RAJALAKSHMI ENGINEERING COLLEGE

(An Autonomous Institution Affiliated to Anna University Chennai)

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 & 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
GE19141	Programming Using C	2	0	4	6	4	ES
GE19201	Engineering Mechanics	2	1	0	3	3	ES
GE19122	Engineering Practices - Electrical & Electronics	0	0	2	2	1	ES
MC19102	Indian Constitution and Freedom Movement (Non Credit course)	3	0	0	3		MC
	Total	**16**	**2**	**10**	**28**	**20**	

Semester III							
Course Code	**Course Title**	**L**	**T**	**P**	**Total**	**C**	**CAT**
GE19301	Life Science for Engineers	3	0	0	3	3	BS
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**
GE19304	Fundamentals of Management for Engineers	3	0	0	3	3	HS
AT19401	Engineering Materials & Metallurgy	3	0	0	3	3	ES
AT19402	Production Technology - I	3	0	0	3	3	PC
AT19441	Fluid Mechanics & 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
	Total	**17**	**2**	**8**	**27**	**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
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	**13**	**2**	**14**	**29**	**22**	

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
ME19741	Mechatronics	3	0	2	5	4	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
AT19713	Project - Phase I	0	0	4	4	2	EEC
	Total	**15**	**0**	**12**	**27**	**21**	

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
ME19P79	Operations Research	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	Automotive Pollution Control	3	0	0	3	3	PE
AT19P77	Vehicle Maintenance	3	0	0	3	3	PE
AT19P78	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**
OAT1901	Automotive Systems	3	0	0	3	3	OE
OAT1902	Automotive Sensors and Actuators	3	0	0	3	3	OE
OAT1903	Elements of Electric and Hybrid Vehicles	3	0	0	3	3	OE
OAT1904	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**	**12**					**20**
III		**7**	**7.5**	**10.5**				**25**
IV	**3**		**3**	**16**			**1**	**23**
V				**17**	**3**	**3**	**1**	**24**
VI				**16**	**3**		**3**	**22**
VII				**12**		**6**	**3**	**21**
VIII						**6**	**6**	**12**
Total	**6**	**23**	**27.5**	**71.5**	**6**	**15**	**14**	**163**
%	**3.68%**	**14.11%**	**16.87%**	**43.87%**	**3.68%**	**9.20%**	**8.59%**	

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,						

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

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CONCEPTS AND CONVENTIONS (Not for Examination)			1
Importanceofgraphicsinengineeringapplications–Useofdraftinginstruments– BIS conventions and specifications–Size, layout and folding of drawing sheets– Lettering and dimensioning. Basic Geometrical constructions.			
UNIT-I	**PLANECURVES 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 OFPOINTS, 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	**PROJECTIONOFSOLIDS**		**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 DEVELOPMENTOF 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 PERSPECTIVEPROJECTIONS**		**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	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	ENVIROMENTAL SCIENCE AND ENGINEERING	MC	3	0	0	0

Common to I sem. B.E. – Aeronautical Engineering, Automobile Engineering, Biomedical Engineering, Civil Engineering, Mechanical Engineering & Mechatronicsand 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	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.
●	experimentallyanalyze 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 (Lab oriented Theory Course)	Category	L	T	P	C
GE19141	PROGRAMMING USING C	ES	2	0	4	4

Objectives:	
●	To develop simple algorithms for arithmetic and logical problems.
●	To develop C Programs using basic programming constructs
●	To develop C programs using arrays and strings
●	To develop applications in C using functions, pointers and structures
●	To do input/output and file handling in C

UNIT-I	**GENERAL PROBLEM SOLVING CONCEPTS**	6
Computer – components of a computer system-Algorithm and Flowchart for problem solving with Sequential Logic Structure, Decisions and Loops.		
UNIT-II	**C LANGUAGE - TYPES OF OPERATOR AND EXPRESSIONS**	6
Introduction- C Structure- syntax and constructs of ANSI C - Variable Names, Data Type and Sizes, Constants, Declarations - Arithmetic Operators, Relational Operators, Logical Operators, Type Conversion, Increment and Decrement Operators, Bitwise Operators, Assignment Operators and Expressions, Precedence and Order of Evaluation, proper variable naming and Hungarian Notation.		
UNIT-III	**I/O AND CONTROL FLOW**	6
Standard I/O, Formatted Output – Printf, Variable-length argument lists- Formatted Input – Scanf, Statements and Blocks, If-Else-If, Switch, Loops – while, do, for, break and continue, GoTo Labels.		
UNIT-IV	**FUNCTIONS AND PROGRAM STRUCTURE**	6
Basics of functions, parameter passing and returning type, External, Auto, Local, Static, Register Variables, Scope Rules, Block structure, Initialisation, Recursion, C Pre-processor, Standard Library Functions and return types.		
UNIT-V	**POINTERS , ARRAYS AND STRUCTURES**	6
Pointers and addresses, Pointers and Function Arguments, Pointers and Arrays, Address Arithmetic, character Pointers and Functions, Pointer Arrays, Pointer to Pointer, Multi-dimensional arrays, Strings, Initialisation of Pointer Arrays, Command line arguments, Pointers to functions, complicated declarations. Basic Structures, Structures and Functions, Array of structures, Pointer of Structures, Self-referential Structures, Table look up, Typedef, Unions, Bit-fields, File Access -Error Handling, Line I/O, Miscellaneous Functions.		
	Contact Hours : 30	

List of Experiments				
1	Algorithm and flowcharts of small problems like GCD.			
Structured code writing with:				
2	Small but tricky codes			
3	Proper parameter passing			
4	Command line Arguments			
5	Variable parameter			
6	Pointer to functions			
7	User defined header			
8	Make file utility			
9	Multi file program and user defined libraries			
10	Interesting substring matching / searching programs			
11	Parsing related assignments			
		Contact Hours	**:**	**60**
		Total Contact Hours	**:**	**90**

Course Outcomes:	
●	To formulate simple algorithms for arithmetic and logical problems.
●	To implement conditional branching, iteration and recursion.
●	To decompose a problem into functions and synthesize a complete program using divide and conquer approach.
●	To use arrays, pointers and structures to formulate algorithms and programs.
●	To apply programming to solve matrix addition and multiplication problems and searching and sorting problems.

Text Books:	
1	Brian W. Kernighan and Dennis M. Ritchie, "The C Programming Language", Pearson Education India; 2nd Edition, 2015.
2	Byron Gottfried, "Programming with C", Second Edition, Schaum Outline Series, 1996.

Reference Books:	
1	Herbert Schildt, "C: The Complete Reference", Fourth Edition, McGraw Hill, 2017.
2	YashavantKanetkar, "Let Us C", BPB Publications, 15th Edition, 2016.

Web links for virtual lab:	
1	https://www.tutorialspoint.com/compile_c_online.php
2	https://www.codechef.com/ide
3	https://www.jdoodle.com/c-online-compiler
4	https://rextester.com/l/c_online_compiler_gcc

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 equipment's – Resistor, colour coding, measurement of AC signal parameter (peak-peak, rms period, frequency) using CRO.		
2	Study of logic gates AND, OR, EXOR 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", SreeSai 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
GE19301	LIFE SCIENCE FOR ENGINEERS	BS	3	0	0	3

Objectives:	
●	Broad objective of this course is to give an introduction of life science to engineering students. The course helps students to familiarize with human physiology, life style diseases and their management and basic diagnostic aspects.

UNIT-I	OVERVIEW OF CELLS AND TISSUES	9
Introduction to Bacteria, virus, fungi and animal cells. Organisation of cells into tissues and organs. Functions of vital organs.		
UNIT-II	**HEALTH AND NUTRITION**	**11**
Balanced diet, Importance of RDA, BMR, and diet related diseases. Role of antioxidants PUFA, DHA, Essential amino acids, Essential fatty acids in diet. Water and its significance for human health. Physical and Mental health – Significance of exercise and yoga.		
UNIT-III	**UNHEALTHY PRACTICES AND THEIR IMPACT ON HEALTH**	**9**
Drug induced toxicity, Unhealthy practices - Drug abuse/Narcotics/Smoking/Alcohol/Self-medication/Undue usage of electronic gadgets.		
UNIT-IV	**COMMON DISEASES AND LIFESTYLE DISORDERS**	**9**
Prevention and management of food, water and airborne illness (Common cold, dehydration, food poisoning etc). Lifestyle disorders – obesity, diabetes, stroke, heart attack, ulcer, renal calculi, cancer, AIDS, hepatitis- prevention and management.		
UNIT-V	**DIAGNOSTIC TESTS AND THEIR RELEVENCE**	**7**
Normal range of biochemical parameters, significance of organ function tests, organ donation.		
	Total Contact Hours : 45	

Course outcomes:
The students at the end of this course, should be able to
• Classify the living organisms and relate the functions of vital organs
• Demonstrate the importance of balanced diet and plan methods for healthy living
• Analyse the hazards of unhealthy practices and take preventive measures
• Categorise the various life style disorders and recommend ways to manage the common diseases
• Evaluate and interpret biochemical parameters and their significance

Text books:
1.Diseases of human body , Carol D Tamparo, Marcia A Lewis , Marcia A, Lewis ,EdD, RN, CMA-AC, F.A Davis Company, 2011.
2.Textbook of Medical Biochemistry ,Chatterjea ; Rana Shinde.
Reference Books
1.Biology for Engineers, Arthur.T.,Johnson, CRC Press, Taylor and Francis, 2011.
2.Cell Biology and Genetics, Cecie Starr, Ralph Taggart, Christine Evers and Lisa Starr, Cengage Learning, 2008.
3. https://nptel.ac.in/courses/122103039/

Subject Code	Subject Name	Category	L	T	P	C
MA19351	**TRANSFORMS AND STATSTICS**	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:		
1. To illustrate the thermodynamic laws and their applications		
2. To make the students to understand second law of thermodynamics and availability.		
3. To make the student to understand basics of ideal and real gases and properties of steam and steam power cycles.		
4. To explain the various refrigeration systems and air compressors used in practice.		
5. 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. Analyze the steam power plant with basic assumptions and find out the efficiency of the system. They can also calculate the properties of real gases using thermodynamics charts.
4. Describe the working principle of different types of refrigeration systems and air compressors
5. Distinguishing the various modes of heat transfer and its applications

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:

1. To understand the basic principles, construction and working of IC engines
2. To understand the concept & working of various fuels systems employed in IC engines
3. To understand the combustion and combustion chamber types in IC engine.
4. To understand the concept of turbocharging, supercharging, and engine testing
5. 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:

1. Students will be able to explain basic construction and Working of IC engines and operating cycles
2. Students will be able to identify and demonstrate various fuel systems employed in automobiles.
3. Students will be able to explain the stages of combustion, types of chambers and various parameters affecting combustion
4. Students will be able to explain turbocharging, and supercharging and to demonstrate about engine testing
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:

1. To understand the fundamental concepts of stress, strain and elastic constants of solids under external loading
2. To learn about the transverse loading and bending loads acting on structural components.
3. To learn about the deformation of shafts subjected to torsion
4. To know about the various methods for calculation deflection of beams
5. To learn about the various stresses acting in shell structures like thin cylinders and spheres.

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 understand the concepts of principal planes and stresses and draw Mohr's circle for the given stress conditions.
2. The students will be able to draw the shear force diagram and bending moment diagram for beams subjected to different loading conditions.
3. The students will be able to calculate the deformation of shafts subjected to torsional loads.
4. The students will be able to calculate the deflection of beams through Macaulay's method, Moment area method and strain energy methods.
5. The students will be able to understand the effect of stresses acting on thin cylinders and spheres and calculate the deformation.

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.	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	The student will able to identify BIS specified symbols for welding joints, riveted joints, keys and fasteners.
2	Students will able to explain the concepts of fits and tolerances
3	The student will able to identify the specification provided in a part drawing prepared for production
4	The student will able to draw various views of a given component in a drafting software (AutoCAD)
5	The student will able to draw assembled/Sectional view of a component in a drafting software (AutoCAD)

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,		
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		
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
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	INTODUCTION TO MANAGMENT	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
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
AT19401	Engineering Materials & Metallurgy	ES	3	0	0	3

Objectives	
1	To impart knowledge on the phase diagram, of alloys.
2	To make the students understand the various heat treatment methods for steels
3	To make the students understand various ferrous and non-ferrous materials
4	To impart the knowledge about various non-metallic materials
5	To impart knowledge on various advanced materials and their applications

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 student will able to identify and read a phase diagrams and salient reactions and constituents in it.
2	The Student will able to select most appropriate heat treat process for required metal characteristics. The student will able to explain various microstructure formation during heat treatment
3	The student will able to distinguish ferrous and nonferrous materials with its characterization and unique application.
4	The student will able to explain the various non-metallic materials unique characteristics and their specific engineering applications
5	The student will able to explain the 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

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

OBJECTIVES:

1. To understand various metal casting process principle and procedure
2. To understand the process principle and application of powder metallurgy and polymer processing
3. To understand the process principle of various types of welding and its applications.
4. To understand the process principles of metal forming techniques.
5. 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

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	**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	**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,

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 understand various metal casting process principle and procedure 2. The students will be able to understand the process principle and application of powder metallurgy and polymer processing. 3. The students will be to understand the process principle of various types of welding and its applications 4. The students will be able to understand the process principles of metal forming techniques. 5. The students will be able to understand 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 K HajraChoudhury and A K HajraChoudhury, Nirjhar Roy, "Elements of WorkshopTechnology Volume I: Manufacturing Processes", Media Publishers and
REFERENCE BOOKS:	
1.	Mikell P Groover, "Fundamentals of Modern Manufacturing Materials processes andsystems"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 SeropeKalpakjian, "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:	
1	The properties of fluids and concept of control volume are studied.
2	The applications of the conservation laws to flow through pipes are studied.
3	To understand the importance of dimensional analysis
4	To understand the importance of various types of flow in pumps
5	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:	
On completion of the course students will be able to	
1	Able to apply mathematical knowledge to predict the properties and characteristics of a fluid.
2	Able to understand the concept of losses during flow of liquid through circular Condit.
3	Able to apply the mathematical knowledge and the properties of fluid for Dimensional Analysis.
4	Able to critically analyze the performance of pumps and its practical applications.
5	Able to critically analyze the performance of turbines and its practical applications.

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:

1. To learn about the types of chassis layout and constructional details of steering systems.
2. To learn about the working principle of transmission and components of driveline system
3. To know about the loads acting on rear axles and the various types of tyres and wheels of an automobile.
4. To know about the necessity, types of suspension systems utilized for automobiles.
5. To understand the need and types of 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 CHASSISLABORATORY:
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 understand the steering geometry and derive the condition for true rolling motion of an automobile
2. The students will have the knowledge about the working of transmission and components of driveline system.
3. The students will able to select the appropriate type of rear axle for a given vehicle and know about the various types of wheels and tires.
4. The students will possess knowledge about the deployment of appropriate type of springs for vehicles.
5. The students will be able to realize the importance of braking systems in a vehicle and possess knowledge about ABS, EBS.

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:
1. To understand the principles in the formation of mechanisms and their kinematics. 2. To understand the fundamental concepts behind gear & power drives. 3. To understand the concepts in cam and gyroscopes. 4. To understand the concepts in balancing in machines. 5. To understand the importance of vibration in machines.

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 calculate the necessary dimensions for a spur gear and speeds of gears in a gear trains also they will be able to calculate the various parameters in a belt drive.
3. The students will be able to generate the cam profile for the given motion of the follower and will be able to apply gyroscopic effect to automobiles.
4. The students will be able to balance the reciprocating and rotating mechanisms.
5. The students will be able to calculate frequency of free, forced and damped vibration in a mechanical system.

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.	L. Balleney, “Theory of Machines and mechanisms”, Khanna Pub. Delhi, 25th edition, 1965
3.	Ambekar A.G., “Mechanism and Machine Theory”, Prentice Hall of India, New Delhi, 2007
4.	AmitabhaGhosh, Asok Kumar Mallik, “Theory of Mechanisms and Machines”, Affiliated East-West Pvt. Ltd., New Delhi, 3rd edition.
5.	RaoJ.S. and Dukkipatti R.V. “Mechanisms and Machines”, Wiley-Eastern Ltd., New Delhi, 1992.
6.	Ramamurthi. V., “Mechanisms of Machine”,Narosa Publishing House, 2002.
7.	Robert L.Norton, “Design of Machinery”, McGraw-Hill, 2004.
8.	John Joseph Uicker, G. R. Pennock, Joseph Edward Shigley, “Theory of Machines and Mechanisms”, Oxford University Press, 2016.
9.	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	
1	To help students break out of shyness.
2	To build confidence
3	To enhance English communication skills.
4	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	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

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 subjected to various types of loading and estimate corresponding stress induced in the machine component
●	The student will able to understand and 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 understand 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:	
●	The students will be able to explain about the global pollution, emission standards and modern drive train technology options.
●	The students can suggest the suitable direct current motor for EV and HEV application.
●	The students can comprehend the AC motors for traction application
●	The students can describe about the advanced motors for powertrain application.
●	The students will be able to compute the various resistances and can estimate the 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

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

OBJECTIVES:

1. To understand the basic principle and types of batteries
2. To understand the basics of starting and ignition systems
3. To understand the basic wiring, lighting and accessories used in vehicles
4. To understand the basic types and working principles of various sensors used in vehicles
5. To understand the various types of actuators along with its application.

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
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 OUTCOMES:

1. The students will be able to explain the basic principle and types of batteries
2. The students will be able to explain the basic principle starting and ignition systems
3. The students will be able to explain the basic wiring, lighting and accessories
4. The students will be able to explain the basic types of sensors and working principles
5. The students will be able to explain the various types of actuators use in vehicles.

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:

1. To understand metal cutting principle and various factors affecting cutting tool life.
2. To understand the working principle and operation capabilities of a turning centre and estimating machining time.
3. To understand the working principle and various process capabilities of shaper and milling machine.
4. To understand working principle and applications of Abrasive machining and broaching machining.
5. To understand the process principle and capabilities of various unconventional machining processes and concept of using various jigs and fixtures.

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	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 understand metal cutting principle and various factors affecting cutting tool life.
2. The students will be able to understand the working principle and various operations performed at turning centers with machining time estimation.
3. The students will be to understand the working principle and various process capabilities of shaper and milling machine
4. The students will be able to understand working principle and applications of Abrasive machining and broaching machining
5. The students will be able to understand the process principle and capabilities of various unconventional machining processes and concept of using various jigs and fixtures.

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:	
●	Graduates will have basic knowledge in testing of two-wheeler vehicles.
●	They will be able to dismantle and assemble of clutch and brake system used in two and three-wheeler vehicles.
●	They will be able to dismantle and assemble of two and three-wheeler gear boxes and find the gear ratios used.
●	They will be able to measuring the dimensions of three-wheeler chassis.
●	They will be able to dismantle and assemble of front fork assembly used in 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 of 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:	
●	The student are able to draw the various resistances acting on a vehicle using Matlab
●	The students are able to demonstrate the characteristic curves for the power, torque, tractive effort and acceleration with respect to vehicle speed for any given vehicle specification
●	The students are able to plot the various efficiencies and p-V diagram for any given vehicle specification.
●	The students are able to plot the velocity and acceleration diagram of piston using software.
●	The students are able to plot 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	
1	To help students break out of shyness.
2	To build confidence
3	To enhance English communication skills.
4	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 around the class and talk to other students and invite them.	The aim of this activity is to develop the art of conversation among students. It also aims at practicing the 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 Ad for a challenging topic only using fictional characters.	The activity aims at 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 understand 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.
  The students can explain the various testing standards and electromagnetic interference and 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 about various traction batteries, their performance and charging techniques.
- The students can estimate the state of the battery and can explain about the cell balancing techniques and also about the thermal management in traction batteries.
- The students can describe about various fuel cell and their suitability for electric and hybrid vehicle application.
- The students can elucidate the various high power switching devices and their operating characteristics in electric and hybrid vehicles.
- The students can explain the various testing standards and electromagnetic interference and 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.

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.
•	To understand the design procedure and calculation of valve train.
•	To know about the various load acting on axles and steering system
•	To identify the various load acting on vehicle frame and suspension system

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	**FRONTAXLE, 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	

Course Outcomes: On completion of the course students will be able to	
●	To calculate and analyse the various calculation for design of cylinder, piston and connecting rod
●	To calculate and explain the design procedure of crankshaft.
●	To choose the materials for valve and to design valve operating components.
●	To describe and calculate the various load acting on axles and steering system.
●	To demonstrate the various load acting on vehicle frame and suspension system.

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 understand the design features of the given component
2. The students will be able to create the 3D model of the connecting rod and crankshaft assembly
3. The students can create 3D models of engine flywheel and valve with fine details
4. The students will be able to create 3D models of engine valves, manifolds and propeller shaft and valve with fine details
5. The students will be able to write the CNC part programming for the given component

TEXT BOOKS:

1. K. L. Narayana - Machine drawing, New Age International,2009.
2. 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 understand the conventional fuels for IC engines, its production, additives and characteristics of fuels
•	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	
●	Explain the distillation process, additives for fuels and characteristics of fuels.
●	Discuss the need and performance characteristics of alternative liquid fuels for both SI and CI engines.
●	Describe the need and performance characteristics of alternative gaseous fuels for both SI and CI engines
●	Calculate and analyse A/F ratio for the engine operating conditions and also can estimate quantitatively the exhaust gas constituents.
●	Explain the need for lubricants, factors influencing the engine lubrication and testing of fuels.

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:

1. To understand the concept of vibration and to measure the same.
2. To understand the various forces acting on tires and performance of tire.
3. To understand the various vertical forces acting on a vehicle
4. To understand the various longitudinal forces acting and control on a vehicle
5. To understand the 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 vibration.
2.The students will be able to design and analysis of suspension, various forces acting on tyres and performance of tire.
3.The students will be able to explain the various vertical forces acting on a vehicle
4.The students will be able to describe the various longitudinal forces acting on a vehicle
5.The students will be able to explain the various lateral forces acting on a vehicle.

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.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 FOR AUTOMOBILE ENGINEERS	EEC	0	0	4	2

UNIT I INTRODUCTION **6**

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 **6**

Introduction - Create Thinking - Generating Design Ideas - Lateral Thinking –Anologies – 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 **6**

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 **6**

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 AND DEPLOYMENT **36**

Applying innovation and design thinking concepts in Automobile Engineering projects.

Procedure and Evaluation of Project:

The students may be grouped into 2 to 4 and work under a project supervisor. The device / system / component(s) to be designed may be decided in consultation with the supervisor and if possible with an industry. A project report to be submitted by the group with Title, Aim of the Project, Research Methodology, Component Design and Design calculations for the model to be fabricated, which will be reviewed and evaluated for internal assessment by a Committee constituted by the Head of the Department. At the end of the semester examination, 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.

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.

Total : 60 Periods

PROFESSIONAL ELECTIVE – I

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

OBJECTIVES:

1. To understand the need and types of clutches and gearboxes
2. To understand the basic construction and working of hydrodynamic transmission systems
3. To understand the need of epicyclic gear and its working principle
4. To understand the applications of automatic transmission
5. To understand the basic principles and working 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 understand the need and types of clutches and gearboxes.
2.The students will be able to understand the construction and working of hydrodynamic transmission system
3.The students will be able to understand the need and 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 understand 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.https://nptel.ac.in › courses
6.https://nptel.ac.in › courses

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 &Heat Conduction through wall, pipes & cylinders etc
●	To understand 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 understand 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:	
●	The student will able to evaluate the amount of heat transfer across surfaces due to conduction and various interface temperature
●	The student will able to evaluate the amount of heat transfer over various surfaces due to convection and the interacting fluid temperature.
●	The student will able to evaluate the amount of heat transfer over various surfaces due to radiation and shape factor responsible for radiation.
●	The student will able to evaluate assess the performance of various heat exchangers by NTU and LMTD method
●	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:	
●	The student can understand the various systems of engines of two and three wheelers
●	The student can understand importance of various frames and the working of power transmission in a two and three-wheelers
●	The student can understand the working of suspension systems, brakes, wheels and tyres in two and three wheelers
●	The student can understand the construction of batteries and possess knowledge about the spark plugs and other electrical accessories
●	The student can understand 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

- Ability to understand the importance of mathematical modeling of a system
- Ability to Demonstrate the concept and needs of feedback control systems and its application
- Ability to Determine the response of different order systems for various step inputs
- Ability to Determine the (absolute) stability of a closed-loop control system
- Ability to understand 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., 5th 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. 6th 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.