VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF MECHANICAL ENGINEERING

M. Tech. Automotive Engineering

M. Tech. (AE)

Curriculum

(*2020-2021 admitted students*)

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VISION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

Transforming life through excellence in education and research.

MISSION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

World class Education: Excellence in education, grounded in ethics and critical thinking, for improvement of life.

Cutting edge Research: An innovation ecosystem to extend knowledge and solve critical problems.

Impactful People: Happy, accountable, caring and effective workforce and students.

Rewarding Co-creations: Active collaboration with national & international industries & universities for productivity and economic development.

Service to Society: Service to the region and world through knowledge and compassion.

VISION STATEMENT OF THE SCHOOL OF MECHANICAL ENGINEERING

- To be a leader in imparting world class education in Mechanical Engineering, leading to nurturing of scientists and technologists of highest caliber who would engage in sustainable development of the globe.

MISSION STATEMENT OF THE SCHOOL OF MECHANICAL ENGINEERING

- The mission of the school is to create and maintain an environment for Excellence in Instruction, Learning and Applied Research in the area of Mechanical and allied disciplines so as to equip our students with necessary knowledge and skills for higher education/employment and to meet the societal demands.

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PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. Graduates will be engineering practitioners and leaders, who would help solve industry's technological problems.

2. Graduates will be engineering professionals, innovators or entrepreneurs engaged in technology development, technology deployment, or engineering system implementation in industry.

3. Graduates will function in their profession with social awareness and responsibility.

4. Graduates will interact with their peers in other disciplines in industry and society and contribute to the economic growth of the country.

5. Graduates will be successful in pursuing higher studies in engineering or management.

6. Graduates will pursue career paths in teaching or research.

PROGRAMME OUTCOMES (POs)

PO_01: Having an ability to apply mathematics and science in engineering applications

PO_02: Having an ability to design a component or a product applying all the relevant standards and with realistic constraints

PO_03: Having an ability to design and conduct experiments, as well as to analyze and interpret data

PO_04: Having an ability to use techniques, skills and modern engineering tools necessary for engineering practice

PO_05: Having problem solving ability- solving social issues and engineering problems

PO_06: Having adaptive thinking and adaptability

PO_07: Having a clear understanding of professional and ethical responsibility

PO_08: Having a good cognitive load management [discriminate and filter the available data] skills

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PROGRAMME SPECIFIC OUTCOMES (PSOs)

On completion of M. Tech (Automotive Engineering), graduates will be able to

PSO_01: Compute, Design, Simulate & analyse various Automotive engineering systems taken into account the social, economic and environmental implications for the current and future mobility.

PSO_02: Practice a multidisciplinary approach to solve real-world automotive problems

PSO_03: Independently carry out research / investigation to solve practical problems and write / present a substantial technical report/document

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M. Tech. Automotive Engineering

CREDIT STRUCTURE

Category-wise Credit distribution

Category	Credits
University Core (UC)	27
Programme Core (PC)	19
Programme Elective (PE)	18
University Elective (UE)	6
Total	**70**

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M. Tech. Automotive Engineering

DETAILED CURRICULUM

University Core

S. No.	Code	Course Title	L	T	P	J	C
1.	MAT 5005	Advanced Mathematical Methods	3	0	0	0	3
2.	ENG5001	Fundamentals of Communication skills*	0	0	2	0	1
3.	ENG5002	Professional and Communication Skills*	0	0	2	0	1
4.	FRE 5001 (or) GRE 5001	Foreign Language	2	0	0	0	2
5.	STS5001	Essentials of Business Etiquette and problem solving	3	0	0	0	1
6.	STS5002	Preparing for Industry	3	0	0	0	1
7.	SET5001	SET Project - 1	-	-	-	-	2
8.	SET5002	SET Projects - 2	-	-	-	-	2
9.	MEE6099	Master's Thesis	-	-	-	-	16
Total Credits							**27**

*ENG 5001 and ENG5002 are not considered for credits

Programme Core

S. No.	Code	Course Title	L	T	P	J	C
1.	MEE5010	Automotive Body and Chassis Systems	3	0	0	0	3
2.	MEE5011	Engine Combustion and Emission	3	0	2	0	4
3.	MEE5012	Automotive Transmission System	3	2	0	0	4
4.	EEE5025	Automotive Electrical and Electronics	3	0	2	0	4
5.	MEE5026	Vehicle Dynamics	2	2	0	4	4

M. Tech. Automotive Engineering

Programme Elective

S. No.	Code	Course Title	L	T	P	J	C
1.	MEE6016	Alternate Fuels	2	0	0	4	3
2.	MEE6017	Engine Design and Development	2	2	0	0	3
3.	MEE6018	Powertrain Tribology	2	0	0	4	3
4.	MEE6019	Automotive Emission Control	2	2	0	4	4
5.	MEE6020	Battery and Fuel Cell	2	0	0	4	3
6.	MEE6021	Vehicle and Engine Testing	2	0	0	4	3
7.	MEE6022	Vehicle Safety and Lighting	3	0	2	0	4
8.	MEE6023	Vehicle Maintenance and Diagnostics	2	0	0	4	3
9.	MEE6024	Vehicle Aerodynamics	3	0	0	0	3
10.	MEE6025	Vehicle Crashworthiness	2	0	0	4	3
11.	MEE6026	Design of Vehicle Drivelines	2	0	0	4	3
12.	MEE6027	Noise, Vibration and Harshness	2	2	2	0	4
13.	MEE6028	Computational Fluid Flow and Heat Transfer	2	2	0	4	4
14.	MEE6029	Hybrid Electric Vehicles	2	0	0	4	3
15.	MEE5015	Finite Element Methods	2	2	2	0	4

MAT5005	Advanced Mathematical Methods	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	None	Syllabus version				
		v.2.0				

Course Objectives:

1. To provide the students with sufficient exposure to advanced mathematical methods and tools that are relevant to engineering research.
2. Improving the computational skills of students by giving sufficient knowledge of analytical and numerical techniques useful for solving problems arising in Mechanical Engineering.
3. Imparting the knowledge of real time applications of Autonomous systems, Non-linear systems of ordinary differential equations and partial differential equations.

Course Outcome:

1. Distinguish and analyse a variety of tools for solving linear systems and finding eigenvalues of these systems.
2. Derive and use the numerical techniques needed for the solution of a given engineering problems
3. Understand and correlate the analytical and numerical methods
4. Demonstrate their ability to write coherent mathematical proofs and scientific arguments needed to communicate the results obtained from differential equation models.
5. Demonstrate the understanding of how physical phenomena are modelled by partial differential equations

Module:1	Eigenvalue Problems		5 hours

Standard Eigen value problems–Eigenvalues and Eigenvectors–Gerschgorin Circles theorem–Rutishauser method, Power method, Inverse Power method.

Module:2	Iteration Methods		6 hours

Sturm sequence, Jacobi method, Given's method, Householder method, Deflation, Lanczo's method.

Module:3	Calculus of Variations		9 hours

Euler-Lagrange's equation –Isoperimetric problems, Rayleigh–Ritz method - Galerkin method.

Module:4	System of First Order Ordinary Differential Equations		6 hours

Linear Systems - Homogeneous linear systems with constant coefficients - Autonomous systems - Phase Plane Phenomena - Critical Points - Stability for linear systems.

Module:5	Nonlinear systems		6 hours

Simple critical points of nonlinear systems-Stability by Liapunov's method –

Non- Linear Mechanics: Conservative systems.			
Module:6	**Partial Differential Equations**		**5 hours**
Classification of Second-Order Partial Differential Equations, Significance of characteristic curves, Canonical Form, Sturm–Liouville problems and Eigen function expansions.			
Module:7	**Wave equation**		**6 hours**
Displacements in a long string – a long string under its weight – a bar with prescribed force on one end – free vibrations of a string. Method of Separation of variables, Solution by method of Laplace transforms			
Module:8	**Contemporary Issues**		**2 hours**
Industry Expert Lecture			
	Total Lecture hours:	**45 hours**	

Text Book(s)	
1	Differential Equations: Theory, Technique and Practice, G.F. Simmons, S. G. Krantz, Tata Mc GrawHill Publishing, 2007. (Topics from Chapters 10, 11)
2	Elements of Partial differential equations, Ian N. Sneddon, Dover Publications, New York, 2006. (Topics from Chapters 3, 5)
3	Numerical Methods for Scientific and Engineering Computation, M. K. Jain, S. R. K. Iyengar, R. K. Jain, New Age International publishers, 7th edition, New Delhi, 2019. (Topics from Chapter 3, 7)
4	Introductory Methods of Numerical Analysis, S. S. Sastry, PHI Pvt. Ltd., 5th Edition, New Delhi, 2015. (Topics from Chapter 11)
5	The Calculus of Variations, Bruce van Brunt, Springer, 2004. (Topics from Chapters 2, 4, 5)
Reference Books	
1	Differential Equations and Dynamical Systems, Lawrence Perko, 3rd ed., Springer-Verlag, 2001.
2	An introduction to Ordinary Differential Equations, James C. Robinson, Cambridge University Press, New York, 2008 (4th print).
3	Elementary Applied Partial Differential Equations, Richard Haberman, Prentice Hall International, 1998.
4	Numerical Analysis, R. L. Burden and J. D. Faires, 10th Edition, Cengage Learning, India edition, 2015.

Mode of Evaluation: Continuous Assessment Tests, Final Assessment Test, Digital Assignments, Quizzes.			
Mode of evaluation:			
Recommended by Board of Studies	03-06-2019		
Approved by Academic Council	No. 55	Date	13-06-2019

Course code	Fundamentals of Communication Skills	L	T	P	J	C
ENG5001		0	0	2	0	1
Pre-requisite	Not cleared EPT (English Proficiency Test)	Syllabus version				
		v. 1.0				

Course Objectives:

1. To enable learners learn basic communication skills - Listening, Speaking, Reading and Writing
2. To help learners apply effective communication in social and academic context
3. To make students comprehend complex English language through listening and reading

Expected Course Outcome:

1. Enhance the listening and comprehending skills of the learners
2.Acquire speaking skills to express their thoughts freely and fluently
3.Learn strategies for effective reading
4.Write grammatical correct sentences in general and academic writing
5. Develop technical writing skills like writing instructions, transcoding etc.,

Module:1	**Listening**	**8 hours**

Understanding Conversation
Listening to Speeches
Listening for Specific Information

Module:2	**Speaking**	**4 hours**

Exchanging Information
Describing Activities, Events and Quantity

Module:3	**Reading**	**6 hours**

Identifying Information
Inferring Meaning
Interpreting text

Module:4	**Writing: Sentence**	**8 hours**

Basic Sentence Structure
Connectives
Transformation of Sentences
Synthesis of Sentences

Module:5	**Writing: Discourse**	**4 hours**

Instructions
Paragraph
Transcoding

	Total Lecture hours:	**30 hours**

Text Book(s)

1. Redston, Chris, Theresa Clementson, and Gillie Cunningham. *Face2face Upper Intermediate Student's Book.* 2013, Cambridge University Press.

Reference Books

1 Chris Juzwiak .*Stepping Stones: A guided approach to writing sentences and Paragraphs (Second Edition),* 2012, Library of Congress.
2. Clifford A Whitcomb & Leslie E Whitcomb, *Effective Interpersonal and Team*

3.	*Communication Skills for Engineers*, 2013, John Wiley & Sons, Inc., Hoboken: New Jersey. ArunPatil, Henk Eijkman &Ena Bhattacharya, *New Media Communication Skills for Engineers and IT Professionals*,2012, IGI Global, Hershey PA.
4.	Judi Brownell, *Listening: Attitudes, Principles and Skills*, 2016, 5th Edition, Routledge:USA
5.	John Langan, Ten Steps to Improving College Reading Skills, 2014, 6th Edition, Townsend Press:USA
6.	Redston, Chris, Theresa Clementson, and Gillie Cunningham. *Face2face Upper Intermediate Teacher's Book*. 2013, Cambridge University Press.
	Authors, book title, year of publication, edition number, press, place

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)		**CO : 1,2,3,4,5**
1.	Familiarizing students to adjectives through brainstorming adjectives with all letters of the English alphabet and asking them to add an adjective that starts with the first letter of their name as a prefix.	2 hours
2.	Making students identify their peer who lack Pace, Clarity and Volume during presentation and respond using Symbols.	4 hours
3.	Using Picture as a tool to enhance learners speaking and writing skills	2 hours
4.	Using Music and Songs as tools to enhance pronunciation in the target language / Activities through VIT Community Radio	2 hours
5.	Making students upload their Self- introduction videos in Vimeo.com	4 hours
6.	Brainstorming idiomatic expressions and making them use those in to their writings and day to day conversation	4 hours
7.	Making students Narrate events by adding more descriptive adjectives and add flavor to their language / Activities through VIT Community Radio	4 hours
8	Identifying the root cause of stage fear in learners and providing remedies to make their presentation better	4 hours
9	Identifying common Spelling & Sentence errors in Letter Writing and other day to day conversations	2 hours
10.	Discussing FAQ's in interviews with answers so that the learner gets a better insight in to interviews / Activities through VIT Community Radio	2 hours
	Total Practical Hours	30 hours

Mode of evaluation: Online Quizzes, Presentation, Role play, Group Discussions, Assignments, Mini Project

Recommended by Board of Studies	22-07-2017		
Approved by Academic Council	No. 46	Date	24-8-2017

Course code	Professional and Communication Skills	L	T	P	J	C
ENG5002		0	0	2	0	1
Pre-requisite	ENG5001	Syllabus version				
		v. 1.1				

Course Objectives:

1. To enable students to develop effective Language and Communication Skills
2. To enhance students' Personal and Professional skills
3. To equip the students to create an active digital footprint

Expected Course Outcome:

1. Improve inter-personal communication skills
2. Develop problem solving and negotiation skills
3. Learn the styles and mechanics of writing research reports
4. Cultivate better public speaking and presentation skills
5. Apply the acquired skills and excel in a professional environment

Module:1	Personal Interaction	2hours

Introducing Oneself- one's career goals
Activity: SWOT Analysis

Module:2	Interpersonal Interaction	2 hours

Interpersonal Communication with the team leader and colleagues at the workplace
Activity: Role Plays/Mime/Skit

Module:3	Social Interaction	2 hours

Use of Social Media, Social Networking, gender challenges
Activity: Creating LinkedIn profile, blogs

Module:4	Résumé Writing	4 hours

Identifying job requirement and key skills
Activity: Prepare an Electronic Résumé

Module:5	Interview Skills	4 hours

Placement/Job Interview, Group Discussions
Activity: Mock Interview and mock group discussion

Module:6	Report Writing	4 hours

Language and Mechanics of Writing
Activity: Writing a Report

Module:7	Study Skills: Note making	2hours

Summarizing the report
Activity: Abstract, Executive Summary, Synopsis

Module:8	Interpreting skills	2 hours

Interpret data in tables and graphs Activity: Transcoding			
Module:9	**Presentation Skills**		**4 hours**
Oral Presentation using Digital Tools Activity: Oral presentation on the given topic using appropriate non-verbal cues			
Module:10	**Problem Solving Skills**		**4 hours**
Problem Solving & Conflict Resolution Activity: Case Analysis of a Challenging Scenario			
	Total Lecture hours:	**30 hours**	

Text Book(s)

	Bhatnagar Nitin and Mamta Bhatnagar, *Communicative English For Engineers And Professionals*, 2010, Dorling Kindersley (India) Pvt. Ltd.

Reference Books

Jon Kirkman and Christopher Turk, *Effective Writing: Improving Scientific, Technical and Business Communication*, 2015, Routledge

Diana Bairaktarova and Michele Eodice, *Creative Ways of Knowing in Engineering*, 2017, Springer International Publishing

Clifford A Whitcomb & Leslie E Whitcomb, *Effective Interpersonal and Team Communication Skills for Engineers*, 2013, John Wiley & Sons, Inc., Hoboken: New Jersey.

ArunPatil, Henk Eijkman &Ena Bhattacharya, *New Media Communication Skills for Engineers and IT Professionals*,2012, IGI Global, Hershey PA.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)		**CO: 1,2,3,4,5**
1.	SWOT Analysis – Focus specially on describing two strengths and two weaknesses	2 hours
2.	Role Plays/Mime/Skit -- Workplace Situations	4 hours
3.	Use of Social Media – Create a LinkedIn Profile and also write a page or two on areas of interest	2 hours
4.	Prepare an Electronic Résumé and upload the same in vimeo	2 hours
5.	Group discussion on latest topics	4 hours
6	Report Writing – Real-time reports	2 hours
7	Writing an Abstract, Executive Summary on short scientific or research articles	4 hours
8	Transcoding – Interpret the given graph, chart or diagram	2 hours
9	Oral presentation on the given topic using appropriate non-verbal cues	4 hours
10	Problem Solving -- Case Analysis of a Challenging Scenario	4 hours
	Total Laboratory Hours	30 hours

Mode of evaluation: : Online Quizzes, Presentation, Role play, Group Discussions, Assignments, Mini Project

Recommended by Board of Studies	22-07-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Deutsch für Anfänger	L	T	P	J	C
GER5001		2	0	0	0	2
Pre-requisite	NIL	Syllabus version				
		v.1.0				

Course Objectives:

The course gives students the necessary background to:

1. enable students to read and communicate in German in their day to day life
2. become industry-ready
3. make them understand the usage of grammar in the German Language.

Expected Course Outcome:

1. To create the basics of German language in their day to day life.
2. To understand the conjugation of different forms of regular/irregular verbs.
3. To understand the rule to identify the gender of the Nouns and apply articles appropriately.
4. To apply the German language skill in writing corresponding letters, E-Mails etc.
5. To create the talent of translating passages from English-German and vice versa and To frame simple dialogues based on given situations.

Module:1	3 hours

Einleitung, Begrüssungsformen, Landeskunde, Alphabet, Personalpronomen, Verb Konjugation, Zahlen (1-100), W-fragen, Aussagesätze, Nomen – Singular und Plural

Lernziel:

Elementares Verständnis von Deutsch, Genus- Artikelwörter

Module:2	3 hours

Konjugation der Verben (regelmässig /unregelmässig) die Monate, die Wochentage, Hobbys, Berufe, Jahreszeiten, Artikel, Zahlen (Hundert bis eine Million), Ja-/Nein- Frage, Imperativ mit Sie

Lernziel :

Sätze schreiben, über Hobbys erzählen, über Berufe sprechen usw.

Module:3	4 hours

Possessivpronomen, Negation, Kasus- AkkusatitvundDativ (bestimmter, unbestimmterArtikel), trennnbare verben, Modalverben, Adjektive, Uhrzeit, Präpositionen, Mahlzeiten, Lebensmittel, Getränke

Lernziel :

Sätze mit Modalverben, Verwendung von Artikel, über Länder und Sprachen sprechen, über eine Wohnung beschreiben.

Module:4	6 hours

Übersetzungen : (Deutsch – Englisch / Englisch – Deutsch)

Lernziel :

Grammatik – Wortschatz - Übung

Module:5		**5 hours**
Leseverständnis,Mindmap machen,Korrespondenz- Briefe, Postkarten, E-Mail **Lernziel :** Wortschatzbildung und aktiver Sprach gebrauch		
Module:6	.	**3 hours**
Aufsätze : Meine Universität, Das Essen, mein Freund oder meine Freundin, meine Familie, ein Fest in Deutschland usw		
Module:7		**4 hours**
Dialoge: a) Gespräche mit Familienmitgliedern, Am Bahnhof, b) Gespräche beim Einkaufen ; in einem Supermarkt ; in einer Buchhandlung ; c) in einem Hotel - an der Rezeption ;ein Termin beim Arzt. Treffen im Cafe		
Module:8		**2 hours**
Guest Lectures/Native Speakers / Feinheiten der deutschen Sprache, Basisinformation über die deutschsprachigen Länder		
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	**Studio d A1 Deutsch als Fremdsprache, Hermann Funk, Christina Kuhn, Silke Demme : 2012**
Reference Books	
1	Netzwerk Deutsch als Fremdsprache A1, Stefanie Dengler, Paul Rusch, Helen Schmtiz, Tanja Sieber, 2013
2	Lagune ,Hartmut Aufderstrasse, Jutta Müller, Thomas Storz, 2012.
3	Deutsche SprachlehrefürAUsländer, Heinz Griesbach, Dora Schulz, 2011
4	ThemenAktuell 1, HartmurtAufderstrasse, Heiko Bock, MechthildGerdes, Jutta Müller und Helmut Müller, 2010
	www.goethe.de wirtschaftsdeutsch.de hueber.de klett-sprachen.de www.deutschtraning.org

Mode of Evaluation: CAT / Assignment / Quiz / FAT			
Recommended by Board of Studies	10.06.2016		
Approved by Academic Council	41	Date	17.06.2016

Course code	FRANCAIS FONCTIONNEL	L	T	P	J	C
FRE5001		2	0	0	0	2
Pre-requisite	NIL	Syllabus version				
		v.1				

Course Objectives:

The course gives students the necessary background to:

1. demonstrate competence in reading, writing, and speaking basic French, including knowledge of vocabulary (related to profession, emotions, food, workplace, sports/hobbies, classroom and family).
2. achieve proficiency in French culture oriented view point.

Expected Course Outcome:

1. To remember the daily life communicative situations via personal pronouns, emphatic pronouns, salutations, negations, interrogations etc.
2. To create communicative skill effectively in French language via regular / irregular verbs.
3. To demonstrate comprehension of the spoken / written language in translating simple sentences.
4. To understand and demonstrate the comprehension of some particular new range of unseen written materials.
5. To demonstrate a clear understanding of the French culture through the language studied.

Module:1	Saluer, Se présenter, Etablir des contacts	9 hours

Les Salutations, Les nombres (1-100), Les jours de la semaine, Les mois de l'année, Les Pronoms Sujets, Les Pronoms Toniques, La conjugaison des verbes réguliers, La conjugaison des verbes irréguliers- avoir / être / aller / venir / faire etc.

Module:2	Présenter quelqu'un, Chercher un(e) correspondant(e), Demander des nouvelles d'une personne.	9 hours

La conjugaison des verbes Pronominaux, La Négation, L'interrogation avec *'Est-ce que ou sans Est-ce que'*.

Module:3	Situer un objet ou un lieu, Poser des questions	9 hours

L'article (défini/ indéfini), Les prépositions (à/en/au/aux/sur/dans/avec etc.), L'article contracté, Les heures en français, La Nationalité du Pays, L'adjectif (La Couleur, l'adjectif possessif, l'adjectif démonstratif/ l'adjectif interrogatif (quel/quelles/quelle/quelles), L'accord des adjectifs avec le nom, L'interrogation avec Comment/ Combien / Où etc.,

Module:4	Faire des achats, Comprendre un texte court, Demander et indiquer le chemin.	8 hours

La traduction simple :(français-anglais / anglais –français)

Module:5	**Trouver les questions, Répondre aux questions générales en français.**	**7 hours**
L'article Partitif, Mettez les phrases aux pluriels, Faites une phrase avec les mots donnés, Exprimez les phrases données au Masculin ou Féminin, Associez les phrases.		
Module:6	**Comment ecrire un passage**	**9 hours**
Décrivez : La Famille /La Maison, /L'université /Les Loisirs/ La Vie quotidienne etc.		
Module:7	**Comment ecrire un dialogue**	**7 hours**
Dialogue: d) Réserver un billet de train e) Entre deux amis qui se rencontrent au café f) Parmi les membres de la famille g) Entre le client et le médecin		
Module:8	**Invited Talk: Native speakers**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Echo-1, Méthode de français, J. Girardet, J. Pécheur, Publisher CLE International, Paris 2010.
2	Echo-1, Cahier d'exercices, J. Girardet, J. Pécheur, Publisher CLE International, Paris 2010.
Reference Books	
1.	CONNEXIONS 1, Méthode de français, Régine Mérieux, Yves Loiseau,Les Éditions Didier, 2004.
2	CONNEXIONS 1, Le cahier d'exercices, Régine Mérieux, Yves Loiseau, Les Éditions Didier, 2004.
3	ALTER EGO 1, Méthode de français, Annie Berthet, Catherine Hugo, Véronique M. Kizirian, Béatrix Sampsonis, Monique Waendendries , Hachette livre 2006.

Mode of Evaluation: CAT / Assignment / Quiz / FAT			
Recommended by Board of Studies	10.06.2016		
Approved by Academic Council	41	Date	17.06.2016

Course code	Essentials of Business Etiquette and problem solving	L	T	P	J	C
STS5001		3	0	0	0	1
Pre-requisite	Nil	Syllabus version				
		1.0				

Course Objectives:

1. To develop the students' logical thinking skills
2. To learn the strategies of solving quantitative ability problems
3. To enrich the verbal ability of the students
4. To enhance critical thinking and innovative skills

Expected Course Outcome:

The students will be able to

1. Be proficient in solving quantitative aptitude and verbal ability questions of various examinations effortlessly
2. To communicate the message to the target audience clearly
3. Enabling students to use relevant aptitude and appropriate language to express themselves

Module:1	Business Etiquette: Social and Cultural Etiquette and Writing Company Blogs and Internal Communications and Planning and Writing press release and meeting notes	9 hours

Value, Manners, Customs, Language, Tradition, Building a blog, Developing brand message, FAQs', Assessing Competition, Open and objective Communication, Two way dialogue, Understanding the audience, Identifying, Gathering Information, Analysis, Determining, selecting plan, Progress check, Types of planning, Write a short, catchy headline, Get to the Point – summarize your subject in the first paragraph., Body – Make it relevant to your audience,

Module:2	Study skills – Time management skills	3 hours

Prioritization, Procrastination, Scheduling, Multitasking, Monitoring, working under pressure and adhering to deadlines

Module:3	Presentation skills – Preparing presentation and Organizing materials and Maintaining and preparing visual aids and Dealing with questions	7 hours

10 Tips to prepare PowerPoint presentation, Outlining the content, Passing the Elevator Test, Blue sky thinking, Introduction , body and conclusion, Use of Font, Use of Color, Strategic presentation, Importance and types of visual aids, Animation to captivate your audience, Design of posters, Setting out the ground rules, Dealing with interruptions, Staying in control of the questions, Handling difficult questions

Module:4	Quantitative Ability -L1 – Number properties	11 hours

	and Averages and Progressions and Percentages and Ratios	
Number of factors, Factorials, Remainder Theorem, Unit digit position, Tens digit position, Averages, Weighted Average, Arithmetic Progression, Geometric Progression, Harmonic Progression, Increase & Decrease or successive increase, Types of ratios and proportions		
Module:5	**Reasoning Ability-L1 – Analytical Reasoning**	**8 hours**
Data Arrangement (Linear and circular & Cross Variable Relationship), Blood Relations, Ordering/ranking/grouping, Puzzle test, Selection Decision table		
Module:6	**Verbal Ability-L1 – Vocabulary Building**	**7 hours**
Synonyms & Antonyms, One-word substitutes, Word Pairs, Spellings, Idioms, Sentence completion, Analogies		
	Total Lecture hours:	**45 hours**

Reference Books

1.	Kerry Patterson, Joseph Grenny, Ron McMillan, Al Switzler (2001) Crucial Conversations: Tools for Talking When Stakes are High. Bangalore. McGraw-Hill Contemporary
2.	Dale Carnegie, (1936) How to Win Friends and Influence People. New York. Gallery Books
3.	Scott Peck. M (1978) Road Less Travelled. New York City. M. Scott Peck.
4.	FACE (2016) Aptipedia Aptitude Encyclopedia. Delhi. Wiley publications
5.	ETHNUS (2013) Aptimithra. Bangalore. McGraw-Hill Education Pvt. Ltd.

Websites:

1.	**www.chalkstreet.com**
2.	**www.skillsyouneed.com**
3.	**www.mindtools.com**
4.	**www.thebalance.com**
5.	**www.eguru.ooo**

Mode of Evaluation: FAT, Assignments, Projects, Case studies, Role plays,
3 Assessments with Term End FAT (Computer Based Test)

Recommended by Board of Studies	09/06/2017		
Approved by Academic Council	45	Date	15.06.2017

Course code	Preparing for Industry	L	T	P	J	C
STS5002		3	0	0	0	1
Pre-requisite	None	Syllabus version				
		1				

Course Objectives:

1. To challenge students to explore their problem-solving skills
2. To develop essential skills to tackle advance quantitative and verbal ability questions
3. To have working knowledge of communicating in English

Expected Course Outcome:

1. Simplify, evaluate, analyze and use functions and expressions to simulate real situations to be industry ready.
2. Interact confidently and use decision making models effectively
3. Be proficient in solving quantitative aptitude and verbal ability questions of various examinations effortlessly

Module:1	Interview skills – Types of interview and Techniques to face remote interviews and Mock Interview	3 hours

Structured and unstructured interview orientation, Closed questions and hypothetical questions, Interviewers' perspective, Questions to ask/not ask during an interview, Video interview, Recorded feedback, Phone interview preparation, Tips to customize preparation for personal interview, Practice rounds

Module:2	Resume skills – Resume Template and Use of power verbs and Types of resume and Customizing resume	2 hours

Structure of a standard resume, Content, color, font, Introduction to Power verbs and Write up, Quiz on types of resume, Frequent mistakes in customizing resume, Layout - Understanding different company's requirement, Digitizing career portfolio

Module:3	Emotional Intelligence - L1 – Transactional Analysis and Brain storming and Psychometric Analysis and Rebus Puzzles/Problem Solving	12 hours

Introduction, Contracting, ego states, Life positions, Individual Brainstorming, Group Brainstorming, Stepladder Technique, Brain writing, Crawford's Slip writing approach, Reverse brainstorming, Star bursting, Charlette procedure, Round robin brainstorming, Skill Test, Personality Test, More than one answer, Unique ways

Module:4	Quantitative Ability-L3 – Permutation-Combinations and Probability and Geometry and mensuration and Trigonometry and Logarithms and Functions and Quadratic Equations and Set Theory	14 hours

Counting, Grouping, Linear Arrangement, Circular Arrangements, Conditional Probability, Independent and Dependent Events, Properties of Polygon, 2D & 3D Figures, Area & Volumes,

Heights and distances, Simple trigonometric functions, Introduction to logarithms, Basic rules of logarithms, Introduction to functions, Basic rules of functions, Understanding Quadratic Equations, Rules & probabilities of Quadratic Equations, Basic concepts of Venn Diagram		
Module:5	**Reasoning ability-L3 – Logical reasoning and Data Analysis and Interpretation**	**7 hours**
Syllogisms, Binary logic, Sequential output tracing, Crypto arithmetic, Data Sufficiency, Data interpretation-Advanced, Interpretation tables, pie charts & bar chats		
Module:6	**Verbal Ability-L3 – Comprehension and Logic**	**7 hours**
Reading comprehension, Para Jumbles, Critical Reasoning (a) Premise and Conclusion, (b) Assumption & Inference, (c) Strengthening & Weakening an Argument		
	Total Lecture hours: **45 hours**	
References	• Michael Farra and JIST Editors(2011) Quick Resume & Cover Letter Book: Write and Use an Effective Resume in Just One Day. Saint Paul, Minnesota. Jist Works • Daniel Flage Ph.D(2003) The Art of Questioning: An Introduction to Critical Thinking. London. Pearson • FACE(2016) Aptipedia Aptitude Encyclopedia.Delhi. Wiley publications	
Mode of Evaluation: FAT, Assignments, Projects, Case studies, Role plays, 3 Assessments with Term End FAT (Computer Based Test)		

Recommended by Board of Studies	09/06/2017		
Approved by Academic Council	45	Date	15-06-2017

Course code	SET – I	L	T	P	J	C
SET 5001		-	-	-	-	2
Pre-requisite		Syllabus Version				
Anti-requisite		1.10				

Course Objectives:

The Objectives of the course are:

1. SET project may be of theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, etc. or a combination of these.
2. The SET project is intended to give each student the fundamental research concept. The projects will explore innovations in technology, systems and business strategy.
3. It improves the research culture and gives confidence for the student to practice and write individual research article in the form of national and international conferences and journal papers.
4. A consciousness of the ethical aspects of research and development work needed for societal improvement
5. SET project is carried along with other academic courses in the institute as a part of academic curriculum

Expected Course Outcome:

On completion of this course student should be able to:

1. Carried out inside the university, in any research area corresponding to their curriculum
2. Publications in the peer reviewed journals / International Conferences will be an added advantage.
3. It motivates and encourage research culture in the young minds of graduate engineers
4. Students are made aware of plagiarism checking and they are advised not to exceed more than 12% as per the academic regulations.

Student Assessment : Mid reviews & SET International Conference Presentation (Oral or Poster)

Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	SET – II	L	T	P	J	C
SET 5002		-	-	-	-	2
Pre-requisite	SET I	Syllabus version				
Anti-requisite		1.10				

Course Objectives:

The Objectives of the course are:

1. SET project may be of theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, etc. or a combination of these.
2. The SET project is intended to give each student the fundamental research concept. The projects will explore innovations in technology, systems and business strategy.
3. It improves the research culture and gives confidence for the student to practice and write individual research article in the form of national and international conferences and journal papers.
4. A consciousness of the ethical aspects of research and development work needed for societal improvement
5. SET project is carried along with other academic courses in the institute as a part of academic curriculum

Expected Course Outcome:

On completion of this course student should be able to:

1. Carried out inside the university, in any research area corresponding to their curriculum
2. Publications in the peer reviewed journals / International Conferences will be an added advantage.
3. It motivates and encourage research culture in the young minds of graduate engineers
4. Students are made aware of plagiarism checking and they are advised not to exceed more than 12% as per the academic regulations.

14. Having an ability to design and conduct experiments, as well as to analyze and interpret data

18. Having critical thinking and innovative skills

20. Having a good digital footprint

Student Assessment : Mid reviews & SET International Conference Presentation (Oral or Poster)

Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Master's Thesis	L	T	P	J	C
MEE6099		0	0	0	0	16
Pre-requisite	As per the academic regulations	Syllabus version				
		1.0				

Course Objectives:

To provide sufficient hands-on learning experience related to the design, development and analysis of suitable product / process so as to enhance the technical skill sets in the chosen field and also to give research orientation.

Expected Course Outcome:

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

1. Formulate specific problem statements for ill-defined real life problems with reasonable assumptions and constraints.
2. Perform literature search and / or patent search in the area of interest.
3. Conduct experiments / Design and Analysis / solution iterations and document the results.
4. Perform error analysis / benchmarking / costing
5. Synthesise the results and arrive at scientific conclusions / products / solution
6. Document the results in the form of technical report / presentation

Contents

1. Capstone Project may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities.
2. Project can be for two semesters based on the completion of required number of credits as per the academic regulations.
3. Should be individual work.
4. Carried out inside or outside the university, in any relevant industry or research institution.
5. Publications in the peer reviewed journals / International Conferences will be an added advantage

Mode of Evaluation: Periodic reviews, Presentation, Final oral viva, Poster submission

Recommended by Board of Studies	10.06.2016		
Approved by Academic Council	41st AC	Date	17.06.2016

Course code	Automotive Body and Chassis Systems	L	T	P	J	C
MEE5010		3	0	0	0	3
Pre-requisite	Nil	Syllabus version				
		2.1				

Course Objectives:

1. To introduce vehicle chassis structure
2. To introduce automotive suspension systems
3. To broaden the importance of conventional and advanced braking systems
4. To introduce steering systems

Expected Course Outcome:

The student shall be able to:

1. Choose and suggest a suitable chassis layout, frame and body construction type for different cars & bus
2. Designing suitable chassis layout for commercial vehicles.
3. Determine and analyse various types of steering systems
4. Select and analyse a suitable suspension system for different types of vehicles
5. Suggest, Identify and Design suitable type of braking system for different types of vehicles

Module:1	Car body	7 hours

Types: saloon, convertibles, limousine, estate car, racing and sports car. Visibility: regulations, driver's visibility, tests for visibility, methods of improving visibility and space in cars. Safety: safety design, safety equipments for cars. Car body construction; design criteria, prototype making, initial tests, crash tests on full scale model, Dummies and Instrumentation.

Module:2	Bus body	6 hours

Types: mini bus, single decker, double-decker, two level and articulated bus. Bus body layout; floor height, engine location, entrance and exit location, seating dimensions. Constructional details: frame construction, double skin construction, types of metal sections used, Regulations, Conventional and integral type construction..

Module:3	Commercial vehicle	6 hours

Types of body; flat platform, drop side, fixed side, tipper body, tanker body, Light commercial vehicle body types. Dimensions of driver's seat relation to controls. Drivers cab design.

Module:4	Chassis	6 hours

Types of Chassis layout, with reference to Power Plant location and drive, various types of frames, Loads acting on vehicle frame, Constructional details and materials for frames, Testing of frames. Integral construction, Monocoque, Back bone.

Module:5	Steering system	6 hours

Front wheel geometry: castor, camber, king pin inclination, toe-in. conditions for true rolling motion of wheels during steering, steering geometry, Ackermann and Davis steering system, constructional details of steering linkages, different types of steering gear boxes, steering linkages and layouts, turning radius, wheel wobble, power assisted steering. Steer by wire

Module:6	**Suspension system**	**6 hours**
Need of suspension system, types of suspension, suspension springs, constructional details and characteristics of leaf, coil and torsion bar springs, independent suspension, rubber suspension, pneumatic suspension, shock absorbers. MR dampers ,Bose suspension		
Module:7	**Braking system**	**6 hours**
Classification of brakes, drum brakes and disc brakes, constructional details, theory of braking, concept of dual brake system, Anti lock braking system , Electronic brake force distribution, parking brake, vacuum assisted system, air brake system, retarded engine brakes, eddy retarders, Electronic stability control		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Newton Steeds and Garrot, "Motor Vehicles" (2008), Butterworths, London.

Reference Books

1	John Fenton, "Vehicle Body layout and analysis" (1982), Mechanical Engg. Publication Ltd., London.
2	Crouse W.H, "Automotive chassis and body" (1971), McGraw-Hill, New York.
3	Gento., Giancarlo., Morello., "The Automotive chassis", (2009), Springer.
4	J.Powloski, "Vehicle Body Engineering" (1989), Business Books Ltd, London.
5	R.K.Rajput, "A Text–Book of Automobile Engineering",(2010),Laxmi Publications Private Limited.
6	Heinz Heisler, "Advanced Vehicle Technology", (2011), Butterworth-Heinemann. ISBN – 0 7506 51318,

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

Mode of assessment:

Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Engine Combustion and Emission	L	T	P	J	C
MEE5011		3	0	2	0	4
Pre-requisite	Nil	Syllabus version				
		2.1				

Course Objectives:

1. To broaden the understanding of engine and its working
2. To underline the importance of engine components
3. To introduce fuel supply, cooling and lubrication systems
4. To broaden the importance of air motion and combustion chamber design
5. To introduce new engine technology

Expected Course Outcome:

The student shall be able to:

1. Understand the combustion phenomena of premixed and diffusion combustion systems
2. Determine fuel rating and ignition systems
3. Design suitable combustion chamber with enhanced air motion and better mixing
4. Adopt new emission control technologies
5. Validate the engine emission characteristics with BS norms
6. Calibration and measurement of emission analysers
7. Analysing the cylinder pressure data to determine various combustion parameters

Module:1	Introduction to Engines	3 hours

Construction and working, Engine operating Cycles – Ideal and Fuel Air Cycles,Engine Classifications

Module:2	SI Engine Combustion	8 hours

Stages of Combustion, Phases of Ignition, Flame Propagation – Factors, Flame Structure, Burning Velocity, Cycle to Cycle Variations.

Module:3	CI Engine Combustion	8 hours

Stages of Combustion, Heat Release Rate analysis, Ignition Delay – Factors, Fuel spray structure, Spray Penetration, Spray angle, Droplet distribution and Evaporation.

Module:4	Abnormal Combustion	4 hours

Knocking and Detonation Concepts, Knock types, Surface Ignition, Fuel Ratings

Module:5	Oxides of Nitrogen Emission	6 hours

Kinetics of NO formation, NO formation in SI Engines, NOx formation in CI Engines – Controlling Techniques – SCR

Module:6	Unburned Hydrocarbon and CO Emission	6 hours

Carbon Monoxide Formation, Flame Quenching and Oxidation, HC emissions in SI Engine, HC emissions Mechanism in Diesel Engines – Controlling Techniques – Catalytic

Converters		
Module:7	**Particulate Emissions and Exhaust gas Treatment**	**8 hours**
SI Engine Particulates, Diesel Engine Particulates, Particulate Distribution, Soot Formation, Soot Formation, Adsorption and Condensation Emission Testing Methods, Thermal reactors, Particulate Traps – DPF, DOF		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	John B Heywood, "Internal Combustion Engine Fundamentals", (2011), McGraw Hill Education.
Reference Books	
1	V. Ganesan, "Internal Combustion Engine", (2012), 4th Edition, McGraw Hill Education.
2	Stephen R Turns, "An Introduction to Combustion", (2011), McGraw Hill Education, 3rd Edition.
3	James D Halderman, "Automotive Fuel and Emissions Control Systems", (2015), Prentice Hall, 4th Edition
4	Klingenberg H, "Automobile Exhaust Emission Testing", (2012), Springer.

List of Challenging Experiments (Indicative)		
1.	Performance, heat balance and emission analysis of S.I Engine	3 hours
2.	Performance, heat balance and emission analysis of C.I Engine	3 hours
3.	Dismantling and assembling an automotive diesel engine	3 hours
4.	Fuel property testing (Calorific value, Density and Viscosity)	3 hours
5.	Fuel property testing (Flash, Fire point, Pour point, Cloud point)	3 hours
6.	Cylinder pressure measurement and Combustion analysis	3 hours
7.	NOx emission control through EGR and Injection retardation	3 hours
8.	NOx emission control through Injection retardation	3 hours
9.	Smoke emission control through biodiesel blended diesel	3 hours
10.	NOx and HC emission control through ethanol blended gasoline	3 hours
	Mode of evaluation: Digital Assignments / Seminars / Surprise Test / CATs / FAT	
	Total Laboratory Hours	30 hours
	Recommended by Board of Studies	17-08-2017

Approved by Academic Council	No. 47	Date	05.10.2017

Course code	Automotive Transmission System	L	T	P	J	C
MEE 5012		3	2	0	0	4
Pre-requisite	Nil	Syllabus version				
		v. xx.xx				

Course Objectives:

1. To provide the students with sufficient background to understand the need for various transmission components.
2. To enable the students to understand different types of clutches and gearboxes.
3. To help the students to design the gearbox for car and trucks. 2.

Expected Course Outcome:

Student will be able to

1. Identify and also select suitable clutch for a given vehicle.
2. Analysis and design the gearbox for any given vehicle.
3. Possess the knowledge of various transmission components
4. Explain the need and function of semi and fully automatic transmission system.
5. Comprehend and also develop new transmission systems.
6. Understand latest technology in transmission systems including hybrid vehicle.

Module:1	Introduction - Clutch	7 hours

Necessity of clutch in an automobile, different types of clutches, friction clutches namely Single plate clutch, multi plate clutch, cone clutch, centrifugal clutch, hydraulic clutches, Vacuum operated clutch. Clutch - adjustment, Clutch troubles and their causes, requirements of a clutch, Clutch material, clutch lining.

Module:2	Fluid coupling	4 hours

Fluid coupling: advantages and limitations, construction details, torque capacity, slip in fluid coupling, performance characteristics. Means used to reduce drag torque in fluid coupling.

Module:3	Introduction - Gearbox	7 hours

Various Resistances to Motion of the Automobile, Traction, tractive effort Performance curves, acceleration grade ability, drawbar pull. The need for transmissions, Necessity of gear box, Desirable ratios of 3speed & 4speed gear boxes. Constructional details of, Sliding-mesh gear box , Constant-mesh gear box, synchromesh gear box, transfer case, overdrive.

Module:4	Tutorial	6 hours

Design of gear box – How to select 4 or 6 or 8 speed gear box for a vehicle. Selection of gear ratio, Selection of number of teeth for a given gear ratio.

Module:5	Drive line	5 hours

Effects of driving thrust and torque reaction. Hotchkiss drive. Torque tube drive, radius rods. Propeller shaft. Universal joints. Final drives – different types, double reaction final drive. Two speed rear axle. Rear axle construction – full floating, three quarter floating and semi-floating arrangements. Differential – conventional type, non-slip type. Differential locks.

Module:6	**Automatic transmission**	**6 hours**
Hydrodynamic drive - Torque Converter: Principal of torque conversion, single, multi stage and polyphase torque converters, performance characteristics, constructional and operational details of typical hydraulic transmission drives. Leyland, White Hydro torque drives. Automatic transmission: Planetary gearboxes - Ford T-model, Cotal and Wilson Gear box: Epicyclic transmission, hydromatic transmission, continuously variable transmission: Types – Belt and Toroidal - Relative merits and demerits when compared to conventional transmission.		
Module:7	**Semi-automatic transmission**	**8 hours**
Hydrostatic drives: advantages and disadvantages, principles of hydrostatic drive systems, construction and working of typical hydrostatic drives, Janney Hydrostatic drive. Electrical drives: advantages and limitations, principles of Ward Leonard system of control Modern electric drive for buses and performance characteristics. Semi automatic transmissions – Dual clutch transmission, Direct shift gearbox, Multimode manual transmission, Tiptronic transmission, Paddle shift gearbox.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Robert fisher, Kücükay, F., Jürgens, G., Najork, R., Pollak, B, "The Automotive Transmission book", Springer- ISBN 978-3-319-05263-2 , 2015.

Reference Books

1.	Heinz Heisler , "Advanced Vehicle Technology", Butterworth-Heinemann- ISBN – 0 7506 51318, 2011.
2.	Gisbert Lechner , Harald Naunheimer, "Automotive Transmissions – Fundamentals , selection , design and selection", Springer-ISBN 3-540- 65903, 2010.
3.	Naunheimer, H., Bertsche, B., Ryborz, J., Novak, W. "Automotive Transmissions-Fundamentals, Selection, Design and Application", Springer-ISBN 978-3-642-16214-5, 2011.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Vehicle Dynamics	L	T	P	J	C
MEE5026		2	2	0	4	4
Pre-requisite	MEE1002- Engineering Mechanics	Syllabus version				
		v. xx.xx				

Course Objectives:

1. To enable students to understand the role of tire mechanics for vehicle dynamics
2. To enable the students to understand longitudinal, lateral and vertical dynamics and the issues involved in it such as braking, traction, vehicle control and stability
3. To prepare the students to understand significance of steering and suspension mechanisms for vehicle dynamics.
4. To demonstrate how to apply fundamentals of vibrations and acoustics for vehicle NVH perspective along with importance of modal analysis and transfer path analysis

Expected Course Outcome:

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

1. Predict the necessary forces and moments during tire/road interaction through various tire models for vehicle dynamic simulations.
2. Compute maximum traction, optimum braking distribution and stability of the vehicle of two and three axle vehicles
3. Demonstrate the application of fundamental governing equations for longitudinal, lateral and vertical dynamics and able to use state space approach.
4. Compute steady state and transient response of vehicle during cornering.
5. Outline the role of suspension in roll over stability.
6. Evaluate the role of suspension for vibration isolation, rattle space and road holding using appropriate mathematical models.
7. Identify the current literature and the necessity of modern tools for vehicle development

Module:1	Introduction to Tyre Mechanics	5 hours

Introduction to Vehicle Dynamics-Tyre types and construction-Tyre forces and moments-Tyre-slip-grip and rolling resistance-Cornering properties of tyres- Tyre models-Tyre performance on wet surfaces-Ride properties of tyres.

Module:2	Longitudinal Dynamics	4 hours

Performance characteristics-Maximum tractive effort-Power plant and Transmission characteristics. Braking performance-Study of tractor-semitrailer-Anti lock brake system- Traction control system

Module:3	Lateral Dynamics	4 hours

Bicycle Model-Low speed turning-High speed cornering-State space approach-Steaty state handling characteristics of two axle vehicle- neutral steer-understeer-oversteer.

Module:4	Vehicle stability	3 hours

Stability and steering conditions-Understeer gradient – Handling response of a vehicle- Lateral transient response-Mimuro plot

Module:5	**Steering and Suspension Mechanisms**	**4 hours**
Steering geometry and mechanism, steering mechanism optimization- Four wheel steering- Solid Axle suspension-Independent suspension-Roll center and Roll axis-Roll mement distribution-Car tyre relative angles-Caster theory		
Module:6	**Vertical Dynamics**	**4 hours**
Vehicle ride characteristics-Human response to vibration-Vehicle ride models-Quarter car model- pitch and bounce model- Suspension performance for ride-vibration isolation,suspension travel, Road holding. Active and Semi-active suspensions. Introduction to random vibration.		
Module:7	**Introduction to Noise, Vibration and Harshness**	**4 hours**
Fundamentals of Acoustics, Noise and Vibrations. Frequency response functions-Modal analysis-Transfer path analysis- Single reference- Multi reference analysis.		
Module:8	**Contemporary issues:**	**2 hours**
Case studies form Industry		
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Reza N Jazar "Vehicle Dynamics: Theory and Application", 3rd Edition, Springer International Publishing AG, Switzerland, 2017
Reference Books	
1.	J. Y. Wong (2008), "Theory of Ground Vehicles", 4th Edition, John Wiley and Sons Inc., New York, 2008
2.	Thomas D. Gillespie,(1992), "Fundamentals of Vehicle Dynamics (R114) Publisher: Society of Automotive Engineers Inc.,1992
3.	C. Sujatha, "Vibration and Acoustics: Measurements and Signal Analysis", McGraw Hill Education (India) Private limited, 2010.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Automotive Electrical and Electronics	L	T	P	J	C
EEE5025		3	0	2	0	4
Pre-requisite		Syllabus version				
		v. xx.xx				

Course Objectives:

To help students to gain essential and basic knowledge of automotive electrical and electronic systems with the working principle and necessary design requirement as per the testing standards, so as to equip them with knowledge required for the automotive electrical development.

Expected Course Outcome:

Students will be able to

1. Gain the knowledge of construction and working of batteries
2. Understand the working of charging and starting systems
3. Gain the knowledge and skills of the automotive wiring design and ignition system
4. Acquiring the sensing technique and working of automotive sensors
5. Understand the working of engine management system and other electronic control unit in the vehicle
6. Gain the skills on the recent development in the area of automotive electronic and electrical systems
7. Understand the real-time of working of the various sensors with its characteristics features

Module:1	Battery	6 hours

Principle and construction of Lead Acid Battery, Choice of battery for automotive applications, Characteristics of Battery, Battery Rating, Capacity and Efficiency.

Module:2	Starting and Charging System and Electric Drives	6 hours

Requirements of Starter Motor, Starter Motor types, construction and characteristics, Starter drive mechanisms, Starter Switches and Solenoids. - Charging system components, Generators and Alternators, types, construction and Characteristics, Voltage and Current Regulation, Cut –out relays and regulators.

Module:3	Wiring and Lighting System	6 hours

Automotive Wiring Harnesses, Insulated and Earth Return System, Positive and Negative Earth Systems, Connectors and its types, Head Lamp and Indicator Lamp construction and working details, Focusing of head lamps, Anti–Dazzling and Dipper Details.

Module:4	Sensors and Actuators	6 hours

Engine sensors and actuator: Manifold Absolute Pressure sensor, knock sensor, Coolant and Exhaust gas temperature, Exhaust Oxygen level sensor, Throttle position sensor, accelerator pedal position sensor and crankshaft position sensor, Air mass flow sensor. Solenoids, stepper motors and relays, piezo actuators. Chassis:- Steering wheel angle sensor, Vibration and acceleration sensors, Pressure sensors, Speed and RPM sensors, torque sensors

Module:5	**Electronic Engine Management system**	**6 hours**
Microprocessor And Microcomputer controlled devices in automobiles, Architecture of an ECU, Electronic engine control: Input, output devices, electronic fuel control system, engine control operating modes, Electronic ignition systems, and Spark advance correction schemes.		
Module:6	**Electric Management System and Dash Board Instrumentation**	**6 hours**
Cruise control system, Antilock braking system, traction control system, electronic suspension system, electronic steering control, transmission control, Airbags, collision avoiding system, low tire pressure warning system. Warning system, driver information system, instrument cluster ECU, types of indication in the cluster, Bus system, CAN and LIN communication, Horns, wiper system and its types, keyless entry system.		
Module:7	**Ignition System**	**6 hours**
Spark Plugs, Constructional details and Types, Battery Coil and Magneto–Ignition System Circuit details and Components, Non–Contact–type Ignition Triggering devices, Capacitive Discharge Ignition, Distributor–less Ignition System.		
Module:8	**Contemporary issues:**	**3 hours**
Electromagnetic Compatibility and its suppression techniques, Hybrid Vehicles		
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	William B.Ribben, Understanding Automotive Electronics (2003), 6th ed., Elsevier Science.
Reference Books	
1.	Tom Denton, Automobile Electrical and Electronic systems (2013), Fourth Ed., Rouletedge, taylor & Francis Group
2.	R.K.Jurgen, Automotive Electronics Handbook (1999), McGraw Hill, 2 edition, 1999
3.	T.mellard, Automotive Electronics, Butterworth Heinmann Ltd, 1991
4	Ronald K.Jurgen, Electric and Hybrid-electric vehicles, SAE 2002
5	Kholi .P.L, "Automotive Electrical Equipment", Tata McGraw-Hill co ltd, New Delhi,2004

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)		
1.	Temperature Measurement – Thermocouple, Thermister, RTD, IR	3hrs
2.	Pressure and Force Measurement	3hrs
3.	Strain measurement	3hrs

4.	Speed measurement	3hrs
5.	Vibration measurement	3hrs
6.	Humidity measurement	3hrs
7.	Light intensity measurement	3hrs
8.	Microcontroller based stepper and servo motor control	3hrs
9.	Basic automotive electrical wiring	3hrs
10.	Head lamp alignment and testing	3hrs
	Total Laboratory Hours	30hours

Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Alternate Fuels	L	T	P	J	C
MEE6016		2	0	0	4	3
Pre-requisite	None	Syllabus version				
		v. xx.xx				

Course Objectives:

1. Familiarize with the various types and classification of alternate fuels
2. Evaluate and characterize the various properties of gaseous, liquid and solid fuels.
3. General knowledge on application of alternate fuels for automotive application.

Expected Course Outcome:

1. Possess the knowledge of various types of alternate fuels their application and limitation.
2. Identify and formulate the gaseous fuels like LPG, CNG and LNG in SI and CI engines and analyze their performance characteristics.
3. Demonstrate the ability to use hydrogen and biogas as alternate fuels for IC engines and gain the knowledge of their storage, handling and safety aspects.
4. Preparation of biodiesel through esterification and analyzing their performance and emission characteristics.
5. Acquiring the knowledge of implementing alcohol, synthetic fuels and bio mass for automotive applications and briefing their merits and limitations.

Module:1	Introduction	2 hours

Need for alternate fuel, availability and properties of alternate fuels, classification of alternative fuels, liquid fuels, gaseous fuels, synthetic fuels, merits and demerits of various alternate fuels, introduction to alternate energy sources- Like EV, hybrid, fuel cell and solar Vehicle.

Module:2	Gaseous fuels	4 hours

Natural Gas, LPG, biogas, producer gas, syngas etc.; Properties; Production and storage methods – CNG and LNG, gasification, digesters; Use in SI and CI engines; Performance and emission characteristics; Dual fuel and HCCI modes.

Module:3	Hydrogen	4 hours

Availability, properties, production methods, modifications required in engines, performance and emission characteristics, storage, handling & dispensing, safety aspects. Effects of fuel on engine life

Module:4	Bio Gas, Producer Gas	5 hours

Availability, properties, Production Methods, modifications required in Engines, performance and emission characteristics, storage, handling & dispensing, safety aspects. Effects of fuel on engine life.

Module:5	SVO and Biodiesel	5 hours

Various vegetable oils for engines, esterification, production, storage, bio diesel and its characteristics, Properties as engine fuel, modifications required in CI Engines, performance and

emission characteristics in CI Engines, Biodiesel standards, current challenges, and safety aspects. Fuel Additives.		
Module:6	**Alcohols and ethers**	**4 hours**
Properties as engine fuel, production, storage, alcohols and gasoline blends, modifications required in engines, performance in SI engine, methanol and gasoline blends. Methanol reformer. - Combustion characteristics in CI engines, emission characteristics, Fuel Additives, Performance analysis, performance in SI & CI Engines. Effects of fuel on engine life.		
Module:7	**Biomass and Synthetic Fuels**	**4 hours**
Biomass - processing and usage, forms - municipal solid waste, wood - DME, GTL: Availability, properties, Production Methods, modifications required in CI engines, performance and emission characteristics, storage, handling and dispensing, safety aspects. Challenges.		
Module:8	**Contemporary issues:**	**2 hours**
Course Mode: Video lectures and demonstrations, Flipped class room, Interactive sessions with multimedia tools, Visit to industry		
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Thipse S. S, (2010), Alternative Fuels: Concepts, Technologies and Developments, Jaico Publishing House.
2.	Richard L.Bechtold, (2014), Alternative Fuels Guidebook, Society of Automotive Engineers (SAE).
Reference Books	
1.	Ganesan V., (2012), Internal Combustion Engines, McGraw-Hill Education India Pvt. Ltd.
2.	Timothy T. Maxwell and Jesse C. Jones, (1994), Alternative Fuels: Emissions, Economics, and Performance, Society of Automotive Engineers (SAE).
3.	Michael F. Hordeski, (2013), Alternative Fuels: The Future of Hydrogen, The Fairmont Press, Inc.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17/08/2017		
Approved by Academic Council	No. 47	Date	05/10/2017

Course code	Engine Design and Development	L	T	P	J	C
MEE6017		2	2	0	0	3
Pre-requisite	NIL	Syllabus version				
		1.1				

Course Objectives:

1. To provide sufficient background of engine design and development.
2. To broaden the understanding constraints in the engine design.
3. To gain the basic knowledge of the concepts in engine design and development.
4. To broaden the understanding of Sizing and design of major components
5. To enable the students to apply the knowledge modern pollution systems

Expected Course Outcome:

Upon Successful Completion of this course ,Students will be able to

1. Possess the fundamental knowledge of engine design and development.
2. Apply the concepts considering material, loads on engine design and development.
3. Analyze the Lubrication and crankcase breathing system capacity
4. Develop the modern vehicle systems using CAD.
5. Impart the knowledge to develop the pollution control system.

Module:1	Requirements definition	4 hours

Key customer requirements to be captured and considered for engine design: Regulatory and technological constraints as well as application needs: Packaging, weight, cost, performance, reliability/durability, regulatory, production volume, life cycle, quality, operating environment - Manufacturing requirements, Plant capability, Supplier capability, Service and after sales considerations (service parts and tools) - Translating customer requirement to technical profile

Module:2	General Considerations In Engine Design	4 hours

Choice of material, stress and fatigue considerations, design for manufacture, Noise, Vibration and Harshness.

Module:3	Engine Architecture Decisions	4 hours

Engine configuration decisions based on requirements: BMEP, Efficiency, Torque curve - Aspiration, Fuel/combustion cycle and 2 stroke/4 stroke cycle - Displacement, Number of cylinders - Bore to stroke ratio optimization (surface-to-volume ration, piston speed consideration) - Configuration – In-line / Vee, Bore spacing, Vibration, engine configuration and balance - Cooling Type (air, oil, coolant) - Air breathing requirements, valve arrangement and liner/cylinder wall type - Cylinder lubrication and wear - Fuel system, Injectors and spark plugs, Combustion chamber design - Gear train type, location.

Module:4	Sizing and design of major components (5-C's)-	4 hours

Crankshaft sizing and proportions, balancing, Bearing loads and sizing, power take-off - Connecting rod size and type - Cylinder block layout and design decisions – Crankcase type, parent bore v/s liner, deck height, engine mounting - Cylinder head design – Valve sizing, Intake port swirl and tumble, Intake port and manifold length, Exhaust port and exhaust manifold length, Cylinder head cooling, Oil deck design - Camshaft and valve train - Type of valve train, Number 33 and location of camshafts, Cam drive type and configuration, Wear characterization and

design.			
Module:5	**Sizing and design of other key sub-systems**		**4 hours**
Lubrication And Crankcase Breathing System Capacity - Pump type, sump size and location, Lubrication circuit, Oil drain back and scavenging, Crankcase ventilation, windage, breathing - COOLING SYSTEM - Pump drive and location, Cooling circuit, Pump capacity and temperature control, Circuit design and analysis - Flywheel sizing - Accessory Systems - Alternator, starter and compressor (air, HVAC) - Additional drives (power steering, hydraulic pump, air pumps)			
Module:6	**Design Of Pollution Control Equipment**		**4 hours**
Introduction to design of catalytic converters, particulate traps and EGR systems			
Module:7	**Concepts Of Computer Aided Design**		**4 hours**
Preparation of working drawings of designed components using CAD system			
Module:8	**Contemporary issues:**		**2hours**
	Total Lecture hours:	**30 hours**	
Tutorials Tutorial class for Module 3 (8 hours) Tutorial class for Module 5 (8 hours) Tutorial class for case studies (14 hours)		**30 hours**	

Text Book(s)	
1.	Hoag Kevin L., Vehicular Engine Design, Springer-Verlag, USA, 2006.
Reference Books	
1.	1. Engineering Know-How in Engine Design (Part 1 to 24), SAE, USA.
2.	SAE SP-1071, Applications and Developments in New Engine Design and Components, SAE, USA
3.	Goetze A. G., Piston Rings Manual, Technischer Verlag Herbert Cram

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Powertrain Tribology	L	T	P	J	C
MEE6018		2	0	0	4	3
Pre-requisite	NIL	Syllabus version				
Anti-requisite		1.1				

Course Objectives:

1. To broaden the importance of Powertrain Tribology.
2. To enable the students to understand the importance of Powertrain Tribology.
3. To assist the students to know about Powertrain Tribology.
4. To acquire the theory of hydrodynamic lubrication.
5. To learn the application of tribology in automotive

Expected Course Outcome:

Upon Successful Completion of this course ,Students will be able to

1. Acquire and analyze the various Powertrain Tribology.
2. Characterize various Powertrain systems.
3. Apply the knowledge to monitor and inspect various powertrain system.
4. Develop the automotive system with appropriate usage of hydro dynamic lubrication
5. Apply the tribology knowledge to wear behavior of engine components and power train

Module:1	Surface features and friction	2 hour

Introduction of Tribology - Nature of surfaces – Surface properties – Surface parameters and measurements. Friction – Sliding friction – Rolling friction- Friction characteristics of common metals and non-metals – Friction under extreme environments. Temperature rise due to friction. Engine friction – Losses and engine design parameters

Module:2	Wear	4 hours

Economic role of wear – wear mechanism – Factors affecting wear – Quantification of wear- Wear testing - Tribometers and Tribometry. Engine wear – mechanisms, wear resistant material and coatings. Failure mode analysis.

Module:3	Lubricants and Monitoring	6 hours

Lubricants – Type of lubricants – Properties and testing – service classification of lubricants- Additives – Lubrication systems – Lubricant monitoring, SOAP, Ferrography and other rapid testing methods for lubricants contamination

Module:4	Hydro Dynamic Lubrication	4 hours

Theory of hydrodynamic lubrication – Mechanism of pressure development in a fluid film bearing - Generalized Reynolds Equation – slider bearings- Fixed and pivoted shoe bearings –Journals bearings – short and finite bearings - Oil flow and thermal equilibrium

Module:5	Hydrostatic and Squeeze Film Lubrication	4 hours

Hydrostatic bearing – basic concepts- Bearing pad coefficients. Restrictors – Capillary, orifice and flow control valve – bearing characteristic number and performance coefficients – flat, conical and

spherical pad thrust bearing – Multi-recess journal and thrust bearings – Air and gas lubricated bearings. Squeeze film bearings.

Module:6	**Elasto Hydro Dynamic Lubrication (EHDL)**	**4 hours**

Lubrication of ball and roller bearings, cams and gears, selection and life estimation, fatigue and diagnostics. Soft EHDL - Lubrication of seals and washers. Rheology - Non-Newtonian fluids, characteristics, Thixotopic, materials and Bingham solids, grease lubrication and stability.Tribology in Extreme environments.

Module:7	**Functional applications of Tribology**	**4 hours**

Automotive Tribology - Tribology of engine components and power train. Industrial tribology Case studies.

Module:8	**Recent Trends**	**2 hours**

	Total Lecture hours:	**30 hours**	

Text Book(s)

1.	Gwidon Stachowiak, Andrew W Batchelor, " Engineering Tribology ", Butterworth-Heinemann, 2013

Reference Books

1.	Bernard J. Hamrock, Steven R. Schmid, Bo O. Jacobson, "Fundamentals of Fluid Film Lubrication", CRC Press,2004.
2.	Bharat Bhushan, : Introduction to Tribology", John Wiley & Sons,2013

List of Challenging Projects (J- Component)

1.	Automotive tribology overview of current advances and challenges for the future	
2.	Analysis of oil film thickness and heat transfer on a piston ring of a diesel engine: Effect of lubricant viscosity	
3.	Manufacturing of surface microstructures for improved tribological efficiency of powertrain components and forming tools	
4.	Analysis of oil film thickness on a piston ring of diesel engine: Effect of oil film temperature	
5.	An investigation of tribological characteristics of energy-conserving engine oils using a reciprocating bench test	
6.	Modeling the dynamics and lubrication of three piece oil control rings in internal combustion engines	
7.	A model for estimating oil vaporization from the cylinder liner as a contributing mechanism to engine oil consumption	
8.	Mechanical hybrid KERS based on toroidal traction drives: an example of smart tribological design to improve terrestrial vehicle performance	
9.	Reliability of Powertrain Components Exposed to Extreme Tribological Environments	
10.	Variation of piston friction force and ring lubricating condition in a diesel engine with EGR	

Recommended by Board of Studies	17/08/2017		
Approved by Academic Council	No. 47th	Date	5/10/2017

Course code	Automotive Emission Control	L	T	P	J	C
MEE6019		2	2	0	4	4
Pre-requisite	Nil	Syllabus version				
		v. 2.00				

Course Objectives:

1. To broaden the importance of noise and air pollution from automobiles.
2. To enable the students to understand the importance of automotive emissions and control.
3. To assist the students with various test procedures to measure emissions and dealing with automotive waste management.

Expected Course Outcome:

Upon Successful Completion of this course ,Students will be able to

1. Possess the knowledge about various sources of air and noise pollution from automobiles.
2. Acquire and analyze the various emissions from SI engines and their controls.
3. Demonstrate the various emission control techniques used in CI engines.
4. Suggest, identify and design suitable after treatment devices for CI engines.
5. To impart knowledge on various test procedures for emission measurements in IC engines.

Module:1	Introduction	4 hours

Sources of Air Pollution. Various emissions from Automobiles — Formation — Effects of pollutants on environment and human beings.

Module:2	Noise pollution	4 hours

Noise pollution from automobiles - Sources of Noise — Engine Noise, Transmission Noise, vehicle structural Noise, aerodynamics noise, Exhaust Noise. Noise reduction in Automobiles — Encapsulation technique for noise reduction — Silencer Design.

Module:3	Emissions from SI Engines and its Control	4 hours

Emission formation in S.I. engines – Hydrocarbons – Carbon monoxide – Nitric Oxide, Lead particulates – Polyneculear aromatic hydro carbon emission – Effects of design and operating variables on emission formation in spark ignition engines – Controlling of pollutant formation in engines – Thermal reactors – Catalytic converters – Charcoal Canister Control for evaporative emission – Positive crank case ventilation system for UBHC emission reduction. Chemical delay – Significance – Intermediate compound formation – Pollutant formation on incomplete combustion – effect of operating variables on pollutant formation – Controlling of emissions – Driving behavior – Fumigation – Exhaust gas recirculation – Air injection – Cetane number effect

Module:4	In-cylinder emission control strategies - CI engine	4 hours

Formation of White, Blue, and Black Smokes, NOx, soot, Sulphur particulate and Intermediate Compounds in CI engines - In-cylinder v/s after-treatment emission control strategies – Pros/Cons,

Impact of various parameters on in-cylinder emission control: Fuel injection pressure, Nozzle through- flow, sac volume, Piston bowl shape, Exhaust gas recirculation (EGR) – Internal/ external/cooled EGR, Injection timing. Swirl, Turbo charging and Inter cooling		
Module:5	**After treatment devices – CI engine**	**4 hours**
DPF – Function / Regeneration techniques, NOx Adsorber, Diesel Oxidation Catalyst (DOC), SCR, Urea dozing systems.		
Module:6	**Emission Measurement and Emission test procedure**	**4 hours**
Measurement of CO, CO2, by NDIR. Hydrocarbon by FID – Chemiluminescent detector for NOx measurement, Smoke meters – Dilution tunnel technique for particulate measurement - Emission test cycles - Procedures on Engine and Chassis Constant Volume Sampling procedures –-Emission Test– Sampling probes and valves – Quantifying emissions –Dynamometers		
Module:7	**Automotive waste management**	**4 hours**
Old vehicle disposal and recycling, Tyre recycling, Lubricating oil and coolant disposal and recycling		
Module:8	**Contemporary issues:**	**2 hours**
Course Mode: Video lectures and demonstrations, Flipped class room, Interactive sessions with multimedia tools, Visit to industry		
	Total Lecture hours:	**30 hours**

Text Book(s)

1.	John B Heywood, ―Internal Combustion Engine Fundamentals‖, McGraw Hill Education, 2011

Reference Books

1.	Springer.G.S, Patterson.D.J, Engine Emissions, pollutant formation, Plenum Press, 1986
2.	Patterson, D.J, Henin.N.A, Emissions from Combustion engines and their Control, Anna Arbor Science, 1985. Linden.D, Handbook of Batteries and Fuel Cells, McGraw Hill, 1995.
3.	Maxwell et al, Alternative Fuel : Emission, Economic and Performance, SAE, 1995
4.	Crouse and Anglin, _Automotive Emission Control‘, McGraw Hill company., Newyork 1993

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05/10/2017

Course code	Battery and Fuel Cell	L	T	P	J	C
MEE6020		2	0	0	4	3
Pre-requisite	NIL	Syllabus version				
		v. 1.1				

Course Objectives:

1. To broaden the importance of Battery and Fuel cell.
2. To enable the students to understand the importance of Battery and Fuel cell.
3. To assist the students to know about Battery performance and selection Battery and Fuel cell.
4. To gain the basic knowledge about Lithium-Ion Batteries.
5. To help the students to identify the Advanced Batteries for Electric Vehicles

Expected Course Outcome:

Upon Successful Completion of this course ,Students will be able to

1. Acquire and analyze the various type's battery and Fuel cell.
2. Characterize various Battery and Fuel cell performance.
3. To maintain and inspect various Battery types and Fuel cell.
4. To develop battery and fuel cell for the modern requirements
5. To apply the advanced batteries for electric vehicles

Module:1	Introduction	2 hours

Introduction to Battery - Battery types - Fundamentals of electrochemistry - galvanic and electrolytic cells, differences -Thermodynamics of electrochemical cells - Definition, derivation of Nernst equation

Module:2	Battery performance and selection	4 hours

Battery Performance Measurements, Factors Affecting Battery Performance - Battery Standardization - Battery Design – Battery Management System - Battery Fault Detection, Maintenance and Test - Battery Installation - Selection of Battery for Automotive application.

Module:3	Lead acid battery	6 hours

theory of operation – cell construction – battery construction – Discharge performance – Charge methods – Temperature effects and limitations – service life – storage characteristics – maintenance requirements – failure modes

Module:4	Lithium-Ion Batteries	4 hours

General Characteristics - Chemistry - Construction of Cylindrical and Prismatic Li-Ion Cells and Batteries - Li-Ion Battery Performance - Charge Characteristics of Li-Ion Batteries - Safety Testing of Cylindrical C/LiCoO2 Batteries - Polymer Li-Ion Batteries - Thin-Film, Solid-State Li-Ion Batteries - Conclusions and Future Trends

Module:5	Advanced Batteries for Electric Vehicles	4 hours

General Characteristics Description of the Electrochemical Systems, Cell Design and Performance Characteristics of - Metal/Air Batteries - Zinc/Bromine Batteries - Sodium-Beta Batteries - Lithium/Iron Sulfide Batteries

Module:6	Fuel cells	4 hours

Introduction and overview of fuel cells - technology: low and high temperature fuel Cells - Fuel 40 cell reaction kinetics: Introduction to electrode kinetics – performance characteristics of fuel cells, efficiency of fuel cell, fuel cell stack, fuel cell power plant: fuel processor, fuel cell power section, power conditioner

Module:7	Types of Fuel Cells	4 hours

Fuel cell types: alkaline fuel cell, polymer electrolyte fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, Direct Methanol Operated fuel cells- Geometries of solid oxide fuel cells: planar, tubular, Types of solid oxide fuel cells: High temperature, intermediate temperature ,Single chamber solid oxide fuel cells, Problems with fuel cells.			
Module:8	**Contemporary issues:**		**2 hours**
	Total Lecture hours:	**30 hours**	
Text Book(s)			
1.	David Linden and Thomas B. Reddy ―Hand Book of Batteries Third Edition‖ , McGraw-Hill, NY, 2010		
Reference Books			
1.	Robert A. Huggins Advanced Batteries - Material Science Aspects, Springer Publications, NY 2009		
2.	D.A.J. Rand, P.T. Moseley,J. Garche , C.D. Parker, Valve Regulated Lead Acid Batteries, Elsevier Publications, USA, 2004		
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
List of Challenging Experiments (Indicative)			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Vehicle and Engine Testing	L	T	P	J	C
MEE6021		2	0	0	4	3
Pre-requisite	Nil	Syllabus version				
		1.0				

Course Objectives:

1. Familiarize with the various regulations, homologation and testing.
2. Evaluate and analyze the vehicle level and component level testing of automobiles.
3. To gain knowledge about the experimental set up for characterizing the engine performance and emission measurements.

Expected Course Outcome:

1. Acquiring the knowledge of homologation, static and dynamic testing of vehicles.
2. Comprehend and possess the various component level testing methods.
3. Imparting the knowledge of vehicle structural crashworthiness.
4. Establishing the various engine testing procedures and data acquisition.
5. Computing the various performance and emission measurements of IC engines.

Module:1	Homologation & Testing	2 hours

Homologation & its Types, Regulations overview (EEC, ECE, FMVSS, AIS, BIS, and CMVR), Type approval Scheme, Homologation for export, Vehicles Categories, Conformity of Production, Various Parameters, Instruments and Test tracks.

Module:2	Static& Dynamic Testing of Vehicle	6 hours

Vehicle Weighment, Tell Tales, External Projection, Arrangement Of Foot Controls For M1 Vehicle, Angle & Dimensions Measurement of Vehicle, The Requirement Of Temporary Cabin For Drive – Away – Chassis, Grade ability Test, Pass-by Noise Measurement Test, Interior Noise Measurement Test, Turning Circle Diameter & Turning Clearance Circle Diameter Measurement Test, Steering Effort Measurement Test, Constant Speed Fuel Consumption Test, Cooling Performance Test, Speedo- meter Calibration Test, Range Test, Maximum Speed Measurement Test, Acceleration Measurement Test, Brakes Test, Hood Latch Test and EMI Test

Module:3	Vehicle Component Testing	4 hours

Safety Glasses Test, Rear View Mirror Test, Horn Testing, Hydraulic Brakes Hoses Test, Fuel Tank Test: Metallic & Plastic, Hinges and Latches Test, Tyre & Wheel Rim Test, Bumper Impact Test, Side Door Intrusion Test, Demist test, Defrost Test, Interior Fittings, Steering Impact Test, Body Block Test, Head Form Test, Driver Field Of Vision, Accelerator Control System Test, Seat & Seat Belt Test And Airbag Test, Photometry

Module:4	Vehicle Structural Crashworthiness	4 hours

Crash Test- Front Impact, Rear Impact & SideImpact Test, Dummies, Crash Barrier, Injury Evaluation, Pedestrian & Occupant Requirement, Survival Space of the occupants of

commercial vehicle, FUPD/RUPD & SUPD Requirement		
Module:5	**Engine Test Facilities** **Engine Dynamometer & Tests Equipments**	**4 hours**
Engine Test Facilities: Test cell requirements, cell console & control room, ventilation, air conditioning & exhaust, cooling, lubrication/fuel supply systems, noise & vibration control in test cells. **Engine Dynamometer & Tests Equipments**: Engine dynamometers, types of dynamometers, dynamometer panels, engine controllers, data acquisition, engine dynamometer coupling, fuel consumption meter, air fuel ratio measurement, oil consumption measurement, temperature & pressure measurement, humidity measurement, calibration & maintenance program/ durability.		
Module:6	**Engine Performance & Emission Measurements**	**4 hours**
Engine test standards, full throttle & part throttle performance, road load testing, ISO mapping, interpolation, heat balance, friction measurement. Emission analyzers, emission cycles for diesel commercial vehicles, tractors &gensets, steady state and transient cycles, dilution tunnel, particulate emissions, calibration and maintenance.		
Module:7	**Advanced Engine Testing**	**4 hours**
Use of special equipments, fuel injection pressure, combustion pressure, needle lift, heat balance, gas exchange process, combustion, photography, swirl measurement, analysis of data.		
Module:8	**Contemporary issues:**	**2 hours**
Course Mode: Flipped Class Room, [Lecture to be videotaped], Use of physical and computer models to lecture, Visit to Industry and study the thermal equipments, Min of 2 lectures by industry experts		
	Total Lecture hours:	**30 hours**

Text Book(s)	
Reference Books	
1.	A.J.Martyr, M.A.Plint, Engine Testing Theory and Practice, SAE International, Third Edition, 2007.
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	
Mode of assessment:	

Recommended by Board of Studies	17/08/2017		
Approved by Academic Council	No. 47	Date	05/10/2017

Course code	Vehicle Safety and Lighting	L	T	P	J	C
MEE 6022		3	0	2	0	4
Pre-requisite	NIl	Syllabus version				
Anti-requisite		v.1.1				

Course Objectives:

1. To introduce vehicle passive and active safety systems.
2. To broaden the understanding crash testing and lighting.
3. To gain the basic knowledge of lighting of automotive vehicles.
4. To broaden the importance of vehicle safety and lighting.
5. To enable the students to apply the knowledge modern vehicle systems

Expected Course Outcome:

Upon Successful Completion of this course ,Students will be able to

1. Impart knowledge about safety and vehicle structural crashworthiness
2. Design the human response to impact response system
3. Analyze the performances of vehicle safety systems and lighting
4. Familiarize the modern lighting system
5. Develop the modern vehicle safety and lighting systems.

Module:1	Introduction to safety and Vehicle structural crashworthiness	4 hours

Automotive Safety-Active and passive safety, Driver assistance systems in automobiles, Definitions and terminology. Balance of stiffness and toughness characteristics and energy absorption characteristics of vehicle structures, Design of crash crumple zones, Modeling and simulation studies, Optimization of vehicle structures for crash worthiness

Module:2	Crash testing	7 hours

Types of impacts, and Impact with rebound, movable barrier tests, Analysis and simulation of vehicle in barrier impacts, Roll over crash tests, Behavior of specific body structures in crash testing, Photographic analysis of impact tests, Regulatory requirements for crash testing. Side and Frontal Pole Impact, Pedestrian Impact

Module:3	Ergonomics and Human response to Impact	7 hours

Importance of Ergonomics in Automotive safety, Locations of controls, Anthropomerty, Human impact tolerance, Determination of Injury thresholds, Severity Index, Study of comparative tolerance, Application of Trauma for analysis of crash injuries. Injury criteria‘s and relation with crash and modeling and simulation studies in dummy

Module:4	Vehicle safety systems	6 hours

Survival space requirements, Restraints systems used automobiles, Types of safety belts, Head restraints, Air bags used in automobiles, Use of energy absorbing systems in automobiles, Impact protection from steering controls, Design of seats for safety, types of seats used in automobiles. Importance of Bumpers in automobiles, Damageability criteria in bumper designs. Introduction to the types of safety glass and their requirements and rearward field of vision in automobiles, Types of rear view mirrors and their assessment. Warning devices, Hinges and latches etc. Active safety		
Module:5	**Fundamentals of light, vision and colour**	**5 hours**
Electromagnetic radiation and light, Propagation of light, Spectral sensitivity of light, Measures of radiation and light, Standard elements for optical control. Illuminant calculations, Derivation of luminous flux from luminous intensity, flux transfer and inter reflection, luminance calculations, discomfort glare, eyes as an optical system, visual processing, lighting for results, modes of appearance, Pointers for lighting devices. Nature of the colour, Tri-chromatic Colorimetry, Surface colour, colour spaces and colour solids,, colour rendering		
Module:6	**Light Measurements, Testing equipment, calibration and photometric practice**	**6 hours**
Basics of standards and detectors, spectral measurements and Colorimetry, illuminant meters and luminance meters, colorimeters. Fundamentals of equipment used for light measurement in Automotive field; Gonio - Photometer, Reflecto-meter, Colorimeter, Integrating sphere, types, application, coordinates system, Types of sensors and working principle, construction, characteristics etc. used in different equipment. National and international Regulations, test requirements and testing procedure		
Module:7	**New Technology in Automotive lighting**	**8 hours**
Technology progress in automotive lighting, Gas Discharges lamps, LED, adoptive front lighting system, Daylight running lamps		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**
List of Challenging Projects		

Study, dismantling and assembling of 1. Vehicle safety monitoring system for viewing blind spots 2. Portable safety lighting device and method for increasing visibility of a person or vehicle 3. Method and system for the precise thermal mapping of roads, runways and the like for wintertime safety monitoring and maintenance 4. Automatic rearview mirror, vehicle lighting control and vehicle interior monitoring system using a photo sensor array 5. Hot vehicle safety system and methods of preventing passenger entrapment and heat suffocation 6. Vehicle surroundings monitor with obstacle avoidance lighting 7. Deceleration based anti-collision safety light control for vehicle 8. Automatic control device for lighting and extinction of headlamps in a vehicle 9. Lighting and driver assistance as systems for improving vehicle safety 10. Running guide apparatus for vehicle capable of keeping safety at passing through narrow path		10x 3 hrs

Total laboratory hours 30 hrs

Text Book(s)

1.	Jullian Happian-Smith _An Introduction to Modern Vehicle Design‘ SAE, 2002

Reference Books

1.	Watts, A. J., et al "Low speed Automobile Accidents" Lawyers and Judges 1996**.**
2.	Johnson, W., and Mamalis, A.G., "Crashworthiness of Vehicles, MEP, London, 1995.
3.	Edward .A, Lamps and Lighting, Hodder & Stoughton, London, 1993.

Recommended by Board of Studies	17/08/2017		
Approved by Academic Council	No. 47	Date	5/10/2017

Course code	Vehicle Maintenance and Diagnostics	L	T	P	J	C
MEE6023		2	0	0	4	3
Pre-requisite	Nil	Syllabus version				
		v. 1.0				

Course Objectives:

1. To provide the students with sufficient background to understand the importance of vehicle maintenance, its types and their diagnostics techniques.
2. To equip students with the knowledge of engine and sub-system maintenance.
3. Develop the students to have in-depth knowledge about on-board diagnostics, chassis system diagnostics and electrical system diagnostics.

Expected Course Outcome:

1. Possess the knowledge of overall vehicle maintenance and its types, on and off-board diagnostics and engine and its sub-system maintenance.
2. Demonstrate the application of oscilloscope and on-board diagnostics for automobiles.
3. Provide an in-depth knowledge about the diagnostics of engine sub-systems like battery charging and starting systems, lubrication systems air supply and exhaust systems.
4. Gain the knowledge of chassis system maintenance and various diagnostics techniques applied to brakes, steering and suspension systems.
5. Acquire and analyze the maintenance and diagnostics of electrical system including HVAC, cruise control diagnostics, airbags diagnostics, advanced fault diagnostics and remote diagnostics.

Module:1	Introduction	4 hours

Need for maintenance, types of maintenance: preventive and breakdown maintenance, requirements of maintenance, preparation of check lists. Inspection schedule, maintenance of records, log sheets and other forms, safety precautions in maintenance: General safety, tool safety - Diagnostic Techniques - diagnostic process - diagnostics on paper - mechanical diagnostic techniques - electrical diagnostic techniques - fault codes - on and off-board diagnostics - Data sources

Module:2	Engine maintenance	4 hours

Dismantling of engine components: cylinder head, valve train, cylinder block, connecting rod, piston and crankshaft assembly; cleaning and inspection of engine components, reconditioning of components.

Module:3	Engine subsystem maintenance	4 hours

Servicing and maintenance of fuel system, Engine tune-up, cooling system: water pump, radiator, thermostat. Lubrication system maintenance, Anticorrosion and anti freeze additives

Module:4	Oscilloscope diagnostics and On-board diagnostics	4 hours

Basic equipment - Oscilloscopes - Scanners - Fault code readers - Engine Analyzers - Sensors -

Actuators - Ignition System - Other components - A first perspective - Petrol / Gasoline on-board diagnostics monitors - a second perspective		
Module:5	**Engine Systems**	**4 hours**
Diagnostics of Engine operation - Fuel system - Ignition - Emission - Fuel Injection - Diesel injection - Engine management - Fault finding information - air supply and exhaust systems - cooling - lubrication - batteries - starting system - charging system.		
Module:6	**Chassis System – maintenance and diagnostics**	**4 hours**
Servicing and maintenance of clutch, gear box, universal joints, propeller shaft, differential system. Service and maintenance of brake – disc and drum brakes, steering wheel and suspension systems, wheel alignment, vehicle body maintenance - Diagnostics of brakes - anti-lock brakes diagnostics - traction control diagnostics - steering diagnostics - suspension diagnostics		
Module:7	**Electrical System**	**4 hours**
Electronic components and circuits diagnosis - multiplexing - lighting - diagnosing auxiliary system faults - in car entertainment security and communication - body electrical system faults - diagnosing instruments system faults - HVAC diagnostics - Cruise control diagnostics - Air bags and belt tensions diagnostics		
Module:8	**Expert lecture-** Advanced Fault diagnostics and remote diagnostics	**2 hours**
Course Mode: Video lectures and demonstrations, Flipped class room, Interactive sessions with multimedia tools, Visit to industry		
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Automotive Technician Training, Tom Denton, Taylor and Francis, New York, 2015
Reference Books	
1.	Automobile Electrical and Electronic Systems : Automotive Technology - Vehicle Maintenance and Repair, Tom Denton, Fourth Edition, Elsevier, New York, 2013
2.	Advanced Automotive Fault Diagnosis: Automotive Technology - Vehicle Maintenance and Repair, Tom Denton, Third Edition, Elsevier, New York, 2012.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17/08/2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Vehicle Aerodynamics	L	T	P	J	C
MEE6024		3	0	0	0	3
Pre-requisite	Nil	Syllabus version				
		v. 1.1				

Course Objectives:

1. To provide the students with sufficient background to understand the aerodynamics of road vehicles.
2. To enable the students to understand the dynamics of the vehicles influenced by aerodynamics.
3. To help the students to understand aerodynamics of vehicles to help in stability, safety and comfort.
4. To teach students how to measure and test vehicles using different techniques.

Expected Course Outcome:

1. Gain the knowledge of basic principles of road vehicle aerodynamics and performance analysis of cars, light trucks and commercial vehicles.
2. Compute the aerodynamics drag, various resistances and to arrive at lesser fuel consumption of vehicles.
3. Possess the knowledge of basic of flow over vehicles and resistance to vehicle motion and analyzing for stability safety and comfort.
4. Predicting the performance of high speed race cars, commercial vehicle aerodynamics and to demonstrate the various measurement and testing techniques used in automobiles.
5. Design, simulate and analyse the flow over cars using computation fluid dynamics technique and to calculate the lift and drag forces through various turbulence models.

Module:1	Introduction to Road Vehicle Aerodynamics	5 hours

Basic principles of road vehicle aerodynamics; evolution of road vehicles; borrowed shapes; streamlining era; parametric studies; one-volume bodies; bathtub bodies; commercial vehicles; motorcycles; shape and detail optimization; futuristic trends; performance analysis of cars and light Trucks.

Module:2	In Motion Dynamics	7 hours

Vehicle equation of motion; aerodynamic drag; tire rolling resistance; climbing resistance; effective mass; traction diagram; acceleration capability and vehicle elasticity; fuel consumption and economy; gear-ratio re-matching; EPA driving cycles – urban, highway, combined; low fuel consumption strategies.

Module:3	Directional Stability, Safety and Comfort	7 hours

Flow field around a vehicle; interior and exterior flows; attached, separated and oscillating flows; aerodynamic forces and moments; cornering and side wind behaviors; stability index; passing maneuvers; spoiler design; safety and aesthetics; water and dirt accumulation; visibility impairment; ventilation, air flow and odor removal. Engine and interior cooling; radiators; HVAC systems.

Module:4	**Race Car, High Performance and Commercial Vehicles**	**6 hours**
Race cars: Front wings, Rear wings, Weight distribution, Over steer and Under steer, Center of gravity effects, Slip streaming. Commercial vehicle aerodynamics: Truck Aerodynamics, Improvements in design, Different styles of trailers. Effect of gap between truck and trailer, fairings.		
Module:5	**Measurement and Testing Techniques**	**6 hours**
Wind tunnel and on-road testing techniques; classification and design of wind tunnels; instrumentation and data acquisition; wind tunnel components and corrections; road testing methods; cross-wind and engine cooling tests; soiling, water and dirt accumulation, visibility measurements on road; wind noise models, analysis and measurement.		
Module:6	**Computational Fluid Dynamics and Applications**	**7 hours**
Introduction to CFD analysis; CFD vs. experimentation; Fundamentals of fluid mechanics; Continuity, Navier-stokes and energy equations; Modeling and Discretization techniques; basic steps in CFD computation; 3-D structured and unstructured grid generation, mesh smoothing and sensitivity checks; turbulence models; Eddy viscosity and non-eddy viscosity models; RANS and ARSM models; LES and DNS methods.		
Module:7	**Vehicle Aerodynamic Simulation**	**5 hours**
Biomass - processing and usage, forms - municipal solid waste, wood - DME, GTL: Availability, properties, Production Methods, modifications required in CI engines, performance and emission characteristics, storage, handling and dispensing, safety aspects. Challenges.		
Module:8	**Contemporary issues:**	**2 hours**
Course Mode: Video lectures and demonstrations, Flipped class room, Interactive sessions with multimedia tools, Visit to industry		
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Theory and Applications of Aerodynamics for Ground Vehicles- T. Yomi Obidi. Published by SAE with ISBN 978-0-7680-2111-0.

Reference Books

1.	Competition car aerodynamics, 3rd edition- Simon McBeath. Published by Veloce Publishing with ISBN 978-1845847760.
2.	Aerodynamics of Road Vehicles, W.H. Hucho, Butterworth and Co, 1987

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

Mode of assessment:

Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Vehicle Crashworthiness	L	T	P	J	C
MEE6025		2	0	0	4	3
Pre-requisite	NIL	Syllabus version				
		1.1				

Course Objectives:

1. To gain the basic knowledge about Vehicle Crashworthiness.
2. To help the students to identify the various testing regulations for Vehicle Crashworthiness.
3. To assist the students to know about vehicle collision models.
4. To broaden the knowledge about the pedestrian safety.
5. To study the fundamental of vehicle safety system

Expected Course Outcome:

Upon Successful Completion of this course ,Students will be able to

1. Acquire and analyze the various testing procedures of Vehicle Crashworthiness.
2. Characterize the various vehicle crashworthiness mechanisms.
3. To develop vehicle safety system for the modern requirements
4. To use various injury Mechanisms for evaluating vehicle crashworthiness.
5. To apply the dummies for different crash test

Module:1	Introduction to safety and crashworthiness	2 hours

Motor Vehicle Safety - The Automobile Structure Materials and Characteristics of Vehicle Structures - Crashworthiness Goals - Crashworthiness Requirements, Achieving Crashworthiness, Crashworthiness Tests, Crashworthiness Models Requirements. Optimization of vehicle structures for crash worthiness – Active and passive safety.

Module:2	Crash Testing	4hours

Types of crash / roll over - Tests, Regulatory requirements for crash testing - Instrumentation, high speed photography, Image Analysis

Module:3	Vehicle Collision Models	6 hours

Impulsive models- central head on collision, oblique collision, collision against fixed obstacle, noncentral - head on collision, lateral collision, simplified approach. Second approximation models - head on collision against fixed - obstacle, Head-on collision between vehicles, and oblique collision between vehicles, Motion after the Collision with locked wheels - and free wheels

Module:4	Pedestrian Safety and Ergonomics	4 hours

Importance of Ergonomics in Automotive safety- Locations of controls- Anthropometry- Human impact tolerance- Determination of Injury thresholds, Severity Index, Study of comparative tolerance. Study of crash dummies

Module:5	Vehicle Safety systems	4 hours

Survival space requirements, Restraint systems used in automobiles - Types of safety belts- Head

restraints, Air bags - Use of energy absorbing systems - Impact protection from steering controls - Design of seats for safety- types of seats-Importance of Bumpers - Damageability criteria in bumper designs - Types of safety glass and their requirements, rearward field of vision in automobiles - Types of rear view mirrors and their assessment - Warning devices - Hinges and latches, etc - External Projections, Door locks & retension systems Rear/front/side under run protection devices.			
Module:6	**Injury Mechanisms**		**4 hours**
Head Injury Mechanisms - Neck Injury Mechanisms - Compression Injuries - Tension-Extension Injuries - Lateral Bending Injuries - Thoracic Injury Mechanisms - Low Speed Crush Injuries - High Speed Impact Injuries			
Module:7	**Introduction to Dummies**		**4 hours**
Hybrid II Dummy Family - Hybrid III Dummy Family - CRABI Infant Dummies - Side Impact Dummies - Dummy Harmonization			
Module:8	**Contemporary issues:**		**2 hours**
	Total Lecture hours:	**30 hours**	
Text Book(s)			
1.	Vehicle Crashworthiness and Occupant Protection, Paul Du Bois, Clifford C. Chou and others, American Iron and Steel Institute.		
Reference Books			
1.	Vehicle Crash Mechanics, Huang, M., CRC Press 2002.		
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Design of Vehicle Drivelines	L	T	P	J	C
MEE6026		2	0	0	4	3
Pre-requisite	NIL	Syllabus version				
Anti-requisite		1.1				

Course Objectives:

1. To broaden the importance of design of vehicle drivelines.
2. To enable the students to understand the importance of design of vehicle drivelines.
3. To assist the students to know about testing of design of vehicle drivelines.
4. To gain the basic knowledge about automatic transmission
5. To know the fundamentals of automatic transmission and electrical drives

Expected Course Outcome:

Upon Successful Completion of this course ,Students will be able to

1. Acquire and analyze the various designs of vehicle drivelines.
2. Characterize various design procedures of vehicle drivelines.
3. To maintain and inspect various design values of vehicle drivelines.
4. To apply the design knowledge to develop modern drivelines.
5. To analyze the performances of different drivelines

Module:1	Introduction to Transmission & Driveline Systems	2 hour

Powertrain and driveline systems. Clutch, gear box, hydraulic coupling, torque converter, manual transmission, automatic transmission system, transfer case, differentials, drive shafts and propeller shafts

Module:2	Clutch	4 hours

Single plate clutch, Band clutch, Multi-disk clutch, Clutch Design and Analysis

Module:3	Powertrain Integration System	6 hours

Various Resistances to Motion of the Automobile, Traction, tractive effort Performance curves, acceleration grade ability, drawbar pull . Necessity of gear box, Desirable ratios of 3speed & 4speed gear boxes - Matching engine and transmission system using road loads and axle loads. Total ratio and overall gear ratio- Selecting the largest power- train ratio, Selecting the smallest power- train ratio, Selecting the intermediate gears- Gear Shift - Functional Requirement – Design

Module:4	Automatic Transmissions	4 hours

Level of automation, Gear shift mode, stepped and Continuously Variable Transmissions, synchronizer gear boxes, epicycloidal gear boxes, Continuously Variable Transmission (CVT) . Design and analysis of planetary gear trains, Gear ratios and clutch engagement schedule, Clutch torques in steady state condition, Torque analysis in shifting process

Module:5	Hydrodynamic Transmission	4 hours

Fluid coupling – principles - Performance characteristics – advantages – limitations – drag torque – reduction of drag torque. Torque converter - principles - Performance characteristics – advantages – limitations – multi and poly stage torque converters		
Module:6	**Hydrostatic Drive and Electric Drive**	**4 hours**
Hydrostatic drive – various types of hydrostatic transmission – principle - Advantages and limitations. Comparison of hydrostatic transmission with hydrodynamic transmission. Construction and working principle of Janny hydrostatic drive. Electric drive- Principle of Early and modified Ward Leonard - control system – advantages and limitations		
Module:7	**Differentials and Final drives**	**4 hours**
working principle -friction free differential, Differential with internal friction, Self-locking differential. Final drives - performance limits, transmission ratios. Differential gears, differential locks and locking differentials, types of self-locking differential		
Module:8	**Recent Trends**	**2 hours**
	Total Lecture hours: **30 hours**	

Text Book(s)	
1.	T. Kenneth Garrett, Kenneth Newton and William Steeds, –The Motor Vehicle‖ 13th Edition, Butterworth-Heinemann Limited, London, 2005.
Reference Books	
1. Heinz Heisler, –Advanced Vehicle Technology‖, second edition, Butterworth – Heinemann, New 2. Dr. N. K. Giri, –Automobile Mechanics‖, Seventh reprint, Khanna Publishers, Delhi, 2005 3. James Larminie –Electric Vehicle Technology Explained‖, John Wiley & Sons Ltd, The Atrium,	

List of Challenging Projects (J- Component)		
1.	Intelligent control of clutch judder and shunt phenomena in vehicle drivelines	
2.	Engine/powertrain/vehicle modeling tool applicable to all stages of the design process	
3.	Dynamic optimization method for design and rating of the components of a hybrid vehicle	
4.	Automotive drive by wire controller design by multi-objective techniques	
5.	Coordination of active steering, driveline, and braking for integrated vehicle dynamics control	
6.	Toward the systematic design of controllers for smooth hybrid electric vehicle mode changes	
7.	Simultaneous estimation of driveline dynamics and backlash size for control design	
8.	Design of automobile driveshaft using carbon/epoxy and kevlar/epoxy composites	

9.	Multidisciplinary design optimization of engine mounts with consideration of the driveline	
10	Drive-by-wire control of automotive driveline oscillations by response surface methodology	

Recommended by Board of Studies	7/08/2017		
Approved by Academic Council	No. 47th	Date	5/10/2017

Course code	Hybrid Electric Vehicles	L	T	P	J	C
MEE6029		2	0	0	4	3
Pre-requisite	NIL	Syllabus version				
		v. xx.xx				

Course Objectives: None

1. To provide the students with sufficient knowledge on series, parallel and full hybrid architectures of automobile vehicles.
2. To enable the students to understand the concept of electric drive trains, hybrid architectures and hybrid power plant specifications.
3. To help the students to understand the concept of sizing the drive system, energy storage and their alternatives, energy management and control system.

Expected Course Outcome:

1. Possess the knowledge of series, parallel, plug-in and full hybrid vehicle architectures.
2. Acquire, analyze, configure and control of DC, induction, permanent magnet, switch reluctance motor drives and compute their efficiency.
3. Demonstrate the various hybrid and load tracking architectures with knowledge on Hybrid power plant specifications.
4. Compute and design the sizing of propulsion motor, power electronics and their allied systems.
5. To impart knowledge on various energy management and control strategies, energy storage systems like batteries and alternate energy storage systems like fuel cells.

Module:1	Hybrid vehicle architectures	4 hours

Series hybrid vehicle architectures - range extender and full hybrid systems - Parallel hybrid architectures - Plug-in hybrid architectures - Commercially available electric and hybrid vehicles

Module:2	Electric Drive-trains	4 hours

Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. - Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Module:3	Hybrid Architecture And Hybrid Power Plant Specifications - Hybrid architecture	4 hours

Series configuration locomotive drives- series parallel switching- load tracking architecture. Pre transmission parallel and combined configurations Mild hybrid- power assist- dual mode power split- power split with shift- Continuously Variable transmission (CVT)- wheel motors. Hybrid power plant specifications: Grade and cruise targets- launching and boosting- braking and energy recuperation- drive cycle implications- engine fraction engine downsizing and range and performance- usage requirements.

Module:4	Sizing the drive system	4 hours

Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems		
Module:5	**Energy management and control**	**4 hours**
All electric range – Engine dominant blended strategy - Electric dominant strategy - Hybrid vehicle control strategies		
Module:6	**Energy Storage Energy Storage**	**4 hours**
Battery types - Battery Performance Measurements, Factors Affecting Battery Performance - Battery Standardization - Battery Design – Battery Management System - Battery Fault Detection, Maintenance and Test - Battery Installation - Selection of Battery - Battery chargers		
Module:7	**Introduction to Alternative Energy Storage Systems**	**4 hours**
Fuel cell –Characteristics - Types – Hydrogen Storage Systems and Fuel cell EV – Ultra capacitors		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	John Miller, ― Propulsion Systems for Hybrid Vehicles,‖ Institute of Electrical Engineers, UK, 2004 (recommended)
Reference Books	
1.	C.M. Jefferson & R.H. Barnard, ― Hybrid Vehicle Propulsion,‖ WIT Press, 2002
2,	Iqbal Husain, ―Electric and Hybrid Vehicles – Design Fundamentals,‖ CRC Press, 2010
3.	James Larminie and John Lowry, ― Electric Vehicle Technology Explained, ― Oxford Brookes University, Oxford, UK, 2003
4.	Chris Mi, M A Masrur, D W Gao, ― Hybrid Electric Vehicles – Principles and applications with practical perspectives,‖ Wiley, 2011

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Noise, Vibration and Harshness	L	T	P	J	C
MEE6027		2	2	2	0	4
Pre-requisite	NIL	Syllabus version				
		v. 1.1				

Course Objectives:

1. To help the students to understand the different sources of noise from automobiles including engine noise, vehicle structural noise, aerodynamic noise, exhaust noise and their reduction techniques.
2. To enable the students the role of NVH engineers in determining the source of noise and vibration, noise quality and development stages of a new vehicle.
3. To assist the students with sound measurement, single degree freedom of vibration, test facilities for measuring noise and vibration and processing the noise signals.

Expected Course Outcome:

1. Characterize various sources of automotive noise and their reduction in automobiles.
2. Possess the knowledge of role of NVH engineers in new vehicle programme.
3. Identify various methods of sound and vibration measurement including transient and Steady state response of a single degree of freedom applied to vehicle systems.
4. Acquire the hands on experience of using semi-anechoic rooms, wind tunnels, rolling
5. Roads simulators to measure various types of noise and vibrations.
6. Outline the role of transducers, acoustics holography and various instrumentation
7. Employed for analyzing the NVH of vehicle systems.
8. Compute sampling, statistical and frequency analysis of various data obtained during NVH measurements.

Module:1	Introduction	2 hours

Noise pollution from automobiles - Engine Noise, Transmission Noise, vehicle structural Noise, aerodynamics noise, Exhaust Noise. Noise reduction in Automobiles

Module:2	NVH in the Automotive Industry	4 hours

Sources of noise and vibration. Design features. Common problems. Marque values. Noise quality. Pass-by noise requirements. Target vehicles and objective targets. Development stages in a new vehicle programme and the altering role of NVH engineers.

Module:3	Sound	6 hours

Sound measurement. Human sensitivity and weighting factors. Combining sound sources. Acoustical resonances. Properties of acoustic materials.

Module:4	Vibration	4 hours

Transient and steady state response of one degree of freedom system applied to vehicle systems. Transmissibility. Modes of vibration

Module:5	Test Facilities and Instrumentation	4 hours

Laboratory simulation: rolling roads (dynamometers), road simulators, semi-anechoic rooms, wind tunnels, etc. Transducers, signal conditioning and recording systems. Binaural head recordings. Sound Intensity technique, Acoustic Holography, Statistical Energy Analysis

Module:6	**Signal Processing**	**4 hours**
Sampling, aliasing and resolution. Statistical analysis. Frequency analysis. Campbell's plots, cascade diagrams, coherence and correlation functions.		
Module:7	**NVH control Strategies & comfort**	**4 hours**
Source ranking. Noise path analysis. Modal analysis. Design of Experiments, Optimization of Dynamic characteristics. Vibration absorbers and Helmholtz resonators. Active control techniques.		
Module:8	**Recent Trends**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Norton M P, Fundamental of Noise and Vibration, Cambridge University Press,1989
Reference Books	
1.	Munjal M.L., Acoustic Ducts and Mufflers, John Wiley, 1987
2.	Baxa, Noise Control of Internal Combustion Engine, John Wiley, 1984

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Computational Fluid Flow and Heat Transfer	L	T	P	J	C
MEE6028		2	2	0	4	4
Pre-requisite	MAT5005	Syllabus version				
		v. 1.1				

Course Objectives:

1. To provide the students with sufficient background to understand the mathematical representation of the governing equations of fluid flow and heat transfer.
2. To equip students with the knowledge base essential for application of computational fluid dynamics to various engineering problems.
3. Develop the students to use appropriate turbulence model for solving engineering problems.

Expected Course Outcome:

1. Apply mathematics and engineering fundamentals to identify the nature of complex fluid flow and heat transfer problems and to formulate governing equations to represent them.
2. Identify and formulate the appropriate discretization techniques to design finite difference and finite volume solutions relevant to professional engineering practice.
3. Demonstrate the ability to use modern CFD software tools to build heat transfer and flow geometries, generate an adequate mesh for an accurate solution, select appropriate solvers to obtain the results using post processing technique.
4. Possess the knowledge of linking the continuity with momentum equation for incompressible flows using SIMPLE algorithm.
5. Analyse and suggest the type of turbulence models to be chosen for IC engines manifolds, ports and vents.
6. Demonstrate the ability to communicate the detailed results in a written format.

Module:1	Introduction	2 hours

Computational Fluid Dynamics, Impact of CFD on engineering applications, Merits of CFD.

Module:2	Fluid Dynamics	4 hours

Models of the flow, Reynold‘s, Transport Theorem, The continuity equation, Momentum Equation, Energy equation, Physical boundary conditions, Forms of governing equations Suited for CFD.

Module:3	Discretization	4 hours

Basic aspects, Techniques – Introduction to FDM, FVM and FEM, Finite differences, Explicit and Implicit approaches, Error and Stability analysis, Implementation of boundary conditions using FDM and FVM.
Grid Generation: General transformation of the equations, Stretched grids, Elliptic grid generation, Adaptive grids.

Module:4	Numerical Techniques for Heat Conduction	4 hours

Steady one dimensional heat conduction, Unsteady one- dimensional conduction – Explicit, Crank-Nicolson and Fully Implicit schemes, Two and three dimensional heat Conduction, Over relaxation and under relaxation.

Module:5	**Convection and Diffusion**	**5 hours**
Steady one-dimensional convection and diffusion, Discritization equation for two and three dimensions, A One-way space coordinate,False Diffusion.		
Module:6	**Numerical Techniques to find flow field**	**5 hours**
Staggered grid, The pressure velocity corrections, The pressure correction equation, The SIMPLE algorithm.		
Module:7	**Turbulence Modelling**	**2 hours**
Nature, Description and Characterization of turbulent flow, Turbulent models for RANS equations.		
Module:8	**Application of CFD in IC engines**	**2 hours**
Flow through manifolds, valves and ports, Elements of air motion in engines. Outline of fluid dynamic models, application of available commercial codes to engine processes with and without chemical reactions.		
Module:9	**Contemporary issues:**	**2 hours**

	Total Lecture hours:	**30 hours**	

Text Book(s)	
1.	Veersteeg. H. K. &Malaseekara, ―Introduction to CFD, The Finite Volume Method, Longman Scientific & Technical, 1995.
2	John, D. Anderson.J R., Computational Fluid Dynamics, McGraw Hill, 1995.
Reference Books	
1.	K. Muralidhar, T. Sundarajan, Computational Fluid Flow and Heat Transfer, NarosaPublishing House, New Delhi, 1997.
2.	C.T.Shaw, Computational Fluid Dynamics, Prentice Hall, 1992.
3.	S.V.Patankar, Numerical Heat Transfer and Fluid Flow, McGraw Hill, 1993.
4.	M.N. Ozisik, Finite Difference Methods in Heat transfer, CRC press, 1994.
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	
Mode of assessment:	

Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Finite Element Methods	L	T	P	J	C
MEE 5015		2	2	2	0	4
Pre-requisite	NIL	Syllabus version				
		1.1				

Course Objectives:

1. To enable the students understand the mathematical and physical principles underlying the Finite Element Method (FEM) as applied to solid mechanics and thermal analysis
2. Introduce students to the theory of elasticity
3. To teach students the characteristics of various elements in structural and thermal analysis and selection of suitable elements for the problems being solved
4. To introduce students to various field problems and the discretization of the problem
5. To make the students drive finite element equations for simple and complex elements

Expected Course Outcome:

Upon Successful Completion of this course ,Students will be able to

1. Apply the knowledge of mathematics and engineering to solve problems in structural and thermal engineering by approximate and numerical methods
2. Design a new component or improve the existing components using FEA
3. Solve the problems in solid mechanics and heat transfer using FEM
4. Apply commercial FEA packages like ANSYS to solve the engineering problems.
5. Modern CAD/CAE tools for solving real life problems

Module:1	Fundamental concepts	4 hours

Physical problems, Finite Element Analysis as Integral part of Computer Aided Design;. Stresses and Equilibrium; Boundary Conditions; Strain-Displacement Relations; Stress –strain relations, Linear and nonlinear material laws; Temperature Effects; Definition of Tensors and indicial notations; Deformation gradients; Classification of different types of deformations; Degree of Freedom; Field Problem and their degree of freedom. Solid Mechanics Problems and Fluid Mechanics Problems. Deformations and stresses in bars, thin beams, thick beams, plane strain-plane stress hypothesis, thin plate, thick plate, axisymmetric bodies; Approximate nature of most of these deformation hypotheses; General 3D deformation (linear small deformation), Large deformation (nonlinear).

Module:2	General Techniques and Tools of Displacement Based Finite Element Analysis	4 hours

Mathematical models, Approximate solutions, Minimization procedure, Variational procedure, Interpolation polynomial method, Nodal approximation method and Finite Element Solutions. Strong or classical form of the problem and weak or Variational form of the problem; Galerkin's and Weighted residual approaches; Shape and interpolation functions for 1D, 2D & 3D applications; Use of shape (interpolation) functions to represent general displacement functions and in establishment of coordinate and geometrical transformations; Hermite, Lagrange and other interpolation functions.

Module:3	One Dimensional Problems: Bars & Trusses	4 hours

Introduction; Local and global coordinate systems; Transformation of vectors in two and three dimensional spaces; Finite Element stiffness matrix and load vector of a basic element in local coordinate system using energy approach; Assembly of Global Stiffness Matrix and Load vector; Treatment of boundary conditions; Solution algorithms of linear system matrices; Example problems in trusses; Formulation of dynamics analysis, global mass matrix; Extraction of modal

frequencies and mode shape.		
Module:4	**One Dimensional Problems – Beams and Frames**	**4 hours**
Finite Element Modeling of a basic beam element in local coordinate system using energy approach; Formulation of element matrices; Assembly of the Global Stiffness Matrix, Mass matrix and Load vector; Treatment of boundary Conditions; Euler Bernoulli (thin) beam element and Timoshenko (thick) beam element; Beam element arbitrarily oriented in plane (2D) as Plane frames and in space as space frame analysis (3D); Solution algorithms of linear systems.; extraction of modal frequencies and mode shape.		
Module:5	**Two Dimensional Analysis – Scalar Variable Problems**	**4 hours**
Formulation of 2D problems using Partial Differential Equations; Solution algorithm using Energy principle; Constant Strain Triangles (CST); Bilinear Quadrilateral Q4; Formulating the element matrices; Modelling boundary conditions; Solving the field problems such as heat transfer in automotive cooling fin, engine cover; Torsion of a non-circular shaft etc.		
Module:6	**Vector Variable problems - Plane stress, Plane Strain and Axi-symmetric Analysis**	**4 hours**
Equilibrium equation formulation – Energy principle and formulating the element matrices - Plane stress, plane strain and axi-symmetric elements; Orthotropic materials; Isoparametric Elements; Natural co-ordinate system; Higher Order Elements; Four-node Quadrilateral for Axisymmetric Problems; Hexahedral and tetrahedral solid elements; Linear, Quadratic and cubic elements in 1D, 2D and 3D; Numerical integration of functions; Gauss and other integration schemes. C0 and C1 continuity elements		
Module:7	**Analysis of Production Processes**	**4 hours**
FE Analysis of metal casting – Special considerations, latent heat incorporation, gap element – time stepping procedures – Crank – Nicholson algorithm – Prediction of grain structure - Basic concepts of plasticity – Solid and flow formulation – small incremental deformation formulation – FE Analysis of metal cutting, chip separation criteria, incorporation of strain rate dependency.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**30 hours**

S. no	**List of Challenging Exercises (Indicative)**	
1	Stress analysis of a bar without considering self-weight	**4 hours**
2	Effect of self-weight on stress of a vertical hanging bar	**4 hours**
3	Stress analysis of the tapered rod	**4 hours**
4	Two dimensional truss problem	**4 hours**
5	Bending moment and shear force diagram of various beams	**4 hours**
6	Plane stress and plane strain analysis	**3 hours**
7	Modal, harmonic and transient analysis on bar, beam and plates	**4 hours**
8	Axi-symmetric analysis	**3 hours**
	Total laboratory hours	**30 hours**

Text Book(s)

1. Seshu. P, Finite Element Analysis, Prentice Hall of India,2013

Reference Books

1. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt,Concepts and

	Applications of Finite Element Analysis, John Wiley & Sons, Incl.2002. 2 3		
2	J.N Reddy, An introduction to the Finite Element Method, 2017, Mcgraw Hill		
3	S.S.Rao, Finite element method in Engineering, 2011, Butterworth Heinemann		
4	Tirupathi R. Chandrapatla, Ashok D. Belegundu, Introduction to Finite Element in Engineering Pearson 4th Edition, 2011		
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
List of Challenging Experiments (Indicative)			
Recommended by Board of Studies	03.03.2016		
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