CURRICULUM & SYLLABUS

For

B.E. (Hons.) Mechanical Engineering with specialization in Electric Vehicles

(Choice Based Credit System)

(With effect from 2018)

DEPARTMENT OF MECHANICAL ENGINEERING

SRI CHANDRASEKHARENDRA SARASWATHI VISWA MAHAVIDYALAYA

SCSVMV

(Deemed to be University U/S 3 of UGC Act 1956)

Accredited with "A" Grade by NAAC

Enathur, Kanchipuram – 631 561

These regulations are applicable to the students admitted from the AY 2019-20 onwards.

1. PRELIMINARY DEFINITIONS AND NOMENCLATURE

1. "**Degree**" referred to as Under-Graduate (UG) Degree, i.e., B.E. Degree.
2. **"Honours** Degree**"** referred to as Under-Graduate (UG) Degree specialization in emerging area of Home Discipline i.e., Mechanical Engineering to facilitate the students to choose additionally the specialized courses of their choice and to build their competence in special area. Students have to undergo additional courses and acquire more than required number of credits & maintaining CGPA – 8.0 during their period of study (4 years) and no history of arrears to obtain B. E (Hons)**.**
3. **"**Minor **Degree"** referred to as Under-Graduate (UG) Degree specialization in emerging areas other than the chosen discipline of Engineering. Students have to undergo additional courses in their special areas of interest and earn additional credits to obtain B. E with Minor Specialization.
4. **"**Programme" referred to as discipline of B.E. Degree programme like Mechanical Engineering.
5. **"Course"** referred to as a theory/practical subject studied in a semester.

2. ELIGIBILITY FOR ADMISSION

1. **Regular Admission**
   - Maximum age limit for the full-time course is 20 years.
   - Students seeking admission to the first semester of the eight semester B.E. -Degree programme shall be required to have a pass in Higher Secondary Examinations (Academic 10+2) or its equivalent examinations in any State/CBSE/IGCSE board with Mathematics, Physics and Chemistry. Passed 10+2 examination with Physics and Mathematics as compulsory subjects along with one of the Chemistry / Biotechnology / Biology / Technical Vocational subject / Computer Science / Information Technology / Informatics Practices / Agriculture / Engineering Graphics / Business Studies.
   - Obtained at least 50%, Marks (40% marks in case of candidates belonging to reserved category) in the above subject taken together.

2. **Lateral Entry Admission**
   Students who possess the Diploma in Engineering (Mechanical/Automobile or its equivalent) awarded by the State Board of Technical Education, Tamil Nadu

or its equivalent board are eligible to apply for Lateral entry admission to the third semester of B.E. Programme.

3. COURSES OFFERED

COURSE - I	:	B.E. – MECHANICAL ENGINEERING
COURSE – II	:	B.E. (HONS.) – MECHANICAL ENGINEERING in Specialization with 3D Printing
COURSE – III	:	B.E. (HONS.) – MECHANICAL ENGINEERING in Specialization with Electric Vehicles
COURSE – IV	:	B.E. (HONS.) – MECHANICAL ENGINEERING in Specialization with Robotics
COURSE – V	:	B.E. – MECHANICAL ENGINEERING with Minor degree in Cyber Security
COURSE – VI	:	B.E.– MECHANICAL ENGINEERING with Minor degree in Internet of Things (IoT)
COURSE – VII	:	B.E.-MECHANICAL ENGINEERING with Minor degree in Artificial Intelligence & Machine Learning
COURSE – VIII	:	B.E.–MECHANICAL ENGINEERING with Minor degree in Sensor Technology

A student may be offered admission to any one of the programmes of study. The recommended credit range for the above programmes are in between 170 to 192.

4. STRUCTURE OF PROGRAMMES

1. Categorization of Courses

Each B.E., programme will have a curriculum with syllabi comprising of Theory and Practical courses with well-defined Program Outcomes and Programme Educational Objectives (PEO) as per Outcome Based Education (OBE). The content of each course is designed based on the Course Outcomes (CO). The courses of a programme are categorized as follows:

1. **Basic Science Courses (BSC)** include Mathematics, Physics, Chemistry, Biology, Environmental Sciences, etc.
2. **Engineering Science Courses (ESC)** include Engineering Practices, Engineering Graphics, Basics of Electrical / Electronics / Mechanical / Computer Engineering, Instrumentation etc.
3. **Professional Core Courses (PCC)** include the core courses relevant to the Mechanical Engineering & chosen specialization.
4. **Professional Core Elective Courses (PCEC)** include the elective courses relevant to the chosen specialization.
5. **Professional Specialised Courses (PSC)** include the specialised courses relevant to the chosen specialization.
6. **Humanities and Social Sciences including Management courses (HSMC) & Open Electives Courses (OEC)** provide an opportunity to study a course from any discipline that includes the courses relevant to the chosen specialization. The student can choose from the curriculum of other B.E. / B. Tech. programmes and the courses offered by the Departments under the Faculty of Science and Humanities.
7. **Project Mechanical Engineering courses (PROJ-ME)**
8. **Mandatory Courses (MC) non-credit courses such as** Environmental Sciences, Induction Program, Indian Constitution, Essence of Indian Traditional Knowledge

2. Mandatory Two-Week Induction Programme

The students are expected to undergo a mandatory two-week induction programme comprising of physical activity, creative arts, universal human values, proficiency modules, lectures by eminent people, visits to local areas and familiarization to department/branch & innovations immediately after admission.

3. Number of courses per semester

The Curriculum of a semester shall normally have a blend of 4 to 7 lecture courses, except the final semesters, and 2-3 laboratory courses. However, the total number of courses per semester shall not exceed 10 (including EEC). Pre-final semester may have 1 design Project. The final semester may have a blend of 2 or 3 lecture courses and 1 innovative Project.

4. Credit Assignment

In assigning the credits for the courses, 1-hour lecture/week, 1-hour tutorial/week, 2 hours practical/week, 2 hours project work or seminar/week is equivalent to 1 credit.

5. Industrial Training / Internship

Student is expected to undergo In-plant training in any industry/organization during the programme of study. Every 2 weeks of internship/training at industry is equivalent to 1 credit. The credit will be awarded to the student based on the recommendation by the evaluation team, and the results will be sent to The Controller of Examinations after the approval by the Head of the Department.

6. Industrial Visit

Student is required to go for at least one Industrial Visit every year, starting from the second year of the Programme. The Heads of Departments shall ensure that necessary arrangements are made in this regard.

7. Medium of Instruction

The medium of instruction is English for all courses.

5. DURATION OF THE PROGRAMMES

1. A student is normally expected to complete the B.E. Programme in 4 years (8 Semesters), but in any case, not more than 7 years (14 Semesters).
2. Each semester shall normally consist of 90 working days (including examination days). The Head of the Department shall ensure that every faculty imparts instruction as per the number of periods specified in the syllabus, covering the full content of the syllabus for the course being taught.
3. **The** total duration for completion of the programme reckoned from the commencement of the first semester to which the student was admitted shall not exceed the maximum duration irrespective of the period of break of study.

6. COURSE ENROLLMENT AND REGISTRATION

1. Student, on admission, shall be assigned to a Faculty Advisor, who shall advice and counsel the student about the details of the academic programme and the choice of courses, considering the student's academic background and career objectives.

2. After registering for a course, a student shall attend the classes, satisfy the attendance requirements, earn continuous assessment marks and appear for the end semester examinations.
3. Each student on admission shall register for all the courses prescribed in the curriculum.
4. If a student fails to secure a pass in any theory or Laboratory course (including elective theory), he/she shall register for the same course in the immediate semester examinations by retaining the Continuous Assessment Marks already earned.
5. The student shall register Project-1 in VII Semester and Project-2 in VIII Semester.
6. The student who fails in any Project work (Project 1 / Project 2) shall register for the course again. In this case, the student shall attend the reviews and fulfil the attendance requirements.

7. RE`QUIREMENTS FOR APPEARING FOR THE END SEMESTER EXAMINATION

1. Student who has fulfilled the following conditions shall be deemed to have satisfied the attendance requirements for appearing for the end semester examination of a particular course.
2. Ideally every student is expected to attend all periods and earn 100% attendance. However, the student shall secure not less than 80% attendance, course wise, taking into account the number of periods required for that course, as specified in the curriculum.
3. If a student secures attendance between 70% and less than 80% in any course in the current semester, due to medical reasons (hospitalization / accident / specific illness) or due to participation in the College / University / State / National / International level Sports events, with prior permission from the Sports director, and Head of the Department concerned, the student shall be given exemption from the prescribed attendance requirement and the student shall be permitted to appear for the end semester examination of that course.
4. In all such cases, the students should submit the required documents on joining after the absence to the Head of the Department through the Faculty Advisor.
5. A student with an attendance between 40% and 70% in any course will fall under the category **"Semester Break"**, which means Students will not be permitted to attend the Regular End Semester Examinations for that course. If

a student has short fall of attendance in all the registered courses in "Semester Break", he/she would be permitted to move to the higher semester and has to repeat the current semester in the subsequent semester.

6. The student, whose attendance falls below 40% for a course in any semester, will be categorized as **"Detained"**, which means detained in the particular course for want of attendance and they will not be permitted to write the End semester exam for that course. Students will be asked to repeat the same course in the next year.
7. A student who has already appeared for a course in a semester and passed the examination is not entitled to reappear for the same course for improvement of grades.

8. FACULTY ADVISOR

To help the students in planning their courses of study and for general advice on the academic programme, the Head of the Department of the students will attach a certain number of students to a faculty of the Department, who shall function as Faculty Advisor for those students throughout their period of study. The Faculty Advisor shall advise the students in registering and reappearance (Arrear) registering of courses, authorize the process, monitor their attendance and progress and counsel them periodically. If necessary, the Faculty Advisor may also discuss with or inform the parents about the progress / performance of the students concerned.

9. CLASS COMMITTEE

The objective of the Class Committee is to improve the teaching-learning process. The functions of the class committee include:

1. Resolving difficulties experienced by students in the classroom and in the laboratories.
2. Clarifying the regulations of the degree programme and the details of rules therein.
3. Discussing the progress of academic schedule and deviations if any.
4. Evaluating the performance of the students of the class after each test and finding the ways and means of improvement.
5. Class committee consisting of faculty members who are teaching in that class, student representatives and a Head of the Department

6. The class committee shall meet 2-3 times in a semester as specified in the academic calendar. The Dean (Engg. & Tech) may participate in any class committee of the institution.
7. During these meetings, the representative of the class shall meaningfully interact and express the opinions and suggestions of the other students of the class to improve the effectiveness of the teaching-learning process.
8. The Head of the Department is required to prepare the minutes of the meeting, signed by the members and submit the same to Dean. In each meeting, the action taken report of the previous meeting is to be presented by the HOD.

10. SYSTEM OF EXAMINATION

Performance in each course of study shall be evaluated for a maximum of 100 marks based on one of the following:

1. Continuous assessment throughout the semester and a terminal examination at the end of the semester. The continuous assessment will carry 40 marks while the end-semester examination will carry 60 marks.
2. The end semester examination (Theory & Practical) of 3 hours duration shall be conducted by the Controller of Examinations between October to December during the Odd Semesters and between April to May during the Even semesters. All Practical examinations shall be conducted and evaluated at the Department itself on behalf of the Controller of Examinations.
3. For all the practical courses, students shall obtain bonafide certificate for the Observation cum Record completed from the Faculty in-charges / Head of the Department on or before the day of the practical examination.
4. For the project works, students shall obtain bonafide certificate for the project work completed from the project Guide and Head of the Department, at the end of the semester.
5. The semester examination for project work shall comprise of evaluation of the final report submitted by the project group (of not exceeding 4 students) by an external examiner. Further, the performance of each student of the project group would be evaluated in a viva-voce examination conducted by a committee consisting of an external examiner appointed by the Head of the Department/the Controller of Examination, Head of the Department or faculty nominated by Head of the Department and Guide of the project group.

6. Student can apply for re-valuation of his/her semester examination answer paper in theory courses within the stipulated period from the declaration of results, on payment of a prescribed fee, as specified by the Controller of Examinations from time to time. The Controller of Examination will arrange for going through the answer scripts by the students and to make appeals. The re-valuation results will be published before the commencement of supplementary examinations. Re-valuation is not permitted for practical courses, project work and industry supported courses.

11. PROCEDURE FOR AWARDING MARKS FOR CONTINUOUS ASSESSMENT

1. Theory courses

1. The award of marks for continuous assessment shall be normally based on two internal assessment tests and five Assignments / tutorials / seminars. The apportioning of marks shall be as follows:
    1. 30 marks for tests
    2. 10 marks for assignments/tutorials/seminars/Attendance

   However, the assessment pattern for awarding the continuous assessment marks may be designed by the course designers based on the nature of the course and is to be approved by the Academic Council.
2. The first and second Continuous Assessment Tests will be normally conducted at the mid and end of the semester respectively. Each test carries maximum of 30 marks.
3. There will be five assignments for each course which will be considered for awarding marks for assignment.
4. Both test and assignment marks put together is 40 marks maximum.
5. If a student fails in a theory course, the Continuous Assessment Marks already earned will be retained for subsequent reappearances.

2. Practical courses

The continuous assessment mark will be awarded as follows:

Observation-cum-Record in regular class works	: **15 marks**
Model Test	: **15 marks**
Viva	: **10 marks**

3. Project work

Head of the Department shall constitute a review committee comprises of Head of the Department or Faculty member nominated by Head of the Department and two faculty members. The student shall make presentation on the progress made by him / her before the committee. The total marks obtained in the three reviews shall be averaged to 40 marks.

- Every faculty member is required to maintain an Attendance and Continuous Assessment Record which consists of attendance marked for each lecture or practical or project work classes, the tests & assignment marks and record of class works (topics covered) separately for each course.

12. ELIGIBILITY FOR PASS IN EACH COURSE

1. A student who secures not less than 50% of total marks (both continuous assessment and end semester examination marks put together) in theory courses, practical courses shall be declared to have passed the examination.
2. If a student fails to secure a pass in a particular course, it is mandatory that he/she shall register for that course in the subsequent semester and attend the end semester examination. He/she should continue to register and appear for the examination till he /she secures a pass.
3. **Award of Grades**

Range of Total marks (Continuous assessment + End semester examination)	Letter Grade	Grade Point (GP)
Between 90 to 100	S	
Between 80 to 89	A	
Between 70 to 79	B	
Between 60 to 69	C	
Between 55 to 59	D	
Between 50 to 54	E	
Between 0 to 49	F	
Absent	AB	

Grade Point Average $GPA = \frac{\sum_{i=1}^{N} C_i G_{P_i}}{\sum_{i=1}^{N} C_i}$

N is the number of courses registered in a particular semester,
GP_i is the grade point obtained in i^{th} course and
C_i is the number of credits assigned to i^{th} course.

Cumulative GPA (CGPA) will be calculated when the student is declared to be eligible for the award of the degree. CGPA calculation is based on all the courses considered for the award of the degree.

13. ELIGIBILITY FOR THE AWARD OF DEGREE

A student shall be declared to be eligible for the award of the degree if he/she has satisfied the following:

1. A student seeking B.E., degree shall be required to undergo the prescribed courses of study and evaluation in the college for the specified duration and to pass all the examinations prescribed therefore.
2. He/ she should register for the courses prescribed in the curriculum of the respective degree programme, fulfil the requirement of credits in each category of credit distribution, pass in all mandatory courses in the curriculum and earn the specified total minimum number of credits.
3. No disciplinary action pending against the student.

14. CLASSIFICATION OF THE DEGREE AWARDED

1. **First class with Distinction**
   A student who qualifies for the award of degree having passed the examination in all registered courses in his / her first appearance (including industry supported courses), within Four years (Three Years for Lateral Entry students), and securing a CGPA of not less than 8.50 shall be declared to have passed in First class with distinction.

2. **First Class**
   A student who qualifies for the award of degree having passed the examination in all the courses within Four years (Three years for Lateral Entry students) and securing a CGPA of not less than 7.00 shall be declared to have passed in First class.

3. **Second Class**
   All other students (not covered in 14.1 and 14.2) who qualify for the award of degree having passed the examination in all the courses and fulfilling the requirements shall be declared to have passed in Second Class.

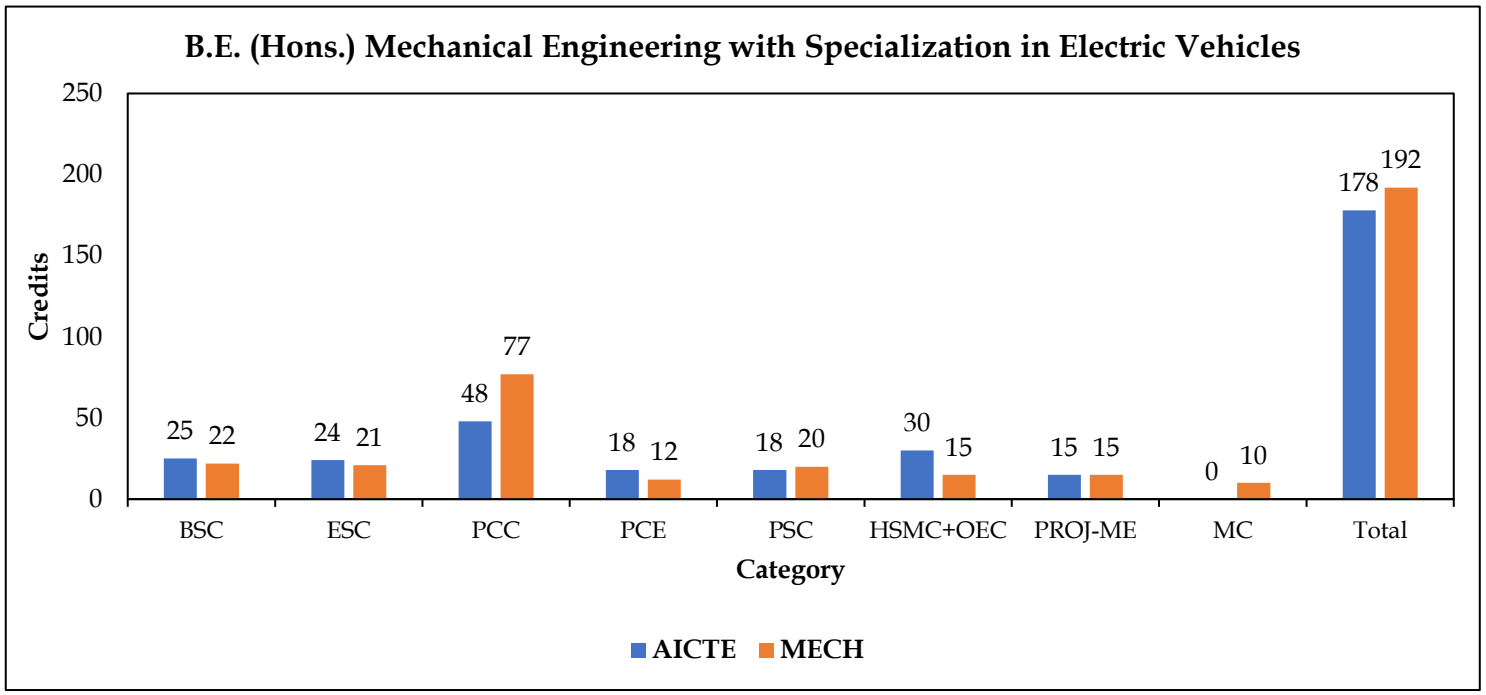
15. DISCIPLINE

1. Every student is required to observe discipline and decorous behavior both inside and outside the college and not to indulge in any activity, which will tend to bring down the prestige of the college. The Registrar shall constitute a disciplinary committee to enquire into acts of indiscipline and notify the institution about the disciplinary action recommended for approval. In case of any serious disciplinary action which leads to suspension or dismissal.
2. If a student indulges in malpractice in any test/examinations, the student shall be liable for punitive action as prescribed by the institution from time to time.

16. REVISION OF REGULATIONS AND CURRICULUM

The standing committee/Academic Council/ of the institution reserves the right to revise or change or amend the regulations, the scheme of examinations, the curriculum and the syllabi from time to time if found necessary.

DISTRIBUTION OF CREDITS				
SL. No	**Course Category**	**As per AICTE regulation 2018**	**Credits**	**Percentage (%)**
1.	**Basic Science Courses (BSC)**	**25**	**22**	13.5
2.	**Engineering Science Courses (ESC)**	**24**	**21**	13.1
3.	**Professional Core Courses (PCC)**	**48**	**79**	48.1
4.	**Professional Core Electives Courses (PCE)**	**18**	**12**	7.5
5.	**Professional Specialised Courses (PSC)**	**18**	**20**	12.5
6.	**Humanities and Social Sciences including Management courses (HSMC) + Open Electives Courses (OEC)**	**30**	**15**	9.3
7.	**Project Mechanical Engineering courses (PROJ-ME)**	**15**	**15**	9.3
8.	**Mandatory Courses (MC)***	**0**	**8***	*
* **Not accountable for CGPA**				
Total		**178**	**192**	**100**



EACH COURSE IN CATEGORY WISE								
B.E. (HONS.) MECHANICAL ENGINEERING WITH SPECIALIZATION IN ELECTRIC VEHICLES								
Basic Science Courses (BSC)								
SL. No	Semester	Course Category	Course Code	Name of the Course	Hours per week			Credit
					L	T	P	
1	1	BSC		Mathematics –I (Calculus & Linear Algebra)	3	1	-	**4**
2	1	BSC		Engineering Chemistry	3	-	-	**3**
3	1	BSC		Chemistry Lab	-	-	3	**2**
4	2	BSC		Mathematics – II (Calculus, Ordinary Differential Equations, and Complex Variables)	3	1	-	**4**
5	2	BSC		Applied Physics for Engineers	3	-	-	**3**
6	2	BSC		Physics Lab	-	-	3	**2**
7	3	BSC		Mathematics III (PDE, Probability & Statistics)	3	1	-	**4**
Total Credits								**22**

Engineering Science Courses (ESC)								
SL. No	Semester	Course Category	Course Code	Name of the Course	Hours per week			Credit
					L	T	P	
1	1	ESC		Basic Electrical Engineering	3	-	-	**3**
2	1	ESC		Engineering Graphics & Design	2	-	2	**3**
3	1	ESC		Basic Electrical Engineering Lab	-	-	3	**2**
4	2	ESC		Programming for Problem Solving	2	1	-	**3**
5	2	ESC		Programming for Problem Solving Lab	-	-	3	**2**
6	2	ESC		Workshop/Manufacturing Practices Lab	-	-	3	**2**
7	3	ESC		Engineering Mechanics	2	1	-	**3**
8	4	ESC		Basic Electronics Engineering	3	-	-	**3**

Total Credits								21
Humanities and Social Sciences including Management courses (HSMC)								
SL. No	**Semester**	**Course Category**	**Course Code**	**Name of the Course**	**Hours per week**			**Credit**
					L	**T**	**P**	
1	2	HSMC		English	2	1	-	**3**
2	6	HSMC		Operation Research & Management	2	1	-	**3**
3	8	HSMC		Engineering Economics	3	-	-	**3**
Total Credits								**09**

Mandatory Courses (MC)								
SL. No	**Semester**	**Course Category**	**Course Code**	**Name of the Course**	**Hours per week**			**Credit**
					L	**T**	**P**	
1	1	MC*		English Proficiency Certification	2	-	-	**1***
2	2	MC*		Environmental Science and Engineering*	2	-	-	**1***
3	3	MC*		Foreign Language Level – II and Above	-	-	-	**1***
4	4	MC		Sanskrit and Indian Culture	2	-	-	**1***
5	5	MC*		Soft Skill and Aptitude Certification	-	-	-	**1***
6	6	MC*		Technical Certification Course	-	-	-	**1***
7	7	MC*		Presentation / Publication in Conference / Seminar	-	-	-	**1***
8	8	MC*		Start ups				**1***
Total Credits								**8**

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Professional Core Courses (PCC)								
SL. No	**Semester**	**Course Category**	**Course Code**	**Name of the Course**	**Hours per week**			**Credit**
					L	**T**	**P**	
1.	3	PCC		Fluid Mechanics & Machinery	2	1	-	**3**
2.	3	PCC		Thermodynamics	3	-	-	**3**
3.	3	PCC		Materials Engineering	3	-	-	**3**
4.	3	PCC		Fluid Mechanics and Machinery Lab	-	-	3	**2**
5.	3	PCC		Materials and Metallurgy Lab	-	-	3	**2**
6.	4	PCC		Applied Thermodynamics	3	-	-	**3**
7.	4	PCC		Strength of Materials	2	1	-	**3**
8.	4	PCC		Kinematics of Machines	2	1	-	**3**
9.	4	PCC		Manufacturing Processes	3	-	-	**3**
10.	4	PCC		Thermal Engineering Lab	-	-	3	**2**
11.	4	PCC		Strength of Materials Lab	-	-	3	**2**
12.	5	PCC		Heat and Mass Transfer	3	-	-	**3**
13.	5	PCC		Dynamics of Machines	2	1	-	**3**
14.	5	PCC		Instrumentation and Control	3	-	-	**3**
15.	5	PCC		Design of Machine Elements	3	-	-	**3**
16.	5	PCC		Manufacturing Technology	3	-	-	**3**
17.	5	PCC		Metrology and Quality Control	3	-	-	**3**
18.	5	PCC		Machine Drawing Practical	-	-	3	**2**
19.	5	PCC		Manufacturing Technology Lab	-	-	3	**2**
20.	5	PCC		Dynamics and Measurements Lab	-	-	3	**2**
21.	6	PCC		Automobile Engineering	3	-	-	**3**
22.	6	PCC		Power Plant Engineering	3	-	-	**3**
23.	6	PCC		CAD/CAM	3	-	-	**3**
24.	6	PCC		Heat Transfer Lab	-	-	3	**2**
25.	6	PCC		CAD/CAM Lab	-	-	3	**2**
26.	7	PCC		Design of Transmission Systems	3	-	-	**3**
27.	7	PCC		Mechatronics	3	-	-	**3**
28.	7	PCC		Computer Aided Analysis Lab	-	-	3	**2**
29.	7	PCC		Mechatronics Lab	-	-	3	**2**
30.	8	PCC		Automation in Manufacturing	3	-	-	**3**
Total Credits								**79**

Professional Core Electives Courses (PCE)								
SL. No	Semester	Course Category	Course Code	Name of the Course	Hours per week			Credit
					L	T	P	
1.	6	PCE -I		Finite Element Analysis	3	-	-	3
2.	6	PCE -I		Fluid Power Systems	3	-	-	
3.	6	PCE -I		Product Design & Development	3	-	-	
4.	6	PCE -I		3D Printing	3	-	-	
5.	6	PCE -I		Tribology	3	-	-	
6.	7	PCE - II		Refrigeration & Air Conditioning	3	-	-	3
7.	7	PCE - II		I.C. Engines	3	-	-	
8.	7	PCE - II		Turbo Machines	3	-	-	
9.	7	PCE - II		Energy Conservation in Industries	3	-	-	
10.	7	PCE - II		Gas Dynamics & Jet Propulsion	3	-	-	
11.	7	PCE - III		Sustainable Manufacturing	3	-	-	3
12.	7	PCE - III		Design for Manufacturing	3	-	-	
13.	7	PCE - III		Theory of Metal Forming	3	-	-	
14.	7	PCE - III		Digital Manufacturing	3	-	-	
15.	7	PCE - III		Composite Materials	3	-	-	
16.	8	PCE - IV		Total Quality Management	3	-	-	3
17.	8	PCE - IV		Entrepreneurship Development	3	-	-	
18.	8	PCE - IV		Non-Traditional Machining Process	3	-	-	
19.	8	PCE - IV		Non Destructive Evaluation	3	-	-	
20.	8	PCE - IV		Flexible Manufacturing Systems	3	-	-	
Total Credits								12

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Professional Specialised Courses (PSC)								
SL. No	Semester	Course Category	Course Code	Name of the Course	Hours per week			Credit
					L	T	P	
1	3	PSC		Electric & Hybrid Vehicles	3	-	-	**3**
2	3	PSC		Energy Storage System and Management System	3	-	-	**3**
3	4	PSC		Electric Drives and Controls for Electric Vehicles	3	-	-	**3**
4	4	PSC		Electro-Chemistry of Fuel Cells	3	-	-	**3**
5	5	PSC		Modelling and Simulation of EHV	3	-	-	**3**
6	6	PSC		Modelling and Simulation of EHV Lab	-	-	2	**2**
7	7	PSC		Testing and Certification of Electric Hybrid Vehicles	3	-	-	**3**
Total Credits								**20**

Project Mechanical Engineering courses (PROJ-ME)								
SL. No	Semester	Course Category	Course Code	Name of the Course	Hours per week			Credit
					L	T	P	
1	7	PROJ		Design and Fabrication Project	-	-	4	**2**
2	7	PROJ-ME		Industrial Internship and Training	-	-	-	**3**
3	8	PROJ-ME		Project Work	-	-	12	**10**
Total Credits								**15**

Open Electives Courses (OEC)								
SL. No	Semester	Course Category	Course Code	Name of the Course	Hours per week			Credit
					L	T	P	
1.	6	OEC - I		Cloud Computing	3	-	-	3
2.	6	OEC - I		Web Design	3	-	-	
3.	6	OEC - I		Digital Image Processing	3	-	-	
4.	6	OEC - I		Data Analysis	3	-	-	
5.	6	OEC - I		Astro-Physics	3	-	-	
6.	6	OEC - I		Business Administration	3	-	-	
7.	6	OEC - I		Chemistry in Crime Investigation	3	-	-	
8.	6	OEC - I		Bioinformatics	3	-	-	
9.	6	OEC - I		Finance for Non Finance Managers	3	-	-	
10.	6	OEC - I		Fuel Cell and Batteries	3	-	-	
11.	7	OEC - II		Autotronics	3	-	-	
12.	7	OEC - II		Artificial Intelligence & Machine Learning	3	-	-	
13.	7	OEC - II		Nano Technology & Surface Engineering	3	-	-	3
14.	7	OEC - II		Disaster Management & Mitigation	3	-	-	
15.	7	OEC - II		Robotics	3	-	-	
16.	7	OEC - II		HR Management	3	-	-	
17.	7	OEC - II		Nuclear and particle physics	3	-	-	
18.	7	OEC - II		Internet of Things (IOT)	3	-	-	
19.	7	OEC - II		Psychology	3	-	-	
20.	7	OEC - II		Statistical methods with excel	3	-	-	
21.	7	OEC - II		Key Board	3	-	-	
22.	7	OEC - II		Logistics and Supply Chain	3	-	-	
23.	7	OEC - II		Violin	3	-	-	
24.	7	OEC - II		Vocal Music	3	-	-	
Total Credits								**06**

B.E. (HONS.) MECHANICAL ENGINEERING WITH SPECIALIZATION IN ELECTRIC VEHICLES							
192 - CREDIT STRUCTURE							
SEMESTER - I (First year)							
SL. No	**Course Category**	**Course Code**	**Name of the Course**	**Hours per week**			**Credit**
				L	**T**	**P**	
1.	BSC		Mathematics –I (Calculus & Linear Algebra)	3	1	-	**4**
2.	BSC		Engineering Chemistry	3	-	-	**3**
3.	ESC		Basic Electrical Engineering	3	-	-	**3**
4.	ESC		Engineering Graphics & Design	2	-	2	**3**
5.	BSC		Chemistry Lab	-	-	3	**2**
6.	ESC		Basic Electrical Engineering Lab	-	-	3	**2**
7.	MC*		English Proficiency Certification	2	-	-	**1***
* Not accountable for CGPA							
Total				**11**	**01**	**08**	**17+1***

SEMESTER - II (First year)							
SL. No	**Course Category**	**Course Code**	**Name of the Course**	**Hours per week**			**Credit**
				L	**T**	**P**	
1.	HSMC		English	2	1	-	**3**
2.	BSC		Mathematics – II (Calculus, Ordinary Differential Equations, and Complex Variables)	3	1	-	**4**
3.	BSC		Applied Physics for Engineers	3	-	-	**3**
4.	ESC		Programming for Problem Solving	2	1	-	**3**
5.	MC*		Environmental Science and Engineering*	2	-	-	**2***
6.	BSC		Physics Lab	-	-	3	**2**
7.	ESC		Programming for Problem Solving Lab	-	-	3	**2**
8.	ESC		Workshop/Manufacturing Practices Lab	-	-	3	**2**
* Not accountable for CGPA							
Total				**10**	**03**	**09**	**19+2***

SEMESTER - III (Second year)							
SL. No	**Course Category**	**Course Code**	**Name of the Course**	**Hours per week**			**Credit**
				L	**T**	**P**	
1.	BSC		Mathematics III (PDE, Probability & Statistics)	3	1	-	**4**
2.	ESC		Engineering Mechanics	2	1	-	**3**
3.	PCC		Fluid Mechanics & Machinery	2	1	-	**3**
4.	PCC		Thermodynamics	3	-	-	**3**
5.	PCC		Materials Engineering	3	-	-	**3**
6.	**PSC**		**Electric & Hybrid Vehicles**	**3**	**0**	**0**	**3**
7.	**PSC**		**Energy Storage System and Management System**	**3**	**0**	**0**	**3**
8.	PCC		Fluid Mechanics and Machinery Lab	-	-	3	**2**
9.	PCC		Materials and Metallurgy Lab	-	-	3	**2**
10.	MC*		Foreign Language Level – II and Above (German, French, Japanese, etc..,)	-	-	-	**1***
* Not accountable for CGPA							
Total				**19**	**03**	**06**	**26+1***

SEMESTER - IV (Second year)							
SL. No	**Course Category**	**Course Code**	**Name of the Course**	**Hours per week**			**Credit**
				L	**T**	**P**	
1.	ESC		Basic Electronics Engineering	3	-	-	**3**
2.	PCC		Applied Thermodynamics	3	-	-	**3**
3.	PCC		Strength of Materials	2	1	-	**3**
4.	PCC		Kinematics of Machines	2	1	-	**3**
5.	PCC		Manufacturing Processes	3	-	-	**3**
6.	**PSC**		**Electric Drives and Controls for Electric Vehicles**	**3**	**-**	**-**	**3**
7.	**PSC**		**Electro-Chemistry of Fuel Cells**	**3**	**-**	**-**	**3**
8.	MC		Sanskrit and Indian Culture	2	-	-	**2***
9.	PCC		Thermal Engineering Lab	-	-	3	**2**
10.	PCC		Strength of Materials Lab	-	-	3	**2**
* Not accountable for CGPA							
Total				**19**	**02**	**06**	**25+2***

SEMESTER - V (Third year)							
SL. No	**Course Category**	**Course Code**	**Name of the Course**	**Hours per week**			**Credit**
				L	**T**	**P**	
1.	PCC		Heat and Mass Transfer	3	-	-	**3**
2.	PCC		Dynamics of Machines	2	1	-	**3**
3.	PCC		Instrumentation and Control	3	-	-	**3**
4.	PCC		Design of Machine Elements	3	-	-	**3**
5.	PCC		Manufacturing Technology	3	-	-	**3**
6.	PCC		Metrology and Quality Control	3	-	-	**3**
7.	**PSC**		**Modelling and Simulation of EHV**	**3**	**-**	**-**	**3**
8.	PCC		Machine Drawing Practical	-	-	3	**1**
9.	PCC		Manufacturing Technology Lab	-	-	3	**2**
10.	PCC		Dynamics and Measurements Lab	-	-	3	**1**
11.	MC*		Soft Skill and Aptitude Certification	-	-	-	**1***
* Not accountable for CGPA							
Total				**20**	**01**	**09**	**25+1***

SEMESTER - VI (Third year)							
SL. No	**Course Category**	**Course Code**	**Name of the Course**	**Hours per week**			**Credit**
				L	**T**	**P**	
1.	HSMC		Operation Research & Management	2	1	-	**3**
2.	PCC		Automobile Engineering	3	-	-	**3**
3.	PCC		Power Plant Engineering	3	-	-	**3**
4.	PCC		CAD/CAM	3	-	-	**3**
5.	**PSC**		**Modelling and Simulation of EHV Lab**	**2**	**-**	**-**	**2**
6.	PEC		Professional Elective – I	3	-	-	**3**
7.	OEC		Open Elective – I	3	-	-	**3**
8.	PCC		Heat Transfer Lab	-	-	3	**2**
9.	PCC		CAD/CAM Lab	-	-	3	**2**
10.	MC*		Technical Certification Course	-	-	-	**1***
* Not accountable for CGPA							
Total				**19**	**01**	**06**	**24+1***

SEMESTER - VII (Fourth year)							
SL. No	**Course Category**	**Course Code**	**Name of the Course**	**Hours per week**			**Credit**
				L	**T**	**P**	
1.	PCC		Design of Transmission Systems	3	-	-	**3**
2.	PCC		Mechatronics	3	-	-	**3**
3.	PEC		Professional Elective – II	3	-	-	**3**
4.	PEC		Professional Elective – III	3	-	-	**3**
5.	OEC		Open Elective – II	3	-	-	**3**
6.	PCC		Computer Aided Analysis Lab	-	-	3	**2**
7.	**PSC**		**Testing and Certification of Electric Hybrid Vehicles**	**3**	**-**	**-**	**3**
8.	PCC		Mechatronics Lab	-	-	3	**2**
9.	PROJ-ME		Design and Fabrication Project	-	-	4	**2**
10.	PROJ-ME		Industrial Internship and Training	-	-	-	**3**
11.	MC*		Presentation / Publication in Conference / Seminar	-	-	-	**1***
* Not accountable for CGPA							
Total Credits				**18**	**-**	**10**	**27+1***

SEMESTER - VIII (Fourth year)							
SL. No	**Course Category**	**Course Code**	**Name of the Course**	**Hours per week**			**Credit**
				L	**T**	**P**	
1.	PCC		Automation in Manufacturing	3	-	-	**3**
2.	HSMC		Engineering Economics	3	-	-	**3**
3.	PEC		Professional Elective – IV	3	-	-	**3**
4.	PROJ-ME		Project Work	-	-	12	**10**
5.	MC*		Start ups				**1***
* Not accountable for CGPA							
Total Credits				**9**	**-**	**12**	**+1***

PROFESSIONAL ELECTIVE COURSES							
SL. No	Category	Code	Course Title	Hours per week			Credit
				L	T	P	
1.	PEC-I		Finite Element Analysis	3	-	-	3
2.			Fluid Power Systems				
3.			Product Design & Development				
4.			3D Printing				
5.			Tribology				
6.	PEC-II		Refrigeration & Air Conditioning	3	-	-	3
7.			I.C. Engines				
8.			Turbo Machines				
9.			Energy Conservation in Industries				
10.			Gas Dynamics & Jet Propulsion				
11.	PEC-III		Sustainable Manufacturing	3	-	-	3
12.			Design for Manufacturing				
13.			Theory of Metal Forming				
14.			Digital Manufacturing				
15.			Composite Materials				
16.	PEC-IV		Total Quality Management	3	-	-	3
17.			Entrepreneurship Development				
18.			Non-Traditional Machining Process				
19.			Non Destructive Evaluation				
20.			Flexible Manufacturing Systems				

OPEN ELECTIVE COURSES							
SL. No	Category	Code	Course Title	Hours per week			Credit
				L	T	P	
1.	OEC – I		Cloud Computing	3	-	-	3
2.			Web Design				
3.			Digital Image Processing				
4.			Data Analysis				
5.			Astro-Physics				
6.			Business Administration				
7.			Chemistry in Crime Investigation				
8.			Bioinformatics				
9.			Finance for Non Finance Managers				
10.			Fuel Cell and Batteries				
11.			Autotronics				
12.			Artificial Intelligence & Machine Learning				
13.	OEC - II		Nano Technology & Surface Engineering	3	-	-	3
14.			Disaster Management & Mitigation				
15.			Robotics				
16.			HR Management				
17.			Nuclear and particle physics				
18.			Internet of Things (IOT)				
19.			Psychology				
20.			Statistical methods with excel				
21.			Key Board				
22.			Logistics and Supply Chain				
23.			Violin				
24.			Vocal Music				

Course Title	ELECTRIC & HYBRID VEHICLES	Credits	L T P C
Course Code			3 0 0 3
Course Category			
Learning Level			

OBJECTIVES

- To understand the concept of electric vehicles.
- To study about the motors & drives for electric vehicles.
- To understand the electronics and sensors in electric vehicles.
- To understand the concept of hybrid vehicles.
- To study about fuel cell for electric vehicles.

UNIT – I Introduction to Electric Vehicles

Electric Vehicle – Need - Types – Cost and Emissions – End of life. Electric Vehicle Technology – layouts, cables, components, Controls. Batteries – overview and its types. Battery plug-in and life. Ultra-capacitor, Charging – Methods and Standards. Alternate charging sources – Wireless & Solar.

UNIT – II Electric Vehicle Motors

Motors (DC, Induction, BLDC) – Types, Principle, Construction, Control. Electric Drive Trains (EDT) – Series HEDT (Electrical Coupling) – Power Rating Design, Peak Power Source (PPS); Parallel HEDT (Mechanical Coupling) – Torque Coupling and Speed Coupling. Switched Reluctance Motors (SRM) Drives – Basic structure, Drive Convertor, Design.

UNIT – III Electronics and Sensor-less control in EV

Basic Electronics Devices – Diodes, Thyristors, BJTs, MOSFETs, IGBTs, Convertors, Inverters. Safety – Risks and Guidance, Precautions, High Voltage safety, Hazard management. Sensors - Autonomous EV cars, Self-drive Cars, Hacking; Sensor less – Control methods- Phase Flux Linkage-Based Method, Phase Inductance-Based, Modulated Signal Injection, Mutually Induced Voltage-Based, Observer-Based.

UNIT – IV Hybrid Vehicles

Hybrid Electric vehicles – Classification – Micro, Mild, Full, Plug-in, EV. Layout and Architecture – Series, Parallel and Series-Parallel Hybrid, Propulsion systems and components. Regenerative Braking, Economy, Vibration and Noise reduction. Hybrid Electric Vehicles System – Analysis and its Types, Controls.

UNIT – V Fuel Cells for Electric vehicles

Fuel cell – Introduction, Technologies & Types, Obstacles. Operation principles, Potential and I-V curve, Fuel and Oxidation Consumption, Fuel cell Characteristics – Efficiency, Durability, Specific power, Factors affecting, Power design of fuel Cell Vehicle and freeze capacity. Lifetime cost of Fuel cell Vehicle – System, Components, maintenance.

CO	COURSE OUTCOMES	PO
Upon completion of this course, Students should be able to		
1.	Describe about working principle of electric vehicles.	
2.	Explain the construction and working principle of various motors used in electric vehicles.	
3.	Understand about working principle of electronics and sensor less control in electric vehicles.	
4.	Describe the different types and working principle of hybrid vehicles.	
5.	Illustrate the various types and working principle of fuel cells.	

TEXT BOOK	
1.	Jack Erjavec and Jeff Arias, "Hybrid, Electric and Fuel Cell Vehicles", Cengage Learning, 2012.
2.	Jack Erjavec and Jeff Arias, "Alternative Fuel Technology – Electric, Hybrid and Fuel Cell Vehicles", Cengage Learning Pvt. Ltd., New Delhi, 2007
3.	Mehrdad Ehsani, Yimin Gao, sebastien E. Gay and Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press, 2009.
REFERENCES	
1.	Hybrid Electric Vehicle System Modeling and Control - Wei Liu, General Motors, USA, John Wiley & Sons, Inc., 2017.
2.	Hybrid Electric Vehicles – Teresa Donateo, Published by ExLi4EvA, 2017.
3.	Electric and Hybrid Vehicles Power Sources, Models, Sustainability, Infrastructure and the Market Gianfranco Pistoia Consultant, Rome, Italy, Elsevier Publications, 2017.
4.	Hybrid, Electric & Fuel-Cell Vehicles Jack Erjavec, Delmar, Cengage Learning.
5.	Electric and Hybrid Vehicles, Tom Denton, Taylor & Francis, 2018.

Course Title	ENERGY STORAGE SYSTEM AND MANAGEMENT SYSTEM	Credits	L T P C
Course Code			3 0 0 3
Course Category			
Learning Level			

OBJECTIVES

- To understand the different types of energy storage system.
- To study about the battery characteristic & parameters.
- To model the types of batteries
- To know the concepts of battery management system and design the battery pack.
- To study about the battery testing, disposal and recycling.

UNIT – I ENERGY STORAGE SYSTEM

Batteries: Lead Acid Battery, Nickel based batteries, Sodium based batteries, Lithium based batteries – Li-ion & Li-poly, Metal Air Battery, Zine Chloride battery; Ultra capacitors; Flywheel Energy Storage System; Hydraulic Energy Storage System; Comparison of different Energy Storage System.

UNIT – II BATTERY CHARACTERISTICS & PARAMETERS

Cells and Batteries- conversion of chemical energy to electrical energy- Battery Specifications: Variables to characterize battery operating conditions and Specifications to characterize battery nominal and maximum characteristics; Efficiency of batteries; Electrical parameters- Heat generation- Battery design- Performance criteria for Electric vehicles batteries- Vehicle propulsion factors- Power and energy requirements of batteries- Meeting battery performance criteria- setting new targets for battery performance.

UNIT – III BATTERY MODELLING

General approach to modelling batteries, simulation model of a rechargeable Li-ion battery, simulation model of a rechargeable NiCd battery, Parameterization of the NiCd battery model, Simulation examples.

UNIT – IV BATTERY PACK AND BATTERY MANAGEMENT SYSTEM

Selection of battery for EVs & HEVs, Traction Battery Pack design, Requirement of Battery Monitoring, Battery State of Charge Estimation methods, Battery Cell equalization problem, thermal control, protection interface, SOC Estimation, Energy & Power estimation, Battery thermal management system, Battery Management System: Definition, Parts: Power Module, Battery, DC/DC Converter, load, communication channel, Battery Pack Safety, Battery Standards & Tests.

UNIT – V BATTERY TESTING, DISPOSAL & RECYCLING

Chemical & structure material properties for cell safety and battery design, battery testing, limitations for transport and storage of cells and batteries, Recycling, disposal and second use of batteries. Battery Leakage: gas generation in batteries, leakage path, leakage rates. Ruptures: Mechanical stress and pressure tolerance of cells, safety vents, Explosions: Causes of battery explosions, explosive process, Thermal Runway: High discharge rates, Short circuits, charging and discharging. Environment and Human Health impact assessments of batteries, General recycling issues and drivers, methods of recycling of EV batteries.

E-VEHICLES - REGULATIONS 2019

CO	COURSE OUTCOMES	PO
Upon completion of this course, Students should be able to		
1.	Discuss about the different types of energy storage system.	
2.	Describe about the battery characteristic & parameters.	
3.	Model different types of batteries	
4.	Apply the concepts of battery management system and design the battery pack.	
5.	Explain about the battery testing, disposal and recycling.	
TEXT BOOK		
1.	Ibrahim Dinçer, Halil S. Hamut and Nader Javani, "Thermal Management of Electric Vehicle Battery Systems", John Wiley& Sons Ltd., 2016.	
2.	Chris Mi, Abul Masrur& David Wenzhong Gao, "Hybrid electric Vehicle- Principles & Applications with Practical Properties", Wiley, 2011.	
3.	Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric Hybrid Electric and Fuel Cell Vehicles", Taylor& Francis Group, 2010.	
4.	James Larminie, John Lowry, "Electric Vehicle Technology Explained", John Wiley & Sons Ltd, 2003.	
REFERENCES		
1.	G. Pistoia, J.P. Wiaux, S.P. Wolsky, "Used Battery Collection and Recycling", Elsevier, 2001. (ISBN: 0-444-50562-8)	
2.	Guangjin Zhao, "Reuse and Recycling of Lithium-Ion Power Batteries", John Wiley & Sons. 2017. (ISBN: 978-1-1193-2185-9)	
3.	T R Crompton, "Battery Reference Book-3rd Edition", Newnes- Reed Educational and Professional Publishing Ltd., 2000.	
4.	4Arno Kwade, Jan Diekmann, "Recycling of Lithium-Ion Batteries: The LithoRec Way", Springer, 2018. (ISBN: 978-3-319-70571-2).	

Course Title	ELECTRIC DRIVES AND CONTROLS FOR ELECTRIC VEHICLES	Credits	L T P C
Course Code			3 0 0 3
Course Category			
Learning Level			

OBJECTIVES

- To study about the motor & device characteristics & parameters.
- To know the various electric drive concepts
- To have a knowledge of DC drive mechanism.
- To have a knowledge of AC drive mechanism.
- To understand about drives for special electrical machines.

UNIT – I MOTOR AND DEVICE CHARACTERISTICS

Review of motor principles, motor load dynamics, starting, braking & speed control of dc and ac motors-power semiconductor SCRs, IGBTs and MOSFETs (9)

UNIT – II ELECTRIC DRIVE CONCEPTS

Basic drive, choice of electric drives, advantages, nature and classification of drives, control and stability of electric drives, feedback control of drives, thermal effects in electrical machines, selection of motor and rating. (9)

UNIT – III DC DRIVES

Transient analysis of separately excited dc motors, converter - single phase uncontrolled, half and fully controlled rectifiers, chopper control, closed loop control of solid-state DC drives. (9)

UNIT – IV AC DRIVES

Operation of induction and induction motor, direct torque and flux control of induction motor drives, starting methods and speed control of single-phase induction motors, self-controlled synchronous motor drive, selection of motor and rating vector control of synchronous motor. (9)

UNIT – V DRIVES FOR SPECIAL ELECTRICAL MACHINES

Drives for variable reluctance motors, microprocessor/ microcontroller –gate trigger signal generation applications to special electrical machines, switched reluctance motor drives, brushless DC motor drives, permanent magnet drives. (9)

CO	COURSE OUTCOMES	PO
Upon completion of this course, Students should be able to		
1.	Describe about the motor & device characteristics & parameters.	
2.	Explain about various electric drive concepts	
3.	Understand the DC drive mechanism.	
4.	Understand the AC drive mechanism.	
5.	Explain about drives for special electrical machines.	

TEXT BOOK	
1.	Gopal K D, "Fundamentals of Electric Drives", Narosa Publishing House Pvt. Ltd., 2011.
2.	Pillai S K, "A first course on Electrical Drives", Wiley Eastern Ltd, Bombay 2011.
REFERENCES	
1.	Ali Elamadi, "Handbook Automotive Power Electronics and Drives", CRC publishers, 2012.
2.	Bimal K Bose, "Modern Power Electronics and Drives", Elsevier publishers, Butterworth Hinnemann, 2012.
3.	Krishnan R, "Permanent Magnet synchronous and Brushless DC Motor Drives", CRC Publishers, 2010.
4.	Krishnan R, "Switched Reluctance Motor Drives: Modeling, Simulation, Analysis, Design and Applications", CRC Publishers, 2012.

Course Title	MODELLING AND SIMULATION OF EHV	Credits	L T P C
Course Code			3 0 0 3
Course Category			
Learning Level			

OBJECTIVES

- To understand the modelling of vehicle performance parameters.
- To model battery electric vehicles.
- To describe the drivetrain characteristics.
- To know the concepts of energy management system.
- To know the vehicle dynamic control systems.

UNIT – I MODELLING IN PERFORMANCE PARAMETER

Modelling Vehicle Acceleration - Acceleration performance parameters, modelling the acceleration of an electric scooter, modelling the acceleration of a small car.

UNIT – II MODELLING OF BATTERY ELECTRIC VEHICLES

Electric Vehicle Modelling - Tractive Effort, Rolling resistance force, Aerodynamic drag, Hill climbing force, Acceleration force, Total tractive effort, Modelling Electric Vehicle Range - Driving cycles, Range modelling of battery electric vehicles, Constant velocity range modelling, Range modelling of fuel cell vehicles, Range modelling of hybrid electric vehicles.

UNIT – III DRIVE TRAIN CHARACTERISTICS

Modelling and Characteristics of EV/HEV Powertrains Components- ICE Performance Characteristics, Electric Motor Performance Characteristics - Battery Performance Characteristics-Transmission and Drivetrain Characteristics-Regenerative Braking Characteristics-Driving Cycles Modelling and Analysis of Electric and Hybrid Electric Vehicles Propulsion and Braking - Longitudinal Dynamics Equation of Motion - Vehicle Propulsion Modelling and Analysis - Vehicle Braking Modelling and Analysis.

UNIT – IV ENERGY MANAGEMENT

Handling Analysis of Electric and Hybrid Electric Vehicles - Simplified Handling Models Energy/Power Allocation and Management - Power/Energy Management Controllers - Rule-Based Control Strategies - Optimization-Based Control Strategies.

UNIT – V VEHICLE DYNAMIC CONTROL

Control of Electric and Hybrid Electric Vehicle Dynamics - Fundamentals of Vehicle Dynamic Control (VDC) Systems, VDC Implementation on Electric and Hybrid Vehicles – Case Studies, Rechargeable Battery vehicles, Hybrid Vehicles, Fuel Cell Powered Bus.

Simulation Tools: Matlab/Simulink, ADVISOR and AVL Cruise.

CO	COURSE OUTCOMES	PO
Upon completion of this course, Students should be able to		
1.	Understand the modelling of vehicle performance parameters.	
2.	Model battery electric vehicles.	
3.	Describe the drivetrain characteristics.	
4.	Apply the concepts of energy management system.	
5.	Explain the vehicle dynamic control systems.	

TEXT BOOK	
1.	James Larminie, John Lowry, "Electric Vehicle Technology Explained", John Wiley & Sons Ltd, 2003.
2.	Amir Khajepour, Saber Fallah and AvestaGoodarzi, "Electric and Hybrid Vehicles-Technologies, Modelling and Control: A Mechatronic Approach", John Wiley & Sons Ltd, 2014.
REFERENCES	
1.	Antoni Szumanowski, "Hybrid Electric Power Train Engineering and Technology: Modelling, Control, and Simulation", IGI Global, 2013.
2.	Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles_ Fundamentals, Theory, and Design, Second Edition", CRC Press, 2010.

Course Title	ELECTRO-CHEMISTRY OF FUEL CELLS	Credits	L T P C
Course Code			3 0 0 3
Course Category			
Learning Level			

OBJECTIVES

- To study about the various types of fuel cells
- To understand the thermodynamics of fuel cells
- To understand the electro chemistry concept of fuel cells.
- To study the performance characteristics of fuel cell.
- To know about hydrogen fueling.

UNIT – I INTRODUCTION OF FUEL CELLS

Introduction-working and types of fuel cell-Low, medium and high temperature fuel cell, Liquid and methanol types, Proton exchange fuel cell solid oxide, hydrogen fuel cells-Thermodynamics and electrochemical kinetics of fuel cells. (5)

UNIT – II THERMODYNAMICS

Enthalpy change of a reacting system, systematic Gibbs free energy, Ideal efficiency of the energy conversion, energy balance in fuel cells (8)

UNIT – III ELECTRO CHEMISTRY

Nernst equation, relation of the fuel consumption versus current output, stoichiometric coefficients and utilization percentages of the fuel and oxygen, mass flow rate calculation for fuel and oxygen in single cell and fuel cell stack, total voltage and current for fuel cells in parallel and serious connection, over-potential and polarizations, DMFC operation scheme, generous issues -water flooding and water management, polarization in PEMFC.

UNIT – IV FUEL CELL COMPONENTS AND THEIR IMPACT ON PERFORMANCE

Fuel cell performance characteristics- Current/voltage, voltage efficiency and power density, Ohmic resistance, Kinetic performance, mass transfer effects-membrane electrode assembly components, fuel cell stacks, bi-polar plate, humidifiers and cooling plates. (12)

UNIT – V FUELING

Hydrogen storage technology-pressure cylinders, liquid hydrogen, metal hydrides, methods of hydrogen production, carbon fibres-reformer technology- steam reforming, partial oxidation, auto thermal reforming-CO removal, fuel cell technology based on removal like bio-mass. (8)

CO	COURSE OUTCOMES	PO
Upon completion of this course, Students should be able to		
1.	Explain the various types of fuel cells.	
2.	Leant the thermodynamics background of fuel cells.	
3.	Gain understanding the fundamental concepts of electro chemistry fuel cells.	
4.	Understand the performance behavior of fuel cell.	
5.	Know the various technology of hydrogen fueling.	

TEXT BOOK	
1.	Frano Babir, "PEM FUEL CELLS: Theory and Practice", Elsevier Academic Press, USA, 2005.
2.	Viswanathan B. and Scibioh Aulice M, "Fuel cells: Principles and Applications", University Press, 2006.
REFERENCES	
1.	Fuel cells for automotive applications - professional engineering publishing UK, 2004.
2.	Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay and Ali Emadi, "Modem Electric, Hybrid Electric and Fuel cell Vehicles", Fundamental, Theory and design", CRS Press, 2004.
3.	Fuel cell Technology Handbook SAE International Gregor Hoogers CRC Press, 2003.
4.	Young G J, "Fuel cells", Rein hold publishing Copr., 1960.

Course Title	TESTING AND CERTIFICATION OF ELECTRIC HYBRID VEHICLES	Credits	L T P C
Course Code			3 0 0 3
Course Category			
Learning Level			

OBJECTIVES

- To gain knowledge in the field of E-vehicle certification.
- To understand the concept of static testing of E-vehicle.
- To understand the concept of dynamic testing of E-vehicle.
- To study about various E-vehicle component testing.
- To understand the fundamentals of charging station & hybrid electric vehicle testing.

UNIT – I INTRODUCTION

Specification & Classification of Vehicles (including M, N and O layout), Homologation & its types, Regulations overview (EEC, ECE, FMVSS, AIS, CMVR), Type approval Scheme, Homologation for export, Conformity of Production, various Parameters, Instruments and Types of test tracks, Hardware in The Loop (HIL) concepts for EV/HEVs.

UNIT – II STATIC TESTING OF VEHICLE

Photographs, CMVR physical verification, Tyre Tread Depth Test, Vehicle Weightment, Horn installation, Rear view mirror installation, Tell Tales, External Projection, Wheel Guard, Arrangement of Foot Controls for M1 Vehicle, Angle & Dimensions Measurement of Vehicle, The requirement of temporary cabin for drive–away – Chassis, electric vehicle – Safety norms, Energy consumption and power test.

UNIT – III DYNAMICS TESTING OF VEHICLE

Hood Latch, Gradeability, Pass-by Noise, Interior Noise, Turning Circle Diameter & Turning Clearance Circle Diameter, Steering Effort, Constant Speed Fuel Consumption, Cooling Performance, Speedo-meter Calibration, Range Test, Maximum Speed, Acceleration Test, Coast-down test, Brakes Performance ABS Test, Broad band / Narrow band EMI Test, Electric vehicle – Range Test.

UNIT – IV VEHICLE COMPONENT TESTING

Horn Testing, Safety Glasses Test: Windscreen laminated and toughened safety glass, Rear View Mirror Test, Hydraulic Brakes Hoses Fuel Tank Test: Metallic & Plastic, Hinges and Latches Test, Tyre & Wheel Rim Test, Bumper Impact Test, Side Door Intrusion, Crash test with dummies, Demist test, Defrost Test, Interior Fittings, Steering Impact test (GVW<1500 kg), Body block test, Head form test, Driver Field of vision, Safety belt assemblies, Safety belt anchorages, Seat anchorages & head restraints test, Airbag Test, Accelerator Control System, Motor power, Safety Requirements of Traction Batteries, EMI-EMC (CI, BCI, RE,RI and CTE).

UNIT – V TESTS FOR HYBRID ELECTRIC VEHICLES, RETRO-FITMENT AND CHARGING STATION

Hybrid Electric Vehicles Tests (M and N category), Tests for Hybrid Electric System Intended for Retro-fitment on Vehicles of M and N Category (GVW < 3500 kg), Test for Electric Propulsion kit intended for Conversion, Test for Electric Vehicle Conductive AC Charging System, and Test for Electric vehicle conductive DC charging system.

E-VEHICLES - REGULATIONS 2019

CO	COURSE OUTCOMES	PO
Upon completion of this course, Students should be able to		
1.	Gain knowledge in the field of E-vehicle certification.	
2.	Explain the concept of static testing of E-vehicle.	
3.	Explain the concept of dynamic testing of E-vehicle.	
4.	Know about various E-vehicle component testing.	
5.	Gain the insight of charging station & hybrid electric vehicle testing.	
TEXT BOOK		
1.	"Vehicle Inspection Handbook", American Association of Motor Vehicle Administrators	
2.	Michael Plint & Anthony Martyr, "Engine Testing & Practice", Butterworth Heinmenn, 3rd ed, 2007	
REFERENCES		
1.	Proceedings- Automotive Testing & Certification held on 20th to 24th July 2010 at ARAI, PUNE	
2.	Bosch Automotive Handbook, Robert Bosch, 7th Edition, 2007.	

Course Title	MODELLING AND SIMULATION OF EHV LAB	Credits	L T P C
Course Code			0 0 3 2
Course Category			
Learning Level			

OBJECTIVES
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Vehicle Dynamics Fundamentals for HEV Modeling and Computer Simulation (MATLAB/Simulink)	
1.	Various strategies for improving vehicle energy/fuel efficiency
2.	Vehicle chassis mathematical model in various operation conditions (steady motion, acceleration, regenerating braking, coasting, moving up and down a hill)
3.	Series HE powertrain mathematical model
4.	Computer model of the HEV
5.	Computer Workshop. Fuel efficiency evaluation of a series HEV in city and high-way cycles: study and analyze two strategies for ICE/Battery power split.
Vehicle Testing Laboratory Works	
•	4x4 Vehicle Chassis Dynamometer: Power Curve Test

CO	COURSE OUTCOMES	PO
Upon completion of this course, Students should be able to		
1.		
2.		
3.		
4.		
5.		

TEXT BOOK	
1.	Advanced Practical Physical Chemistry, J.B.Yadhav, Krishna Prakasan Media, 2016.
2.	Experiments in Applied Chemistry, Sunita Rattan, S.K. Kataria& Sons, 2012