutra of Patanjali, Ramakrishna Mission, Kolkata.
3	GN Jha (Eng. Trans.), Ed. RN Jha, Yoga-darshanam with Vyasa Bhashya,Vidyanidhi Prakashan, Delhi 2016.
4	RN Jha, Science of Consciousness Psychotherapy and Yoga Practices, Vidyanidhi Prakashan, Delhi 2016.

IV SEMESTER

Subject Code	Subject Name	Category	L	T	P	C
AT19401	**Engineering Materials & Metallurgy**	ES	**3**	**0**	**0**	**3**

Objectives
• To impart knowledge on the phase diagram of alloys. • To make the students comprehend the various heat treatment methods for steels • To make the students understand various ferrous and non-ferrous materials • To make aware about various non-metallic material • To make the students understand various destructive testing methods for metals

UNIT-I	**ALLOYS AND PHASE DIAGRAMS**	**9**
Phase diagrams: - Limitations of pure metals and need of alloying–classification of alloys-Iron-Carbon equilibrium diagram with microstructure and properties changes in austenite, ledeburite, ferrite, cementite, special features of martensite transformation, bainite, spheroiditeetc Classification of steel and cast iron microstructure, properties and application.		
UNIT-II	**HEAT TREATMENT**	**10**
Definition – Full annealing, stress relief, recrystallisation and spheroidising – normalising, hardening and Tempering of steel. Isothermal transformation diagrams – cooling curves superimposed on I.T. diagram CCR – Hardenability, Jominy end quench test - Austempering, martempering – case hardening, carburizing, Nitriding, nito-carburising, carbonitriding – Flame and Induction hardening – Vacuum and Plasma hardening, electron beam hardening, lazer beam hardening		
UNIT-III	**FERROUS AND NON-FERROUS METALS**	**9**
Effect of alloying additions on steel- α and β stabilisers– stainless and tool steels – HSLA, Maraging steels – Cast Iron - Grey, white, malleable, spheroidal – alloy cast irons, Copper and copper alloys – Brass, Bronze and Cupronickel – Aluminium and Al-Cu – precipitation strengthening treatment – Bearing alloys, Mg-alloys, Ni-based super alloys and Titanium alloys.		

UNIT-IV	NON-METALLIC MATERIALS	9
Polymers – types of polymers, commodity and engineering polymers – Properties and applications of various thermosetting and thermoplastic polymers (PP, PS, PVC, PMMA, PET, PC, PA, ABS, PI, PAI, PPO, PPS, PEEK, PTFE, Polymers – Urea and Phenol formaldehydes)- Engineering Ceramics – Properties and applications of Al2O3, SiC, Si3N4, PSZ and SIALON –Composites- Classifications- Metal Matrix and FRP - Applications of Composites.		
UNIT-V	**ADVANCED MATERIALS**	**8**
Shape memory alloys, Pseudoelastic effect - Ni-based super alloys, Titanium alloys and NiTi alloys and applications. Carbon Fibre, Carbon nanotubes – types, properties-applications (Fundamentals only). Quasi crystal, Nano crystalline materials. Introduction to Ferro fluids, Self-healing materials, Piezoelectric materials and magnetorheological fluid		
	Total Contact Hours :	**45**

Course Outcomes:

On completion of the course students will be able to

1. The students will be able to construct a phase diagram for alloys
2. The student will be able to select the most appropriate heat treat process for required metal characteristics.
3. The student will be able to suggest ferrous and nonferrous materials for a given application.
4. The student will able to explain the various non-metallic materials and their specific engineering applications
5. The student will be familiar about the properties and application of various advanced materials

Text Books:

1	Avner S.H., "Introduction to Physical Metallurgy", McGraw Hill Education; 2 edition 2017.
2	R. Balasubramaniam, Williams D Callister, "Material Science and Engineering", Wiley India Pvt Ltd, 2nd edition, 2014

Reference Books / Web links:	
1	R.Srinivasan,Engineering Materials and Metallurgy, McGraw Hill Education,edition, 2nd Edition 2009
2	V. Raghavan, Materials Science and Engineering: A First Course,6th Edition, PHI Publications
3	Williams D Callister, ―Material Science and Engineering‖, Revised Indian edition, Wiley India Pvt Ltd, 2007
4	Vivek Pancholi, "Material science and engineering" Department of metallurgical and materials engineering. IITR, https://nptel.ac.in/courses/113107078

Subject Code	Subject Name	Category	L	T	P	C
AT19402	Production Technology – I	PC	3	0	0	3

OBJECTIVES:

- To learn about various metal casting process principle and procedure involved
- To rephrase the process principle and application of powder metallurgy and polymer processing
- To learn about the process principle of various types of welding and its applications.
- To understand the process principles of metal forming techniques.
- To understand various sheet metal operations and processing techniques.

UNIT I	METAL CASTING PROCESSES	9

Sand Casting : Sand Mould – Type of patterns - Pattern Materials – Pattern allowances – Moulding sand Properties and testing – Cores –Types and applications – Moulding machines– Types and applications; Melting furnaces : Blast and Cupola Furnaces; Principle of special casting processes : Shell - investment – Ceramic mould – Pressure die casting - Centrifugal Casting - CO2 process – Stir casting; Defects in Sand casting. Design of patterns, moulds and cores; riser and gating design.

UNIT II	POWDER METALLURGY AND POLYMER PROCESSING	9

Historical and modern developments in Powder Metallurgy. Advantages, limitations and applications of Powder Metallurgy. Basic Steps for Powder Metallurgy. Powder Compaction Methods, Powder Forming Methods and Sintering.
Types of plastics- Working principles and typical applications of - Injection Moulding- Compression molding- Extrusion- Thermoforming- Transfer molding

UNIT III	JOINING PROCESSES	9

Operating principle, basic equipment, merits and applications of: Fusion welding processes: Gas welding - Types – Flame characteristics; Manual metal arc welding – Gas Tungsten arc welding - Gas metal arc welding – Submerged arc welding – Electro slag welding; Operating principle and applications of: Resistance welding - Plasma arc welding – Thermit welding – Electron beam welding –Laser Beam welding, Friction welding and Friction Stir Welding; Weld defects: types, causes and cure. Principles of brazing, soldering and adhesive bonding.

UNIT IV	METAL FORMING PROCESSES	9

Hot working and cold working of metals – Forging processes – Open, impression and closed die forging – forging operations. Rolling of metals– Types of Rolling – Flat strip rolling – shape rolling operations – Defects in rolled parts. Principle of rod and wire drawing – Tube drawing – Principles of Extrusion – Types – Hot and Cold extrusion. Load estimation for bulk (forging,

rolling, extrusion and drawing).		
UNIT V	**SHEET METAL PROCESSES**	**9**
Sheet metal characteristics – shearing, bending and drawing operations – Stretch forming operations – Formability of sheet metal – Test methods –special forming processes-Working principle and applications – Hydro forming – Rubber pad forming – Metal spinning– Introduction of Explosive forming, magnetic pulse forming, peen forming, Super plastic forming – Micro forming.		
	TOTAL :	**45 PERIODS**

COURSE OUTCOMES:

1. The students will be able to comprehend various metal casting process principle and procedure
2. The students will be able to demonstrate the working principle and application of powder metallurgy and polymer processing.
3. The students will be to explain principle of various types of welding and its applications
4. The students will be able to illustrate the working principles of metal forming techniques.
5. The students will be able to demonstrate various sheet metal operations and processing techniques.

TEXT BOOKS:

1	P N Rao, "Manufacturing Technology: Vol. I",4th Edition, McGraw hill Education, 2013.
2	2013S SK HajraChoudhury and A K HajraChoudhury, Nirjhar Roy, "Elements of WorkshopTechnology Volume I: Manufacturing Processes", Media Publishers and Promoters Pvt. Ltd., 2008.

REFERENCE BOOKS:

1.	Mikell P Groover, "Fundamentals of Modern Manufacturing Materials processes and systems"Fourth Edition, Wiley Publication.
2.	Roy. A. Lindberg, "Processes and Materials of Manufacture", PHI / Pearson education, 2006
3.	J. T. Black, Ronald A. Kohser, "DeGarmo's Materials and Processes in Manufacturing" Twelfth Edition, John Wiley & Sons, 2017.
4.	Steven R. Schmid and Serope Kalpakjian, "Manufacturing Engineering and Technology" Seventh Edition, Pearson Education, 2014.

Subject Code	Subject Name	Category	L	T	P	C
AT19441	FLUID MECHANICS & MACHINERY FOR AUTOMOBILE ENGINEERS	PC	2	1	2	4

Objectives:

- The properties of fluids and concept of control volume are studied.
- The applications of the conservation laws to flow through pipes are studied.
- To understand the importance of dimensional analysis
- To understand the importance of various types of flow in pumps
- To understand the importance of various types of flow in turbines.

UNIT-I	FLUID PROPERTIES AND FLOW CHARACTERISTICS	10

Units and dimensions- Properties of fluids- mass density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapour pressure, surface tension and capillarity, hydrostatics. Flow characteristics – concept of control volume - application of continuity equation, energy equation and momentum equation –venturi.

UNIT-II	FLOW THROUGH CIRCULAR CONDUITS	9

Hydraulic and energy gradient - Laminar flow through circular conduits and circular annuli - Boundary layer concepts - types of boundary layer thickness - Darcy Weisbach equation -friction factor - Moody diagram - commercial pipes - minor losses - Flow through pipes in series and parallel –Flow over a flat plate–concept of Drag and Lift, airfoil and spoiler.

UNIT-III	DIMENSIONAL ANALYSIS	8

Need for dimensional analysis - methods of dimensional analysis - Similitude - types of similitude - Dimensionless parameters- application of dimensionless parameters - Model analysis - Similarity between Model and Prototype Vehicle.

UNIT-IV	PUMPS	9

Impact of jets – Euler's equation - Theory of roto-dynamic machines - various efficiencies - velocity components at entry and exit of the rotor- velocity triangles - Centrifugal pumps - working principle - work done by the impeller - performance curves - Reciprocating pump -working principle - Diaphragm pump - Rotary pumps - Gear, Vane and Lobe types.

UNIT-V	TURBINES	9
Classification of turbines - heads and efficiencies - velocity triangles. Axial, radial and mixed flow turbines - Pelton wheel, Francis turbine and Kaplan turbines - working principles - work done by water on the runner - draft tube. Specific speed - unit quantities - performance curves for turbines - governing of turbines.		
	Total Contact Hours : 45	

List of Experiments	
1	Determination of the Coefficient of discharge of given Orifice meter.
2	Determination of the Coefficient of discharge of given Venturi meter.
3	Conducting experiments and drawing the characteristic curves of centrifugal pump.
4	Conducting experiments and drawing the characteristic curves of Reciprocating pump.
5	Conducting experiments and drawing the characteristic curves of Gear pump.
6	Determination of friction factor of given set of pipes.
7	Determination of minor losses for given set of pipes.
8	Conducting experiments and drawing the characteristic curves of Pelton wheel.
9	Conducting experiments and drawing the characteristic curves of Kaplan turbine.
10	Drag estimation of basic models in wind tunnel.
	Contact Periods : 30

Course Outcomes:

1. The students will be able to calculate the properties and explain the characteristics of a fluid. The students will be able to perform tests on orifice and venturi meter.
2. The students will be able to calculate the various losses and friction factor during flow of liquid.
3. The students will be able to apply the mathematical knowledge for dimensional analysis.
4. The students will be able to compute the performance parameters of hydraulic pumps and identify suitable pumps for a given practical application.
5. The students will be able to compute the performance parameters of hydraulic turbine and identify suitable turbine for a given practical application.

Text Books:	
1	Bansal, R.K., “Fluid Mechanics and Hydraulics Machines”, 5th edition, Laxmi Publications Pvt. Ltd, New Delhi, 2008.
2	Modi P.N. and Seth, S.M. "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi, 2004.

Reference Books / Web links:	
1	Fox W.R. and McDonald A.T., "Introduction to Fluid Mechanics", John-Wiley and Sons, Singapore, 1995.
2	Jain A. K. "Fluid Mechanics", Khanna Publishers, 2010.
3	Roberson J.A and Crowe C.T., “Engineering Fluid Mechanics", Jaico Books Mumbai, 2000.
4	Streeter, V.L., and Wylie, E.B., "Fluid Mechanics", McGraw Hill, 2000.
5	White, F.M., "Fluid Mechanics", Tata McGraw Hill, 5th Edition, New Delhi, 2003.

Subject code	Subject Name	Category	L	T	P	C
AT19442	AUTOMOTIVE DRIVE LINE AND CHASSIS	PC	4	0	2	5

OBJECTIVES:

- To impart knowledge on types of chassis layout and constructional details of drive lines
- To learn about the steering geometry and components of the steering system of a vehicle.
- To make the students understand the loads acting on rear axles, types of tyres and wheels of an automobile.
- To impart the knowledge about various suspension systems utilized for automobiles.
- To impart knowledge on various braking system in automobile.

UNIT I	LAYOUT , FRAME AND DRIVE LINE	15

Basic construction of vehicles, Types of Chassis layout, with reference to Power Plant location and drive, various types of frames, forces acting on a vehicle, Clutch and types, Gear Box and types, Fluid coupling, Torque converter and its characteristics, Hotchkiss drive, torque tube drive, Propeller Shaft, Universal Joints, Constant Velocity Universal Joints, Final drive and its types. Principle and Constructional details of differential unit, Non–Slip differential, Differential locks.

UNIT II	FRONT AXLE AND STEERING SYSTEM	12

Types of Front Axles and Stub Axles, Front Wheel Geometry. Condition for True Rolling Motion. Ackerman‘s and Davis’s Steering Mechanisms, Steering Linkages, Different Types of Steering Gear boxes, Slip Angle, effects of Over–Steer and Under–Steer, Reversible and Irreversible Steering, Power Steering, radius rods and stabilizers.

UNIT III	REAR AXLES, WHEELS, RIMS AND TYRES	09

Construction of rear axles, Types of Loads acting on rear axles, Full –Floating, Three–Quarter Floating and Semi–Floating Axles, Twist beam rear axle, Multi axle vehicles and its types. Wheels and Rims, Types of Tyres and their constructional details.

UNIT IV	SUSPENSION SYSTEM	12

Requirement of Suspension System, Types of Suspension Springs, Constructional details and characteristics of Single Leaf, Multi–Leaf spring, Coil and Torsion bar Springs, Rubber, Pneumatic and Hydro – elastic Suspension Spring Systems, Independent and dependent

Suspension System, Shock Absorber and its types, anti-roll bar, wheel alignment.		
UNIT V	**BRAKE SYSTEMS**	**12**
Need for Brake systems, Stopping Distance, Time and Braking Efficiency, Effect of Weight Transfer during Braking, Classification of brakes, Braking Torque, drum brake and disc Brake Theory, Types and Construction of Hydraulic Braking System, Mechanical Braking System, Pneumatic Braking System, Power–Assisted Braking System, Servo Brakes, Retarders – antilock braking systems(ABS), Electromagnetic brake system, Electronic brake system(EBS).		

	TOTAL:	**60**	**PERIODS**

AUTOMOTIVE DRIVE LINE AND CHASSIS LABORATORY:
LIST OF EXPERIMENTS:
1. Study, measurement of light and heavy commercial Vehicle Frame
2. Measurement of wheel alignment parameters.
3. Study, dismantling and assembling of steering gear boxes and calculation of gear ratios
4. Study, dismantling and assembling of clutches
5. Study, dismantling and assembling of Light and Heavy gear box
6. Study, dismantling and assembling of differential system
7. Study, dismantling and assembling of front axle
8. Study, dismantling and assembling of rear axle
9. Study, dismantling and assembling of suspension systems
10. Study of braking system, mapping pedal displacement with pressure.
11. Study of vehicle tyres and its specifications.
12. Study of different types of wheels and features
Total : 30 Periods

COURSE OUTCOMES:
1. The students will be able to explain types of chassis layout, frames and derive lines in the vehicle. The students will be able to identify the components and function of vehicle frame, clutch, gearboxes and differential. 2. The students will be able to illustrate the steering geometry, condition for true rolling motion and types of vehicle steering systems. The students will be able to identify the components, function of the steering gear boxes, front axle, and measure the wheel alignment parameters. 3. The students will be able to describe various types of rear axles, wheels and tires. The students will be able to identify the components and function of the rear axles, different types of wheels and tires with features. 4. The students will be able to comprehend the various suspension springs for vehicles. The students will be able to demonstrate the function and components of the various suspension systems. 5. The students will be able to realize the importance of braking systems in a vehicle and possess knowledge about ABS, EBS. The students will be able to explain function and components of the braking system and mapping pedal displacement with pressure.

TEXT BOOKS:
1. T.K. Garrett, K. Newton and W. Steeds, "The Motor Vehicle", Butterworth-Heinemann Publication, 13th Edition, 2000
2. Kirpal Singh, "Automobile Engineering Vol.1", Standard Publisher Distributors, 14th Edition, 2017.

REFERENCE BOOKS
1. Giri. N.K., "Automobile Mechanics" Khanna Publishers, New Delhi, 1998.
2. S.K.Gupta, "A Textbook of Automobile Engineering", S CHAND Publication, Copyright edition, 2013.
3. Heinz Heisler, "Advanced Vehicle Technology", Butterworth Heinemann Publications 2nd Edition, 2002.
4. S Srinivasan, "Automotive mechanics", McGraw-Hill Education, 2nd edition, 2003.

Subject Code	Subject Name	Category	L	T	P	C
AT19443	THEORY OF MACHINES	PC	2	1	2	4

OBJECTIVES:

- To understand the principles in the formation of mechanisms and their kinematics.
- To understand the fundamental concepts behind gears and experimentally determine the various speeds in a gearbox.
- To understand the concepts in cam and gyroscopes and generate the cam profile practically.
- To understand the principle in balancing of rotating masses in machines and validate the concept experimentally.
- To understand the importance of vibration in machines and practically determine the natural frequency of a given mechanical system.

UNIT I	MECHANISMS	09

Machine Structure – Kinematic link, pair and chain – Grueblers criteria – Constrained motion – Degrees of freedom – Slider crank and crank rocker mechanisms – Inversions – Applications – Kinematic analysis of simple mechanisms – Determination of velocity and acceleration by relative velocity Method. Velocity and acceleration of piston, angular velocity and angular acceleration of connecting rod of reciprocating engine.

UNIT II	GEARING AND POWER DRIVES	09

Gears: profile and geometry – Nomenclature of spur and helical gears –Velocity of sliding, Length of path of contact and arc of contact, Contact ratio, Interference, Calculation of minimum number of teeth.
Gear trains: Simple, compound gear trains and epicyclic gear trains – Determination of speed and torque.
Belt drive: Types of belts, Selection of belt drive, length of open and crossed belt drive Velocity ratio, slip and creep of belt drives, Power transmitted by a belt, Condition for transmission of maximum power.
Chain drive: Advantages over belt drive, Classification of chains.

UNIT III	CAMS AND CLUTCHES	09

Cams – Types of cams – Design of profiles – Knife edged, flat faced and roller ended followers with and without offsets for various types of follower motions.
CLUTCH : Different types of clutches, principle & Construction of Single and multiple plate clutches, Centrifugal clutches

UNIT IV	BALANCING AND GYROSCOPIC MOTION	09

Static and dynamic balancing – Several masses rotating in same and different planes – Balancing of reciprocating masses- primary balancing and concepts of secondary balancing – Single and multi cylinder engines (Inline). Balancing of radial V engine - direct and reverse crank method (descriptive treatment only). **Gyroscopes:** Gyroscopic forces and couple – Forces on bearing due to gyroscopic action – Gyroscopic effect in Ship, motor cycle, car and aircraft.		
UNIT V	**VIBRATION**	**09**
Free, forced and damped vibrations of single degree of freedom systems – Force transmitted to supports – Vibration isolation – Vibration absorption – Torsional vibration of shaft – Single and multi rotor systems – Geared shafts – Critical speed of shaft.		
	TOTAL : 45 PERIODS	

List Of Experiments	
1	Study of gear terminologies and determination of velocity ratios of simple, compound, Epicyclic and differential gear trains.
2	Motorized gyroscope – Study of gyroscopic effect and couple.
3	Determination of range sensitivity and effort of Hartnell Governor.
4	Cams – Cam profile drawing, Motion curves and study of jump phenomenon
5	Determination of natural frequency and damping coefficient of spring mass system.
6	Balancing of rotating masses
7	Determination of natural frequency of torsional vibration in single rotor system.
8	Determination of free transverse vibration of a cantilever and simply supported beam
	Total : 30 Periods

COURSE OUTCOMES:
1. The students will be able to calculate the velocity and acceleration for simple mechanisms 2. The students will be able to deduce the dimensions for a spur gear and speeds of gears in a gear train, and validate the results experimentally. 3. The students will be able to generate the cam profile for the given follower motion and will be able to apply gyroscopic effect to automobiles. 4. The students will be able to balance the reciprocating and rotating masses in machines. 5. The students will be able to compute the frequency of free, forced and damped vibration in a mechanical system and validate the results practically.

TEXT BOOKS:	
1.	Thomas Bevan, “Theory of Machines”, Dorling Kindersley India Pvt. Ltd. New Delhi, 2010.
2.	Rattan S S, “Theory of Machines”, MCGraw Hill, 2014.
REFERENCE BOOKS/NPTEL web link:	
1.	R.S.Khurmi, “Theory of Machines” by, S. Chand Pub. 2005
2.	Ambekar A.G., “Mechanism and Machine Theory”, Prentice Hall of India, New Delhi, 2007
3.	AmitabhaGhosh, Asok Kumar Mallik, “Theory of Mechanisms and Machines”, Affiliated East-West Pvt. Ltd., New Delhi, 3rd edition.
4.	Ramamurthi. V., “Mechanisms of Machine”,Narosa Publishing House, 2002.
5.	Robert L.Norton, “Design of Machinery”, McGraw-Hill, 2004.
6.	John Joseph Uicker, G. R. Pennock, Joseph Edward Shigley, “Theory of Machines and Mechanisms”, Oxford University Press, 2016.
7.	NPTEL course on Kinematics of Machines: https://nptel.ac.in/courses/112/104/112104121/

Subject Code	Subject Name	Category	L	T	P	C
GE19421	**Soft Skills-I**	EEC	**0**	**0**	**2**	**1**

Objectives
• To help students break out of shyness. • To build confidence • To enhance English communication skills. • To encourage students' creative thinking to help them frame their own opinions

Learning and Teaching Strategy:

The program is completely student centric where the focus is on activities led by students which include role plays, discussions, debates other games as well. These activities would be supplemented by interactive use of technology and brief trainer input.

1	Introduction	The trainer and the college facilitator talk to the students about the course and in turn the students introduce themselves.	To set expectations about the course and the students are made aware of the rules and regulations involved in this program
2	If I ruled the world	This is a quick and useful game by getting students to form a circle and provide their point of view. Each student then repeats what the other has said and comes up with their own opinion.	The aim of this activity is to for students to get to know each other and also develop their listening skills as well as learning how to agree and disagree politely.
3	Picture Narrating	This activity is based on several sequential pictures. Students are asked to tell the story taking place in the sequential pictures by paying attention to the criteria provided by the teacher as a rubric. Rubrics can include the vocabulary or structures they need to use while narrating.	The aim of this activity is to make the students develop creative way of thinking.

4	Brainstorming	On a given topic, students can produce ideas in a limited time. Depending on the context, either individual or group brainstorming is effective and learners generate ideas quickly and freely. The good characteristics of brainstorming are that the students are not criticized for their ideas so students will be open to sharing new ideas.	The activity aims at making the students speak freely without the fear of being criticized. It also encourages students to come up with their own opinions.
5	Debate	Is competition necessary in regards to the learning process?	The aim of this activity is to develop the student's ability to debate and think out of the box
6	Short Talks	Here the students are given topics for which they take one minute to prepare and two minutes to speak. They can write down points but can't read them out they can only use it as a reference.	The activity aims at breaking the students' shyness and encouraging them to standup in front of the class and speak. It also aims at creating awareness that they are restricted for time so they only speak points that are relevant and important.
7	Debate	Will posting students' grades on bulletin boards publicly motivate them to perform better or is it humiliating?	This activity aims at enhancing the students unbiased thought process when it comes to exams and grades as well as develop their skills to debate
8	The Art of diplomacy	The facilitator proceeds to share multiple concepts of conversation and helps the participants to identify the various methods of being diplomatic and how do deal with misinformation.	The aim of the lesson is to provide an opportunity for the participants to learn about body language and choosing the appropriate words for conversation.
9	Debate	Are humans too dependent on computers?	The aim of this activity is to test the students debating skills and thought process with a topic that affects everybody in daily life.
10	Story Completion	The teacher starts to tell a story but after 2 sentences he/she asks students to work in groups to create the rest of the story which includes the plot and the ending.	This activity aims at building their narrating skills as well as their creativity and ability to work in a team.

11	Role play debate	Students scrutinize different points of view or perspectives related to an issue. For example, a debate about the question "Should students be required to wear uniforms at school?" might yield a range of opinions. Those might include views expressed by a student (or perhaps two students – one representing each side of the issue), a parent, a school principal, a police officer, a teacher, the owner of a clothing store, and others.	The aim of this activity is to get students to speak based on other people's perspective instead of their own. The students take the role of various characters and debate accordingly.
12	I Couldn't Disagree More	This is a game where students practice rebuttal techniques where one student provides a thought or an idea and the other students starts with the phrase I couldn't disagree more and continues with his opinion	The aim of this activity is to improve general communication skills and confidence.
13	Feedback	At the end of the session in the final week (12) the trainer would provide feedback to the students on best practices for future benefits	The aim is to do both give feedback to students as well as obtain feedback on the course from them.

Total : 30 Periods

Course Outcomes	
1	Students should be able to be more confident
2	Students should be able to speak in front of a large audience
3	Students should be able to be better creative thinkers
4	Students should be able to be spontaneous
5	Students should be able to know the importance of communicating in English

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
CS19411	**PYTHON PROGRAMMING FOR MACHINE LEARNING** (with effect from 2021 batch onwards) (Common to AERO, AUTO, BME, BT, CHEMICAL, CIVIL, EEE, ECE, FT, MECH, MCT, R&A)	ES	1	0	4	3

Course Objectives:

- To understand the relationship of the data collected for decision making.
- To know the concept of principle components, factor analysis and cluster analysis for profiling and interpreting the data collected.
- To lay the foundation of machine learning and its practical applications.
- To develop self-learning algorithms using training data to classify or predict the outcome of future datasets.
- To prepare for real-time problem-solving in data science and machine learning.

List of xperiments

1.	NumPy Basics: Arrays and Vectorized Computation
2.	Getting Started with pandas
3.	Data Loading, Storage, and File Formats
4.	Data Cleaning and Preparation
5.	Data Wrangling: Join, Combine, and Reshape
6.	Plotting and Visualization
7.	Data Aggregation and Group Operations
8.	Time Series
9.	Supervised Learning
10.	Unsupervised Learning
11.	Representing Data and Engineering Features
12.	Model Evaluation and Improvement

Contact Hours : 75

Course Outcomes:

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

- Develop a sound understanding of current, modern computational statistical approaches and their application to a variety of datasets.
- Use appropriate packages for analysing and representing data.
- Analyze and perform an evaluation of learning algorithms and model selection.
- Compare the strengths and weaknesses of many popular machine learning approaches.
- Apply various machine learning algorithms in a range of real-world applications.

Text Books:

1. Wes McKinney, Python for Data Analysis - Data wrangling with pandas, Numpy, and ipython, Second Edition, O'ReillyMedia Inc, 2017.
2. Andreas C. Müller and Sarah Guido, Introduction to Machine Learning with Python - A Guide for Data Scientists, First Edition, O'Reilly Media Inc, 2016.

Reference Books:

1. AurélienGéron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition, O'Reilly Media Inc, 2019.

SEMESTER -V

Subject Code	Subject Name	Category	L	T	P	C
AT19501	MACHINE DESIGN	PC	2	1	0	3

Objectives:	
●	To enable the student to design a machine component when subjected to various types of loading and estimate corresponding stress induced in the machine component
●	To understand the phenomenon of combined bending and torsional moment while designing a shaft, key and coupling
●	To evaluate the loading conditions and design the joints (permanent/temporary) based on requirement
●	To enable the student to design the energy absorbing members for the given constraints
●	To understand the selection and design of bearing for the given set of constrains

UNIT I	STEADY STATE STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS	20
Introduction to the design process - factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers, fits and tolerances – Direct, Bending and torsional stress equations – Impact and shock loading – calculation of principle stresses for various load combinations, eccentric loading – curved beams – crane hook and 'C' frame- Factor of safety - theories of failure – Design based on strength and stiffness – stress concentration – Design for variable loading.		
UNIT II	**SHAFTS AND COUPLINGS**	**15**
Design of solid and hollow shafts based on strength, rigidity and critical speed – Keys, keyways and splines - Rigid and flexible couplings.		
UNIT III	**TEMPORARY AND PERMANENT JOINTS**	**14**
Indian Standard for fasteners - Threaded fasteners –- Bolted joints including eccentric loading, Specification of Bolts, Estimation of torque in bolt tightening- Knuckle joints, Cotter joints – Welded joints, riveted joints for structures.		

UNIT IV	**ENERGY STORING ELEMENTS**	**14**
Various types of springs, optimization of helical springs - rubber springs - Flywheels considering stresses in rims and arms for single cylinder engines, multi cylinder engine and punching machines		
UNIT V	**BEARINGS**	**12**
Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, Sommerfeld Number, Raimondi and Boyd graphs - Selection of Rolling Contact bearings.		

	Total Contact Hours	**:**	**75**

Course Outcomes:	
•	The student will able to design a machine component when it subjected to various types of loading and estimate corresponding stress induced in the machine component
•	The student will able to design a shaft, key and coupling on satisfying the given loading conditions
•	The student will able to evaluate the loading conditions and design the joints (permanent/temporary) based on requirement
•	The student will able to design the energy absorbing members(springs, flywheel) for the given constraints
•	The student will able to explain the selection of roller bearing and design of journal bearing for the given set of constrains

Text Books:	
1	Bhandari V, “Design of Machine Elements”, 3rd Edition, Tata McGraw-Hill Book Co, 2016.
2	Richard G Budynas Richard Gordon Budynas, J.KeithNisbett., “Shigley's Mechanical Engineering Design”, 10th edition, Tata McGraw-Hill, 2015

Reference Books / Web links:	
1.	R.S. Khurmi& J. K. Guptha, "A Textbook of Machine Design", 34th edition, S. Chand publication. 2014.
2.	Sundararajamoorthy T. V. Shanmugam N, "Machine Design", Anuradha Publications, Chennai, 2003.
3.	Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Design", 6th Edition, Wiley, 2018
4.	Alfred Hall, Halowenko, A and Laughlin, H., "Machine Design", Tata McGraw-Hill BookCo.(Schaum's Outline), 2010.
5.	Bernard Hamrock, Steven Schmid,Bo Jacobson, "Fundamentals of Machine Elements", 2nd Edition, Tata McGraw-Hill Book Co., 2006.
6.	Orthwein W, "Machine Component Design", Jaico Publishing Co, 2003.
7.	Ansel Ugural, "Mechanical Design – An Integral Approach", 1st Edition, Tata McGraw-Hill Book Co, 2003.
8.	Merhyle F. Spotts, Terry E. Shoup and Lee E. Hornberger, "Design of Machine Elements", 8th Edition, Printice Hall, 2003.

Subject Code	Subject Name	Category	L	T	P	C
AT19502	Electric and Hybrid Vehicles - I	PC	3	0	0	3

Objectives:

- To give the students the idea of global energy scenario, pollution levels and green mobility technology solutions
- To make the students understand the suitability and control of direct current machines for EV and HEV application.
- To make the students understand the characteristics of alternating current motors, their performance and control.
- To make the students realise the potential of advanced electric motors for traction application.
- To make the students realise the importance of various design parameters and their effect on the performance of the vehicle.

UNIT-I	Introduction	9

Global energy scenario - Electric and hybrid vehicle – need, advantages, challenges – Hybrid vehicle – advantages, disadvantages, architecture and energy flow– series, parallel, series-parallel, micro, mild, full and plugin hybrid. Hybrid and Electric vehicle layouts - Drive train for hybrid and electric vehicles-Hybrid vehicle operating modes. Electronic control system for EV & EHV. Power flow control.

UNIT-II	DC Motors	9

Introduction – types of motors – trends. DC Series motor – structure and principle of operation. Moor control – speed control and regenerative braking. BLDC motor - Types of BLDC Motor - Torque Equation, Speed-Torque Characteristics, Microprocessor and DSP based control of BLDC motor. Sensorless control of DC motor. EV Motor sizing. Thermal management in BLDC motors. Losses in DC motors

UNIT-III	AC Motors	9

Three phase induction motor – basics, Inverter Based Induction Motor Drive, Modifying Torque-speed characteristics of 3 phase induction motor – Variable voltage, variable frequency control, field oriented control, direct torque control. Braking of the Induction Motor – Regenerative braking and dynamic braking. Losses in AC motors

UNIT-IV	PMSM and SRM machines	9

PMSM –structure – Principle of operation, Torque equation. Speed- torque Characteristics, Speed Control – vector control of PMSM, sensorless control, Microprocessor and DSP based control. Introduction - Constructional features of Switched Reluctance Motor – Principle of operation – Torque equation and characteristics – Losses - Drive circuits of SRM, Control of SRM- Speed

torque Characteristics.		
UNIT-V	**Vehicle Mechanics**	**9**
Vehicle forces – tractive effort and vehicle speed, estimation of power, range, and energy consumption, rolling resistance power, downgrade force and regeneration. Sizing of power train components in a hybrid drive. Maximum speed of the vehicle. Gradeability. Vehicle acceleration. Vehicle fuel economy estimation in a hybrid drive.		
	Total Contact Hours : 45	

Course Outcomes:

1. The students will be aware of global pollution, emission standards and modern drive train technology options available for automobiles.
2. The students will able to suggest a suitable direct current motor for EV and HEV application.
3. The students will be able to comprehend the use of AC motors for traction application
4. The students will be able to describe the suitability of advanced motors for powertrain application.
5. The students will be able to compute the various vehicular resistances and performance parameters for the vehicle.

Text Books:

1	Tom denton. " Electric and Hybrid Vehicles" Routledge Publications, 2016
2	Austin Hughes and Bill Drury. " Electric Motors and Drives – Fundamentals, Types and Applications, Newnes-Elsevier, 2013.
3	Vinodhkumar, Ranjan Kumar Behera, Dheeraj Joshi " Power Electronics, Drives and Advanced Applications", CR press, 2020.

Reference Books

1	Gianfranco Pistoia. "Electric And Hybrid Vehicles Power Sources, Models, Sustainability, Infrastructure and The Market". Elsevier, 2010.
2	Jack Erjavec. "Hybrid, Electric & Fuel-Cell Vehicles". Cenage Learning, 2013.
3	Chau. K. T. "Electric Vehicle Machines and Drives – Design, Analysis and Application", John Wiley & Sons Singapore Pte. Ltd., 2015
4	"Introduction to hybrid and electric vehicles", Department of electrical engineering, IITG. https://archive.nptel.ac.in/courses/108/103/108103009/#

Subject Code	Subject Name	Category	L	T	P	C
AT19541	AUTOMOTIVE ELECTRICAL AND ELECTRONICS	PC	3	0	3	4.5

OBJECTIVES:

- To understand the basic principle, types, testing and maintenance of batteries
- To learn the basics of starting and ignition systems and the fundamentals of wiring, lighting and accessories used in vehicles
- To learn the working principles of various sensors used in vehicles and actuators along with its application.
- To conduct tests on battery, starter motor, alternator and DC shunt motor.
- To study about of rectifiers, filters, logic gates, adder, flip-flops and ADC for Data Acquisition

UNIT I	INTRODUCTION AND TYPES OF BATTERIES	7

Electrical and electronic principles, insulator, conductor and semiconductor, voltage current and resistance, measurement of current, voltage and resistance, common circuit symbols for automobiles. Principle and construction of Lead Acid Battery - Characteristics, Battery Rating, Capacity and Efficiency, Various Tests on Battery, Battery–Charging Techniques, Defects - Effect of overheating, Effect of overcharging, Dislocation of active material, sulphation, Internal short circuits, Corrosion / sulphation of terminals. Storage of lead acid battery (in dry & wet condition), Maintenance of batteries. Maintenance free battery-dry battery-Tubular battery.

UNIT II	STARTING, CHARGING AND IGNITION SYSTEMS	11

Starter motors characteristics, capacity requirements. Types of starter motor drives – mechanisms of Standard Bendix drive, Folo-thru' Bendix drive, Over running clutch drive, Dyer drive, Pre-engaged type. Starter switches- manual, solenoid switch cum shift, solenoid with relay. DC Generators and Alternators their characteristics. Control unit – cut out, electronic regulators. Spark plugs. Spark advance mechanisms. Different types of ignition systems, Electronic ignition systems.

UNIT III	AUTOMOTIVE WIRING, LIGHTING AND ACCESSORIES	9

Wiring cables, color codes, harness, multiplexing, electromagnetic compatibility, vehicle Interior wiring circuit, vehicle exterior wiring circuit, lamps-types-gas discharge, xenon, LED, headlight – bulbs, reflectors, lenses, leveling and beam setting- Adaptive Front Lights (AFL)-Digital turn signals- Auto dimming mirror- Dashboard instruments, Horn, windscreen wipers and its controls, power windows, electric pumps –fuel pump, wiper pump. Electric power steering, vehicle tracking system.

UNIT IV	AUTOMOTIVE SENSORS	11
Sensors construction with automotive applications Temperature measurement –Thermistor, Thermocouple - Potentiometer – LVDT and rotary – Air flow measurement, Throttle position, Hot wire anemometry – air flow measurement, Inductive – Magnetic and Hall effect – speed and position detection, Piezoelectric – Knock detection, Acceleration sensor – inertia and capacitive type, Yaw rate sensor Feedback sensor – EGO sensor-construction and working - Manifold Absolute Pressure (MAP) sensor, Differential exhaust gas pressure and Air bag sensor		
UNIT V	**AUTOMOTIVE ACTUATORS**	**7**
Construction and working of actuators with automotive applications: Relays, Solenoid type – Injectors, Air valve, Linear motor – Door lock actuator, DC motors – Fuel pump, Gear shift actuators. Stepper motors – Idle speed control, Cruise control.		
	TOTAL :	**45 PERIODS**

LIST OF EXPERIMENTS	
(a) AUTOMOTIVE ELECTRICAL LABORATORY	
1.	Testing of batteries and battery maintenance
2.	Testing of starting motors and generators
3.	Study of Automobile electrical wiring, Sensors and Actuators
4.	Open circuit and load characteristics of DC shunt generator- critical resistance and critical speed.
5.	Load test on DC shunt and compound motor.
6.	Load test on DC series motor
7.	Load test on single-phase induction motor.
8.	Load test on three-phase induction motor.
(b) AUTOMOTIVE ELECTRONICS LABORATORY	
9.	Study of rectifiers, filters, logic gates, adder and flip-flops
10.	Study of SCR and IC timer

11.	Interfacing Sensors like RTD, LVDT, Load Cell etc.
12.	Interfacing ADC for Data Acquisition
13.	Interfacing DAC for Control Application
	Total : 45 Periods

COURSE OUTCOME:

1. The students will be able to explain the principle, types of batteries and its applications. The students will be able to conduct various tests on the battery.

2. The students will be able to describe the principle of starting system and ignition systems in a vehicle. The students will be able to perform tests on various motors used in vehicle.

3. The students will be able to explain procedure for wiring, lighting and accessories.

4. The students will be able to identify the sensors and explain their working principles.

5. The students will be able to gain knowledge about the actuators employed in vehicles and perform diagnosis tests.

TEXT BOOKS:	
1	Kohli. P.L, "Automotive Electrical Equipment", Tata McGraw-Hill co ltd, New Delhi, 2006.
2	Bosch Automotive Electrics and Automotive Electronics, 5th Edition, Springer Vieweg, 2014.
REFERENCE BOOKS:	
1	Ronald. K, Jurgen, "Automotive Electronics Handbook", McGraw Hill, New Delhi, 1999.
2	William B Ribbens, "Understanding Automotive Electronics – An engineering perspective", 8th Edition, Butterworth-Heinemann, 2017.
3	Hillier. V.A.W., Peter Coombes & David Rogers, "Hillier's Fundamentals of Motor Vehicle Technology", Nelson Thornes., United Kingdom, 2012.
4	Judge. A.W., "Modern Electrical Equipment of Automobiles", Chapman & Hall, London, 1992
5	https://nptel.ac.in/courses/108102121/

Subject Code	Subject Name	Category	L	T	P	C
AT19542	PRODUCTION TECHNOLOGY – II	PC	3	0	3	4.5

OBJECTIVES:

- To demonstrate the working principle and operation capabilities of a turning machine
- To demonstrate the gear manufacturing process and working of unconventional machining process
- To learn about computer aided manufacturing and understand operation of CNC machine
- To learn about principle working and operation of various additive manufacturing process
- To learn about the industry 4.0 and to explain various advanced manufacturing process

UNIT I	TURNING MACHINING	9

General principles (with schematic diagrams only) of working and commonly performed operations in the following machines: Lathe, Shaper, Planer, Horizontal milling machine, Universal drilling machine, Broaching machines, Cylindrical grinding machine, Capstan and Turret lathe.

UNIT II	MANUFACTURING OF GEARS AND UNCONVENTIONAL MACHINING PROCESSES	12

Gear cutting - forming and generation principle and construction of gear milling, hobbing and gear shaping processes - finishing of gears. Thread Rolling.
General principles and applications of the following processes: Abrasive jet machining, Ultrasonic machining, Electric discharge machining, Electro chemical machining, Electro chemical grinding, Plasma arc machining, Chemical machining, Electron beam machining and Laser beam machining.

UNIT III	COMPUTER AIDED MANUFACTURING	8

Introduction to NC systems and CNC - Machine axis and Co-ordinate system - CNC machine tools- Principle of operation CNC- Introduction of Part Programming, types - Detailed Manual part programming on Turning centres and Vertical Milling centres using G codes and M codes- Cutting Cycles, Loops, Sub program.

UNIT IV	ADDITIVE MANUFACTURING SYSTEMS	8

Three dimensional Printing (3DP): Principle, basic process, Physics of 3DP, types of printing, Stereolithography Apparatus (SLA), Solid Ground Curing (SGC), Fused deposition Moulding (FDM), Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications.

UNIT V	ADVANCED MANUFACTURING PROCESSES	8
Group Technology (GT), Part Families – Parts Classification and coding – Cellular Manufacturing – Types of Flexibility – Flexible Manufacturing System (FMS) – FMS Components – FMS Application and Benefits. Robot Anatomy – Classification of Robots – Robot Control systems – Sensors in Robotics – Industrial Robot – Application. Introduction to INDUSTRY 4.0		
	TOTAL :	**45 PERIODS**

LIST OF EXPERIMENTS	
Cylindrical Surface processes	
Lathe	Taper Turning
Lathe	External thread cutting
Drilling Machine	Drilling, Tapping & Reaming
Milling Processes	
Milling Machine	Surface Milling
Gear Manufacturing Processes	
Milling Machine	Spur gear
Gear hobber	Gear Hobbing
Shaping Process	
Shaping Machine	Keyway cutting
Surface Finishing Processes	
Grinding Machine	Surface Grinding
Grinding Machine	Cylindrical Grinding
Tool Manufacturing Processes	
Tool and Cutter Grinder	Machining of single point cutting tool
Demonstration	
Practice on CNC Machines – Part programming	
Demonstration of Mould preparation in sand casting process.	
Demonstration of TIG welding process.	

Demonstration of 3D Printing			
	TOTAL :	**45**	**PERIODS**

COURSE OUTCOMES:

1. The students will be able to demonstrate the working principle and operation capabilities of a lathe, shaper, milling, drilling, broaching and grinding machine
2. The students will be able to explain the gear manufacturing process and working of unconventional machining process
3. The students will be able to comprehend about computer aided manufacturing and their codes for machining operation for part programming.
4. The students will be able to rephrase about the principle working, operation limitation and application of various additive manufacturing process
5. The students will be able to describe the industry 4.0 and the potential use of robotics in advanced manufacturing process.

TEXT BOOKS:

1.	Mikell P Groover, “Fundamentals of Modern Manufacturing: Materials, Processes, and Systems”, Sixth edition, John Wiley & sons, Inc, 2015.
2.	Rao. P.N “Manufacturing Technology - Metal Cutting and Machine Tools”, Third edition, Tata McGraw-Hill, New Delhi, 2013.

REFERENCE BOOKS:

1.	Joshi, P.H. “Jigs and Fixtures”, Third Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2010.
2.	HMT, "Production Technology", First edition, Tata McGraw Hill, New Delhi, 1980.
3.	Winston A. Knight, Geoffrey Boothroyd, "Fundamentals of Metal Machining and Machine Tools", Third edition, CRC Press, 2005.
4.	Roy. A. Lindberg, “Process and Materials of Manufacture”, Fourth Edition, PHI/Pearson Education 2006.

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
AT19521	TWO AND THREE WHEELERS LABORATORY	PC	0	0	2	1

Objectives:	
•	To impart students with fundamentals of two-wheeler testing methods
•	To impart students with fundamentals principles of two and three-wheeler clutch and braking system
•	To impart students with fundamentals principles of gear boxes used in two and three wheeled vehicles
•	To impart students with fundamentals of chassis measurement of two and three wheelers.
•	To impart students with fundamentals of steering systems used in three wheelers and two wheelers.

List of Experiments			
1.	Performance test of a two-wheeler using chassis dynamometer.		
2.	Dismantling and assembling of two-wheeler and three wheeler engine		
3.	Performance test on coil spring.		
4.	Two-wheeler chain test and chain adjustment.		
5.	Brake and Clutch adjustment as per specification.		
6.	Dismantling and assembling of two-wheeler gear box and finding gear ratios		
7	Dismantling and assembling of three-wheeler gear box and finding gear ratios		
8	Three-wheeler brake and clutch play adjustment		
9	Dismantling and assembling of three-wheeler steering system.		
10	Study of three-wheeler chassis frame and power transmission system.		
	Total Contact Hours	**:**	**30**

Course Outcomes:	
●	The students will be able to describe basic knowledge in testing of two-wheeler vehicles.
●	The students will be able to identify and explain the function of clutch and brake system used in two and three-wheeler vehicles.
●	The students will be able to dismantle and assemble the two and three-wheeler gearboxes and find the gear ratios used.
●	The students will be able to measure the dimensions of a three-wheeler chassis.
●	The students will be able to dismantle and assemble the front fork assembly used in the two and three-wheeler steering system.

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
AT19522	**COMPUTER AIDED VEHICLE DESIGN DATA CHARACTERISTICS LABORATORY**	**PC**	**0**	**0**	**2**	**1**

Objectives:

- To know about the various resistance acting on a vehicle and their effects.
- To calculate and draw the characteristic curves for the power, torque, tractive effort and acceleration with respect to vehicle speed.
- To calculate and draw the characteristic curves for various efficiencies with respect to engine speed and simulate the cylinder pressure with respect to crank angle of an engine.
- To calculate instantaneous velocity and acceleration of the piston and connecting rod with respect of crank angle.
- To find various forces and turning moment diagram with respect to crank angle.

LIST OF EXPERIMENTS	
Theory of Various Resistances, Brake power required, Relationship between engine and vehicle speed, Tractive force, Equivalent vehicle weight, acceleration, grade ability, gear ratios, problems on vehicle performance.	
1	Calculation of Air, Rolling and Total Resistances of the selected vehicle & Plotting them against vehicle speed.
2	Calculation of Brake Power and Brake torque of the engine of the selected vehicle & Plotting them against engine speed.
3	Calculation of Vehicle speed of the selected vehicle at each gear & Plotting them against engine speed.
4	Calculation of Tractive force of the selected vehicle at each gear & Plotting them against vehicle speed.
5	Calculation of Acceleration of the selected vehicle at each gear & Plotting them against vehicle speed.
Theory of Engine performance parameters, Relationship between them, Bore to Stroke ratio, crank radius to connecting rod length ratio (λ), piston instantaneous velocity & acceleration, connecting rod instantaneous velocity & acceleration, P-V diagram, Gas force, inertia force & resultant force, side thrust, turning moment and combined turning moment.	
6	Calculation of Brake thermal efficiency, Mechanical Efficiency, Volumetric Efficiency and Brake specific fuel consumption of the engine of the selected vehicle & Plotting them against engine speed.

7	Calculation of Cylinder Pressure at every crank angle of the cycle of the selected engine & Plotting them against crank angle.		
8	Calculation of Brake mean effective Pressure of the engine of the selected vehicle from P-V diagram plotted from pressure, volume data calculated against each crank angle.		
9	Calculation of gas force, inertia force and resultant force & plotting them against each crank angle.		
10	Calculation of side thrust, turning moment and combined turning moment & plotting them against each crank angle.		
	Total Contact Hours	**:**	**30**

Course Outcomes:

1. The students will be able to calculate the various resistances acting on a vehicle.
2. The students will be able to draw the characteristic curves for the power, torque, tractive effort and acceleration with respect to vehicle speed for any given vehicle specification.
3. The students will be able to estimate the various efficiencies and draw the p-V diagram for vehicular engine.
4. The students will be able to plot the velocity and acceleration profile of piston using software.
5. The students will be able to draw the turning moment diagram of engine with respect to crank angle

Subject Code	Subject Name	Category	L	T	P	C
GE19521	SOFT SKILLS-II	EEC	0	0	2	1

Objectives

- To help students break out of shyness.
- To build confidence
- To enhance English communication skills.
- To encourage students' creative thinking to help them frame their own opinions

Learning and Teaching Strategy:

The program is completely student centric where the focus is on activities led by students which include role plays, discussions, debates other games as well. These activities would be supplemented by interactive use of technology and brief trainer input.

Week	Activity Name	Description	Objective
1	The News hour	Students are made to read news articles from the English newspapers. The students also have to find words and their meaning from the article they have not come across before and share it with the group. They then use these words in sentences of their own	The aim of this activity is not only to get the students to read the newspaper but also aims at enhancing the students' vocabulary.
2	Court Case	The facilitator provides the participants the premise of a story and proceeds to convert the story into a court case. The students are required, department-wise to debate and provide their points to win the case for their clients.	The aim of the lesson is to encourage creative and out-of-the -box thinking to ensure a good debate and defense skills.
3	The ultimate weekend	The students design activities they are going to do over the weekend and they have to invite their classmates to join in the activity. The students move	The aim of this activity is to develop the art of conversation among students. It also aims at practicing the

		around the class and talk to other students and invite them.	grammatical structures of “going to” “have to” and asking questions.
4	The Four Corners	This is a debate game that uses four corners of the classroom to get students moving. The following is written on the 4 corners of the room “Strongly Agree, Somewhat Agree, Somewhat Disagree and Strongly Disagree”. The topics are then given to the class and students move to the corner that they feel best explains their opinions	This activity aims at getting students to come up with their own opinions and stand by it instead of being overshadowed by others and forcing themselves to change based on others opinions.
5	Debate	Boarding school or day school? Which is more beneficial for a student?	The aim of this activity is to encourage students to draw up feasible points on the advantages and benefits of both. And enhance their debating ability
6	Grand Master	The facilitator starts the session by keeping an individual in mind, upon which the students guess it only through "Yes or No" questions. Post few trials the students are given same opportunity to do the same with the crowd.	The aim of the lesson is designed to teach the art of questioning. It also helps to enhance the students' speaking and listening skills.
7	Debate	Does violence on the TV and Video games influence children negatively?	This activity aims at encouraging the students to debate on real life scenarios that most students spend a lot of time on.
8	Turn Tables	This is a speaking activity where the students need to speak for and against the given topics when the facilitator shouts out 'Turn Table'.	The aim of this activity is to make the participants become spontaneous and have good presence of mind.
9	Debate	Do marks define the capabilities of a student?	This debate activity aims at allowing the students to argue on this worrisome adage of marks.
10	FictionAD	The Participants are asked to create an	The activity aims at

		Ad for a challenging topic only using fictional characters.	developing their creativity and presentation skills.
11	Debate	Are social networking sites effective, or are they just a sophisticated means for stalking people?	This activity aims at refining the students debating skills on a very real life situation
12	Talent Hunt	Talent Hunt is a fun activity where the students are selected at random and supported to present any of their own skills.	The aim of this activity is designed to evoke their inner talents and break the shyness and the fear of participating in front of a crowd
	Feedback	At the end of the session in the final week (12) the trainer would provide feedback to the students on best practices for future benefits.	The aim is to do both give feedback to students as well as obtain feedback on the course from them.

Total : 45 Periods

Course Outcomes	
1	Students should be able to be more confident
2	Students should be able to speak in front of a large audience without hesitation
3	Students should be able to think creatively
4	Students should be able to be Speak impromptu
5	Students should be able to communicating in English

SEMESTER –VI

Subject Code	Subject Name	Category	L	T	P	C
AT19601	ELECTRIC AND HYBRID VEHICLES - II	PC	3	0	0	3

OBJECTIVES:

- To give the students the basics about traction batteries and their charging technologies
- To make the students understand the importance of battery management in electric and hybrid electric vehicles.
- To make the students realise the potential of Fuel cells as primary energy storage systems.
- To make the students understand the basics of power electronics used in hybrid and electric vehicles.
- To make the students be aware of various testing standards, electromagnetic interference and its suppression techniques for electric vehicles.

UNIT I	Traction batteries and its charging	9

Targets and properties of batteries for EV and HEV. Construction, working principle and properties of Li-Po battery, Li ion battery, Nickel Metal Hydride Battery, Sodium Sulphur Battery and Aluminium Air Battery. Battery charging - battery charging profile. Fast charging affect health of battery cell- charging time – charging standards – charging methods – charging modes – vehicle to grid technology – Wireless power transfer. Estimation of battery pack capacity – BEV battery sizing.

UNIT II	Battery management systems	9

Functions of a BMS – Block diagram, main functions, sensing requirements, Cell/module level: cell voltage, cell/module temperature, (humidity, smoke, air/fluid flow), Pack level: current, pre-charge temperature, bus voltage, pack voltage, isolation, Control Requirements, Contactor control, pre-charge circuitry, Thermal system control, State of Charge estimation; State of Health estimation, Non-contact methods. Failure modes of individual cell & pack and its prognosis. Power estimation, Energy estimation (range estimation). Ageing of cells. Ultra capacitors and their role.

UNIT III	Fuel cells and other energy storage devices	9

Operation principles of fuel cells – Electrode potential and current-voltage curves. Types – Proton exchange membrane fuel cells, alkaline fuel cells, phosphoric acid fuel cells, molten carbonate fuel cells, solid oxide fuel cells, direct methanol fuel cells. Fuel cell hybrid drive train. Control strategy. Power design of fuel cell system - Fuel cell characteristic curves- Energy flow in FCEV. Case study – Honda FCX. Energy storage in flywheels. Hydraulic and pneumatic

hybrid systems

UNIT IV	Power Electronics	9

Semiconductor power diodes, transistors, MOSFET, IGBT, Thyristor, triacs, GTOs. AC-DC converters, DC-DC converters and types – buck, boost, fly back. Isolated converters. Inverters based on MOSFET. Microcontrollers/DSP based controllers, Types of sensors for electric drive, Current sensors and signal conditioners.

UNIT V	Electromagnetic Interference and Testing	9

EMI – Noise propagation modes – cabling – components – PCB EMC – SAE Automotive EMC standards – SAE J551- SAE J 1113 – Test methodology- Need for testing EVs – Safety checklist (AIS 038). – significance of isolation resistance - measurement of isolation resistance – water tests motor power test (AIS 041) – chassis dynamometer– Energy consumption test (AIS 039) – battery testing (AIS 048) –Range test (AIS 040).

	TOTAL :	45	PERIODS

COURSE OUTCOMES:

- The students will be able to describe various traction batteries, their performance and charging techniques.
- The students will be able to estimate the battery capacity and can suggest suitable cell balancing techniques for traction batteries.
- The students will be able to explain of various fuel cells and their suitability for electric and hybrid vehicle application.
- The students will be able to comprehend the operation of electronic controllers used in electric and hybrid vehicles.
- The students will be aware of various testing standards and electromagnetic interference suppression techniques for electric vehicles.

TEXT BOOKS:

1. Iqbal Hussain. “Electric and Hybrid Vehicles Design Fundamentals”. CRC Press, 2013
2. MehrdadEhsani, Yimin Gao, Ali Emadi, “Modern Electric, Hybrid Electric and Fuel cell Vehicles”, CRC press, 2017.
3. Philip Weicker, “ A Systems Approach to Lithium Ion Battery Management”, Artech House, London, 2014.

REFERENCE BOOKS:

1. Gianfranco Pistoia. "Electric And Hybrid Vehicles Power Sources, Models, Sustainability, Infrastructure and The Market". Elsevier, 2010.
2. Jack Erjavec. "Hybrid, Electric & Fuel-Cell Vehicles". Cenage Learning, 2013. John Wiley & Sons, 2015.
3. MengChu Zhou, Advances in Battery Manufacturing, Service and Management System, IEEE press series on Systems Science and Engineering, 2016.
4. NPTEL course on Introduction to Hybrid and Electric Vehicles, https://nptel.ac.in/courses/108/103/108103009/

AT19602	AUTOMOTIVE POLLUTION AND CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn the sources and causes of emission from automobiles and their effect on human beings and the environment.
- To make the student to understand the sources of emission from SI engine and methods to control the same
- To study the sources of emission from CI engine and methods to control the same
- To analyse the sources of noise and methods to reducing the noise
- To understand the various methods to measure emission

UNIT I	EMISSION FROM AUTOMOBILES	8

Sources of Air Pollution. Various emissions from Automobiles — Formation — Effects of pollutants on environment and human beings - global warming – Acid Rain - National and International Emission standards - Automotive vehicle waste management - Old vehicle disposal, Recycling of Metals, Nonmetals, tyres and liquids.

UNIT II	EMISSION FROM SPARK IGNITION ENGINE AND ITS CONTROL	10

Emission formation in SI Engines- Carbon monoxide & Carbon di oxide - Unburned hydrocarbon, NOx and PM — Effects of design and operating variables on emission formation – controlling of pollutants - fuel modifications – cylinder deactivation - Positive Crank case ventilation system, Evaporative Emission Control, Exhaust Gas Recirculation, Secondary air injection, thermal reactor, Catalytic converters Types – substrate, Wash coat and Catalyst, Cold start emission control - Close coupled catalytic converter, Catalyst deactivation-Hydrocarbon Adsorber- Lean de-NOx Catalysts- NOx traps.

UNIT III	EMISSION FROM COMPRESSION IGNITION ENGINE AND ITS CONTROL	10

Formation of White, Blue, and Black Smokes, Soot, Particulate Matter NOx, SOx, HC, CO and Intermediate Compounds – Significance Effect of design and Operating variables on Emission formation —Fuel modification/additives, CRDI - High Injection Pressure and Injection Rate Shaping and Multiple injection, EGR- EGR Cooling, EGR Control, Fumigation, Diesel Oxidation Catalysts, Diesel de-NOx Catalysts, NOx traps, SCR, Diesel Particulate Filters - DPF material, structure and regeneration.

UNIT IV	NOISE POLLUTION FROM AUTOMOBILES	8
Sources of Noise — Engine Noise, Transmission Noise, vehicle structural Noise, aerodynamics noise, Exhaust Noise. Noise reduction in Automobiles — Encapsulation technique for noise reduction — Silencer Design - Active cabin noise suppression - Active Exhaust noise suppression		
UNIT V	**TEST PROCEDURES AND EMISSION MEASUREMENTS**	**9**
Test cycles for light and medium duty vehicles – US-EPA cycle, ECE and EUDC cycle, Japanese cycle, Indian driving cycles – steady state and transient cycles - SHED Test - Chassis dynamometer – Constant Volume Sampling (CVS) Procedure for driving cycles - Emission analyzers — NDIR, FID, ChemiluminesecentAnalyzer (CLA), Smoke meters, Gas Chromatography, Particulate Emission Measurement - Dilution Tunnel, Sound level meters.		
	TOTAL :	**45 PERIODS**

COURSE OUTCOMES:

1. The students will be able to explain the sources and causes of emission and effects of emission on human beings and environment.
2. The students will be able to describe the sources of emission from SI engine and methods to control the same
3. The students will be able to examine the sources of emission from CI engine and methods to control the same
4. The students will be able to explain the sources of noise and methods to reducing the noise
5. The students will be able to describe the various methods to measure emission

TEXT BOOKS:

1	B.P. Pundir, "Engine Emissions - Pollutant Formation and Advances in Control Technology" Narosa Publishing house Pvt. Ltd, 2011
2	Paul Degobert, "Automobiles and Pollution", EditionsTechnics, 1995

REFERENCE BOOKS:

1	EranSher “Handbook of Air Pollution from Internal Combustion Engines- Pollutant Formation and Control”, Academic Press, 2011.
2	Matthew Harrison, “Vehicle refinement: controlling noise and vibration in road vehicles”, Elsevier, Indian Edition, 2011
3	Marco P Nuti, “Emissions from two stroke engines”, SAE Publication – 1998.
4	AsifFaiz, Christopher S. Weaver, Michael P Walsh, “Air Pollution from Motor Vehicles – Standards and Technologies for Controlling Emissions” The world bank, Washington DC, 1996.

Subject Code	Subject Name	Category	L	T	P	C
AT19641	AUTOMOTIVE SYSTEM DESIGN	PC	2	1	3	4.5

Objectives:

- To understand the design considerations and procedure for cylinder, piston and connecting rod.
- To learn the design considerations and procedure for crankshaft, valve train
- To know about the various load acting on axles, steering system, vehicle frame and suspension system
- To draw 3D modelling of I.C.Engine components using CREO software.
- To draw 3D modelling of propeller shaft with universal joints using CREO software.

UNIT I	**DESIGN OF CYLINDER, PISTON AND CONNECTING ROD**	**9**

Fundamentals of engineering design, Choice of material for cylinder and piston, design of cylinder, piston, piston pin, piston rings, piston failures, lubrication of piston assembly. Material for connecting rod, determining minimum length of connecting rod, small end design, shank design, design of big end cap bolts

UNIT-II	**DESIGN OF CRANKSHAFT**	**9**

Balancing of I.C. engines, significance of firing order. Material for crankshaft, design of crankshaft under bending and twisting, balancing weight calculations, development of short and long crank arms. Front and rear-end details.

UNIT-III	**DESIGN OF VALVE MECHANISM**	**9**

Rankine's formula – Johnson formula design of push- rods, Design of inlet & exhaust valves, valve springs, tappets, valve train, rocker arm.

UNIT-IV	**FRONT AXLE, STEERING SYSTEM AND REAR AXLES**	**9**

Analysis of loads-moments and stresses at different sections of front axle. Determination of bearing loads at Kingpin bearings. Wheel spindle bearings. Choice of Bearings. Determination of optimum dimensions and proportions for steering linkages, ensuring minimum error in steering. Design of propeller shaft, final drive gearing, full floating, semi-floating and three quarter floating rear shafts and rear axle housings and final drive.

UNIT-V	**VEHICLE FRAME AND SUSPENSION**	**9**

Study of loads-moments and stresses on frame members. Design Of frame for passenger and commercial vehicle – Design of leaf Springs-Coil springs and torsion bar springs.

	Total Contact Hours	**:**	**45**

Text Books:	
1	U.C. Jindal, “Machine Design”, Pearson Education, 2013.
2	Bhandari V, “Design of Machine Elements”, 3rd Edition, Tata McGraw-Hill Book Co, 2016.

LIST OF EXPERIMENTS				
1.	Introduction to 3D geometric modelling and application of GD&T.			
2.	3D modelling of piston assembly.			
3.	3D modelling of connecting rod with complete details.			
4.	3D modelling of crankshaft assembly.			
5.	3D modelling of engine flywheel.			
6.	3D modelling of engine valves.			
7.	3D modelling of inlet and exhaust manifolds.			
8.	3D modelling of propeller shaft with universal joints.			
9.	3D modelling of final drive with axle housing.			
		TOTAL :	**45**	**PERIODS**

COURSE OUTCOMES:

1. The students will be able to explain and perform the design calculations for engine cylinder, piston and connecting rod. The students will be able to draw 3D modelling of piston and connecting rod.
2. The students will be able to describe and perform the design calculations for the crankshaft. The students will be able to perform 3D modelling of crankshaft
3. The students will be able to elucidate and carry out the design calculations for valve operating components. The students will be able to create 3D models of engine valves, manifolds and propeller shaft
4. The students will be able to calculate the various loads acting on the axles and steering system. The students will be able to draw 3D modelling of the propeller shaft with universal joints.
5. The students will be able to compute the loads acting on the vehicle frame and suspension system. The students will be able to make 3D modelling the final drive with axle housing.

TEXT BOOKS:

K. L. Narayana - Machine drawing, New Age International,2009.

R. K. Dhawan - A Text book on Machine Drawing, S. Chand Publishing, 2015.

LIST OF EQUIPMENTS

(for the batch of 30 students)

Sl. No.	Equipment Name	Nos.
1	**Computer System : i3, TFT** Color Monitor, 500 GB HDD, 4 GB RAM	30
2	Printer	1
3	**Software's like** CREO, FANUC	30 licenses

Reference Books / Web links:

1	R.S. Khurmi& J. K. Guptha, "A Textbook of Machine Design", 34th edition, S. Chand publication. 2014.
2	Giri, N.K., "Automobile Mechanics", Khanna publishers, New Delhi, 2007
3	Richard G Budynas Richard Gordon Budynas, J.KeithNisbett., "Shigley's Mechanical Engineering Design" 10th edition, Tata McGraw-Hill, 2015
4	Jain. R. K, "Machine Design", Khanna Publishers, New Delhi, 2005.
5	Heldt, P.M., Automotive Chassis, Chilton Book Co., 1992.
6	Dean Averns, Automobile Chassis Design, Illife Book Co., 2001.

Subject Code	Subject Name	Category	L	T	P	C
AT19642	**AUTOMOTIVE FUELS AND LUBRICANTS**	PC	**3**	**0**	**3**	**4.5**

Objectives:	
●	To study the world energy scenario in automotive sector and the conventional fuels for IC engines, its production, characteristics and additives
●	To impart the knowledge of alternate liquid fuels for engines with their compatibility, performance and emission characteristics
●	To understand the alternate gaseous fuels for engines with their compatibility, performance and emission characteristics
●	To learn about the Air-Fuel ratio based on the engine operating conditions.
●	To know about the need of lubricants, factors influencing the lubricants and testing of fuels.

UNIT I	**CONVENTIONAL FUELS FOR I.C. ENGINES**	**9**
Petroleum based conventional fuels for SI and CI engine, Demand and Availability of crude oil – Production - national and international standards for conventional fuels. Crude Distillation, chemical structure, desirable characteristics of SI Engine fuels – Petrol – Properties, Specification, Volatility characteristics, knock rating and additives. Desirable characteristics of CI Engine fuels – Diesel – Properties, Specification, chemical structure, Ignition quality, Cetane rating and additives.		
UNIT-II	**ALTERNATIVE LIQUID FUELS**	**9**
Need for alternative liquid fuels - Availability, Properties, Composition, Merits, Demerits, Performance and Emission characteristics of Methanol, Ethanol, Straight Vegetable Oil, Bio diesel (Esterification) and their blends.		
UNIT-III	**ALTERNATIVE GASEOUS FUELS**	**9**
Need for alternative gaseous fuels – Availability, Properties, Composition, Merits, Demerits, Performance and Emission characteristics of Hydrogen, Compressed Natural Gas(CNG), Liquefied Petroleum Gas (LPG). Modifications required for LPG and CNG in the conventional engines.		
UNIT-IV	**COMBUSTION OF FUELS**	**9**
Stoichiometry – calculation of theoretically correct air required for combustion of liquid and gaseous fuels – Volumetric and gravimetric analysis of the dry products of combustion, mass of dry gas per kg of fuel burnt, mass of carbon in the exhaust gas, mass of carbon burnt to carbon-monoxide per kg of fuel, heat loss due to incomplete combustion.		

UNIT-V	LUBRICANTS AND TESTING OF FUELS	9

Lubricants: Need for lubricants, engine friction, effect of engine variables on friction requirements of automotive lubricants- Mineral & Synthetic, classification of lubricating oils, properties of lubricating oils, additives and tests on lubricants – Grease, classification, properties, testing of grease.

Testing of fuels: Relative density, calorific value, distillation, Reid vapour pressure, flash point, spontaneous ignition temperature, viscosity, pour point, flammability, ignitability, diesel index, API gravity and aniline point.

	Total Contact Hours	**:**	**45**

LIST OF EXPERIMENTS	
1.	Study of International and National standards for fuels and lubricants.
2.	Study of Octane and Cetane Number of fuels.
3.	Distillation test of liquid fuels
4.	Aniline Point test of diesel
5.	Calorific value of liquid fuel.
6.	Calorific value of gaseous fuel.
7.	Reid vapour pressure test.
8.	Flash and Fire points of fuel and oil.
9.	Copper strip Corrosion Test
10	Cloud & Pour point Test
11	Temperature dependence of viscosity of lubricants by Redwood Viscometer
12	Viscosity Index of lubricants by Saybolt Viscometer
13	Viscosity measurement of lubricant and fuels by kinematic viscosity bath
14	Ash content and Carbon Residue Test
15	Drop point of grease and mechanical penetration in grease.

	TOTAL :	**45**	**PERIODS**

LIST OF EQUIPMENTS
(for the batch of 30 students)

Sl. No.	Equipment Name	Nos.
1	Distillation test Apparatus	1 No.
2	Aniline point Apparatus	1 No.
3	Bomb Calorimeter	1 No.
4	Junkers Calorimeter	1 No.
5	Reid vapor pressure test Apparatus	1 No.
6	Flash and Fire point apparatus – Open and Closed cup	1 No. each
7	Abels flash point apparatus for Petrol Fuel	1 No.
8	Copper Strip Corrosion Test Apparatus	1 No.
9	Cloud and Pour point Apparatus	1 No.
10	Redwood Viscometer	1 No.
11	Saybolt Viscometer	1 No.
12	Kinematic viscosity bath	1 No.
13	Ash Content Test Apparatus	1 No.
14	Carbon Residue Test Apparatus	1 No.
15	Drop point and penetration Apparatus for grease	1 No.

Course Outcomes:
On completion of the course students will be able to

1. Explain the distillation process, additives for fuels and characteristics of fuels.
2. Discuss the need and performance characteristics of alternative liquid fuels for both SI and CI engines.
3. Describe the need and performance characteristics of alternative gaseous fuels for both SI and CI engines
4. Calculate theoretically correct air required for combustion of liquid and gaseous fuels and estimate quantitatively the exhaust gas constituents.
5. Explain the need for lubricants and factors influencing the engine lubrication, test fuels and lubricants to find various properties.

Text Books:	
1	B.P. Pundir, “IC Engines – Combustion and Emissions”, Narosa Publication, 2017
2	S.S. Thipse, “Alternative Fuels”, JAICO Publishing House, 2010.

Reference Books / Web links:	
1	EranSher “Handbook of Air Pollution from Internal Combustion Engines- Pollutant Formation and Control”, Academic Press, 2011.
2	Matthew Harrison, “Vehicle refinement: controlling noise and vibration in road vehicles”, Elsevier, Indian Edition, 2011.
3	Marco P Nuti, “Emissions from two stroke engines”, SAE Publication – 1998.
4	Owen, Keith, Coley, Trevor, “Automotive Fuels Reference Book”, SAE International, 1995.
5	Sarkar, S., “Fuels And Combustion”, Oriented Longmann Press, 1990.
6	Demirbas, Ayhan, “Biofuels: Securing The Planet's Future Energy Needs” Published By Springer, 2009.
7	Sterret, Frances S., “Alternative Fuels And The Environment”, Lewis Publishers, 1994
8	Caines, Arthur J; Haycock, Roger F., “Automotive Lubricants Reference Book”, Published By SAE International, 1996

Subject code	Subject Name	Category	L	T	P	C
AT19643	VEHICLE DYNAMICS	PC	2	1	3	4.5

OBJECTIVES:

- To study the concept of vibration and types of vibration measuring instruments.
- To impart knowledge about the various forces acting on tires and performance of tire.
- To study about the various vertical forces acting on a vehicle
- To identify the various longitudinal forces acting and control on a vehicle
- To impart knowledge on various lateral forces acting on a vehicle.

UNIT I	CONCEPT OF VIBRATION	9

Definitions, Modelling and Simulation, Free, Forced, Undamped and Damped Vibration, Response Analysis of Single DOF, Two DOF, Multi DOF, Magnification factor, Transmissibility, Vibration absorber, Vibration measuring instruments, Torsional vibration, Critical speed.

UNIT II	TIRES	9

Tire forces and moments, Tire structure, Longitudinal and Lateral force at various slip angles, rolling resistance, Tractive and cornering property of tire. Performance of tire on wet surface. Ride property of tires. Tire models, Estimation of tire road friction. Test on Various road surfaces. Tire vibration.

UNIT III	VERTICAL DYNAMICS	9

Human response to vibration, Sources of Vibration. Design and analysis of Passive, Semi-active and Active suspension using Quarter car, half car and full car model. Influence of suspension stiffness, suspension damping, and tire stiffness. Air suspension system and their properties.

UNIT IV	LONGITUDINAL DYNAMICS	9

Aerodynamic forces and moments. Equation of motion. Load distribution for three wheeler and

four wheeler. Calculation of Maximum acceleration, Reaction forces for Different drives. Braking and Driving torque. Prediction of Vehicle performance. ABS, stability control, Traction control, stability of vehicle on slope.		
UNIT V	**LATERAL DYNAMICS**	**9**
Steady state handling characteristics. Steady state response to steering input. Testing of handling characteristics. Transient response characteristics, Direction control of vehicles. Roll center, Roll axis, Vehicle under side forces. Stability of vehicle on banked road and curved road.		
	TOTAL:	**45 PERIODS**

LIST OF EXPERIMENTS:

The following exercises can be included in vehicle dynamics as a MATLAB exercise

1.	Effect of stiffness and damping ratio of Single DOF spring mass system (Free Vibration)
2.	Response analysis of Single DOF spring mass system in Forced Vibration
3.	Response analysis of multi DOF spring mass system in Free Vibration
4.	Simulation study of Quarter car model for step input (by varying Suspension stiffness and suspension damping and tyre stiffness)
5.	Simulation study of Half car model for step input (by varying Suspension stiffness and suspension damping and tyre stiffness)
6.	Simulation of steady state handling characteristics of a vehicle based on steering input (varying under steer coefficient)
7.	Simulation study of vehicle stability on a banked road (various bank angle)
8.	Simulation study of vehicle stability on a curved road (various speeds)
TOTAL :	**45 PERIODS**

COURSE OUTCOMES:
1. The students will be able to explain the concepts involved in vehicle vibration. The students will be able to calculate the natural frequency of Single DOF, multi DOF of free and forced vibrations using MATLAB. 2. The students will be able to explain the various forces acting on tyres and their performance. 3. The students will be able to calculate the various vertical forces acting on a vehicle. The students will be able to perform the simulation of Quarter car model and Half car model for step input using MATLAB. 4. The students will be able to describe the various longitudinal forces acting on a vehicle. 5. The students will be able to calculate the various lateral forces acting on a vehicle. The students will be able to simulate the steady state handling characteristics of a vehicle based on steering input, vehicle stability on a banked road and curved road-using MATLAB.

TEXT BOOKS:
1.Rajesh Rajamani, "Vehicle Dynamics and Control", 2nd edition, Springer, 2012
2.Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics", Society of Automotive Engineers Inc, 1992
REFERENCE BOOKS/WEB LINK
1.Wong. J. Y., "Theory of Ground Vehicles", 4th Edition, John Wiley & Sons, 2008
2.Singiresu S. Rao, "Mechanical Vibrations", 5th Edition, Prentice Hall, 2010
3.Dean Karnopp, "Vehicle Stability", 1st Edition, Marcel Dekker, 2004
4.Reza N. Jazar, "Vehicle Dynamics: Theory and Application", 3rd Edition, Springer, 2017
5.Mike Blundell & Damian Harty, "The Multibody Systems Approach to Vehicle Dynamics", 2nd Edition, Butterworth-Heinemann, Elsevier, 2015
6.Hans B Pacejka, "Tire and Vehicle Dynamics", 3rd Edition, Butterworth-Heinemann, Elsevier, 2012
7.John C. Dixon, "Tires, Suspension, and Handling", 2nd edition, Society of Automotive Engineers Inc, 1996
8.JanZuijdijk, "Vehicle dynamics and damping", First revised edition, Author House, 2013.
9.R. Krishnakumar, "Introduction to Vehicle Dynamics" Department of Engineering design, IITM. https://nptel.ac.in/courses/107106080/

\Subject Code	Subject Name	Category	L	T	P	C
GE19621	**PROBLEM SOLVING TECHNIQUES**	EEC	**0**	**0**	**2**	**1**

Objectives:	
•	To improve the numerical ability
•	To improve problem-solving skills.

Course topics:

S.No.	Topics
1	Numbers system
2	Reading comprehension
3	Data arrangements and Blood relations
4	Time and Work
5	Sentence correction
6	Coding & Decoding, Series, Analogy, Odd man out and Visual reasoning
7	Percentages, Simple interest and Compound interest
8	Sentence completion and Para-jumbles
9	Profit and Loss, Partnerships and Averages
10	Permutation, Combination and Probability
11	Data interpretation and Data sufficiency

12	Logarithms, Progressions, Geometry and Quadratic equations.
13	Time, Speed and Distance
	Total : 30 Periods

Course Outcomes	
•	Students should be able to have mental alertness
•	Students should be able to have numerical ability
•	Students should be able to Solve quantitative aptitude problems with more confident

Subject Code	Subject Name	Category	L	T	P	C
AT19611	DESIGN THINKING AND INNOVATION	EEC	0	1	2	2

UNIT I INTRODUCTION

Need for design creativity – creative thinking for quality – essential theory about directed creativity Product Life Cycle - Design Ethics - Design Process - Four Step – Five Step - Twelve Step - Creativity and Innovation in Design Process - Design limitation.

UNIT II GENERATING AND DEVELOPING IDEAS

Introduction - Create Thinking - Generating Design Ideas - Lateral Thinking –Analogies – Brainstorming - Mind mapping - National Group Technique – Synectics - Development of work - Analytical Thinking ICEDIP – Inspiration, Clarification, Distillation, Perspiration, Evaluation and Incubation.

UNIT III DESIGN REVERSE ENGINEERING

Process Design, Emotional Design – Three levels of Design – Viceral, Behavioral and Reflective-Recycling and availability-Creativity and customer needs analysis. Introduction - Reverse Engineering Leads to New Understanding about Products -Reasons for Reverse Engineering - Reverse Engineering Process - Step by Step – Case Study

UNIT IV INNOVATION

Achieving Creativity – Introduction to TRIZ methodology of Inventive Problem Solving - the essential factors – Innovator's solution – creating and sustaining successful growth – Disruptive Innovation model – Segmentive Models.

UNIT V IMPLEMENTATION, DEPLOYMENT AND MAINTENANCE

Mapping Design (Models) to Code - Testing - Usability - Deployment - Configuration Management - Maintenance, Case Study.

Total : 45 Periods

References :

1. John.R.Karsnitz, Stephen O'Brien and John P. Hutchinson, "Engineering Design", Cengage learning (International edition) Second Edition, 2013.
2. Wego Wang " Reverse Engineering – Technology of Reinvention", CRC Press, 2010.
3. Nigel Cross, " Engineering Design Methods – Strategies for Product Design", 4th edition. John Wiley & Sons,2005.
4. Tim Brown, " Change by design" Harper Collins, 2009.
5. Balaram. S, "Thinking Design", Sage Publications, 2011.

SEMESTER –VII

AT19701	VEHICLE MANAGEMENT SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

1. To learn about the principles of control systems
2. To study the electronic engine management systems for petrol engines
3. To study the electronic engine management systems for diesel engines
4. To study various chassis management systems employed in automobiles
5. To study and understand the need for fault diagnosis systems

UNIT I	CONTROL SYSTEMS	9

Microprocessor architecture, open and closed loop control strategies, PID control, Look up tables, introduction to modern control strategies like Fuzzy logic and adaptive control, overview of automotive control systems.

UNIT II	SI ENGINE MANAGEMENT SYSTEMS	9

MPFI systems – Layout and working, Phases of SI engine control - Cold start and warm up phases, idle speed control, acceleration and full load enrichment, deceleration fuel cut-off, Cylinder deactivation. Fuel control maps, Gasoline Direct Injection, Exhaust after treatment systems.

UNIT III	CI ENGINE MANAGEMENT SYSTEMS	9

Cylinder charge management – Turbocharger and supercharger, Fuel injection parameters, Diesel fuel injection designs, Discrete fuel injection pumps, Unit injector system, Unit pump system, Common rail system – working principle, operation and high-pressure components, Homogeneous combustion process, Exhaust gas treatment.

UNIT IV	CHASSIS MANAGEMENT SYSTEMS	9

Anti-Lock braking system, Traction and stability control system, Active suspension system, Automatic transmission control system, Electric power steering, Brake assist systems, Cruise control system. Vehicle dynamics control, XBW System.

UNIT V	FAULT DIAGNOSIS SYSTEMS	9
Need for diagnosis systems, Diagnostic process, Basic equipment – Oscilloscopes, Fault code readers, Diagnostics of sensors and actuators, On Board Diagnostics(OBD) – Requirements, Petrol/Diesel engines OBD, OBD2		
	TOTAL: **45** **PERIODS**	

COURSE OUTCOMES:

On completion of the course students will be able to:

1. Explain and compare various control systems
2. Describe fuel system layouts, injection techniques, phases of operation and parameter control in SI engine management.
3. Identify the theoretical reasons for combustion quality, emission and noise. They will be able to explain injection techniques, Unit injection system and CRDI systems and EGR control.
4. Explain the control system operation behind the function of various chassis management systems
5. Demonstrate their knowledge on various On-Board Diagnosis systems

TEXT BOOKS:

1	William B Ribbens, Understanding Automotive Electronics – An engineering perspective, 8th Edition, Butterworth-Heinemann, 2017.
2	Robert Bosch "Diesel Engine Management" SAE Publications, 2006
3	Robert Bosch, "Gasoline Engine Management" SAE Publications, 2006

REFERENCE BOOKS:

1	Tom Denton, Advanced automotive fault diagnostics, 4th Edition, Routledge, Oxon, 2016.
2	A. GalipUlsoy, HueiPeng, MelihCakmakci, Automotive Control Systems, Cambridge University Press, New Delhi, 2012.
3	Bernd Heibing, Meting Ersoy, Chassis Handbook ATZ, Fundamentals, Driving Dynamics, Components, Mechatronics, Perspectives, ViewegTeubnerVerlag, Mercedes Druck, Berlin, 2011.

AT19702	INTELLIGENT VEHICLE SYSTEM	L	T	P	C
		3	0	0	3

OBJECTIVES:

1. To learn the importance of IVS to the modern world and working principles of various ADAS systems. .
2. To learn various principles and technologies used in connected vehicle systems.
3. To understand the basic ideology of autonomous driving
4. To understand the perception, prediction and routing of autonomous driving.
5. To understand the planning and control of autonomous driving.

UNIT I	INTRODUCTION TO INTELLIGENT VEHICLE SYSTEM	9

Need for IVS, Benefits, Modern trends in automotive industry, Goals and Visions for the Future. Overview of smart mobility.

ADAS (Advanced Driver Assistance Systems) - Driver Alertness Monitoring, Navigation system. Night Vision, Head-up Display, Adaptive Cruise Control (ACC), Curve speed warning system, Lane Departure Warning, Hill hold control, Adjustable Steering, Traffic assist system, Parking assistance, Automatic Braking.

UNIT II	CONNECTED VEHICLE SYSTEM	9

Introduction to V2V Communication, Telematics Control System,Vehicle -Vehicle interaction using TCS, Mirror link, Web link, App link, Apple Icar, Android car, V2I(Vehicle to infrastructure interaction), DSRC, vehicle OBU(OBD).

UNIT III	INTRODUCTION TO AUTONOMOUS DRIVING	9

Autonomous driving technology overview, Autonomous driving algorithm – object recognition and tracking, autonomous driving client system and cloud platform. Autonomous vehicle localization - Localization with GNSS, LIDAR and HD map – visual odometry.

UNIT IV	PERCEPTION, PREDICTION AND ROUTING IN AUTONOMOUS DRIVING	9

Perception in Autonomous Driving – data sets, detection, segmentation and tracking, Introduction to Autonomous driving modeling - Planning and control – Traffic prediction – lane level routing.

UNIT V	DECISION PLANNING AND CONTROL IN AUTONOMOUS DRIVING	9

Behavioral Decision - Motion Planning – Vehicle and Road Model, Motion planning with path and speed planning. – Feedback control.	
TOTAL :	**45 PERIODS**

COURSE OUTCOMES:

1. Students will be able to describe the intelligent vehicle system and explain the convenience systems in vehicles.
2. Students will be able to explain the latest technologies and foster implementation in connected vehicle systems.
3. Students will be able to illustrate the object detection and tracking in autonomous driving
4. Students will be able to explain the perception, prediction and routing of autonomous driving.
5. Students will be able to explain the planning and control of autonomous driving.

TEXT BOOKS:

1	A. Perallos, U. Hernandez-jayo, E. Onieva and I. Garcia-Zuazola (Eds.), Intelligent Transport Systems: Technologies and Applications, Wiley publications, 2015.
2	Shaoshan Liu; Liyun Li; Jie Tang; Shuang Wu; Jean-Luc Gaudiot, "Creating AutonomousVehicle Systems", in Creating Autonomous Vehicle Systems, Morgan &Claypool, 2017.

REFERENCE BOOKS:

1	H. Cheng, Autonomous Intelligent Vehicles: Theory, Algorithms, and Implementation, Berlin:Springer, 2011.
2	Michael E. McGrath, "Autonomous Vehicles: Opportunities, Strategies, and Disruptions", Amazon, 2018
3	Andreas Herrmann, Walter Brenner, Rupert Stadler, "Autonomous Driving: How the Driverless Revolution will Change the World" Emerald Publishing, 2018
4	R. K. Jurgen, Navigation and Intelligent Transportation Systems - Progress in Technology, Automotive Electronics Series, Warrendale, PA: SAE International, 2014.

5	A. Eskandarian (Ed.), Handbook of Intelligent Vehicles, Springer-Verlag London Ltd, 2012.
6	Richard Bishop, Intelligent Vehicle Technology and Trends,ARTECH House, 2005 Website: http://www.mogi.bme.hu/TAMOP/jarmurendszerek_iranyitasa_angol/math-ch09.html

AT19721	VEHICLE MAINTENANCE LABORATORY	L	T	P	C
		0	0	2	1

OBJECTIVES:

1. To know about the tune up of gasoline and diesel engines and also the calibration of the fuel injection pump.
2. To provide a clear view on the fault diagnosis of engine and transmission system
3. To impart knowledge about the fault diagnosis for driveline and braking system
4. To learn and visualize the fault diagnosis for suspension and steering system
5. To provide a clear view on the fault diagnosis of car electrical and air conditioning system

STUDY EXPERIMENTS:

1.	Tools and instruments required for maintenance
2.	Safety aspects with respect to man, machine and tools
3.	General procedures for servicing and maintenance schedule
4.	Wheel Alignment procedure

LIST OF EXPERIMENTS:

1.	Minor and major tune up of gasoline and diesel engines
2.	Calibration of Fuel pump
3.	Engine fault diagnosis using scan tool
4.	Fault diagnosis and service of transmission system
5.	Fault diagnosis and service of driveline system
6.	Fault diagnosis and service of braking system
7.	Fault diagnosis and service of suspension system

8.	Fault diagnosis and service of steering system
9.	Fault diagnosis and service of Electrical system like battery, starting system, charging system, lighting system etc.
10.	Fault diagnosis and service of vehicle air conditioning system
11.	Practice the following: i. Adjustment of pedal play in clutch, brake, hand brake lever and steering wheel play. ii. Air bleeding from hydraulic brakes, air bleeding of diesel fuel system. iii. Wheel bearings tightening and adjustment. iv. Adjustment of head lights beam. v. Removal and fitting of tire and tube.

	TOTAL :	**30**	**PERIODS**

COURSE OUTCOMES:

1. The students will be able to perform a major and minor tune up of gasoline and diesel engines and will be able to calibrate the fuel pump
2. The students will be able to do fault diagnose and service the engine and transmission system using scan tool
3. The students will be able to perform fault diagnose and service the driveline and braking system
4. The students will be able to demonstrate the servicing procedure of suspension and steering system
5. The students will be able to explain servicing procedure with diagnose the electrical and air conditioning system

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S. No.	NAME OF THE EQUIPMENT	Qty.
1.	Engine Analyzer	1 No.
2.	Cylinder compression pressure gauge	1 No.
3.	Vacuum gauge	1 No.
4.	Spark plug cleaner and tester	1 No.

5.	Cam angle and rpm tester	1 No.
6.	Tachometer	1 No.
7.	Wheel alignment apparatus	1 No.
8.	Gas welding equipment	1 No.
9.	Tyre remover	1 No.
10.	Bearing puller	1 No.
11.	Head light alignment gauge	1 No.
12.	Service manuals of petrol, diesel engines	1 No.: each
13.	Cylinder reboring machine	1 No.
14.	Valve grinding machine 1 No.	1 No.
15.	Valve lapping machine 1 No.	1 No.
16.	Fuel injection calibration test bench with nozzle tester	1 No.
17.	HRD tester, Clamp on meter, Hydrometer	1 No.: each

AT19722	COMPUTER AIDED ANALYSIS OF AUTOMOTIVE COMPONENTS LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

1. To make the students understand the deflection of various beams under different loading conditions.
2. To make the students realize the distribution of stress on piston and piston pin.
3. To make the students visualize the stress distribution on connecting rod and mode frequency analysis of different beams
4. To make the students perform the mode frequency analysis on quarter car model and propeller shaft
5. To make the students understand the behaviour of exhaust valve and piston under thermal stress

LIST OF EXPERIMENTS
ANALYSIS (SIMPLE TREATMENT ONLY)

1	Stress analysis of beams (Cantilever, Simply supported, Fixed ends).
2	Stress analysis of a chassis frame.
3	Stress analysis of Piston.
4	Stress analysis of piston pin.
5	Stress analysis of connecting rod.
6	Mode frequency analysis of beams (Cantilever, Simply supported, Fixed ends).
7	Mode frequency analysis of a Quarter Car Model.
8	Mode frequency analysis of propeller shaft.
9	Thermal stress analysis of Exhaust Valve
10	Redesigning of Exhaust Valve for performance enhancement
11	Thermal stress analysis of Piston.

TOTAL :60 PERIODS

COURSE OUTCOMES:

1. The students will be able to estimate the deflection of various beams under different loading conditions.
2. The students will be able to perform stress distribution analysis on piston and piston pin.
3. The students will be able to perform stress distribution analysis on connecting rod and mode frequency analysis of different beams
4. The students can perform mode frequency analysis on quarter car model and propeller shaft
5. The students will be able to analyze the behaviour of exhaust valve and piston under thermal stress

LIST OF EQUIPMENTS
(for the batch of 30 students)

Sl. No.	Equipment Name	Nos.
1	**Computer System : Computer System : i3, TFT** Colour Monitor, 500 GB HDD, 4 GB RAM	30
2	Printer	1
3	**Software:** Suitable analysis software (example ANSYS)	30 licenses
4	C / MATLAB	5 licenses

TEXT BOOKS:

1	ErdoganMadenci, Ibrahim Guven, “The finite element method and applications in engineering using ANSYS” Springer Publication, First Indian Edition 2011.
2	PaletiSrinivas, Sambana Krishna ChaitanyaDatti Rajesh Kumar, “Finite Element Analysis Using Ansys 11.0”, Phi Learning Private Limited, 2010

AT19723	TECHNICAL SEMINAR / INDUSTRIAL TRAINING / COMPREHENSION	L	T	P	C
		0	0	2	1

TECHNICAL SEMINAR
(for students opted for Technical Seminar)
Objectives:
To develop the ability to understand and present any technical topic.
Method of Evaluation:
To enrich the communication skills of the student and presentations of technical topics of interest, this course is introduced. In this course, a student has to present three Technical papers or recent advances in engineering/technology that will be evaluated by a Committee constituted by the Head of the Department.
Course Outcomes:
On completion of the course, students will be able to prepare and present any technical topic related to automotive domain.

INDUSTRIAL TRAINING
(for students completed three weeks of industrial training)
Objective:
To motivate the students to have a practical industrial training in the reputed automotive companies to understand the process and best practices followed in the company.
Method of Evaluation:
1. The students have to undergo practical industrial training for three weeks in recognized
industrial establishments during their vacation periods.
2. At the end of the training they have to submit a report with following information:
a. Profile of the industry
b. Product range
c. Organization structure
d. Plant layout
e. Processes/Machines/Equipments/Devices
f. Personnel welfare schemes
g. Details of the training undergone
h. Projects undertaken during the training, if any
i. Learning points

The assessments will be based equally on the report in the prescribed format and viva-voce examination by a committee nominated by the Head of the Department
Course Outcomes:
On completion of the course students will take on the challenges in the industry, prepare a presentation in a professional manner, and document all aspects.

COMPREHENSION
(for students opted for Comprehension)
Objectives :
To encourage the students to comprehend the knowledge from the previous semester course through periodic exercise.
Method of Evaluation:
The students will be assessed 100 % internally through weekly test with objective type questions on all the subject related topics.
Course Outcomes:
Ability to understand and comprehend any given problem related to the automobile engineering domain.

Subject code	Subject Name	Category	L	T	P	C
AT19711	AI and ML for Automobile Engineers	PE	0	0	6	3

OBJECTIVE:

To enable students to apply the concepts of Artificial Intelligence and Machine Learning in the field of Automobile Engineering, students must choose one of the following topics, complete a mini-project, and submit a report.

LIST OF TOPICS

1. AI in Vehicle Health Monitoring Systems.
2. AI and ML in Fuel Efficiency and Emissions Control.
3. Driver Assistance Systems.
4. Smart Traffic Management.
5. AI in Connected Vehicles
6. AI in Electric and Hybrid Vehicles
7. AI in Vehicle Dynamics and Control Systems.
8. AI in Fleet Management
9. AI in Supply Chain and Inventory Management
10. AI in Crash Prediction and Prevention
11. AI in Road Infrastructure and Maintenance
12. Human-Centered AI in Automobiles

	TOTAL	**45**	**PERIODS**

COURSE OUTCOMES:

1. The students will be able to explain tracking of objects and in estimation algorithms of integrated vehicle safety functions.
2. The students will be able to perform program for prevent accidents in complex traffic situations involving many dynamic road users, methods of machine learning
3. The students will be able to use of machine learning techniques in combination with model-based approaches for safety-critical applications.

TEXT BOOKS:
1. Pattern Recognition and Machine Learning, Christopher M. Bishop
REFERENCE BOOKS and web link:
1. Artificial Intelligence: A Modern Approach, Stuart J. Russell and Peter Norvig
2. https://www.it-jim.com/blog/applications-of-artificial-intelligence-in-automotive-industry/

AT19713	PROJECT –PHASE I	L	T	P	C
		0	0	4	2

OBJECTIVES:

- Discovering potential research areas in the field of Automobile Engineering.
- Comparing and contrast the several existing solutions for the problem identified through literatures.
- Formulate and propose a plan for the identified work.
- To train the students in preparing project reports and to face reviews and viva voice examination.

The students in a group of 3 to 4 works on a topic approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

	TOTAL :	60	PERIODS

COURSE OUTCOMES:

On Completion of the project work, students will be able to

- Formulate the objectives of the project work
- Know the recent developments in their project area through Literature survey
- Identify the research Gap from the literature survey
- Formulate the methodology of the project work.
- Prepare the time line for each stage of their project Work.

SEMESTER VIII

AT19811	PROJECT PHASE II	L	T	P	C
		0	0	12	6

OBJECTIVES:

To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same. To train the students in preparing project reports and to face reviews and viva voce examination

The students in a group of 3 to 4 works on a topic approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

	TOTAL :	180	PERIODS

COURSE OUTCOMES:

- On completion, the students can able to execute the proposed plan, identify and overcome the bottlenecks during each stage.
- On completion of the project work students will be in a position to take up any challenging practical problems and find solution by formulating proper methodology.
- Students will obtain a hands-on experience in converting a small novel idea / technique into a working model / prototype involving multi-disciplinary skills and / or knowledge and working in at team.
- Students will be able to interpret the outcome of their project.
- Students will take on the challenges of teamwork, prepare a presentation in a professional manner, and document all aspects of design work.

PROFESSIONAL ELECTIVE – I

Subject code	Subject Name	Category	L	T	P	C
AT19P51	AUTOMOTIVE TRANSMISSION	PE	3	0	0	3

OBJECTIVES:

- To study the need and types of clutch and gearbox
- To make the students understand the basic construction and working of hydrodynamic transmission systems
- To make the students understand the need of epicyclic gear and its working principle
- To impart knowledge about the applications of automatic transmission
- To make the students realise the importance of hydrostatic and electric drives

UNIT I	CLUTCH AND GEAR BOX	12

Requirement of transmission system, Different types of clutches, principle & Construction of Single plate coil spring and Diaphragm spring clutches, Need and Objectives of Gear box. Construction and operation of Sliding mesh, Constant mesh and Synchromesh gearboxes. – Determination of gear ratios for vehicles. Performance characteristics at different speeds. Problems on performance of automobile such as Resistance to motion, Tractive effort, Engine speed, Power and acceleration. Design Consideration for Matching a transmission system to a vehicle.

UNIT II	HYDRODYNAMIC TRANSMISSION	9

Fluid coupling-Principle-Constructional details. Torque capacity. Performance characteristics. Reduction of drag torque in fluid coupling. Torque converter-Principle-constructional details, performance characteristics. Multistage torque converters and Polyphase torque converters.

UNIT III	EPICYCLIC GEARBOXES USED IN AUTOMATIC TRANSMISSION	8

Principle of Planetary gear trains - Wilson Gear box, Simpson planetary gear train, Ravigneaux planetary gear train, Lepelletier gear train, Cotal electromagnetic transmission- Hydraulic control system for Automatic Transmission.

UNIT IV	AUTOMATIC TRANSMISSION APPLICATIONS	8

Automated Manual Transmission (AMT) - Need for automatic transmission, Four speed longitudinally mounted automatic transmission - Chevrolet “Turboglide” Transmission, Continuously Variable Transmission (CVT) – Types –Operations of a typical CVT. ShiftFX

Electronic Shift Transmission.

UNIT V	HYDROSTATIC AND ELECTRIC DRIVE		8
Principles of Hydrostatic drive; Various types of hydrostatic systems. Advantages and limitations. Comparison of hydrostatic drive with hydrodynamic drive, construction and working of typical Janny hydrostatic drive. Electric drive-types- Principle of early and modified Ward Leonard Control system -Advantages & limitations. Modern Electric drive, buses and performance characteristics.			
	TOTAL	**45**	**PERIODS**

COURSE OUTCOMES:
1. The student will be able to describe the needs, types of gearbox and clutch. 2.The students will be able to explain the construction and working of hydrodynamic transmission system 3. The students can comprehend the working of epicyclic gear train in transmission systems. 4. The students will be able to explain the working principle and applications of automatic transmission. 5.The students will be able to compute the principles of hydrostatic and electric drives
TEXT BOOKS:
1.GarrettT.K., New ton. K., Steeds.W., "The Motor Vehicle" Published: Butterworth Heinemann,13th Edition-2000.
2.JackErkavec, "Automotive Technology-A Systems approach", Cengage learning, Delmar,2010.
REFERENCE BOOKS:
1.Devaradjane. Dr. G., Kumaresan. Dr. M., "Automobile Engineering", AMK Publishers, 2013.
2.Judge.A.W., "Modern Transmission System", Chapman and Hall Ltd, 2000.
3.HeinzHeisler, "Advance vehicle Technology", Butterworth-Heinemann, Elsevier, India Edition, 2011.
4.Heldt, P.M., "Torque converters", Chilton Book Co., 1992.
5.C.S.Shankar Ram, "Fundamentals of Automotive Systems", Department of Engineering Design, IITM. https://nptel.ac.in/courses/107106088

Subject Code	Subject Name	Category	L	T	P	C
AT19P52	**AUTOMOTIVE HEAT TRANSFER**	PE	**3**	**0**	**0**	**3**

Objectives:

- To understand the various modes of heat transfer and heat Conduction through wall, pipes and cylinder.
- To study the free and forced convection mode of heat transfer over surfaces due to fluid flow
- To understand the radiation and concept of black body , shape factor and radiation shield
- To learn the principle of heat transfer features in various heat exchangers and their performances
- To understand the various design aspects of radiator and its types

UNIT-I	**HEAT TRANSFER BY CONDUCTION**	**9**

.Fourier's law. General heat conduction equation in Cartesian coordinates and its transformation to cylindrical coordinates. Electrical analogy concept of overall heat transfer coefficient. One-dimensional steady-state heat conduction from plane wall, cylindrical wall and composite wall. Critical thickness of insulation for cylinder and sphere. Heat flow through plane wall with variable thermal conductivity. One dimensional steady state heat conduction with uniform heat generation through plane wall; hollow cylinder and solid cylinder. Heat transfer from extended surfaces. Efficiency and effectiveness in various configuration

UNIT-II	**HEAT TRANSFER BY CONVECTION**	**9**

Basic Concepts – Convective Heat Transfer Coefficients – Boundary Layer Concept –Types of Convection – Forced Convection – Dimensional Analysis – External Flow – Flow over Plates, Cylinders and Spheres – Internal Flow – Laminar and Turbulent Flow – Combined Laminar and Turbulent – Flow over Bank of tubes – Free Convection – Dimensional Analysis – Flow over Vertical Plate, Horizontal Plate, Inclined Plate, Cylinders and Spheres

UNIT-III	**HEAT TRANSFER BY RADIATION**	**9**

Basic Concepts, Laws of Radiation – Stefan Boltzman Law, Kirchoff Law –Black Body Radiation –Grey body radiation Shape Factor Algebra – Electrical Analogy – Radiation Shields – Introduction to Gas Radiation.

UNIT-IV	**HEAT EXCHANGERS**	**9**

Heat Exchanger Types - Overall Heat Transfer Coefficient – Fouling Factors - Analysis – LMTD

method - NTU method		
UNIT-V	**HEAT TRANSER IN ENGINE AND ITS COOLING SYSTEM**	**9**
Temperature distribution in a engine, Heat transfer in intake system and Combustion chambers, Piston cooling, valve cooling Effects of various operating variables on engine heat transfer (Mixture strength, Compression ratio, Spark timing, Engine size etc) , Liquid cooling and air cooling systems of an engine, Cooling system for Hybrid and Electric Vehicles		
	Total Contact Hours : 45	

Course Outcomes:

1. The student will able to evaluate the amount of heat transfer across surfaces due to conduction and various interface temperature
2. The student will be able to calculate the amount of heat transfer over various surfaces due to convection and the interacting fluid temperature.
3. The student will able to evaluate the amount of heat transfer over various surfaces due to radiation and shape factor responsible for radiation.
4. The student will able to evaluate the performance of various heat exchangers by NTU and LMTD method
5. The student will able to explain the various components of Automotive cooling system

Text Books:

1	Holman J.P, Souvik Bhattacharyya "Heat Transfer" 10 th Edition, McGraw-Hill Education Pvt. Ltd., 2011.
2	Kothandaraman C.P "Fundamentals of Heat and Mass Transfer" 4th Edition, New Age International (P) Ltd., New Delhi, 2012

Reference Books / Web links:

1	Sachdeva R C, "Fundamentals of Engineering Heat and Mass Transfer" 5th Edition, New Age International publishers, 2010
2	H.N Gupta "Fundamentals of Internal Combustion engines", PHI Learning India Ltd, New delhi,2013.
3	A course in Heat and Mass transfer , 7th Edition, DhanpatRai Publication,

Subject Code	Subject Name	Category	L	T	P	C
AT19P53	TWO AND THREE WHEELERS	PE	3	0	0	3

Objectives:	
●	To know about the power plant of two and three wheelers
●	To learn about the construction of frames, transmission systems, controls & attachments used in two wheelers
●	To Learn about the suspension systems, brakes, wheels and tyres
●	To know about the layout and working of electrical systems in a two-wheeler
●	To learn about the emissions from two wheelers

UNIT-I	POWER UNIT	9

SI Engines and CI engines for two and wheelers, Types of scavenging processes: merits and demerits, scavenging pumps, Rotary valve engine, Fuel supply systems for SI and CI engines, Lubrication and Cooling systems of two and three-wheeler engines, Kick starting system. Electric drives for two and three wheelers.

UNIT-II	CHASSIS AND SUB-SYSTEMS	9

Main-frame and its types for two and three wheelers, Chassis and shaft drive, Single, multi plate clutches, diaphragm clutch, centrifugal and Semi centrifugal clutches. Primary drive, Gear box and gear controls. Power transmission layout for two and three wheelers, Chain and sprockets, CVT, Panel meters and controls on handle bar.

UNIT-III	SUSPENSION SYSTEMS, BRAKES, WHEELS AND TYRES	9

Front, rear suspension systems and shock absorbers used for two wheelers & three wheelers, Drum brakes, disc brakes, front and rear brake actuating mechanisms, Brake system layout for two and three wheelers, regenerative brake system, Two-wheeler ABS. Spoked wheel, cast wheel, disc wheel, disc types. Tyres and tubes, tyre aspect ratio, tyre pressure.

UNIT-IV	ELECTRICAL AND ELECTRONIC SYSTEMS	9

Batteries for two and three wheelers, Magneto coil and battery coil spark ignition systems, electronic ignition system, Multiple Spark Plug Systems, Self-starting system-layout,& working, Electrical wiring layout of two and three wheelers- lighting, signal indicators, horn & buzzer, fault diagnosis, Servicing and maintenance of two and three wheelers.

UNIT-V	EMISSION CONTROL OF TWO- AND THREE- WHEEL VEHICLES	9

Introduction – World Wide Emission Standards for Two- and Three- Wheel Vehicles – Emission Control Technologies for Motorcycles – Engine Combustion Controls – Evaporative Emission Controls – Catalyst Technology – Catalytic Converters for Motorcycle Engines. Case study of major Indian models of motor cycles and three wheelers.

	Total Contact Hours	**:**	**45**

Course Outcomes:

1. The students will be able to explain the various types of engines of two and three wheelers
2. The students will be able to Illustrate the working of power transmission in a two wheeler
3. The students be able to explain the working of brakes, wheels and tyres in two and three wheelers
4. The students be able to describe the construction of batteries and possess knowledge about the spark plugs and other electrical accessories
5. The students will be able to explain the emission control technologies in two wheelers

Text Books:

1	K.K. Ramalingam, ―Two Wheelers‖, published by scitech, 2009.
2	Irving., ―P.E. Motor Cycle Engineering‖, Temple Press Book, London – 1992

Reference Books / Web links:

1	Encyclopedia of Motorcycling - 20 volume Marshall, Cavensih, UK - 1989
2	Emission Control of Two- and Three- Wheel Vehicles, Published by Manufacturers of Emission Controls Association, August 2008
3	The Cycle Motor Manual - Temple Press Limited, London - 1990

4	BrayantR.V,Vespa - Maintenance and Repair Series – S.Chand& Co., New Delhi - 1986.
5	Raymond Broad Lambretta, ―A Practical Guide to maintenance and repair‖, S.Chand& Co., New Delhi - 1987.

Subject Code	Subject Name	Category	L	T	P	C
AT19P54	CONTROL ENGINEERING	PE	3	0	0	3

Objectives:

- To know about the hydraulic and thermal systems and development of flight control systems
- To learn about the open and closed loop systems.
- To know about the characteristic equation and functions**.**
- To know about the concept of stability
- To learn about the sampled data systems

UNIT-I	**INTRODUCTION**	**9**
Historical review, Simple pneumatic, hydraulic and thermal systems, Series and parallel system, Analogies, mechanical and electrical components.		
UNIT-II	**OPEN AND CLOSED LOOP SYSTEMS**	**5**
Feedback control systems – Control system components - Block diagram representation of control systems, Reduction of block diagrams, Signal flow graphs, Output to input ratios.		
UNIT-III	**CHARACTERISTIC EQUATION AND FUNCTIONS**	**9**
Laplace transformation, Response of systems to different inputs viz., Step impulse, pulse, parabolic and sinusoidal inputs, Time response of first and second order systems, steady state errors and error constants of unity feedback circuit.		
UNIT-IV	**STABILITY AND CONTROL DESIGN**	**14**
Necessary and sufficient conditions, Routh-Hurwitz criteria of stability, Root locus and Bode techniques, Concept and construction, frequency response, PID controllers.		
UNIT-V	**SAMPLED DATA SYSTEMS**	**8**
Z-Transforms Introduction to digital control system, Digital Controllers.		
	Total Contact Hours : 45	

Course Outcomes: On completion of the course students will be able to
1. Explain the importance of mathematical modeling of a system 2. Demonstrate the concept and needs of feedback control systems and its application 3. Determine the response of different order systems for various step inputs 4. Determine the (absolute) stability of a closed-loop control system 5. Explain the concept of data system sampling and digital controller

Text Books:	
1	OGATO, Modern Control Engineering, Prentice-Hall of India Pvt. Ltd., New Delhi, 1998.
2	Azzo, J.J.D. and C.H. HoupisFeed back control system analysis and synthesis, McGraw-Hill international 3rs Edition, 1998.

Reference Books	
1	Kuo, B.C. "Automatic control systems", Prentice-Hall of India Pvt. Ltd., New Delhi, 1998.
2	Houpis, C.H. and Lamont, G.B. "Digital control Systems", McGraw Hill Book co., U.S.A. 1995.
3	Naresh K Sinha, "Control Systems", New Age International Publishers, New Delhi, 1998.

Subject Code	Subject Name	Category	L	T	P	C
MA19451	**NUMERICAL METHODS** **Common to IV sem. B.E. Aeronautical Engineering, Civil Engineering and B.Tech. Chemical Engineering**	BS	**3**	**1**	**0**	**4**

Objectives:

- To provide the necessary basic concepts of a few numerical methods.
- To provide procedures for solving numerically different kinds of problems occurring in the field of Engineering and Technology.

UNIT-I	**SOLUTION OF EQUATIONS**	**12**

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method- Solution of linear system of equations - Gauss elimination method – Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel.

UNIT-II	**INTERPOLATION**	**12**

Interpolation with equal intervals - Newton's forward and backward difference formulae - Interpolation with unequal intervals – Newton's divided difference interpolation - Lagrange's interpolation – Cubic Splines

UNIT-III	**NUMERICAL DIFFERENTIATION AND INTEGRATION**	**12**

Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal, Simpson's 1/3 rule and Simpson's 3/8 rule – Romberg's method - Two point and three point Gaussian quadrature formulae – Evaluation of double integrals by Trapezoidal rule.

UNIT-IV	**INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS**	**12**

Single Step methods: Taylor's series method - Euler's method - Modified Euler's method – Fourth order Runge - Kutta method for solving first order equations - Multi step methods: Milne's and Adams- Bash forth predictor corrector methods for solving first order equations.

UNIT-V	**BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS**	**12**

Finite difference method for solving second order differential equations - Finite difference techniques for the solution of two dimensional Laplace and Poisson equations on rectangular domain – One dimensional heat flow equation by implicit and explicit methods – One Dimensional Wave Equation by Explicit method.

	Total Contact Hours	**:**	**60**

Course Outcomes: On completion of course, students will be able to	
●	solve algebraic equations that arise during the study of Engineering problems.
●	use various interpolation techniques for solving problems in Engineering.
●	use numerical methods to solve problems involving numerical differentiation and integration.
●	solve initial value problems numerically that arise in Science and Engineering.
●	solve boundary value problems that encounter in different fields of Engineering study.

Text Books:	
1	Kandasamy P., Thilagavathy K., and Gunavathy,S., 'Numerical Methods', Chand and Co., 2008.
2	Grewal B.S., and Grewal. J.S.,"Numerical methods in Engineering and Science",Khanna Publishers, 10th Edition, New Delhi, 2012.
3	Sastry S.S, "Introductory Methods of Numerical Analysis", Prentice- Hall of India PVT. LTD., 5^{th} edition, New Delhi, 2012.

Reference Books / Web links:	
1	Veerarajan T., Ramachandran T., 'Numerical Methods with Programs in C and C++' Tata McGraw Hill., 2007.
2	Jain M.K., Iyengar, S.R., and Jain, R.K., 'Numerical Methods for Scientific and Engineering Computation', New Age Publishers. 6^{th} edition, 2007.
3	Chapra S.C., and Canale. R.P, "Numerical Methods for Engineers", 7th Edition, McGrawHill, New Delhi, 2016.
4	Brian Bradie "A friendly introduction to Numerical analysis", Pearson Education, Asia, New Delhi, 2007.
5	Sankara Rao K., "Numerical methods for Scientists and Engineers", Prentice Hall of India Private, 4th Edition, New Delhi, 2018.

PROFESSIONAL ELECTIVE – II

AT19P71	AUTOMOTIVE SENSORS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To make the students to accustom the various types of sensors and its characteristics used in automobiles.
- To expose the students for various types of sensors used for position and speed and their applications in automobiles.
- To organise the information on various types of sensors used for acceleration, pressure, force and torque and their applications in automobiles
- To discuss the information on the various types of sensors used for temperature, flow and climate control and their applications in automobiles.
- To provide a clear view on the various types of optoelectronic sensors and Actuators used in automobiles

UNIT I	INTRODUCTION	9

General concept- Automotive sensors, electronic control unit, actuator, Terms, definitions, Automotive applications, Features of vehicle sensors, sensor classification: assignment and application, Characteristic curve types, Types of output signal, Error types and tolerance requirements, Reliability, Main requirements and trends, Over view of the physical effects for sensors, Overview and selection of sensor technologies.

UNIT II	POSITION AND SPEED SENSORS	9

Position sensors: Characteristics, measured variables, Measuring principle, types- Potentiometer sensors, Magnetically inductive type sensors, Wave-propagation sensors, GPS position and distance traveled measurement. **Speed sensors:** measured variables, measuring principles, relative rpm and speed measurement- inductive types sensor, Absolute rotating speed measurement-oscillation gyroscope

Applications : Accelerator-pedal sensors: Application, design and operating concept**,** potentiometric accelerator pedal sensor, hall angular position sensors. **Engine speed sensors:** Application, design and operating concept, Inductive speed sensors, Active speed sensors, Hall phase sensors, Speed sensors for transmission control, Wheel speed sensors, Micromechanical yaw rate sensors, Piezoelectric "Tuning fork" yaw rate sensor. **Position sensors for transmission control**: Application, design and operating concept, requirements, Linear position determination on the basis of Hall switches, Rotational position determination on the basis of eddy currents. **Steering angle sensors:** Application

and operating principle of steering angle sensor with AMR element and GMR element. **Axle sensors:** Application and operating principle

UNIT III	ACCELERATION, PRESSURE, FORCE AND TORQUE SENSORS	9

Acceleration sensors: measured variables, Measuring principles: displacement or travel measuring system, systems for measuring mechanical stress, Thermal acceleration sensors, packaging. **Pressure sensors:** measured variables, Measuring principles: Direct pressure measurement, Diaphragm type sensors, Transfer to a force sensor. **Force and torque sensors:** measured variables, Measuring principles: Strain measuring force sensors, Travel measuring force sensors. **Torque sensor:** strain measuring sensor, angle measuring sensors, eddy current sensors.

Applications: Acceleration sensors: Surface micromechanical (SMM) acceleration sensors, Micromechanical bulk silicon acceleration sensors, piezoelectric acceleration sensors. **Micro mechanical pressure sensors**: application, Version with the reference vacuum on the component side, version with reference vacuum in a special chamber, High pressure sensors. **Force sensor, Torque sensor, Piezoelectric knock sensors:** application and operating principle, mounting.

UNIT IV	TEMPERATURE , FLOW AND CLIMATE CONTROL SENSORS	9

Temperature sensors: Measured variables, Measuring principles for direct contact sensors: Resistive sensors, sintered ceramic NTC resistors, PTC thin-film / thick-film metallic resistors, thick film resistors (PTC/NTC), mono crystalline silicon semiconductor resistors (PTC), Thermocouples, semiconductor depletion layers. Measuring principles for non-contacting temperature measurement: bolometer, thermopile sensor, single point sensors, imaging sensors. **Flow meters:** measured variables, Measuring principles. **Gas sensors and concentration sensors:** measured variables, Measuring principles

Applications: Temperature sensors: Application: engine temperature sensor, air temperature sensor, engine oil temperature sensor, fuel temperature sensor, exhaust gas temperature sensor, operating principles. **Hot film air mass meters:** application, HFM5 type, HFM6 type. **Climate control sensor.**

UNIT V	OTHER SENSORS AND ACTUATORS	9

Optoelectronic sensors: Internal photoelectric effect, Light sensitive sensor elements: photo resistors, semiconductor PN junctions, Imaging sensors: intergrading photodiodes, CCD imaging sensors, CMOS imaging sensors. Applications of optoelectronics sensors.

Other Sensors: Working principle of Ultrasonic sensor, Rain/light sensor, Dirt sensor, Two sep lambda oxygen sensors, Planar wide band lambda oxygen sensors, crash sensor.

Actuators: Working of Solenoids, Relays and Electric motors: stepper motors, permanent Magnet field motors and its applications.

	TOTAL :45 PERIODS

COURSE OUTCOMES:

1. The students will be able to describe the working of various sensors and its characteristics in cars.
2. The students will be able to explain the various sensors used to determine position and speed in automobiles.
3. The students will be able to elucidate the working and selection of various sensors used to determine acceleration, pressure, force and torque in modern cars.
4. The students will be able to illustrate the working and selection of various sensors for temperature, flow and climate control in automobiles.
5. The students will be able to explain the optoelectronic sensors and actuators in automobiles

TEXT BOOKS :

1	"Automotive Sensors" by Robert Bosch GmbH, 2007.
2	Joseph Bell "Diesel Engineering – Electricity and Electronics" Cengage learning, Indian Edition, 2007.

REFERENCE BOOKS/WEBLINKS :

1	Steve V. Hatch "Electronic Engine controls" Cengage learning, Indian Edition, 2009.
2	Sean Bennett "Diesel Engineering – Electronic diesel engine diagnosis" Cengage learning, Indian Edition, 2007.
3	Ian Sinclair, "Sensors and Transducers", Newnes, Elsevier, Indian Edition, 2011
4	Hardik Pandya, "Sensors and Actuators" Division of EECS, IISc. https://nptel.ac.in/courses/108108147

AT19P72	TRACTORS AND FARM EQUIPMENTS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To make the students understand the basics of tractors and their engines
- To make the students realise the importance of control and engine operation of a tractor.
- To make the students be aware of the steering, transmission and brake systems of a tractor
- To make the students understand the traction performance of a tractor
- To make the students gain knowledge on the farm implements and equipment

UNIT I	BASICS OF TRACTORS	9

Classification of tractors - Different types and purpose - Main components of tractor - Safety rules. Tractor Engines – basics, air induction system, exhaust system, cooling system and lubrication systems. Tractor chassis concepts

UNIT II	CLUTCH, DRIVE TRAINAND REAR TRANSMISSION	9

Clutch – necessity of clutch, types, Gear box – Types, Common Construction, Unique features and differences of differential gear boxes. Differential unit and final drive. Rear Transmission – Components and function. Power take-off. Continuously variable transmissions (CVTs). Rear wheel Drive – Four wheel drive

UNIT III	STEERING, WHEELS, SUSPENSION AND BRAKES	9

Steering – components, types, power steering mechanism, hydrostatic steering. Wheels – size, Inflation, Ballasting, Wheel Slippage. Front axle suspension. Brakes – principle of operation, classification of brakes.

UNIT IV	TRACTION	9

Traction Mechanics – Performance equations – Tire size, Load, and Air pressure relationship-Tread design – Traction Improvement – Traction devices for paddy fields. Speed and slope limits. Tire soil interaction. Weight transfer

UNIT V	FARM IMPLEMENTS AND EQUIPMENTS	9

Working attachment of tractors - Farm equipment - Classification –Sowing and Planting equipment, Spraying equipment, Auxiliary equipments - Trailers and body tipping mechanism.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

1. The students will be able to explain about the various components of tractor and its power unit
2. The students will be able to sketch the layout and the drivetrain components and will explain their working principle.
3. The students will be able to describe working of steering system, wheels and brake systems of a tractor
4. The students will be able to compute the tractive force and methods to improve the traction of a tractor
5. The students will be able to suggest suitable attachments to the tractor based on the type of crop and soil.

TEXT BOOKS:

1. K. Srinivasan, "Tractor and Agricultural Machinery", 2nd edition, New India Publishing Agency, 2015.
2. Segun R. Bello, "Farm Tractor Systems: Maintenance and Operations",Createspace Independent Pub, 2012.
3. Karl Theodor Renius, "Fundamentals of Tractor Design", Springer, 2019.

REFERENCE BOOKS:

1. Rodichev and Rodicheva. G, Tractor and Automobiles, MIR Publishers, 1987
2. Kolchin. A and Demidov. V, Design of Automotive engines for tractor, MIR Publishers, 1972
3. John B Lijedahl., Tractors and their power units, 4th edition, Van Nostrand Reinhold
4. V.K.Tewari, "Farm Machinery" Department of agricultural and food engineering, IITKGP. https://nptel.ac.in/courses/126105009
5. Karl Th.Renius . Fundamentals of Tractor Design, Springer, 2019

AT19P73	AUTOMOTIVE SAFETY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To comprehend the vehicle classifications, regulations and need for certification
- To understand the various tests performed on brakes, steering system and vehicle related tests
- To impart knowledge about the various tests performed on passenger safety and engine emissions.
- To learn the various tests performed on the Individual Vehicle Components.
- To learn about the various comfort and convenience systems in automobiles

UNIT I	INTRODUCTION	9

Design of the body for safety, energy equation, engine location, deceleration of vehicle inside passenger compartment, deceleration on impact with stationary and movable obstacle, concept of crumble zone, safety sandwich construction, Safety Standards.

UNIT II	SAFETY CONCEPTS	9

Active safety: driving safety, conditional safety, perceptibility safety, operating safety, passive safety: exterior safety, interior safety, deformation behaviour of vehicle body, speed and acceleration characteristics of passenger compartment on impact.

UNIT III	SAFETY EQUIPMENTS	9

Seat belt regulations, automatic seat belt tightener system, seat belt pre-tensioner, collapsible steering column, tiltable steering wheel, air bags, electronic system for activating air bags, bumper design for safety, Seat Position Control.

UNIT IV	ACTIVE SAFETY AND COLLISION AVOIDANCE SYSTEM	9

Collision warning system, causes of rear end collision, frontal object detection, rear vehicle object detection system, object detection system with braking system interactions. Electronic Stability Control, Active vibration Control, Accident recorder, Event data recorder, Automatic Braking.

UNIT V	COMFORT AND CONVENIENCE SYSTEM	9

Steering and mirror adjustment, Remote keyless entry, central locking system, Garage door opening system, tyre pressure control system, rain sensor system, Cabin environment controls, Head-up Display, Digital turn signals, Intelligent Speed Adaptation, Traffic assist, Hill hold control, Lane Correction, Lane Departure Warning, Night Vision. Blind spot recognition system, safety standard, case study.	
	TOTAL :45 PERIODS

COURSE OUTCOMES:

1. The student will be able to derive the crash equation based on energy principles
2. The student will be able to explain active and passive safety.
3. The student will be able to illustrate the working of seat belts, air bags and other safety systems.
4. The student will be able to describe the working of collision warning system and integration with braking system
5. The student will be able to elaborate the various comfort systems in a vehicle.

TEXT BOOKS:

1	Bosch, “Automotive Handbook”, 8th Edition, SAE publication, 2011
2	Powloski J., “Vehicle Body Engineering”, Business books limited, London, 1969

REFERENCE BOOKS/WEBLINK:

1	Ronald K.Jurgen, “Automotive Electronics Handbook”, Second Edition, McGraw-Hill Inc., 1999.
2	Ashish Verma, “Geo-informatics and transpoprtation engineering” IISc. https://nptel.ac.in/courses/105108073. Module-3/Lecture-8

AT19P74	INSTRUMENTATION AND METROLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand various characteristics of measuring instruments.
- To learn various instruments used for measuring pressure, temperature and flow and their applications.
- To know the various instruments used for measuring strain, force and torque and their applications.
- To understand various instruments used for linear and angular measurements and their applications.
- To make the student to know the various instruments used for form measurements and their applications.

UNIT I	GENERAL CONCEPTS OF MECHANICAL INSTRUMENTATION, GENERALISED MEASUREMENT SYSTEM	9

General concept – generalized measurement system – Units and standards- measuring instruments – sensitivity, readability, range of accuracy, precision – static and dynamic response – repeatability – systematic and random errors – correction, calibration, interchangeability.
Measurement of displacement, time, speed, frequency, acceleration, - Vibrometer, accelerometer.

UNIT II	MEASUREMENT OF PRESSURE, TEMPERATURE & FLOW	9

PRESSURE MEASUREMENT: Gravitational, Bourdon, elastic transducers, strain gauge, pressure cells, Measurement of high and low pressure, Dynamic characteristic of pressure measuring devices.

TEMPERATURE MEASUREMENT: Bi-metallic, pressure and resistance thermometer, Thermocouples, Pyrometer and Thermistors, Calibration.

FLOW MEASUREMENT: Orifice, flow nozzle, venturi, pitot tube, rotometer, Turbine type anemometer, Hot-wire anemometer, Magnetic flow meter, Ultrasonic flow meter, Calibration.

UNIT III	MEASUREMENT OF STRAIN, FORCE & TORQUE	9

STRAIN: Strain gauges, types, surface preparation and bonding technique, Wheatstone circuit, Temperature compensation, Gauge rosettes, calibration.

FORCE MEASUREMENT: Scales and balance, Elastic force meter, Strain gauge, Load cells, Hydraulic and pneumatic load cells.

TORQUE MEASUREMENT: Mechanical torsion meter, Optical torsion meter, Electrical torsion meter, Strain gauge torsion meter.

UNIT IV	LINEAR AND ANGULAR MEASUREMENTS	9
Definition of metrology - Linear Measuring Instruments – Evolution – Types – Classification – Limit gauges – gauge design – terminology – procedure – concepts of interchange ability and selective assembly. Angular measuring instruments – Types – Bevel protractor clinometers angle gauges, spirit levels sine bar – Angle alignment telescope – Autocollimator – Applications.		
UNIT V	**FORM MEASUREMENTS**	**9**
Principles and Methods of straightness – Flatness measurement – Thread measurement, gear measurement, surface finish measurement, Roundness measurement – Applications. Coordinate measuring machine (CMM): constructional features – types and applications - Basic concepts of Machine Vision System.		
		TOTAL :45 PERIODS

COURSE OUTCOMES :

1. Students will be able to explain the various characteristics of measuring instruments and able to select the instruments based on applications.
2. Students will be able to describe various instruments used for measuring pressure, temperature and flow and apply the required instruments based on the applications.
3. Students will be able to explain various instruments used for measuring strain, force and torque and apply the required instruments based on the applications.
4. Students will be able to illustrate various instruments used for measuring linear and angular measurements and apply the required instruments based on the applications.
5. Students will be able to explain various instruments used for form measurements.

TEXT BOOKS:	
1	Backwith, Marangoni, Lienhard, “Mechanical Measurements”, Pearson Education, 2006.
2	Jain R.K. “Engineering Metrology”, Khanna Publishers, 2005
REFERENCE BOOKS/WEB LINK:	
1	Alan S Morris, The Essence of Measurement, PHI, 1997
2	Gupta. I.C., “Engineering Metrology”, Dhanpatrai Publications, 2005.
3	Charles Reginald Shotbolt, “Metrology for Engineers”, 5th edition, Cengage Learning EMEA,1990.
4	K. Sadashivappa, “Metrology”, IITM. https://nptel.ac.in/courses/112106179/
5	SP. Venkateshan, “Mechanical Measurements and Metrology” Department of Mechanical Engineering, IITM. https://nptel.ac.in/courses/112106138/

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME19P81	OPERATIONS RESEARCH	PE	3	0	0	3

Objectives:

- To create awareness about optimization techniques in utilization of resources and to formulate the linear programming model for industrial applications based on the constraints and availability of the resources.
- To provide knowledge and training in Transportation and other production models and to obtain the optimal solution to maximize the profit.
- To provide knowledge about the Network models and to furnish the solution for the failure of item.
- To understand the deterministic and stochastic inventory models and to plan, manage the stocks to meet the customer demands.
- To understand the Queuing models, queue discipline and to explore the ways to give better customer service.

UNIT-I	LINEAR PROGRAMMING MODELS	9

Introduction to Operations Research - Scope, objectives, phases, models and limitations. Linear programming – formulation of LPP - Graphical method – Simplex algorithm – Artificial variables – Big M method – Two phase method – Duality formulation.

UNIT-II	TRANSPORTATION MODELS	9

Transportation Models - Finding basic feasible solution – LCM, NWC and VAM methods – Optimal solution using MODI method – Unbalanced model and Degeneracy.
Assignment Models – Hungarian method for optimal solution - Unbalanced problem - Traveling Salesman problem.
Sequencing Models - Processing n Jobs through 2 Machines, n Jobs through 3 Machines, n Jobs through m Machines using Johnson algorithm.

UNIT-III	NETWORK AND REPLACEMENT MODELS	9

Networks models: Network logic – Ford - Fulkerson's rule – Shortest route – Project network – CPM and PERT networks – Critical path scheduling – Types of Floats and calculations.
Replacement models: Types of failures - Present value factor - Replacement of items that deteriorate with time, Items that fail suddenly - Individual and Group replacement policies.

UNIT-IV	INVENTORY MODELS	9

Need for Inventory – Types of Inventories – Inventory costs - Economic order quantity – Deterministic Inventory models – with and without shortages - Quantity discount models – Stochastic inventory models – Multi product models – Inventory control – P and Q systems - Determination of Buffer stock and Reorder level.			
UNIT-V	QUEUEING MODELS		9
Queueing models - Queueing systems and structures – Notation parameter – Poisson input – Exponential service - Single server and multi-server models — Constant rate service – Infinite population – Simulation – Monte Carlo technique – Inventory and Queuing problems.			
	Total Contact Hours	:	45

Course Outcomes: At the end of this course, the students will be able to

1. Formulate a real-world mathematical linear programming model, select the constraints based on the availability of the resources and determine the optimal solution.
2. Build and solve specialized Transportation, Assignment and Sequencing problems with optimum results.
3. Investigate the nature of the project / failure and give suggestions towards decision making.
4. Know about the maintenance of inventory level, Plan the manufacturing policies and manage the stocks according to the customer demands.
5. Model a dynamic system as a queuing model and compute important performance measures for better customer service.

Text Books:

1	Hamdy A Taha, “Operations Research: An Introduction”, 10th edition, PHI/Pearson education, 2017.
2	Wayne L. Winston, Jeffrey B. Goldberg, “Operations Research Applications and Algorithms”, Thomson Brooks/Cole, 2004.

Reference Books(s) / Web links:

1	Premkumar Gupta and D.S.Hira, “Problems in Operations Research”, S.Chand, 2009.

2	Sharma J K, "Operations Research: Theory and Applications", 5th edition, Macmillan India, 2013.
3	Pannerselvam R, "Operations Research", 2nd edition, PHI, 2009.
4	Srinivasan G, "Operations Research: Principles and Applications", 3rd edition EEE PHI, 2017.
5.	Tulsian and Pasdey V., "Quantitative Techniques", Pearson Asia, 2002.

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME19P68	Geometric Dimensioning and Tolerancing	PE	3	0	0	3

UNIT-I	**INTRODUCTION**	**9**
Dimensioning and Tolerancing - Dimensioning Units - Fundamental Dimensioning Rules Tolerancing Fundamentals - Maximum Material Condition (MMC) - Least Material Condition (LMC) , Basics of Fits , Dimensioning, Rules and Concepts of GD&T		
UNIT-II	**Datum Control**	**9**
Datums - Datum Feature Symbol - Datum Feature - The Datum Reference Frame Concept - Datum Target Symbols - Partial Datum Surface - Coplanar Surface Datums – Datum Axis - Movable Datum Target Symbols and Datum Target Points - Movable Datum Target Symbols and Datum Target Spheres. Datum Center Plane - The Center of a Pattern of Features as the Datum Axis .		
UNIT-III	**Form and Orientation Control**	**9**
Introduction - Straightness, Flatness, Circularity, Free State Variation, Cylindricity Tolerance , Applying Form Control to a Datum Feature . Orientation Tolerances - Parallelism Tolerance - Perpendicularity Tolerance, Angularity Tolerance.		
UNIT-IV	**Location Tolerance**	**9**
Positional Tolerance - Locating Multiple Features - Positional Tolerancing of Coaxial Features- Positional Tolerancing of Nonparallel Holes - Locating Slotted Features -Positional Tolerancing of Spherical Features. Fasteners - Projected Tolerance Zone - Virtual Condition - Concentricity Tolerance - Positional Tolerancing for Coaxiality - Symmetry- Composite.		
UNIT-V	**Profile and Runout Tolerance**	**9**
Non-Uniform Profile Tolerance Zone - Specifying Basic Dimensions in a Note - Combination of Geometric Tolerances. Runout Tolerances - Combination of Geometric Tolerances Specifying Independency.		
	Total Contact Hours :	**45**

Course Outcomes: Upon completion of the course students should be able to:

- Read and understand basic GDT symbols on a print.
- Explain basic GDT concepts.
- Identify minimum and maximum material conditions.
- Measure and verify position tolerances with applied material conditions
- Set up and use basic rectangular datum reference frames.

Text Books:

1. Dimensioning and Tolerancing, Engineering Product Definition and Related Documentation Practices, ASME Y14.5-2018,2019.
2. N D Bhatt and VM Panchal , Machine Drawing, Charotar Publishing, 2014.

Reference Books(s) / Web links:	
1	David A. Madsen and David P. Madsen. Geometric Dimensioning and Tolerancing, 9th Edition, The Goodheart-Wilcox Company Inc, USA,2013.
2	Hoda A. ElMaraghy. Geometric Design Tolerancing: Theories, Standards and Applications. 2nd edition. Springer US. 2012
3	Henzold. G. Geometrical Dimensioning and Tolerancing for Design, Manufacturing and Inspection. 2nd edition, Elsevier Science, 2006
4	P.S.Gill Geometric Dimensioning and Tolerancing, S K Kataria and Sons, 2009.

PROFESSIONAL ELECTIVE – III

AT19P75	FINITE ELEMENT ANALYSIS FOR AUTOMOBILE ENGINEERS	L	T	P	C
		3	0	0	3

OBJECTIVES:

1. To introduce the concepts of mathematical modelling of engineering problems.
2. To solve one dimensional problem in solid mechanics, heat transfer and vibrations.
3. To solve two dimensional problems in solid mechanics, heat transfer and vibrations.
4. To solve problems using plane stress, plane strain and axisymmetric conditions.
5. To solve problems using isoparametric formulation

UNIT I	INTRODUCTION	9

Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.

UNIT II	ONE-DIMENSIONAL PROBLEMS	9

One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices - Solution of problems from solid mechanics and heat transfer. Fourth Order Beam Equation –Transverse deflections.

UNIT III	TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS	9

Second Order 2D Equations involving Scalar Variable Functions – Variational formulation –Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems - Thermal problems – Quadrilateral elements – Higher Order Elements

UNIT IV	TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS	9

Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations.		
UNIT V	**ISOPARAMETRIC FORMULATION**	**9**
Natural co-ordinate systems – Isoparametric elements – Shape functions for iso parametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems - Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software.		
	TOTAL :	**45 PERIODS**

COURSE OUTCOMES:

1. The students will be able to explain the concepts of Mathematical Modelling of Engineering Problems.
2. The students will be able to solve one-dimensional problems in solid mechanics, heat transfer and vibrations.
3. The students will be able to give solution for two-dimensional problems in solid mechanics, heat transfer and vibrations.
4. The students will be able to calculate problems using plane stress, plane strain and axisymmetric conditions.
5. The students will be able to solve problems using isoparametric formulation.

TEXT BOOKS:

1	Reddy. J.N., "An Introduction to the Finite Element Method", 3rd Edition, McGraw-Hill Education, 2006.
2	Seshu, P, "Text Book of Finite Element Analysis", PHI Learning Pvt. Ltd., 2004.

REFERENCE BOOKS:

1	Singiresu S. Rao "The Finite Element Method in Engineering", Butterworth-Heinemann, 5th Edition, 2010.
2	Logan, D.L., "A first course in Finite Element Method", 5th Edition, CL-Engineering, 2011.
3	Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, "Concepts and Applications of Finite Element Analysis", 4th Edition, Wiley Student Edition, 2002.
4	Tirupathi R Chandrupatla& Ashok D. Belagundu, "Introduction to Finite Elements in Engineering", 3rd Edition, Prentice Hall College Div, 2002
5	BhattiAsghar M, "Fundamental Finite Element Analysis and Applications", John Wiley & Sons, 2013.
6	David Hutton, "Fundamentals of Finite Element Analysis" Tata McGraw Hill India, 2003.
7	Dhanaraj. R and Prabhakaran Nair. K, "Finite Element Analysis", Oxford Publications, 2015.

AT19P76	VEHICLE MAINTENANCE	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study the classification of maintenance work, vehicle insurance, workshop practices, safety and tools.
- To provide the knowledge of general engine services, engine subsystem maintenance and engine maintenance.
- To know the importance of the transmission and driveline maintenance**.**
- To study the steering, brake, suspension and wheel maintenance.
- To provide the knowledge of auto electrical and air conditioning maintenance.

UNIT I	MAINTENANCE, WORKSHOP PRACTICES, SAFETY AND TOOLS	9

Maintenance – Need, classification of maintenance work – policies- vehicle insurance - basic problem diagnosis. Automotive service procedures – workshop operations – workshop manual and records, Safety – Personnel, machines and equipment, vehicles, fire safety - First aid. Basic tools – special service tools – measuring instruments –Motor vehicle Act, traffic rules, driving rules and regulations.

UNIT II	ENGINE AND ENGINE SUBSYSTEM MAINTENANCE	8

General Engine service- Dismantling of Engine components- Engine repair- working on the underside, front, top, ancillaries- Service of basic engine parts, cooling and lubricating system, fuel system, Intake and Exhaust system, electrical system - Electronic fuel injection engine management - emission controls service and fault diagnosis.

UNIT III	TRANSMISSION AND DRIVELINE MAINTENANCE	9

Clutch- general checks, adjustment and service- Dismantling, identifying, checking and reassembling transmission, transaxle- Removing and replacing propeller shaft, servicing of cross and yoke joint and constant velocity joints- Rear axle service points- removing axle shaft and bearings servicing differential assemblies- fault diagnosis.

UNIT IV	STEERING, BRAKE, SUSPENSION, WHEEL MAINTENANCE	9

Inspection, Maintenance and Service of Hydraulic brake, Drum brake, Disc brake, Bleeding of brakes. Inspection, Maintenance and Service of Mc person strut, coil spring, leaf spring, shock absorbers. Dismantling and assembly procedures. Wheel alignment and balance, removing and fitting of tyres, tyre wear and tyre rotation. Inspection, Maintenance and Service of steering linkage, steering system and types.

UNIT V	**AUTO ELECTRICAL AND AIR CONDITIOING MAINTENANCE**	**10**

Maintenance of batteries, starting system, charging system and body electrical -Fault diagnosis using Scan tools. Maintenance of air conditioning parts like compressor, condenser, expansion valve, evaporator - Replacement of hoses- Leak detection- AC Charging- Fault diagnosis Vehicle body repair like panel beating, tinkering, soldering, polishing, painting.

	TOTAL :	**45**	**PERIODS**

COURSE OUTCOMES:

1. Students will be able to explain the classification of maintenance work, vehicle insurance, workshop practices, safety and tools.
2. Students will be able to comprehend the general engine services, engine subsystem maintenance and engine maintenance.
3. Students will be able to describe the transmission and driveline maintenance**.**
4. Students will be able to elucidate about the steering, brake, suspension and wheel maintenance.
5. Students will be able to illustrate about the auto electrical and air conditioning maintenance.

TEXT BOOKS:

1	Ed May, "Automotive Mechanics Volume One" , McGraw Hill Publications, 2003
2	Ed May, "Automotive Mechanics Volume Two" , McGraw Hill Publications, 2003
3	Vehicle Service Manuals of reputed manufacturers

REFERENCE BOOKS:

1	Bosch Automotive Handbook, Sixth Edition, 2004

AT19P77	NOISE, VIBRATION AND HARSHNESS CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study the basic characteristics of noise and its sources from automobiles
- To provide a clear view on the different techniques to control noise from automobiles
- To make the students to understand the basic characteristics of vibration and its sources from automobiles
- To impart knowledge about the different techniques to vibration from automobiles
- To make the students aware of the Harshness and ride comfort in automobiles

UNIT I	BASICS OF NOISE AND SOURCES	9

Introduction, noise dose level, legislation, measurement and analysis of noise in engines, Noise characteristics, overall noise levels, assessment of combustion noise, assessment of mechanical noise, engine radiated noise, intake and exhaust noise, engine accessory contributed noise, transmission noise, aerodynamic noise, tyre noise, brake noise and Electromagnetic noise.

UNIT II	NOISE CONTROL	9

Methods for control of engine noise, combustion noise, mechanical noise, predictive analysis, palliative treatments and enclosures, automotive noise control principles, sound in enclosures, sound energy absorption, sound transmission through barriers.

UNIT III	BASICS AND MEASUREMENT OF VIBRATION	9

Introduction to basic principles of vibration - determination of natural frequencies - Lumped modelling of automotive structure - Vibration measuring techniques -standard test procedure for vibration measurement.

UNIT IV	VIBRATION CONTROL TECHNIQUES	9

Vibration isolation, tuned absorbers, untuned viscous dampers, damping treatments, application dynamic forces generated by IC engines, engine isolation, crank shaft damping, modal analysis of the mass elastic model shock absorbers

UNIT V	ADVANCED CONCEPTS	9

Harshness definition and achieving Ride comfort - Latest computational tools and techniques to

control noise and vibration in automobiles - Vehicle refinement - Recent material used for controlling interior and exterior noise produced in the vehicle- case studies.	
	TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. Explain the various types of noise and its measurements in automobiles
2. Describe the different control measures for noise in cars.
3. Elucidate the vibration and its measurements in vehicles.
4. Suggest the various control measures of vibration in automobiles.
5. Summarise about the harshness and advanced techniques to reduce harshness from passenger cars.

TEXT BOOKS:

1	Matthew Harrison, "Vehcile Refinement – Controlling Noise and Vibration in Road Vehicle", Butterworth-Heinemann, Indian Edition,2011.
2	SingiresuS.Rao - "Mechanical Vibrations" - Pearson Education, 2004.

REFERENCE BOOKS/WEBLINK:

1	Bernard Challen and RodicaBaranescu - "Diesel Engine Reference Book" -Second edition - SAE International, 1999.
2	Julian Happian-Smith - "An Introduction to Modern Vehicle Design"- Butterworth-Heinemann, 2004
3	John Fenton - "Handbook of Automotive body Construction and Design Analysis" - Professional Engineering Publishing, 1998.
4	KewalPujara "Vibrations and Noise for Engineers", DhanpatRai& Sons, 1992.
5	M. Moser, "Engineering Acoustics – An Introduction to Noise Control", Springer, Indian Edition, 2009
6	https://nptel.ac.in/courses/107106080/31

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME19P72	ADDITIVE MANUFACTURING	PE	3	0	0	3

Objectives:	
●	To familiarize the development of Additive Manufacturing, various business opportunities and applications.
●	To understand various software tools, techniques and file formats to create 3D models that helps in product development / prototyping requirements using AM.
●	To be familiar with Liquid and Solid based AM processes.
●	To be familiar with Powder and Wax based processes.
●	To understand the use of Bio Additive manufacturing and 4D printing.

UNIT-I	INTRODUCTION	9
Need, Fundamentals of Additive and digital Manufacturing, Advantages and Applications, Comparison of Additive Manufacturing with traditional Manufacturing, Additive Manufacturing (AM) process chain: 3D model, converting into STL file, transfer to system, checking, machine setup and building, Post process. Classification of AM process. Materials used in Additive Manufacturing Processes, Need for AM in product development and rapid tooling.		
UNIT-II	REVERSE ENGINEERING AND DESIGN FOR ADDITIVE MANUFACTURING (DFAM)	9
Introduction to Reverse Engineering: Applications, Steps in reverse Engineering. Design for additive manufacturing: CAD model preparation, Part orientation and support generation and removal, Model slicing and software's – Tool path generation. File formats in AM. Data Processing and Controllers.		
UNIT-III	LIQUID AND SOLID BASED ADDITIVE MANUFACTRING PROCESSES	9
Guidelines for process selection, Liquid based AM process - Stereo lithography apparatus, Polyjet printing, Digital Light Processing - Principle, Process, Machine parameters, Process parameters, Materials used, Strength and weakness, Applications, Case studies. Solid Based AM process - Fused Deposition Modeling (FDM), Solid Ground Curing (SGC), Laminated Object Manufacturing (LOM) - Principle, Process, Machine parameters, Process parameters, Materials used, Strength and weakness, Applications, Case studies.		

UNIT-IV	POWDER BASED AND OTHER ADDITIVE MANUFACTRING PROCESSES	9
Selective Laser Sintering (SLS), Selective Laser Melting (SLM) and Electron Beam Melting (EBM), Laser Engineered Net Shaping (LENS): Principle, Process, Machine parameters, Process parameters, Materials used, Strength and weakness, Applications, Case studies. Wax printing– Principle, Process, materials used and applications.		
UNIT-V	BIO ADDITIVE MANUFACTURING AND 4D PRINTING	9
Bio-Additive Manufacturing, Computer Aided Tissue Engineering (CATE) – Processing Steps and Case Studies. Customized Implants and Prosthesis, Materials used in bio printing and limitations. Design and Production of Medical devices. Sustainability in AM processes – Introduction to 4D printing and Smart materials used.		
	Total Contact Hours :	45

Course Outcomes: At the end of this course, students can have the	
●	Ability to explain the development of AM technology and how AM technology propagated into various businesses and developing opportunities.
●	Ability to explain the process of transforming a concept / existing product into 3D model used in AM technology.
●	Ability to explain Liquid and Solid based AM processes.
●	Ability to explain Powder and Wax based processes.
●	Ability to evaluate the advantages, limitations, applications and use of Bio Additive manufacturing and 4D printing.

Text Books:	
1	Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015.
2	Ian Gibson, David W. Rosen and Brent Stucker “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, 2nd edition, Springer., United States, 2015.

Reference Books(s) / Web links:	
1	Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1st Edition, CRC Press.,United States, 2015.
2	Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011
3	Kamrani A.K. and Nasr E.A., “Rapid Prototyping: Theory and practice”, Springer., United States, 2006.
4	Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press., United States, 2011.
5.	Milan Brandt, “Laser Additive Manufacturing: Materials, Design, Technologies, and Applications”, Woodhead Publishing., United Kingdom, 2016.

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME19603	Total Quality Management	PC	3	0	0	3

Objectives:

- To facilitate the understanding of basic quality management in engineering.
- To facilitate the understanding of various principles of TQM.
- To be acquainted with management tools, six sigma and benchmarking.
- To be acquainted with quality functions, TPM concepts &continuous improvement tools.
- To learn various quality systems and TQM implementation in manufacturing and service sectors.

UNIT-I	INTRODUCTION	9
Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Quality statements - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention.		
UNIT-II	TQM PRINCIPLES	9
Leadership - Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen, 8D methodology - Supplier partnership - Partnering, Supplier selection, Supplier Rating.		
UNIT-III	TQM TOOLS AND TECHNIQUES I	9
The seven traditional tools of quality - New management tools - Six sigma, Lean Six Sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.		
UNIT-IV	TQM TOOLS AND TECHNIQUES II	9
Quality Circles – Cost of Quality – Quality Function Deployment (QFD) – Taguchi quality loss function – TPM – Concepts, improvement needs – Performance measures, POKA-YOKE, JIT Concepts.		
UNIT-V	QUALITY MANAGEMENT SYSTEM	9

Introduction—Benefits of ISO Registration—ISO 9000 Series of Standards—Sector-Specific Standards—AS 9100, TS16949 and TL 9000– ISO 9001 Requirements—Implementation—Documentation—Internal Audits—Registration- ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001—Benefits of EMS.			
	Total Contact Hours	:	45

Course Outcomes: At the end of this course, students can have the

1. Ability to explain the importance of quality in engineering.
2. Ability to explain various principles in TQM.
3. Explore the knowledge of implementing various TQM tools.
4. Ability to create rapport among workers to form a quality team.
5. Ability to explain the benefits of implementing ISO-9000 & ISO-14000 in manufacturing and service sectors.

Text Book:

1	Dale H.Besterfield, Carol Besterfield- Michna, Glen H. Besterfield, Mary Besterfield - Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe ―Total Quality Management, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013.

Reference Books(s) / Web links:

1	James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.
2	Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
3	Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.
4.	ISO9001-2015 standards-A Complete Guide to Quality Management Systems by ItayAbuhav.
5.	Poka - Yoke, "Improving Product Quality by Preventing Defects", Productivity Press, 2004.

PROFESSIONAL ELECTIVE – IV

AT19P81	VEHICLE BODY ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart knowledge on the different types of car body details.
- To make the students understand the different types of bus body details.
- To make the students understand the importance of commercial vehicle details.
- To impart the knowledge about importance of vehicle aerodynamics
- To impart knowledge on different types of body materials, trims and mechanisms.

UNIT I	CAR BODY DETAILS	9

Types of Car body - Saloon, convertibles, Limousine, Estate Van, Racing and Sports car – Visibility regulations, driver's visibility, improvement in visibility and tests for visibility. Driver seat design -Car body construction-Various panels in car bodies. Safety aspect of car body.

UNIT II	BUS BODY DETAILS	9

Types of bus body: based on capacity, distance travelled and based on construction.– Conventional and Modernbus body layouts - Types of metal sections used – Regulations – Constructional details: Conventional and integral. driver seat design- Safety aspect of bus body.

UNIT III	COMMERCIAL VEHICLE DETAILS	9

Types of commercial vehicle bodies - Light commercial vehicle body. Construction details of commercial vehicle body - Flat platform body, Trailer, Tipper body and Tanker body – Dimensions of driver's seat in relation to controls – Drivers cab design - Regulations.

UNIT IV	VEHICLE AERODYNAMICS	9

Objectives, Vehicle drag and types. Various types of forces and moments. Effects of forces and moments. Side wind effects on forces and moments. Various body optimization techniques for minimum drag. Wind tunnels – Principle of operation, Types. Wind tunnel testing such as: Flow visualization techniques, Airflow management test – measurement of

various forces and moments by using wind tunnel.		
UNIT V	**BODY MATERIALS, TRIM, MECHANISMS AND BODY REPAIR**	**9**
Types of materials used in body construction-Steel sheet, timber, plastics, GRP, properties of materials. Body trim items-body mechanisms. Hand tools-power tools-panel repair-repairing sheet metal-repairing plastics-body fillers-passenger compartment service- corrosion: Anticorrosion methods, Modern painting process procedure-paint problems		
		TOTAL :45 PERIODS

COURSE OUTCOMES:

1. Students will be able to describe the different types of car body details.
2. Students will be able to explain the different types of bus body details.
3. Students will be able to describe the importance of commercial vehicle details.
4. Students will be able to illustrate the importance of vehicle aerodynamics
5. Students will be able to select the materials for vehicle body and explain trims and mechanisms.

TEXT BOOKS:

1	Powloski, J., "Vehicle Body Engineering", Business Books Ltd., 1998.
2	James E Duffy, "Body Repair Technology for 4-Wheelers", Cengage Learning, 2009.

REFERENCE BOOKS:

1	Giles, G.J., "Body construction and design", Illiffe Books Butterworth & Co., 1991.
2	John Fenton, "Vehicle Body layout and analysis", Mechanical Engg. Publication Ltd., London, 1992.
3	Braithwaite, J.B., "Vehicle Body building and drawing", Heinemann Educational Books Ltd., London, 1997

AT19P82	OFF ROAD VEHICLES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To accustom the basics of off road vehicles
- To impart knowledge about the constructional features and working of earth movers
- To provide a clear view on the constructional features and working of Shovels, ditchers, scrappers, graders
- To study the constructional features and working of farm equipments, military and combat vehicles
- To impart knowledge about the vehicle systems and features

UNIT I	CLASSIFICATION OF OFF ROAD VEHICLES	7

Introduction to off road vehicles – Classification :Construction layout, capacity and applications, Power Plants, Chassis and Transmission and Multi-axle vehicles.

UNIT II	EARTH MOVING AND MATERIAL HANDLINGMACHINES	10

Earthmovers like dumpers, loaders, dozers, excavators, backhoe loaders, bush cutters, stumpers, rippers – Power, Capacity and Mechanisms of earth moving machines. Material handling vehicles used in the industries – Hydraulic and Electric drives.

UNIT III	SCRAPPERS ,GRADERS, SHOVELS AND DITCHERS	10

Scrappers, elevating graders, motor graders, self-powered scrappers and graders, Power shovel, revolving and stripper shovels – drag lines – ditchers – Power, Capacity and Mechanisms of mining machines.

UNIT IV	FARM EQUIPMENTS, MILITARY AND COMBAT VEHICLES	8

Constructional details of Tractors - power take off, special implements. **Case study of any one tractor.** Special features and constructional details of tanks, gun carriers and military transport vehicles.

UNIT V	VEHICLE SYSTEMS,FEATURES	10

Brake system and actuation – OCDB and dry disc caliper brakes. Body hoist and bucket

operational hydraulics. Hydro-pneumatic suspension cylinders. Power steering system. Kinematics for loader and bulldozer operational linkages. Safety features, safe warning system for dumper. Design aspects on dumper body, loader bucket and water tank of sprinkler, Electrification of Off Road Vehicles –Hybrid and Electric Off Road Vehicles
TOTAL :45 PERIODS

COURSE OUTCOMES
1. The students will be able to describe the working of various sensors and its characteristics in cars.
2. The students will be able to explain the various sensors used to determine position and speed in automobiles.
3. The students will be able to elucidate the working and selection of various sensors used to determine acceleration, pressure, force and torque in modern cars.
4. The students will be able to illustrate the working and selection of various sensors for temperature, flow and climate control in automobiles.
5. The students will be able to explain the optoelectronic sensors and actuators in automobiles

TEXT BOOKS:	
1	Robert Peurifoy, Clifford J. Schexnayder, AviadShapira, Robert Schmitt, "Construction Planning, Equipment, and Methods", Tata McGraw-Hill Education Pvt. Ltd.,2011
2	Nakra C.P., "Farm machines and equipments", Dhanparai Publishing company Pvt. Ltd. 2003

REFERENCE BOOKS:	
1	Wong.J.T., "Theory of Ground Vehicles", John Wiley & Sons, New York, 1987.
2	Off the road wheeled and combined traction devices – Ashgate Publishing Co. Ltd. 1988.
3	Schulz Erich.J, Diesel equipment I & II, Mcgraw Hill company, London.
4	Bart H Vanderveen, Tanks and Transport vehicles, Frederic Warne and Co Ltd London.
5	Satyanarayana. B., Construction planning and equipment, standard publishers and distributors, New Delhi.

AT19P83	PRODUCTION OF AUTOMOTIVE COMPONENTS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand various process involved in powder metallurgy and various process available for processing plastics
- To learn the process capabilities and application of metal forming techniques such as forging and extrusion in automobile component production.
- To understand and identify the suitable casting and machining process available for making automobile component
- To understand the application of abrasive machining in automobile component production and to learn various gear generating and manufacturing techniques available
- To understand the part programming concept in a Computer numeric controlled machine considering various machining and production constraints.

UNIT I	POWDER METALLURGY AND PROCESSING OF PLASTICS	9

Powder Metallurgy – Advantages and Limitations –metal powders manufacturing and Characteristics – Mixing and Blending – Compacting (Briquetting)- sintering – secondary operations-properties of Powder Metallurgy – General Applications and Manufacture of friction lining materials for clutches and brakes,
Processing of Plastics – Polymers-polymerization – plastics – Processing of Thermoplastic Plastics: Injection moulding, Extrusion process and Sheet forming process- Processing of Thermosetting plastics: Compression moulding – Casting, machining, welding and other processing like Calendering, Rotational moulding, Blow moulding – applications in automotive parts.

UNIT II	FORGING AND EXTRUSION PROCESSES	9

Principles and applications of the following processes: Forging, Rolling, Extrusion, Wire drawing and Spinning.
Forging; materials, process flow chart, forging of valves, connecting rod, crank shaft, cam shaft, propeller shaft, transmission gear blanks, steering column.
Extrusions; Basic process steps, extrusion of transmission shaft, housing spindle, steering worm blanks, piston pin and valve tappets.
Hydro forming – Process, hydro forming of manifold and comparison with conventional methods- Hydro forming of tail lamp housing – forming of wheel disc and rims.
Stretch forming – Process, stretch forming of auto body panels –Super plastic alloys for auto

body panels		
UNIT III	**CASTING AND MACHINING**	**9**
Sand casting of cylinder block and liners – Centrifugal casting of flywheel, piston rings, bearing bushes, and liners, permanent mould casting of piston, pressure die casting of carburetor other small auto parts. Machining of connecting rods – crank shafts – cam shafts – pistons – piston pins – piston rings – valves – front and rear axle housings – fly wheel – Honing of cylinder bores – Copy turning and profile grinding machines.		
UNIT IV	**ABRASIVE PROCESSES AND GEAR CUTTING**	**9**
Abrasive processes: grinding wheel – specifications and selection, types of grinding process – cylindrical grinding, surface grinding, centreless grinding – honing, lapping, super finishing, polishing and buffing, abrasive jet machining – Gear cutting, forming, generation, shaping, hobbing.		
UNIT V	**CNC MACHINE TOOLS AND PART PROGRAMMING**	**9**
Numerical control (NC) machine tools – CNC: types, constructional details, special features – design considerations of CNC machines for improving machining accuracy – structural members – slide ways –linear bearings – ball screws – spindle drives and feed drives. Part programming fundamentals – manual programming – computer assisted part programming.		
		TOTAL :45 PERIODS

COURSE OUTCOMES:

1. The student will be able to explain various process involved in powder metallurgy and various process available for processing plastics
2. The student will be able to describe the process capabilities and application of metal forming techniques such as forging and extrusion in automobile component production.
3. The student will be able to identify the suitable casting and machining process available for making automobile component
4. The student will be able to explain the application of abrasive machining in automobile component production and to learn various gear generating and manufacturing techniques available
5. The student will be able to explain the part programming concept in a Computer numeric controlled machine considering various machining and production constraints

TEXT BOOKS:

1	P.C. Sharma, "A Textbook of Production Technology", S. Chand & Company Ltd., New Delhi, 2011.
2	HajraChoudhury, "Elements of Workshop Technology", Vol. I and II, Media Promoters and Publishers Pvt., Ltd., Mumbai, 2005.
REFERENCE BOOKS/WEBLINK:	
1	M. Groover and E Zimmers, "CAD/CAM – Computer Aided Design and Manufacturing" Pearson Education Inc, 2011.
2	Rusinoff, "Forging and Forming of metals ", D.B. Taraporevala Son & Co. Pvt Ltd., Mumbai, 1995.
3	"H.M.T. Production Technology – Handbook", Tata McGraw-Hill Education Pvt. Ltd., 2000.
4	Sabroff.A.M. & Others, "Forging Materials &Processes ", Reinhold Book Corporation, New York, 1988.
5	Upton, "Pressure Die Casting", Pergamon Press, 1985.
6	High Velocity "Forming of Metals", ASTME, prentice Hall of India (P) Ltd., New Delhi, 1990.
7	ASME Metals Handbook
8	Pradeep Kumar Jha "Theory of Production Processes", Department of mechanical and industrial engineering, IITR. https://nptel.ac.in/courses/112107239

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME19P74	HYDRAULICS AND PNEUMATICS	PE	3	0	0	3

Objectives:

- To accustom the basics of fluid power system and its applications.
- To impart the knowledge of the Hydraulic systems and its components.
- To provide a clear view on the Hydraulic circuits and Hydrostatic transmission.
- To accustom the basic concepts of pneumatic system and its logic circuits.
- To provide a clear view on the design of Hydraulic and pneumatic circuits with causes of trouble shooting/remedies

UNIT-I	FLUID POWER PRINCIPLES AND HYDRAULIC SYSTEMS (ACTUATOR-PUMPS)	7

Introduction to Fluid power- Advantages and Applications- Fluid power systems – Types of fluids- Properties of fluids Basics of Hydraulics – Pascal's Law- Principles of flow – Work, Power and Torque. Properties of air– Perfect Gas Laws. Sources of Hydraulic power: Pumping Theory – Pump Classification- Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criterion of Linear, Rotary- Fixed and Variable displacement pumps.

UNIT-II	HYDRAULIC SYSTEM (ACTUATORS) AND COMPONENTS	9

Hydraulic Actuators: Cylinders – Types and construction, Hydraulic motors -Types and construction -Control Components: Direction control, Flow control and Pressure control valves- Types, Construction and Operation- Applications – Types of actuations. Accessories: Reservoirs, Accumulators, Intensifiers, Pressure Switches-Classification and functions- Applications- Fluid Power ANSI Symbol.

UNIT-III	HYDRAULIC CIRCUITS AND HYDRO STATIC TRANSMISSION	9

Industrial hydraulic circuits- Regenerative, Pump Unloading, Double-pump, Pressure Intensifier, Air- over oil, Sequence, Reciprocation, Synchronization, Fail-safe, Speed control, Hydrostatic transmission, Accumulators application circuits, Electro hydraulic circuits, Mechanical Hydraulic servo systems

UNIT-IV	PNEUMATIC SYSTEM	8

Compressors- Filter, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust valves, Pneumatic actuators, Servo systems. Introduction to Fluidics, Pneumatic logic circuits.

UNIT-V	DESIGN OF HYDRALIC AND PNEUMATIC CIRCUITS		12
Design of circuits using the components of hydraulic system for Drilling, Planning, Shaping, Punching, Press. – Selection, fault finding and maintenance of hydraulic components- Sequential circuit design for simple application using cascade method, Electro pneumatic circuits. Selection criteria of pneumatic components – Installation fault finding and maintenance of pneumatic components. Microprocessor and PLC- Applications in Hydraulic and Pneumatics- Low-cost Automation – Hydraulic and Pneumatic power packs			
	Total Contact Hours	:	45

Course Outcomes: On Successful Completion of the course, students will be able to	
1	Apply the basics of fluid power system and its applications in industry
2	Analyze the Hydraulic systems and its components
3	Design the Hydraulic circuits and Hydro static transmission
4	Execute the basic concepts of pneumatic system and its logic circuits.
5	Design of Hydraulic and pneumatic circuits with causes of trouble shooting/remedies.
Text Books:	
1	Anthony Esposito," Fluid Power with Applications", PHI / Pearson Education, 2014
2	Majumdar, S.R., "Oil Hydraulics Systems- Principles and Maintenance", Tata McGraw Hill, 2017

Reference Books(s) / Web links:	
1	Shanmugasundaram.K, "Hydraulic and Pneumatic controls", Chand & Co, 2011.
2	Srinivasan. R, "Hydraulic and Pneumatic Control", IInd Edition, Tata McGraw - Hill Education,2012.
3	Majumdar, S.R., "Pneumatic Systems – Principles and Maintenance", Tata McGraw Hill, 2007
4.	R.Maiti, "Fundamentals of industrial oil hydraulics an pneumatics" Department of mechanical engineering, IITKGP. https://archive.nptel.ac.in/courses/112/105/112105047/

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ME19P84	COMPUTATIONAL FLUID DYNAMICS	PE	3	0	0	3

Objectives: The main learning objective of this course is to prepare the students	
●	To understand mathematical and computational methods for fluid flow and heat transfer simulations
●	To implement the Finite difference and volume method for solving diffusion problems
●	To learn finite volume method for convection diffusion
●	To assess the flow parameters in internal and external flows
●	To expose the students to various models in flow analysis

UNIT-I	GOVERNING EQUATIONS AND BOUNDARY CONDITIONS	9
Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations – Mathematical behavior of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations.		
UNIT-II	FINITE DIFFERENCE AND FINITE VOLUME METHODS FOR DIFFUSION	9
Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy – Finite volume formulation for steady state One, Two and Three -dimensional diffusion problems – Parabolic equations – Explicit and Implicit schemes – Example problems on elliptic and parabolic equations – Use of Finite Difference and Finite Volume methods.		
UNIT-III	FINITE VOLUME METHOD FOR CONVECTION DIFFUSION	9
Steady one-dimensional convection and diffusion – Central, upwind differencing schemes properties of discretization schemes – Conservativeness, Boundedness, Transportive, Hybrid, Power-law, QUICK Schemes.		
UNIT-IV	FLOW FIELD ANALYSIS	9
Finite volume methods -Representation of the pressure gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants – PISO Algorithms.		
UNIT-V	TURBULENCE MODELS AND MESH GENERATION	9

Turbulence models, mixing length model, Two equation (k- Є) models – High and low Reynolds number models – Structured Grid generation – Unstructured Grid generation – Mesh refinement – Adaptive mesh – Software tools.			
	Total Contact Hours	:	45

Course Outcomes: On successful completion of this course, students will be able to
1. Apply the basics of fluid power system and its applications in industry 2. explain the Hydraulic systems and its components 3. Design the Hydraulic circuits and Hydrostatic transmission 4. Execute the basic concepts of the pneumatic system and its logic circuits. 5. Design the Hydraulic and pneumatic circuits with causes of trouble shooting/remedies.

Text Book(s):	
1	Versteeg, H.K., and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The finite volume Method", Pearson Education Ltd., 2007
2	Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw Hill Publishing Company Ltd., 1998.
3	Jiyuan TL, Guan Heng Yeoh, "Computational Fluid Dynamics a Practical Approach" Butterworth-Heinemann, 1st Edition 2008.
4	Anderson, Jr., John D.., "Computational fluid Mechanics the Basics withApplications" McGraw Hill Education, 2012.

Reference Books(s) / Web links:	
1	Patankar, S.V. "Numerical Heat Transfer and Fluid Flow", Hemisphere Publishing Corporation, 2004
2	Chung, T.J. "Computational Fluid Dynamics", Cambridge University, Press, 2002
3	Fletcher, C. A. J., "Computational Techniques for Fluid Dynamics", Springer Verlag, 2011
4	Hyoung Woo Oh, "Applied Computational Fluid Dynamics", InTech Publishers, 2012
5	John F Wendt "Computational Fluid Dynamics" Springer, 2012

PROFESSIONAL ELECTIVE – V

AT19P84	AUTOMOTIVE TESTING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the vehicle classifications, regulations and need for certification
- To be aware of the various test to be done on brakes, steering system and vehicle related tests
- To impart knowledge about the various tests performed on passenger safety and Engine emissions.
- To learn the various tests to be performed on the Individual Vehicle Components.
- To elucidate the various tests conducted on the vehicle lighting system

UNIT I	INTRODUCTION	10

Specification & Classification of Vehicles (including M, N and O layout), Regulations overview (ECE, EEC, FMVSS, AIS, CMVR, ADR), Type approval and Conformity of Production, Engine and Vehicle specifications, 2 Wheeler certification

UNIT II	4 WHEELER PASSENGER VEHICLE – M1 CATEGORY (VEHICLE RELATED TESTS)	9

Vehicle Testing - Photographs, CMVR physical verification, Vehicle weightment, Coast down test, Brake test, ABS, Turning circle diameter test, Steering effort test, Speedometer calibration, Pass by noise test, External projection test, Gradeability test, Acceleration control system, Horn installation, Rear view mirror installation, Installation requirement for lighting &signalling devices, Wind screen wiping system. Electric vehicles – Safety Norms, Range, Energy consumption, Power test.

UNIT III	4 WHEELER PASSENGER VEHICLE – M1 CATEGORY (PASSENGER SAFETY AND EMISSION TESTS)	10

Steering Impact test (GVW<1500 kg), Body block test, Head form test, Fixtures charges,

Crash test with dummies, Different crash tests, Crash worthiness/ratings, Bumper testing, OBD I, Engine power test (petrol & diesel), Indian driving cycle, Vehicle mass emission, Evaporative emission (petrol vehicles), Broad band / Narrow band EMI test.		
UNIT IV	**4 WHEELER PASSENGER VEHICLE – M1 CATEGORY (COMPONENT RELATED TESTS)**	**7**
Size and Ply rating of tyres, Safety Glasses: Windscreen laminated safety glass, Side window / door glass, Back light / Rear toughened glass, Wind screen wiping system, Wiper Blade, Hydraulic brake hose, Hydraulic brake fluid, Rear view mirror specification (Exterior), Rear view mirror specification (Interior), Wheel rims, Wheel nut, Wheel discs & hub caps, Safety belt assemblies, Safety belt anchorages, Seat anchorages & head restraints, door locks & door retention, EV Battery Safety, EV Motor power test, EMI-EMC (CI, BCI, RE,RI and CTE)		
UNIT V	**AUTOMOTIVE LIGHTING TESTS**	**9**
Performance requirement for lighting & signalling devices - Vertical orientation of dipped beam- head lamp, driver's field of vision, Head lamp assembly (glass lens & plastic lens), Head lamp + Front position lamp / Front indicator lamp / front fog lamp, Rear combinational lamp (each additional function), Independent front position lamp / Front direction indicator lamp / Front fog lamp, Rear combination lamp (single function), Warning triangles, Fuel tank: Metallic & Plastic (excluding fire resistance test).		
		TOTAL :45 PERIODS

COURSE OUTCOMES:

1. The students will be able to classify the vehicle and their regulations for production certification.

2. The students will be able to describe e of various testing standards related to braking, steering systems of four wheeled vehicles.

3. The students will be able to explain the various tests related to passenger safety and vehicular engine emissions.

4. The students will be familiar with the standard testing procedures of individual vehicle components.

5. The students will be able to explain the standard tests performed on vehicle lighting system

TEXT BOOKS :	
1	"Vehicle Inspection Handbook", American Association of Motor Vehicle Administrators
2	Michael Plint& Anthony Martyr,"Engine Testing & Practice", Butterworth Heinmenn, 3rd edition, 2007
REFERENCE BOOKS /WEBLINK:	
1	Proceedings- Automotive Testing & Certification held on 20th to 24th July 2010 at ARAI PUNE
2	Bosch Automotive Handbook, Robert Bosch, 7th Edition, 2007
3	Tim Gilles, "Automotive Service" Delmar publishers, 1998.
4	Motor Vehicle Manual
5	ECE standards
6	EEC standards
7	FMVSS standards
8	CMVR standards

AT19P85	AUTOMOTIVE AIR-CONDITIONING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To accustom the basics of Psychrometry and air conditioning
- To impart knowledge about the various components used in the automotive air conditioning system and usage of various refrigerant and its uses.
- To provide a clear view on the basics of power requirement of the air conditioning system based on the environmental conditions
- To impart knowledge about the air routing an temperature control
- To provide a clear view on the servicing procedure used in the automotive air conditioning system.

UNIT I	**PHYSCHROMETERY AND AIR CONDITIONING**	10

Psychrometry : Psychrometric properties, psychrometric tables/charts, psychrometric processes, comfort charts, factors affecting comfort, effective temperature, ventilation requirements. Introduction to Air conditioning & Refrigeration: Methods of refrigeration. Vapour compression refrigeration system, vapour absorption refrigeration system, applications of refrigeration & air conditioning, Automobile air conditioning, air conditioning for passengers, isolated vehicles, Refrigerated transport vehicles, applications related with very low temperatures.

UNIT II	**AIR CONDITIONING SYSTEM AND REFRIGERANTS**	9

Air Conditioning Systems: Classification, layouts, central / unitary air conditioning systems. System components like compressor, evaporator, condenser, expansion devices, Receiver dryer, fan blowers, heating system etc. Switch and electrical wiring circuit. Refrigerants: Classification, properties, selection criteria, commonly used refrigerants, alternative refrigerants, eco-friendly refrigerants, applications of refrigerants, refrigerants used in automobile air conditioning.

UNIT III	**LOAD CALCULATION**	**10**

Load Calculations & Analysis: Design considerations for achieving desired inside/room conditions with respect to prevailing outside/environment conditions. Factors affecting/contributing towards the load on refrigeration & air conditioning systems. Cooling & heating load calculations. Load calculations for automobiles. Effect of air conditioning load on engine performance in terms of loss of available Peak Torque/Power and Fuel consumption.

UNIT IV AIR DISTRIBUTION AND ROUTING SYSTEMS 9

Air Distribution Systems: Distribution ducting, sizing, supply / return ducts, type of grills, diffusers, ventilation, air noise level, layout of duct systems for automobiles and their impact on load calculations. Air Routing & Temperature Control: Objectives of the dashboard re-circulating unit, automatic temperature control, controlling flow, control of air handling systems & air flow through – evaporator care

UNIT V AIR CONDITIONING SERVICE **7**

Air Conditioning Service: Air conditioner maintenance & service - removing & replacing Components. Compressor service. Testing, Diagnosis & trouble shooting of air conditioning system. Refrigerant gas charging procedure &. Servicing of heater system.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

1. The students will be able to explain the working of the air conditioning system and its components.
2. The students will be able to describe the heating system used in automobiles.
3. The students will be able to elucidate procedures to handle refrigerants and diagnostic procedure for refrigerants.
4. The students will be able to illustrate various steps involved in designing of air routing and temperature controls.
5. The students will be able to explain various steps in services of automotive air conditioning and heating systems

Text & Reference Books:

1. “Automotive Air-Conditioning”, by Crouse & Anglin – Mc Graw Hill Pub.

2. “Automotive Air-Conditioning”, by Paul Weiser – Reston Publishing Co.

3. “Automatic Heating & Air Conditioning Systems” – Mitchell Information Services.

4. “Air Conditioning”, by Paul Lang, C.B.S. Publisher & Distributor, Delhi.
5. Principles of Refrigeration by Roy J. Dossat – Pearson Publication.
6. “Modern Air Conditioning”, by Harris.

7. “Automobile Engg”, by Anil Chhikara - Satya Prakashan.
8. “American Society of Heating, Refrigeration & Air Conditioning – Fundamentals”, ASHRAE Handbook – 1985.

REFERENCE BOOKS/WEBLINK:

1	Mark Schnubel, “Automotive Engineering – Heating and Air conditioning” classroom and shop manual, Cengage learning, Indian Edition, 2011
2	Arora C.P., “Refrigeration and Air conditioning HVAC”, Tata McGraw-Hill Education Pvt. Ltd., 2008.
3	Arthur Bell, “HVAC Equations, Data, and Rules of Thumb”, Tata McGraw-Hill Education Pvt. Ltd., 2008.
4	Ravi Kumar, “Refrigeration and air-conditioning” Department of mechanical and industrial engineering, IITR. https://nptel.ac.in/courses/112107208/

AT19P86	AUTOMOTIVE AERODYNAMICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To make the students understand the design concept of automobile
- To understand the effect of drag force on car
- To optimize Automobile shapes for better aerodynamic performance
- To study the characteristics of forces and moments when a vehicle is running on the road.
- To learn the wind tunnel experiment procedure and measurement techniques

UNIT I	INTRODUCTION	9

Scope – historical development trends – Fundamentals of fluid mechanics – Flow phenomenon related to vehicles – External & Internal flow problems – Resistance to vehicle motion – Performance – Fuel consumption and performance – Potential of vehicle aerodynamics.

UNIT II	AERODYNAMIC DRAG OF CABS	9

Car as a bluff body – Flow field around car – drag force – types of drag force – analysis of aerodynamic drag – drag coefficient of cars – strategies for aerodynamic development – low drag profiles, Application of spoilers and diffusers

UNIT III	SHAPE OPTIMIZATION OF CABS	9

Front and Rear modification – front and rear wind shield angle – Boat tailing – Hatch back, fast back and square back – Dust flow patterns at the rear – Effect of gap configuration – effect of fasteners.

UNIT IV	VEHICLE HANDLING	9
The origin of force and moments on a vehicle – side wind problems – methods to calculate forces and moments – vehicle dynamics Under side winds – the effects of forces and moments – Characteristics of forces and moments – Dirt accumulation on the vehicle – wind noise – drag reduction in commercial vehicles.		
UNIT V	**WIND TUNNELS FOR AUTOMOTIVE AERODYNAMICS**	**9**
Introduction – Principles of wind tunnel technology – Limitation of simulation – Stress with scale models – full scale wind tunnels – measurement techniques – Equipment and transducers – road testing methods – Numerical methods.		
	TOTAL :45 PERIODS	

COURSE OUTCOMES:

1. The student will be able to design a vehicle with good aerodynamic characteristics.
2. The student will be able to compute drag and lift force acting on the car.
3. The student will be able to optimize the front and rear shape for better aerodynamic performance.
4. The student will be able to explain the effect forces and moment induced on the car.
5. The student will be able to describe a wind tunnel for calculating aerodynamic forces on a car.

TEXT BOOKS:

1	Hucho, Wolf-Heinrich., "Aerodynamics Of Road Vehicles: From Fluid Mechanics To Vehicle Engineering" Published by SAE International, 1998.
2	Anderson, John D., "Fundamentals Of Aerodynamics, by Tata Mcgraw-Hill, 2007.

REFERENCE BOOKS/WEBLINK:

1	Houghton, E. L; Carpenter, P. W., "Aerodynamics For Engineering Students" Cbs Publisher & Distributors, 2003

2 3	Pope,A., Wind Tunnel Testing, John Wiley & Sons, 2nd Edn., New York, 1974. https://nptel.ac.in/courses/101106042/2

AT19P87	TRANSPORT MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the various functions and their significance of personnel management. To introduce the basic job selection process.
- To understand the importance of motor transport among other transport means, functions of various divisions and structure of various forms of ownerships.
- To comprehend various components of operating costs, fare structure, fare collection methods and to prepare fare table. To study the basic factors and problems involved in bus scheduling
- To familiarize with various aspects of motor vehicle acts related to road users, vehicle owners, drivers, and vehicle designers.
- To realize the importance of vehicle maintenance in running profitable transport fleet and to know the basic bus depot layout.

UNIT I	INTRODUCTION	9

Personnel management; objectives and functions of personnel management, psychology, sociology and their relevance to organization, personality problems. Selection process: job description, employment tests, interviewing, introduction to training objectives, advantages, methods of training, training procedure, psychological tests.

UNIT II	TRANSPORT SYSTEMS	9

Introduction to various transport systems including shared mobility. Advantages of motor transport. Principal function of administrative, traffic, secretarial and engineering divisions. Chain of responsibility forms of ownership by state, municipality, public body and private undertakings. Case study of transport system.

UNIT III	SCHEDULING AND FARE STRUCTURE	9
Principal features of operating costs for transport vehicles with examples of estimating the costs. Fare structure and method of drawing up of a fare table. Various types of fare collecting methods. Basic factors of bus scheduling. Problems on bus scheduling.		
UNIT IV	**MOTOR VEHICLE ACT**	**9**
Traffic signs, fitness certificate, registration requirements, permit insurance, constructional regulations, description of vehicle-tankers, tippers, delivery vans, recovery vans, Power wagons and fire fighting vehicles. Spread over, running time, test for competence to drive.		
UNIT V	**MAINTENANCE**	**9**
Preventive maintenance system in transport industry, tyre maintenance procedures. Causes for uneven tyre wear; remedies, maintenance procedure for better fuel economy, Design of bus depot layout.		
	TOTAL :45 PERIODS	

COURSE OUTCOMES:

1. Students will know the objectives and functions of personnel management team, job selection and training processes.
2. Students will be able to explain the importance of motor transport, functions of transport departments and various forms of ownerships
3. Students will be able to calculate operating cost, prepare fare charts, and he can explain fare structure, fare collection methods and factors involved in bus scheduling
4. Students will be able to classify traffic signs, explain the requirements for vehicle fitness, registration, permit insurance and describe various types of vehicles.
5. Students will be able to explain the various vehicle maintenance procedures and can prepare a depot layout to run a successful transport fleet.

TEXT BOOKS:	
1	John Duke, "Fleet Management", McGraw-Hill Co, USA, 1984.
2	Kitchin.L.D., "Bus Operation", III edition, Illiffee and Sons Co., London, 1992
REFERENCE BOOKS/WEBLINK:	
1	Government Motor Vehicle Act, Publication on latest act to be used as on date
2	https://nptel.ac.in/courses/105101008/29

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
GE19P72	Entrepreneurship Development	PE	3	0	0	3

Objectives:

- To understand the types and characteristics of entrepreneurship and its role in economic development.
- To understand the theories of motivation and the principles of entrepreneurship development programs.
- To select the appropriate form of business ownership in setting up an enterprise.
- To mobilize and manage initial and working capital for the enterprise.
- To identify sickness in industry, select the appropriate corrective measures and identify the growth strategies for the enterprise.

UNIT-I	ENTREPRENEUR AND ENTREPRENEURSHIP	9

Entrepreneurship – definition and characteristics - characteristics of entrepreneur - classification of entrepreneurs – Danhofi's classification - other classifications - Functions of entrepreneurs – role of entrepreneurship in economic development and job creation - Emergence of entrepreneurial class in India – Entrepreneurship in ancient period - Entrepreneurship in pre-Independence era - Entrepreneurship in post-Independence period.

UNIT-II	ENTREPRENEURIAL MOTIVATION	9

Theories of entrepreneurship – sociological theories, economic theories, cultural theories and psychological theories - Entrepreneurial motivation: Theories of motivation - Entrepreneurial competencies – Entrepreneurship development Programs – need, objectives - Time management - Stress management.

UNIT-III	BUSINESS	9

Small Enterprises – Definition, characteristics, project identification and selection – Feasibility and profitability analysis – Formulation of project report– significance and content - Types of business ownership structures– suitability - Expansion, diversification, forward and backward integration.

UNIT-IV	FINANCING AND PROFITABILITY	9

Financing: Need, capital structure– Sources of finance – internal and external sources of finance - break even analysis – Capital budgeting - simple problems – Introduction to balance sheet and profit and loss statement – Importance of profitability – sustainability - Working capital

management: significance, assessment, factors, sources, management.		
UNIT-V	SUPPORT TO ENTREPRENEURS AND CASE STUDIES	9
Sickness in small business: concept, signals, symptoms, magnitude, causes and consequences, corrective measures – Government policy for small-scale enterprises – Growth strategies in small-scale enterprise – Institutional support to entrepreneurs: need and support – Taxation benefits to small scale industry. Case studies in entrepreneurship.		
	Total Contact Hours :	45

Course Outcomes: At the end of this course, the student will be able to	
●	Analyse the types, characteristics of entrepreneurship and its role in economic development.
●	Apply the theories of motivation and the entrepreneurial competencies.
●	Select the appropriate form of business ownership in setting up an enterprise.
●	Mobilise and manage initial and working capital for the enterprise.
●	Identify sickness in industry, select the appropriate corrective measures and identify the growth strategies in enterprise.
Text Books:	
1	Kurahko & Hodgetts, “Entrepreneurship – Theory, Process and Practices”, 6th edition, Thomson learning, 2009.
2	S.S. Khanka, “Entrepreneurial Development”, S.Chand & Co. Ltd., New Delhi, 1999.
Reference Books(s) / Web links:	
1	Sangram Kesari Mohanti, “Fundamentals of Entrepreneurship”, PHI Learning Private Ltd., Delhi, 2006.
2	Charantimath, P. M., “Entrepreneurship Development and Small Business Enterprises”, Pearson, 2006.
3	Hisrich R D and Peters M P, “Entrepreneurship”, 5th Edition, Tata McGraw-Hill, 2002.
4	Mathew J Manimala, “Entrepreneurship theory at cross roads: paradigms and praxis”, 2nd edition, Dream Tech., 2006.
5.	Rabindra N. Kanungo, “Entrepreneurship and Innovation”, Sage Publications, New Delhi, 1998.
6.	Singh, A. K., “Entrepreneurship Development and Management”, University Science Press, 2009.

Open Elective (Offered to other branches)

Subject Code	Subject Name	Category	L	T	P	C
AT19O31	AUTOMOTIVE SYSTEMS	OE	3	0	0	3

Course Objective:

- To make the students gain knowledge about the layout of an automobile and various parts of an engine.
- To provide a clear view on the working and types of suspension systems.
- To provide knowledge about the working and types of clutch and brake systems.
- To discuss the construction and working principle of transmission systems.
- To impart knowledge about steering system and final drive

UNIT-I	ENGINE MOUNTING AND FRAME	9

Vehicle Classification and Layouts Study various vehicle layouts as front engine and front wheel drive, front engine & rear wheel drive, rear engine & rear wheel drive, Four wheel drives, Chassis Frames and Body Types of Chassis frames & body

UNIT-II	SUSPENSION SYSTEM	9

Material, Unitized construction Suspension System Purpose, Types of suspension system, Front and rear suspension, Coil spring, types of rubber & Leaf spring, Torsion bars, Shock absorbers, Air and rubber suspension, Plastic suspensions, Hydro-pneumatic suspension, Independent suspension

UNIT-III	CLUTCH,BRAKING SYSTEM	9

Recent advances in Clutch and Brakes Electromagnetic and hydraulic clutches, Lining material, Release mechanism, Fluid flywheel Function, Internal expanding brakes, Brake lining material, Properties, Hydraulic braking system, Brake oil, Bleeding of brakes, Pneumatic braking system, Vacuum brakes, Exhaust brakes, Electrical brakes, Parking brake and braking efficiency		
UNIT-IV	TRANSMISSION SYSTEM	9
Components of transmission system, Automatic transmission system Semi-automatic and automatic transmission system Requirements, types, Torque converter, Hydro-static and hydro-dynamic transmission, Continuously variable transmission, Belt and friction drive		
UNIT-V	STEERING, TYRE AND FINAL DRIVE	9
Types of Steering system and Steering gears, Steering geometry, Wheel alignment, Power steering, Types of front axle& stub axles, Propellers shaft, Types of drive as torque tube and hotch kiss drive, Final drive types, Type of drive axles & differential – double reduction gear and clutch type differential, Fully or semi floating and three quarter floating, . Tractive efforts and draw bar pull, Tyres Types of wheel rims, Tread patterns, Types of tyres, Cross ply, Radial & tubeless tyres,		

	Total Contact Hours	:	45

Course Outcomes:

1. The students will be able to demonstrate the different layouts used in automobiles and function of all the engine parts.
2. The students will be able to describe the suspension system
3. The students will be able to illustrate the various parts of the clutch and braking system.
4. The students will be able to explain the working of transmission and its types.
5. The students will be able to elucidate steering and final drive

Text Books:	
1	Kirpal Singh, "Automobile Engineering Vol.1& 2", Standard Publisher Distributors, 14th Edition, 2017.
2	R.S. Khurmi& J. K. Guptha, "A Textbook of Machine Design", 34th edition, S. Chand publication. 2014.
3	R K Rajput " A Textbook of Automobile engineering" Lakshmi Publication pvt. Ltd.,
4	Automobile Engineering Vol-I & II Dr. K.M. Gupta

REFERENCE BOOKS:
1.Devaradjane. Dr. G., Kumaresan. Dr. M., "Automobile Engineering", AMK Publishers, 2013.
2.Judge.A.W., "Modern Transmission System", Chapman and Hall Ltd, 2000.
3. Giri, N.K., "Automobile Mechanics", Khanna publishers, New Delhi, 2007
4. Automotive mechanics by W. Crouse, - TMH.
5. Motor vehicle Newton and steed

Subject Code	Subject Name	Category	L	T	P	C
AT19O32	AUTOMOTIVE SENSORS AND ACTUATORS	OE	3	0	0	3

Objectives:

- To accustom the various types of sensors and its characteristics used in automobiles
- To impart knowledge about the various types of sensors used for position and speed and their applications in automobiles
- To study the various types of sensors used for acceleration, pressure, force and torque and their applications in automobiles
- To provide a clear view on the various types of sensors used for temperature, flow and climate control and their applications in automobiles
- To study the various types of optoelectronic sensors and Actuators used in automobiles

UNIT-I	INTRODUCTION	9

Automotive sensors, Terms and definitions, Automotive applications, Features of vehicle sensors, sensor classification based on application, types of characteristic curves, types of output signals, types of error signals, tolerance requirements, reliability. Main requirements and trends, overview of the physical effects for sensors, selection of sensors.

UNIT-II	POSITION, SPEED AND RPM SENSORS	9

Position sensors: Characteristics, measured variables, Potentiometer sensors, magnetically inductive type sensors, Wave-propagation sensors, GPS position and distance travelled measurement. Speed and rpm sensors: measured variables, measuring principles, relative rpm and speed measurement, Absolute rotating speed measurement.

Applications: Accelerator-pedal sensors: potentiometric accelerator pedal sensor, hall angular position sensors. Engine speed sensors:Inductive speed sensors, Active speed sensors, Hall phase sensors, Speed sensors for transmission control, Wheel speed sensors, Micromechanical yaw rate sensors, Piezoelectric-Tuning forkyaw rate sensor. Position sensors for transmission control: application, requirements, Linear position determination on the basis of Hall switches, Rotational position determination on the basis of eddy currents. Steering angle sensors: Application and operating principle of steering angle sensor. Axle sensors: Application and operating principle.

UNIT-III	ACCELERATION, PRESSURE, FORCE AND TORQUE SENSORS	9

Acceleration sensors: measured variables, measuring principles: displacement or travel measuring system, systems for measuring mechanical stress, Thermal acceleration sensors, packaging. Pressure sensors: measured variables, Measuring principles: Direct pressure measurement, Diaphragm type sensors, transfer to a force sensor. Force and torque sensors: measured variables, measuring principles: Strain measuring force sensors, Travel measuring force sensors. Torque sensor: strain measuring sensor, angle measuring sensors, eddy current sensors.

Applications: Acceleration sensors: Surface micromechanical (SMM) acceleration sensors, Micromechanical bulk silicon acceleration sensors, piezoelectric acceleration sensors. Micro mechanical pressure sensors: application, Version with the reference vacuum on the component side, version with reference vacuum in a special chamber, High pressure sensors. Force sensor, Torque sensor, Piezoelectric knock sensors: application and operating principle, mounting.

UNIT-IV	TEMPERATURE, FLOW AND CLIMATE CONTROL SENSORS	9

Temperature sensors: Measured variables, measuring principles for direct contact sensors: Resistive sensors, sintered ceramic NTC resistors, PTC thin-film / thick-film metallic resistors, thick film resistors (PTC/NTC), mono crystalline silicon semiconductor resistors (PTC), Thermocouples, semiconductor depletion layers. Measuring principles for non-contacting temperature measurement: bolometer, thermopile sensor, single point sensors, imaging sensors. Flow meters: measured variables, Measuring principles. Gas sensors and concentration sensors: measured variables, Measuring principles

Applications: Temperature sensors: Application: engine temperature sensor, air temperature sensor, engine oil temperature sensor, fuel temperature sensor, exhaust gas temperature sensor, operating principles. Hot film air mass meters: application, HFM5 type, HFM6 type. Climate control sensor.

UNIT-V	OTHER SENSORS AND ACTUATORS	9

Optoelectronic sensors: Internal photoelectric effect, Light sensitive sensor elements: photo resistors, semiconductor PN junctions, Imaging sensors: intergrading photodiodes, CCD imaging sensors, CMOS imaging sensors. Applications of optoelectronics sensors.

Other Sensors: Working principle of Ultrasonic sensor, Rain/light sensor, Dirt sensor, Two step lambda oxygen sensors, Planar wide band lambda oxygen sensors, crash sensor.

Actuators: Working principle and applications of solenoids, relays, piezo actuators and electric motors: stepper motors, permanent magnet field motors. Applications: Solenoid and Piezo based fuel injectors, Starter motor relay function, windshield wiper operation

	Total Contact Hours	:	45

Course Outcomes:

On completion of the course students will be able to

1. The students will be able to describe the working of various sensors and its characteristics in cars.
2. The students will be able to explain the various sensors used to determine position and speed in automobiles.
3. The students will be able to elucidate the working and selection of various sensors used to determine acceleration, pressure, force and torque in modern cars.
4. The students will be able to illustrate the working and selection of various sensors for temperature, flow and climate control in automobiles.
5. The students will be able to explain the optoelectronic sensors and actuators in automobiles.

Text Books:	
1	Automotive Sensors by Robert Bosch GmbH, 2007
2	Joseph Bell ―Diesel Engineering – Electricity and Electronics‖ Cengage learning, Indian Edition, 2007.

Reference Books / Web links:	
1	Steve V. Hatch ―Electronic Engine controls‖ Cengage learning, Indian Edition, 2009
2	Sean Bennett ―Diesel Engineering – Electronic diesel engine diagnosis‖ Cengage learning, Indian Edition, 2007.
3	Ian Sinclair, ―Sensors and Transducers‖, Newnes, Elsevier, Indian Edition, 2011

Subject Code	Subject Name	Category	L	T	P	C
AT19O33	ELEMENTS OF ELECTRIC AND HYBRID VEHICLES	OE	3	0	0	3

OBJECTIVES:

- To understand the need for alternative power train system
- To provide adequate knowledge in high energy and power density batteries and fuel cells.
- To give basic knowledge in power controls and motors used in EV and HEV applications.
- To make the students understand the calculations involved in the basic design of electric vehicle
- To understand the fundamentals of hybrid electric vehicle

UNIT I	NEED FOR ALTERNATIVE SYSTEM	9

Energy demands for transportation sector- Emission regulations-Need of electric vehicles hybrid vehicles – comparative study of diesel, petrol, pure electric and hybrid vehicles. Limitations of electric vehicles. Basic layout of electric and hybrid vehicles

UNIT II	ENERGY SOURCES : BATTERIES AND FUEL CELLS	9

Battery Parameters-Power requirement of electric vehicles- Different types of batteries - Lead acid- Nickel based-Sodium based-Lithium based- Metal Air based. Battery charging- Charger design- Quick charging devices- Charging profile for batteries. Battery Management System. Fuel Cell- Fuel cell characteristics- Fuel cell types-Hydrogen fuel cell- Connecting cell in series- water management in the PEM fuel cell- Thermal Management of the PEM fuel cell

UNIT III	TRACTION MOTORS AND CONTROLLERS	12

Requirements of motors for EV and HEV application. Characteristic of permanent magnet and separately exited DC motors.PMSM and SRM motors- AC single phase and 3-phase motor – inverters – DC and AC motor speed controllers. DC-DC convertors – AC-DC convertors. DC-AC convertors.

UNIT IV	VEHICLE DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES	6
Aerodynamic-Rolling resistance- Transmission efficiency- Vehicle mass- Electric vehicle chassis and Body design considerations - Gradability requirements. Heating and cooling systems- Controllers- Power steering- Tyre choice- Wing Mirror, Aerials and Luggage racks		
UNIT V	HYBRID VEHICLES	9
Concept of hybridization. Types of Hybrid- Series, parallel, split – parallel, series - parallel - Advantages and Disadvantages. Power split device – Energy Management System - Design consideration - HEV driving modes. Plug-in hybrid vehicles. Case study – Toyota prius, Honda civic.		
	Total : 45 PERIODS	

COURSE OUTCOMES:

1. The students will be able to explain the various alternative power trains for automobiles.
2. The students will be able to suggest high energy and power density batteries for automotive application.
3. The students will be able to suggest suitable motor that can be used for a given category of EV.
4. The students will be able to calculate the different resistance experienced by the automobile and arrive at the power requirement for EV propulsion.
5. The students will be able to explain of the fundamentals of hybrid electric vehicles.

Text Books:

1	James Larminie and John Lowry, “Electric Vehicle Technology Explained “ John Wiley & Sons,2003
2	Iqbal Husain, “ Electric and Hybrid Vehicles-Design Fundamentals”, CRC Press,2003

3	MehrdadEhsani, " Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRC Press,2005
Reference BOOKS:	
1	Ron HodKinson, "light Weight Electric/ Hybrid Vehicle Design", Butterworth Heinemann Publication,2005
2	Lino Guzzella, " Vehicle Propulsion System" Springer Publications,2005
3	"Introduction to hybrid and electric vehicles", Department of electrical engineering, IITG. https://archive.nptel.ac.in/courses/108/103/108103009/#

AT19O34	FUNDAMENTALS OF AUTOMOTIVE ELECTRONICS	Category	L	T	P	C
		OE	3	0	0	3

OBJECTIVES:

- To learn about the fundamental principles of automotive electronics
- To gain knowledge about the various sensors used in automobiles
- To understand the electronic engine management systems for Petrol engines
- To know about the electronic engine management systems for diesel engines
- To understand the chassis management systems used in modern vehicles

UNIT I	FUNDAMENTALS OF AUTOMOTIVE ELECTRONICS	9

Microprocessor architecture, open and closed loop control strategies, PID control, Look up tables, introduction to modern control strategies like Fuzzy logic and adaptive control. Parameters to be controlled in SI and CI engines and in the other parts of the automobile.

UNIT II	SENSORS	9

Inductive, Hall effect, hot wire anemometer, thermistor, piezo electric, piezo resistive, based sensors. Throttle position, air mass flow, crank shaft position, cam position, engine and wheel speed, steering position, tire pressure, brake pressure, steering torque, fuel level, crash, exhaust oxygen level (two step and linear lambda), knock, engine temperature, manifold temperature and pressure sensors.

UNIT III	SI ENGINE MANAGEMENT	9

Three-way catalytic converter, conversion efficiency versus lambda. Layout and working of SI engine management systems like Bosch L-Jetronic and LH-Jetronic. Group and sequential injection techniques. Working of the fuel system components. Cold start and warm up phases, idle speed control, acceleration and full load enrichment, deceleration fuel cut off. Fuel control maps, open loop control of fuel injection and closed loop lambda control. Electronic ignition systems and spark timing control. Closed loop control of knock.

UNIT IV	CI ENGINE MANAGEMENT	9

Fuel injection system parameters affecting combustion, noise and emissions in CI engines. Pilot, main, advanced post injection and retarded post injection. Electronically controlled Unit Injection system. Layout of the common rail fuel injection system. Working of components like fuel injector, fuel pump, rail pressure limiter, flow limiter, EGR valves		
UNIT V	VEHICLE MANAGEMENT SYSTEMS	9
Electric power steering, Supplementary Restraint System of air bag system – crash sensor, seat belt tightening. Cruise control. Vehicle security systems- alarms, vehicle tracking system. On board diagnostics. Collision avoidance Radar warning system		
	Total : 45 PERIODS	

COURSE OUTCOMES:

1. The student will be able to explain the various control strategies used in automotive electronics
2. The student will be able to expose the working principle of various sensors and its applications in automobiles
3. The student will be able to describe various principles involved in electronic engine management systems for Petrol engines
4. The student will be able to explain various principles involved in electronic engine management systems for diesel engines
5. The student will be able to illuminate the control system operation behind the function of various chassis management systems

Text Books:

1	William B Ribbens“Understanding Automotive Electronics”, SAE Publications, 1998

2	Eric Chowanietz“Automobile Electronics” SAE Publications, 1994
REFERENCE BOOKS/WEBLINK:	
1	Robert Bosch,“Diesel Engine Management”,SAE Publications, 2006
2	Robert Bosch, “Gasoline Engine Management” SAE Publications, 2006
3	Hardik Pandya, “Sensors and Actuators” Division of EECS, IISc. https://nptel.ac.in/courses/108108147