KUMARAGURU COLLEGE OF TECHNOLOGY

(An autonomous Institution affiliated to Anna University, Chennai)

COIMBATORE – 641 049

B.E., AUTOMOBILE ENGINEERING

REGULATION 2018

CURRICULUM AND SYLLABUS

I to VIII Semesters

(Version, V1.1)

Applicable 2020 Batch onwards

DEPARTMENT OF AUTOMOBILE ENGINEERING

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DEPARTMENT OF AUTOMOBILE ENGINEERING

Vision

To be a renowned Learning Centre in the field of Automobile Engineering contributing towards development of the society.

Mission

- Develop students for successful careers in Industry, and Academia.
- Provide required learning environment and processes to become socially responsible Engineering Professionals.
- Establish Industry-Institute interaction.
- Inculcate the entrepreneurial mind set among the students.

Program Educational Objectives (PEO's)

Graduates will be able to

1. Design and develop products, utilize their knowledge and skills as engineer / start their own ventures as entrepreneurs
2. Practice managerial leadership roles with values and social responsibility.
3. Pursue higher studies and research in core, allied fields and management.

Program Outcomes (PO's)

The following are the program outcomes:

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

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4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, 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)

Graduates will be able to

PSO 1: provide solutions for designing safe and affordable automotive and mobile equipment.

PSO 2: explore the Automotive Manufacturing, Automotive Electrical & Electronics, vehicle maintenance and service domains.

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DEPARTMENT OF AUTOMOBILE ENGINEERING

B.E., AUTOMOBILE ENGINEERING

CURRICULUM- REGULATION- 2018

SEMESTER 1

S.No	Course Code	Course Name	Course Mode	CT	L	T	P	J	C	Pre-requisite
1	U18MAI1201	Linear Algebra and Calculus	Embedded - Theory & Lab	BS	3	0	2	0	**4**	Nil
2	U18ENI1201	Fundamentals of Communication -I	Embedded - Theory & Lab	HS	2	0	2	0	**3**	Nil
3	U18CHI1201	Engineering Chemistry	Embedded - Theory & Lab	ES	3	0	2	0	**4**	Nil
4	U18CSI1202	Problem Solving and Programming using C	Embedded - Theory & Lab	BS	2	0	2	0	**3**	Nil
5	U18MEI1201	Engineering Graphics	Embedded - Theory & Lab	ES	2	0	2	0	**3**	Nil
6	U18INI1600	Engineering Clinic I	Embedded - Practical & Project	ES	0	0	4	2	**3**	Nil
Total Credits									**20**	
Total Contact Hours/week									**28**	

SEMESTER 2

S.No	Course Code	Course Name	Course Mode	CT	L	T	P	J	C	Pre-requisite
1	U18MAI2201	Advanced Calculus and Laplace Transforms	Embedded – Theory & Lab	BS	3	0	2	0	**4**	U18MAI1201
2	U18ENI2201	Fundamentals of Communication-II	Embedded – Theory & Lab	HS	2	0	2	0	**3**	Nil
3	U18PHI2201	Engineering Physics	Embedded – Theory & Lab	ES	3	0	2	0	**4**	Nil
4	U18CSI2201	Python Programming	Embedded – Theory & Lab	ES	2	0	2	0	**3**	Nil
5	U18MET2003	Engineering Mechanics	Theory	ES	3	0	0	0	**3**	Nil
6	U18MEP2501	Engineering Practices Laboratory	Lab	ES	0	0	2	0	**1**	Nil
7	U18INI2600	Engineering Clinic II	Embedded - Practical & Project	ES	0	0	4	2	**3**	U18INI1600
Total Credits									**21**	
Total Contact Hours/week									**29**	

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SEMESTER 3

S.No	Course Code	Course Name	Course Mode	CT	L	T	P	J	C	Pre-requisite
1	U18MAT3101	Partial Differential Equations and Transforms	Theory	BS	3	1	0	0	4	Nil
2	U18AUI3201	Automotive Chassis and Transmission	Embedded – Theory & Lab	PC	3	0	2	0	4	Nil
3	U18AUI3202	Strength of Materials	Embedded – Theory & Lab	PC	3	0	2	0	4	Nil
4	U18AUT3103	Thermodynamics and Thermal Engineering	Theory	ES	3	1	0	0	4	Nil
5	U18AUT3004	Materials and Metallurgy	Theory	ES	3	0	0	0	3	Nil
6	U18INI3600	Engineering Clinic III	Embedded - Practical & Project	ES	0	0	4	2	3	Nil
Total Credits									**22**	
Total Contact Hours/week									**27**	

SEMESTER 4

S.No	Course Code	Course Name	Course Mode	CT	L	T	P	J	C	Pre-requisite
1	U18MAT4101	Numerical Methods and Probability	Theory	BS	3	1	0	0	**4**	Nil
2	U18AUI4201	Automotive Engines and Systems	Embedded – Theory & Lab	PC	3	0	2	0	**4**	U18AUT3103
3	U18AUI4202	Fluid Mechanics and Machinery	Embedded – Theory & Lab	PC	3	0	2	0	**4**	Nil
4	U18AUI4203	Manufacturing Technology	Embedded – Theory & Lab	PC	3	0	2	0	**4**	Nil
5	U18AUI4204	Machine Drawing	Embedded – Theory & Lab	PC	3	0	2	0	**4**	Nil
6	U18AUT4005	Automotive Electrical Engineering	Theory	PC	3	0	0	0	**3**	Nil
7	U18INI4600	Engineering Clinic IV	Embedded - Practical & Project	ES	0	0	4	2	**3**	U18INI3600
Total Credits									**26**	
Total Contact Hours/week									**33**	

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SEMESTER 5

S.No	Course Code	Course Name	Course Mode	CT	L	T	P	J	C	Pre-requisite
1	U18AUT5001	Automotive Electronics	Theory	PC	3	0	0	0	**3**	Nil
2	U18AUT5102	Design of Machine Elements	Theory	PC	3	1	0	0	**4**	U18AUI3202
3	U18AUT5103	Mechanics of Machines	Theory	PC	3	1	0	0	**4**	Nil
4	U18AUI5204	Finite Element Analysis	Embedded – Theory & Lab	PC	3	0	2	0	**4**	U18MAT4101
5	U18AUP5505	Automotive Electrical and Electronics Engineering Laboratory	Practical	PC	0	0	2	0	**1**	U18AUT4005
6	U18_____	Open Elective - I	Theory	OE	3	0	0	0	**3**	--
7	U18INI5600	Engineering Clinic V	Embedded - Practical & Project	ES	0	0	4	2	**3**	U18INI4600
Total Credits									**22**	
Total Contact Hours/week									**27**	

SEMESTER 6

S.No	Course Code	Course Name	Course Mode	CT	L	T	P	J	C	Pre-requisite
1	U18AUI6201	Automotive Embedded Systems	Embedded – Theory & Lab	PC	3	0	2	0	**4**	U18AUT5001
2	U18AUI6202	Vehicle Dynamics	Embedded – Theory & Lab	PC	3	0	2	0	**4**	U18AUT5103
3	U18AUT6003	Vehicle Body Engineering	Theory	PC	3	0	0	0	**3**	U18AUI3201
4	U18AUT6004	Total Quality Management and Project Management	Theory	HS	3	0	0	0	**3**	Nil
5	U18AUE__	Professional Elective – I	Theory	PE	3	0	0	0	**3**	--
6	U18__	Open Elective - II	Theory	OE	3	0	0	0	**3**	--
Total Credits									**20**	
Total Contact Hours/week									**22**	

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SEMESTER 7

S.No	Course Code	Course Name	Course Mode	CT	L	T	P	J	C	Pre-requisite
1	U18AUI7201	Vehicle Maintenance and Reconditioning	Embedded – Theory & Lab	PC	2	0	2	0	**3**	U18AUI3201
2	U18AUT7002	Automotive Emissions	Theory	PC	3	0	0	0	**3**	U18AUI4201
3	U18AUT7003	Hybrid and Electric Vehicles	Theory	PC	3	0	0	0	**3**	U18AUT4005
4	U18AUE__	Professional Elective –II	Theory	PE	3	0	0	0	**3**	--
5	U18AUE__	Professional Elective –III	Theory	PE	3	0	0	0	**3**	--
6	U18AUE__	Professional Elective –IV	Theory	PE	3	0	0	0	**3**	--
7	U18AUP7703	Project Work - Phase I	Project only Course	PW	0	0	0	6	**3**	--
Total Credits									**21**	
Total Contact Hours/week									**25**	

SEMESTER 8

S.No	Course Code	Course Name	Course Mode	CT	L	T	P	J	C	Pre-requisite
1	U18AUP8701	Project Work - Phase II	Project only Course	PW	0	0	0	24	12	--
Total Credits									**12**	
Total Contact Hours/week									**24**	

Total Credits	**167**

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List of mandatory courses						
S.No	**Couse Code**	**Course Title**	**Course Mode**	**CT**	**Credits**	**Semester**
1	U18CHT3000	Environmental Science and Engineering	Theory	MC	0	3
2	U18INT4000	Constitution of India	Theory	MC	0	4
3	U18VET3101 / U18VET4101	Universal Human Values 2: Understanding Harmony	Theory	MC	3	3/4

PROFESSIONAL ELECTIVES

Automotive Design

S.No	Course Code	Course Name	Course Mode	CT	L	T	P	J	C	Pre-requisite
1	U18AUE0001	Design of Engine Components	Theory	PE	3	0	0	0	**3**	U18AUI3202 U18AUI4201 U18AUT5102
2	U18AUE0002	Design of Chassis Components	Theory	PE	3	0	0	0	**3**	U18AUI3201 U18AUI3202
3	U18AUE0003	Computational Fluid Dynamics	Theory	PE	3	0	0	0	**3**	U18AUI4202
4	U18AUE0004	Computer Simulation of IC Engine Processes	Theory	PE	3	0	0	0	**3**	U18AUI4201

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Automotive Manufacturing

S.No	Course Code	Course Name	Course Mode	CT	L	T	P	J	C	Pre-requisite
1	U18AUE0005	Automotive Components Manufacturing	Theory	PE	3	0	0	0	**3**	U18AUI4203
2	U18AUE0006	Design for Manufacture and Assembly	Theory	PE	3	0	0	0	**3**	U18AUI4203
3	U18AUE0007	Composite Materials and Structures	Theory	PE	3	0	0	0	**3**	U18AUT3004
4	U18AUE0008	Additive Manufacturing and Tooling	Theory	PE	3	0	0	0	**3**	Nil

Automotive Electrical and Electronics

S.No	Course Code	Course Name	Course Mode	CT	L	T	P	J	C	Pre-requisite
1	U18AUE0009	Automotive Control System	Theory	PE	2	0	2	0	**3**	U18AUI6201
2	U18AUE0010	Auxiliary Vehicle Systems	Theory	PE	3	0	0	0	**3**	Nil
3	U18AUE0011	Fuel Cell Technology	Theory	PE	3	0	0	0	**3**	Nil
4	U18AUE0012	Automotive Communication Protocols	Theory	PE	3	0	0	0	**3**	Nil
5	U18AUE0013	Intelligent Vehicle Technology	Theory	PE	3	0	0	0	**3**	Nil
6	U18AUE0021	Advanced STM32 Microcontroller and Embedded C Programming	Theory	PE	3	0	0	0	**3**	U18AUI6201

Automotive Technology and Management

S.No	Course Code	Course Name	Course Mode	CT	L	T	P	J	C	Pre-requisite
1	U18AUE0014	Off Road Vehicles	Theory	PE	3	0	0	0	3	Nil
2	U18AUE0015	Tyre Technology	Theory	PE	3	0	0	0	3	Nil
3	U18AUE0016	Vehicle Testing and Validation	Theory	PE	3	0	0	0	3	Nil
4	U18AUE0017	Entrepreneurship Development	Theory	PE	3	0	0	0	**3**	Nil
5	U18AUE0018	Vehicle Transport Management	Theory	PE	3	0	0	0	**3**	Nil

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S.No	Course Code	Course Name	Course Mode	CT	L	T	P	J	C	Pre-requisite
6	U18AUE0019	Applied Hydraulics and Pneumatics	Theory	PE	3	0	0	0	**3**	U18AUI4202
7	U18AUE0020	Automotive Aerodynamics	Theory	PE	3	0	0	0	**3**	U18AUI4202
8	U18AUE0022	Product Design and Development	Theory	PE	3	0	0	0	**3**	Nil
9	U18AUE0023	Product Lifecycle Management	Theory	PE	2	0	2	0	**3**	Nil

ONE CREDIT COURSES

S.No	Course Code	Course Name
1	U18AUC0001	Motorsports Engineering
2	U18AUC0002	Automotive Styling
3	U18AUC0003	Electronic Engine Management Systems
4	U18AUC0004	Intellectual Property Rights
5	U18AUC0005	Vehicle Maintenance
6	U18AUC0006	Lean Manufacturing

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SEMESTER 1

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U18MAI1201

LINEAR ALGEBRA AND CALCULUS
(Common to All branches)

L	T	P	J	C
3	0	2	0	**4**

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Identify eigenvalues and eigenvectors and apply Cayley Hamilton theorem.
CO2: Apply orthogonal diagonalisation to convert quadratic form to canonical form.
CO3: Solve first order ordinary differential equations and apply them to certain physical situations.
CO4: Solve higher order ordinary differential equations.
CO5: Evaluate the total derivative of a function, expand the given function as series and locate the maximum and minimum for multivariate function.
CO6: Determine Rank, Inverse, Eigenvalues, Eigenvectors of the given matrix, Maxima-Minima of the function and Solving Differential equations using MATLAB

Pre-requisite:

1 NIL

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S	S			M				M	M		M		
CO2:	S	S			M				M	M		M		
CO3:	S	S			M				M	M		M		
CO4:	S	S			M				M	M		M		
CO5:	S	S			M				M	M		M		
CO6:	S	S			M				M	M		M		

Course Assessment methods:

	Direct		Indirect
1	Continuous Assessment Test I, II (Theory component)	**1**	Course Exit Survey
2	Open Book Test; Cooperative Learning Report, Assignment; Journal Paper Review, Group Presentation, Project Report, Poster Preparation, Prototype or Product		
3	Demonstration etc (as applicable) (Theory component)		
4	Pre/Post - Experiment Test/Viva; Experimental Report for each Experiment (lab Component)		
5	Model Examination (lab component)		
6	End Semester Examination (Theory and lab components)		

THEORY COMPONENT

MATRICES **L: 6 Hrs**

Rank of a matrix – Consistency of a system of linear equations - Rouche's theorem - Solution of a system of linear equations - Linearly dependent and independent vectors– Eigenvalues and Eigenvectors of a real matrix – Properties of eigenvalues and eigenvectors – Cayley Hamilton theorem (excluding proof)

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DIAGONALISATION OF A REAL SYMMETRIC MATRIX **L: 6 Hrs**

Orthogonal matrices – Orthogonal transformation of a symmetric matrix to diagonal form – Reduction of quadratic form to canonical form by orthogonal transformation.

FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS **L: 11 Hrs**

Leibnitz's equation – Bernoulli's equation – Equations of first order and higher degree - Clairauts form – Applications: Orthogonal trajectories.

HIGHER ORDER LINEAR DIFFERENTIAL EQUATIONS **L: 11 Hrs**

Linear equations of second and higher order with constant coefficients – Euler's and Legendre's linear equations – Method of variation of parameters – First order Simultaneous linear equations with constant coefficients – Applications.

FUNCTIONS OF SEVERAL VARIABLES **L: 11 Hrs**

Total derivative – Taylor's series expansion – Maxima and minima of functions of two variables – Constrained maxima and minima: Lagrange's multiplier method with single constraints – Jacobians.

Practical

List of MATLAB Programmes: **P: 30 Hrs**

1. Introduction to MATLAB.
2. Matrix Operations - Addition, Multiplication, Transpose, Inverse
3. Rank of a matrix and solution of a system of linear equations
4. Characteristic equation of a Matrix and Cayley-Hamilton Theorem.
5. Eigenvalues and Eigenvectors of Higher Order Matrices
6. Curve tracing
7. Solving first order ordinary differential equations.
8. Solving second order ordinary differential equations.
9. Determining Maxima and Minima of a function of one variable.
10. Determining Maxima and Minima of a function of two variables.

Theory : 45 Hrs	Practical: 30 Hrs	**Total Hours: 75**

References:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 41st Edition, 2011.
2. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., New Delhi, 11th Reprint, 2010.
3. Kreyzig E., "Advanced Engineering Mathematics", Tenth Edition, John Wiley and sons, 2011.
4. Veerarajan T., Engineering Mathematics (for First Year), Tata McGraw Hill Pub. Co. Ltd., New Delhi, Revised Edition, 2007
5. Kandasamy P., Thilagavathy K., and Gunavathy K., "Engineering Mathematics", S. Chand & Co., New Delhi, (Reprint) 2008
6. Venkataraman M.K., "Engineering Mathematics", The National Pub. Co., Chennai,2003
7. Weir, MD, Hass J, Giordano FR: Thomas' Calculus, Pearson education 12th Edition, 2015
8. P.Bali., Dr. Manish Goyal., Transforms and partial Differential equations, University Science Press, New Delhi, 2010
9. G.B.Thomas and R.L.Finney, Calculus and analytical geometry, 11th Edition, PearsonEducation, (2006)

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U18ENI1201 FUNDAMENTALS OF COMMUNICATION-I

L	T	P	J	C
2	0	2	0	**3**

Course Objectives:

1. To communicate effectively by using appropriate grammar and technical parlance in a range of academic scenarios.
2. To interpret and critically evaluate discourses related to functional English.
3. To disseminate professional information through appropriate means of communication.

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Communicate in English with correct grammar
CO2: Communicate effectively (Oral and Written)
CO3: Use communication skills in the real world

Pre-requisite:

1 NIL

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:										S		S		
CO2:		M		W		W			M	S		S		
CO3:		M		M		W			M	S		S		

Course Assessment methods:

Direct		Indirect	
1	Continuous Assessment of Skills	**1**	Course Exit Survey
2	Assignment		
3	Written Test		
4	End Semester Examination		

S.No	Topic	Hours
	MODULE I - 12 Hrs	
1.1	Parts of Speech	2
1.2	Subject Verb Agreement	2
1.3	Speak up (Self Introduction, JAM)	4
1.4	Writing sentences using 'Be-forms'	3
1.5	Test	1
	MODULE II - 12Hrs	
2.1	Articles, Gerunds, Infinitives	2
2.2	Speak up (Greetings & Polite English)	4
2.3	Dialogue Writing	3
2.4	Skimming & Scanning	2
2.5	Listening Skills - I	1

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MODULE III - 12 Hrs		
3.1	Tenses & Voice	2
3.2	Sentences & its kinds	2
3.3	Speak up (Narration & Description)	4
3.4	Summarizing & Note-making	3
3.5	Listening Skills - II	1
MODULE IV - 12 Hrs		
4.1	Framing Questions – 4 types	2
4.2	Speak up (Role play)	4
4.3	Letter writing – Formal and Informal & Email Writing	3
4.4	Reading Comprehension & Cloze test	2
4.5	Listening Skills - III	1
MODULE V - 12 Hrs		
5.1	Degrees of Comparison	2
5.2	Clauses	2
5.3	Speak up (Power Point Presentation)	4
5.4	Writing (Picture perception)	3
5.5	Test	1
Total		**60**

References:

1 A Modern Approach to Non Verbal Reasoning (English, Paperback, Dr. R S Aggarwal)
2 The Power of Words(Bloomsbury, UK, 2012, Hyacinth Pink)
3 Word Power Made Easy: The Complete Handbook for Building a Superior Vocabulary (By Norman Lewis)
4 Effective Technical Communication Tata Mc Graw Hills Publications (Ashraf Rizvi)
5 English and Soft skills Orient Black Swan Publishers (S. P. Dhanavel)
6 Know Your Grammar: Trans.in Tamil & Malayalam –A Bilingual Approach (Bloomsbury, UK, 2012, Hyacinth Pink)

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U18CHI1201

ENGINEERING CHEMISTRY
(Common to All Branches)

L	T	P	J	C
3	0	2	0	**4**

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Apply the basic principles of chemistry at the atomic and molecular level.
CO2: Analyze the impact of engineering solutions from the point of view of chemical principles
CO3: Apply the chemical properties to categorize the engineering materials and their uses
CO4: Integrate the chemical principles in the projects undertaken in field of engineering and technology
CO5: Develop analytical proficiency through lab skill sets to demonstrate in professional practice.

Pre-requisite:

1 NIL

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S	M												
CO2:	S	M		M										
CO3:	S	M		S										
CO4:	S	M		S										
CO5:	M	S		S										

Course Assessment methods:

	Direct		Indirect
1	Continuous Assessment Test I, II	**1**	Course Exit Survey
2	Open book test; Cooperative learning report, Assignment; Journal paper review, Group		
3	Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc (as applicable)		
4	End Semester Examination		

Theory Component

CHEMICAL BONDING **L: 7 Hrs**

Bonding: Introduction – Ionic bonding - Van der Waal's forces (dipole - dipole, dipole - induced dipole, induced dipole - induced dipole interactions) - hydrophobic interaction.

Bonding in organic molecules: covalent and co-ordinate bonds (overview only) - hybridization (sp, sp2, sp3) - hydrogen bonding and its consequences.

THERMODYNAMICS **L: 7 Hrs**

Introduction - Thermodynamic process – Internal energy – Enthalpy – limitations of First law of thermodynamics – Second law of thermodynamics - Entropy - Third law of thermodynamics – Free

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Energy and Work Function – Clausius-Clapeyron equation – Maxwell's relations – Kirchhoff's equation.

ELECTROCHEMISTRY AND CORROSION **L: 7 Hrs**

Electrodes - Electrode Potential – Nernst equation and problems - Galvanic cell - Electrochemical Series.

Corrosion: Classification and mechanism of chemical and electrochemical corrosion - Factors influencing corrosion

Corrosion control: Inhibitors – Cathodic protection (Sacrificial anodic protection, Impressed current cathodic protection) – Protective coating: Electroplating (Au) and Electroless plating (Ni).

WATER TECHNOLOGY **L: 6 Hrs**

Introduction - soft/hard water - Disadvantages of hard water in industries– scale, sludge, priming and foaming, caustic embrittlement.

Treatment of hard water: External treatment (Ion exchange method) - Internal treatment (colloidal, carbonate, phosphate and calgon conditioning) - Desalination (Reverse osmosis, Electrodialysis)

ENGINEERING MATERIALS **L: 9 Hrs**

Polymer: Introduction – Preparation, Properties and Applications of PMMA, PET, PVC.

Composites: Constituents of Composites – Polymer Composites - Metal Matrix Composites - Ceramic Matrix Composites – Applications

Lubricants: Classification - Functions - Properties (viscosity index, flash and fire point, oiliness, carbon residue, aniline point, cloud point and pour point) - Semi solid lubricant (greases with calcium based, sodium based, lithium based) - Solid lubricants (graphite, molybdenum disulphide)

SURFACE CHEMISTRY AND CATALYSIS **L: 9 Hrs**

Adsorption: Types of adsorption – Adsorption isotherms: Freundlich's adsorption isotherm – Langmuir's adsorption isotherm – Applications of adsorption on pollution abatement.

Catalysis: Catalyst – catalytic poisoning and catalytic promoters - autocatalysis –- acid base catalysis – enzyme catalysis – Michaelis-Menten equation – applications.

Chemical kinetics: Introduction – first order, pseudo first order, second order, zero order equations – parallel reactions – opposing reactions.

Practical

List of Exercises : **P: 30 Hrs**

1 Preparation of Standard solutions
2 Conductometric estimation of mixture of acids vs strong base
3 Estimation of extent of corrosion of Iron pieces by Potentiometry
4 Estimation of the extent of dissolution of Copper / Ferrous ions by spectrophotometry.
5 Estimation of acids by pH metry.
6 Determination of total, temporary and permanent hardness by EDTA method.
7 Estimation of DO by Winkler's method

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8 Estimation of Alkalinity by Indicator method.
9 Estimation of Chloride by Argentometric method
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 relative and kinematic viscosities of lubricating oil at different temperatures
14 Determination of corrosion rate on mild steel by Weight loss method
15 Morphological studies of corrosion on mild steel by microscopic techniques

Theory : 45 Hrs	Practical: 30 Hrs	**Total Hours: 75**

References:

1 Jeffery G.H., Bassett J., Mendham J. and Denny R.C., Vogel's Text Book of Quantitative Chemical Analysis, Oxford, ELBS, London,2012.
2 Shoemaker D.P. and C.W. Garland., Experiments in Physical Chemistry, Tata McGraw-Hill Pub. Co., Ltd., London,2003.

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U18CSI1202 **PROBLEM SOLVING AND PROGRAMMING USING C**

L	T	P	J	C
2	0	2	0	**3**

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Acquire knowledge on different problem solving techniques.
CO2: Use appropriate data types and control structures for solving a given problem.
CO3: Execute different array and string operations.
CO4: Experiment with the usage of pointers and functions.
Organize data using structures and unions.
CO5: Acquire knowledge on different problem solving techniques.

Pre-requisite:

1 NIL

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S	M							L					
CO2:	S	M							L	L				
CO3:	S	L			L	L			L	L		L		
CO4:	M	L	M	**L**	L	L			L	L		M		
CO5:	M	L	M	**L**	L	L			L	L		M		

Course Assessment methods:

Direct		**Indirect**	
1	Continuous Assessment Test I, II (Theory Component)	**1**	Course end survey
2	Assignment (Theory Component)		
3	Group Presentation (Theory Component)		
4	Pre/Post - experiment Test/Viva; Experimental Report for each experiment (lab component)		
5	Model examination (lab component)		
6	End Semester Examination (Theory and lab component)		

Theory Component

STRUCTURED PROGRAMMING **L: 6 Hrs**

Algorithms, building blocks of algorithms (instructions/statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple

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strategies for developing algorithms (iteration). Introduction to C Programming – Operators and Expressions – Data Input and Output – Control Statements.

ARRAYS AND STRINGS **L: 6 Hrs**

Defining an array – Processing an array –Multidimensional Arrays Character Arithmetic – Defining a string – Initialization of Strings – Reading and Writing Strings – Processing Strings –Searching and Sorting of Strings

FUNCTIONS, STORAGE CLASSES **L: 6 Hrs**

Defining a function – Accessing a function – Function prototypes – Passing arguments to a function – Passing arrays to functions – Function with string - Recursion – Storage classes

POINTERS **L: 6 Hrs**

Pointer Fundamentals – Pointer Declaration – Passing Pointers to a Function – Pointers and one dimensional arrays – operations on pointers– Dynamic memory allocation.

STRUCTURES AND UNIONS **L: 6 Hrs**

Structures and Unions: Defining a Structure – Processing a Structure – User defined data types (Typedef) – Unions

Practical

List of Exercises : **P: 30 Hrs**

1. Writing algorithms, flowcharts and pseudo codes for simple problems.
2. Programs on expressions and conversions
3. Programs using if, if-else, switch and nested if statements
4. Programs using while, do-while, for loops
5. Programs on one dimensional arrays, passing arrays to functions and array operations
6. Programs using two dimensional arrays, passing 2D arrays to functions
7. Programs using String functions
8. Programs using function calls, recursion, call by value
9. Programs on pointer operators, call by reference, pointers with arrays
10. Programs using structures and unions.

Theory : 30 Hrs	Practical: 30 Hrs	**Total Hours: 60**

References:

1. Byron S Gottfried and Jitendar Kumar Chhabra, “Programming with C”, Tata McGraw Hill Publishing Company, Third Edition, New Delhi, 2011.
2. Pradip Dey and Manas Ghosh, “Programming in C”, Second Edition, Oxford University Press, 2011.
3. Kernighan,B.W and Ritchie,D.M, “The C Programming language”, Second Edition, Pearson Education, 2006
4. Ashok N. Kamthane, “Computer programming”, Pearson Education, 2007.
5. Reema Thareja, “Programming in C”, Second Edition, Oxford University Press, 2011.

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U18MEI1201 **ENGINEERING GRAPHICS**

L	T	P	J	C
2	0	2	0	**3**

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Construct various plane curves.
CO2: Construct projection of points and projection of lines.
CO3: Develop projection of surfaces and solids.
CO4: Solve problems in sections of solids and development of surfaces.
CO5: Apply free hand sketching and concepts of isometric in engineering practice.
CO6: Draw engineering drawing in AutoCAD with dimensions.

Pre-requisite:

1 NIL

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S	M										S	M	
CO2:	S	S									W	S	M	
CO3:	S	S									M	S	S	
CO4:	S	S										S	S	
CO5:	S	S										S	S	
CO6:	S											S	S	

Course Assessment methods:

	Direct		Indirect
1	Continuous Assessment Test I, II (Theory Component)	**1**	Course end survey
2	Assignment (Theory Component)		
3	Viva, Experimental Report for each Experiment (lab Component)		
4	Model examination (lab component)		
5	End Semester Examination (Theory and lab components)		

Theory Component

PLANE CURVES, PROJECTION OF POINTS, LINES AND PLANES L: 10 Hrs

Importance of graphics in design process, visualization, communication, documentation and drafting tools, Construction of curves - ellipse, parabola, and hyperbola by eccentricity method only. Orthographic projection of points.

Projections of straight lines located in first quadrant - determination of true length and true inclinations. Projections of plane surfaces - polygonal lamina and circular lamina, located in first quadrant and inclined to one reference plane.

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PROJECTION AND SECTION OF SOLIDS **L: 10 Hrs**

Projection of simple solids - prism, pyramid, cylinder and cone. Drawing views when the axis of the solid is inclined to one reference plane.

Sectioning of simple solids - prisms, pyramids, cylinder and cone. Obtaining sectional views and true shape when the axis of the solid is vertical and cutting plane inclined to one reference plane.

DEVELOPMENT OF SURFACES, ISOMETRIC PROJECTIONS AND FREE-HAND SKETCHING **L: 10 Hrs**

Development of lateral surfaces of truncated prisms, pyramids, cylinders and cones.

Isometric projection, Isometric scale, Isometric views of simple solids, truncated prisms, pyramids, cylinders and cones.

Free hand sketching techniques, sketching of orthographic views from given pictorial views of objects, including free-hand dimensioning.

Theory 30 Hrs

PRACTICAL (30 Hrs)

INTRODUCTION TO AUTOCAD

Introduction to Drafting Software (AutoCAD) & its Basic Commands. Introduction to coordinate systems, object selection methods, selection of units and precession. Sketching – line, circle, arc, polygon, rectangle and ellipse. Working with object snaps, layers and object properties. Editing the objects – copy, move, trim, extend, working with arrays, mirror, scale, hatch, fillet and chamfer.

ISOMETRIC VIEWS WITH AUTOCAD

Building drawings – Single and double bed room house (sectional Top view only). Introduction to Motion path animation. Isometric views of simple solid blocks.

Theory : 30 Hrs	Practical: 30 Hrs	**Total Hours: 60**

References:

1 Basant Agrawal and CM Agrawal, Engineering Drawing, McGraw-Hill, New Delhi, First Edition, 2008.
2 Venugopal K. and Prabhu Raja V., Engineering Graphics, New Age International (P) Limited, New Delhi, 2008.
3 Natarajan K.V., Engineering Drawing and Graphics, Dhanalakshmi Publisher, Chennai, 2005.
4 Warren J. Luzadder and Jon. M. Duff, Fundamentals of Engineering Drawing, Prentice Hall of India Pvt. Ltd., New Delhi, Eleventh Edition, 2005.
5 Gopalakirishna K.R., Engineering Drawing (Vol. I & II), Subhas Publications, 2001.
6 James Leach, AutoCAD 2017 Instructor, SDC Publications, 2016.

7. N.D.Bhatt, Engineering drawing, Charotra publications, 50 th edition,2011.

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U18INI1600 **ENGINEERING CLINIC - I**

L	T	P	J	C
0	0	4	2	3

Course objectives

- To help the students look into the functioning of simple to complex devices and systems
- To enable the students to design and build simple systems on their own
- To help experiment with innovative ideas in design and team work
- To create an engaging and challenging environment in the engineering lab

Course Outcomes

After successful completion of this course, the students should be able to:

CO1: Identify a practical problems and find a solution
CO2: Understand the project management techniques
CO3: Demonstrate their technical report writing and presentation skills

Pre-requisite:

1. Nil

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	S	S	S	M	W		S			S		
CO2											S			
CO3										S				

Course Assessment methods:

Direct	Indirect
1. Project reviews	1. Course Exit Survey
2. Workbook report	
3. Demonstration & Viva-voce	

Content:

The course will offer the students with an opportunity to gain a basic understanding of computer controlled electronic devices and apply the concepts to design and build simple to complex devices. As a practical project based embedded course, the students will be taught the concepts using a variety of reference material available in the public domain. While the course will start with formal instruction on hardware, programming and applications, the major portion of the course will provide the students with ample opportunity to be innovative in designing and building a range of products from toys to robots and flying machines.

In the first semester, students will focus primarily on IOT with C programming using Audino.

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GUIDELINES:

1. Practical based learning carrying credits.
2. Multi-disciplinary/ Multi-focus group of 5-6 students.
3. Groups can select to work on a specific tasks, or projects related to real world problems.
4. Each group has a faculty coordinator/Instructor who will guide/evaluate the overall group as well as individual students.
5. The students have to display their model in the 'Engineering Clinics Expo' at the end of semester.
6. The progress of the course is evaluated based on reviews and final demonstration of prototype.

Total Hours: 90

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SEMESTER 2

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U18MAI2201 **ADVANCED CALCULUS AND LAPLACE TRANSFORMS**
(Common to All branches)

L	T	P	J	C
3	0	2	0	**4**

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Evaluate double and triple integrals in Cartesian coordinates and apply them to calculate area and volume.

CO2: Apply various integral theorems for solving engineering problems involving cubes and rectangular parallelepipeds.

CO3: Construct analytic functions of complex variables and transform functions from z-plane to w-plane and vice-versa, using conformal mappings.

CO4: Transform Functions in Time Domain to Frequency Domain using Laplace Transform
Use Laplace Transforms to Solve Ordinary Differential Equations and Integral Equations

CO5: Determine multiple integrals, vector differentiation, vector integrals and Laplace transforms using MATLAB.

CO6: Evaluate double and triple integrals in Cartesian coordinates and apply them to calculate area and volume.

Pre-requisite:

1 U18MAI1201- Linear Algebra and Calculus

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S	S			M				M	M		M		
CO2:	S	S			M				M	M		M		
CO3:	S	S			M				M	M		M		
CO4:	S	S			M				M	M		M		
CO5:	S	S			M				M	M		M		
CO6:	S	S			M				M	M		M		

Course Assessment methods:

	Direct		Indirect
1	Continuous Assessment Test I, II (Theory component)	**1**	Course end Survey
2	Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc (as applicable) (Theory component)		
3	Pre/Post - experiment Test/Viva; Experimental Report for each experiment (lab component)		
4	Model examination (lab component)		
5	End Semester Examination (Theory and lab component)		

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THEORY COMPONENT

MULTIPLE INTEGRALS **L: 10 Hrs**

Double integration – Cartesian coordinates – Change of order of integration - Application: Area as double integral - Triple integration in Cartesian coordinates — Volume as triple integral.

VECTOR DIFFERENTIATION **L: 6 Hrs**

Gradient, divergence and curl – Directional derivative – Irrotational and Solenoidal vector fields.

VECTOR INTEGRATION **L: 6 Hrs**

Green's theorem in a plane, Gauss divergence theorem and Stoke's theorem (excluding proofs) – Verification of theorem and simple applications

ANALYTIC FUNCTIONS **L: 8 Hrs**

Functions of a complex variable – Analytic functions – Necessary conditions, Cauchy- Riemann equations in Cartesian coordinates and sufficient conditions (excluding proofs) – Properties of analytic function – Construction of analytic function by Milne Thomson method – Conformal mapping : $w = z + c$, cz , .

LAPLACE TRANSFORMS **L: 8 Hrs**

Definition of the Laplace Transform; Properties of the Laplace Transform – Superposition, Shift in t or Time Delay, Shift in s, Time Derivatives, Time Integral-Initial Value Theorem - Final Value Theorem; Transform of periodic functions

INVERSE LAPLACE TRANSFORMS **L: 7 Hrs**

Inverse transforms - Convolution theorem – Applications to solution of linear ordinary differential equations of second order with constant coefficients - Solution of integral equations.

Practical

List of MATLAB Programmes: **P: 30 Hrs**

1. Evaluating double integral with constant and variable limits.
2. Area as double integral
3. Evaluating triple integral with constant and variable limits
4. Volume as triple integral
5. Evaluating gradient, divergence and curl
6. Evaluating line integrals and work done
7. Verifying Green's theorem in the plane
8. Evaluating Laplace transforms and inverse Laplace transforms of functions including impulse.
9. Heaviside functions and applying convolution.
10. Applying the technique of Laplace transform to solve differential equations.

Theory : 45 Hrs	Practical: 30 Hrs	**Total Hours: 75**

References:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 41st Edition, 2011.
2. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., New Delhi, 11th Reprint, 2010.
3. Veerarajan T., Engineering Mathematics (for First Year), Tata McGraw Hill Pub. Co. Ltd., New Delhi, Revised Edition, 2007.

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4 Kandasamy P., Thilagavathy K., and Gunavathy K., “Engineering Mathematics”, S. Chand & Co., New Delhi, (Reprint) 2008.
5 Kreyzig E., “Advanced Engineering Mathematics”, Tenth Edition, John Wiley and sons, 2011.
6 Venkataraman M.K., “Engineering Mathematics”, The National Pub. Co., Chennai, 2003.
7 Weir, MD, Hass J, Giordano FR: Thomas’ Calculus Pearson education 12th ED, 2015.
8 N.P.Bali., Dr. Manish Goyal., — Transforms and Partial Differential equations, University science Press, New Delhi, 2010

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U18ENI2201 FUNDAMENTALS OF COMMUNICATION - II

L	T	P	J	C
2	0	2	0	**3**

Course Objectives:

1. To adopt relevant job related oral and written communication skills to competently perform in campus recruitments.
2. To train students in presentation skills, persuasive skills and career skills.
3. To comprehend critical text leading to academic articulation.

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Read, understand, and interpret material on technology.

CO2: Communicate knowledge and information through oral and written medium.

CO3: Compare, collate and present technical information according to the audience and purpose.

Pre-requisite:

1 NIL

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:		W		S					S	S		S		
CO2:				S					S	S		W		
CO3:				M					S	S		S		

Course Assessment methods:

Direct		Indirect	
1	Continuous Assessment of Skills	**1**	Course Exit Survey
2	Assignment		
3	Written Test		
4	End Semester Examination		

No	TOPIC	
	MODULE I	**12 Hrs**
1.1	Introduction to Technical Writing Technical Definitions	2
1.2	Writing Instructions / Instruction Manual	2
1.3	Writing Recommendations	2
1.4	Speaking Activity I	6
	MODULE II	**12 Hrs**
2.1	Process Writing	2
2.2	Review Writing I - Product	2
2.3	Review Writing II – Article	2
2.4	Speaking Activity II	6
	MODULE III	**12 Hrs**

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3.1	Interpreting and Transcoding Graphics	2
3.2	Types of Report / Writing a Report	2
3.3	Reading & Responding to texts	2
3.4	Speaking Activity III	6
	MODULE IV	**12 Hrs**
4.1	Drafting a project proposal	2
4.2	Listening to technical talks	2
4.3	Preparing a survey Questionnaire	2
4.4	Speaking Activity IV	6
	MODULE V	**12 Hrs**
5.1	Writing Memos, Circulars, Notices	2
5.2	Writing Agenda and Minutes	2
5.3	Inferential Reading	2
5.4	Speaking Activity V	6
	Total	**60**

References:

1 Technical English Workbook, VRB Publishers Pvt. Ltd (Prof. Jewelcy Jawahar, Dr.P.Ratna)

2 Effective Technical Communication, Tata McGraw Hills Publications (Ashraf Rizvi)

3 Technical Communication – English Skills for Engineers, Oxford Higher Education (Meenakshi Raman, Sangeeta Sharma)

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U18 PHI2201	Engineering Physics (Common to AU, ECE, CE, MEC, ME)	L	T	P	J	C
		3	0	2	0	4

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Understand the principles of motion and rotation of a rigid body in the plane.

CO2: Enhance the fundamental knowledge in properties of matter and its applications relevant to various streams of engineering and technology.

CO3: To introduce the phenomenon of heat and account for the consequence of heat transfer in engineering systems.

CO4: To apply the concepts of electrostatics and dielectrics for various engineering Applications.

CO5: To understand the basics of magnetostatics.

CO6: To introduce and provide a broad view of the smart materials and Nano science to undergraduates.

Pre-requisites:

High School Education

CO PO Mapping

COs	Programme Outcomes (POs)												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S		M									M		
CO2	S		M									M		
CO3	S		M									M		
CO4	S		M									M		
CO5	S		M									M		
CO6	S		M	M								M		

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Course Assessment methods

Direct
1. Continuous Assessment Test I, II (Theory component) 2. Cooperative learning report, Assignment; Group Presentation, Project report, Poster preparation, 3. Pre/Post - experiment Test/Viva; Experimental Report for each experiment (lab component) 4. Model examination (lab component) 5. End Semester Examination (Theory and lab component)
Indirect
1. Course-end survey

Theory Component contents

KINEMATICS & RIGID BODY MOTION **9 Hours**

Definition and motion of a rigid body in the plane; Rotation in the plane; Kinematics in a coordinate system rotating and translating in the plane; Angular momentum about a point of a rigid body in planar motion; Euler's laws of motion, their independence from Newton's laws, and their necessity in describing rigid body motion; Examples.

PROPERTIES OF MATTER **9 Hours**

Hooke's Law Stress - Strain Diagram - Elastic moduli - Relation between elastic constants - Poisson's Ratio - Expression for bending moment and depression - Cantilever - Expression for Young's modulus by Non-uniform bending and its experimental determination.

HEAT **9 Hours**

Specific heat capacity, thermal capacity. Temperature rise. Coefficient of linear thermal expansion. Methods of measurement of thermal expansion. Thermal stresses in composite structures due to non-homogeneous thermal expansion. Applications -The bimetallic strip. Expansion gaps and rollers in engineering structures. Thermal conductivity: differential equation of heat flow. Lee's disc apparatus for determination of thermal conductivity. Thermal Insulation. Convection and radiation. Applications to refrigeration and power electronic devices.

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ELECTROSTATICS & MAGNETOSTATICS **9 Hours**

ELECTROSTATICS : Maxwell's equation for electrostatics – E due to straight conductors, circular loop, infinite sheet of current - electric field intensity (D) - Electric potential - dielectrics - dielectric polarization - internal field – Clasious - Mosotti equation - dielectric strength - applications.

MAGNETOSTATICS: Maxwell's equation for magnetostatics - B in straight conductors, circular loop, infinite sheet of current - Lorentz force, magnetic field intensity (H) – Biot–Savart's Law – Ampere's Circuit Law –Magnetic flux density (B).

NEW ENGINEERING MATERIALS AND NANO TECHNOLOGY **9 Hours**

New Engineering Materials: Metallic glasses – preparation, properties and applications – Shape memory alloys (SMA) – characteristics, properties of NiTi alloy applications - advantages and disadvantages of SMA.

Nano Materials: synthesis - Ball milling - Sol-gel - Electro deposition — properties of nano particles and applications. – Carbon Nano Tubes – fabrication by Chemical Vapour Deposition - structure, properties & applications.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES

1. Essential University Physics, Vols. 1 and 2., Richard Wolfson, Pearson Education, Singapore, 2011.
2. Engineering Mechanics (2nd ed.), Harbola M. K., Cengage publications, New Delhi, 2009.
3. Concepts of Physics, H. C. Verma vol 1 and 2, Bharati Bhawan Publishers & Distributors; First edition (2017).
4. Engineering Electromagnetics, W. H. Hayt and John A. Buck, 6th Edition, Tata McGraw Hill, New Delhi, 2014.
5. Theory and Problems of Electromagnetic Schaum's Outline Series, 5th Edition, Joseph A. Edminister, Tata McGraw Hill Inc., New Delhi, 2010.
6. Engineering Physics, Rajendran V., Tata McGraw-Hill Education Pvt. Ltd., 2010
7. Nano – the Essentials, Pradeep T., McGraw-Hill Education, Pvt. Ltd., 2007.

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Lab component:

LIST OF EXPERIMENTS

1. Non-uniform bending – Determination of Young's modulus
2. Compound Pendulum – Determination of acceleration due to gravity
3. Spectrometer – Determination of wavelength of mercury source using grating
4. Air wedge - Determination of thickness of thin sheet
5. Semiconductor Laser:
    a. Determination of wavelength of laser
    b. Determination acceptance angle and numerical aperture of an optial fibre.
    c. Determination of particle size
6. Melde's string – Determination of frequency of a turing fork
7. Determination of band gap of a semiconductor
8. Ultrasonic interferometer – Determination of velocity of sound and compressibility of a liquid
9. Luxmeter – Determination of efficiency of solar cell
10. Lee's disc – Determination of thermal conductivity of a bad conductor

Experiments for Demonstration:

1. Hall effect
2. Hardness Test
3. Four probe experiment
4. Hysteresis curve

Theory: 0	**Tutorial: 0**	**Practical: 30**	**Project: 0**	**Total: 30 Hours**

REFERENCES

1. Laboratory Manual of Engineering Physics, Dr. Y. Aparna & Dr. K. Venkateswara Rao, V.G.S Publishers.
2. Practical Physics, G.L. Squires, Cambridge University Press, Cambridge, 1985.
3. Great Experiments in Physics, M.H. Shamos, Holt, Rinehart and Winston Inc., 1959.
4. Experiments in Modern Physics, A.C. Melissinos, Academic Press, N.Y., 1966.

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U18CSI2201 **PYTHON PROGRAMMING**
(Common to All Branches)

L	T	P	J	C
2	0	2	0	**3**

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Classify and make use of python programming elements to solve and debug simple logical problems.(K4)
CO2: Experiment with the various control statements in Python.(K3)
CO3: Develop Python programs using functions and strings.(K3)
CO4: Analyze a problem and use appropriate data structures to solve it.(K4)
CO5: Develop python programs to implement various file operations and exception handling.(K3)

Pre-requisite:

1 NIL

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:		S			M					M		M		
CO2:			M							M		M		
CO3:			M							M		M		
CO4:	S	S	M		M					M		M		
CO5:			M							M		M		

Course Assessment methods:

	Direct		Indirect
1	Continuous Assessment Test I, II (Theory component)	**1**	Course-end survey
2	Open Book Test, Assignment, Group Presentation		
3	Viva, Experimental Report for each Experiment (lab Component)		
4	Model Examination (lab component)		
5	End Semester Examination (Theory and lab components)		

THEORY COMPONENT

BASICS OF PYTHON PROGRAMMING **L: 6 Hrs**

Introduction-Python interpreter- interactive and script mode; values and types, operators, expressions, statements, precedence of operators, Multiple assignments, comments.

CONTROL STATEMENTS AND FUNCTIONSIN PYTHON **L: 6 Hrs**

Conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Functions: Introduction, inbuilt functions, user defined functions, passing parameters, return values, recursion.

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DATA STRUCTURES: STRINGS,LSTS,SET **L: 7 Hrs**

Strings: string slices, immutability, string methods and operations; Lists: creating lists, list operations, list methods, mutability, aliasing, cloning lists, list and strings, list and functions ; list processing : list comprehension, searching and sorting, Sets: creating sets, set operations.

DATA STRUCTURES: TUPLES, DICTIONARIES **L: 5 Hrs**

Tuples: Tuple assignment, Operations on Tuples, lists and tuples, Tuple as return value; Dictionaries: operations and methods, Nested Dictionaries.

FILES, MODULES, PACKAGES **L: 6 Hrs**

Files and exception: text files, reading and writing files, format operator, exception handling, modules, packages.

Practical

LIST OF EXPERIMENTS: **P: 30 Hrs**

1. Programs using expressions and input and output statements.
2. Programs using operators and built in functions.
3. Programs using conditional statements.
4. Program to exchange the values of two variables.
5. Program to test whether a given year is a leap year or not
6. Programs performing all string operations.
7. Programs using functions
8. Programs to find square root, GCD, exponentiation, sum an array of numbers
9. Programs to perform linear search, binary search
10. Programs to perform operations on list
11. Programs using dictionary and set
12. Programs to work with Tuples.
13. Programs to sort elements (Selection, Insertion, Merge, Quick)
14. Programs to search element.
15. Program to perform word count in file.
16. Program to copy file
17. Program to read and write file
18. Programs using modules and packages

Theory : 30 Hrs	Practical: 30 Hrs	**Total Hours: 60**

References:

1. Ashok NamdevKamthane,Amit Ashok Kamthane, Programming and Problem Solving with Python , Mc-Graw Hill Education,2018.
2. Allen B. Downey, Think Python: How to Think Like a Computer Scientist, Second edition, Updated for Python 3, Shroff / O'Reilly Publishers, 2016John V Guttag, Introduction to Computation and Programming Using Python, Revised and expanded Edition, MIT Press , 2013.
3. Robert Sedgewick, Kevin Wayne, Robert Dondero, Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.
4. Timothy A. Budd, Exploring Python, Mc-Graw Hill Education (India) Private Ltd., 2015.
5. Kenneth A. Lambert, Fundamentals of Python: First Programs, CENGAGE Learning, 2012.
6. Charles Dierbach, Introduction to Computer Science using Python: A Computational Problem Solving Focus, Wiley India Edition, 2013.

E BOOKS AND ONLINE LEARNING MATERIALS

7. www.mhhe.com/kamthane/python
8. Allen B. Downey, Think Python: How to Think Like a Computer Scientist, Second edition, Updated for Python 3, Shroff / O'Reilly Publishers, 2016
9. **ONLINE COURSES AND VIDEO LECTURES:**

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http://nptel.ac.in
https://www.edx.org/course/introduction-to-python-fundamentals-1
https://www.edx.org/course/computing-in-python-ii-control-structures-0
https://www.edx.org/course?search_query=Computing+in+Python+III%3A+Data+Structures

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U18MET2003 **ENGINEERING MECHANICS**

L	T	P	J	C
3	0	0	0	**3**

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Apply the fundamental concepts in determining the effect of forces on a particle.
CO2: Make use of various principles in the determination of effect of forces in a rigid body.
CO3: Determine the geometry dependant properties of solids and sections
CO4: Solve problems in static friction
CO5: Identify motion and determine the velocity and acceleration of a particle.
CO6: Apply the principles of kinetics in solving problems in dynamics.

Pre-requisite:

1 NIL

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S								M	M	S		M	
CO2:	S								M	M	S		M	
CO3:	S								M	M	S		M	
CO4:	S								M	M	S			
CO5:	S								M	M	S		S	
CO6:	S								M	M	S		M	

Course Assessment methods:

Direct		Indirect	
1	Assignments	**1**	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

STATICS OF PARTICLES **L: 9 Hrs**

Introduction - Laws of Mechanics, Parallelogram and triangular Laws of forces – Coplanar Forces - Resolution and Composition of forces – Free body diagram - Equilibrium of a particle – Lami's theorem – Equilibrium of a particle in space.

STATICS OF RIGID BODIES **L: 9 Hrs**

Principle of transmissibility – Moment of force about a point – Varignon's theorem – Moment of a couple – Equivalent couple – Moment of force about an axis – Coplanar non-concurrent forces acting on rigid bodies – Resultant and equilibrium – Resolution of a given force into force couple system – Equilibrium in three dimensions – Reactions and supports.

GEOMETRY DEPENDANT PROPERTIES **L: 9 Hrs**

Centre of gravity, Centre of mass and Centroid – Moment of Inertia of simple and complex areas – Transfer formula – Radius of gyration – Polar moment of inertia – Product of inertia - Mass moment of Inertia of simple solids.

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FRICTION **L: 9 Hrs**

Laws of friction – coefficient of friction – Dry friction – wedge friction – ladder friction – rolling resistance.

DYNAMICS OF PARTICLES **L: 9 Hrs**

Kinematics – Rectilinear and curvilinear motion – projectile motion

Kinetics – Newton's second law – D'Alembert's Principle – Work Energy method – Principle of Impulse momentum – Impact of Elastic Bodies

Theory : 45 Hrs	Practical: 0 Hrs	**Total Hours: 45**

References:

1 Beer F P and Johnson E R, "Vector Mechanics for Engineers, Statics and Dynamics", Tata Mc-Graw Hill Publishing Co. Ltd., New Delhi, 2006.

2 Hibbeller, R.C., Engineering Mechanics: Statics, and Engineering Mechanics: Dynamics, 13th edition, Prentice Hall, 2013.

3 J.L. Meriam & L.G. Karige, Engineering Mechanics: Statics (Volume I) and Engineering Mechanics: Dynamics (Volume II), 7th edition, Wiley student edition, 2013.

4 P. Boresi & J. Schmidt, Engineering Mechanics: Statics and Dynamics, 1/e, Cengage learning, 2008.

5 Irving H. Shames, G. Krishna Mohana Rao, Engineering Mechanics - Statics and Dynamics, Fourth Edition – PHI / Pearson Education Asia Pvt. Ltd., 2006.

6 Rajasekaran S and Sankarasubramanian G, "Engineering Mechanics-Statics and Dynamics", Vikas Publishing House Pvt. Ltd., New Delhi, 2006

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U18MEP2501

ENGINEERING PRACTICES LABORATORY

L	T	P	J	C
0	0	2	0	**1**

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Understand the applications of simple tools used in the fabrication workshop.
CO2: Select the appropriate tools required for specific operation.
CO3: Make simple joints using Carpentry and Fitting tools also make simple components using sheet metal tools.
CO4: Understand the applications of different plumbing tools and fittings.
CO5: Demonstrate and evaluate the parameters of basic electronic components (wires, resistors, capacitors, diodes etc.) and test the components.
CO6: Estimate DC and AC Voltage and currents using appropriate measuring instruments.

Pre-requisite:

1 NIL

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:			W					M		M			M	
CO2:			W					M		M				
CO3:			W					M		M			M	
CO4:			W					M		M				S
CO5:			W					M		M				M
CO6:			W					M		M				M

Course Assessment methods:

Direct		Indirect	
1	Workbook	**1**	Course Exit Survey
2	Model Practical Examination		
3	Mini Project		

PRACTICAL

LIST OF EXERCISES :

GROUP – I

A. CIVIL ENGINEERING **P: 30 Hrs**

1 Carpentry
- Study of carpentry tools
- Preparation of T joint
- Preparation of dovetail joint

2 Plumbing
- Study of pipeline joints

B. MECHANICAL ENGINEERING

1 Fitting
- Study of fitting tools
- Preparation of L joint

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2 Sheet Metal Working
- Study of sheet metal working tools
- Preparation of Tray
- Preparation of Cone

3 Demonstration of mold preparation

4 Demonstration of smithy operations

5 Demonstration of SMA welding process

GROUP – II
(ELECTRICAL & ELECTRONICS ENGINEERING)

C. 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 energy using single phase energy meter.

D. ELECTRONIC ENGINEERING PRACTICE

1 Assembling simple electronic component on a small PCB and Testing.
2 Soldering simple electronic circuits and checking continuity.
3 Measurements using digital multimeter.
- DC and AC voltage measurement
- DC and AC current measurements.
- Resistance Measurement.
- Continuity measurement.

4 Testing of Electronic components
- Resistors
- Inductors and capacitors
- Diodes (resistance in forward bias and reverse bias)
- Transistors

5 Study of CRO and Function generator
- Study of Panel Controls
- Measurement of Amplitude, Frequency, phase difference

Practical: 30 Hrs		**Total Hours: 30**

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U18INI2600 **ENGINEERING CLINIC - II**

L	T	P	J	C
0	0	4	2	3

Course objectives

- To help the students look into the functioning of simple to complex devices and systems
- To enable the students to design and build simple systems on their own
- To help experiment with innovative ideas in design and team work
- To create an engaging and challenging environment in the engineering lab

Course Outcomes

After successful completion of this course, the students should be able to:

CO1: Identify a practical problems and find a solution
CO2: Understand the project management techniques
CO3: Demonstrate their technical report writing and presentation skills

Pre-requisite:

1. U18INI1600 - Engineering Clinic - I

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	S	S	S	M	W		S			S		
CO2											S			
CO3										S				

Course Assessment methods:

Direct	Indirect
1. Project reviews	1. Course Exit Survey
2. Workbook report	
3. Demonstration & Viva-voce	

Content:

The course will offer the students with an opportunity to gain a basic understanding of computer controlled electronic devices and apply the concepts to design and build simple to complex devices. As a practical project based embedded course, the students will be taught the concepts using a variety of reference material available in the public domain. While the course will start with formal instruction on hardware, programming and applications, the major portion of the course will provide the students with ample opportunity to be innovative in designing and building a range of products from toys to robots and flying machines.

In the second semester, students will focus primarily on Solid Modelling and Python programming.

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GUIDELINES:

1. Practical based learning carrying credits.
2. Multi-disciplinary/ Multi-focus group of 5-6 students.
3. Groups can select to work on a specific tasks, or projects related to real world problems.
4. Each group has a faculty coordinator/Instructor who will guide/evaluate the overall group as well as individual students.
5. The students have to display their model in the 'Engineering Clinics Expo' at the end of semester.
6. The progress of the course is evaluated based on reviews and final demonstration of prototype.

Total Hours: 90

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SEMESTER 3

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U18MAT3101

PARTIAL DIFFERENTIAL EQUATIONS AND TRANSFORMS (Common to AE/AUE/CE/ME/MCE/EEE)

L	T	P	J	C
3	1	0	0	**4**

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Form partial differential equations and solve certain types of partial differential equations.

CO2: Know how to find the Fourier Series and half range Fourier Series of a function

CO3: Know how to solve one dimensional wave equation, one dimensional heat equation in steady state using Fourier series.

CO4: Apply Fourier series to solve the steady state equation of two dimensional heat equation in Cartesian coordinates.

CO5: Apply the Fourier transform, Fourier sine and cosine transform to certain functions and use Parseval's identity to evaluate integrals.

CO6: Evaluate Z – transform for certain functions. Estimate Inverse Z – transform of certain functions and to solve difference equations using them.

Pre-requisite:

1 NIL

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S	M			M				M	M		S		
CO2:	S	M		M										
CO3:	S	S	S		S				M	M		S		
CO4:	S	M	M									M		
CO5:	S	M	M		S									
CO6:	S	S			S				M	M		S		

Course Assessment methods:

	Direct		Indirect
1	Continuous Assessment Test I, II	**1**	Course-end survey
2	Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable)		
3	End-Semester Examination		

PARTIAL DIFFERENTIAL EQUATIONS **L: 9 Hrs T: 3 Hrs**

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions - Solution of PDE by variable separable method – Solution of standard types of first order partial differential equations (excluding reducible to standard types) – Lagrange's linear equation – Linear Homogeneous partial differential equations of second and higher order with constant coefficients.

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FOURIER SERIES **L: 9 Hrs T: 3 Hrs**

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Parseval's identity – Harmonic Analysis.

BOUNDARY VALUE PROBLEMS – ONE DIMENSIONAL EQUATIONS **L: 5 Hrs T: 2 Hrs**

Classification of second order quasi linear partial differential equations – Formulation of wave and heat equations using physical laws - Solutions of one dimensional wave equation – One dimensional heat equation (excluding insulated ends)

BOUNDARY VALUE PROBLEMS – TWO DIMENSIONAL EQUATIONS **L: 4 Hrs T: 1 Hrs**

Steady state solution of two-dimensional heat equation (Insulated edges excluded) – Fourier series solutions in Cartesian coordinates.

FOURIER TRANSFORM **L: 9 Hrs T: 3 Hrs**

Fourier Integral Theorem – Representation of Functions – Infinite Fourier transforms – Sine and Cosine Transforms – Properties – Transforms of simple functions – convolution theorem – Parseval's identity.

Z –TRANSFORM **L: 9 Hrs T: 3 Hrs**

Z-transform - Elementary properties – Convolution theorem- Inverse Z – transform (by using partial fractions, residue methods and convolution theorem) – Solution of difference equations using Z - transform.

Theory : 45 Hrs	Tutorial : 15 Hrs	**Total Hours: 60**

References:

1 Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44th Edition. 2014.

2 Veerarajan. T., "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt. Ltd., New Delhi, Second reprint, 2012.

3 Kandasamy P., Thilagavathy K. and Gunavathy K., "Engineering Mathematics Volume III", S.Chand & Company ltd., New Delhi, 2006.

4 Ian Sneddon., "Elements of partial differential equations", McGraw – Hill, New Delhi, 2003.

5 Arunachalam T., "Engineering Mathematics III", Sri Vignesh Publications, Coimbatore 2009.

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U18AUI3201 **AUTOMOTIVE CHASSIS AND TRANSMISSION**

L	T	P	J	C
3	0	2	0	**4**

Course Objective:
Educate about modern driveline and to gain knowledge on different types of steering geometry, axles, suspension and brakes.

Course Outcomes:
After successful completion of this course, the students should be able to:
CO1: Outline the construction details of various automotive Chassis Frame layouts.
CO2: Explain the functions of steering system and components
CO3: Select the appropriate transmission system for various automobiles
CO4: Demonstrate the working principle of final drive system.
CO5: Choose suitable axles, wheels and tyres for a vehicle.
CO6: Distinguish various types of suspension system & brakes.

Pre-requisite:
1 NIL

CO-PO/PSO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	M	M	M			M		M	M				S	
CO2:	S	S	S	W				M	M	W			S	
CO3:	S	S	S	M			M	M	M	M			S	
CO4:	S	S	S	M									M	
CO5:	S	S	M	W		M	S	S	M	W			S	
CO6:	M	M	M			M	S	S	M				S	

Course Assessment methods:

Direct		Indirect	
1	Assignments	**1**	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

CHASSIS AND STEERING SYSTEM **L: 12 Hrs**
Types of Chassis layout, with reference to Power Plant location and drive, various types of frames, Constructional details and materials for frames
Steering Geometry, Castor, Camber, King Pin Inclination and Toe–in, Toe-out, Slip Angle, Over–Steer and Under–Steer, Ackerman's Steering Mechanisms, Steering Linkages, radius rods and stabilizers, Types of Steering Gear boxes, Reversible and Irreversible Steering, Power–Assisted Steering.

TRANSMISSION AND DRIVE LINE **L: 12 Hrs**
Requirement of transmission system, Clutches- Types and construction, Types of Transmission – Chain, Belt and gear drives, Sliding mesh gearbox, Constant mesh gearbox and Synchromesh gearbox. Automatic transmission – Fluid coupling, Torque converter, planetary gear trains, CVT.

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Driving Thrust, torque reactions and side thrust, Hotchkiss drive, torque tube drive, Propeller Shaft, Universal Joints, Constant Velocity Joints, Front Wheel drive, Multi–axle vehicles, Differential - principle and types, Non–Slip differential, Differential locks.

AXLES AND WHEELS **L: 6 Hrs**

Types of Front Axles and Stub Axles, Types of Loads acting on drive axles, Full – Floating, Three–Quarter Floating and Semi–Floating Axles, Axle Housings.

Wheels - Rims – Types and constructional details, Tyres – Types, specification and constructional details.

SUSPENSION SYSTEM **L: 6 Hrs**

Functions of Suspension System, Active and semi-active, Types of Suspension Springs - Single Leaf, Multi–Leaf, Coil, Torsion bar, Rubber, Pneumatic and Hydro – Gas , elastic Spring Systems, Boggy suspension system, Independent Suspension System, Shock Absorbers.

BRAKING SYSTEM **L: 9 Hrs**

Theory of Automobile Braking, Stopping Distance Time and Braking Efficiency, Braking Torque, Effect of Weight Transfer during Braking, Constructional Details - Drum Brake & Disc Brake, Hydraulic Braking System, Mechanical Braking System, Pneumatic Braking System, Power–Assisted Braking System, Servo Brakes, Retarders, Anti–Lock Braking System , Regenerative braking system, Exhaust braking system.

Practical

List of Exercises : **P: 30 Hrs**

1 Measurement of the automotive frames
2 Measurement of steering angle
3 Assessment of Frame bend
4 Damping test on two wheeler shock absorber
5 Assessment of wheels and tyres
6 Calculation of final drive ratio
7 Calculation of different gear ratios
8 Performance test of two wheeler using Eddy current type chassis dynamometer
9 Demonstration of different types of clutches.

Theory : 45 Hrs	Practical: 30 Hrs	**Total Hours: 75**

References:

1 "Automotive Chassis-Brakes, Steering and Suspension", Tim Gilles, Thomson Delmer Learning, 2008.
2 "Automotive Chassis: Engineering Principles", Jornsen Reimpell, Helmut Stoll, Elsevier, 2nd edition, 2001.
3 "Motor Vehicles" Newton Steeds and Garret, 13th Edition, Butterworth, London, **2005.**
4 "Modern Vehicle Technology", Heinz Hazler, Butterworth, London, **2005.**
5 "Automobile Engineering" Kripal Singh, ,Standard Publishers,2011
6 "A Text–Book of Automobile Engineering", R.K. Rajput, Laxmi Publications Pvt. Ltd, **2007.**
7 "Automotive Chassis", Heldt.P.M, Chilton Co., New York, 1990.
8 "Steering Suspension and tyres", Giles.J.G, Iliffe Book Co.,London,1988

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U18AUI3202 **STRENGTH OF MATERIALS**

L	T	P	J	C
3	0	2	0	**4**

Course Objective:
Gain knowledge on calculation of stresses, strains and deformation in materials due to external loads.

Course Outcomes:
After successful completion of this course, the students should be able to:
CO1: Estimate the strength of various structural elements subjected to different loading conditions.
CO2: Analyse the different types of beams.
CO3: Determining the slope and deflection of beams
CO4: Analyse the shafts and columns with different edge conditions by using different theories
CO5: Interpret the concepts and theories to design pressure vessels.
CO6: Examine the mechanical properties of materials

Pre-requisite:
1 NIL

CO-PO/PSO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S	S	M	M					M				S	
CO2:	S	S	M	M						M			S	
CO3:	S	S	M	M					M				S	
CO4:	S	S	M	M					M				S	
CO5:	S	S	M	M									S	
CO6:	M	M		S					S				S	

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

CONCEPT OF STRESSES AND STRAINS **L: 10 Hrs**
Concept of stress and strain, Hooke's law – Tension, Compression, and Shear, stress-strain diagram – Poisson's ratio, elastic constants and their relationship – Deformation of simple and compound bars. Thermal stresses – simple and Composite bars. Principal plane, principal stress, maximum shearing stress – Uniaxial, biaxial state of stress – Mohr's circle for plane stresses.

ANALYSIS OF BEAMS **L: 9 Hrs**
Types of beams and loads – shear force and bending moment diagrams for cantilevers, simply supported and over hanging beams. Theory of pure bending – Bending stresses in simple and composite beams. Shear stress distribution in beams of different sections.

DEFLECTION OF BEAMS **L: 7 Hrs**
Slope and deflection of cantilever, simply supported beam by double integration method – Macaulay's method – Moment area method.

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TORSION OF SHAFTS **L: 10 Hrs**

Theory of pure torsion, derivation of shear stress produced in terms of torque in a circular shaft. Strength, stiffness of shaft and Torsional rigidity & power transmitted – Expression for torque in terms of polar moment of inertia in a circular shaft subjected to torsion – Circular shafts in series and parallel – Circular shaft subjected to combined bending and torsion – Circular shaft subjected to combined bending and torsion – Composite Shaft.

COLUMNS AND CYLINDERS **L: 9 Hrs**

Columns and struts: Member subjected to combined bending and axial loads, Euler's theory, Crippling load, Rankine's theory.

Cylinders and Shells: Thin cylinder, thin spherical shells under internal pressure – Thick cylinders – Lame's equation – Shrink fit and compound cylinders.

Practical

List of Exercises : **P: 30 Hrs**

1. Tension & Shear Test on Steel Rod
2. Torsion Test on Steel Rod
3. Compression Test on wood
4. Hardness Test- Brinell, Vickers and Rockwell Hardness tests
5. Impact Test- Izod, Charpy Impact Tests
6. Test on Helical Springs- Compression and Tension Springs
7. Deflection Test on Beams

Theory : 45 Hrs	Practical: 30 Hrs	**Total Hours: 75**

References:

1. Strength of Materials, S. Ramamrutham and R. Narayanan,Dhanpat Rai Publications, 16th edition,2011.
2. "A Text Book of Strength of Materials", Bansal R.K, , Lakshmi Publications Pvt. Limited, New Delhi, 2010.
3. " Elements of Strength of Materials" ,D.H. Young, S.P. Timoshenko ,East West Press Pvt. Ltd., 5th Edition (Reprint 2014)
4. Strength of Materials" in SI Units, B.S. Basavarajaiah, P.Mahadevappa University Press (India) Pvt. Ltd., 3rd Edition, 2010
5. " Strength of Materials" ,S.S. Rattan, McGraw Hill Education (India) Pvt. Ltd., 2nd Edition (Sixth reprint 2013)
6. Strength of Materials ,Timoshenko, S.P. and Young, D.H., (2011), East West Press Ltd. 5th edition

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U18AUT3103 **THERMODYNAMICS AND THERMAL ENGINEERING**

L	T	P	J	C
3	1	0	0	**4**

(Use of approved Steam table, Mollier chart, Psychrometry chart permitted)

Course Objective:
Prepare the students with strong fundamental knowledge in thermodynamics and to develop the ability to apply the same for thermal systems

Course Outcomes:
After successful completion of this course, the students should be able to:

CO1: Familiarize laws of Thermodynamics
CO2: Apply energy balance to systems and control volumes, in situations involving heat and work interactions
CO3: Compare the performance of thermal systems with idealized systems.
CO4: Make use of the properties of pure substance in vapour power cycles
CO5: Solve problems using thermodynamic concepts related to air compressor, refrigeration and air conditioning.
CO6: Utilize modes of heat transfer to design thermal equipment

Prerequisite:
1 NIL

CO-PO/PSO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S	S	W						W				M	
CO2:	S	S	M				W			W			M	
CO3:	S	S	M	S			W		W				M	
CO4:	S	S	W				W		W				M	
CO5:	S	S	M				M			W			M	
CO6:	S	S	M				M		W				M	

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

LAWS OF THERMODYNAMICS **L: 10 Hrs T: 3 Hrs**

System, thermodynamic equilibrium, zeroth law state, property, process, cycle, P-V & T-S diagrams, energy: work, heat, first law of thermodynamics, Concept of continuum, Perpetual motion machine, steady flow energy equation.

Application of first law of thermodynamics to closed and open systems.

Statements of second law of thermodynamics, heat engine, heat pump, refrigerator, Carnot cycle, Reversed Carnot cycle, Carnot theorem, entropy, Clausius inequality, Entropy generation principle.

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AIR STANDARD CYCLES AND COMPRESSORS **L: 8 Hrs T: 3 Hrs**

Assumption for air standard cycles - Otto, Diesel, and Dual cycles, Comparison of cycles. Compressors, Classifications- Single stage and multi stage with intercooler, Volumetric efficiency.

PROPERTIES OF STEAM AND VAPOUR POWER CYCLE **L: 9 Hrs T: 3 Hrs**

Steam formation, properties of steam. Use of steam tables and Mollier chart, Ideal Rankine cycle, Reheat and regenerative cycle Rankine cycle.

PSYCHROMETRY, REFRIGERATION AND AIR CONDITIONING **L: 9 Hrs T: 3 Hrs**

Properties of air, Psychometric Processes and use of Psychometric chart. Principles of refrigeration, Types - Vapour compression and Vapour absorption types – Coefficient Of Performance (COP), Properties of refrigerants, Summer, winter and Year round Air conditioning. Introduction to Automotive air conditioning systems.

HEAT TRANSFER **L: 9 Hrs T: 3 Hrs**

Modes of heat transfer, Heat conduction in parallel, radial and composite wall – Basics of Convective heat transfer. Fundamentals of Radiation heat transfer. Flow through heat exchangers, Types and Performance evaluation – Parallel and counter flow.

Theory : 45 Hrs	Tutorial: 15 Hrs	**Total Hours: 60**

References:

1 Nag .P.K, "*Engineering Thermodynamics"*, 6th Edition, Tata McGraw Hill Education, New Delhi, 2017.
2 Yunus A Cengel, "Heat and Mass Transfer – A Practical Approach", Tata McGraw Hill, New Delhi, 2007.
3 Rajput R.K, "*Thermal Engineering"*, Laxmi Publications, 10th Edition, New Delhi, 2015.
4 Yunus.N.J, Cengel.A, and Michael Boles, "A., Thermodynamics – An Engineering Approach, 8th Edition", Tata McGraw Hill- Education, 2015
5 Kothandaraman.C.P, Domkundwar.S, Anand Domkundwar, "A Course in Thermal Engineering", Dhanpat Rai & Co. (P) Ltd., 2014
6 Mahesh M. Rathore, "Thermal Engineering", Tata Mc Graw Hill Education private limited, Reprint 2012.

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U18AUT3004 **MATERIALS AND METALLURGY**

L	T	P	J	C
3	0	0	0	**3**

Course Objective:

Impart Knowledge on Various engineering materials and the influence of its constituents, chemical composition, mechanical treatment and heat treatment over its properties.

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Compare and explain materials based on structure and properties
CO2: Infer the state and composition of material through phase diagram
CO3: Explain the mechanism of deformation in materials
CO4: Explain the various testing method of material Properties
CO5: Select the suitable treatment processes for the engineering material.
CO6: Survey and report the material used in automotive sector.

Pre-requisite:

1 NIL

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	M	S	M						M	M			S	
CO2:	S	S								M				
CO3:	M	M							M	M			M	
CO4:	M	M							M	M				
CO5:	S	S	M						M	M			M	
CO6:	S	M							M	M			M	

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

INTRODUCTION ON SOLID SOLUTION AND PHASE DIAGRAM **L: 10 Hrs**

Introduction to material and its properties, overview on crystal structure –types and its Imperfection, crystallization –mechanism, Solid solution- substitutional- Hume Rothery rules- interstitial solid solution, cooling curve- Pure metal- alloy- Phase diagram- Phase rule- lever rule, Isomorphism, Iron-Carbon system-micro constituents of iron and steel, Iron-iron carbide equilibrium.

METAL AND NON METALS **L: 12 Hrs**

Ferrous alloys: classification, structure and properties- carbon steel- low alloy - high alloy- stainless steel- tool steel, micro alloy steel, HSLA, TRIP steel.

Nonferrous- Classification, structure and properties: Cu, Al, Mg, Ni and its alloys, Application of metal alloys in automobile

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Polymers: classification, structure, properties: polyethylene, polypropylene, PVC, Polystyrene, ABS, PPO, PEEK, polyamide and its Application in automobile.
Ceramic- Structure, Properties: Al_2O_3, SiC,Si_2N_4, Sialons and its Application in automobile.

INTRODUCTION TO COMPOSITE **L: 6 Hrs**

Composite- constituents of composite, types- Metal Matrix Composite- Polymer Matrix composite- Fibre Reinforced Plastic –fibres-types, reinforcement- types- classification and properties, production techniques and Application in automobile.

HEAT TREATMENT **L: 10 Hrs**

Heat treatment - Factors in heat treatment- principles- Annealing- stages and its types- Normalizing - Hardening –Tempering- Jominy End Quench Test - TTT Curve- Austempering- Martempering, Cooling Curves Superimposed On I.T. Diagram, , surface hardening-case hardening- cyaniding- Nitriding-induction hardening- flame hardening- Age hardening, Carburizing.

MECHANICAL BEHAVIOUR AND TESTING OF MATERIALS **L: 7 Hrs**

Deformation of Metals- Elastic and Plastic - mechanism - slip and Twinning, Work Hardening- principle and Stages, Fracture- mechanism- Brittle and ductile, Fatigue and Creep.
Testing of materials- tensile, compression and shear, Hardness test- Brinell, Vickers and Rockwell, impact test - Izod and Charpy

Theory : 45 Hrs	Tutorial: 0 Hrs	**Total Hours: 45**

References:

1 Introduction to Physical Metallurgy , Sidney H Avner , McGraw Hill Education; 2 edition (1 July 2017), ISBN-13: 978-0074630068.
2 Materials for Automobile Bodies - Geoff Davies., Butterworth-Heinemann, 2012.
3 Physical Metallurgy , A GULYAEV, Volume 1, 1980
4 Physical Metallurgy , A GULYAEV, Volume 2, 1980
5 Material Selection in Mechanical Design, Michael F Ashby, Butterworth-HeineMann, Third edition 2005.
6 Materials and Metallurgy , H S BAWA, 1986

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U18INI3600 **ENGINEERING CLINIC - III**

L	T	P	J	C
0	0	4	2	3

Course objectives

- To help the students look into the functioning of simple to complex devices and systems
- To enable the students to design and build simple systems on their own
- To help experiment with innovative ideas in design and team work
- To create an engaging and challenging environment in the engineering lab

Course Outcomes

After successful completion of this course, the students should be able to:

CO1: Identify a practical problems and find a solution
CO2: Understand the project management techniques
CO3: Demonstrate their technical report writing and presentation skills

Pre-requisite:

1. Nil

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	S	S	S	S	S	S	S			S	S	S
CO2								S	S	S	S		M	M
CO3								S		S				

Course Assessment methods:

Direct	Indirect
1. Project reviews	1. Course Exit Survey
2. Workbook report	
3. Demonstration & Viva-voce	

Content:

The course will offer the students with an opportunity to gain a basic understanding of computer controlled electronic devices and apply the concepts to design and build simple to complex devices. As a practical project based embedded course, the students will be taught the concepts using a variety of reference material available in the public domain. While the course will start with formal instruction on hardware, programming and applications, the major portion of the course will provide the students with ample opportunity to be innovative in designing and building a range of products from toys to robots and flying machines.

In the third semester, students will focus primarily on Design project.

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GUIDELINES:

1. Practical based learning carrying credits.
2. Multi-disciplinary/ Multi-focus group of 5-6 students.
3. Groups can select to work on a specific tasks, or projects related to real world problems.
4. Each group has a faculty coordinator/Instructor who will guide/evaluate the overall group as well as individual students.
5. The students have to display their model in the 'Engineering Clinics Expo' at the end of semester.
6. The progress of the course is evaluated based on reviews and final demonstration of prototype.

Total Hours: 90

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U18CHT3000	ENVIRONMENTAL SCIENCE AND ENGINEERING (Common to All branches)	L	T	P	C
		3	0	0	0

Course Outcomes

After successful completion of this course, the students would be able to

CO 1: Analyze the impact of engineering solutions in a global and societal context.

CO 2: Discuss contemporary issues that results in environmental degradation and would attempt to provide solutions to overcome those problems.

CO 3: Highlight the importance of ecosystem and biodiversity.

CO 4: Consider issues of environment and sustainable development in his/her personal and professional undertakings.

CO 5: Paraphrase the importance of conservation of resources.

CO 6: Play an important role in transferring a healthy environment for future generations.

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1		M					S		M			
CO 2						M				M		
CO 3							M					
CO 4						M	S					
CO 5							S					
CO 6			W				S					M

Course Assessment methods

Direct	Indirect
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group presentation 5. End Semester Exam	Course end survey

INTRODUCTION TO ENVIRONMENTAL STUDIES AND NATURAL RESOURCES **14 Hours**

Definition, scope and importance – Need for public awareness – Forest resources: Use and over-exploitation, deforestation, case studies – Timber extraction, mining, dams and their effects on forests and tribal people.

Water resources: Use and overutilization of surface and ground water, conflicts over water, dams – benefits and problems – Water conservation, rain water harvesting, watershed management.

Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

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Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, case studies.
Energy resources: Growing energy needs, renewable and nonrenewable energy sources, use of alternate energy sources, case studies.
Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification, Wasteland reclamation – Role of an individual in conservation of natural resources.

ECOSYSTEMS AND BIODIVERSITY **9 Hours**

ECOSYSTEM: Concept of an ecosystem – Structure and function of an ecosystem: Producers, consumers and decomposers, Food chain, Food web, Energy flow in the ecosystem and Ecological pyramids – Ecological succession – Introduction, types, characteristic features, structure and function of the (a) Forest ecosystem (b) Grassland ecosystem (c) Desert ecosystem (d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).

BIODIVERSITY: Introduction to Biodiversity – Definition: genetic, species and ecosystem diversity – Bio geographical classification of India – Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic values – India as a mega-diversity nation – Hot-spots of biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

ENVIRONMENTAL POLLUTION **8 Hours**

Definition – Causes, effects and control measures of: (a) Air pollution – Organic and inorganic pollution – cyclone separator, electrostatic precipitator (b) Water pollution (c) Heavy metal pollution (d) Noise pollution (e) Thermal pollution (f) Nuclear hazards – Role of an individual in prevention of pollution – Pollution case studies – Solid waste and hazardous Management: Causes, effects and control measures from factories, small scale and large scale industries – Waste minimization – Disaster management: floods, earthquake, cyclone and landslides.

SOCIAL ISSUES AND THE ENVIRONMENT **7 Hours**

From Unsustainable to Sustainable development – Urban problems related to energy – Resettlement and rehabilitation of people; its problems and concerns, case studies – Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion – Environment Production Act – Air (Prevention and Control of Pollution) Act – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Human Rights.

HUMAN POPULATION AND THE ENVIRONMENT **7 Hours**

Population growth and explosion – Welfare Program – Environment and human health – Communicable disease – Role of Information Technology in Environment and human health – Case studies.

Theory: 45 Hours **Total: 45 Hours**

REFERENCES

1. G. Tyler Miller and Scott Spoolman, 'Environmental Science', Fourteenth Edition, Brooks Cole, 2012.

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2. Gilbert M. Masters and Wendell P. Ela, 'Introduction to Environmental Engineering and Science', Third Edition, Pearson Education, 2013.
3. Bharucha Erach, 'The Biodiversity of India', Mapin Publishing Pvt. Ltd., Ahmedabad, 2002.
4. Trivedi R.K and P.K.Goel, 'Introduction to Air Pollution', Techno-Science Publications, 2003.
5. Trivedi R.K., 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media, 1996.
6. Cunningham, W.P.Cooper and T.H.Gorhani, 'Environmental Encyclopedia', Jaico Publication House, Mumbai, 2001.
7. Wager K.D., 'Environmental Management', W.B. Saunders Co., Philadelphia, USA, 1998.
8. Colin R. Townsend, Michael Begon and John L. Harper, 'Essentials of Ecology', Third Edition, Blackwell Publishing, 2008.

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SEMESTER 4

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U18MAT4101

NUMERICAL METHODS AND PROBABILITY

L	T	P	J	C
3	1	0	0	4

(Common to AE/AUE/CE/ME/MCE/EEE)

COURSE OUTCOMES

After successful completion of this course, the students will be able to

- **CO1:** Apply various numerical techniques for solving non-linear equations and systems of linear equations.
- **CO2:** Analyze and apply the knowledge of interpolation and determine the integration and differentiation of the functions by using the numerical data.
- **CO3:** Predict the dynamic behaviour of the system through solution of ordinary differential equations by using numerical methods.
- **CO4:** Solve PDE models representing spatial and temporal variations in physical systems through numerical methods
- **CO5:** Apply the concepts of probability to random variables
- **CO6:** Construct probabilistic models for observed phenomena through distributions which play an important role in many engineering applications.

Pre-requisite: NIL

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S												
CO2	S	S												
CO3	S	S							M					
CO4	S	S												
CO5	S	S							M					
CO6	S	S												

COURSE ASSESSMENT METHODS

Direct

1. Continuous Assessment Test I, II
2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable)
3. End Semester Examination

Indirect

1. Course-end survey

SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS **9+3 Hours**

Linear interpolation method – Iteration method – Newton's method – Solution of linear system by Gaussian elimination and Gauss-Jordan methods - Iterative methods: Gauss Jacobi and Gauss - Seidel methods – Inverse of matrix by Gauss – Jordan method – Eigenvalues of a matrix by Power method.

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INTERPOLATION, NUMERICAL DIFFERENTIATION AND INTEGRATION 9+3 Hours

Lagrange's and Newton's divided difference interpolation – Newton's forward and backward difference interpolation – Approximation of derivatives using interpolation polynomials – Numerical integration using Trapezoidal and Simpson's rules.

NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS 9+3 Hours

Single step methods: Taylor's series method – Euler and Improved Euler methods for solving a first order equations – Fourth order Runge-Kutta method for solving first and second order equations – Multistep method: Milne's predictor and corrector method.

BOUNDARY VALUE PROBLEMS IN PARTIAL DIFFERENTIAL EQUATIONS 9+3 Hours

Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain–Solution of one dimensional heat equation using Bender Schmidt and Crank Nicholson difference schemes –Solution of one dimensional wave equation by explicit scheme.

PROBABILITY AND RANDOM VARIABLES 9+3 Hours

Axioms of probability - Conditional probability – Total probability – Bayes' theorem – Random variable – Distribution function – properties – Probability mass function- Probability density function – moments - Binomial, Poisson and Normal distributions – Properties.

Theory: 45 Hours Tutorials: 15 Hours Total: 60 Hours

REFERENCES

1. Grewal, B.S. and Grewal,J.S., " Numerical methods in Engineering and Science", 9th Edition, Khanna Publishers, New Delhi, 2007.
2. Gerald, C. F. and Wheatley, P. O., "Applied Numerical Analysis", 7th Edition, Pearson Education Asia, New Delhi, 2007.
3. Chapra, S. C and Canale, R. P. "Numerical Methods for Engineers", 7th Edition, Tata McGraw-Hill, New Delhi, 2016.
4. R.A. Johnson and C.B. Gupta, "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 9th Edition, 2016.
5. R.E. Walpole, R.H. Myers, S.L. Myers, and K Ye, "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 9th edition, 2017.
6. Gupta S.C, and Kapur V.K "Fundamentals of Applied Statistics", Sultan Chand, New Delhi, 4th Edition, 2014.

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U18AUI4201 **AUTOMOTIVE ENGINES AND SYSTEMS**

L	T	P	J	C
3	0	2	0	**4**

Course Objective:
Impart knowledge on IC engines and its subsystems for understanding their role in automobiles.

Course Outcomes:
After successful completion of this course, the students should be able to:

CO1: Outline the various components of the engine and its functions.
CO2: Examine the combustion process in SI and CI Engine for understanding the performance and emission characteristics.
CO3: Summarize various fuel supply and injection system used in IC engines.
CO4: Identify the suitable lubrication and cooling system to be used in IC Engines.
CO5: Explain the concepts of Supercharging and Turbocharging.
CO6: Analyze the various properties of fuels used in I.C engines.

Pre-requisite:
1 U18AUT3103 - Thermodynamics and Thermal Engineering

CO-PO/PSO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S		S			S	S	M		M				S
CO2:	S		S			S	S	S	M	S				S
CO3:	S		S			M		M		M				M
CO4:	M		S			M		M		M				S
CO5:	S		S			S	M	M		M				M
CO6:	S		S			S	S	S		S				S

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

ENGINE CONSTRUCTION AND ITS COMPONENT **L: 9 Hrs**

Four stroke SI and CI engines – Working principle- Constructional details of engine components, function, materials, Intake system components - Discharge coefficient, Pressure drop Air filter, intake manifold, Connecting Pipe, Exhaust system components – Exhaust manifold and exhaust pipe, Spark arresters - Exhaust mufflers, Types, operation.

COMBUSTION IN SI ENGINES **L: 12 Hrs**

Combustion process in IC engines, Stages of combustion, Flame propagation Flame velocity and area of flame front - Rate of pressure rise - Cycle to cycle variation, Abnormal combustion - Theories of detonation -Effect of engine operating and design variables on combustion, Combustion chambers – types, factors controlling combustion chamber design. Gasoline injection Systems

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COMBUSTION IN CI ENGINES **L: 12 Hrs**

Importance of air motion – Swirl, squish and turbulence – Swirl ratio. Fuel air mixing – Stages of combustion – Delay period – Factors affecting delay period, Knock in CI engines – methods of controlling diesel knock. CI engine combustion chambers – Combustion chamber design objectives – open and divided. Induction swirl, turbulent combustion chambers. – Air cell chamber – M Combustion chamber, Diesel injection system.

LUBRICATION AND COOLING SYSTEM **L: 3 Hrs**

Need for cooling system – Types of cooling system – Liquid cooled system: Thermosyphon system, Forced circulation system, pressure cooling system – properties of coolant, additives for coolants Need for lubrication system – Mist lubrication system, wet sump any dry sump lubrication – Properties of lubricants, consumption of oil.

SUPERCHARGING AND TURBOCHARGING **L: 9 Hrs**

Objectives – Effects on engine performance – engine modification required – Thermodynamics of supercharging and Turbocharging – Turbo lag-Windage losses- Turbo charging methods – Engine exhaust manifold arrangements.

Practical

List of Exercises : **P: 30 Hrs**

1. Dismantling and Assembly of Engine components.
2. Experimental investigation on performance and emission characteristics of Twin cylinder C.I engines
3. Experimental Investigation on Performance, combustion and emission characteristics of Single cylinder D.I Diesel engines
4. Experimental investigation on performance and emission characteristics of Multi cylinder S.I engines
5. Study on CRDI and MPFI fuel injection system.
6. Flash and fire point of fuels
7. Cloud and pour point test
8. Calorific value of liquid and gaseous fuel
9. Viscosity of fuels, Lubricants
10. Drop point of grease and mechanical penetration in grease.

Theory : 45 Hrs	Practical: 30 Hrs	**Total Hours: 75**

References:

1. "*Internal combustion engines*", Ganesan V, 4th edition, Tata McGraw Hill Education, 2017.
2. IC Engines Combustion and Emissions, B.P.Pundir, Narosa Publishers, 2010
3. "A textbook of Internal Combustion Engines - Rajput R. K, 2nd edition, Laxmi Publications (P) Ltd, 2017.
4. "*Internal Combustion Engine Fundamentals*", John. B, Heywood, McGraw Hill Publishing Co., New York, 2017.
5. *Internal Combustion Engines and Air Pollution* Edward F, Obert,*"*, Intext Education Publishers, 1980.
6. Mathur and Sharma, "*A course on Internal combustion Engines*", Dhanpat Rai & Sons, 2015.

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U18AUI4202 **FLUID MECHANICS AND MACHINERY**

L	T	P	J	C
3	0	2	0	**4**

Course Objective:
To understand the fundamental concepts of fluid flow and its application in flow measurement devices, pipes and hydraulic machines.

Course Outcomes:
After successful completion of this course, the students should be able to:

CO1: Understand the properties of the fluid, flow concepts and measuring devices
CO2: Apply the fluid flow concepts and solve the problems
CO3: Analyse the practical flow problems using mathematical techniques
CO4: Apply the laws of conservation in flow through pipes
CO5: Illustrate the working principles of hydraulic machines
CO6: Correlate the Fluid Mechanics principles by performing laboratory experiments.

Pre-requisite:
1 NIL

CO-PO/PSO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S	M	M									M		
CO2:	S	M	M									M	M	
CO3:	S	M	M									M	M	
CO4:	S	M	M									M	M	
CO5:	M											M		
CO6:	S	M	M						M			M	M	

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

PROPERTIES OF FLUIDS AND FLUID STATICS **L: 9 Hrs**

Fluid properties: Mass density, specific weight, specific volume, specific gravity, viscosity, vapour pressure, compressibility, surface tension and capillarity. Fluid statics: fluid pressure at a point, variation of pressure within a static fluid, hydrostatic law – Pressure head, Pascal's law. Measurement of pressure – Piezometric tube, manometry.

FLUID KINEMATICS AND FLUID DYNAMICS **L: 12 Hrs**

Fluid kinematics: Lagrangian and Eulerian description of fluid flow – Velocity and acceleration of fluid particles – Different types of fluid flow. Description of flow pattern: Stream line, streak line, path line, Vorticity and rotationality. Principle of conservation of mass – Continuity equation, Navier-Stokes Equations-Applications

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Fluid dynamics: Euler's equation of motion along a streamline – Bernoulli's equation. Practical applications of Bernoulli's equation in flow measurement devices like Venturimeter, Orificemeter and Pitot tube. Concept of impulse momentum equation & angular momentum principle with applications.

DIMENSIONAL AND MODEL ANALYSIS **L: 9 Hrs**

Dimensional analysis: dimensions, dimensional homogeneity, methods of dimensional analysis-Buckingham π theorem. Model analysis – Advantages and applications of model testing. Similitude, derivations of important dimensionless numbers, model laws, distorted models.

FLOW THROUGH PIPES **L: 9 Hrs**

Laminar and turbulent flow characteristics, laminar flow through circular pipes – Hagen Poiseuille law, Turbulent flow – development of Darcy – Weisbach equation, major and minor losses in pipes, Flow through pipes in series and parallel,Hydraulic gradient and Total energy line.

HYDRAULIC MACHINES **L: 6 Hrs**

Hydraulic turbine: Classification, difference between impulse and reaction turbine. Construction and working of Pelton turbine, Francis turbine and Kaplan turbine.
Pumps: classification, difference between positive and non-positive displacement pumps. Construction and working of reciprocating pump and Centrifugal pump, Performance curves of turbines and pumps.

Practical

List of Exercises : **P: 30 Hrs**

1 Verification of Bernoulli's theorem
2 Determination of Darcy's friction factor
3 Determination of coefficient of discharge of Venturimeter
4 Determination of coefficient of discharge of Orificemeter
5 Determination of coefficient of discharge of notches
6 Determination of coefficient of discharge of mouthpiece/Orifice
7 Performance study on centrifugal pump
8 Performance study on gear oil pump/Reciprocating Pump
9 Load test on Pelton wheel turbine
10 Load test on Francis tubine
11 Load test on Kaplan turbine

Theory : 45 Hrs	Practical: 30 Hrs	**Total Hours: 75**

References:

1 "Fluid mechanics and hydraulic machines", R.K. Bansal, Laxmi Publications (P) Ltd, Tenth edition, 2018.
2 "Hydraulics and Fluid Mechanics", Modi P.N. and Seth S.M., Standard Book House, New Delhi, 21 edition, 2018.
3 Robert W. Fox, Alan T. McDonald, Philip J. Pritchard, "Introduction to Fluid Mechanics", Wiley, 8th Edition, 2013.
4 Frank M.White, "Fluid Mechanics", McGraw-Hill, 7th Edition, New Delhi, 2011.
5 Irving H. Shames, "Mechanics of Fluids", McGraw Hill, 3rd Edition, 2013.

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U18AUI4203 **MANUFACTURING TECHNOLOGY**

L	T	P	J	C
3	0	2	0	**4**

Course Objective:

Impart knowledge on various manufacturing process used for components manufacturing.

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Outline the various moulding and special casting processes and identify the defects that occur during the process.
CO2: Familiarize the Forming and Powder metallurgy processes.
CO3: Demonstrate the metal joining processes and identify the defects.
CO4: Apply knowledge and skill on Conventional Machining processes.
CO5: Explain the various Unconventional Machining processes.
CO6: Select the appropriate processes used for Automotive Components manufacturing.

Pre-requisite:

1 NIL

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	M	M	S				M		S					M
CO2:	M	M	S				M		S					M
CO3:	M	M	S				M		S					M
CO4:	S	S	S				M		S					M
CO5:	M	M	S	M										M
CO6:	S	S	S				M							M

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

CASTING **L: 9 Hrs**

Casting types, Procedure to make sand mould, types of core, moulding tools, machines used for moulding, Special moulding processes – CO_2 moulding, Shell moulding, Investment moulding, Permanent mould casting- Pressure die casting, Centrifugal casting, Continuous casting, Casting defects, Application of Castings in Automobile.

FORMING PROCESSES AND POWDER METALLURGY **L: 9 Hrs**

Principles and applications of the following processes: Forging, Rolling, Extrusion, Wire drawing and Spinning - Principles of Hydroforming process, its advantages and limitations-Powder metallurgy – Principal steps involved, advantages, disadvantages and limitations of powder metallurgy - Forming and Shaping of Plastics –Types of plastics and Molding Types.

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METAL JOINING TECHNIQUES **L: 9 Hrs**

Classification of welding processes. Principles of gas welding- Oxy-acetylene- A.C metal arc welding, Resistance welding, Submerged arc welding, Tungsten inert gas welding, Metal inert gas welding, Plasma arc welding, Electron beam welding, Laser beam welding, defects in welding, Soldering and brazing, Application of Welding in Automobile.

METAL CUTTING AND MACHINE TOOLS **L: 9 Hrs**

Introduction to metal cutting, Principle and Geometry of single point turning tools, Different types of cutting tools, Single point cutting tool, tool nomenclature, Tool materials, types of chips
Construction and working principle of the Lathe-Capstan and Turret lathe, Shaper, Milling machines, Drilling machines, grinding machine, CNC machines.

UNCONVENTIONAL MACHINING PROCESSES **L: 9 Hrs**

Principles and applications of the Abrasive jet machining, Ultrasonic machining, Electric discharge machining, Electro chemical machining, Plasma arc machining, and Electron beam machining and Laser beam machining.

Practical

List of Exercises : **P: 30 Hrs**

1. Facing, and plain turning and step turning
2. Taper Turning using compound rest method
3. Taper Turning using taper turning attachment method
4. Single start 'V' Thread Cutting and Knurling
5. Machining a 'V '- block using shaping machine
6. Machining an internal keyway using slotting machine
7. Drilling 4 holes at a given pitch circle on a plate
8. Drilling, reaming & tapping
9. Plain milling operation using milling machine
10. Milling of spur gear using Universal Milling machine
11. Surface grinding
12. Moulding using single and Split Pattern

Theory : 45 Hrs	Practical: 30 Hrs	**Total Hours: 75**

References:

1. Hajra Choudhury, "Elements of Workshop Technology", Vol. I and II, Media Promoters and Publishers Pvt., Ltd., Mumbai, 2005.
2. NagendraParashar B.S. and Mittal R.K., "Elements of Manufacturing Processes", Prentice-Hall of India Private Limited, 2007.
3. SeropeKalpajian, Steven R.Schmid, "Manufacturing Processes for Engineering Materials", 4/e, Pearson Education, Inc. 2007.
4. R.K.Jain and S.C. Gupta, "Production Technology", Khanna Publishers. 16th Edition, 2001.
5. "H.M.T. Production Technology – Handbook", Tata McGraw-Hill, 2000.
6. Roy. A. Linberg, "Process and Materials of Manufacture", PHI, 2000.
7. M. Adithan and A.B. Gupta, "Manufacturing Technology", New Age, 2006
8. Fundamentals of Metal Cutting and Machine Tools, B.L.Juneja, G.S.Sekhon, Nitin Seth, New Age International (P) Limited ,Publishers, 2005
9. Modern Machining Processes, P. C. Pandey, H. S. Shan, Tata McGraw-Hill Education, 1980

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U18AUI4204 **MACHINE DRAWING**

L	T	P	J	C
3	0	2	0	**4**

Course Objective:
To make the students to understand the concepts of I.S. conventions, methods of dimensioning and sectioning, to draw part and assemble drawings using drawing instruments and software tools.

Course Outcomes:
After successful completion of this course, the students should be able to:
CO1: Interpret the conventional representation of components
CO2: Construct part drawings with required views and dimensions
CO3: Apply the knowledge of Limits, Fits and Tolerances in the drawings.
CO4: Build part and assembly drawings according to BIS with Bill of Materials
CO5: Identify and draw the different types of Screwed Fastenings.
CO6: Make use of CAD software to model and draft components and assemblies.

Pre-requisite:
1 NIL

CO-PO/PSO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S		M		S			M	M	S		M	S	
CO2:	S	M	S	M	S			M	S	S		M	S	
CO3:	S	M	S	M	S	W		S		S			M	S
CO4:	M	S	S		S			M	S	S			S	
CO5:	M	M	M		S			M	M	S			S	
CO6:	M	S	S		S			M	S	S			S	

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

Introduction **L: 2 Hrs**
Need of Graphical Language, Importance Machine Drawing
Classification of Machine Drawings
Part Drawing and Assembly Drawing

Sectioning **L: 2 Hrs**

Conventional Representations **L: 2 Hrs**
Standard parts and Screwed Fastenings.

Limits, Fits, Dimensional and Form Tolerances **L: 6 Hrs**
Definitions, Classifications of Fits, System of Fits, Selection of Fits, Method of Indicating Fits on Drawings, Tolerance Grade, Positions of Tolerance, Form Tolerance, Fundamental of Deviations, Shaft and Hole Basis systems, Method of Placing Limit Dimensions

Part and Assembly Drawings **L: 3 Hrs**
Introduction, BOM and its Importance, Assembly procedures

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List of Exercises: (Any Five to be practiced) **L: 30 Hrs**
P: 30 Hrs

1. Part and Assembly Drawing of Screw Jack
2. Part and Assembly Drawing of Knuckle Joints
3. Part and Assembly Drawing of Universal coupling
4. Part and Assembly Drawing of Lathe Tail Stock
5. Part and Assembly Drawing of Gear Pump
6. Part and Assembly Drawing of Crankshaft with connecting road and piston
7. Part and Assembly Drawing of Single Plate Clutch

Theory : 45 Hrs	Practical: 30 Hrs	**Total Hours:75**

References:

1. Machine Drawing Textbook By ND Bhatt – 53rd Edition 2016
2. Machine Drawing- P.S. Gill, S.K. Kataria & Sons, 17 th Edition, 2012.
3. Machine Drawing- K.L. Narayana, P.Kannaiah & K.Venkata Reddy, New Age Publishers, 4 th Edition, 2012.
4. "Machine Drawing", Gopalakrishnan.K.R, Subash Publishers, Bangalore, 2000.
5. "Machine Drawing", N. D. Junnarkar , Pearson India, 2006
6. Technical Graphics Communication (IRWIN Graphic Series), Bertoline, Wiebe, Miller, Nasma., Richard D Irwin; 2nd edition (June 1997)

U18AUT4005

AUTOMOTIVE ELECTRICAL ENGINEERING

L	T	P	J	C
3	0	0	0	**3**

Course Objective:

- Understand battery, Cranking motor construction and testing methods.
- Understand the principle of alternator and to test the alternator
- Recognize different electrical wiring diagrams used in automobile manuals

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Apply the fundamental of ac and dc circuits to real time applications
CO2: Classify the different types of motors and generators based on different parameters
CO3: Select a suitable motor for automotive application
CO4: Distinguish the various basic electrical and electronics systems of an automobile.
CO5: Outline the working of different batteries available and select them based on the application
CO6: Recognize and build small wiring applications / wiring diagrams used in vehicles

Pre-requisite:

1 NIL

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S								M	M	M			M
CO2:		S	M											M
CO3:		S	M	M										S
CO4:	S		M											M
CO5:	S			M		M								S
CO6:			S	S					M	M	M			M

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

AC AND DC CIRCUITS **L: 7 Hrs**

Ohm's law - Ideal voltage and current sources-Independent sources -dependent sources-circuit elements - Kirchhoff's law - voltage and current division in series and parallel circuits-Node and Mesh analysis –Introduction to AC Circuits, Sinusoidal voltage and current-RMS and average value of periodic waves - Form factor - Phase and Phase difference – Simple RC.RL and RLC circuits - power and power factor.

ELECTRICAL MACHINES **L: 10 Hrs**

DC Machines: Construction and working principle of dc machines, Basic Equations and Applications, types of dc machines, speed - torque characteristics of dc motors, speed control of dc motors, braking of dc motors

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Ac Machines: Construction and working principle of ac machines, Basic Equations and Applications, types of ac motors - Induction motors, Synchronous motors, speed - torque characteristics of Induction motors, speed control of ac motors, braking of induction motors
Transformer - single phase and three phase transformers

STARTING SYSTEM **L: 6 Hrs**

Requirement of a starting System, Starter motor Construction and Working, Starter Drive Mechanism –Bendix drive and Folo-thru drive, Over Running Clutch and Solenoid Mechanism. Starter Motor Fault Diagnosis, New Developments in Starting System

CHARGING SYSTEM **L: 6 Hrs**

Alternator - Construction and working of alternators, advantages of alternators over D.C Generator, Alternator Charging Circuits and Rectification of AC to DC, Alternator Testing Methods, Mechanical and Electronic Voltage regulator, charging circuits

BATTERIES **L: 6 Hrs**

Batteries – Construction and working Principle of Lead acid battery, Nickel Cadmium Battery, Nickel Metal Hydride Battery, Sodium Sulphur Battery and Aluminum air Battery, Lithium ion batteries, Battery Rating, selection of batteries, Lead Acid battery - Charging methods, Testing Methods and Fault Diagnosis, New Developments in Battery Technologies

WIRING SYSTEM **L: 10 Hrs**

Automotive electrical wiring, terminals and switching, multiplexed wiring system, electromagnetic compatibility(EMC), Lighting system – basic lighting system, Head Lamp and Indicator Lamps, Anti–Dazzling and Dipper system, Wiper system, Signaling and Warning system, Earthing - positive earthing and negative earthing,

Theory : 45 Hrs	Tutorial: 0 Hrs	**Total Hours: 45**

References:

1 Tom Denton “Automobile Electrical and Electronic Systems” 3rd edition, Elsevier Butterworth-Heinemann 2004.
2 Sudhakar. A, Shyammohan. S.P “Circuits and Networks-Analysis and Synthesis”; Tata McGraw Hill publishers, 2006.
3 M Nahvi I J A Edminster “Electric Circuits”; Schaum's outline series , Tata Mcgraw Hill companies, 4th Edition, 2009
4 Robert Bosch Gmbh “Bosch Automotive Electric and Electronics” 5th edition Springer-Vieweg.2007
5 Fitzgerald, A.E.Charles Kingsley Jr.Stephen D.Umans, ‘Electric Machinery’, McGraw Hill Book Company, Sixth Edition 2003.
6 William.B.Ribbens , “Understanding Automotive Electronics” 7th edition Butterworth-Heinemann publications,2012
7 Allan.W.M.Bonnick “Automotive Computer Controlled System”, Butterworth-Heinemann. 2001

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U18INI4600 **ENGINEERING CLINIC - IV**

L	T	P	J	C
0	0	4	2	3

Course objectives

- To help the students look into the functioning of simple to complex devices and systems
- To enable the students to design and build simple systems on their own
- To help experiment with innovative ideas in design and team work
- To create an engaging and challenging environment in the engineering lab

Course Outcomes

After successful completion of this course, the students should be able to:

CO1: Identify a practical problems and find a solution
CO2: Understand the project management techniques
CO3: Demonstrate their technical report writing and presentation skills

Pre-requisite:

1. U18INI3600 - Engineering Clinic - III

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	S	S	S	S	S	S	S			S	S	S
CO2								S	S	S	S		M	M
CO3								S		S				

Course Assessment methods:

Direct	Indirect
1. Project reviews	1. Course Exit Survey
2. Workbook report	
3. Demonstration & Viva-voce	

Content:

The course will offer the students with an opportunity to gain a basic understanding of computer controlled electronic devices and apply the concepts to design and build simple to complex devices. As a practical project based embedded course, the students will be taught the concepts using a variety of reference material available in the public domain. While the course will start with formal instruction on hardware, programming and applications, the major portion of the course will provide the students with ample opportunity to be innovative in designing and building a range of products from toys to robots and flying machines.

In the fourth semester, students will focus primarily on Reverse engineering project to improve performance of a product.

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GUIDELINES:

1. Practical based learning carrying credits.
2. Multi-disciplinary/ Multi-focus group of 5-6 students.
3. Groups can select to work on a specific tasks, or projects related to real world problems.
4. Each group has a faculty coordinator/Instructor who will guide/evaluate the overall group as well as individual students.
5. The students have to display their model in the 'Engineering Clinics Expo' at the end of semester.
6. The progress of the course is evaluated based on reviews and final demonstration of prototype.

Total Hours: 90

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U18INT4000 **CONSTITUTION OF INDIA**
(Mandatory course)

L	T	P	J	C
2	0	0	0	0

Course Outcomes:

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

CO 1: Gain Knowledge about the Constitutional Law of India
CO 2: Understand the Fundamental Rights and Duties of a citizen
CO 3: Apply the concept of Federal structure of Indian Government
CO 4: Analyze the Amendments and Emergency provisions in the Constitution
CO 5: Develop a holistic approach in their life as a Citizen of India

Pre-requisites : NIL

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						M			W			S
CO2						S		S				M
CO3									M	S		W
CO4								W	M			M
CO5						M		M				S
CO6												

Course Assessment methods

Direct
1. Group Activity / Quiz/ Debate / Case studies 2. Class test / Assignment
Indirect
Surveys

THEORY COMPONENT:

Module.1: Introduction to Indian Constitution **4 hours**

Meaning of the constitution law and constitutionalism - Historical perspective of the Constitution - Salient features and characteristics of the Constitution of India

Module.2: Fundamental Rights **8 hours**

Scheme of the fundamental rights - Right to Equality - Fundamental Right under Article 19 - Scope of the Right to Life and Liberty - Fundamental Duties and its legal status - Directive Principles of State Policy – Its importance and implementation

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Module.3: Federal Structure **8 hours**

Federal structure and distribution of legislative and financial powers between the Union and the States - Parliamentary Form of Government in India - The constitutional powers and status of the President of India

Module.4: Amendment to Constitution **6 hours**

Amendment of the Constitutional Powers and Procedure - The historical perspectives of the constitutional amendments in India

Module.5: Emergency Provisions **4 hours**

National Emergency, President Rule, Financial Emergency
Local Self Government – Constitutional Scheme in India

Total **30 hours**

Theory: 30	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 30 hours**

REFERENCES

1. Constitution of India - Ministry of Law & Justice – PDF format
   awmin.nic.in/coi/coiason29july08.pdf

2. **Introduction to the Constitution of India by Durgadas Basu**

3. The Constitution of India – Google free material - www.constitution.org/cons/india/const.html

4. Parliament of India – PDF format
   download.nos.org/srsec317newE/317EL11.pdf

5. The Role of the President of India – By Prof.Balkrishna

6. Local Government in India – E Book - Pradeep Sachdeva
   https://books.google.com/books/.../Local_Government_in_In..

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U18VET3101 / U18VET4101	UNIVERSAL HUMAN VALUES 2: UNDERSTANDING HARMONY (Common to all UG branches from 2020-2024 batch onwards)	L	T	P	J	C
		2	1	0	0	3

COURSE OUTCOMES:

After successful completion of this course, the students shall be able to

CO 1:	Develop a holistic perspective based on self- exploration about themselves (human being), family, society and nature/existence.
CO 2:	Understand (or develop clarity) of the harmony in the human being, family, society and nature/existence
CO 3:	Strengthen their self-reflection.
CO 4:	Develop commitment and courage to act.

Pre-requisites: - None. Universal Human Values 1 (Desirable)

CO-PO AND CO-PSO MAPPING:

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						M	M	M	S			M	-	-
CO2						S	M		S	S		S	-	-
CO3								M	M		W	S	-	-
CO4								S	M		M	M	-	-

COURSE ASSESSMENT METHODS:

Direct
4. Assessment by faculty mentor 5. Self-assessment 6. Socially relevant project/Group Activities/Assignments 7. End Semester Examination
Indirect
1. Assessment by peers (Survey form)

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COURSE CONTENTS:

Module 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

1. Purpose and motivation for the course, recapitulation from Universal Human Values-I.
2. Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration.
3. Continuous Happiness and Prosperity- A look at basic Human Aspirations
4. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority.
5. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
6. Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.

Module 2: Understanding Harmony in the Human Being - Harmony in Myself!

1. Understanding human being as a co-existence of the sentient 'I' and the material 'Body'.
2. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility.
3. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer).
4. Understanding the characteristics and activities of 'I' and harmony in 'I'.
5. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail.
6. Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available tome. Identifying from one's own life.

Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.

Module 3: Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship

1. Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship
2. Understanding the meaning of Trust; Difference between intention and competence
3. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship

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4. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals
5. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.

Module 4: Understanding Harmony in the Nature and Existence - Whole existence as Coexistence

1. Understanding the harmony in the Nature
2. Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self-regulation in nature.
3. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space.
4. Holistic perception of harmony at all levels of existence.
5. Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

Module 5: Implications of the above Holistic Understanding of Harmony on Professional Ethics

1. Natural acceptance of human values
2. Definitiveness of Ethical Human Conduct
3. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
4. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
5. Case studies of typical holistic technologies, management models and production systems
6. Strategy for transition from the present state to Universal Human Order:

   a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers
   b. At the level of society: as mutually enriching institutions and organizations
7. Sum up.

Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions e.g. To discuss the conduct as an engineer or scientist etc.

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COURSE DURATION:

No	MODULE	HOURS
1	Module 1	[7 Theory+ 3 Tutorial] 10 Hrs
2	Module 2	[6 Theory+ 3 Tutorial] 9 Hrs
3	Module 3	[7 Theory+ 3 Tutorial] 10 Hrs
4	Module 4	[5 Theory+ 3 Tutorial] 8 Hrs
5	Module 5	[5 Theory+ 3 Tutorial] 8 Hrs
	Total	**45**

Theory: 30 Hours	**Tutorial:15**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

TEXT BOOK:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

REFERENCE BOOKS:

1. Jeevan Vidya: EkParichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi.
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj - PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)
14. https://www.youtube.com/watch?v=E1STJoXCXUU&list=PLWDeKF97v9SP_Kt6jqzA3pZ3yA7g_OAQz
15. https://www.youtube.com/channel/UCo8MpJB_aaVwB4LWLAx6AhQ
16. https://www.uhv.org.in/uhv-ii

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SEMESTER 5

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U18AUT5001 **AUTOMOTIVE ELECTRONICS**

L	T	P	J	C
3	0	0	0	**3**

Course Objective:

To give insight of the basic concepts of automotive electronics and develop the application for automotive

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Exposure on fundamentals of electronic components
CO2: Design the power supply for the given specification
CO3: Construct the digital circuit using logic gates for the given logical operation
CO4: Familiarize the student with electronic component functions involved in automotive electronic circuits
CO5: Explain the working principle of application specific Electronic control unit
CO6: Construct the ECU architecture for the given application

Pre-requisite:

1 Automotive Electrical Engineering

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S	M			S									S
CO2:	M	M	S		S									S
CO3:	M	M	M		S									S
CO4:	S	M			S									S
CO5:	M	M			S									S
CO6:	S	M			S									S

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Quiz		
3	Continuous Assessment Tests		
4	End-Semester Examination		

ELECTRONIC COMPONENTS IN THE VEHICLE **L: 9 Hrs**

Basic principle of semiconductor technology, Passive Linear Components – Resistor, Types of Resistors, Practical Application of Variable Resistors, Capacitors - Types of Capacitors, Inductors, semiconductor Non Linear Components – Diodes, Types of Diodes, Switches, semiconductor resistor-NTC resistor and PTC resistor, Active Electronic Components – Transistors, Types of Transistor - Integrated Circuit, Manufacture of semiconductor components and circuits.

DESIGN OF REGULATED POWER SUPPLY **L: 9 Hrs**

Introduction to regulated power supply, Basic Circuit Configuration, Types of rectifier- Bridge rectifier, Types of voltage regulator - Voltage regulator applications, Regulator Circuit Design using IC7805, IC 7812 and IC 7905, IC7912, IC LM317, Zener diode1N4728A applications, Designing of power supplies.

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INTRODUCTION TO DIGITAL ELECTRONICS **L: 9 Hrs**

Basic difference between analog and digital signal, Concept of negative and positive logic, Binary and hexadecimal number system, conversion from decimal and hexadecimal to binary and vice versa, Definition, symbols and truth tables of NOT, AND, OR, NAND,EXOR Gates, NAND and NOR as universal gates, application of digital electronics.

AUTOMOTIVE ELECTRONIC CIRCUITS **L: 9 Hrs**

Single Pushbutton Latching Relay Engine Start Circuit, Adaptive Lighting System for Automobiles, 555 Ignition Coil Driver, Car Interior Light Dimmer, 12V Car Battery Monitor, Engine Running Detector, Load Switch, Anti-theft Car Alarm Circuit, keyless entry circuit, Automotive Wash Wiper Timer, DC motor speed control using electronic components.

AUTOMOTIVE ECU APPLICATIONS **L: 9 Hrs**

Introduction to ECU - Development of electronic system, task of an electronic system, ECU architecture - Input signals to ECU - Discrete, Frequency, and Analog, Embedded controller, Output signals from ECU - Switch output, PWM output, and Frequency output, Types of ECU - Engine Control Module (ECM), Electronic Brake Control Module (EBCM), Powertrain Control Module (PCM), Vehicle Control Module (VCM), Body Control Module (BCM), Battery management system (BMS).

Theory :45 Hrs	Tutorial: 0 Hrs	**Total Hours: 45**

References:

1 Bosch Automotive Electrics and Automotive Electronics: Systems and Components, Networking and Hybrid Drive (Bosch Professional Automotive Information) 5th ed. 2014 Edition by Robert Bosch gmbh

2 The 2018-2023 World Outlook for Automotive Electronic Control Unit (ECU) Safety Systems by Icon Group International.

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U18AUT5102 **DESIGN OF MACHINE ELEMENTS**

L	T	P	J	C
3	1	0	0	**4**

(Use of PSG design data book is allowed)

Course Objective:

To impart knowledge on theory and design of machine elements and train them in solving design problems involving common machine elements.

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Understand Design Morphology & categorize design types.
CO2: Apply the design concepts of Shafts & Springs
CO3: Infer Gear terminology & Apply in gear design
CO4: Design and validation of bearing
CO5: Infer Energy storage capacity and design flywheel
CO6: Apply safe design concepts in machine elements

Pre-requisite:

1 U18AUI3202- Strength of Materials

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S	M	M						M	M		S	M	
CO2:	S	S	S							M		S	S	
CO3:	S	S										S		
CO4:	S	S								M		S	S	
CO5:	S	S	S						M	M		S	S	
CO6:	S	S	S						M	M		S	S	

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

L: 9 Hrs T: 3 Hrs

INTRODUCTION

Introduction to design and machine elements and, Classification of design – Selection of materials – Factors of safety in design – Endurance limit of materials – Determination of endurance limit for ductile materials.

DESIGN OF SHAFTS AND SPRINGS **L: 9 Hrs T: 3 Hrs**

Introduction – Material and design stresses – Design of axles – Design of shafts on the basis of strength – Design of shaft on the basis of rigidity – Design of hollow shafts – Design of close coiled helical spring subjected to axial loading – Torsion of helical springs.

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GEAR DESIGN **L: 9 Hrs T: 3 Hrs**

Design considerations – strength of gear teeth – Lewis equation – Terminology of gears Dynamic tooth load – Design of spur gears – helical gears – bevel gears and worm Gears.

DESIGN OF BEARINGS **L: 9 Hrs T: 3 Hrs**

Design of journal bearings – Ball and Roller bearings – Types of Roller bearings – Bearing life – Static load capacity – Dynamic load capacity – Bearing material – Boundary lubrication – Oil flow and temperature rise.

FLYWHEELS **L: 9 Hrs T: 3 Hrs**

Determination of the mass of a flywheel for a given co-efficient of speed fluctuation. Engine flywheels stresses of rim of flywheels. Design of hubs and arms of flywheel – Turning moment diagram.

Theory : 45 Hrs	Tutorial: 15 Hrs	**Total Hours: 60**

References:

1 " Fundamentals of Machine Elements", Bernard J Hamrock, Tata McGraw Hill, 2004
2 " Design of Machine Elements " Bhandari V B , Tata McGraw Hill, 1990
3 "Material selection in mechanical design" Michael F ashby, Butterworth-Heinemann,2001
4 "Machine Design", U C Jindal, Pearson,2010.
5 " A textbook of Machine Design" , R S Khurumi, Eurasia Publishing House.2005
6 "Mechanical Engineering Design" Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett, 9th Edition, Tata McGraw-Hill, 2011.
7 "Machine Design", Sundararajamoorthy T. V. Shanmugam .N, Anuradha Publications, Chennai, 2015.

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U18AUT5103 **MECHANICS OF MACHINES**

L	T	P	J	C
3	1	0	0	**4**

Course Objective:
Understand the mechanisms of mechanical systems and analyze the forces and motions.

Course Outcomes:
After successful completion of this course, the students should be able to:
CO1: Calculate the velocity and acceleration of simple mechanisms.
CO2: Create the cam profile for different follower motions.
CO3: Identify the different gear trains and calculate the gear ratio.
CO4: Solve and draw the plots for the static and dynamic balancing of various mechanical systems.
CO5: Evaluate the free and forced vibrations for different applications.
CO6: Summarise the kinematic aspect of the mechanisms in automotive applications

Pre-requisite:
1 NIL

CO-PO/PSO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S	S	S							S			S	
CO2:	S	S	M	M				M	M	S			S	
CO3:	S	S	S	M									M	
CO4:	S	S	M					M		S			M	
CO5:	S	S	S	M		W	W	M					S	
CO6:	S	S	M	W				M		M		S	M	

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

BASICS OF MECHANISMS **T: 9 Hrs T: 3 Hrs**
Machine Structure – Kinematic link, pair and chain – Grueblers criteria – Constrained motion – Degrees of freedom – Kinematic analysis of simple mechanisms –Four bar mechanisms Slider crank and crank rocker mechanisms - Inversions –Applications– Velocity and Acceleration diagram – Calculation of simple four bar and slider crank mechanism using relative velocity method.

DESIGN OF CAM PROFILE **T: 9 Hrs T: 3 Hrs**
Types of cams, Types of followers, Radial cam, Terminology of radial cam, Types of follower motions: uniform motion, simple harmonic motion, constant acceleration/deceleration motion, cycloidal motion, Cam profile for knife edge, Roller and flat faced follower – Graphical method (Mushroom)

KINEMATICS OF GEAR TRAINS **T: 9 Hrs T: 3 Hrs**
Gear profile and geometry – Nomenclature of spur and helical gears, Classification of gear trains, Calculation of Gear ratio, Number of teeth for the gears in the gear trains, Velocities of the gears in gear

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trains such as Simple, Compound, Reverted and Epicyclic (using tabulation method) gear trains, Differential gear train.

BALANCING **T: 9 Hrs T: 3 Hrs**

Static and dynamic balancing – Single and several masses in different planes - Whirling of shafts– Critical speed of shafts - 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

VIBRATIONS **T: 9 Hrs T: 3 Hrs**

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.

Theory : 45 Hrs	Tutorial: 15 Hrs	**Total Hours: 60**

References:

1 Theory of Machines and Mechanisms - Shigley J.E., Pennock G.R., Uicker J.J., 5th Edition, Oxford University Press, 2017.
2 Theory of Machines - Rattan S.S., Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2014.
3 Kinematics and Dynamics of Machinery - Robert L. Norton, Tata McGraw-Hill, 2009.
4 Theory of Machines - Khurmi R.S and Gupta J.K. 14th Revised Edition, S. Chand and Company Ltd., New Delhi, 2005.
5 Theory of Machines - Ballaney P.L., 3rd Edition, Khanna Publishers, New Delhi, 2004.

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U18AUI5204 **FINITE ELEMENT ANALYSIS**

L	T	P	J	C
3	0	2	0	**4**

Course Objective:

This course focuses on the fundamentals concepts and formulation of the finite element method for solving engineering problems arising in structural mechanics & heat transfer.

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Recognize the concepts of finite element method.
CO2: Formulate finite element techniques for design problems
CO3: Devise equations in finite element analysis for 1D, 2D and 3D problems.
CO4: Analyze and solve problems in heat transfer and structural mechanics
CO5: Familiarise a CAE software, to simulate engineering problems in heat transfer and structural mechanics
CO6: Apply finite element techniques for Non Linear Analysis.

Pre-requisite:

1 U18MAT4101- Numerical Methods and Probability

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S	M	M	M	S							M	S	
CO2:	S	M	M	M	S							M	M	
CO3:	S	M	S	M	S							M		
CO4:	S	M		M	S							M	M	
CO5:	M		M	M	S							M	S	
CO6:	S	M	M	M	S							M	S	

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

FINITE ELEMENT METHODS **L: 9 Hrs**

Historical background , Relevance of FEA to design problems, Application to the continuum, Discretization – Matrix approach, Matrix algebra – Gaussian elimination – Governing equations for continuum – Classical Techniques in FEM – Weighted residual method – Ritz method, Galerkin method.

ONE DIMENSIONAL PROBLEMS **L: 9 Hrs**

Finite element modeling – Coordinates and shape functions – Potential energy approach–Element matrices and vectors – Assembly for global equations – Boundary conditions – Higher order elements – Shapes functions – Applications to axial loadings of rods – Extension to plane trusses – Bending of beams – Finite element formulation of stiffness matrix and load vectors – Assembly to Global equations –boundary conditions – Solution to problems– Examples.

TWO DIMENSIONAL PROBLEMS **L: 9 Hrs**

Finite element modeling – CST element, Shell – Element equations, Load vectors and boundary conditions – Assembly – Application to heat transfer – Vector Variable problems – Elasticity equations

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– Plane Stress, Plane Strain and Axisymmetric problems – Formulation – element matrices – Assembly – boundary conditions and solution examples

HEAT TRANSFER ANALYSIS **L: 9 Hrs**

Basic differential equations of heat transfer, one dimensional and two dimensional finite element formulation using variational method, one dimensional steady state heat transfer problems involving conduction and convection. Analysis of tapered fin, Formulation of thermal stress problems and examples

ISOPARAMETRIC FORMULATION **L: 5 Hrs**

Natural co-ordinate systems – Isoparametric elements – Shape functions for iso parametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems - Matrix solution techniques – Solutions Techniques to Dynamic problems.

NON LINEAR ANALYSIS **L: 4 Hrs**

Introduction, Non-linear differential equation, Solution procedures for non-linear problems Material non-linearity-analysis of axially loaded bars. Introduction to geometric nonlinearity.

Practical

List of Exercises : **P: 30 Hrs**

1 Structural analysis of frames using Truss Elements
2 Static Structural Analysis using 2D Elements
3 Heat Transfer Analysis using 1D Elements
4 Heat Transfer Analysis using 2D Elements
5 Buckling Analysis of Connecting rod
6 Torsional Analysis of bar using 3D Analysis
7 Dynamic Analysis of Leaf and Coil springs
8 Material Non linearity of Axially loaded bars

Theory : 45 Hrs	Practical: 30 Hrs	**Total Hours: 75**

References:

1 "Introduction to Finite Elements in Engineering", Chandrupatla T R and Belegundu A D , Pearson Education, New Delhi, 2015
2 "A First Course in the Finite Element Method", Logan D L, Thomson Learning, 2012.
3 "A Text book on Finite Element Analysis", Seshu P, Prentice Hall of India, New Delhi, 2003.
4 JN Reddy
5 "The Finite Element Method in Engineering", Rao S S, Elsevier, 2005.
6 "Finite Element Analysis in Engineering Design", Rajasekaran S, S Chand, 2008

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U18AUP5505 **AUTOMOTIVE ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY**

L	T	P	J	C
0	0	2	0	**1**

Course Objective:
To make the students apply the knowledge and skills acquired in the courses to a specific problem or issue.

Course Outcomes:
After successful completion of this course, the students should be able to:
CO1: Design and build a power supply, rectifier
CO2: Apply the knowledge of basic electrical and electronic circuits to automotive systems
CO3: Analyze the performance of converters using simulation software's
CO4: Recognize and understand the different wiring diagrams used in automobile manuals
CO5: Build a Fuel cell and estimate the performance of the fuel cell
CO6: Diagnose the faults in the systems like ignition system , battery

Pre-requisite:
1 U18AUT4005 - Automotive Electrical Engineering

CO-PO/PSO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S	M	S			M			M	M				S
CO2:	S	M							M	M				M
CO3:		M		M	S									
CO4:	M	M							S	M		M		
CO5:		M	S	S										M
CO6:			M	S										S

Course Assessment methods:

Direct		Indirect	
1	Model Practical	1	Course Exit Survey
2	End-Semester Examination		

Practical

List of Exercises : **P: 30 Hrs**

1 Design and implementation of Half and Full wave Rectifier
2 Design/implementation of Power supply 9V/12V/15V
3 Design and analysis of Chopper, Inverter, Rectifier circuits using any one of the simulation software
4 Two wheeler / Four wheeler wiring system
5 Wiring Harness of Lighting System and Horn System
6 No Load test on Starter Motor and load test on Alternator
7 Wiring diagram of Power window
8 Performance Estimation of BLDC Motor using any one of the simulation software
9 Testing of batteries and battery maintenance
10 Study of Proton Exchange membrane Fuel cell.

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U18INI5600 **ENGINEERING CLINIC - V**

L	T	P	J	C
0	0	4	2	3

Course objectives

- To help the students look into the functioning of simple to complex devices and systems
- To enable the students to design and build simple systems on their own
- To help experiment with innovative ideas in design and team work
- To create an engaging and challenging environment in the engineering lab

Course Outcomes

After successful completion of this course, the students should be able to:

CO1: Identify a practical problems and find a solution
CO2: Understand the project management techniques
CO3: Demonstrate their technical report writing and presentation skills

Pre-requisite:

1. U18INI4600 - Engineering Clinic - IV

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	S	S	S	S	S	S	S			S	S	S
CO2								S	S	S	S		M	M
CO3								S		S				

Course Assessment methods:

Direct	Indirect
1. Project reviews	1. Course Exit Survey
2. Workbook report	
3. Demonstration & Viva-voce	

Content:

The course will offer the students with an opportunity to gain a basic understanding of computer controlled electronic devices and apply the concepts to design and build simple to complex devices. As a practical project based embedded course, the students will be taught the concepts using a variety of reference material available in the public domain. While the course will start with formal instruction on hardware, programming and applications, the major portion of the course will provide the students with ample opportunity to be innovative in designing and building a range of products from toys to robots and flying machines.

In the fourth semester, students will focus primarily on Design and developing a prototype.

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GUIDELINES:

1. Practical based learning carrying credits.
2. Multi-disciplinary/ Multi-focus group of 5-6 students.
3. Groups can select to work on a specific tasks, or projects related to real world problems.
4. Each group has a faculty coordinator/Instructor who will guide/evaluate the overall group as well as individual students.
5. The students have to display their model in the 'Engineering Clinics Expo' at the end of semester.
6. The progress of the course is evaluated based on reviews and final demonstration of prototype.

Total Hours: 90

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SEMESTER 6

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U18AUI6201 **AUTOMOTIVE EMBEDDED SYSTEMS**

L	T	P	J	C
3	0	2	0	**4**

Course Objective:

To give insight on the concepts of automotive embedded systems and to impart skills in developing models.

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Select suitable sensors for measuring parameters in automotive systems
CO2: Choose the appropriate actuator and driver for automotive applications
CO3: Outline the concepts of embedded systems
CO4: Design of hardware model for automotive system using microcontroller
CO5: Build codes for automotive embedded applications
CO6: Compare the wired and wireless communication protocols

Pre-requisite:

1 U18AUT5001 - Automotive Electronics

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S				S		S					S		S
CO2:	S				S							M		S
CO3:	M				S									S
CO4:		S	S		S								M	S
CO5:		S	S		S				M				M	S
CO6:					S							M		S

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Quiz		
3	Continuous Assessment Tests		
4	End-Semester Examination		

SENSORS **L: 9 Hrs**

Introduction to automotive sensors ,Proximity sensors- inductive, capacitive, magnetic, Photoelectric, Ultrasonic sensors, Thermistor, Thermocouple, Hall effect sensor, Load cell, Optical rain sensor, Liquid level sensor, Lambda sensor, NOX sensor, MAP and MAF, Knock sensor, Angle sensor, Vibration sensor, Acceleration sensor, Pressure sensor, RPM sensor, Torque sensors, Position sensor.

ACTUATORS **L: 9 Hrs**

Solenoid –Types , Solenoid Switching, Relays and Optoisolators – Electromechanical relay, driving a relay, solid-state relay, Reed switch , Optoisolator, Servo and stepper motors, Piezoelectric Actuators, Actuator Driver - H Bridge driver, Door actuator driver, Stepper motor driver, Transistor driver, Signal conditioner - Amplifier, Filter, Data Acquisition.

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EMBEDDED SYSTEM **L: 9 Hrs**

Introduction, Embedded system design process, Microcontroller v/s microprocessor, Architecture of 8/32 Bit controller - ADC, DAC, Memory, Timer and interrupts. Software development in IDE - Hardware/ Software configuration, Models of programs - Assembly, linking and loading. Structure of the Program - variables, functions, loops and I/O parameters.

INTERFACING WITH MICROCONTROLLER **L: 9 Hrs**

Sensor Interfacing: Analog and digital sensor, keyboard interface with 8/32 bit controller.

Actuator Interfacing: Motor control applications - Pulse width modulation (PWM), LCD display, relay and solenoid Interfacing with 8/32 bit controller. Serial communication interfacing.

COMMUNICATION PROTOCOLS **L: 9 Hrs**

Introduction to Communication protocol in embedded systems, Wired communication protocols – SPI, I2C and USB, CAN. Wireless communication protocols - Bluetooth HC05, Wi-Fi, RF transmitter and receiver, Internet of Things (IoT).

Practical

List of Exercises : **P: 30 Hrs**

1. Study of 8/32 Bit Microcontroller Architecture
2. LED Blinking using PWM
3. Interfacing Analog sensor
4. Interfacing Digital sensors
5. Interfacing DC Motor speed control with PWM
6. Interfacing Relay and solenoid Control application
7. Interfacing LCD
8. Interrupts and Timers
9. Study of CAN communication Network
10. Interfacing Serial communication

Theory : 45 Hrs	Practical: 30 Hrs	**Total Hours: 75**

References:

1. Electronic control unit (ECU). In: Reif K. (eds) Gasoline Engine Management. Bosch Professional Automotive Information by Kaiser M. (2015)
2. Sensors and Transducers - Ronald K. Jurgen, —, 2nd Edition, SAE, 2003
3. Automotive Sensors, BOSCH. 2002
4. Automotive Electronics Design Fundamentals 1st ed. 2015 Edition by Najamuz Zaman
5. Comprehensible Guide to Controller Area Network Paperback – 1 Aug 2005 by Wilfried Voss

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U18AUI6202 **VEHICLE DYNAMICS**

L	T	P	J	C
3	0	2	0	**4**

Course Objective:

To make the students familiarize over the forces and moments that generated in a vehicle and its influence over performance in acceleration and braking, handling qualities and ride qualities.

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Determine the forces acting on vehicle for the given conditions
CO2: Inference the forces and moments developed at the vehicle tire
CO3: Illustrate the concept and dynamics involved in suspension system of the vehicle.
CO4: Explain the lateral stability and cornering behavior of the vehicle
CO5: Brief about properties of sound & noise measurement techniques
CO6: Analyse the vehicle responses for longitudinal, lateral and vertical dynamics

Pre-requisite:

1 U18AUT5103- Mechanics of Machines

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S	S			S				M	M				
CO2:	S	S		M	S				M	M		M	M	
CO3:	S	S			S							S		
CO4:	S	S	M	S	S							M	S	
CO5:	S	M	M	S	S							S	S	
CO6:	S	S	M	S	S				M	M		S	M	

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

LONGITUDINAL DYNAMICS **L: 9 Hrs**

Introduction: Earth and vehicle coordinate system, Forces and Moments. Vehicle Load Distribution – position of CG - gradability- Acceleration - Free body diagram of accelerating vehicle, maximum transferable tractive force- tractive effort and reactions for different drive, Deceleration - free body diagram of decelerating vehicle, maximum decelerating rates, stopping distance, maximum braking force, Vehicle performance .

TIRE MECHANICS **L: 9 Hrs**

Tire mechanics: Introduction -Mechanical Properties of Rubber - Slip, Grip and Rolling Resistance - Tire Construction and Force Development - Contact Patch and Pressure Distribution. Lateral Force Generation - cornering properties - Tire Models – Magic Formula - Classification of Tire Models.

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RIDE DYNAMICS **L: 9 Hrs**

Vibration – introduction, types, terminologies, source of vibration, human response, Degrees of freedom-single, two and multi degrees of freedom system, free, forced and damped vibration, magnification factor, transmissibility, vibration absorbers, pitch and bounce motion, oscillation centers, Suspension- types, active and semi active suspension, sprung mass and un-sprung mass, calculation of effective spring rate.

LATERAL DYNAMICS **L: 9 Hrs**

Vehicle control-low speed cornering and static steering – Ackerman steering geometry, steady-state cornering- steering factors, vehicle control parameters (understeer, neutral steer and over steer) steady state handling – lateral acceleration gain , characteristic speed, yaw velocity gain and critical speed- effect of braking on vehicle handling and constant radius testing and fish hook measurement testing.

VEHICLE STABILITY AND NOISE **L: 9 Hrs**

Stability of a vehicle – on slope, on curve and banked road

Noise- Introduction, properties of sound, sound level designation and measurement techniques- sound isolation and absorption- silencer and mufflers.

Practical

List of Exercises : **P: 30 Hrs**

1. Simulation of a telescopic suspension system
2. Simulation of a Rack and Pinion Steering system
3. Simulation of Mc Phearson strut suspension system
4. Simulation of braking characteristics of a four wheeler passenger car
5. Simulation of Cornering characteristics of a four wheeler passenger car.
6. Simulation test for roll stability of a four wheeler passenger car.
7. Driving Simulation of a passenger car in ISO Lane change and 3D road

Theory : 45 Hrs	Practical: 30 Hrs	**Total Hours: 75**

References:

1. Fundamentals of vehicle dynamics, Gillespie T D , SAE USA ,1992
2. Automotive Mechanics, Giri N K, Khanna Publisher, 2007
3. Ground vehicle Dynamics, Karl Popp and Werner O Schiehlen, Springer. 2012.
4. Road Vehicle dynamics – Theory and Application ,Masato Abe, Elsevier ,2009
5. Motor Vehicle dynamics- Modeling and Simulation, Giancarlo Genta, World Scientific,2006
6. Vehicle dynamics- Theory and Application, Reza N Jazzar, Springer,2008
7. Elementary Vehicle Dynamics, Cole D E , Ann Arbor, Michigan, USA,1972.
8. Theory of Ground Vehicles, Wong J Y, John Wiley and Sons, 1978
9. Martin Meywerk , Vehicle Dynamics- Automotive Series,Wiley,2015
10. Dr.R Krishnakumar,Vehicle Dynamics, NPTEL course https://nptel.ac.in/courses/107106080/

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U18AUT6003 **VEHICLE BODY ENGINEERING**

L	T	P	J	C
3	0	0	0	3

Course Objective:
Impart knowledge for the construction of vehicle with light weight, improved aerodynamics and body trims in accordance with safety regulations.

Course Outcomes:
After successful completion of this course, the students should be able to:
CO1: Classify the vehicles and define basic terminologies.
CO2: Select appropriate body material for automobiles.
CO3: Calculate various aerodynamic forces and moments acting on vehicle.
CO4: Examine the various loads distribution in vehicle frames.
CO5: Familiarize the ergonomics concepts related to the vehicles.
CO6: Apply various safety aspects as per the norms.

Pre-requisite:
1 U18AUI3201 - Automotive Chassis and Transmission

CO-PO/PSO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S	W				M						M	M	
CO2:	S	M	M			M	M	M		M		M	S	
CO3:	S	S	S	M			M	M	M	M			S	
CO4:	S	S	S	S				M	M	M			S	
CO5:	M	W	W			S		M					M	
CO6:	M	W	S			S		M	M	M		M	S	

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

VEHICLE BODY DETAILS **L: 7 Hrs**
Body Terminologies, Vehicle body construction techniques, BIW, Regulations, Drivers visibility - Methods for improving visibility and space in cars, Seat – dimensions & parameters, Types of loads, Frame design and bending - Idealized structure, surface, crash worthiness, vehicle safety - Crash and Roll Test.

VEHICLE AERODYNAMICS **L: 8 Hrs**
Aerodynamics – concept, objectives, Forces and Moments – types and effects on vehicle body, Body optimization techniques for minimum drag and lift. Wind tunnel testing – concept – types - test setup - testing process - Flow visualization techniques - Scale model testing - Component balance to measure aerodynamic forces

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CAR BODY DETAILS **L: 8 Hrs**

Classifications – Hatchback, Saloon, Convertibles, Limousine, Estate Van, SUV, Racing and Sports Car – Car body construction Driver seat design – Car body panels, windows, doors, locks – remote and central locking - Safety aspect of car body.

BUS BODY DETAILS **L: 8 Hrs**

Types: Mini bus, single decker & double decker, two level, split level and articulated bus, bus body layout, floor height, engine location, entrance and exit locations, passenger seating dimensions, seat layout for RTO registration, constructional details, frame construction, double skin construction, conventional and integral coach type construction. Bus body Code Regulations (ARAI). Pneumatic equipment for passenger door opening & closing. Air conditioning equipment selection and mounting.

COMMERCIAL BODY DETAILS **L: 7 Hrs**

Types of body, flat platform, drop side, fixed side, tanker body, tipper body - designs, volume/weight considerations, pay load and related regulations, light commercial vehicle body types. Dimensions of driver's seat in relation to controls, drivers cab design.

BODY MATERIALS AND MECHANISMS **L: 7 Hrs**

Types of materials used in body construction - steel sheet, timber, plastics, GRP, FRP - properties of materials. Body trim items - body mechanisms. body repair - body fillers - passenger compartment service – corrosion – types, anticorrosion methods, modern painting process procedure - paint problems, dash board - instrument panel, audio – visual systems.

Theory : 45 Hrs	Tutorial: 0 Hrs	**Total Hours: 45**

References:

1. Body Engineering Design and Construction of Motor Vehicle Bodywork - Sydney F page., Chapman & Hall Ltd, London, 1967
2. Vehicle Body Engineering - Giles J Pawlowsky., Business books limited, 1989
3. Vehicle Body Layout and Analysis - John Fenton., Mechanical Engg. Publication ltd, London, 1980
4. Vehicle Body Building and Drawing - Braithwaite, J.B., Heinemann Educational Books Ltd., London, 1997
5. The Passenger Car Body - Dieler Anselm., SAE International and Vogel Verlag, 2000
6. Materials for Automobile Bodies - Geoff Davies., Butterworth-Heinemann, 2012
7. The Repair of Vehicle Bodies - A. Robinson, W. A. Livesey., Butterworth-Heinemann Ltd, 2018
8. Aerodynamics of Road Vehicles - Wolf-Heinrich Hucho., Published by SAE International, USA, 1998
9. Vehicle Aerodynamics - Dr. V. Sumantran and Dr. Gino Sovram., SAE International, USA, 1994
10. Automotive Chassis & Body - P. L. Kohli., Papyrus Publishing House, New Delhi.
11. Automotive Chassis - Crouse W. H. &Anglin D. L., McGraw-Hill Int. Book Co.

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U18AUT6004 **TOTAL QUALITY MANAGEMENT AND PROJECT MANAGEMENT**

L	T	P	J	C
3	0	0	0	**3**

Course Objective:
Expose the students to learn how to apply the Total Quality Management Techniques for an industry in turn for the product & To develop their ability in planning and execution of a project effectively.

Course Outcomes:
After successful completion of this course, the students should be able to:
CO1: Relate quality concepts and philosophies of TQM
CO2: Apply TQM tools as a means to improve quality
CO3: Select the lean six sigma tools for improving the productivity
CO4: Categorize the structure of the organization
CO5: Identify competency in project planning, scheduling and related activities
CO6: Develop network models and analyze the cost accounting

Pre-requisite:
1 NIL

CO-PO/PSO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	M	M							S	S	S	S		
CO2:	M	M			S				S	S	S	S		
CO3:	M	M			S				S	S	S	S		
CO4:		M							S	S	S	S		
CO5:	M	M							S	S	S	S		
CO6:		M			S				S	S	S	S		

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests	2	
3	End-Semester Examination	3	

TQM PRINCIPLES **L: 9 Hrs**
Definition of Quality, Dimensions of Quality, Quality Costs, Top Management Commitment, Quality Council, Quality Statements, Barriers to TQM Implementation, Contributions of Deming, Juran and Crosby, Team Balancing. Customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Continuous Process Improvement,5S, Kaizen, Just-In-Time.

TQM TOOLS & STATISTICAL TOOLS **L: 9 Hrs**
The seven tools of quality, New seven Management tools, Statistical Fundamentals .Concept of six sigma. Quality Policy Deployment (QPD), Quality Function Deployment (QFD), Benchmarking, Taguchi Quality Loss Function.

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QUALITY SYSTEMS **L: 9 Hrs**

Need for ISO 9000 and Other Quality Systems, ISO 9001:2008 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, ISO 14001:2004

PROJECT ORGANIZATION AND MANAGEMENT **L: 9 Hrs**

Introduction, project characteristics, taxonomy of projects, project identification and formulation. Organizing human resources, organizing systems & procedures for implementation. Project direction. selection of project organization structure, project breakdown structures, project contracts, types of contracts, types of payments to contractors.

PLANNING ,SCHEDULING , NETWORK MODELS, PROJECT APPRAISAL **L: 9 Hrs**

PERT & CPM Cost accounting systems, lowest Cost schedule, crashing of networks, linear programming formulation of event oriented networks, updating of networks, LOB technique. computer aided project management- essential requirements of PM software, software packages for CPM. Enterprise- wide PM, using spread sheets for financial projections. Cost analysis of the project, components of capital Cost of a project, modern approach to project performance analysis.

Theory : 45 Hrs	Tutorial: 0 Hrs	**Total Hours: 45**

References:

1 Dale H.Besterfield et al, Total Quality Management, Third edition, Pearson Education 2011
2 Shridhara Bhat K, Total Quality Management – Text and Cases, Himalaya Publishing House, First Edition 2002.
3 D.R. Kiran Total Quality Management: Key Concepts and Case Studies Butterworth-Heinemann, 2016
4 Nagarajan. K, "Project "Management, New Age International, 2012.
5 Harvey Maylor, "Project Management", Prentice Hall, 2010.
6 Erik W. Larson, "Project Management": The Managerial Process (Special Indian Edition), Tata McGraw-Hill Education, 2006
7 Joseph Phillips,PMP Project Management Professional Study Guide, Fourth Edition,McGraw Hill Professional, 2013

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SEMESTER 7

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U18AUI7201

VEHICLE MAINTENANCE AND RECONDITIONING

L	T	P	J	C
2	0	2	0	**3**

Course Objective:

Impart knowledge and skill on Vehicle Maintenance and Troubleshooting of automotive systems.

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Familiarise the need and procedures of service records used for vehicle maintenance
CO2: Examine and troubleshoot engine malfunctions
CO3: Identify the conditions of battery and auxiliary electrical systems.
CO4: Describe the repair procedure for vehicle chassis and body components
CO5: Asses and rectify the wheel and tire parameters
CO6: Inspect and troubleshoot the HVAC system

Pre-requisite:

1 U18AUI3201- Automotive Chassis and Transmission

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:			S		M	S			M			M		S
CO2:	M			M		S					S			S
CO3:			S		M	S	M							S
CO4:	S	M	M		S	S	M							S
CO5:		S			M	S								S
CO6:			S		M	S	M							S

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

LAYOUT OF AUTOMOTIVE SERVICE STATION - RECORDS AND PROCEDURES **L: 8 Hrs**

Introduction to vehicle maintenance, Importance and need for maintenance, preventive and breakdown maintenance. Tools and Instruments used in Maintenance shop, Layout of Automotive Repair, Service & Maintenance Shop.

Preparation of check lists, safety. Inspection schedule, maintenance of records, log sheets Trip sheet and Road test report. Service schedule and service history maintenance, Workshop Management, spare parts warranty.

REPAIR AND MAINTENANCE OF ENGINE AND CHASSIS SYSTEM **L: 8 Hrs**

Dismantling of engine components and cleaning, cleaning methods, visual and dimensional inspections, minor and major reconditioning of various components, reconditioning methods, engine assembly, special tools used for maintenance overhauling, engine tune up.- Need for overhauling- Preparation of Cost sheets (estimation)- Engine performance analysis-Troubleshoot and Remedies Mechanical and automobile clutch and gear box, servicing and maintenance, maintenance servicing of propeller shaft

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and differential system. Servicing of suspension systems, steering systems, overhauling and maintenance. On Road Vehicle Handling and Testing.

MAINTENANCE OF ELECTRICAL SYSTEM **L: 6 Hrs**

Testing methods for checking electrical components, checking- battery, starter motor, charging systems, DC generator and alternator, ignitions system, lighting systems. Fault diagnosis and maintenance of electronic systems, checking and servicing of instrument cluster.

REPAIR AND MAINTENANCE OF FUEL SYSTEM, COOLING SYSTEMS, LUBRICATION SYSTEM AND VEHICLE BODY **L: 8 Hrs**

Servicing and maintenance of fuel system of different types of vehicles, calibration and tuning of engine for optimum fuel supply. Cooling systems, water pump, radiator, thermostat, anticorrosion and antifreeze additives. Lubrication maintenance, lubricating oil changing, greasing of parts. Vehicle body maintenance, minor and major repairs. Door locks and window glass actuating system maintenance. Manufacture recommended fluids- Kaizen method on schedule services, how to increase productivity and efficiency- Case studies. Field surveys. - Latest technologies in servicing

Practical

List of Exercises : **P: 30 Hrs**

1 Lighting System Trouble shooting & Servicing.
2 Fault diagnosis of Air-Conditioning system.
3 Tire maintenance and wheel balancing.
4 Measurement of camber, caster, kingpin inclination and alignment of toe-in and toe-out
5 Braking System Troubleshooting & Servicing
6 Diagnosis of Engine ECU
7 Performance Testing of Two-Wheeler using 2-Wheeler Chassis Dynamometer
8 Experimental Study about Gearbox, Steering, Suspension system Maintenance
9 On-road Braking, Acceleration and Fuel economy test

Theory : 30 Hrs	Practical: 30 Hrs	**Total Hours: 60**

References:

1 John Doke, "Fleet management ", McGraw Hill Co, 1984.
2 James D Halderman - Advanced Engine Performance Diagnosis PHI - 1998.
3 Judge A N, “Motor vehicle engine servicing, 3rd, Edition ", Pitman Paper pack, London, 1969.
4 Automotive Trouble shooting and Maintenance by Anderson Ashburn
5 Venk. Spicer, Automotive Maintenance and Trouble shooting.
6 Service Manuals from Different Vehicle Manufacturers
7 Vehicle Maintenance and Garage Practices -Dhruv U. Panchal, Jigar A. Doshi, PHI learning Pvt, Ltd.

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U18AUT7002 **AUTOMOTIVE EMISSIONS**

L	T	P	J	C
3	0	0	0	**3**

Course Objective:

Impart knowledge on the wastes produced from automobiles and the emission formation mechanisms.

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Outline the impact of pollutants on global environment and its climatic change
CO2: Examine the emission formation mechanisms and techniques to minimize emissions formation in I.C. engines.
CO3: Describe automotive emission control technologies.
CO4: Familiarise about emission standard, measurement, test procedure and regulations
CO5: Identify the wastes produced from automobiles.
CO6: Explain the available disposal methods of waste.

Pre-requisite:

1 U18AUI4201- Automotive Engines and Systems

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S		S			S	S		M				S	
CO2:	S		S			S	S		M				S	
CO3:	S		S			S	S		M				S	
CO4:	S		S			S	S	S	M				S	
CO5:			M			S	S	M	M				S	
CO6:	S		S			S	S	S	M				S	

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

POLLUTANT FORMATION EFFECT ON ENVIRONMENT **L: 7 Hrs**

Pollutants – sources – formation – effects of pollution on environment - human – transient operational effects on pollution – Regulated –- Emission Standards-Euro, Bharat Stage & Legislative Norms.

EMISSION FORMATION IN S.I ENGINES **L: 7 Hrs**

Pollution formation in SI Engines – HC and CO formation in SI engines – NO formation in SI engines – Smoke emissions from SI engines – Effect of operating and design variables on emission formation.

EMISSION FORMATION IN CI ENGINES **L: 7 Hrs**

Pollutant Formation In CI Engines – Smoke emission and its types in diesel engines – NOx emission and its types from diesel engines-– Particulate emission in diesel engines- Effect of operating and design variables on emission formation.

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EMISSION CONTROL AND MEASUREMENT TECHNIQUES **L: 12 Hrs**

Design Of Engine, Optimum Selection Of Operating Variables For Control Of Emissions- EGR, SCR, Lean DeNOx catalyst-Thermal Reactors, Secondary Air Injection, Water Injection.- After Treatment: Catalytic Converters, Catalysts, CO_2 Emission Reduction- Diesel Particulate Filter- Fuel Modifications. Emission Standards, Driving Cycles - USA, Japan, Euro And India.– NDIR analyzer – Flame ionization detectors – Chemiluminescent analyzer – Dilution tunnel – Gas chromatograph – Smoke meters –SHED test.

AUTOMOTIVE WASTES **L: 6 Hrs**

Introduction-Types of Automobile waste-Electrical waste, Battery waste, Copper elements-Electronic circuit wastes-Tyre wastes-Mechanical wastes, Body panel, Chassis components.

WASTE DISPOSAL AND MANAGEMENT TECHNIQUES **L: 6 Hrs**

Battery disposal procedure, management of battery waste, Steps involved in recycling batteries, Hydrometallurgical process, Hydrometallurgical process, Mercury distillation-Tyre disposal techniques, Battery recycling techniques.

Theory : 30 Hrs	Tutorial: 0 Hrs	**Total Hours: 45**

References:

1 IC Engines Combustion and Emissions, B.P.Pundir, Narosa Publishers, 2010
2 Internal Combustion Engines,Ganesan, V- Tata McGraw-Hill Co.- 2017
3 Robert Bosch, "Emissions-Control Technology for Diesel Engines", BENTLEY ROBERT Incorporated, 2005.
4 Automobiles and Pollution, Paul Degobert– SAE International ISBN-156091-563-3, 1991.
5 *Internal Combustion Engines and Air Pollution* Edward F, Obert,*"*, Intext Education Publishers, 1980.
6 Mathur and Sharma, "*A course on Internal combustion Engines*", Dhanpat Rai & Sons, 1985.

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U18AUT7003 **HYBRID AND ELECTRIC VEHICLES**

L	T	P	J	C
3	0	0	0	**3**

Course Objective:

This course will introduce general aspects of Hybrid and Electric Vehicle (HEV) technologies, including architectures, modeling, sizing, sub-system design and vehicle control. It will cover energy storage sources, electric propulsion systems, power electronics design, and HEV control.

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Describe the configuration of hybrid and electric vehicles.
CO2: Identify the basic components of hybrid and elective vehicles.
CO3: Assess the characteristics and performance of the electric vehicle
CO4: Select suitable electric propulsion and control systems for HEV.
CO5: Choose proper energy storage systems for vehicle applications
CO6: Describe the operation of fuel cell and solar cell vehicles.

Pre-requisite:

1 U18AUT4005- Automotive Electrical Engineering

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S	M	M		S		S		M	S		M		M
CO2:	S	S	M	M	S		S		S	S		S		S
CO3:	S	S	M	M	S		S	S	S	M				S
CO4:	S	S	S	M	S		S	S	S	M				S
CO5:	S	S	M	M	S		S	S	S	M				S
CO6:	S	M	M		S		S		M	S		M		M

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

ELECTRIC PROPULSION SYSTEMS **L: 8 Hrs**

Drive systems for EV & HEV, DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, Switch Reluctance Motor drives, drive system efficiency - Control System principles, Speed and Torque control, Power electronic converters for HEV, Regenerative Braking.

ENERGY STORAGE SYSTEMS **L: 8 Hrs**

Requirements in Hybrid and Electric Vehicles, Types of batteries – lead acid batteries, nickel based batteries, and lithium based batteries - Battery Charging, Battery Characterization - capacity, discharge rate, state of charge, state of discharge, depth of Discharge, Technical characteristics, battery pack design, battery management system, Ultra capacitors.

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ELECTRIC VEHICLES **L: 7 Hrs**

History of electric vehicles, social importance of electric mobility, performance of e-vehicles - tractive effort and transmission requirements, vehicle performance, energy consumption, Specifications - System Components, Electric drive-trains topologies, power flow control in electric drive-train, fuel efficiency analysis.

HYBRID VEHICLES **L: 7 Hrs**

History of hybrid vehicles, social and environmental importance of hybrid vehicles, impact of modern drive-train on energy supplies. Hybrid Electric Drive-train configurations - basic concept of hybrid traction, architecture - merits and challenges, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

HEV PERFORMANCE **L: 8 Hrs**

Maximum speed - Acceleration – Gradeability, HEV - mechanics, efficiency, driving cycles, regulations, sizing the propulsion motor and power electronics, Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV), Vehicle Simulation, Comparison of ICEV and HEV, Well-to-Wheel Analysis.

FUEL CELL AND SOLAR VEHICLES **L: 7 Hrs**

Operations and Properties of Fuel cells – Phosphoric Acid Fuel cell, Proton Exchange membrane Fuel cell, Direct Methanol fuel cell Alkaline Fuel Cells, Solid Oxide Fuel Cell, Molten Carbonate Fuel Cell – Characteristics, electrochemical energy conversion – factors affecting electrochemical energy conversion - Solar Vehicles - photovoltaic cells, tracking, efficiency and cost comparison.

Theory : 45 Hrs	Tutorial: 0 Hrs	**Total Hours: 45**

References:

1. "Electric and Hybrid – Electric Vehicles" - Ronald K Jurgen,, SAE International, 2011.
2. "Electric and Hybrid Vehicles- Design Fundamentals" - Iqbal Husain, CRC Press, 2011.
3. "Electric Vehicle Technology Explained" - James Larminie, John Lowry, Wiley, 2012.
4. "Electric Vehicle Battery Systems" - Sandeep Dhameja, Butterworth – Heinemann, 2002.
5. "Modern Electric, Hybrid Electric and Fuel cell vehicles: Fundamentals, Theory and Design" - Mehrdad Ehsani, Yimin Gao, Sebatien Gay and Ali Emadi, CRC Press, 2018.
6. "Fuel Cells Principles and Applications" - Viswanathan, B. and Aulice Scibioh, M., Universities Press (India) Pvt. Ltd., Hyderabad, 2006.
7. "Light Weight Electric Hybrid Vehicle Design" - Ron Hodkinson and John Fenton, Butterworth – Heinemann, 2009.
8. "Vehicular Electric Power Systems" - Ali Emadi, Mehrdad Ehsani, John M. Muller, , Marcel Dekker,Inc., 2004.
9. "Recent Trends in Fuel cell Science and Technology" - Basu .S, Anamaya Publishers, New Delhi.,2007.
10. "Fuel Cell Technology Handbook", Gregor Hoogers, CRC Press, 2003.

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U18AUP7703 **PROJECT WORK - PHASE – I**

L	T	P	J	C
0	0	0	6	**3**

Course Outcomes

After successful completion of this course, the students should be able to:

CO1: Identify practical problems and find a solution related to automotive and relative domains
CO2: Understand the project management practices
CO3: Demonstrate their report writing and presentation skills

Pre-requisite:

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CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S	S	S	S	S	S	S	S	S			S	S	S
CO2:								S	S	S	S		M	M
CO3:								S		S				

Course Assessment methods:

Direct	Indirect
1. Project reviews	1. Course Exit Survey
2. Project report	
3. Viva Voce	

GUIDELINES:

1. The Project work in Phase-I and II may contain a theoretical study and analysis, experimental analysis, design, modeling & simulation, fabrication of a model or a prototype or a combination of the above related to automotive area and allied areas.
2. The project work include literature review, modeling, analysis, simulation, fabrication, testing and analysis & correlation of test data etc.
3. Can be individual or a group project, with maximum of 3 students per group.
4. The progress of the project is evaluated based on a minimum of three reviews and end semester review.
5. In Phase-I of the project, literature survey, projects task plan and design phases should have been completed
6. A project report is required to be submitted at the end of the semester in the required format.
7. The review presentations and project report should contain the individual work allocation & contribution, estimated & actual time schedule with charts (PERT/GANTT), literature survey, drawings in addition to the details of project work carried out.

Total Hours 90

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SEMESTER 8

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U18AUP8701 **PROJECT WORK - PHASE – II**

L	T	P	J	C
0	0	0	24	**12**

Course Outcomes

After successful completion of this course, the students should be able to:

CO1: Identify and solve practical problems and find a solution related to automotive and relative domains

CO2: Understand the project management techniques

CO3: Demonstrate their report writing and presentation skills

Pre-requisite:

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CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S	S	S	S	S	S	S	S	S			S	S	S
CO2:								S	S	S	S		M	M
CO3:								S		S				

Course Assessment methods:

Direct	Indirect
1. Project reviews	1. Course Exit Survey
2. Project report	
3. Viva Voce	

GUIDELINES:

1. To continue the Phase- I project and executing the same in consultation with the project coordinator and project guide
2. A Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment is a must to complete and an effort leading to paper publication or patenting is desired.
3. A working model or prototype is to be submitted for end semester evaluation for the most appropriate problems.
4. A project report is required to be submitted at the end of the semester in the required format.
5. The review presentations and project report should contain the individual work execution & contribution, actual time schedule with charts (PERT/GANTT), literature survey, drawings, analysis report, DFMEA/FMEA charts in addition to the details of project work carried out.
6. Project work done at Industry should be duly supported by certificate from the Industry.
7. The progress of the project is evaluated based on a minimum of three reviews and end semester viva-voce examination.

Total Hours 360

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PROFESSIONAL ELECTIVE

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AUTOMOTIVE DESIGN

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U18AUE0001 **DESIGN OF ENGINE COMPONENTS**

L	T	P	J	C
3	0	0	0	**3**

Course Objective:
The course provides basic knowledge on designing of IC engine components.

Course Outcomes:
After successful completion of this course, the students should be able to:
CO1: Understand the design procedure for piston and cylinder
CO2: Apply the design assumption in validating the types of connecting rod used in IC engines.
CO3: Calculate the parameters required for designing the crankshaft
CO4: Understand the steps involved in designing of different types of automotive clutch
CO5: Apply the assumption and design valves and valve train
CO6: Explain design methods for engine components

Pre-requisite:
1 U18AUI3202 - Strength of Materials
2 U18AUI4201 - Automotive Engines and Systems
3 U18AUT5102- Design of Machine Elements

CO-PO/PSO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	M	M	W						W	W			S	
CO2:	S	S	M						M	M			M	M
CO3:	S	S	M					W					S	
CO4:	S	S	M					W					S	
CO5:	S	S	M										S	
CO6:	S	S	M										S	

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests	2	
3	End-Semester Examination	3	

L: 9 Hrs

DESIGN OF CYLINDER AND PISTON
Choice of material for cylinder and piston, design assumptions and procedure for cylinder and piston. Design of cylinder, piston, piston pin, piston rings.

DESIGN OF CONNECTING ROD **L: 9 Hrs**
Design of Connecting Rod-determining minimum length of connecting rod, small end design, Big end design, shank design, design of cap bolts.

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DESIGN OF CRANKSHAFT **L: 9 Hrs**

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.

DESIGN OF CLUTCH **L: 9 Hrs**

Design of single plate clutch, multiplate clutch, design of centrifugal clutch, and cone clutch, energy dissipated, torque capacity of clutch, design of Clutch Components.

DESIGN OF VALVES AND VALVE TRAIN **L: 9 Hrs**

Design aspects of intake & exhaust manifolds, inlet & exhaust valves, valve springs, tappets and valve train. Design of cam & camshaft. Design of rocker arm.

Theory : 45 Hrs	Tutorial: 0 Hrs	**Total Hours: 45**

References:

1 Engine Design – Giles J. G., Lliffe Book Ltd.1968
2 Engine Design – Crouse, Tata McGraw Publication, Delhi
3 Khurmi. R.S. & Gupta. J.K., A textbook of Machine Design, Eurasia Publishing House (Pvt) Ltd, 2001.
4 Vehicular Engine Design – Hoag, Kevin, Springer
5 Internal Combustion Engine Design – John Manning, Ricardo UK Ltd
6 Giri.N.K, Automobile Mechanics, Khanna Publishers, New Delhi, 2007.

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U18AUE0002 **DESIGN OF CHASSIS COMPONENTS**

L	T	P	J	C
3	0	0	0	**3**

Course Objective:
Build knowledge on design of Automotive Chassis components.

Course Outcomes:
After successful completion of this course, the students should be able to:
CO1: Calculate loads, moments and stresses on frame members and suspensions.
CO2: Design front axle and examine the steering components
CO3: Explain the design concepts of final drive and rear axle
CO4: Determine parameters involved in gear box design.
CO5: Solve problems related to Automotive braking System
CO6: Improve the overall design of chassis.

Pre-requisite:
1 U18AUI3201- Automotive Chassis and Transmission
2 U18AUI3202 - Strength of Materials

CO-PO/PSO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	**S**	**S**	M	M									**S**	
CO2:	**S**	**S**	S	M									**S**	
CO3:	**S**	**S**	M	S									**S**	
CO4:	**S**	**S**	M	S									**S**	
CO5:	**S**	**S**	M	M									**S**	
CO6:	**S**	**S**	S	S									**S**	

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

VEHICLE FRAME AND SUSPENSION **L: 9 Hrs**
Study of Loads-Moments and Stresses on Frame Members. Design of Frame for Passenger and Commercial Vehicles.
Design of Leaf Springs-Coil Springs and Torsion Bar Springs.

FRONT AXLE AND STEERING SYSTEMS **L: 9 Hrs**
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 Dimension and Proportions for Steering Linkages ensuring minimum error in Steering.

DRIVE LINE AND REAR AXLE **L: 9 Hrs**
Design of propeller shaft. Design details of final drive gearing. Design details of full floating, semi-floating and three quarter floating rear shafts and rear axle housings and design aspects of final drive.

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GEAR BOX **L: 9 Hrs**

Gear train calculations, layout of gearboxes. Design of gearboxes.

BRAKING SYSTEM **L: 9 Hrs**

Function, stopping time and distance, weight transfer during braking, brake actuating mechanisms – mechanical, hydraulic and pneumatic, disc and drum brakes - design of brake shoes and friction pads.

Theory : 45 Hrs	Tutorial: 0 Hrs	**Total Hours: 45**

References:

1 "Automobile Chassis Design Book", Dean Averns, 2nd edition, Kotelian sky Press, 2009.
2 "Introduction to Modern Vehicle Design", Julian Happian-Smith, SAE International, 2004.
3 Automobile Mechanics, Giri, N.K., Khanna publishers, New Delhi, 2007.
4 Heldt, P.M., Automotive Chassis, Chilton Book Co., 1992.
5 Dean Averns, Automobile Chassis Design, Illife Book Co., 2001.

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U18AUE0003 **COMPUTATIONAL FLUID DYNAMICS**

L	T	P	J	C
3	0	0	0	**3**

Course Objective:
Impart knowledge on various CFD Techniques to solve simple fluid flow and heat transfer problems.

Course Outcomes:
After successful completion of this course, the students should be able to:

CO1: Introduce Governing Equations of viscous fluid flows
CO2: Discretize the governing equations by Finite Difference Method and Finite volume Method.
CO3: Solve basic convection and diffusion equations and understand its role in fluid flow and heat transfer problems..
CO4: Apply the solution algorithms to determine the flow field variables.
CO5: Understand turbulence equations in mathematical form and various types of grids used to solve the flow problem.
CO6: Create confidence to solve flow and heat transfer problems by using commercial software packages.

Pre-requisite:
1 U18AUI4202- Fluid Mechanics and Machinery

CO-PO/PSO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	M											M		
CO2:	S	S	S	M	M							M	M	
CO3:	S	S	S	M	M							M	M	
CO4:	S	S	S	M	M							M	M	
CO5:	S	S	S	M	M							M	M	
CO6:	S	S	S	M	M							M	S	

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

GOVERNING EQUATIONS AND BOUNDARY CONDITIONS **L: 8 Hrs**
Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations – Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations.

FINITE DIFFERENCE AND FINITE VOLUME METHODS FOR DIFFUSION **L: 9 Hrs**
Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy – Finite volume formulation for steady state One, Two and Three –dimensional diffusion

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problems –Parabolic equations – Explicit and Implicit schemes – Example problems on elliptic and parabolic equations – Use of Finite Difference and Finite Volume methods.

FINITE VOLUME METHOD FOR CONVECTION DIFFUSION **L: 10 Hrs**

Steady one-dimensional convection and diffusion – Central, upwind differencing schemes properties of discretization schemes – Conservativeness, Boundedness, Transportiveness, Hybrid, Power-law, QUICK Schemes.

FLOW FIELD ANALYSIS **L: 9 Hrs**

Finite volume methods -Representation of the pressure gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants – PISO Algorithms.

TURBULENCE MODELS AND MESH GENERATION **L: 6 Hrs**

Turbulence models, mixing length model, Two equation (k-ε) models – High and low Reynolds number models – Structured Grid generation – Unstructured Grid generation – Mesh refinement – Adaptive mesh.

PRACTICAL ASPECT OF CFD **L: 3 Hrs**

Grid generation – Structured and unstructured mesh, Case study using commercial CFD software

Theory : 45 Hrs	Tutorial: 0 Hrs	**Total Hours: 45**

References:

1 "An Introduction to Computational Fluid Dynamics: The finite volume Method", Versteeg H.K., and Malalasekera W., Pearson Education Ltd., 2nd Edition, 2007.

2 "Numerical Heat Transfer and Fluid Flow", Patankar, S.V., Hemisphere Publishing Corporation (CRC Press), 1st Edition, 1980.

3 "Computer Simulation of flow and heat transfer", Ghoshdastidar, P.S., Tata McGraw Hill Publishing Company Ltd., 1998.

4 "Computational Fluid Dynamics", Chung, T.J., Cambridge University, Press, 2nd Edition, 2010.

5 "Computational Fluid Flow and Heat Transfer", Muralidhar, K., and Sundararajan, T., Alpha Science International Ltd., 2nd Revised edition edition, 2003.

6 "Introduction to Computational Fluid Dynamics", Prodip Niyogi, Chakrabarty, S.K., Laha, M.K., Pearson Education, 1st Edition, 2005.

7 https://confluence.cornell.edu/display/SIMULATION/FLUENT+Learning+Modules

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U18AUE0004

COMPUTER SIMULATION OF IC ENGINE PROCESSES

L	T	P	J	C
3	0	0	0	**3**

Course Objective:
To Impart Knowledge In Simulating IC Engine Processes.

Course Outcomes:
After successful completion of this course, the students should be able to:
CO1: Understand the significance of various processes in I.C Engines.
CO2: Learn the simulation of engine combustion based on first and second law of thermodynamics.
CO3: Calculate minimum air required for combustion of I.C Engines.
CO4: Write combustion equation for hydrocarbon fuels.
CO5: Apply the simulation techniques for modification of combustion chamber
CO6: Apply the simulation techniques to develop new engine concept

Pre-requisite:
1 U18AUI4201 - Automotive Engines and Systems

CO-PO/PSO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S													
CO2:	S													
CO3:	S	S												
CO4:	S	M												
CO5:	S	S	S	S								M	S	
CO6:	S	S	S	S								M	S	

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

INTRODUCTION **L: 9 Hrs**

Introduction to Simulation, Advantages of computer simulation, Classification of engine models. Intake and exhaust flow models – Quasi steady flow - Filling and emptying - Gas dynamic Models. Thermodynamic based in cylinder models. Step by step approach in SI & CI engine simulation.

COMBUSTION AND STOICHIOMETERY **L: 9 Hrs**

Reactive processes, Heat of reaction, measurement of URP, measurement of HRP. Introduction - combustion equation for hydrocarbon fuels. Calculation of minimum air required for combustion, excess air supplied and stoichiometric air required for complete combustion. Conversion of volumetric analysis to mass analysis.

ADIABATIC FLAME TEMPERATURE **L: 9 Hrs**

Introduction, complete combustion in C-H-N-O systems, constant volume adiabatic combustion, constant pressure adiabatic combustion, calculation of adiabatic flame temperature, isentropic changes of state. SI Engine simulation with air as working medium, deviation between actual and ideal cycle

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SIMULATION OF IC ENGINES **L: 9 Hrs**

SI and CI engine simulation – Air standard cycle, fuel-air cycle, progressive combustion cycle and actual cycle simulation – Part throttle, full throttle and supercharged conditions

SIMULATION OF NEW ENGINE CONCEPT **L: 9 Hrs**

Dual fuel engine, low heat rejection engine, lean burn engine, variable compression ratio engine, homogeneously charged compression ignition engine and controlled auto ignition engine.

Theory : 45 Hrs	Tutorial: 0 Hrs	**Total Hours: 45**

References:

1 Ganesan,V., Computer Simulation of spark ignition engine process, Universities Press (I) Ltd., Hyderabad, 2013.

2 Ganesan V, "Computer Simulation of Compression-Ignition Engine Processes", University Press (I) Ltd, Hyderabad, 2013

3 Ramoss,A.L., Modelling of Internal Combustion Engines Processes, McGraw Hill Publishing Co., 1992.

4 Benson,R.S., Whitehouse,N.D., Internal Combustion Engines, Pergamon Press, Oxford, 1979.

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AUTOMOTIVE MANUFACTURING

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U18AUE0005

AUTOMOTIVE COMPONENTS MANUFACTURING

L	T	P	J	C
3	0	0	0	**3**

Course Objective:
Impart knowledge on various processes involved in the manufacturing of automotive components.

Course Outcomes:
After successful completion of this course, the students should be able to:

CO1: Distinguish the various Manufacturing Processes employed in manufacturing Engine components
CO2: Choose the right Manufacturing Process for manufacturing Transmission system components
CO3: Select the relevant Heat and surface treatment methods for Engine and Transmission Components
CO4: Outline the Automotive Body Components Manufacturing methods
CO5: Identify the surface Coating Processes used in Automotive Industry
CO6: Suggest the suitable machining process for Automotive components manufacturing

Pre requisite:
1 U18AUI4203-Manufacturing Technology

CO-PO/PSO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S	S	M				M	M		S			M	S
CO2:	S	S	M				M	M		S			M	S
CO3:	S	S	M			M	M							S
CO4:	M	S	M			M	M	M		S				S
CO5:	S	M				S	S	S						S
CO6:	S	S	M							S				S

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

ENGINE COMPONENTS **L: 10 Hrs**

Casting of Engine block - conventional and expendable pattern, Casting of cylinder heads,Cylinder liners, Crankshaft, Connecting rod and Gudgeon pins-forging and casting, machining and heat treatment.
Casting of Piston - gravity casting, squeeze casting, machining and finishing and piston ring manufacturing.
Upset forging of valves - heat treatment and surface improvement.
Engine bearing manufacturing.

TRANSMISSION COMPONENTS - I **L: 10 Hrs**

Manufacturing of friction plates using conventional blanking and fine blanking. Manufacture of composite friction lining, composite moulding of phenol formaldehyde lining.

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Casting of gear box casing,
Precision forging of gears, gear hobbing, shaping, powder metallurgy, orbital forming of spur, helical, and bevel gears, hypoid gears, heat treatment and finishing.

TRANSMISSION COMPONENTS-II **L: 10 Hrs**

Propeller shaft – Continuous Casting, extrusion, heat treatment and surface hardening, Composite propeller shaft manufacturing.
Forging of rear axles, casting of rear axle casing,
Manufacturing of wheels and brake drums.

BODY COMPONENTS **L: 10 Hrs**

Introduction- Thermoforming and Hydro forming, Press forming of body panels. Welding of body panels - resistance welding, Spot welding, Seam welding.
Injection moulding – Introduction, instrument panel, bumpers, Reinforced Reaction injection moulding.
Manufacture of metal and polymer panels.
Adhesives and sealants
Manufacturing of Springs , Wrap forming of coil springs,leaf springs, Composite leaf springs

SURFACE COATINGS **L: 5 Hrs**

Chemical Vapour deposition, Physical Vapour deposition, sol-gel processing
Spraying, Plating, Painting in paint booth.

Theory : 45 Hrs	Tutorial: 0 Hrs	**Total Hours: 45**

References:

1 Philip F. Ostwald & Jairo Munuz, "Manufacturing Processes and Systems", John Wiley & Sons, New York, 1998.
2 Degarmo E.P., "Materials and process in Manufacturing", Macmillan Publishing Co, 2012 .
3 Kalpakjian, "Manufacturing Engineering and Technology", Publisher: Pearson, 2013
4 Sanjay K Mazumdar, "Composites Manufacturing", CRC Press, NY, 2003.

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U18AUE0006 **DESIGN FOR MANUFACTURE AND ASSEMBLY**

L	T	P	J	C
3	0	0	0	**3**

Course Objective:
To learn the design process /aspects and its effect on different manufacturing processes and to acquire knowledge for providing tolerance specification and representation used in assembly.

Course Outcomes:
After successful completion of this course, the students should be able to:

CO1: Outline the design aspects for selection of Materials, Manufacturing processes for economical production.
CO2: Identification of design processes for various machining and metal joining processes.
CO3: Apply a systematic understanding of design knowledge in the areas of metal casting and forging
CO4: Familiarise the knowledge of Geometric Dimensioning and Tolerances
CO5: Identify the details required for mechanical documentation.
CO6: Integrate the knowledge of compliance analysis and interference analysis for assembly.

Pre-requisite:
1 U18AUI4203 - Manufacturing Technology

CO-PO/PSO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S	S	S	S				M		S		M	M	
CO2:	S	M	M	M					M	M			M	S
CO3:	M	M	M	M					M				M	S
CO4:	S	S	S	M					M	S			S	M
CO5:	M				M					M				M
CO6:	S	S	S	M						M			S	M

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

DFM APPROACH, SELECTION AND SUBSTITUTION OF MATERIALS IN INDUSTRY **L: 9 Hrs**

DFM approach, DFM guidelines, standardization, group technology, value engineering, comparison of materials on Cost basis.

GEOMETRIC DIMENSIONING & TOLERANCE INTRODUCTION **L: 9 Hrs**

Process capability, process capability metrics, Cp, Cpk , Cost aspects, feature tolerances, geometric tolerances, surface finish, review of relationship between attainable tolerance grades and different machining process, cumulative effect of tolerances, sure fit law, normal law and truncated normal law, 6σ concept.

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TOLERANCE CHARTING TECHNIQUE **L: 9 Hrs**

Operation sequence for typical shaft type of components, preparation of process drawings for different operations, tolerance worksheets and centrality analysis, examples.

DESIGN FOR MANUFACTURE **L: 9 Hrs**

Design features to facilitate machining, datum features - Functional and manufacturing, component design-machining considerations, redesign for manufacture, examples Redesign of castings based on parting line considerations, minimizing core requirements, redesigning cast members using weldments, use of welding symbols – Case studies.

SELECTIVE ASSEMBLY **L: 9 Hrs**

Interchangeable and selective assembly, deciding the number of groups, Model-I: group tolerances of mating parts equal; Model-II: total and group tolerances of shaft, control of axial play-introducing secondary machining operations, laminated shims, examples

Theory : 45 Hrs	Tutorial: 0 Hrs	**Total Hours: 45**

References:

1. Design for Manufacturability Handbook, James G. Bralla, Second Edition, McGraw-Hill companies, New York, USA. (1998)
2. Product Design for Manufacture and Assembly, Geoffrey Boothroyd, Peter Dewhurst and Winston Knight Second Edition, CRC press, Taylor & Francis, Florida, USA (2002)
3. G. E. Dieter and L. C. Schmidt (2009), Engineering Design, Fourth edition, McGraw-Hill companies, New York, USA
4. Design for Manufacturing and assembly, O. Molloy, S. Tilley and E.A. Warman , First Edition, Chapman &Hall, London, UK (1998).
5. "Design for Economic Production", Trucks H E, Society of Manufacturing Engineers, Michigan, 1987.
6. J. J. Shah, An Assessment of Features Technology, Proc. CAM-1 Features Symposium, Boston, MA, August 9-10, 1990, p. 55.
7. J. Lesko, (1999) Industrial Design, Materials and Manufacture Guide, John Willy and Sons, Inc.
8. I. Zeid, R. Siva Subramanian (2009) CAD/CAM Theory and Practice, 2nd edition Tata McGraw-Hill education private limited, New Delhi.
9. Port-compatibility and connectability based assembly design, P. Singh, B.Bettig, Journal of Computing and Information Science in Engineering, 4 (2004) pp.197-205.
10. Extended liaison as an interface between product and process model in assembly, A.K. Swain, D Sen, B. Gurumoorthy,Robotics and Computer-Integrated Manufacturing, 30 (5), pp.527-545.

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U18AUE0007 **COMPOSITE MATERIALS AND STRUCTURES**

L	T	P	J	C
3	0	0	0	**3**

Course Objective:
Provide knowledge on properties, micromechanics, macro mechanics and also the manufacturing of Composite materials.

Course Outcomes:
After successful completion of this course, the students should be able to:
CO1: Outline the types, advantages and properties of Composite Materials
CO2: Apply the knowledge of micro mechanics to calculate the properties of a Lamina
CO3: Calculate the properties of a Laminate
CO4: Analyze the material properties and failure criteria Composites
CO5: Explain the basic design concepts and materials used for sandwich construction
CO6: Summarize the methods used for fabrication of fiber

Pre-requisite:
1 U18AUT3004 - Materials and Metallurgy

CO-PO/PSO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	W					W						M	S	
CO2:	S	S	M				W						S	
CO3:	S	S	S				W					M	S	
CO4:	S	S	S				W						S	
CO5:	M	W	W										S	
CO6:	M					W	W					M	S	

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

STRESS STRAIN RELATION **L: 8 Hrs**
Introduction- Advantages and application of composite materials, reinforcements and matrices – Generalized Hooke's Law – Elastic constants for anisotropic, orthotropic and isotropic materials.

METHODS OF ANALYSIS **L: 10 Hrs**
Micro mechanics – Mechanics of materials approach, elasticity approach to determine material properties – Macro Mechanics – Stress-strain relations with respect to natural axis, arbitrary axis – Determination of material properties.

LAMINATED PLATES **L: 12 Hrs**
Governing differential equation for a general laminate, angle ply and cross ply laminates. Failure criteria for composites.

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SANDWICH CONSTRUCTIONS **L: 8 Hrs**

Basic design concepts of sandwich construction -Materials used for sandwich construction - Failure modes of sandwich panels.

FABRICATION PROCESS **L: 7 Hrs**

Various Open and closed mould processes. Manufacture of fibers – Types of resins and properties and applications – Netting analysis.

Theory : 45 Hrs	Tutorial: 0 Hrs	**Total Hours: 45**

References:

1 Calcote, L R. "The Analysis of laminated Composite Structures", Von – Noastrand Reinhold Company, New York 1998
2 Jones, R.M., "Mechanics of Composite Materials", McGraw-Hill, Kogakusha Ltd., Tokyo, 1985.
3 Agarwal, B.D., and Broutman, L.J., "Analysis and Performance of Fibre Composites", John Wiley and sons. Inc., New York, 1995.
4 Lubin, G., "Handbook on Advanced Plastics and Fibre Glass", Von Nostrand Reinhold Co., New York, 1989
5 https://nptel.ac.in/courses/101104010/
6 Autar K. Kaw., 'Mechanics of Composite Materials', Taylor & Francis-India; Second Edition edition (2006)

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U18AUE0008 **ADDITIVE MANUFACTURING AND TOOLING**

L	T	P	J	C
3	0	0	0	**3**

Course Objective:
Expose the students with fundamental and advanced knowledge in the field of Additive manufacturing technology and its industrial applications.

Course Outcomes:
After successful completion of this course, the students should be able to:
CO1: Classify the concepts and terminologies of additive manufacturing
CO2: Apply the reverse engineering concepts for design development
CO3: Identify the variety of additive manufacturing techniques based on end product applications
CO4: Design and develop newer tooling models
CO5: Familiarise with cutting edge technologies in rapid tooling and manufacturing
CO6: Analyse the cases relevant to Additive manufacturing

Pre-requisite:
1 NIL

CO-PO/PSO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S	M				W	M					M		M
CO2:	S	S	S	M	W		S	M				M		S
CO3:	S	M					M							M
CO4:	S	S	S	M	W		S	M	M					S
CO5:	S	M			W		M					M		S
CO6:	S	S	S	M			M	M						S

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

INTRODUCTION **L: 9 Hrs**
Need - Development of AM systems – AM process chain - Impact of AM on Product Development - Virtual Prototyping- Rapid Tooling – RP to AM -Classification of AM processes-Benefits Applications.

REVERSE ENGINEERING & CAD MODELING **L: 9 Hrs**
Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modeling techniques: Wire frame, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation-Software for AM- Case studies.

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ADDITIVE MANUFACTURING SYSTEMS **L: 9 Hrs**

Stereo lithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications. Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused deposition Modeling (FDM): Principle, details of processes, process variables, types, products, materials and applications. Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

SINTERING BASED ADDITIVE MANUFACTURING SYSTEMS **L: 9 Hrs**

Selective Laser Sintering (SLS): Principle, process, Indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications– Case Studies

TOOLING **L: 9 Hrs**

Classification, Soft tooling, Production tooling, Bridge tooling, direct and indirect tooling, Fabrication processes, Applications Case studies automotive, aerospace and electronics industries

Theory : 45 Hrs	Tutorial: 0 Hrs	**Total Hours: 45**

References:

1 "Rapid prototyping: Principles and applications", Chua, C.K., Leong K.F. and Lim C.S., second edition, World Scientific Publishers, 2010.
2 Rapid Tooling: Technologies and Industrial Applications, Hilton, P.D. and Jacobs, P.F., CRC press, 2005.
3 "Rapid prototyping", Gebhardt, A., Hanser Gardener Publications, 2003.
4 Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
5 Kamrani, A.K. and Nasr, E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.

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AUTOMOTIVE ELECTRICAL AND ELECTRONICS

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U18AUE0009 **AUTOMOTIVE CONTROL SYSTEM**

L	T	P	J	C
2	0	2	0	**3**

Course Objective:

To impart knowledge in the Model based system design. By the end of the course, it should enable the student

- To obtain the mathematical model of any system/sub system of a vehicle.
- To model and simulate automotive systems with the help of modern simulation tools

To design a suitable controller for any given application.

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Identify the level of the system that is more suitable for model based system design
CO2: Select appropriate modelling technique according to the available inputs for automobiles.
CO3: Understand and apply the fundamental laws of physics and mathematics to obtain the mathematical model of any system / sub system of a vehicle.
CO4: Create a simulation model of a simple automotive system
CO5: Implement a suitable controller applicable for any automotive system.
CO6: Analyse the performance of the sub-system / system using software tools based on the test inputs given to the system.

Pre-requisite:

1 U18AUI6201- Automotive Embedded Systems

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	**S**		**S**											M
CO2:		**S**	**S**											
CO3:	S	M												S
CO4:				S	S				M	M	M			
CO5:			S	S	S				M	M	M			M
CO6:			S	S	S				M	M	M			S

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

MODEL BASED SYSTEM DESIGN **L: 6 Hrs**

Introduction to model based design, Model based system design in Functional level, Architectural level, Implementation level, limitations on model based design, Process Design- requirements, mathematical modeling, validation and verification, In-loop testing - SIL, HIL

MODELING TECHNIQUES **L: 6 Hrs**

Introduction to Modeling - Graphical modeling, Signal flow modeling, State machines modeling, Transfer function modeling, State space modeling, Event based modeling, Statistical modeling for system identification

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MATHEMATICAL MODELING OF ELEMENTARY SYSTEMS **L: 6 Hrs**

System, Control system, Modeling – Lumped system dynamic behavior represented by ordinary differential equations –Modeling Translational and rotational mechanical Systems, Electrical systems, Electrical Analogous for Mechanical Systems, hydraulic systems and thermal systems

INTRODUCTION TO TIME AND FREQUENCY RESPONSE ANALYSIS **L: 6 Hrs**

Time response, test signals, obtaining dynamic response of first order and second order linear systems for different inputs through simulation – Transient response specifications – Delay time, rise time, peak overshoot, undamped natural frequency, damping factor, settling time

Introduction to Frequency response, frequency domain specifications, Excitation and response signals of systems

REALTIME SIMULATION OF AUTOMOTIVE SYSTEMS **L: 6 Hrs**

Introduction to controllers, different types of controllers, tuning of PID controller, Plant and Controller stand alone simulation, Plant and controller implementation on single target, RT simulation by Separating the plant from the controller, Controller and plant on real time target

Practical

P: 30 Hrs

List of Exercises:

1 Mathematical modelling of elementary systems using simulink
2 Modelling of suspension system using simulink and simscape
3 Determination of time response parameters for an automotive system using simulink.
4 Multibody dynamic simulation of a simple system using Matlab
5 Implementation of controller to a simple automotive system
6 Tuning of PID controller
7 Simulation of a cruise control system using dSPACE

Theory : 30 Hrs	Tutorial: 30 Hrs	**Total Hours: 60**

References:

1 Peter Wilson and H.AlanMantooth “Model based Engineering for complex Electronics system” 2013,Newness
2 AgamKumarTyagi “Matlab and simulink for Engineers” Oxford Higher education,2012
3 P.D. Cha, J.J. Rosenberg & C.L. Dym, `Fundamentals of Modeling and Analyzing Engineering Systems’, Cambridge University Press, 2000
4 Rao V.Dukkipati, ‘MATLAB – An introduction with applications’, New age international publishers, 2010.
5 Web course by Zachariah chambers and Marc Herniter –Rose Hulman institute of technology on “Introduction to model based design and Advanced model based design.”
6 Reference manual: dSPACE - DS1104 R&D Controller Board, Release 2016-A – May 2016

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U18AUE0010 **AUXILIARY VEHICLE SYSTEMS**

L	T	P	J	C
3	0	0	0	**3**

Course Objective:

To familiarize the students with the fundamentals of modern auxiliary vehicle systems which includes the construction and operational details of ECUs, engine auxiliaries, safety, security, comfort and driver assistance systems.

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Apply the concept of embedded systems for automotive applications.
CO2: Outline the importance of stability and safety systems in automobiles.
CO3: Interface automotive sensors and actuators with microcontrollers.
CO4: Obtain an overview of vehicle comfort systems.
CO5: Review the telematics systems in modern vehicles.
CO6: Recognize the various automotive security systems.

Pre-requisite:

1 NIL

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S	S	S		W		S	M	M					S
CO2:	S	M				M	S		W	W		M		M
CO3:	S	S	S		W			M	M					S
CO4:	S	M				M	S		M	W		M		M
CO5:	S	M				M	S		M	W		M		M
CO6:	S	M				M	S		M	W		M		M

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

DIGITAL VEHICLE CONTROL SYSTEMS **L: 9 Hrs**

Modern Automotive Systems, need for electronics in automobiles, applications, Microcontroller and Microprocessors in automobiles, Input devices – oxygen sensors, fuel metering, vehicle speed sensors, detonation sensor, flow sensor, throttle position sensors, Output devices – displays, solenoids, stepper motors, and relays, Engine Control Unit.

ENGINE SYSTEMS **L: 9 Hrs**

Gasoline injection systems - throttle body injection, advanced GDI and multi point fuel injection system, Electronic ignition systems – distributor less ignition system, solid-state ignition system, electronic spark timing control, Open loop and Close loop control system, engine cooling and warm up control, detonation and idle speed control, exhaust emission control, on-board diagnostics.

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SAFETY SYSTEMS **L: 9 Hrs**

Active Safety - vehicle motion control, collision avoidance control, vehicle stabilization system, antilock-braking system, traction control system, anti-slip regulation, electronic stability program, dual circuit brakes, safety glass, bad weather equipment – wiper-washer systems.

Passive Safety - air bags, seat belt pretensioner systems, occupant and passenger safety, driver monitoring systems, pedestrian protection, collapsible steering, rollover bars, head restraints, anti-burst door locks.

COMFORT SYSTEMS **L: 9 Hrs**

Power Steering, ePAS, Cruise control, Adaptive cruise control, Transmission - fundamentals, control, types MT, AT, CVT and DCT, hill assist, HVAC – Climate Control, Tyre pressure monitoring systems, Seats, Mirrors, Sun-Roofs, Park assist, Infotainment – Car Stereo and Radio.

DRIVER ASSISTANCE SYSTEMS **L: 9 Hrs**

Telematics, global positioning systems, geographical information systems, navigation systems, voice command systems, automotive vision system, lane departure warning system, Security Systems – central lock, vehicle immobilizers, keyless entry, anti-theft technology, smart card system, number plate coding.

Theory : 45 Hrs	Tutorial: 0 Hrs	**Total Hours: 45**

References:

1 "Navigation and Intelligent Transportation Systems" - Ronald K. Jurgen, SAE International, USA, 1998.
2 "Electronic Engine Control Technologies" - Ronald K. Jurgen, SAE International, 2004.
3 "Intelligent Vehicle Technologies: Theory and Applications" - Ljubo Vlacic, Michel Parent & Furnio Harshima, Butterworth-Heinemann publications, 2001
4 "Automotive Electrical and Electronic Systems : Automotive Technology - Vehicle Maintenance and Repair" Tom Denton, Burlington, MA 01803, Elsevier Butterworth - Heinemann, 2012.
5 "Automotive Telematics" – Dennis Foy, Red Hat, 2002.
6 "Understanding Automotive Electronics" - Williams. B. Ribbens, 6th Edition, Elsevier Science, Newnes Publication, 2017.
7 Bosch Automotive Electrics and Automotive Electronics: Systems and Components, Networking and Hybrid Drive , Robert Bosch GmbH, 2014
8 "Telematics Communication Technologies and Vehicular Networks: Wireless Architectures and Applications: Wireless Architectures and Applications" Huang, Chung-Ming, IGI Global, 2009.
9 "Automotive Electricity and Electronics" - James D. Halderman, PHI Publication, 2016.

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U18AUE0011 **FUEL CELL TECHNOLOGY**

L	T	P	J	C
3	0	0	0	**3**

Course Objective:

- To create an awareness on the recent developments in Fuel cell technology
- Develop a single cell of PEM fuel cell / Microbial fuel cell

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Identify the different components and materials used in a fuel cell
CO2: Familiarize with the safety aspects and the recent advancements in field of fuel cells
CO3: Apply the knowledge of thermodynamics and material science to understand the thermodynamic equations and electrochemical kinetics of the fuel cell
CO4: Compare the different types of fuel cells and choose an appropriate fuel cell suitable for specific application
CO5: Develop a single cell of PEM fuel cell / Microbial fuel cell on their own
CO6: Estimate the performance of the fuel cell

Pre-requisite:

1 NIL

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S	M	M											
CO2:			S	M		S								M
CO3:	S	S												
CO4:		M	S	M										
CO5:			S	S					M	M	M			S
CO6:			S	S					M	M	M			S

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

INTRODUCTION TO FUEL CELLS **L: 9 Hrs**

Introduction – working and types of fuel cell – low, medium and high temperature fuel cells - Proton Exchange Membrane fuel cell, Solid Oxide fuel cell, Alkaline fuel cells, Molten carbonate fuel cell, Phosphoric acid fuel cell, liquid and methanol type fuel cells, Microbial fuel cell

FUEL CELLS COMPONENTS FOR AUTOMOTIVE APPLICATIONS **L: 9 Hrs**

Fuel cells for automotive applications, components of fuel cell - Membrane Electrode Assembly components, fuel cell stack, bi-polar plate, humidifiers and cooling plates, materials for fuel cell- carbon fibre, Fuel cell based vehicle, technological advancements in fuel cell vehicle systems

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FUEL CELL COMPONENTS AND THEIR IMPACT ON PERFORMANCE L: 9 Hrs

Thermodynamics and electrochemical kinetics of fuel cells, Fuel cell performance characteristics – current/voltage, voltage efficiency and power density, ohmic resistance, kinetic performance, mass transfer effects on membrane electrode assembly components, fuel cell stack, bi-polar plate, humidifiers and cooling plates

FUELING - PRODUCTION AND STORAGE OF HYDROGEN L: 9 Hrs

Hydrogen storage technology – pressure cylinders, liquid hydrogen, metal hydrides, Reformer technology – steam reforming, partial oxidation, auto thermal reforming, Fuel Cell Control Systems and Ancillaries, removal of Biomass and CO

FUEL CYCLE ANALYSIS L: 9 Hrs

Introduction to fuel cycle analysis – application to fuel cell and other competing technologies like battery powered vehicles, SI engine fuelled by natural gas and hydrogen and hybrid electric vehicle, road map of fuel cells to market- concern and challenges

Theory : 45 Hrs	Tutorial: 0 Hrs	**Total Hours: 45**

References:

1 "Electric & Hybrid Vehicles – Design Fundamentals" - Iqbal Hussain, CRC Press, Second Edition, , 2011

2 "Electric Vehicle Technology Explained", James Larminie, John Wiley & Sons, 2003

3 "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, theory and design", Mehrdad Ehsani, Yimin Gao, Ali Emadi, CRC Press, 2010

4 "Fuel Cell Technology Handbook- SAE International" - Gregor Hoogers, CRC Press ISBN 0-8493-0877-1-2003.

5 "Fuel Cells for automotive applications", professional engineering publishing UK. ISBN 1-86058 4233, 2004.

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U18AUE0012 **AUTOMOTIVE COMMUNICATION PROTOCOLS**

L	T	P	J	C
3	0	0	0	**3**

Course Objective:
Provide knowledge in concepts of acquiring ECU data, storage and exchange of data for ECU Communication in-vehicle network systems.

Course Outcomes:
After successful completion of this course, the students should be able to:
CO1: Outline the concepts of Communication Protocols
CO2: Compare the different communication protocols
CO3: Select suitable communication protocols for Automotive Application
CO4: Develop and understand Embedded C code for CAN Protocol
CO5: Understand the in-vehicle networking protocols in automobile
CO6: Apply the knowledge to In vehicle network diagnostics

Pre-requisite:
1 NIL

CO-PO/PSO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	M		S											
CO2:		S	S											
CO3:	S	M												S
CO4:				S	S				M	M	M			M
CO5:			S	S	S				M	M	M			M
CO6:			S	S	S				M	M	M			S

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

EMBEDDED NETWORKING **L: 9 Hrs**
Introduction – Serial/Parallel Communication – Serial communication protocols -RS232 standard – RS485 – Synchronous Serial Protocols -Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C) – PC Parallel port programming -ISA/PCI Bus protocols - Firewire USB bus – Speed Identification on the bus – USB States – USB bus communication: Packets –Data flow types – Enumeration –Descriptors –PIC 18 Microcontroller USB Interface – C Programs.

CONTROLLER AREA NETWORK (CAN) PROTOCOL **L: 9 Hrs**
History and foundation of CAN, CAN Applications, Main characteristics of CAN, CAN in OSI Reference Model, CAN Data Link Layer, Principles of data exchange in CAN, Arbitration, Data Frame, Remote Frame, Error detection and management in CAN, CAN physical Layer, Bit encoding, Bit timing and synchronization, Relationship between data rate and bus length, Single wire and twin wire media,

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CAN repeaters, Medium-to-medium gateway, Protocol handlers, Micro-controllers and line drivers, Time-Triggered CAN (TTCAN), CANoe based applications development.

LOCAL INTERCONNECT NETWORK (LIN) PROTOCOL **L: 9 Hrs**

Introduction to LIN, LIN consortium, LIN specification, LIN features, Technical overview, Work flow concept, LIN operation, LIN frame format, Scheduling table, Network management of LIN cluster, LIN Transport Layer, LIN node configuration and identification, LIN diagnostics, LIN physical layer.

FLEXRAY PROTOCOL **L: 9 Hrs**

Future on board systems, Need for FlexRay, Origin of FlexRay, FlexRay consortium, FlexRay Objectives, FlexRay Features, Application requirements, Working of FlexRay, Network topologies, ECU architecture, Segment Configuration, Communication Cycles, FlexRay frame format, Timing of configuration protocol, Error control, and FlexRay core mechanisms, Coding and Decoding, Medium Access Control, Frame and Symbol Processing, Clock Synchronization, FlexRay Components.

IN VEHICLE NETWORK DIAGNOSTICS **L: 9 Hrs**

Process of Automotive Fault Diagnostics, Fault Codes, Vehicle Systems (open-loop and closed-loop), On- and Off- Board Diagnostics, OBD-I, OBD-II, Engine Analyzers, Steps taken to diagnose a fault, Diagnostics Protocol-KWP2000, SAE-J1587, SAE-J1708 and Case Study

Theory : 45 Hrs	Tutorial: 0 Hrs	**Total Hours: 45**

References:

1 Multiplexed Networks for Embedded Systems - by Dominique ParetPublisher: John Wiley & Sons, July 2007.

2 Understanding and Using the Controller Area Network Communication Protocol: Theory and Practice -Marco Di Natale(Author), Haibo Zeng(Author), Paolo Giusto(Author), ArkadebGhosal – springer 2012

3 Embedded Networking with CAN and CANopen Paperback – June 28, 2016 by Olaf Pfeiffer (Author), Andrew Ayre (Author), Christian Keydel (Author) -Embedded Systems Academy Inc.; 1 edition (June 28, 2016)

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U18AUE0013 INTELLIGENT VEHICLE TECHNOLOGIES

L	T	P	J	C
3	0	0	0	**3**

Course Objective:
This course is to impart knowledge on autonomous vehicle and driver assistant systems and also the architectural overview of IoT

Course Outcomes:
After successful completion of this course, the students should be able to:

CO1: Gain knowledge on different driver assistant system of autonomous vehicle and their applications
CO2: Understand the Radio communication technologies for Intelligent Vehicle
CO3: Identify different control techniques
CO4: Select the appriporiate architectures for motion autonomy
CO5: Understand the model of autonomous vehicles needed in road applications
CO6: Apply IoT configurations for Intelligent Vehicle

Pre-requisite:
1 NIL

CO-PO/PSO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S				S	S		S					S	S
CO2:	S	M			S	S		S					S	S
CO3:	M	M			S	S		S					S	S
CO4:	M				S	S		S					S	S
CO5:	M				S	S		S					S	S
CO6:	S				S	S		S					S	S

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

AN INTRODUCTION TO AUTONOMOUS DRIVING TECHNOLOGIES L: 9 Hrs
Levels of Driving Automation - Architecture for Autonomous System – Hardware and Software Architecture - Computer vision – Deep learning - Sensor fusion – localization - path planing – decisdition and Control - System intergration .

RADIO COMMUNICATION AND INTELLIGENT- TRANSPORTATION-SYSTEMS L: 9 Hrs
Introduction – ITS communication systems, Multimedia communication in a car, Current ITS communication systems and services - Inter-vehicle communication system - Road-vehicle communication system - Device technologies.

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INTELLIGENT VEHICLE DECISION AND CONTROL TECHNOLOGIES L: 9 Hrs

Adaptive control system techniques - Adaptive control - an overview - System models for adaptive control- Design of self tuning controllers - Fuzzy control systems - Fuzzy control of distance and tracking.

DECISIONAL ARCHITECTURES FOR MOTION AUTONOMY L: 9 Hrs

Introduction - Robot control architectures and motion autonomy - Sharp control and decisional architecture for autonomous vehicles - Motion planning for vehicles - Trajectory planning and state time space - Nonholonomic path planning.

IOT – INTERNENT OF THINGS L: 9 Hrs

Introduction of IoT - IoT – architecture, Basic Components ,Network Protocol Stack - M2M and IoT Technology Fundamentals - Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service(XaaS), M2M and IoT Analytics, Knowledge Management - Applications of IoT.

Theory : 45 Hrs	Tutorial: 0 Hrs	**Total Hours: 45**

References:

1 Intelligent Vehicle Technologies - Ljubo Vlacic, Michel Parent and Fumio Harashima,“”, Butterworth-Heinemann publications, Oxford, 2001.

2 Internet of Things: A Hands-On Approach Paperback – 2015 by Arsheep Bahga (Author), Vijay Madisetti (Author) - Orient Blackswan Private Limited - New Delhi; First edition (2015)

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U18AUE0021	ADVANCED STM32 MICROCONTROLLER AND EMBEDDED C PROGRAMMING	L	T	P	J	C
		3	0	0	0	**3**

Course Objective:
This course is to impart knowledge on 32-bit Microcontroller & configuration of peripherals.

Course Outcomes:
After successful completion of this course, the students should be able to:
CO1: Gain knowledge on different peripherals of 32-bit microcontroller and their applications
CO2: Understand the Timer and counter configuration and programming
CO3: Identify different GPIO interface using I/O devices
CO4: Apply the PWM techniques for motor speed control using timer
CO5: Understand the ADC, DAC, Sensor Interfacing
CO6: Apply the CAN communication technologies for ECU communication

Pre-requisite:
1 Automotive Embedded systems

CO-PO/PSO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S						S					S		
CO2:	S											M		
CO3:	M													
CO4:		S	S		M									S
CO5:		S	S			M								S
CO6:					M	M			M			M		

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

INTRODUCTION OF STM 32 BIT MICROCONTROLLER **L: 9 Hrs**
C for Embedded systems- C data types for embedded systems, STM32F Introduction – Features – STM32 bit Architecture – Functional overview – Pinout and Pin description – STM32 IC electrical characterises.

STM ARM TIMER PROGRAMMING **L: 9 Hrs**
Introduction to timer and counter – System tick timer- Timer and delay generation – Compare register and waveform output – Using timer/ counter input capture – Pulse counter programming.

STM32 ARM I/O Programming **L: 9 Hrs**
GPIO – I/O programming and interfacing – Seven segment LED interfacing and programming - Relays and optoisolators interfacing – Stepper motor interfacing. PWM and DC motor Control.

ADC, DAC, Sensor interfacing **L: 9 Hrs**
ADC characteristics – ADC programming with STM32 ARM – Sensor interfacing and signal conditioning –Interfacing to a DAC.

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L: 9 Hrs

CAN PROTOCOL (Hands on Mode)

Introduction to the CAN protocol - CAN frame formats - Understanding a CAN node - CAN signaling - CAN Bus recessive state and dominant state - CAN Bit timing Calculation - CAN network with Transceivers - Exploring inside view of CAN transceivers - CAN Self-test modes, LOOPBACK, SILENT LOOPBACK - Exploring STM32 bXCAN peripheral - self-testing of bxCAN peripheral - bXCAN block diagram - Tx/Rx path of the bxCAN Peripheral - CAN frame filtering and executrices - CAN in Normal Mode - Communicating between 2 boards over CAN - Code exercises.

Theory : 45 Hrs	Tutorial: 0 Hrs	**Total Hours: 45**

References:

1 STM32 Arm Programming for Embedded Systems by Muhammad Ali Mazidi -2018

2 Discovering the STM32 Microcontroller by Geoffrey Brown Indiana University - 2016

3 Mastering the STM32 Microcontroller by Carmine Noviello - 2016

4 Advanced Programming with STM32 Microcontrollers by Majid Pakdel - 2020

5 Getting Started with STM32 Nucleo Development by Agus Kurniawan -2016

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AUTOMOTIVE TECHNOLOGY & MANAGEMENT

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U18AUE0014 **OFF ROAD VEHICLES**

L	T	P	J	C
3	0	0	0	**3**

Course Objective:
Impart knowledge on different types of special purpose vehicles and their systems.

Course Outcomes:
After successful completion of this course, the students should be able to:
CO1: Categorise vehicles based on their specification.
CO2: Infer the different types of subsystem and its functioning used in the construction of special purpose vehicle
CO3: Classify and observe the application of special purpose vehicles in construction activities.
CO4: Explain various safety systems used in Utility and military vehicles.
CO5: Interpret kinematics used in the off-road vehicles to understand its operational stability.
CO6: Identify the design requirements of tracked vehicles.

Pre-requisite:
1 NIL

CO-PO/PSO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	M	M							M	M				
CO2:	M	M							M	M		M		
CO3:	M	M							M	M				
CO4:	M	M	M						M	M		M		
CO5:	S	S	M						M	M			M	
CO6:	S	S	M						M	M			S	

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests	2	
3	End-Semester Examination	3	

LAYOUT AND REQUIREMENTS **L: 9 Hrs**
Requirements of Off Road vehicles- Classification of Off Road vehicles-Construction layout, drive, capacity based on ARAI, Frame, Engine Location, type of wheel, Transmission, Multi-axle vehicles and applications.

TRACTORS **L: 9 Hrs**
Classification of tractors-lay out of wheeled tractor- power transmission system- steering system- accessories of wheeled tractors- hydraulic control system- power take off unit and special implements

EARTH MOVING MACHINES **L: 9 Hrs**
Earthmovers –Dumpers-types, Body construction and transmission, loaders- types-single bucket, Multi-bucket, rotary and backhoe, Body construction and transmission – dozers- types and utilities. Excavators- scrappers, drag and self-powered types, Power take off, special implements. Bush cutters, stumpers, tree dozer, rippers. – Power -and capacity of earth moving machines

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MILITARY AND SPECIAL UTILITY VEHICLES **L: 9 Hrs**

Special features and constructional details of tankers, gun carriers and transport vehicles. Oil tankers-Articulated vehicles, working -features of Ambulance, fire extinguishing vehicle. Mobile Cranes: Basic characteristics of truck cranes, stability & design features, control systems & safety devices

VEHICLE SYSTEMS **L: 9 Hrs**

Brake system and actuation – OCDB and dry disc caliper brakes. Body hoist and bucket operational hydraulics. Hydro-pneumatic suspension cylinders. Power steering system.

Kinematics for loader and bulldozer operational linkages. Safety features, safe warning system for Dumper. Design aspects on dumper body, loader bucket and water tank of sprinkler.

Theory : 45 Hrs	Tutorial: 0 Hrs	**Total Hours: 45**

References:

1 "Construction, Planning equipment and methods ",Robert L Peurifoy, Tata McGrawel Hill Publishing company Ltd.

2 "Farm machines and equipments" , Nakra C.P.,Dhanparai Publishing company Pvt. Ltd

3 "Road making machinery", Abrosimov.K. Bran berg.A and Katayer.K., MIR Publishers,Moscow, 1971

4 "Construction planning and equipment", Satyanarayana. B., standard publishers and distributors, New Delhi.

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U18AUE0015 **TYRE TECHNOLOGY**

L	T	P	J	C
3	0	0	0	**3**

Course Objective:
Provide the fundamental knowledge about the construction, performance and dynamic behaviour of automotive tyres.

Course Outcomes:
After successful completion of this course, the students should be able to:
CO1: Outline the various methods of tyre manufacturing.
CO2: Identify the forces and moments acting on tyres.
CO3: Explain wear possibilities, their causes and measurements
CO4: Estimate the safety of tyres and its failure analysis
CO5: List the types of tyre testing methods
CO6: Summarize Tyre retreading and recycling.

Pre-requisite:
1 NIL

CO-PO/PSO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	M											M	S	
CO2:	M	W											S	
CO3:	M	M				S	W						S	
CO4:	S	W	W			S	W	M				S	S	
CO5:	M	M										M	S	
CO6:	S	S				S	W					S	S	

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

INTRODUCTION TO BASICS OF TYRES **L: 10 Hrs**

Types of tyres, tyre components and its role, tread patterns, outline of production of tires, Requirements and function of tyres – Tyre Performance Criteria – Indoor Test and Outdoor Test - Tyre Manufacturing - Compound Preparation - Basic concepts of Tread Extrusion - Effect of viscosity & temperature on extrusion - Die swell & shrinkage phenomenon - Calendering - Tyre Assembly – Curing – Inspection - Quality Control Tests.

TYRE FORCES AND MOMENTS **L: 8 Hrs**

Forces and Moments – Rolling Resistance – Cornering Properties – Slip Angle and Cornering Force – Performance of Tyre on Wet Surface – Ride Properties of Tyres – Study of Tyre types based on different road conditions and applications.

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RUBBER ABRASION AND TYRE WEAR **L: 8 Hrs**

Sliding Abrasion – Tyre Wear – Influence of Road Surface – Driving Influences – Speed and Load Distributions – Road Wear and Force Distribution – Tyre Construction

TYRE RETREADING, TYRE DURABILITY AND FAILURE ANALYSIS **L: 10 Hrs**

Defects of tyres – Tyre classification for defects – causes and discussions - Examination of: (i) Returned tyres (ii) Tyres for retreading - Norm of tyre adjustments for fast wear, poor retreading Bead/casing failures. Hot and cold process.

Service - Maintenance Safety- On Vehicle- In-Service Safety - Fundamentals Of Tyre Durability - Nature Of Tyre Durability- Deflection, Heat, Speed, Tyre Structural Failures - Common In-Service Tyre Failure Modes - Run Low/ Flux Break- Tyre Tread Bead Detachment- Rapid Air Loss - Over Deflection- Intra-Carcass Pressurization- Cuts And Punctures- Improper Repair

NON-DESTRUCTIVE TESTS AND INSPECTIONS, RECOVERY AND RE-USE **L: 9 Hrs**

Introduction of Inspection Techniques - X-Ray Examination – Shearography – Ultrasound – Eddy Currents - Recovery and Re-use Reclaiming Technology – Surface Treatment – Grinding and Pulverization technology – Devulcanization Technology Use of Recovered Tyre rubber.

Theory : 45 Hrs	Tutorial: 0 Hrs	**Total Hours: 45**

References:

1 J. Y. Wong, “Theory of Ground Vehicles”, 4th Edition“2008
2 US Department of Transportation., “The Pneumatic Tire”,February 2006
3 Bireswar Banerjee, “Tyre Retreading” Smithers Information Ltd., 2015
4 V. L. Shulman, “Tyre Recycling” Rapra Review Reports Volume 15, Number 7, 2004
5 Tom French, Tyre technology, The University of Michigan, 1989.

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U18AUE0016 VEHICLE TESTING AND VALIDATION

L	T	P	J	C
3	0	0	0	**3**

Course Objective:
Familiarize the tests to be performed on the vehicle and its subsystems.

Course Outcomes:
After successful completion of this course, the students should be able to:
CO1: Outline the basic measurement systems.
CO2: Examine the vehicle body strength using crash tests.
CO3: Explain the various engine performance testing methods.
CO4: Estimate the different vehicle test parameters and its influence on fuel economy.
CO5: Summarize the tests performed on steering, suspension and its impact on driving stability.
CO6: List the tests conducted to analyse the transmission, brakes and wheel performance.

Pre-requisite:
1 NIL

CO-PO/PSO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	M				S							W	M	
CO2:	S	M			S		M					M	S	
CO3:	M	M			S		M					W	S	
CO4:	M	M			S		M					W	M	
CO5:	M	M			S	M	W					W	M	
CO6:	M	M			S		W					M	S	

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

INTRODUCTION TO MEASUREMENT SYSTEMS L: 3 Hrs
Introduction - static and dynamic measurement - closed and open loop system - Requirements and characteristics

VIBRATION MEASUREMENT AND VEHICLE BODY STRENGTH ANALYSIS L: 9 Hrs
Instrument – Accelerometer and signal conditioning, Graphical presentation. Dynamic simulation sled testing, methodology, Vehicle acceleration measurement and Documentation.
Dolly roll over test, dolly role over fixture, photographic / video coverage, instrumentation. Vehicle roof strength test – test procedure and test measurements. Door system crush test - procedure and measurements.

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ENGINE TESTING & FUEL ECONOMY **L: 8 Hrs**

I.S Code for Engine testing – Laboratory testing: Basic engine parameters, Measurement of BHP, IHP, Engine testing on dynamometers, different types of dynamometers.

Field Testing: Type I & II, test route selection, vehicle test speeds, cargo weights, driver selection, test data form, calculations. Test on rough terrain, pot holes with laden and unladen conditions.

VEHICLE STEERING, SUSPENSION AND STABILITY TEST **L: 14 Hrs**

Analysis of constant radius test, constant steer angle test, constant speed variable radius test, constant speed variable steer angle test, response gain test.

Measurement of dimensional and geometric characteristics, measurement of centre of gravity position, measurement of moments and products of inertia, measurement of suspension kinematic characteristics, measurement of suspension elastic and coulomb friction characteristics, measurement of shock absorber characteristics.

WHEELS AND TRANSMISSION AND BRAKE PERFORMANCE TEST **L: 11 Hrs**

Friction Clutches - Diagnosing of Slippage, Drag, Binding and Vibration - Performance of Automatic Transmission Systems

Dynamic cornering fatigue, dynamic radial fatigue tests – procedure, bending moment and radial load calculations. Impact test – road hazard impact test for wheel and tyre assemblies, test procedures, failure criteria and performance criteria. Bumpers - types of tests, pendulum test, fixed collision barrier test, procedure, performance criteria. Air and hydraulic brake test, air brake actuator, valves test, performance requirements. Parking brake – drawbar pull test, grade holding test.

Theory : 45 Hrs	Tutorial: 0 Hrs	**Total Hours: 45**

References:

1. Crouse W H and Anglin D L., “Automotive Mechanics”’ Tata McGraw Hill Publishing Company, 2004
2. Rangan, Mani and Sharma, “Instrumentation”, Tata McGraw Hill Publishers, New Delhi, 2004
3. Stockel M W, “Auto Mechanics Fundamentals”, Good Heart-Wilcox Co., Inc., 2000
4. Jain R K “Mechanical and Industrial Measurements”, Khanna Publishers, Delhi, 1999.
5. Martyr A. J, Plint M. A, “Engine Testing Theory and Practice”, 3rd edition, Butterworth-Heinemann, 2007.
6. Ken Pickerill, “Automotive Engineering Engine Performance Shop Manual”, Cengage Learning, 2010
7. SAE Hand book, Vol. 3, SAE Publications, 2000
8. Tim Gilles, “Automotive Service”’ Delmar Publishers, 1998.
9. Beckwith TG and Buck N L, “Mechanical Measurements”, Addition Wesley Publishing Company Limited, 1995
10. Giles J. G, “Vehicle Operation & Performance”.
11. Crouse. W. H, Anglin. D. L, “Motor Vehicle Inspection”, McGraw Hill, 1978.

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U18AUE0017 **ENTREPRENEURSHIP DEVELOPMENT**

L	T	P	J	C
3	0	0	0	**3**

Course Objective:
Provide knowledge on Entrepreneurship to be become responsible Entrepreneurs.

Course Outcomes:
After successful completion of this course, the students should be able to:
CO1: List the merits and demerits of entrepreneurial culture
CO2: Develop the entrepreneurial characteristics to understand strength and weakness
CO3: Utilize the opportunity
CO4: Formulate a business plan to solve problems
CO5: Choose the processes involved in setting up a business
CO6: Compare the role of government and banks in promoting entrepreneurship.

Pre-requisite:
1 NIL

CO-PO/PSO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:					S	S	S	S	S	S	S	S		
CO2:					S	S	S	S	S	S	S	S		
CO3:					S	S	S	S	S	S	S	S		
CO4:					S	S	S	S	S	S	S	S		
CO5:					S	S	S	S	S	S	S	S		
CO6:					S	S	S	S	S	S	S	S		

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

ENTREPRENEURSHIP **L: 9 Hrs**
Entrepreneur - Types of Entrepreneurs, Intrapreneur, Multiprener, Entrepreneurship in Economic Growth of a country, Factors Affecting Entrepreneurial Growth

ACHIEVEMENT MOTIVATION TRAINING **L: 9 Hrs**
Factors influencing a person to become on his own. Need to achieve. Training through Activities. Goal setting. Role Play. Awareness programs.

MARKET RESEARCH & MARKETING **L: 9 Hrs**
Market potential. Questionnaire for Market survey. Market research. Consumer behavior. Voice of a customer. Scope for new product. Product distribution channels.

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BUSINESS PLAN **L: 9 Hrs**

Types of business. Classification based on investment. Detailed Business Plan PPR and DPR. Feasibility study. Technical appraisal of the business. Profitability calculations. Brake-Even analysis, Demand Fore casting and Inventory. Costing and accounting. Taxes. Formalities and processes in setting up a business.

SUPPORT TO ENTREPRENEURS **L: 9 Hrs**

Sickness in small Business. Causes and Consequences, Corrective Measures. Technology Business Incubators Government Policy for funding Start Ups & Small Scale Enterprises. Role of MSME State Level. Growth Strategies in small industry. Expansion, Diversification, Joint Venture, Merger and Sub Contracting. Venture capitalists. Patents. Intellectual Property Rights.

Theory : 45 Hrs	Tutorial: 0 Hrs	**Total Hours: 45**

References:

1 Khanka. S.S, "Entrepreneurial Development" S.Chand& Co. Ltd., Ram Nagar, New Delhi,2013.
2 Donald F Kuratko, "Entreprenuership – Theory, Process and Practice", 9th Edition, Cengage Learning, 2014.
3 Hisrich R D, Peters M P, "Entrepreneurship" 8th Edition, Tata McGraw-Hill, 2013
4 Mathew J Manimala,Princy Thomas Entrepreneurship Education: Experiments with Curriculum, Pedagogy and Target groups. Springer 2017
5 Rajeev Roy, 'Entrepreneurship', 2nd Edition, Oxford University Press, 2011
6 EDII "Faulty and External Experts – A Hand Book for New Entrepreneurs Publishers: Entrepreneurship Development", Institute of India, Ahmadabad, 1986

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U18AUE0018 **VEHICLE TRANSPORT MANAGEMENT**

L	T	P	J	C
3	0	0	0	**3**

Course Objective:
Provides knowledge on fleet management methods and Motor vehicle act.

Course Outcomes:
After successful completion of this course, the students should be able to:
CO1: Collect concept of personal Management objectives and functions.
CO2: Explain the Passenger transport operation.
CO3: Explain the Good Transport management Systems.
CO4: Describe the Motor Vehicle Act.
CO5: Outline the process of traffic engineering and its management.
CO6: Extend knowledge of fleet management.

Pre-requisite:
1 NIL

CO-PO/PSO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:						S		S	M	M	M	M		S
CO2:			M			S		S	M		M	M		S
CO3:						S		S	M	M	M	M		S
CO4:						S	S	S		M		M		S
CO5:	M					S	M	S	M	M	S			S
CO6:						S		S	M	M	M	M		S

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

INTRODUCTION **L: 9 Hrs**

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

PASSENGER TRANSPORT OPERATION **L: 9 Hrs**

Structure of passenger transport organizations- Typical depot layouts- Requirements and Problems on fleet management- Fleet maintenance- Planning -Scheduling operation & control- Personal & training-training for drivers & conductors- Public relations, Propaganda, publicity and passenger amenities-Parcel traffic - Theory of fares-Basic principles of fare charging- Differential rates for different types of services- Depreciation & debt charges- Operation Cost and Revenues- Economics & records

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GOODS TRANSPORT OPERATION **L: 9 Hrs**

Structure of goods transport organizations- Scheduling of goods transport- Management Information System (MIS) in passenger / goods transport operation- Storage & transportation of petroleum products- Advance Techniques in Traffic Management- Traffic navigation- Global positioning system.

MOTOR VEHICLE ACT **L: 9 Hrs**

Traffic signs, fitness certificate, registration requirements, permit insurance, constructional regulations, description of vehicle-tankers, tippers, delivery vans, recovery vans, Power wagons and fire fighting vehicles. Spread over, running time, test for competence to drive.

TRAFFIC ENGINEERING & MANAGEMENT **L: 9 Hrs**

Road user characteristics, human and vehicle characteristics, speed, density, volume, travel time, headway, spacing, time-space diagram, time mean speed, space mean speed and their relation, relation between speeds, flow, density, fundamental diagrams; Traffic volume Measurement, equipment for flow measurement, Density measurement, Travel time measurement, Automotive traffic measurement devises, Traffic signal design, Parking study, accident study, congestion study, toll operation, pedestrian study.

Theory : 45 Hrs	Tutorial: 0 Hrs	**Total Hours: 45**

References:

1 John Duke - Fleet Management – McGraw-Hill Co, USA -1984.
2 Government Motor Vehicle Act – Eastern Book Company, Lucknow – 1989
3 Kitchin.L.D., - Bus Operation - Illiffee and Sons Co., London, III edition – 1992
4 Roess, RP., McShane, WR. and Prassas,ES.(1998), Traffic Engineering,Prentice Hall
5 May,A. D.(1990), Fundamentals of Traffic Flow,Prentice Hall.
6 The motor vehicle Act 1939 - Ejaz Ahemad, Ashok law house, India – 1989.
7 Kadiyali, LR (1987), Traffic Engineering and Transportation Planning, Khanna

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U18AUE0019 APPLIED HYDRAULICS AND PNEUMATICS

L	T	P	J	C
3	0	0	0	**3**

Course Objective:
Provides knowledge on the application of hydraulic and pneumatic systems.

Course Outcomes:
After successful completion of this course, the students should be able to:
CO1: Understand the Fluid properties and functions and applications of Fluid Power
CO2: Describe the concept used to design the systems
CO3: Illustrate the working of hydraulic components
CO4: Summarize the working of pneumatic components
CO5: Design and implement simple fluid power systems common in industrial applications using commercial components
CO6: Familiarize the actual fluid power circuits used in Automotive and Industrial Applications

Pre-requisite:
1 U18AUI4202 - Fluid Mechanics and Machinery

CO-PO/PSO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S	M								S			S	
CO2:	S				M								S	
CO3:	S						M					S	S	
CO4:	S						M					S	S	S
CO5:	S	M	S		M		S					S	S	S
CO6:	S		M	M	M		M						S	S

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

INTRODUCTION TO FLUID POWER & PRINCIPLE **L: 7 Hrs**

Introduction to fluid power control - Hydraulic and Pneumatics - Selection criteria, application of fluid power, Application of Pascal's law, Equation, Transmission and Multiplication of force pressure losses - fluids, selection and properties - ISO symbols

FLUID POWER DRIVES **L: 11Hrs**

Fluid power drives – Pumps - working principle and construction details of gear, vane and piston pumps, hydraulic motor, Hydrostatic transmission drives and characteristics - Hydraulic supply components - Pneumatic power supply - Compressor, air distribution, air motors.

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FLUID POWER ELEMENTS **L: 9 Hrs**

Control valves - pressure, flow direction - working principles and construction - Special type valves- proportional and servo - Selection and actuation methods.

Actuators - Selection and specification, cylinders - mounting, cushioning - Fluid conditioning elements - Accumulators.

HYDRAULICS AND PNEUMATICS CIRCUITS DESIGN **L: 9 Hrs**

Design of Hydraulic and Pneumatic circuits for automation, Selection and specification of circuit components, sequencing circuits, cascade and Karnaugh - Veitch map method - Regenerative, speed control, Synchronizing circuits

ELECTRO-PNEUMATICS **L: 9 Hrs**

Use of electrical timers, switches, solenoid, relay, proximity sensors - Electro pneumatic sequencing Ladder diagram.

PLC: – elements, function and selection - PLC programming - Ladder and different programming methods - Sequencing circuits.

Theory : 45 Hrs	Tutorial: 0 Hrs	**Total Hours: 45**

References:

1 Anthony Esposito, “Fluid power with applications” , 5th Edition, Pearson Education 2003.
2 Majumdar, “Oil Hydraulics: Principles and Maintenance”, Tata McGraw Hill, 2004
3 Majumdar, “Pneumatic system: Principles and maintenance”, Tata McGraw Hill,2004
4 Andrew Parr, “Hydraulics & Pneumatics” Jaico Publishing House,2004
5 William W. Reaves, “Technology of Fluid Power”, Delmer Publishers,1997
6 Shanmugasundaram.K, “Hydraulic and Pneumatic controls”, Chand & Co, 2006.
7 Peter Rohner,” Fluid Power Logic Circuit Design” MacMillion Press Ltd., 1990.
8 Micheal J, Pinches and Ashby, J.G., “Power Hydraulics”, Prentice Hall, 1989.
9 Dudelyt, A Pease and John J Pippenger, “Basic Fluid Power”, Prentice Hall, 1987.

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U18AUE0020 **AUTOMOTIVE AERODYNAMICS**

L	T	P	J	C
3	0	0	0	**3**

Course Objective:
Provides knowledge on basic principles of aerodynamics for the design of vehicle body.

Course Outcomes:
After successful completion of this course, the students should be able to:

CO1: Understand the fluid flow concepts for aerodynamic studies in vehicle.
CO2: Understand the importance of aerodynamics for automobiles.
CO3: Explain the aerodynamic drag concepts and aerodynamic development strategies for car.
CO4: Analyze various aerodynamic shapes of cars and commercial vehicles.
CO5: Explain the vehicle lateral stability due to side wind, wind noise and occurrence of dirt accumulation on vehicle.
CO6: Apply the concept of wind tunnel and numerical methods for aerodynamic design of automobiles.

Pre-requisite:
1 U18AUI4202 - Fluid Mechanics and Machinery

CO-PO/PSO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S	M							S	M		S	S	
CO2:	S	M							S	M		S	S	
CO3:	S	M	M						S	M		S	S	
CO4:	S	S	S						S	M		S	S	
CO5:	S	S	M						S	M		S	S	
CO6:	S	S	M		M				S	M		S	S	

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

INTRODUCTION **L: 9 Hrs**

Scope, historical developments, fundamental of fluid mechanics, flow phenomenon related to vehicles, external and Internal flow problem, resistance to vehicle motion, performance, fuel consumption and performance potential of vehicle aerodynamics, engine cooling requirement, air flow to passenger compartment, duct for air conditioning, cooling of transverse engine and rear engine.

AERODYNAMIC DRAG OF CARS **L: 9 Hrs**

Cars as a bluff body, flow field around car, drag force, types of drag force, analysis of aerodynamic drag, drag coefficient of cars, strategies for aerodynamic development, low drag profiles.

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SHAPE OPTIMIZATION OF CARS **L: 9 Hrs**

Front end modification, front and rear wind shield angle, boat tailing, hatch back, fast back and square back, dust flow patterns at the rear, effects of gap configuration, effect of fasteners.

VEHICLE HANDLING **L: 9 Hrs**

The origin of forces and moments on a vehicle, lateral stability problems, methods to calculate forces and moments – vehicle dynamics under side winds, the effects of forces and moments, characteristics of forces and moments, dirt accumulation on the vehicle, wind noise, drag reduction in commercial vehicles.

WIND TUNNELS FOR AUTOMOTIVE AERODYNAMICS **L: 9 Hrs**

Introduction, principle of wind tunnel technology, limitation of simulation, Tests with scale models, full scale wind tunnels, measurement techniques, equipment and transducers, road testing methods, numerical methods.

Theory : 45 Hrs Tutorial: 0 Hrs **Total Hours: 45**

References:

1 Hucho.W.H. - "Aerodynamic of Road Vehicles" - Butterworths Co., Ltd., - 1997.
2 Pope - "Wind Tunnel Testing " - John Wiley & Sons - 2nd Edition, New York - 1974.
3 Automotive Aerodynamic: Update SP-706 - SAE – 1987
4 Vehicle Aerodynamics - SP-1145 - SAE – 1996.

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U18AUE0022 PRODUCT DESIGN AND DEVELOPMENT

L	T	P	J	C
3	0	0	0	**3**

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Apply concepts of product development and outline product planning process
CO2: Apply relative importance of customer needs in establishing product specifications
CO3: Identify concept generation activities and summarize the methodology involved in concept selection and testing
CO4: Outline supply chain considerations in product architecture and understand the industrial design process
CO5: Apply design for manufacturing concepts in estimating manufacturing costs
CO6: Apply principles of prototyping in product development economics and highlight importance of managing projects

Pre-requisite:

1 Nil

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	M		M		M					W			M	
CO2:			M										M	
CO3:	M		M										S	
CO4:			S			W				M	M		S	
CO5:			S		M	M							S	
CO6:					M				M		S		S	

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

INTRODUCTION - DEVELOPMENT PROCESSES AND ORGANIZATIONS - PRODUCT PLANNING **L: 9 Hrs**

Characteristics of successful product development to Design and develop products, duration and cost of product development, the challenges of product development. A generic development process, concept development: the front-end process, adapting the generic product development process, the AMF development process, product development organizations, the AMF organization. The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process.

IDENTIFYING CUSTOMER NEEDS - PRODUCT SPECIFICATIONS **L: 9 Hrs**

Gathering raw data from customers, interpreting raw data in terms of customer needs, organizing the needs into a hierarchy, establishing the relative importance of the needs and reflecting on the results

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and the process. Specifications, establish specifications, establishing target specifications setting the final specifications.

CONCEPT GENERATION - CONCEPT SELECTION - CONCEPT TESTING **L: 9 Hrs**

The activity of concept generation clarify the problem search externally, search internally, explore systematically, reflect on the results and the process, Overview of methodology, concept screening, concept scoring, caveats. Purpose of concept test, choosing a survey population and a survey format, communicate the concept, measuring customer response, interpreting the result, reflecting on the results and the process.

PRODUCT ARCHITECTURE - INDUSTRIAL DESIGN -DESIGN FOR MANUFACTURING **L: 9 Hrs**

Meaning of product architecture, implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues. Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, is assessing the quality of industrial design. Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors.

PROTOTYPING PRODUCT DEVELOPMENT ECONOMICS MANAGING PROJECTS **L: 9 Hrs**

Prototyping basics, principles of prototyping, technologies, planning for prototypes, Elements of economic analysis, base case financial mode,. Sensitive analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis. Understanding and representing task, baseline project planning, accelerating projects, project execution, postmortem project evaluation.

Theory : 45 Hrs	Tutorial: 0	**Total Hours: 45**

References:

1 Karl Ulrich,T, Steven Eppinger, D, “Product Design and Development”, McGrawHill, 2015.
2 Chitale, AK, Gupta, RC, “Product Design and Manufacturing” PHI, 2013.
3 Timjones, “New Product Development:An Introduction to a multifunctional process”, Butterworth-Heinemann, 1997.
4 Geoffery Boothroyd, Peter Dewhurst and Winston Knight,A, “Product Design for Manufacture and Assembly”, CRC Press, 2011.

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U18AUE0023 **PRODUCT LIFECYCLE MANAGEMENT**

L	T	P	J	C
2	0	2	0	**3**

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Apply concepts of product lifecycle management and visioning
CO2: Apply relative importance of product concepts, processes and workflow
CO3: Apply principles of collaborative product development
CO4: Outline considerations in system architecture understand the industrial process
CO5: Apply product lifecycle management strategy and assessment
CO6: Apply the infrastructure assessment, assessment of current systems and applications.

Pre-requisite:

1 Nil

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	M		M		M					W			M	
CO2:			M										M	
CO3:	M		M										M	
CO4:			S			W				M	M		M	
CO5:			S		M	M								S
CO6:						M							M	

Course Assessment methods:

Direct		Indirect	
1	Assignments	1	Course Exit Survey
2	Continuous Assessment Tests		
3	End-Semester Examination		

INTRODUCTION TO PRODUCT LIFE CYCLE MANAGEMENT **L: 6 Hrs**

Definition, PLM Lifecycle Model, Threads of Product Lifecycle Management, Need for Product Lifecycle Management, Opportunities and Benefits of Product Lifecycle Management, Views, Components and Phases of Product Lifecycle Management, Product Lifecycle Management feasibility study, Product Lifecycle Management Visioning.

PLM CONCEPTS, PROCESSES AND WORKFLOW **L: 6 Hrs**

Characteristics of Product Lifecycle Management, Environment Driving Product Lifecycle Management, Product Lifecycle Management Elements, Drivers of Product Lifecycle Management, Conceptualization, Design, Development, Validation, Production, Support of Product Lifecycle Management.

COLLABORATIVE PRODUCT DEVELOPMENT **L: 6 Hrs**

Engineering Vaulting, Product Reuse, Smart Parts, Engineering Change Management, Bill of Materials and Process Consistency, Digital Mock-Up and Prototype Development, Design for Environment, Virtual Testing and Validation, Marketing Collateral.

SYSTEM ARCHITECTURE **L: 6 Hrs**

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Introduction, Types of Product Data, Product Lifecycle Management systems, Features of Product Lifecycle Management System, System architecture, Product information models, Functionality of the Product Lifecycle Management Systems

DEVELOPING A PLM STRATEGY AND ASSESSMENT **L: 6 Hrs**

Strategy, Impact of strategy, Implementing a PLM strategy, PLM Initiatives to Support Corporate Objectives, Infrastructure Assessment, Assessment of Current Systems and Applications

PRACTICAL: **P: 30Hrs**

1. Streamline collaboration to capture and manage the creation, revision, release of CAD data simulation models and documentations
2. Create, assign and mange task, setting priorities of task to the teams on track,
3. Resolving issues (issue management)
4. View and markup complex 3D product design
5. Change management capabilities
6. Customization and implementation of various industrial practices
7. Conceptualization for Product Lifecycle Management
8. Validation for Product Lifecycle Management
9. Building Product information models

Theory : 30 Hrs	Practical: 30 Hrs	**Total Hours: 60**

References:

1 Michael Grieves, Product Lifecycle Management: Driving the Next Generation of Lean Thinking, Mc Graw Hill, 2015.

2 Martin Eigner, System Lifecycle Management – Engineering Digitalization (Engineering 4.0), Springer Vieweg 2021.

3 Karl Ulrich,T, Steven Eppinger, D, “Product Design and Development”, McGrawHill, 2015

4 Chitale, AK, Gupta, RC, “Product Design and Manufacturing” PHI, 2013.

5 Geoffery Boothroyd, Peter Dewhurst and Winston Knight,A, “Product Design for Manufacture and Assembly”, CRC Press, 2011.

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ONE CREDIT COURSES

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U18AUC0001 MOTORSPORTS ENGINEERING

Course Outcomes

On successful completion of the course the learner would be able to:

CO1: Classify various motorsport events across the globe
CO2: Identify the rules and regulation for the different motor sport events
CO3: Recognize the career opportunities in motorsport engineering

Pre-requisite:

1. Nil

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:		S			S							S	S	S
CO2:		S				S	S		M	S		S	S	S
CO3:						S					S		S	S

Course Assessment methods:

Direct	Indirect
1. Quiz	1. Course end survey
2. Seminar / Case Study Report	

INTRODUCTION TO MOTORSPORT ENGINEERING **2 Hours**

The history of motorsport engineering-Review of motorsport engineering-Pioneers of Motorsport engineering -Motorsport technology evolution review.

LIST OF MOTORSPORT COMPETITIONS FOR STUDENTS **3 Hours**

A brief look at all the events students can take part to develop their skills - Formula SAE - Baja SAE - SAE Super mileage.

PROFESSIONAL MOTORSPORT EVENTS **4 Hours**

The various types of professional motorsport events that take place around the world - Cars – Formula One, World rally championship, Touring car championship, GP2, GP3, World Endurance Racing Championship, dirt track racing, NASCAR, Indy Car, Cross Country rallies, drag racing - Motorcycles – MotoGP, Superbike, Endurance, Motocross, Supermoto, Freestyle, Trials, Cross-country rallies, Speedway, Board track, drag racing

RULES AND REGULATIONS OF MOTORSPORTS **3 Hours**

Introduction about the rule book - About - the world governing bodies of the sport - Why the rule book keeps changing - How to interpret the rule book- Rules for car races - Rules for bikes races

CAREER IN MOTORSPORTS ENGINEERING **3 Hours**

Motorsport Engineer Race Driver / Rider - Test Driver / Rider - Design engineer - Race technician -Aerodynamics Engineer - Race official / steward

Total Hours: 15

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U18AUC0002 **AUTOMOTIVE STYLING**

Course Outcomes

On successful completion of the course the learner would be able to:

CO1: Understand the design trends of concept cars

CO2: Apply the concept of ergonomics in designing concept cars

Pre-requisite:

1. Nil

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S	W											S	
CO2:		M										M	S	

Course Assessment methods:

Direct	Indirect
1. Quiz	1. Course end survey
2. Assignment / Case study	

DESIGN EXPRESSIONS **4 Hours**

Design methodology, Lifestyle board, Mood board, Theme board, Design trends, Design movements, Application of design principles and product aesthetics

INTRODUCTION TO CONCEPT CARS **4 Hours**

Importance of concept cars, Blending technology, Form in concept cars

CAR DESIGN **4 Hours**

Art and colour, Product styling, Introduction to human factors engineering, Digital design, Concept to reality, Auto show vehicles

VISUAL FACTORS IN DESIGN **3 Hours**

Colour harmony, Colour in design, Artist's spectrum, Basic color schemes

Total Hours: 15

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U18AUC0003 **ELECTRONIC ENGINE MANAGEMENT SYSTEMS**

Course Outcomes

On successful completion of the course the learner would be able to:

CO1: Familiarize the importance of ECU for better performance of engines.

Pre-requisite:

1. Nil

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:		S									W			S

Course Assessment methods:

Direct	Indirect
1. Quiz	1. Course end survey
2. Assignment / Case study	
3. Test	

Topics covered

- An overview of Engine Management System
- Current trends in automotive electronic engine management system
- Control of SI & CI engines for better performance and low emissions
- Closed loop control of engine parameters of fuel injection and ignition.
- Digital control techniques – Dwell angle calculation, Ignition timing calculation and Injection duration calculation.
- Electronics emission control techniques

Total Hours 15

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U18AUC0004 INTELLECTUAL PROPERTY RIGHTS

Course Outcomes

On successful completion of the course the learner would be able to:

CO1: Understand the IPR and its classification

CO2: Understand the Patens for Inventions

Pre-requisite:

1. Nil

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	M		S		S	S	S			S	S	S	**S**	
CO2:	M		S		S	S	S			S	S	S	**S**	

Course Assessment methods:

Direct	Indirect
1. Test	1. Course end survey
2. Quiz	
3. Assignment / Case study	

Module:

1.Overview on IPR and its classification **3 Hours**

2.Patents **4 Hours**

3.International Conventions related to IPR **4 Hours**

4.Patens for Inventions in Automotive Engineering - Case Studies **4 Hours**

Total Hours: 15

References:

1. T. M Murray and M.J. Mehlman, Encyclopedia of Ethical, Legal and Policy issues in Biotechnology, John Wiley & Sons 2000
2. Ajit Parulekar and Sarita D' Souza, Indian Patents Law – Legal & Business Implications; Macmillan India ltd , 2006
3. P. Narayanan; Law of Copyright and Industrial Designs; Eastern law House, Delhi , 2010

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U18AUC0005 VEHICLE MAINTENANCE

Course Outcomes

On successful completion of the course the learner would be able to:

CO1: Understand the Basics of maintenance & workshop statements preparation

CO2: Understand the Engine, Chassis, Electrical Maintenance systems

Pre-requisite:

1. Nil

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	M		S		S	S	S			S	S	S		S
CO2:	M		S		S	S	S			S	S	S		S

Course Assessment methods:

Direct	Indirect
1. Test	1. Course end survey
2. Quiz	
3. Assignment / Case study	

MAINTENANCE OF RECORDS AND SCHEDULES **2 Hours**

Preventive (scheduled) and breakdown (Unscheduled) maintenance, requirements of maintenance, preparation of check Lists, Inspection schedule, maintenance of records, log sheets.

ENGINE MAINTENANCE **4 Hours**

List of Engine components and cleaning methods, visual and Inspections, minor reconditioning of various components, Reconditioning methods, special tools used for maintenance.

CHASSIS MAINTENANCE **6 Hours**

Maintenance of Automobile clutch, gear box, drive, suspension, Brake and Steering systems.

ELECTRICAL SYSTEM MAINTENANCE **3 Hours**

Testing methods battery, starter motor, charging, Ignition and lighting Systems. Checking and servicing of dash board instruments.

Total Hours: 15

References:

1. John Doke, “Fleet Management”, McGraw Hill Co. 1984.
2. James D Halderman, “Advanced Engine Performance Diagnosis”, PHI, 1998.
3. Service Manuals from Different Vehicle Manufacturers.

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U18AUC0006 LEAN MANUFACTURING

Course Outcomes

On successful completion of the course the learner would be able to:

CO1: Understand the Concept of Six Sigma and Value Engineering

CO2: Understand the Concept of Reliability Engineering and Learn Manufacturing

Pre-requisite:

1. Nil

CO-PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S	S	S	S	S	W	M					S	S	
CO2:	S	S	S	S	S	W	M			M		S	S	S

Course Assessment methods:

Direct	Indirect
1. Test	1. Course end survey
2. Quiz	
3. Assignment / Case study	

Course Description

Lean Manufacturing is about creating value. The Lean process starts with creating value for the ultimate customer, which requires providing the right product at the right time for the specified price. While all manufacturing attempts to do this, what makes Lean Manufacturing distinct is the relentless pursuit and elimination of waste. Students will learn the concepts and tools of Lean, which include types of waste, visual management, 5S, value stream mapping, A3, & flow.

Module:

1. Definition of Lean
2. Importance of Lean
3. Application of Lean Tools
4. Difference between Value-Added and Non-Value-Added
5. Preparing to Work in a Lean Environment
6. Dos and Don'ts for Lean Terms
7. Traditional Manufacturing
8. Introduction to New Advanced Lean Tools
9. Eight Wastes
10. Introduction to Key Terms
11. Visual Controls
12. 5S and Standardized Work

Total Hours: 15

Reference

1. "The Machine that Changed the World" - J.P. Womack, D.T. Jones, D. Roos, Free Press, 1990 (2007 in paperback). ISBN-13: 978-0-7432-9979-4.
2. "The Toyota Way" J.K. Liker, McGraw Hill, 2004. ISBN 0-007-139231-9
3. "Learning to See" - M. Rother, J. Shook, Lean Enterprise Institute, 2009. ISBN: 9978-0-9667843-0-5

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