Course Code: EEE302	**Course Title: Electrical Machine Design** **Type of Course: Discipline Elective and Theory only**			**L- T- P- C**	3	0	0	3
Version No.	2.0							
Course Pre-requisites	Electrical Machine I and Electrical machines II courses, Knowledge on working, construction, operating characterises and applications of machines. Basics of MATLAB and CAD Software.							
Anti-requisites	**Nil**							
Course Description	This course provides basic knowledge of the preliminary design of rotating DC and AC electrical machines by applying fundamental knowledge of physical and mathematical principles that have been established and considering economic aspects. This includes the design of DC machines, transformers, the design of induction motors and the design of synchronous machines. Also, the course develops critical thinking and analytical skills. The course also enhances programming and drawing skills through modern tools.							
Course Objective	The objective of the course is to familiarize the learners with the concepts of electrical machine design and attain **Entrepreneurial Skills** through **Problem Solving** methodologies.							
Course Out Comes	**On successful completion of the course the students shall be able to:** 1. Discuss briefly design factors, limitations, and properties of materials used in the electrical machines. 2. Derive the output equations of transformer, DC machines. 3. Compute the necessary parameters for designing of various parts of Transformers. 4. Compute the necessary parameters for designing of 3 phase induction motors. 5. Compute the necessary parameters for designing of synchronous machine.							
Course Content:								
Module 1	Basic Considerations of Electrical Machine Design	Assignment	Data Collection	**8 Sessions**				
Topics: Fundamental aspects, Electrical Conducting Materials, Insulating Materials, Classification of Insulating materials based on Thermal Consideration. Factors for consideration in electrical machine design								
Module 2	Design of DC Machines	Assignment	CAD Modelling	**9 Sessions**				
Topics: Output Equation, Choice of Specific Loadings, Choice of Number of Poles, Main Dimensions of armature, Design of Armature Slot Dimensions, Commutator and Brushes. Dimensions of Yoke, Main Pole and Air Gap. Design of Shunt and Series Field Windings.								
Module 3	Design of Transformer	Assignment	Open book Test	**9 Sessions**				
Topics: Introduction, Design details of Single Phase and Three phase Transformer, Design of core, Design of windings- Estimation of Number of Turns and Conductor Cross Sectional area of Primary and Secondary Windings, Design of yoke. Design of Tank and Cooling (Round and Rectangular) Tubes								
Module 4	Design of Three Phase Induction Motors	Assignment	Quiz	**9 Sessions**				
Topics: Design Details, choice of specific loading Main Dimensions of Stator. Design of stator slots and Winding, Choice of Length Air Gap, Estimation of Number of Slots for Rotor.								
Module 5	Design of Synchronous Machines Analysis	Assignment	CAD Modelling	**9 Sessions**				

Topics: Output Equation, Choice of Specific Loadings, Main Dimensions of Stator. Design of stator slots and Winding. Magnetic Circuit & Field Winding, Design of Salient and non- salient Pole Rotors.

Targeted Application & Tools that can be used:

Design of electrical machines for various applications. Professionally Used Software: CAD/ MATLAB/ C/C++

Text Book

1. A.K Sawhney. A course in Electrical Machine Design Dhanpat Rai & Co . New Delhi

References

1. Performance and Design of AC machines by M.G. Say,CBS publishers and Distributors pvt.Ltd.
2. V. N. Mittle, "Design Of Electrical Machines", N.C. Jain Publishers
3. Class Notes

Online Resources

1. EBook: https://puniversity.informaticsglobal.com/
2. Seminar: https://onlinecourses.nptel.ac.in/noc19_e62/
3. Case Study: http://www.eols.net/sample-chapters/c05/6-39a-06-02.pdf.
4. https://www.ebookmela.co.in/download/electrical-machine-design-by-mittle

Topics relevant to "ENTREPRENEURIAL SKILLS": Designing of various machines armature winding for developing **Entrepreneurial Skills** through **Problem Solving methodologies**. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	**Mr. Ravi V Angadi**
Recommended by the Board of Studies on	BoS No: 15th BoS held on 27/7/2022
Date of Approval by the Academic Council	18th Academic Council Meeting held on 03/08/2022

REGISTRAR

PRESIDENCY UNIVERSITY Registrar BANGALORE

PRESIDENCY UNIVERSITY

(Established under the Presidency University Act, 2013 of the Karnataka Act 41 of 2013)

SCHOOL	**: Engineering**
DEPARTMENT	**: Electrical & Electronics Engineering.**
DATE OF ISSUE	**: 27.08.2022**
NAME OF THE PROGRAM	**: B. Tech (EEE)**
P.R.C. APPROVAL REF.	**: PU/AC-18.5/EEE 15/EEE/2019-2023**
NAME OF THE COURSE	**: ELECTRICAL MACHINE DESIGN.**
COURSE CODE	**: EEE302**
SEMESTER	**: 7th (7EEE)**
YEAR	**: 4th**
COURSE CREDIT STRUCTURE	**: 3-0-0-3**
CONTACT HOURS	**: 3 Hours/ week**
COURSE INSTRUCTOR IN CHARGE	**: Mr. Ravi V Angadi.**

PROGRAM OUTCOMES:

Graduates of the B. Tech. Program in Electronics and Communication Engineering will be able to:

PO1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. [H].

PO2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. [H]

PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations [L].

PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions [L].

PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations [M].

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PO6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings**.**

PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. [L]

PO11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

COURSE PREREQUISITES:

Electrical Machine I and Electrical machines II courses, Knowledge on working, construction, operating characterises and applications of machines. Basics of MATLAB and CAD Software.

COURSE DESCRIPTION:

This course provides basic knowledge of the preliminary design of rotating DC and AC electrical machines by applying fundamental knowledge of physical and mathematical principles that have been established and considering economic aspects. This includes the design of DC machines, transformers, the design of induction motors and the design of synchronous machines. Also, the course develops critical thinking and analytical skills. The course also enhances programming and drawing skills through modern tools.

COURSE OBJECTIVE:

The objective of the course is to familiarize the learners with the concepts of electrical machine design and attain **Entrepreneurial Skills** through **Problem Solving** methodologies.

COURSE OUTCOMES:

After the completion of the course students shall be able to:

CO 1: **Discuss** briefly design factors, limitations, and properties of materials used in the electrical machines.
CO 2: **Derive** the output equations of transformer, DC machines.
CO 3: **Compute** the necessary parameters for designing of various parts of Transformers.
CO 4: **Compute** the necessary parameters for designing of 3 phase induction motors.
CO 5: **Compute** the necessary parameters for designing of synchronous machine.

MAPPING OF C.O. WITH P.O.
[H-HIGH, M- MODERATE, L-LOW]

CO NO.	PO 1	PO 2	PO 3	PO 4	PO 5	PO 10
1	H	H	L	L	M	L
2	H	H	L	L	M	L
3	M	M	M	M	M	L

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4	M	L	L	L	L	L
5	M	L	L	L	L	L

COURSE CONTENT (SYLLABUS):

Module: 1:

Basic Considerations of Electrical Machine Design: Introduction, Fundamental aspects, Electrical Conducting Materials, Insulating Materials, Classification of Insulating materials based on Thermal Consideration. Factors for consideration in electrical machine design

[08-Hrs] [Blooms 'level selected: Comprehension]

Module: 2

Design of DC Machines: Output Equation, Choice of Specific Loadings, Choice of Number of Poles, Main Dimensions of armature, Design of Armature Slot Dimensions, Commutator and Brushes. Dimensions of Yoke, Main Pole and Air Gap. Design of Shunt and Series Field Windings.

[09-Hrs] [Blooms 'level selected: Application]

Module: 3:

Design of Transformer: Introduction, Design details of Single Phase and Three phases Transformer, Design of core, Design of windings- Estimation of Number of Turns and Conductor Cross Sectional area of Primary and Secondary Windings, Design of yoke. Design of Tank and Cooling (Round and Rectangular) Tubes.

[09-Hrs] [Blooms 'level selected: Application]

Module: 4:

Design of Three Phase Induction Motors: Design Details, choice of specific loading Main Dimensions of Stator. Design of stator slots and Winding, Choice of Length Air Gap, Estimation of Number of Slots for Rotor. Introduction to design of Synchronous Machines.

[09-Hrs] [Blooms 'level selected: Comprehension]

Module: 5:

Design of Synchronous Machine: Output Equation, Choice of Specific Loadings, Main Dimensions of Stator. Design of stator slots and Winding. Design of Salient and non- salient Pole Rotors.

[08-Hrs] [Blooms 'level selected: Comprehension]

DELIVERY PROCEDURE (PEDAGOGY):

Self-Learning Topics:

a. Magnetic Materials, Ferromagnetic Materials: Soft Magnetic materials – Solid Core Materials.
b. Electrical Sheet and Strip.
c. Cold Rolled Grain Oriented Steel

Experiential Learning Topics:

Computer applications in electrical machine design

Technology Enabled Learning:

a. Conducting a Continuous Assessment using Edhitch & Microsoft Team.
b. Design of Armature winding of using AUTOCAD software.

Some of the Topics are planned covered through Guest lecture by Industry Experts.

REFERENCE MATERIALS:

A). Textbooks:

T1: A.K Sawhney. A course in Electrical Machine Design Dhanpat Rai & Co . New Delhi

B). Reference books:

R1. Performance and Design of AC machines by M.G. Say, CBS publishers and Distributors pvt. Ltd.
R2. V. N. Mittle, "Design Of Electrical Machines", N.C. Jain Publishers
R3. Class Notes

C). Online Resources:

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5. EBook: https://puniversity.informaticsglobal.com/
6. Seminar:https://onlinecourses.nptel.ac.in/noc19_e62/
7. Case Study:http://www.eols.net/sample-chapters/c05/6-39a-06-02.pdf.
8. https://www.ebookmela.co.in/download/electrical-machine-design-by-mittle

GUIDELINES TO STUDENTS:

i. Maintain a separate 200 page note book for class notes.

ii. Be regular to all the classes and maintain minimum 90% of attendance.

iii. Bring Scientific Calculator to the class.

iv. Refer online study materials and videos are suggested to watch in the NTPEL site.

SCHEDULE OF INSTRUCTION:

Sl. No	Session No [date if possible]	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1.		Program Integration & Course Integration	Overview of the Course, Scopes and Opportunities of EMD	-	-	-
2.	S1	Module No. 1 Basic Considerations of Electrical Machine Design	Course Integration & Introduction	CO1	PPT	T1.Ch 1
3.	S2	Basic Considerations of Electrical Machine Design	Introduction to Design of Machines, Design Factors	CO1	PPT	T1.Ch 1
4.	S3	Basic Considerations of Electrical Machine Design	Factors for consideration in electrical machine design	CO1	PPT	T1.Ch 1
5.	S4	Basic Considerations of Electrical Machine Design	Electrical Conducting Materials, Insulating Materials	CO1	PPT	T1.Ch 1
6.	S5	Basic Considerations of Electrical Machine Design	Desirabilities of Conducting Materials. Comparison of Aluminium and Copper wires	CO1	PPT	T1.Ch 1
7.	S6	Basic Considerations of Electrical Machine Design	Classification of Insulating materials based on Thermal Consideration	CO1	PPT	T1.Ch 1
8.	S7	Basic Considerations of Electrical Machine Design	Insulating Materials,Desirable Properties, Temperature Rise	CO1	PPT	T1.Ch 1

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			and Insulating Materials			
9.	S8	Basic Considerations of Electrical Machine Design	Limitations in design			
10.	CA1	MCQ/ Quiz		CO1		
11.	S9	Module No. 2 Design of DC Machines	Course Integration & Introduction	CO2	Chalk & Talk	T1. Ch2
12.	S10	Design of DC Machines	Output Equation, Choice of Specific Loadings	CO2	Chalk & Talk	T1. Ch2
13.	S11	Design of DC Machines	Choice of Number of Poles, Main Dimensions of armature	CO2	Chalk & Talk	T1. Ch2
14.	S12	Design of DC Machines	Design of Armature Slot Dimensions	CO2	Chalk & Talk	T1. Ch2
15.	S13	Design of DC Machines	Design of Commutator and Brushes	CO2	Chalk & Talk	T1. Ch2
16.	S14	Design of DC Machines	Design of Dimensions of Yoke, Main Pole and Air Gap	CO2	Chalk & Talk	T1. Ch2
17.	S15	Design of DC Machines	Design of Shunt and Series Field Windings.	CO2	Chalk & Talk	T1. Ch2
18.	S16	Design of DC Machines	Numerical solving based on DC Machine design	CO2	Chalk & Talk	T1. Ch2
19.	S17	Design of DC Machines	Numerical solving based on DC Machine design	CO2	Chalk & Talk	T1. Ch2
20.	CA1	Model Design		CO2		
21.	S18	Module No. 3 Design of Transformer	Course Integration & Introduction	CO3	Chalk & Talk / Industrial Visit	T1 Ch5
22.	S19	Design of Transformer	Design details of Single Phase and Three phases Transformer	CO3	Chalk & Talk / Industrial Visit	T1 Ch5
23.	S20	Design of Transformer	Choice of Specific Loadings, Expression for Volts/Turn	CO3	Chalk & Talk / Industrial Visit	T1 Ch5
24.	S21	Design of Transformer	Design of transformer core	CO3	Chalk & Talk / Industrial Visit	T1 Ch5

25.	S22	Design of Transformer	Estimation of Number of Turns and Conductor Cross Sectional area of Primary and Secondary Windings	CO3	Chalk & Talk / Industrial Visit	T1 Ch5
26.	S23	Design of Transformer	Estimation of Number of Turns and Conductor Cross Sectional area of Primary and Secondary Windings	CO3	Chalk & Talk / Industrial Visit	T1 Ch5
27.	S24	Design of Transformer	Design of yoke. Design of Tank and Cooling (Round and Rectangular) Tubes	CO3	Chalk & Talk / Industrial Visit	T1 Ch5
28.	S27	Design of Transformer	Numerical solving based on transformer design	CO3	Chalk & Talk / Industrial Visit	T1 Ch5
29.	S27	Design of Transformer	Numerical solving based on transformer design	CO3	Chalk & Talk / Industrial Visit	T1 Ch5
30.	CA3	Case Study		CO3		
31.	S28	Module No. 4 Design of Three Phase Induction Motors	Course Integration & Introduction	CO4	Chalk & Talk	T1 Ch11
32.	S29	Design of Three Phase Induction Motors	Design Details, choice of specific loading.	CO4	Chalk & Talk	T1 Ch11
33.	S30	Design of Three Phase Induction Motors	Main Dimensions of Stator.	CO4	Chalk & Talk	T1 Ch11
34.	S31	Design of Three Phase Induction Motors	Design of stator slots and Winding, Choice of Length Air Gap	CO4	Chalk & Talk	T1 Ch11
35.	S32	Design of Three Phase Induction Motors	Estimation of Number of Slots for Rotor	CO4	Chalk & Talk	T1 Ch11
36.	S33	Design of Three Phase Induction Motors	Estimation of Number of Slots for Squirrel Cage Rotor.	CO4	Chalk & Talk	T1 Ch11
37.	S34	Design of Three Phase Induction Motors	Design of Rotor Bars and End Ring	CO4	Chalk & Talk	T1 Ch11

38.	S35	Design of Three Phase Induction Motors	Numerical solving based on Induction Motor design	CO4	Chalk & Talk	T1 Ch11
39.	S36	Design of Three Phase Induction Motors	Numerical solving based on Induction Motor design	CO4	Chalk & Talk	T1 Ch11
40.	CA4	Open Book test		CO4		
41.	S37	Module No. 5 Design of Synchronous Machine	Program Integration & Introduction	CO5	Chalk & Talk	T1 Ch11
42.	S38	Design of Synchronous Machine	Output Equation, Choice of Specific Loadings	CO5	Chalk & Talk	T1 Ch11
43.	S39	Design of Synchronous Machine	Main Dimensions of Stator	CO5	Chalk & Talk	T1 Ch11
44.	S40	Design of Synchronous Machine	Design of stator slots and Winding	CO5	Chalk & Talk	T1 Ch11
45.	S41	Design of Synchronous Machine	Magnetic Circuit & Field Winding	CO5	Chalk & Talk	T1 Ch11
46.	S42	Design of Synchronous Machine	Design of Salient and non- salient Pole Rotors	CO5	Chalk & Talk	T1 Ch11
47.	S43	Design of Synchronous Machine	Numerical solving based on Synchronous Machine design	CO5	Chalk & Talk	T1 Ch11
48.	S44	Design of Synchronous Machine	Numerical solving based on Synchronous Machine design	CO5	Chalk & Talk	T1 Ch11
49.	S45	Design of Synchronous Machine	Numerical solving based on Synchronous Machine design	CO5	Chalk & Talk	T1 Ch11

Topics relevant to "ENTREPRENEURIAL SKILLS": Designing of various machines armature winding for developing **Entrepreneurial Skills** through **Problem Solving methodologies**. This is attained through the **Assignment** as mentioned in the assessment component.

ASSESSMENT SCHEDULE:

Sl.no	Assessment type	contents	Course outcome Number	Duration In Minutes	Marks	Weightage	Venue, Date & Time
1	Assignment-I (Calculations of machine parameters)	Module-1	CO1 & 2	60	10	5%	MS Teams

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3	Assignment-II (Model Design)	Module-2	CO3	60	10	5%	Edhitch
4	Midterm Examination	Module- 3 & 4th Module half	CO 4 & CO 5	90	60	30%	Notify later
5	Assignment-III (Case study)	**M**odule-3	CO 4	60	10	5%	MS Teams
6	Assignment-IV (Open Book Test)	**M**odule-4	CO 5	60	10	5%	MS Teams
7	End Term Final Examination	Module-1,2,3 & 4	CO1, CO2, CO3, CO4 & CO5	180	100	50%	Notify later

COURSE CLEARANCE CRITERIA:

i. Minimum of 75% Attendance is most to take up examination.
ii. Minimum of 40% score is must in internal assessment.
iii. Minimum of 30% in the Final Examination.
iv. Make-up policy will be only as per academic regulation.
v. There will be no make-up for ASSIGNMENT and QUIZ

CONTACT TIMINGS IN THE CHAMBER FOR ANY DISCUSSIONS:

It will be announced in the class. Interested students may meet the Instructor In-charge during the Chamber Consultation Hour to clear doubts.

SAMPLE THOUGHT PROVOKING QUESTIONS

Sl. No	Question	Marks	CO No	Bloom's Level
1	Discus the factors which imposes limitation on electrical machine design	05	CO 1	Knowledge
2	Briefly discuss the various factors need to be consider during the selection of Specific magnetic and electric loading.	05	CO 1	Comprehension
3	Summaries the advantages of large length of air gap in DC machine and derive how to design the air gap length in dc machine	05	CO 2	Comprehension
4	A 350 kW, 500 Volts, 450 rpm, 6-pole dc generator is built with an armature diameter of 0.87 mt and core length of 0.32 mt. The lap wound armature has 660 conductors.Estimate the specific electric loading and magnetic loading	10	CO 2	Comprehension
5	The tank of 1250 kVA, natural oil cooled transformer has the dimension length, width and height as 0.65x1.55x1.85mt respectively. The full load loss is 13.1 kW, loss dissipation due to radiation is 6w/m ˚c, loss dissipation due to convection is 6.5 6w/m-˚c, improvement in convection due to provision of tubes is 40%, temp rise=40 °C, length of each tube is 1mt, diameter is 50mm, Estimate the number of tubes for this transformer, neglect the top and bottom surface of the tank as regards the cooling.	10	CO 3	Comprehension

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6	A 250 kVA, 6600/400 V, 3-ϕ, core type transformer has a total loss of 4800 watts on full load. The transformer tank is 1.25mt in height and 1mtx0.5mt in plan. Design a suitable scheme for cooling tubes if the average temp rise is to be limited to 35°C. The diameter of the tube is 50mm and are spaced 75mm from each other. The average length of the tube is 0.15mt.	10	CO 3	Comprehension
7	Estimate the main dimensions of, air gap, stator slots, stator turns/phase and cross sectional area of stator and conductors for a three phase 15HP, 400 V, 6-Pole, 50 Hz, 975 rpm Induction motor is suitable for Star-Delta starting. Bav=0.45 Wb/mt2, ac=20000, amp-Cond/mt, L/τ=0.85, η=0.9, power factor=0.85, Kw=0.96.	10	CO4	Comprehension
8	Identify and list out the various factors that should be considered while the choice of length of air gap in the Induction motor	05	CO4	Comprehension
9	For a 250 kVA, 1100 Volts, 12 Pole, 500 rpm, 3-ϕ alternator is having the air gap density is 0.6 Wb/mt2 and Specific electrical loading is 30,000 Amp-Cond /mt and L/τ=1.5. Estimate the air gap diameter, core length, number of stator conductors, number of stator slots and cross section of stator conductor.	10	CO5	Comprehension
10	5. With usual notations derive an Output equation of Synchronous machine in terms of its main dimensions and specific loadings	05	CO5	Comprehension

Target Set For Course Outcome Attainment:

Sl. No	**C.O. No.**	**Course Outcomes**	**Target set for attainment in percentage**	**Actual C.O. Attainment In Percentage**	**Remarks on attainment & Measures to enhance the attainment**
01	CO1	Discuss briefly design factors, limitations, and properties of materials used in the electrical machines.	50%		
02	CO2	Derive the output equations of transformer, DC machines.	40%		
03	CO3	Compute the necessary parameters for designing of various parts of Transformers	40%		
04	CO4	Compute the necessary parameters for designing of 3 phase induction motors.	50%		
05	CO5	Compute the necessary parameters for designing of synchronous machine.	50%		

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Any specific suggestion/Observations on content/coverage/pedagogical methods used etc.:

Signature of the course Instructor
Mr. Ravi V Angadi

This course has been duly verified Approved by the D.A.C.

Signature of the Chairperson D.A.C.

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BANGALORE

Course Code: **EEE 319**	**Course Title: Electric Vehicles** **Type of Course: 1]. Discipline Elective** **2]. Theory only**	**L-T-P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Basics of Electric circuits, Fundamentals of DC and AC motors					
Anti-requisites						
Course Description	This course introduces the fundamental concepts, principles, analysis and design of hybrid and electric vehicles. This course helps students to understand vehicle mechanics and working of Electric Vehicles and recent trends. The course enables them to analyze different power converter topology used for electric vehicle applications. Also, it provides the ability to develop the electric propulsion unit and its control for application of electric vehicles through assignments. The course is both conceptual and analytical in nature and needs fair knowledge of mathematical and computing.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Electric Vehicles and attain **Entrepreneurial Skills** through **Problem Solving** methodologies.					
Course Out Comes	**On successful completion of the course the students shall be able to:** 1. Describe the importance and configurations of Electric Vehicles in recent trends 2. Discuss the design parameters of Electric Vehicles **3.** Summarize the properties of batteries and electric vehicle drive systems **4.** Explain different charging methods of Electric vehicles.					
Course Content:						
Module 1	Introduction To Electric Vehicles	Assignment	Computation and Data Analysis	**No. of Sessions: 6**		
Review of Conventional Vehicle, History of electric vehicles, impact of modern drive-trains on energy supplies, Types of EVs, Configurations and Architectures of EVs.						
Module 2	Design Parameters Of Electric Vehicles	Quiz	Data collection and Analysis	**No. of Sessions: 12**		
Introduction, dynamics of the vehicle, capacity and weight of the vehicle, torque and type of Motor used, speed required (during up-hill, down-hill and normal road), range of the vehicle, battery selection, Tractive effort in normal driving, Design prospects of EVs.						
Module 3	Energy Storage For Evs And Electric Propulsion Systems	Case study	Simulation and data analysis	**No. of Sessions:12**		
Energy storage requirements, Battery parameters, Types of Batteries, Super capacitors, Fuel Cell based energy storage and its analysis, SoC of batteries, Introduction to electric components, EV considerations, Configuration and control of DC motor drives, and AC motor drives						
Module 4	Power Converters For Battery Charging	ignment	collection	**No. of Sessions:10**		
CHAdeMO, Tesla, European EV Plug Standards, Charging methods and characteristics, V2G, G2V, V2B, V2H, isolated bidirectional DC-DC converter, and high frequency transformer based isolated charger topology.						
Targeted Application & Tools that can be used: Application: Automotive industry. Software tools: Matlab-Simulink						
Text Book 1.Mehrdad Ehsani, YiminGao, sebastien E. Gay and Ali Emadi, ―Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design‖, CRC Press, 2009.						

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2. Iqbal Husain, —Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2011, Second Edition.

References

1. James Larminie and John Loury, —Electric Vehicle Technology-Explained‖, John Wiley & Sons Ltd., 2003, Second Edition.
2. C.C. Chan and K.T. Chanu Modern Electric Vehicle Technology, OXFORD University, 2011
3. Sheldon S. Williamson,- Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Springer,2013
4. Chris Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011, Second Edition

Online learning resources:

1. https://nptel.ac.in/courses/108/102/108102121/
2. https://nptel.ac.in/courses/108/106/108106170/
3. IEEE Explore - School of Engineering
4. https://www.coursera.org/learn/electric-vehicles-mobility
5. Seminar:https://puniversity.informaticsglobal.com:2069/search/searchresult.jsp?newsearch=true&queryText=ELECTRIC%20VEHICLES
6. Video: https://www.youtube.com/watch?v=GHGXy_sjbgQ
7. Text book of Electric and Hybrid Vehicles : Power Sources, Models, Sustainability, Infrastructure and the Market, Gianfranco Pistoia, 1st ed. Amsterdam : Elsevier. 2010 https://puniversity.informaticsglobal.com:2284/ehost/detail/detail?vid=0&sid=52da4e6e-8813-45d5-87f9-73b9f493f358%40redis&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d#AN=342445&db=nlebk

Case Study:

I. **https://www.simpli.com/answers**
II. **https://www.upgrad.com/ev_technology/iit-delhi**
III. **https://www.coursera.org/**

Topics relevant to "ENTREPRENEURIAL SKILLS ": Vehicle fundamentals, total tractive effort calculation and design of drive train for different vehicle architectures for developing the **Entrepreneurial Skills** by using **Problem Solving** methodologies. This is attained through the assessment component mentioned in course handout.

Catalogue prepared by	Mr.K Sreekanth Reddy
Recommended by the Board of Studies on	BoS No: 12th BoS held on 27/7/2021
Date of Approval by the Academic Council	16th Academic Council meeting held on 23/10/2021

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PRESIDENCY UNIVERSITY

(Established under the Presidency University Act, 2013 of the Karnataka Act 41 of 2013)

A-2[2020] COURSE HAND OUT

SCHOOL: Engineering **DEPT.: EEE** **DATE OF ISSUE: 11/03/2022**

NAME OF THE PROGRAM **: B.TECH (EEE)**

P.R.C. APPROVAL REF. **: PU/AC-16/EEE/2019-2023/2021**

SEMESTER/YEAR **: VI / 3rd**

COURSE TITLE & CODE **: Electric Vehicles & EEE 319**

COURSE CREDIT STRUCTURE **: 3-0-0-3**

CONTACT HOURS **: 3 (Mon 6th hr, Tue 2nd hr, Thu 3rd hr)**

COURSE INSTRUCTOR **: Mr. K Sreekanth Reddy**

COURSE URL **: https://www.edhitch.com/gotodashboard**

PROGRAM OUTCOMES:

Graduates of the B.Tech. Program in Electrical and Electronics Engineering will be able to:

PO1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.(H)

PO2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.(H)

PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.(L)

PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.(L)

PO6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.(L)

PO11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

COURSE PREREQUISITES:
Fundamental knowledge of power electronics, machines, control systems and drives.

COURSE DESCRIPTION:
This course introduces the fundamental concepts, principles, analysis and design of hybrid and electric vehicles. This course aids to understand vehicle mechanics and working of Electric Vehicles and recent trends. The course enables them to analyze different power converter topology used for electric vehicle applications. Also, it provides the ability to develop the electric propulsion unit and its control for application of electric vehicles through assignments. The course is both conceptual and analytical in nature and needs fair knowledge of mathematical and computing.

COURSE OBJECTIVE:
The objective of the course is to familiarize the learners with the concepts of Electric Vehicles and attain **Entrepreneurial Skills** through **Problem Solving** methodologies.

COURSE OUTCOMES: On successful completion of the course the students shall be able to:
1) Describe the importance and configurations of Electric Vehicles in recent trends
2) Discuss the design parameters of Electric Vehicles
3) Summarize the properties of batteries and electric vehicle drive systems
4) Explain different charging methods of Electric vehicles.

MAPPING OF C.O. WITH P.O. :
[H-HIGH, M- MODERATE, L-LOW]

C.O.N0.	P.O.01	P.O.02	P.O.03	P.O.05	P.O.10	P.O.012
1	H	H			L	
2	H	H	L			L
3	H	M			L	L
4	H	M	M	L	L	L

COURSE CONTENT (SYLLABUS):

MODULE: 1: INTRODUCTION TO ELECTRIC VEHICLES

History of electric vehicles, impact of modern drive-trains on energy supplies, Types of EVs, Configurations and Architectures of EVs. **[8-Hrs] [Blooms 'level selected: Knowledge]**

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MODULE: 2: DESIGN PARAMETERS OF ELECTRIC VEHICLES

Introduction, dynamics of the vehicle, capacity and weight of the vehicle, torque and type of Motor used, speed required (during up-hill, down-hill and normal road), range of the vehicle, battery selection, Tractive effort in normal driving, Design prospects of EVs

[13-Hrs] [Blooms 'level selected: Comprehension]

MODULE: 3: ENERGY STORAGE FOR EVS AND ELECTRIC PROPULSION SYSTEMS

Energy storage requirements, Battery parameters, Types of Batteries, Super capacitors, Fuel Cell based energy storage and its analysis, SoC of batteries, Introduction to electric components, EV considerations, Configuration and control of DC motor drives, AC motor drives. **[12-Hrs] [Blooms 'level selected: Comprehension]**

MODULE: 4: POWER CONVERTERS FOR BATTERY CHARGING

CHAdeMO, Tesla, European EV Plug Standards, Charging methods and characteristics, G2V, V2B, V2H, isolated bidirectional DC-DC converter, and high frequency transformer based isolated charger topology

[12Hrs] [Blooms 'level selected: Comprehension]

DELIVERY PROCEDURE (PEDAGOGY):

Topics for Self-Learning:

1. Battery management system.
2. Selection of wires for EVs.
3. Different types of controllers that are used in EVs.

Experiential Learning Topics:

1. Power converter based Charging method using MATLAB Simulink
2. Vehicle dynamics using MATLAB.

Note:

1. All the Topics will be covered through **Lecture Method.**
2. E-materials available at the website of NPTEL- http://nptel.ac.in/ https://www.coursera.org/learn/electric-vehicles-mobility

REFERENCE MATERIALS:

Textbooks:

T1: M. Ehsani, Y. Gao, S. Gay and Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, CRC Press, 2005

T2: Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.

Reference book(s):

R1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.

R2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

Other resources:

Reputed journal papers are to be referred.

1. https://nptel.ac.in/courses/108/102/108102121/
2. https://nptel.ac.in/courses/108/106/108106170/
3. IEEE Explore - School of Engineering
4. https://www.coursera.org/learn/electric-vehicles-mobility
5. Seminar:https://puniversity.informaticsglobal.com:2069/search/searchresult.jsp?newsearch=true&queryText=ELECTRIC%20VEHICLES
6. Video: https://www.youtube.com/watch?v=GHGXy_sjbgQ
7. https://presiuniv.knimbus.com/user#/home

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8. Text book of Electric and Hybrid Vehicles : Power Sources, Models, Sustainability, Infrastructure and the Market, Gianfranco Pistoia, 1st ed. Amsterdam : Elsevier. 2010 https://puniversity.informaticsglobal.com:2284/ehost/detail/detail?vid=0&sid=52da4e6e-8813-45d5-87f9-73b9f493f358%40redis&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d#AN=342445&db=nlebk

GUIDELINES TO STUDENTS: (Here mention a few tips to study this course effectively)

- The students are advised to be very much regular to the classes and sincerely attempt the learnings listed in the Pedagogical section.
- The students are advised to take down the notes legibly which serves as a firsthand information to study and revise lecture topics on day to day basis.
- The students are advised to visit the Edhitch portal and Microsoft teams on a regular basis to study the supporting materials shared by the course instructors.
- The students are advised to use the journals, technical magazines and other relevant materials.
- The students are advised to watch the video lectures available online to understand and review the concepts delivered in the class as well as problems assigned for self-learning topics.

COURSE SCHEDULE: (This is a macro level planning. Mention the unit wise expected starting and ending dates along with the tests/assignments/quiz and any other activities) [allot about 75% for delivary,about10 to 12% for Evaluation Discussion, about 10 to 15% on integrating the learning Modules within the course and to the program]

Sl. No.	ACTIVITY	STARTING DATE	CONCLUDING DATE	TOTAL NUMBER OF PERIODS
01	Program integration Over View of the course	24-03-2022	28-03-2022	02
02	**Module : 01**	28-03-2022	7-04-2022	06
03	Integration of module 2	11-4-2022	11-4-2022	01
04	**Module : 02**	12-04-2022	12-05-2022	08
05	**Test-1**	18-04-2022	20-04-2022	NA
06	Test-1 Paper Discussion	21-04-2022	21-04-2022	01
07	**Module : 02**	25-04-2022	12-05-2022	
08	Course Integration of Module:3	16-05-2022	16-05-2022	01
09	**Module:03**	17-05-2022	09-6-2022	6
10	Test-II	23-05-2022	26-05-2022	NA
11	Discussion of Test-2 paper	30-05-2022	30-05-2022	01
12	**Module:03**	31-05-2022	09-06-2022	
13	Case Study / Mini Project	31/3/2022	02/6/2022	NA
14	**Module 4** Course Integration	13-06-2022	20-06-2022	05
15	Program integration	20/06/2022	20/6/2022	
16	Quiz	May 1st week		01 Extra class

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SCHEDULE OF INSTRUCTION:

MODULE: 1: INTRODUCTION TO ELECTRIC VEHICLES

Sl. no	Session no	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	S1 24/3/2022	Program Integration				
2	S2 28/3/2022	Course Integration	Introduction to course		Lecture Mode	T1:Ch.1
3	S 3 29/3/2022	History of Modern Transportation	History of hybrid electric, electric and fuel cell vehicles	CO. 1	Lecture Mode	T1:Ch.1
4	S4 31-3-2022		Impact of different transportation technologies on environment and energy supply	CO. 1	Lecture Mode	T1:Ch.1
5	S5 4-4-2022		Types of EVs,	CO. 1	Lecture Mode	T1:Ch.1
6	S6 5-4-2022	EVs	Configurations of EVs	CO. 1	Lecture Mode	T1:Ch.5
7	S7 7-4-2022	EVs	Configurations of EVs	CO. 1	Lecture Mode	T1:Ch.5
8	S8 11-4-2022	**Hybrid Electric**	Architectures of Hybrid Electric Drive Trains	CO. 1	Lecture Mode	T1:Ch.6
Module 1 is completed						

MODULE: 2: DESIGN PARAMETERS OF ELECTRIC VEHICLES

Sl. no	Session no	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	**S9** **11-4-2022**	Course Integration	Introduction of Design parameters	CO. 2	Lecture Mode	Technical papers
2	**S10** **12-4-2022**		Test-1 paper Discussion			
3	**S11** **21-4-2022**		Dynamics of the vehicle	CO. 2	Lecture Mode	Technical papers
4	**S12** **25-4-2022**	Design parameters	capacity and weight of the vehicle,	CO. 2	Lecture Mode	Technical papers
5	**S13** **26-4-2022**		torque and type of Motor used	CO. 2	Lecture Mode	Technical papers
6	**S14** **28-4-2022**		speed required (during up-hill, down-hill and normal road),	CO. 2	Lecture Mode	Technical papers
7	**S15** **3-5-2022**		range of the vehicle, battery selection, Energy Consumption	CO. 2	Lecture Mode	Technical papers
8	**S16** **5-5-2022**		Tractive effort in normal driving	CO. 2	Lecture Mode	Technical papers
9	**S17** **6-5-2022**		Tractive effort in normal driving	CO. 2	Lecture Mode	Technical papers
10	**S18** **8-5-2022**		Design prospects of EVs	CO. 2	Lecture Mode	T1
11	**S19** **10-5-2022**		Design prospects of EVs	CO. 2	Lecture Mode	T1
			Vehicle dynamics using MATLAB.		Experiential learning	

Module 2 is completed

MODULE: 3: ENERGY STORAGE FOR EVS AND ELECTRIC PROPULSION SYSTEMS

Sl. no	Session no	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	**S20 12-05-2022**	Course Integration	Energy storage requirements			
2	S21 16-5-2022	Energy Storage	Battery parameters	CO. 3	Lecture Mode	T1.Ch.13
3	**S22 17-5-2022**		Types of Batteries	CO. 3	Lecture Mode	T1.Ch.13
4	**S23 19-5-22**		Test-2 Paper Discussion	CO. 3	Lecture Mode	T1.Ch.13
5	**S24 30-5-2022**		Super Capacitors	CO. 3	Lecture Mode	T1.Ch.13
6	**S25 31-5-2022**		Fuel Cell based energy storage and its analysis,	CO. 3	Lecture Mode	T1.Ch.13
7	**S26 1-06-2022**		SoC & DoD of batteries	CO. 3	Lecture Mode	T1.Ch.13
8	**S27 2-06-2022**	Electric Propulsion Systems	Introduction to electric components, EV Considerations	CO. 3	Lecture Mode	T1.Ch.7
9	**S28 6-6-2022**		Configuration and control DC motor drives	CO. 3	Lecture Mode	T1.Ch.7
10	**S29 7-6-2022**		Configuration and control AC motor drives	CO. 3	Lecture Mode	T1.Ch.7
	Self Learning Topic		Different types of controllers that are used in EVs.			Library IEEE Explore - School of Engineering https://puniversity.informaticsglobal.com/login

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			Case study/Mini project submission			
Module 3 is completed						

MODULE: 4: POWER CONVERTERS FOR BATTERY CHARGING

Sl. no	Session no	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	**S30 9-6-2022**	Course Integration	CHAdeMO, Tesla, European EV Plug Standards	CO .4	Lecture Mode	Technical papers
2	**S31 10-6-2022**		CHAdeMO, Tesla, European EV Plug Standards	CO .4	Lecture Mode	Technical papers
3	**S32 12-6-22**		Charging methods and characteristics	CO .4	Lecture Mode	Technical papers
4	**S33 13-6-2022**		Charging from Grid	CO .4	Lecture Mode	Technical papers
5	**S34 14-6-2022**	Charging Methods	**G2V, V2B, V2H**	CO .4	Lecture Mode	Technical papers
6	**S35 16-6-2022**		**G2V, V2B, V2H**	CO .4	Lecture Mode	Technical papers
7	**S36 17-06-2022**		isolated bidirectional DC-DC converter	CO .4	Lecture Mode	Technical papers
7	**S37 18-6-2022**		isolated bidirectional DC-DC converter	CO .4	Experiential mode	Technical papers
8	**S31 20-6-2022**		Overview of different Charging systems Program Integration	CO .4	Lecture Mode	Technical papers
Module 4 is completed						

Topics relevant to "ENTREPRENEURIAL SKILLS": Vehicle fundamentals, total tractive effort calculation and design of drive train for different vehicle architectures for developing the **Entrepreneurial Skills** by using **Problem Solving** methodologies. This is attained through the **Assignment** as mentioned in the assessment component.

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ASSESSMENT SCHEDULE:

Sl.no	Assessment type[Include here assessment method for self-learning component also]	contents	Course outcome Number	Duration In Hours	marks	weightage	Venue, DATE &TIME
1	Assignment 1 Problem Solving	Topic can be selected from any Module	CO 2 and CO 4	-	30	15%	4th Week of May 2022
2	Test 1	Module-1&2	CO1	1 hr	30	15%	18-04-2022 to 20-04-2022
3	Test 2	Module-2&3	CO2	1 hr	30	15%	23-05-2022 to 26-05-2022
4	Assignment 2 as self Learning topics Review of digital/e-resources from Pres. Univ.link given in the references section (Mandatory to submit the screenshots of accessing digital Resource. Otherwise it will not be evaluated	**https://puniversity.informaticsglobal.com/login**	CO3	-	10	05%	1st Week of May 2022

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5	End Term Final Examination	Module-1,2,3 & 4	CO1-CO4	3 hrs	100	50%	27-06-2022 to 09-07-2022

COURSE CLEARANCE CRITERIA: (Here mention the minimum requirements of attendance, marks in continuous assessment &term end examination, make up exam policy and other details as per the academic regulations & PRC):

- Minimum of 75% Attendance is must to take up examination.
- Minimum of 40% score is must in internal assessment.
- Minimum of 30% in the Final Examination
- Minimum of 40% AGGREGATE is must combining continuous assessment and End Term Final Examination.
- Make up policy is applicable only as per academic regulation
- There will be no make-up for ASSIGNMENT and QUIZ.

MAKEUP POLICY:

If the student misses an evaluation component, he/she may be granted a make-up. In case of an absence that is foreseen, make-up request should be personally made to the Instructor-in-Charge, well ahead of the scheduled evaluation component. Reasons for unanticipated absence that qualify a student to apply for make-up include medical emergencies or personal exigencies. In such an event, the student should contact the Instructor-in-Charge as soon as practically possible.

CONTACT TIMINGS IN THE CHAMBER FOR ANY DISCUSSIONS:

Interested students may contact the Instructor In-charge during the student free Hour and Wednesday, Friday 4:00 – 4:45 pm to clear doubts.

SAMPLE THOUGHT PROVOKING QUESTIONS: (Here type sample typical questions for students 'reference)

SL NO	QUESTION	MARKS	COURSE OUTCOME NO.	BLOOM'S LEVEL
1	Under what condition a pure EV can be chosen as a better option compared to hybrid vehicles considering the impact on climate change? Why? What are the social and environmental impacts of electric vehicles?	8 + 4	1	Knowledge
2	Draw the different configurations of drivetrains in electric vehicles. Briefly explain each configuration.	10	1	Comprehension
3	Briefly explain with appropriate expressions, what are the different forces acting on the electric Two-wheeler moving on a flat road with a velocity of V m/sec. (assume necessary data related to vehicle model and road profile)	10	2	Comprehension

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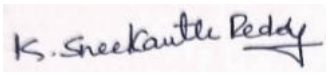
4	Name different types of energy sources used in electric vehicles and explain how to size the power supply for any given direct drive electric two or three wheelers?	10	3	Comprehension
5	Explain how to operate separately excited DC motor in four quadrant mode? Comment on the suitability of this motor in pure EV application?	10	3	Comprehension
6	Where does the battery charge, and how long does it take? Explain different charging methods.	10	4	Comprehension

Target set for course Outcome attainment:

Sl.no	C.O. No.	Course Outcomes	Target set for attainment in percentage
01	Co1	Describe the importance of Electric Vehicles in recent trends	50
02	Co2	Discuss the components of Electric Vehicles and Hybrid Electric Vehicles	55
03	Co3	Summarize the properties of batteries and electric vehicle drive systems	60
04	Co4	Explain different charging methods of Electric vehicles	65



Signature of the course Instructor

This course has been duly verified Approved by the D.A.C.

Signature of the Chairperson D.A.C.

Course Code: EEE3026	**Course Title:** Energy Audit and Demand side Management **Type of Course:** Discipline Elective & Theory only	**L- T- P- C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	EEE 2008 - Electrical Power Generation Transmission and Distribution Basic concepts of Power Generation and transmission and tariff schemes.					
Anti-requisites	**NIL**					
Course Description	Energy Audit helps to map the flow of energy (in its various forms) across the value chain, highlighting areas for interventions. It also introduces to the methods of evaluating lifetime of machine based on time value money and demand,economic analysis with repect to demand side management. This course is designed to develop analytical ability on the mechanism of energy audit and the technologies/simulation tools typically employed to undertake an audit exercise, supported by case studies & site visits.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Energy Audit and Demand side Management and attain **Entrepreneurial Skills** through **Problem Solving** methodologies.					
Course Outcomes	**On successful completion of this course the students shall be able to:** 1. Discuss the need of energy audit and energy audit methodology. 2. Explain audit parameters and working principles of measuring instruments used to measure the parameters. 3. Illustrate energy audit of boilers, furnaces, power plant, steam distribution system and compressed air systems. 4. Illustrate energy audit HVAC systems, motors, pumps, blowers and cooling towers. **5.** Explain load management techniques, effects of harmonics, electricity tariff, improvement of power factor and losses in transmission.					
Course Content:						
Module 1	**Energy Audit :Methodology and Types**	Assignment	Data Collection		**11 Sessions**	
Topics: Energy Scenarios: Energy Conservation, Energy Audit, Energy Scenarios, Energy Consumption, Energy Security, Energy Strategy, Codes, standards and Legislation. Definition of Energy Audit, Place of Audit, Energy – Audit Methodology, Financial Analysis, Sensitivity Analysis, Project Financing Options, Energy Monitoring and Training.						
Module 2	**Energy Audit: Boilers & Buildings**	Case Study/ Assignment	Data Collection/ Design		**9 Sessions**	
Topics: Classification of Boilers, Parts of Boiler, Efficiency of a Boiler, Role of excess Air in Boiler Efficiency, Energy Saving Methods. Energy Audit Applied to Buildings: Energy – Saving Measures in New Buildings, Water Audit, Method of Audit, General Energy – Savings Tips Applicable to New as well as Existing Buildings.						
Module 3	**Energy Audit of HVAC Systems**	Case study	Data Collection		**11 Sessions**	

Topics:
Introduction to HVAC, Components of Air – Conditioning System, Types of Air – Conditioning Systems, Human Comfort Zone and Psychrometry, Vapour – Compression Refrigeration Cycle, Energy Use Indices, Energy – Saving Measures in HVAC, Star Rating and Labelling by BEE.
Electrical-Load Management: Electrical Basics, Electrical Load Management, Variable- Frequency Drives, Harmonics and its Effects, Electricity Tariff, Power Factor.

Module 4	**Energy Audit: Motors, Lighting system and DSM**	Assignment/ Presentation	Data Collection / Estimation	**14 Sessions**

Topics: **Energy Audit of Lighting Systems:** Fundamentals of Lighting, Different Lighting Systems, Ballasts, Fixtures (Luminaries), Reflectors, Lenses and Louvres, Lighting Control Systems, Lighting System Audit, Energy Saving Opportunities. Demand side Management: Scope of DSM, Evolution of DSM concept, DSM planning and Implementation, Load management as a DSM strategy, Applications of Load Control, End use energy conservation, Tariff options for DSM.

Targeted Application & Tools that can be used:

Application Area is Power System Data collection, Electricity Transmission and Distributed companies, Power Grid and State Electricity Boards
Professionally Used Software: Mi Power/ PS CAD

Textbooks:

1. **"**Industrial Energy management systems" Array .C, White,Philip S, David R Brown, Hemisphere publishing corporation, New York.
2. "Handbook on Energy Audit "Sonal Desai McGraw Hill 1st Edition, 2015

References

1. "Energy management "by W.R. Murphy & G. Mckay Butter worth, Heinemann publications.

Online resources:

1. https://www.youtube.com/watch?v=iY2YaIlfEGk
2. https://vemu.org/uploads/lecture_notes/03_01_2020_1480276911.pdf
3. https://idoc.pub/documents/anilkumar-km-notes-for-energy-auditing-demand-side-management-unit1-1pdf-klzzqgxxpglg
4. Case study: A Research article onDemand Side Management: Demand Response, Intelligent Energy Systems, and Smart Loads
5. Ebook: https://puniversity.informaticsglobal.com:2069/document/7503335

Topics relevant to "ENTREPRENEURIAL SKILLS": The load Management techniques, effects of harmonics, electricity tariff, improvement of power factor and losses in transmission for developing **Entrepreneurial Skills** through **Problem Solving methodologies.** This is attained through assessment component mentioned in course handout.

Topics relevant to HUMAN VALUES and PROFESSIONAL ETHICS: Energy- Saving measures in New buildings, Audit, Saving Tips .

Catalogue prepared by	Ms. Ramya N
Catalogue Updated by	Mr. K Sreekanth Reddy

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Recommended by the Board of Studies on	BoS No: 12th BoS held on 27/7/2021
Date of Approval by the Academic Council	16th Academic Council Meeting held on 23/10/21

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PRESIDENCY UNIVERSITY

(Established under the Presidency University Act, 2013 of the Karnataka Act 41 of 2013)

A-2[2020] COURSE HAND OUT

SCHOOL: Engineering **DEPT.: EEE** **DATE OF ISSUE: 14-08-2021**

NAME OF THE PROGRAM : B.TECH (EEE)

P.R.C. APPROVAL REF. : PU/AC-16/EEE/2019-23/2021

SEMESTER/YEAR : V/3rd year

COURSE TITLE & CODE & EEE 328 : Energy Audit and Demand side Management

COURSE CREDIT STRUCTURE : 3-0-0-3

CONTACT HOURS : 3 hrs/week

COURSE INSTRUCTOR :

COIURSE URL : PROGRAM OUTCOMES:

Graduates of the B.Tech. Program in Electrical and Electronics Engineering will be able to:

PO1.Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.(H)

PO2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.(H)

PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.(L)

PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.(M)

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PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. (L)

PO11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. (L)

COURSE PREREQUISITES:

Basic concepts of Power Generation and transmission and tariff schemes.

COURSE DESCRIPTION:

Energy Audit helps to map the flow of energy in its various forms across the value chain, highlighting areas for interventions. It also introduces to the methods of evaluating lifetime of machine based on time value money and demand,economic analysis with repect to demand side management. This course is designed to develop analytical ability on the mechanism of energy audit and the technologies/simulation tools typically employed to undertake an audit exercise, supported by case studies & site visits.

COURSE OBJECTIVE:

The objective of the course is to familiarize the learners with the concepts of Energy Audit and Demand side Management and attain **Entrepreneurial Skills** through **Problem Solving** methodologies.

COURSE OUTCOMES: On successful completion of the course the students shall be able to:

6. Discuss the need of energy audit and energy audit methodology.
7. Explain audit parameters and working principles of measuring instruments used to measure the parameters.
8. Illustrate energy audit of boilers, furnaces, power plant, steam distribution system and compressed air systems.
9. Illustrate energy audit HVAC systems, motors, pumps, blowers and cooling towers.
5. Explain load management techniques, effects of harmonics, electricity tariff, improvement of power factor and losses in transmission

MAPPING OF C.O. WITH P.O. :

[H-HIGH, M- MODERATE, L-LOW]

C.O.N0.	P.O.01	P.O.02	P.O.04	P.O.08	P.O.10	P.O.12
1	H	H				L
2	H	H	L			L
3	M	M		M	L	

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4	M	M	L	M	L	L

COURSE CONTENT (SYLLABUS):

MODULE: 1: ENERGY AUDIT: METHODOLOGY AND TYPES

Energy Scenarios: Energy Conservation, Energy Audit, Energy Scenarios, Energy Consumption, Energy Security, Energy Strategy, Codes, standards and Legislation.

Definition of Energy Audit, Place of Audit, Energy – Audit Methodology, Financial Analysis, Sensitivity Analysis, Project Financing Options, Energy Monitoring and Training **[11-Hrs] [Blooms 'level selected: Comprehension]**

MODULE: 2: ENERGY AUDIT: BOILERS & BUILDINGS

Classification of Boilers, Parts of Boiler, Efficiency of a Boiler, Role of excess Air in Boiler Efficiency, Energy Saving Methods.

Energy Audit Applied to Buildings: Energy – Saving Measures in New Buildings, Water Audit, Method of Audit, and General Energy – Savings Tips Applicable to New as well as Existing Buildings.
[9-Hrs] [Blooms 'level selected: Application]

MODULE: 3: ENERGY AUDIT OF HVAC SYSTEMS

Introduction to HVAC, Components of Air – Conditioning System, Types of Air – Conditioning Systems, Human Comfort Zone and Psychrometry, Vapour – Compression Refrigeration Cycle, Energy Use Indices, Energy – Saving Measures in HVAC, Star Rating and Labelling by BEE.
Electrical-Load Management: Electrical Basics, Electrical Load Management, Variable- Frequency Drives, Harmonics and its Effects, Electricity Tariff, Power Factor. **[11 Hrs] [Blooms 'level selected: Application]**

MODULE: 4: ENERGY AUDIT: MOTORS, LIGHTING SYSTEM AND DSM

Energy Audit of Lighting Systems: Fundamentals of Lighting, Different Lighting Systems, Ballasts, Fixtures (Luminaries), Reflectors, Lenses and Louvres, Lighting Control Systems, Lighting System Audit, Energy Saving Opportunities. Demand side Management: Scope of DSM, Evolution of DSM concept, DSM planning and Implementation,Load management as a DSM strategy, Applications of Load Control, End use energy conservation, Tariff options for DSM **[14 -Hrs] [Blooms 'level selected: Comprehension]**

DELIVERY PROCEDURE (PEDAGOGY):

Topics for Self-Learning:

4. Energy Use Indices
5. DSM concept.

Experiential Learning Topics:

3. Energy audit of university blocks

Note:

3. All the Topics will be covered through **Lecture Method.**

E-materials:

6. https://www.youtube.com/watch?v=iY2YaIlfEGk
7. https://vemu.org/uploads/lecture_notes/03_01_2020_1480276911.pdf
8. https://idoc.pub/documents/anilkumar-km-notes-for-energy-auditing-demand-side-management-unit1-1pdf-klzzqgxxpglg
9. **Case study: A Research article onDemand Side Management: Demand Response, Intelligent Energy Systems, and Smart Loads**
10. Ebook: https://puniversity.informaticsglobal.com:2069/document/7503335
11. https://presiuniv.knimbus.com/user#/home

REFERENCE MATERIALS:

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Textbooks:

1. "Handbook on Energy Audit "Sonal Desai McGraw Hill 1st Edition, 2015
2. "Industrial Energy management systems" Array .C, White,Philip S, David R Brown, Hemisphere publishing corporation, New York.

Reference book(s):

"Energy management "by W.R. Murphy & G. Mckay Butter worth, Heinemann publications

GUIDELINES TO STUDENTS: (Here mention a few tips to study this course effectively)

- The students are advised to be very much regular to the online classes and sincerely attempt the learnings listed in the Pedagogical section.
- The students are advised to take down the notes legibly which serves as a firsthand information to study and revise lecture topics on day to day basis.
- The students are advised to visit the Edhitch portal and Microsoft teams on a regular basis to study the supporting materials shared by the course instructors.
- The students are advised to use the journals, technical magazines and other relevant materials.
- The students are advised to watch the video lectures available online to understand and review the concepts delivered in the class as well as problems assigned for self-learning topics.

COURSE SCHEDULE: (This is a macro level planning. Mention the unit wise expected starting and ending dates along with the tests/assignments/quiz and any other activities) [allot about 75% for delivary,about10 to 12% for Evaluation Discussion, about 10 to 15% on integrating the learning Modules within the course and to the program]

Sl. No.	ACTIVITY	STARTING DATE	CONCLUDING DATE	TOTAL NUMBER OF PERIODS
01	Program Integration Over View of the course			2
02	**Module : 01 Content**			11
03	Module:2 Course Integration & content			9
04	Mid Term **Test**			
05	Test Paper Discussion			1
06	**Module:03** Course Integration and content			11
07	**Module:04** Course Integration and content			14
08	Case Study			NA
09	Program integration			01

SCHEDULE OF INSTRUCTION:

MODULE: 1: ENERGY AUDIT: METHODOLOGY AND TYPES

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Sl. no	Session no	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	**S1**	Program Integration	Introduction to course			
2	S2	Course Integration	Energy Scenarios: Energy Conservation			
3	S3	Energy Audit	Energy Audit	CO. 1	Lecture Mode/PPT	T1
4	S4		Energy Scenarios, Energy Consumption, Energy Security	CO. 1	Lecture mode, white board	T1
5	S5		Energy Strategy,	CO. 1	Lecture Mode	T1
6	S6		Codes, standards and Legislation	CO. 1	Lecture Mode	T1
7	S7		Definition of Energy Audit, Place of Audit, Energy –	CO. 1	Lecture Mode/PPT	T1
8	S8		Audit Methodology, Financial Analysis,	CO. 1	Lecture Mode	T1
9	S9		Sensitivity Analysis, Project Financing Options, Sensitivity Analysis, Project Financing Options	CO. 1	Video clip	T1
10	S10		Energy Monitoring and Training	CO. 1	Lecture mode/PPT	T1
11	S11		Energy Monitoring and Training	CO. 1	Lecture mode/PPT	T1
Module 1 is completed						

MODULE: 2: ENERGY AUDIT: BOILERS & BUILDINGS

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Sl. no	Session no	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	S12	Course Integration	Classification of Boilers, Parts of Boiler,			
2	S13	BOILERS & BUILDINGS	Efficiency of a Boiler,	CO. 2	Lecture Mode	T1
3	S14		Role of excess Air in Boiler Efficiency	CO. 2	Lecture Mode/Video clip	T1
4	S15		Energy Saving Methods. Energy Audit Applied to Buildings:	CO. 2	Lecture Mode/Video clip	T1
5	S16		Energy – Saving Measures in New Buildings,	CO. 2	Lecture Mode	T1
6	S17		Water Audit, Method of Audit.	CO. 2	Lecture Mode	T1
7	S18		General Energy – Savings Tips Applicable to New as well as Existing Buildings	CO. 2	Lecture Mode	T1
8	S19		General Energy – Savings Tips Applicable to New as well as Existing Buildings	CO. 2	Lecture Mode	T1
9	S20		General Energy – Savings Tips Applicable to New as well as Existing Buildings	CO. 2	Lecture Mode	T1
Module 2 is completed						

MODULE: 3: ENERGY AUDIT OF HVAC SYSTEMS

Sl. no	Session no	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	S21	Course Integration	Introduction to HVAC	CO. 3	Lecture Mode	T1

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2	S22		Components of Air – Conditioning System	CO. 3	Lecture Mode	T1
3	S23		Types of Air – Conditioning Systems	CO. 3	Lecture Mode	T1
4	S24		Human Comfort Zone and Psychrometry, Vapour – Compression	CO. 3	Lecture Mode	T1
5	S25		Human Comfort Zone and Psychrometry, Vapour – Compression	CO. 3	Lecture Mode	T1
6	S26		Refrigeration Cycle, Energy Use Indices,	CO. 3	Lecture Mode	T1
7	S27		Energy – Saving Measures in HVAC	CO. 3	Lecture Mode	T1
8	S28		Star Rating and Labelling by BEE	CO. 3	Lecture Mode	T1
9	S29		Electrical-Load Management: Electrical Basics,	CO. 3	Lecture Mode	T1
10	S30		Variable- Frequency Drives			
11	S31		Harmonics and its Effects, Electricity Tariff, Power Factor	CO. 3	Lecture Mode	T1
Module 3 is completed						

MODULE: 4: ENERGY AUDIT: MOTORS, LIGHTING SYSTEM AND DSM

Sl. no	Session no	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	**S32**	Course Integration	Fundamentals of Lighting,	CO .4	Lecture Mode	Texas papers
2	**S33**		Different Lighting Systems, Ballasts, Fixtures (Luminaries),	CO .4	Lecture Mode	Texas papers

3	**34**		Reflectors, Lenses and Louvres,	CO .4	Lecture Mode	Texas papers
4	**S35**		Lighting Control Systems, Lighting System Audit,	CO .4	Lecture Mode	Texas papers
5	**S36**		Energy Saving Opportunities.	CO .4	Lecture Mode	Texas papers
6	**S37**		Demand side Management: Scope of DSM, Evolution of DSM concept	CO .5	Lecture Mode	Texas papers
7	**S38**		DSM planning and Implementation	CO .5	Lecture Mode	T1
8	**S39**		Load management as a DSM strategy,	CO .5	Lecture Mode	T1
9	**S40**		Load management as a DSM strategy	CO .5	Lecture Mode	T1
10	**S41**		Applications of Load Control,	CO .5	Lecture Mode	T1
11	**S42**		End use energy conservation,	CO .5	Lecture Mode	T1
12	**S43**		Tariff options for DSM.	CO .5	Lecture Mode	T1
13	**S44**		Tariff options for DSM.	CO .5	Lecture Mode	T1
14	**S45**		Program integration	CO 1 to CO 5		
Module 4 is completed						

Topics relevant to "ENTREPRENEURIAL SKILLS": The load management techniques, effects of harmonics, electricity tariff, improvement of power factor and losses in transmission for developing **Entrepreneurial Skills** through **Problem Solving Methodologies**. This is attained through the Assignment as mentioned in the assessment component.

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ASSESSMENT SCHEDULE:

S. No.	Assessment Type	Contents	CO Number	Duration In Hours	Marks	Weightage	Venue, DATE &TIME
1	Assignment Problem Solving	Topic can be selected from any Module-I/II/III/IV	CO1-CO4	-	20	10%	
2	Test-1	M1	CO1	60 Minutes	30	15%	
3	Test-2	M2	CO2	60 Minutes	30	15%	
4	Assignment as self-Learning topics Review of digital/e-resources from Pres. Univ.link given in the references section (Mandatory to submit the screenshots of accessing digital Resource. Otherwise it will not be evaluated	Mentioned.	CO2	-NA-	20	10%	
1.	End Term	All modules	CO 1,2,3,4	3 hours	100	50%	

COURSE CLEARANCE CRITERIA: (Here mention the minimum requirements of attendance, marks in continuous assessment &term end examination, make up exam policy and other details as per the academic regulations & PRC):

i. Minimum of 75% Attendance is must to take up examination.
ii. Minimum of 40% score is must in internal assessment.
iii. Minimum of 30% in the Final Examination.

MAKEUP POLICY:

If the student misses an evaluation component, he/she may be granted a make-up. In case of an absence that is foreseen, make-up request should be personally made to the Instructor-in-Charge, well ahead of the scheduled evaluation component. Reasons for unanticipated absence that qualify a student to apply for make-up include medical emergencies or personal exigencies. In such an event, the student should contact the Instructor-in-Charge as soon as practically possible.

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CONTACT TIMINGS IN THE CHAMBER FOR ANY DISCUSSIONS:

Interested students may contact the Instructor In-charge during the student free Hour to clear doubts.

SAMPLE THOUGHT PROVOKING QUESTIONS: (Here type sample typical questions for students 'reference)

SL NO	QUESTION	MARKS	COURSE OUTCOME NO.	BLOOM'S LEVEL
1	Write down the steps involved in 'Energy management Strategy'?	8	1	Knowledge
2	Demonstrate the typical energy audit reporting format	10	3	Application
3	Explain the energy audit and its analysis for Boiler and it's allied.	10	2	Comprehension
4	Explain how matching energy usage to requirement can enhance energy Efficiency.	10	4	Comprehension

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Course Code: EEE332	**Course Title: Electric Vehicles II** **Type of Course: Discipline Elective** **Theory only**		**L-T-P-C**	3	0	0	3
Version No.	1.0						
Course Pre-requisites	Power Electronics & Drives and Fundamentals of Electric Vehicles						
Anti-requisites	NIL						
Course Description	This course introduces the concepts, principles, analysis and design of hybrid and electric vehicles. Also, it provides the ability to develop the electric propulsion unit and its control for application of electric vehicles through assignments. The course is both conceptual and analytical in nature and needs fair knowledge of mathematical and computing. The course develops the critical thinking and analytical skills.						
Course Objective	The objective of the course is to familiarize the learners with the concepts of Electric Vehicles and attain **Entrepreneurial Skills** through **Problem Solving** methodologies.						
Course Out Comes	**On successful completion of the course the students shall be able to:** 1. Review the working and design of Electric Vehicle drive trains. 2. Demonstrate different power converter topology used for electric vehicle application. 3. Illustrate the electric propulsion unit and its control for application of electric vehicles. 4. Employ converters for battery charging and explain transformer less topology.						
Course Content							
Module 1	**Drive Train Design**	Assignment	Computation and Data Analysis	**12 Sessions**			
Series Hybrid Electric Drive Train Design: Operating patterns, control strategies, Sizing of major components, power rating of traction motor, power rating of engine/generator, design of PPS **Parallel Hybrid Electric Drive Train Design:** Control strategies of parallel hybrid drive train, design of engine power capacity, design of electric motor drive capacity, transmission design, energy storage design.							
Module 2	**Energy storage for EV and HEV:**	Quiz	Data collection and Analysis	**12 Sessions**			
Energy storage for EV and HEV: Energy storage requirements, Battery parameters, Types of Batteries, Modelling of Battery, Fuel Cell basic principle and operation, Types of Fuel Cells, PEMFC and its operation, Modelling of PEMFC, Supercapacitors.							
Module 3	**Electric Propulsion Systems**	Case study	Simulation and data analysis	**10 Sessions**			
Electric Propulsion: EV consideration, DC motor drives and speed control, Induction motor drives, Permanent Magnet Motor Drives, Switch Reluctance Motor Drive for Electric Vehicles, Configuration and control of Drives.							
Module 4	**Power Electronic Converter for Battery Charging:**	Assignment	Data collection	**11 Sessions**			
Power Electronic Converter for Battery Charging: Charging methods for battery, Termination methods, charging from grid, The Z-converter, Isolated bidirectional DC-DC converter, Design of Z- converter for battery charging, High-frequency transformer based isolated charger topology, Transformer less topology							

Targeted Application & Tools that can be used:

Application: Automotive industry.

Software tools: Matlab-Simulink

Text Books

1. Mehrdad Ehsani, YiminGao, sebastien E. Gay and Ali Emadi, ―Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design‖, CRC Press, 2009.
2. Iqbal Husain,Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2011, 2nd edition.

References:

1. James Larminie and John Loury, ―Electric Vehicle Technology-Explained‖, John Wiley & Sons Ltd., 2003, Second Edition.
2. C.C. Chan and K.T. Chanu Modern Electric Vehicle Technology, OXFORD University, 2011
3. Sheldon S. Williamson,- Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Springer,2013
4. Chris Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011, Second Edition

Online resources:

1. https://nptel.ac.in/courses/108/102/108102121/
2. https://www.coursera.org/learn/electric-vehicles-mobility
3. Video: https://www.youtube.com/watch?v=GHGXy_sjbgQ
4. Text book of Electric and Hybrid Vehicles: Power Sources, Models, Sustainability, Infrastructure and the Market, Gianfranco Pistoia, 1st ed. Amsterdam: Elsevier. 2010 https://puniversity.informaticsglobal.com
5. Case Study: https://www.simpli.com/answers, https://www.upgrad.com/ev_technology/iit-delhi,

Topics relevant to "ENTREPRENEURIAL SKILLS": Isolated bidirectional DC-DC converter, Design of Z-converter for battery charging, High-frequency transformer based isolated charger topology for developing **Entrepreneurial Skills** through **Problem Solving methodologies**. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Ms. Ragasudha C P
Recommended by the Board of Studies on	BoS No: 11th BoS held on 05/09/2020
Date of Approval by the Academic Council	14th Academic Council meeting held on 24/12/2020

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PRESIDENCY UNIVERSITY

(Established under the Presidency University Act, 2013 of the Karnataka Act 41 of 2013)

A-2[2020] COURSE HAND OUT

SCHOOL: Engineering **DEPT.: EEE** **DATE OF ISSUE: 22/01/2021**

NAME OF THE PROGRAM : B.TECH (EEE)

P.R.C. APPROVAL REF. : PU/AC-14/07/12_2020

SEMESTER/YEAR : VI/ III

COURSE TITLE & CODE : Electric Vehicles II & EEE 332

COURSE CREDIT STRUCTURE : 3-0-0-3

CONTACT HOURS : 3 hrs/week

COURSE INSTRUCTOR :

COIURSE URL :

PROGRAM OUTCOMES: [LIST ALL AND CIRCLE THE RELEVANT SELECTED OUTCOMES]

Graduates of the B.Tech. Program in Electrical and Electronics Engineering will be able to:

PO1.Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.(H)

PO2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.(H)

PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.(M)

PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.(L)

PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.(L)

PO6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.(L)

PO11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

COURSE PREREQUISITES:

[1] Power Electronics & Drives

[2] Fundamentals of Electric Vehicles

COURSE DESCRIPTION:

This course introduces the concepts, principles, analysis and design of hybrid and electric vehicles. Also, it provides the ability to develop the electric propulsion unit and its control for application of electric vehicles through assignments. The course is both conceptual and analytical in nature and needs fair knowledge of mathematical and computing. The course develops the critical thinking and analytical skills.

COURSE OBJECTIVE:

The objective of the course is to familiarize the learners with the concepts of Electric Vehicles and attain **Entrepreneurial Skills** through **Problem Solving** methodologies.

COURSE OUTCOMES: On successful completion of the course the students shall be able to:

5. Review the working and design of Electric Vehicle drive trains.
6. Demonstrate different power converter topology used for electric vehicle application.
7. Illustrate the electric propulsion unit and its control for application of electric vehicles.
8. Employ converters for battery charging and explain transformer less topology

MAPPING OF C.O. WITH P.O. :

[H-HIGH, M- MODERATE, L-LOW]

C.O.N0.	P.O.01	P.O.02	P.O.03	P.O.04	P.O.05	P.O.06	P.O.07	P.O.08	P.O.09	P.O.10
1	H	H	M							L

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2	**H**	**H**	**M**							**L**
3	**H**	**H**	**M**	**L**						**L**
4	**H**	**H**	**M**	**L**	**L**					**L**

COURSE CONTENT (SYLLABUS):

MODULE: 1: DRIVE TRAIN DESIGN

Series Hybrid Electric Drive Train Design: Operating patterns, control strategies, Sizing of major components, power rating of traction motor, power rating of engine/generator, design of PPS
Parallel Hybrid Electric Drive Train Design: Control strategies of parallel hybrid drive train, design of engine power capacity, design of electric motor drive capacity, transmission design, energy storage design.

[12-Hrs] [Blooms 'level selected: Application]

MODULE: 2: ENERGY STORAGE FOR EV AND HEVS

Energy storage for EV and HEV: Energy storage requirements, Battery parameters, Types of Batteries, Modelling of Battery, Fuel Cell basic principle and operation, Types of Fuel Cells, PEMFC and its operation, Modelling of PEMFC, Supercapacitors..

[12-Hrs] [Blooms 'level selected: Application]

MODULE: 3: ELECTRIC PROPULSION SYSTEMS

Electric Propulsion: EV consideration, DC motor drives and speed control, Induction motor drives, Permanent Magnet Motor Drives, Switch Reluctance Motor Drive for Electric Vehicles, Configuration and control of Drives.

[10-Hrs] [Blooms 'level selected: Application]

MODULE: 4: POWER CONVERTERS FOR BATTERY CHARGING

Power Electronic Converter for Battery Charging: Charging methods for battery, Termination methods, charging from grid, The Z-converter, Isolated bidirectional DC-DC converter, Design of Z- converter for battery charging, High-frequency transformer based isolated charger topology, Transformer less topology

[11-Hrs] [Blooms 'level selected: Application]

DELIVERY PROCEDURE (PEDAGOGY):

Topics for Self-Learning:

6. Battery management system.
7. Selection of wires for EVs.
8. Different types of controllers that are used in EVs.

Experiential Learning Topics:

4. Power converter based Charging method using MATLAB Simulink

Note:

4. All the Topics will be covered through **online Lecture Method in Microsoft teams.**
5. E-materials available at the website of NPTEL- http://nptel.ac.in/

REFERENCE MATERIALS:

Textbooks:

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T1: M. Ehsani, Y. Gao, S. Gay and Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, CRC Press, 2005

T2: Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.

Reference book(s):

5. James Larminie and John Loury, ―Electric Vehicle Technology-Explained‖, John Wiley & Sons Ltd., 2003, Second Edition.
6. C.C. Chan and K.T. Chanu Modern Electric Vehicle Technology, OXFORD University, 2011
7. Sheldon S. Williamson,- Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Springer,2013
8. Chris Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011, Second Edition

Online learning resources::

W1.https://nptel.ac.in/courses/108/102/108102121/

W2.https://nptel.ac.in/courses/108/106/108106170/

W3. IEEE Explore - School of Engineering

W4.https://www.coursera.org/learn/electric-vehicles-mobility

W6.Video: https://www.youtube.com/watch?v=GHGXy_sjbgQ

W7. Text book of Electric and Hybrid Vehicles : Power Sources, Models, Sustainability, Infrastructure and the Market, Gianfranco Pistoia, 1st ed. Amsterdam : Elsevier. 2010 **https://presiuniv.**knimbus**.com/user#/home**

Case Study:

1. **https://www.simpli.com/answers**
2. **https://www.upgrad.com/ev_technology/iit-delhi**

Other resources:

Reputed journal papers are to be referred.

GUIDELINES TO STUDENTS: (Here mention a few tips to study this course effectively)

- The students are advised to be very much regular to the online classes and sincerely attempt the learnings listed in the Pedagogical section.
- The students are advised to take down the notes legibly which serves as a firsthand information to study and revise lecture topics on day to day basis.
- The students are advised to visit the Edhitch portal and Microsoft teams on a regular basis to study the supporting materials shared by the course instructors.
- The students are advised to use the journals, technical magazines and other relevant materials.
- The students are advised to watch the video lectures available online to understand and review the concepts delivered in the class as well as problems assigned for self-learning topics.

COURSE SCHEDULE: (This is a macro level planning. Mention the unit wise expected starting and ending dates along with the tests/assignments/quiz and any other activities) [allot about 75% for delivary,about10 to 12% for Evaluation Discussion, about 10 to 15% on integrating the learning Modules within the course and to the program]

Sl. No.	ACTIVITY	STARTING DATE	CONCLUDING DATE	TOTAL NUMBER OF PERIODS
01	Over View of the course			02
02	**Module : 01**			09

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03	Course Integration of Module:2			01
04	**Module : 02**			09
05	Quiz 1/ Assignment 1/self LT			01
06	**Test-1**			NA
07	Test-1 Paper Discussion			01
08	Course Integration of Module:3			01
09	**Module:03**			10
10	Test-II			NA
11	Discussion of Test-2 paper			01
12	Case Study / Mini Project			NA
13	**Module 4**			13
14	Course Integration of Module:4			01
15	Program integration			01

SCHEDULE OF INSTRUCTION:

MODULE: 1:

Sl. no	Session no	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	S-1	Program Integration				
2	S-2	Course Integration	Introduction to course			
3	S-3	Series Hybrid Electric Drive Train Design	Operating patterns, control strategies	CO. 1	PPT/Digital Board	T1:Ch.1
4	S-4		Operating patterns, control strategies	CO. 1	PPT/Digital Board	T1:Ch.1

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5	S-5	Series Hybrid Electric Drive Train Design	Sizing of major components, power rating of traction motor	CO. 1	PPT/Digital Board	T1:Ch.1
6	S-6		power rating of engine/generator, design of PPS	CO. 1	PPT/Digital Board	T1:Ch.1
7	S-7	Parallel Hybrid Electric Drive Train Design	Control strategies of parallel hybrid drive train	CO. 1	PPT/Digital Board	T1:Ch.1
8	S-8	Parallel Hybrid Electric Drive Train Design	Control strategies of parallel hybrid drive train	CO. 1	PPT/Digital Board	T1:Ch.1
9	S-9	Parallel Hybrid Electric Drive Train Design	design of engine power capacity, design of electric motor drive capacity	CO. 1	PPT/Digital Board	T1:Ch.4
10	S-10		design of engine power capacity, design of electric motor drive capacity	CO. 1	PPT/Digital Board	T1:Ch.4
11	S-11		transmission design, energy storage design.	CO. 1	PPT/Digital Board	T1:Ch.4
12	S-12		transmission design, energy storage design.	CO. 1	PPT/Digital Board	T1:Ch.4
Module 1 is completed						

MODULE: 2:

Sl. no	Session no	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	S-1	Course Integration				
2	S-2	Energy storage for EV and HEV	Energy storage requirements	CO. 3	PPT/Digital Board	
3	S-3	Energy storage for EV and HEV	Battery parameters	CO. 3	PPT/Digital Board	Text Book

4	S-4	Energy storage for EV and HEV	Types of Batteries	CO. 3	PPT/Digital Board	
5	S-5	Energy storage for EV and HEV	Super Capacitors	CO. 3	PPT/Digital Board	
6	S-6	Energy storage for EV and HEV	Modelling of Battery	CO. 3	PPT/Digital Board	T1.Ch.6
7	S-7		Fuel Cell basic principle and operation, Types of Fuel Cells	CO. 3	PPT/Digital Board	
8	S-8		PEMFC and its operation	CO. 3	PPT/Digital Board	T1.Ch.6.1
9	S-9	**Energy storage for EV and HEV**	Modelling of PEMFC, Supercapacitors.	CO. 3	PPT/Digital Board	T1.Ch.6.1
10	S-10		PEMFC and its operation, Modelling of PEMFC	CO. 3	PPT/Digital Board	T1.Ch.6.2

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MODULE: 3:

Sl. no	Session no	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	S-1	Course Integration				
2	S-2	Electric Propulsion	Introduction	CO. 2	PPT/Digital Board	Technical papers
3	S-3		EV consideration, DC motor drives and speed control	CO. 2	PPT/Digital Board	Technical papers
4	S-4		EV consideration, DC motor drives and speed control		PPT/Digital Board	
5	S-5		Induction motor drives	CO. 2	PPT/Digital Board	Technical papers
6	S-6		Permanent Magnet Motor Drives	CO. 2	PPT/Digital Board	Technical papers
7	S-7		Switch Reluctance Motor Drive for Electric Vehicles	CO. 2	PPT/Digital Board	Technical papers
8	S-8		Configuration and control of Drives.	CO. 2	PPT/Digital Board	Technical papers
9	S-9		Problem Solving	CO. 2	PPT/Digital Board	Technical papers
10	S-10		Problem Solving	CO. 2	PPT/Digital Board	Technical papers
Module 3 is completed						

MODULE: 4:

Sl. N	Session no	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference

Sl. no	Session no	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	S-1	Course Integration				
2	S-2	Power Electronic Converter	Charging methods and characteristics	CO .4	PPT/Digital Board	
3	S-3	Power Electronic Converter	Charging from Grid	CO .4	PPT/Digital Board	
4	S-4	Power Electronic Converter	isolated bidirectional DC-DC converter	CO .4	PPT/Digital Board	Technical papers
5	S-5	Power Electronic Converter	isolated bidirectional DC-DC converter	CO .4	PPT/Digital Board	Technical papers
6	S-6	Power Electronic Converter	high frequency transformer based isolated charger topology	CO .4	PPT/Digital Board	Technical papers
7	S-7	Battery Charging method	high frequency transformer based isolated charger topology	CO .4	PPT/Digital Board	Technical papers
8	S-8	Battery Charging method	Energy management strategies	CO .4	PPT/Digital Board	Technical papers
9	S-9	Battery Charging method	Overview of different Charging systems	CO .4	PPT/Digital Board	Technical papers
10	S-10	Battery Charging method	Overview of different Charging systems	CO .4	PPT/Digital Board	Technical papers
11	S-11	Battery Charging method	Overview of different Charging systems	CO .4	PPT/Digital Board	Technical papers
12	S-12		Program Integration	CO .1-4	PPT/Digital Board	
Module 4 is completed						

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Topics relevant to "ENTREPRENEURIAL SKILLS": Isolated bidirectional DC-DC converter, Design of Z- converter for battery charging, High-frequency transformer based isolated charger topology for developing **Entrepreneurial Skills** through **Problem Solving methodologies**. This is attained through the **Assignment** as mentioned in the assessment component.

ASSESSMENT SCHEDULE:

Sl.no	Assessment type[Include here assessment method for self-learning component also]	contents	Course outcome Number	Duration In Hours	marks	weightage	Venue, DATE &TIME
1	Assignment Problem Solving	Module-4	CO 2 and CO 4	-	20	10%	
2	Test 1	Module-1	CO1	1 hr	30	15%	
3	Test 2	Module-2	CO2	1 hr	30	15%	
4	Quiz/Assignment as self Learning topics	Module-3	CO3	-	20	10%	
5	End Term Final Examination	Module-1,2,3 & 4	CO1-CO4	3 hrs	100	50%	

COURSE CLEARANCE CRITERIA: (Here mention the minimum requirements of attendance, marks in continuous assessment &term end examination, make up exam policy and other details as per the academic regulations & PRC):

- Minimum of 75% Attendance is must to take up examination.
- Minimum of 40% score is must in internal assessment.
- Minimum of 30% in the Final Examination.
- Make up policy is applicable only as per academic regulation
- There will be no make-up for ASSIGNMENT and QUIZ.

MAKEUP POLICY:

If the student misses an evaluation component, he/she may be granted a make-up. In case of an absence that is foreseen, make-up request should be personally made to the Instructor-in-Charge, well ahead of the scheduled evaluation component. Reasons for unanticipated absence that qualify a student to apply for make-up include medical emergencies or personal exigencies. In such an event, the student should contact the Instructor-in-Charge as soon as practically possible.

CONTACT TIMINGS IN THE CHAMBER FOR ANY DISCUSSIONS:

Interested students may contact the Instructor In-charge during the student free Hour and Wednesday, Friday 3:00 – 4:00 pm to clear doubts.

SAMPLE THOUGHT PROVOKING QUESTIONS: (Here type sample typical questions for students reference)

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SL NO	QUESTION	MARKS	COURSE OUTCOME NO.	BLOOM'S LEVEL
1	Identify different types of energy sources used in electric vehicles and explain how to size the power supply for any given direct drive electric two or three wheelers?	10	3	Comprehension
2	Explain how to operate separately excited DC motor in four quadrant mode? Comment on the suitability of this motor in pure EV application?	10	3	Comprehension

Target set for course Outcome attainment:

Sl.no	C.O. No.	Course Outcomes	Target set for attainment in percentage
01	Co1	Describe the importance of Electric Vehicles in recent trends	60
02	Co2	Discuss the components of Electric Vehicles and Hybrid Electric Vehicles	60
03	Co3	Summarize the properties of batteries and electric vehicle drive systems	50
04	Co4	Explain different charging methods of Electric vehicles	50

Signature of the course Instructor

This course has been duly verified Approved by the D.A.C.

Signature of the Chairperson D.A.C.

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Course Code: **EEE221**	**Course Title: Energy Audit** **Type of Course: Open Elective & Theory only**		**L-T-P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	Electrical and Electronics Measurement and Instrumentation & Basic of measurement devices.					
Anti-requisites	NIL					
Course Description	Energy Audit helps to map the flow of energy (in its various forms) across the value chain, highlighting areas for interventions. This course is designed to develop analytical ability on the mechanism of energy audit and the technologies/simulation tools typically employed to undertake an audit exercise, supported by case studies & site visits.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Energy Audit and attain **Entrepreneurial Skills** through **Problem Solving** methodologies.					
Course Outcomes	**On successful completion of this course the students shall be able to:** 1. Explain audit parameters and working principles of measuring instruments used to measure the parameters. 2. Discuss energy audit of boilers, furnaces, power plant, steam distribution system and compressed air systems. 3.Explain energy audit of HVAC systems & Motors 4. Discuss energy audit of lighting systems and buildings					
Course Content:						
Module 1	**Energy Audit - Methodology and Types**	Assignment	Data Collection		**12 Sessions**	
To Energy Scenarios: Energy Conservation, Energy Audit, Energy Scenarios, Energy Consumption, Energy Security, Energy Strategy, Clean Development Mechanism. Definition of Energy Audit, Place of Audit, Energy – Audit Methodology, Financial Analysis, Sensitivity Analysis, Project Financing Options, Energy Monitoring and Training.						
Module 2	**Energy Audit of Boilers & Buildings**	Case Study/ Assignment	Data Collection/ Design		**11 Sessions**	
Classification of Boilers, Parts of Boiler, Efficiency of a Boiler, Role of excess Air in Boiler Efficiency, Energy Saving Methods. Energy Audit Applied to Buildings: Energy – Saving Measures in New Buildings, Water Audit, Method of Audit, General Energy – Savings Tips Applicable to New as well as Existing Buildings.						
Module 3	**Energy Audit of HVAC Systems & motors**	Case study	Data Collection		**12 Sessions**	

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Introduction to HVAC, Components of Air – Conditioning System, Types of Air – Conditioning Systems, Human Comfort Zone and Psychrometry, Vapour – Compression Refrigeration Cycle, Energy Use Indices, Impact of Refrigerants on Environment and Global Warming, Energy – Saving Measures in HVAC, Star Rating and Labelling by BEE. Classification of Motors, Parameters related to Motors, Efficiency of a Motor, Energy Conservation in Motors, BEE Star Rating and Labelling.

Module 4	**Energy Audit of Lighting systems**	Assignment/ Presentation	Data Collection / Estimation	**10 Sessions**

Energy Audit of Lighting Systems: Fundamentals of Lighting, Different Lighting Systems, Ballasts, Fixtures (Luminaries), Reflectors, Lenses and Louvres, Lighting Control Systems, Lighting System Audit, Energy Saving Opportunities

Targeted Application & Tools that can be used:

Application Area is Power System Data collection, Electricity Transmission and Distributed companies, Power Grid and State Electricity Boards

Professionally Used Software: Mi Power/ PS CAD

Textbooks

3. "Industrial Energy management systems" Array .C, White,Philip S, David R Brown, Hemisphere publishing corporation, New York.
4. "Handbook on Energy Audit "Sonal Desai McGraw Hill 1st Edition, 2015

References

1. "Energy management "by W.R. Murphy & G. Mckay Butter worth, Heinemann publications.

Online Resources

1. https://www.youtube.com/watch?v=iY2YaIlfEGk
2. https://vemu.org/uploads/lecture_notes/03_01_2020_1480276911.pdf
3. Ebook: A Research article on Demand Side Management: Demand Response, Intelligent Energy Systems and Smart Loads,
4. https://puniversity.informaticsglobal.com

TOPICS RELEVANT TO "ENTREPRENEURIAL SKILLS": Energy Audit Applied to Buildings: Energy – Saving Measures in New Buildings, Water Audit, Method of Audit for developing **Entrepreneurial Skills** through **Problem Solving methodologies**. This is attained through assessment component mentioned in course handout.

TOPICS RELEVANT TO HUMAN VALUES AND PROFESSIONAL ETHICS: Energy Saving measures in New buildings, Audit and Saving Tips.

Catalogue prepared by	Ms. Ragasudha C P
Recommended by the Board of Studies on	BoS No: 11th. BoS held on 5/9/2020
Date of Approval by the Academic Council	14th Academic Council Meeting held on 24/12/2020

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PRESIDENCY UNIVERSITY

(Established under the Presidency University Act, 2013 of the Karnataka Act 41 of 2013)

[A-2] COURSE HAND OUT

SCHOOL	:	**Engineering**
DEPT.	:	**EEE**
DATE OF ISSUE	:	
NAME OF THE PROGRAM	:	**B. Tech**
P.R.C. APPROVAL REF.	:	**PU/AC-14/07/12_2020**
SEMESTER/YEAR	:	**VI/ III**
COURSE TITLE & CODE	:	**Energy Audit**
		EEE 221
COURSE CREDIT STRUCTURE	:	**3 - 0 - 0 - 3**
CONTACT HOURS	:	**3hrs/week**
COURSE INSTRUCTOR	:	

Program Outcomes:

Graduates of the B.Tech. Program in Electrical and Electronics Engineering will be able to:

PO1.Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

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PO6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

1. **Course Prerequisites: Basic electronics, Measurements and Instruments**
   [1] Electrical and Electronics Measurement and Instrumentation
   [2] Basic of measurement devices.
2. **Course Description.**

   Energy Audit helps to map the flow of energy (in its various forms) across the value chain, highlighting areas for interventions. This course is designed to develop analytical ability on the mechanism of energy audit and the technologies/simulation tools typically employed to undertake an audit exercise, supported by case studies & site visits.
3. **COURSE OBJECTIVE :**
   The objective of the course is to familiarize the learners with the concepts of Energy Audit and attain **Entrepreneurial Skills** through **Problem Solving methodologies.**
4. **COURSE OUTCOMES:**
   On successful completion of this course the students shall be able to:

CO1: Explain audit parameters and working principles of measuring instruments used to measure the parameters.

CO2: Discuss energy audit of boilers, furnaces, power plant, steam distribution system and compressed air systems.

CO3: Explain energy audit of HVAC systems & Motors

CO4: Discuss energy audit of lighting systems and buildings

MAPPING OF C.O. WITH P.O: [H-HIGH, M- MODERATE, L-LOW]

C.O.N0.	P.O.01	P.O.02	P.O.07	P.O.10
1	H	M	L	L
2	H	M	L	L

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3	**H**	**M**	**L**	**L**
4	**H**	**M**	**L**	**L**

1. CONTENT:

Module-I:
Energy Audit -Methodology and Types

Energy Scenarios: Energy Conservation, Energy Audit, Energy Scenarios, Energy Consumption, Energy Security, Energy Strategy, Clean Development Mechanism.

Definition of Energy Audit, Place of Audit, Energy – Audit Methodology, Financial Analysis, Sensitivity Analysis, Project Financing Options, Energy Monitoring and Training.

[12 Sessions] [Bloom's level selected: Comprehension]

Module-2:
Energy Audit of Boilers & Buildings

Classification of Boilers, Parts of Boiler, Efficiency of a Boiler, Role of excess Air in Boiler Efficiency, Energy Saving Methods. Energy Audit Applied to Buildings: Energy – Saving Measures in New Buildings, Water Audit, Method of Audit, General Energy – Savings Tips Applicable to New as well as Existing Buildings.

[11 Sessions] [Bloom's level selected: Comprehension]

Module- III
Energy Audit of HVAC Systems & motors :

Introduction to HVAC, Components of Air – Conditioning System, Types of Air – Conditioning Systems, Human Comfort Zone and Psychrometry, Vapour – Compression Refrigeration Cycle, Energy Use Indices, Impact of Refrigerants on Environment and Global Warming, Energy – Saving Measures in HVAC, Star Rating and Labelling by BEE.

Classification of Motors, Parameters related to Motors, Efficiency of a Motor, Energy Conservation in Motors, BEE Star Rating and Labelling.

[12 Sessions] [Bloom's level selected: Comprehension]

Module -IV

Energy Audit of Lighting Systems :

Fundamentals of Lighting, Different Lighting Systems, Ballasts, Fixtures (Luminaries), Reflectors, Lenses and Louvres, Lighting Control Systems, Lighting System Audit, Energy Saving Opportunities

[10 Sessions] [Bloom's level selected: Comprehension]

DELIVERY PROCEDURE (PEDAGOGY):

Topics for Self-Learning: Take an example of a particular motor manufacturing industry and describe the BEE Star Rating and Labelling of Electric motors.

Experiential Learning Topics:

Case Study: 1] Prepare a compressive report on Energy situation in India and world.

Case Study: 2] Discuss different techniques of DSM and also throw light on practical difficulties with Time of Day pricing.

Note:

6. All the Topics will be covered through offline lecture mode
7. NPTEL video lectures of selected topics on smart sensors

Text Book

Textbooks:

1. "Industrial Energy management systems" Array .C, White,Philip S, David R Brown, Hemisphere publishing corporation, New York.
2. "Handbook on Energy Audit "Sonal Desai McGraw Hill 1st Edition, 2015

(ii) Reference Book(s)

References

1. "Energy management "by W.R. Murphy & G. Mckay Butter worth, Heinemann publications.

Weblinks

1. https://www.youtube.com/watch?v=iY2YaIlfEGk

2. https://vemu.org/uploads/lecture_notes/03_01_2020_1480276911.pdf

3. A **Research article onDemand Side Management: Demand Response, Intelligent Energy Systems, and Smart Loads** https://presiuniv.knimbus.com/user#/home

GUIDELINES TO STUDENTS:

- The students are advised to be very much regular to the online classes and sincerely attempt the learnings listed in the Pedagogical section.
- The students are advised to take down the notes legibly which serves as a firsthand information to study and revise lecture topics on day to day basis.
- The students are advised to visit the Edhitch portal on a regular basis to study the supporting materials shared by the course instructors.
- The students are advised to use the journals, technical magazines and other relevant materials.
- The students are advised to watch the video lectures available online to understand and review the concepts delivered in the class as well as problems assigned for self-learning topics.

2. COURSE SCHEDULE:

Sl. No.	ACTIVITY	STARTING DATE	CONCLUDING DATE	TOTAL NUMBER OF PERIODS
01	Over View of the course			02
02	**Module : 01**			10
03	Course Integration of Module:2			01
04	Module **: 02**			10

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05	Quiz / Assignment			NA
06	Mid- term Test			NA
07	Test Paper Discussion			01
08	Course Integration of Module:3			01
09	**Module:03**			08
13	Course Integration of Module:4			01
14	**Module 4**			10
15	Project /case study			NA
16	**End Term Examination**			NA

3. SCHEDULE OF INSTRUCTION:

Module: 1

Sl. No	Session no	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	S1	Program Integration		**CO1**	Lecture/PPT/ Black Board	**T1**
2	S2	Course Integration & course handout discussion		**CO1**	Lecture/PPT/ Black Board	**T1**
3	S3	Energy Audit - Methodology and Types	Energy Conservation, Energy Audit	**CO1**	Lecture/PPT/ Black Board	**T1**
4	S4	Energy Audit - Methodology and Types	Energy Conservation, Energy Audit	**CO1**	Lecture/PPT/ Black Board	**T1**
5	S5	Energy Audit - Methodology and Types	Energy Scenarios, Energy Consumption	**CO1**	Lecture/PPT/ Black Board	**T1**
6	S6	Energy Audit - Methodology and Types	Energy Scenarios, Energy Consumption	**CO1**	Lecture/PPT/ Black Board	**T1**
7	S7	Energy Audit - Methodology and Types	Energy Security, Energy Strategy	**CO1**	Lecture/PPT/ Black Board	**T1**
8	S8	Energy Audit - Methodology and Types	Clean Energy Development Mechanism.	**CO1**	Lecture/PPT/ Black Board	**T1**

9	S9	Energy Audit - Methodology and Types	Definition of Energy Audit, Place of Audit	**CO1**	Lecture/PPT/ Black Board	**T1**
10	S10	Energy Audit - Methodology and Types	Energy – Audit Methodology	**CO1**	Lecture/PPT/ Black Board	**T1**
11	S11	Energy Audit - Methodology and Types	Financial Analysis, Sensitivity Analysis	**CO1**	Lecture/PPT/ Black Board	**T1**
12	S12	Energy Audit - Methodology and Types	Project Financing Options, Energy Monitoring and Training.	**CO1**	Lecture/PPT/ Black Board	**T1**
Module 1 is completed						

Module: 2

Sl. No	**Session no**	**Lesson Title**	**Topics**	**Course Outcome Number**	**Delivery Mode**	**Reference**
1	S1	Course integration				
2	S2	Energy audit of boilers & buildings	Classification of Boilers, Parts of Boiler	CO2	Lecture/PPT/ Black Board	**T1**
3	S3	Energy audit of boilers & buildings	Efficiency of a Boiler	CO2	Lecture/PPT/ Black Board	**T1**
4	S4	Energy audit of boilers & buildings	Role of excess Air in Boiler Efficiency	CO2	Lecture/PPT/ Black Board	**T1**
5	S5	Energy audit of boilers & buildings	Energy Saving Methods	CO2	Lecture/PPT/ Black Board	**T1**
6	S6	Energy audit of boilers & buildings	Energy Audit Applied to Buildings: Energy – Saving Measures in New Buildings	CO2	Lecture/PPT/ Black Board	**T1**
7	S7	Energy audit of boilers & buildings	Energy Audit Applied to Buildings: Energy – Saving Measures in New Buildings	CO2	Lecture/PPT/ Black Board	**T1**

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8	S8	Energy audit of boilers & buildings	Water Audit	CO2	Lecture/PPT/ Black Board	**T1**
9	S9	Energy audit of boilers & buildings	Method of Audit	CO2	Lecture/PPT/ Black Board	**T1**
10	S10	Energy audit of boilers & buildings	Method of Audit	CO2	Lecture/PPT/ Black Board	**T1**
11	S11	Energy audit of boilers & buildings	General Energy – Savings Tips Applicable to New as well as Existing Buildings.-	CO2	Lecture/PPT/ Black Board	**T1**
12	S12	Energy audit of boilers & buildings	General Energy – Savings Tips Applicable to New as well as Existing Buildings.-	CO2	Lecture/PPT/ Black Board	**T1**
Module 2 is completed						

Module: 3

Sl. No	Session no	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	S1		Course integration of Module-3,			
2	S2	Energy audit of HVAC systems	Introduction to HVAC, Components of Air – Conditioning System	CO3	Lecture/PPT/ Black Board	T2
3	S3	Energy audit of HVAC systems	Types of Air – Conditioning Systems, Comfort Zone and Psychrometry	CO3	Lecture/PPT/ Black Board	T2
4	S4	Energy audit of HVAC systems	Vapour – Compression Refrigeration Cycle	CO3	Lecture/PPT/ Black Board	T2
5	S5	Energy audit of HVAC systems	Energy Use Indices	CO3	Lecture/PPT/ Black Board	T2
6	S6	Energy audit of HVAC systems	Impact of Refrigerants on Environment and Global Warming	CO3	Lecture/PPT/ Black Board	T2

7	S7	Energy audit of HVAC systems	Star Rating and Labelling by BEE.	CO3	Lecture/PPT/ Black Board	T2
9	S9	Energy audit of motors	Classification of Motors, Parameters related to Motors	CO3	Lecture/PPT/ Black Board	T2
10	S10	Energy audit of motors	Efficiency of a Motor	CO3	Lecture/PPT/ Black Board	T2
11	S11	Energy audit of motors	Energy Conservation in Motors	CO3	Lecture/PPT/ Black Board	T2
12	S12	Energy audit of motors	BEE Star Rating and Labelling.	CO3	Lecture/PPT/ Black Board	T2
		Self-Learning Topic/case study		CO1-CO3	https://presiuniv.knimbus.com/user#/home	
Module 3 is completed						

Module: 4

Sl. no	Session no	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	S1		Course integration of module-4			
2	S2	**Energy Audit of Lighting Systems**	Fundamentals of Lighting	CO4	Lecture/PPT/ Black Board	T2
3	S3	**Energy Audit of Lighting Systems**	Different Lighting Systems	CO4	Lecture/PPT/ Black Board	T2
4	S4	**Energy Audit of Lighting Systems**	Ballasts, Fixtures (Luminaries)	CO4	Lecture/PPT/ Black Board	T2
5	S5	**Energy Audit of Lighting Systems**	Reflectors, Lenses and Louvres	CO4	Lecture/PPT/ Black Board	T2

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6	S6	**Energy Audit of Lighting Systems**	Lighting Control Systems,	CO4	Lecture/PPT/ Black Board	T2
7	S7	**Energy Audit of Lighting Systems**	Lighting Control Systems,	CO4	Lecture/PPT/ Black Board	T2
8	S8	**Energy Audit of Lighting Systems**	Energy Saving Opportunities	CO4	Lecture/PPT/ Black Board	T2
9	S9	**Energy Audit of Lighting Systems**	Lighting System Audit	CO4	Lecture/PPT/ Black Board	T2
10	S10	Program integration-2				

TOPICS RELEVANT TO "ENTREPRENEURIAL SKILLS": Energy Audit Applied to Buildings: Energy – Saving Measures in New Buildings, Water Audit, Method of Audit for developing **Entrepreneurial Skills** through **Problem Solving methodologies**. This is attained through the **Assignment** as mentioned in the assessment component.

4. ASSESSMENT SCHEDULE:

Sl.no	Assessment type	contents	Course outcome Number	Duration In Minutes	marks	weightage	Venue, DATE &TIME
1	Assignment Problem Solving	Module 2	CO2- CO3	---	40	20%	
2	Assignement as self Learning topics Review of digital/e-resources from Pres. Univ.link given in the references section (Mandatory to submit the screenshots of accessing digital Resource. Otherwise it will not be evaluated	**Module1-3**	CO3	---	10	5%	
3	Midterm Test	Module-1	CO1,CO2	1 hr	50	25%	
4	End Term Final Examination	Module-1,2,3 & 4	CO1-CO4	3 hrs	100	50%	

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Sl. No.	Assessment type [Include here assessment method for self-learning component also]	List of Tasks	Course outcome Number	Duration In Hours	marks	weightage	Venue, DATE &TIME

5. **COURSE CLEARANCE CRITERIA: : (Here mention the minimum requirements of attendance, marks in continuous assessment &term end examination, make up exam policy and other details as per the academic regulations & PRC):**
   - Minimum of 75% Attendance is must to take up examination.
   - Minimum of 40% score is must in Midterm and Final End Term Examination.
   - However a minimum of 50% of grand total marks or F-grade limit under relative grading, whichever is lower.
   - Make up policy is applicable only as per academic regulation
   - There will be no make-up for ASSIGNMENT and QUIZ.

MAKEUP POLICY:

If the student misses an evaluation component, he/she may be granted a make-up. In case of an absence that is foreseen, make-up request should be personally made to the Instructor-in-Charge, well ahead of the scheduled evaluation component. Reasons for unanticipated absence that qualify a student to apply for make-up include medical emergencies or personal exigencies. In such an event, the student should contact the Instructor-in-Charge as soon as practically possible.

6. **CONTACT TIMINGS FOR ANY DISCUSSIONS:**

Interested students may contact the Instructor In-charge during the student free Hour and Monday (2pm – 4pm) to clear doubts.

Sample Thought Provoking Questions [For Theory Component]:

(Here type sample typical questions for students 'reference)

Sl No.	Question	Marks	Course Outcome No.	Bloom's Level
1.	a. Identify the methods to determine the energy efficiency of a building b. Discuss the process for identifying areas of improvement within a building	8	CO1	Comprehension

Target set for course Outcome attainment:

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Sl.no	C.O. No.	Course Outcomes	Target set for attainment in percentage
01	CO 1	Explain audit parameters and working principles of measuring instruments used to measure the parameters.	60%
02	CO 2	Discuss energy audit of boilers, furnaces, power plant, steam distribution system and compressed air systems	60%
03	CO 3	Explain energy audit of HVAC systems & Motors	60%
04	CO 4	Discuss energy audit of lighting systems and buildings	60%

Signature of the course Instructor

This course has been duly verified Approved by the D.A.C.

Signature of the Chairperson D.A.C.

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Course Code: EEE3048	**Course Title: Power Electronics Applications for Electrical Vehicles** **Type of Course: Discipline Elective & Theory only**	**L-T- P- C**	3	0	0	3
Version No.	1.0					
Course Pre-requisites	ELECTRIC DRIVES					
Anti-requisites	**Nil**					
Course Description	The course includes an overview of system architectures of EV's and system dynamic modeling and control at levels appropriate to determine requirements, also this course introduces a concept of design and control of power converters for electric drive vehicles, also enables to know the various drives used for EV's and energy management in EV's. The course develops an analytical skills and enhances the programming/Simulink modeling abilities through assignments.					
Course Objectives	The objective of the course is to familiarize the learners with the concepts of Power Electronics Applications for Electrical Vehicles and attain **Entrepreneurial Skills** through **Problem Solving** methodologies.					
Course Out Comes	**On successful completion of the course the students shall be able to:** 1] Explain the various technologies are associated with EV's. 2] Describe the architectures of HEV, PHEV and EV's. 3] Analyze the modelling of DC-DC converter systems for EV's. 4] Describe the AC Motor drive operation for EV's 5] Analyze the electrical circuit modelling of Battery system.					
Course Content:						
Module 1	An Overview of Power Electronics in EV's	Assignment	QUIZ/True or FALSE Type	**No. of Sessions: 7**		
Topics: Introduction, Multidisciplinary Technologies (Body Design, Batteries, Electric Propulsion, Intelligent Energy Management), EV Propulsion (Motors, Power Converters, Electronic Controllers), Battery Charging, Power Accessories (Temperature Control Unit, Power Steering, Auxiliary Power Converter Unit. Hybrid Electric Vehicles.						
Module 2	System overview	Assignment	Data Collection rating of various Electric Vehicles	**No. of Sessions:7**		
Topics: Vehicle dynamics, Architectures of hybrid (HEV), plug-in hybrid (PHEV) and electric vehicles (EV), Rating and sizing of drivetrain components.						
Module 3	Bidirectional DC-DC converters	Assignment	Modeling and simulations of DC-DC Converter.	**No. of Sessions: 8**		
Topics: Introduction, Introduction to switched-mode power converters, isolated and non-isolated converters, Steady-state operation, analysis and simulations, Modeling of losses and efficiency.						
Module 4	Inverter Based AC Motor Drives	Assignment	Modeling and simulations	**No. of Sessions: 8**		
Topics: An introduction to AC machine operation and models, Permanent magnet synchronous machine, Induction machine, DC-to-AC inverter operation and controls, advanced control techniques, AC drive modeling.						
Module 5	Energy Management Strategies	Assignment	Modeling and simulations of battery systems	**No. of Sessions:8**		
Topics: An introduction to battery electro- chemistry, Types and characteristics of battery cells, energy, power, cycle life, calendar life, cost, Cell charge/discharge characteristics, electrical circuit modeling, Battery management system, cell balancing, Modeling battery systems.						
Targeted Application & Tools that can be used: The major targeted applications of the course is extended to various fields such as mainly Automotive electrical and electronic systems, commercial, industrial, residential, telecommunication, transportation, utility systems and Aerospace etc. In case of automotive electronics, the electrically-generated systems are used in automobiles such as road vehicles like telematics, in-car entertainment systems, and so on. The need to control engines of automobiles originated in automotive electronics for proper controlling and conversion. Professionally Used Software: MATLAB/Simulink						

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Text Book

1. Ehsani, Mehrdad, Yimin Gao, Stefano Longo, and Kambiz Ebrahimi, "Modern electric, hybrid electric, and fuel cell vehicles", CRC press, 2018, 3rd Edition.
2. Haitham Abu-Rub, Mariusz Malinowski, Kamal Al-Haddad, "Power Electronics for Renewable Energy Systems, Transportation and Industrial Applications",Wiley Publishers, June 2014.

References

1. Yangsheng Xu, Jingyu Yan, Huiihuan Qian and Tin Lun Lam, "Hybrid Electric Vehicle Design and Control: Intelligent Omni directional Hybrids", Mc-Graw Hill Education, 2014.
2. R. Erickson, D. Maksimovic, Fundamentals of Power Electronics, Springer 2001 (Chapters 1-5); on-line access available from CU network.
3. Evaluation of the 2010 Toyota Prius Hybrid Electric Drive System, Oak Ridge National Lab report.
4. Davide Andrea, Battery Management Systems for Large Lithium-Ion Battery Packs, Artech House, 2010.
5. C.Mi, M.A.Masrur, D.W.Gao, Hybrid Electric Vehicles, Wiley 2011.

Online Resources:

1.Ebook:
https://puniversity.informaticsglobal.com:2282/ehost/ebookviewer/ebook/bmxlYmtfXzE2NjQ0OF9fQU41?sid=5ac3e684-9a30-45af-a5c4-a4c437d65a8c@redis&vid=3&format=EB

2.Casestudy:
https://puniversity.informaticsglobal.com:2282/ehost/ebookviewer/ebook/bmxlYmtfXzE2NjYwNV9fQU41?sid=5ac3e684-9a30-45af-a5c4-a4c437d65a8c@redis&vid=4&format=EB

3. Seminar: https://puniversity.informaticsglobal.com/menu
4. https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ee18/
5. https://www.elprocus.com/power-electronics-in-automotive-applications/
6. https://www.energy.gov/eere/vehicles/power-electronics-research-and-development

Topics relevant to "ENTREPRENEURIAL SKILLS": Introduction to switched-mode power converters, vehicle dynamics are for developing **Entrepreneurial Skills** through **Problem Solving** methodologies**.** This is attained through assessment components mentioned in the course handout.

Catalogue prepared by	Mr. Ravi V Angadi & Mr. K Sreekanth Reddy
Recommended by the Board of Studies on	BoS No: 12th BoS held on 27/7/21
Date of Approval by the Academic Council	16th Academic Council Meeting held on 23/10/2021

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(Established under the Presidency University Act, 2013 of the Karnataka Act 41 of 2013)

ACA-2[2020] COURSE HAND OUT

SCHOOL: School of Engineering **DEPARTMENT: EEE** **DATE OF ISSUE:**

NAME OF THE PROGRAM	**: Electrical & Electronics Engineering**
P.R.C. APPROVAL REF	**: PU/AC-16/EEE/2018-2022/2021**
SEMESTER/YEAR	**:**
COURSE TITLE & CODE	**: PWM CONVERTERS - EEE 317**
COURSE CREDIT STRUCTURE	**: 3-0-0-3**
CONTACT HOURS	**: Monday 1:00-1:50 PM**
	: Wednesday: 2PM-2:50PM
	: Friday 3PM-3:50PM
COURSE INSTRUCTOR	**:Mr. Sarin**
COURSE INCHARGE	**: Mr.Sarin**

5. Program Outcomes:

Graduates of the B.Tech. Program in Electrical and Electronics Engineering will be able to:

PO1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

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PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

6. Course Prerequisites:

Electric power generation, Transmission and Distribution

7. Course Description.

As the Smart Grid is the integration of numerous technologies, systems and processes with the aim to modernize and fully automate the entire electricity grid covering generation, transmission, distribution, utilization plus conservation of energy. This course aims at introducing the concepts of SG, its definitions, architectures along with the policies followed by various countries. Also this course includes various technologies pertaining to smart grid, smart metering with power reliability, types of smart meters and its communication interfaces along with its applications in distribution power generation and cyber security. It also deals with aspects of modern substation and automation and also introduces the students to the concept of distribution management system. Lastly it includes the various types of energy storage technologies in smart grid.

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8. Course Objective.

The objective of the course is to familiarize the learners with the concepts of Power Electronics Applications for Electrical Vehicles and attain **Employability Skills** through **Problem Solving** methodologies.

Course Outcomes.

On successful completion of the course the student shall be able to:

CO1 : Understand the basic operations of various PWM techniques for Power Converters

CO2 : Analysis and Design of Control Loops for PWM power converters
CO3 : Explain various topologies of PWM Converters.
CO4 : Summarize various the various power factor improvement in PWM Converters

9. Mapping of Course Outcomes and Program Outcomes:

PO / CO	PO4	PO5	PO6	PO10	PO12
CO1	M	L	L	M	H
CO2	H	L	M	M	H
CO3	H	L	L	L	H
CO4	H	M	L	M	H

10. Course content: (Syllabus)

Module-I: Introduction to PWM Converters

AC/DC and DC/AC power conversion, overview of applications of voltage source converters, pulse modulation techniques for bridge converters. **[7 Sessions][Blooms Level Selected: Knowledge]**

Module-II: PWM Techniques

Bus clamping PWM, space vector based PWM, advanced PWM techniques, practical devices in converter; calculation of switching and conduction losses. **[14 Sessions][Blooms Level Selected: Comprehensive]**

Module-III: Multi Level Converters

Compensation for dead time and DC voltage regulation; dynamic model of a PWM converter, multilevel converters. **[10 Sessions][Blooms Level Selected: Comprehensive]**

Module-IV: Power factor improvements

Estimation of current ripple and torque ripple in inverter fed drives; line – side converters with power factor compensation.

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[5 Sessions][Blooms Level Selected: Knowledge]

11. Delivery Procedures:

- **The teaching pedagogy adopted here in this course are Explaining, Lecturing, Demonstrating, Collaborating and Facilitating.**

Topics for Self-learning:

- The Main Features of SG

Topics for Participative Learning:

- Major Challenges in design of SG.

Topics for Technology Enabled Learning.

- Smart Grid Road Map for India.
- Smart Grid Developments in India

Topics for Problem Based Learning:

- Demand Side Management in India

12. Learning Materials: All the Articles are from standard reputed journals. Along with this the **class notes** also will be given.

Text Book: "Smart Grid Technologies and Applications" Janaka Ekanayake et al, Wiley 2012.

Research Articles:

- Introduction to Smart Grid.
- Smart Grid Initiatives in India.
- Introduction to Smart Grid Architecture.
- Demand response in smart electricity grids equipped with renewable energy sources: A review
- IoT-enabled Smart Grid via SM: An Overview.

13. Guidelines to Students:

- A Separate note book and attendance is mandatory.
- Late comers to the class is not entertained.
- Prior Intimation has to be done before taking the leave.
- Continues access to Edhitch portal for all the important documents.
- Students are advised to go through all the available diverse technologies for SG
- The assignments given are viewed seriously, on time submission is a prerequisite.
- As it's a course based on theory, students are asked to understand the concept by reading the given research articles and class notes.
- Absent during class test and assignment hours is not entertained which may affect the qualitative assessment.

14. Course Schedule

S.No	Activity	Date Of Start	Date Of End	Total No. of Hours
Course Integration: Module – 1.				

1	Module : 01			7
Course Integration: Module – 2.				
2	Module : 02			14
3	IA-1			60 Min
Course Integration: Module – 3.				
4	Module : 03			10
Submission of Digital Assignment for Module 1, 2 DOS: 12th MAY' 2022.				
5	IA – 2			60 Min
Course Integration: Module – 4.				
6	Module : 04			5
Submission of Digital Assignment for Module 3, 4. DOS: 20th Nov' 2020.				
7	Term End Examination			

- **Digital Assignments can be also hand written by mentioning proper details. The diagrams should not be drawn in free hand. The written documents are to be scanned using Cam Scanner and convert them into a PDF for submission.**

- **The aforementioned dates may be considered as tentative. Changes can be done accordingly.**
- **DA's have to be done individually. Similar documents are not considered for assessment.**

15. Schedule Of Instruction

S. No	Session No (Tentative Dates)	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Text Books and Reference Books
Module: 1: Basic Concepts of Smart Grid.						
1	L1	Basic Concepts of Smart Grid	Introduction and Definitions, Objectives, Benefits of SG	CO1	Lecture/Online Classroom	T1 Ch 1
2	L2		Comparison of Traditional Grid and SG, SG Domains	CO1	Lecture	T1 Ch 1
3	L3		Aims and Technologies of SG.	CO1	Lecture	T1 Ch 1
4	L4		Functions of SG	CO1	Lecture	T1 Ch 1

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5	L5		Policies of SG by different Countries	CO1	Lecture	T1 Ch 1
6	L6		Issues and Challenges of SG	CO1	Lecture	T1 Ch 1
7	L7		Characteristics of SG ,overview of technologies for SG	CO1	Lecture	T1 Ch 1
Module-2: Communication technologies and information security in Smart Grid and smart metering.						
8	L8	Communication technologies and information security in Smart Grid and smart metering.	Data communication - Dedicated and shared communication channels	CO2	Lecture	T1 Ch 2
9	L9		Communication channels - Switching techniques	CO2	Lecture	T1 Ch 2
10	L10		Layered architecture and protocols	CO2	Lecture	T1 Ch 2
11	L11		Information security for the Smart Grid	CO2	Lecture	T1 Ch 4
12	L12		-Encryption-decryption methods	CO2	Lecture	T1 Ch 4
13	L13		Authentication-Digital signatures-	CO2	Lecture	T1 Ch 4
14	L14		Authentication-Digital signatures	CO2	Lecture	T1 Ch 4
15	L15		Advanced Metering Infrastructure Technology (AMI)	CO2	Lecture	T1 Ch 5
16	L16		Smart meters: An overview of the hardware used	CO2	Lecture	T1 Ch 5

17	L17		Smart meters: An overview of the hardware used	CO2	Lecture	T1 Ch 5
18	L18		Communications infrastructure and protocols for smart metering	CO2	Lecture	T1 Ch 5
19	L19		Communications infrastructure and protocols for smart metering	CO2	Lecture	T1 Ch 5
20	L21		Demand-side integration	CO2	Lecture	T1 Ch 5
MODULE 3: Distribution Automation and DMS						
21	L22		Distribution automation equipment Introduction	CO3	Lecture	T1 Ch 6
22	L23		Substation automation equipment	CO3	Lecture	T1 Ch 6
24	L24		Components of modern substation	CO3	Lecture	T1 Ch 6
25	L25		Faults in distribution systems	CO3	Lecture	T1 Ch 6
26	L26		Voltage regulation	CO3	Lecture	T1 Ch 6
27	L27		Distribution Management Systems– Introduction	CO3	Lecture	T1 Ch 7
28	L28		SCADA	CO3	Lecture	T1 Ch 7
29	L29		Modelling and analysis tools	CO3	Lecture	T1 Ch 7
30	L30		Applications of DMS	CO3	Lecture	T1 Ch 7

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31	L31		Applications of DMS	CO3	Lecture	T1 Ch 7
MODULE 4:Energy Storage Technologies in SG						
32	L32	Energy Storage Technologies in SG.	Energy Storage system – Introduction	CO4	Lecture	T1 Ch 10
33	L33		Application areas of Energy storage systems	CO4	Lecture	T1 Ch 10
34	L34		Application areas of Energy storage systems	CO4	Lecture	T1 Ch 10
35	L35		Different Energy storage technologies.	CO4	Lecture	T1 Ch 10
36			Different Energy storage technologies. Revision from 17th Nov-10th Dec 20	CO4	Lecture	T1 Ch 10

Topics relevant to "ENTREPRENEURIAL SKILLS": Introduction to switched-mode power converters, vehicle dynamics are for developing **Entrepreneurial Skills** through **Problem Solving** methodologies**.** This is attained through **Assignment** components as mentioned in the Components.

16. Assessment Schedule:

Component	Duration (minutes)	% Weightage	*Date & Time	Syllabus
Assignment	**20**	**10**		
Test 1	60	15		
Test 2	60	15		
*End Term Final Examinations	100	50		
Assignment Review of digital/e-resources from Pres. Univ.link given in the references		10		Assignments

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section (Mandatory to submit the screenshots of accessing digital Resource. Otherwise it will not be evaluated				
* Final Date & Time and Venue will be notified by the COE later.				

17. Course Clearance Criteria

- Minimum of 75% Attendance is a prerequisite for take up of examination.
- Minimum of 40% is mandatory for Internal Assessment.
- Minimum of 30% in the Term End Examination..

18. Contact Timings In The Chamber For Any Discussions:

- Thusday (9AM to 11AM).

19. Sample Thought Provoking Questions

- Power line communication simulation tools, Libraries etc available?
- Credit to ICT or ICT based Products?
- Suitable Areas of research in SG?
- Best plat form to design battery bank Simulator?
- How to develop simulation and prediction tools for demand side management in SG?

20. Target Set For Course Outcome Attainment:

S.NO	Course Outcome	CO's	Target Set for Attainment in %
1	CO1	**Relate** the concepts of traditional grid to Smart Grid.	50%
2	CO2	**Discuss** the aspects of communication and information technologies in Smart grid and smart Metering.	50%
3	CO3	**Discuss** the components of modern substation and Distribution management system	55%
4	CO4	**Distinguish** different types of Energy storage Technologies in Smart Grid	60%

21. Course completion Table

Sl. No.	Activity As listed in the course Schedule	Scheduled Completion Date	Actual Completion Date	Remarks

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1	Module-1			
2	Module-2			
3	Module-3			
4	Module-4			
5	Test-1			
6	Test-2			

Course Outcome Attainment:

C.O No.	Course Outcomes	Target set for attainment in percentage	Actual C.O. Attainment In Percentage	Remarks on attainment & Measures to enhance the attainment
01	**Relate** the concepts of traditional grid to Smart Grid.			
02	**Discuss** the aspects of communication and information technologies in Smart grid and smart Metering.			
03	**Discuss** the components of modern substation and Distribution management system			
04	**Distinguish** different types of Energy storage Technologies in Smart Grid			

Signature of the course Instructor:

This course has been duly verified Approved by the D.A.C.

Signature of the Chairperson D.A.C.

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Course Code: EEE3036	**Course Title:** Battery Management Systems **Type of Course:** Discipline Elective & Theory only	**L-P- C**	3	0	3
Version No.	1.0				
Course Pre-requisites	**NIL**				
Anti-requisites	**NIL**				
Course Description	This course will provide a firm foundation on the architecture and functioning of battery-management-system, how Lithium-ion batteries work and how to model their behavior mathematically. It also gives an exposure to the role of battery management system in Electric Vehicles. The course is of analytic type which involves building the equivalent circuit models of batteries and learning various algorithms. The course develops analytical and problem-solving abilities.				
Course Objectives	The objective of the course is to familiarize the learners with the concepts of Battery Management Systems and attain **Entrepreneurial Skills** through **Problem Solving** methodologies.				
Course Out Comes	On successful completion of the course the students shall be able to: 1. Summarize the basic components and functionality of the Battery Management System 2. Discuss various requirements and topologies of Battery Management System. 3. Explain various algorithms used in Battery Management System 4. Describe the Battery Management System of Electric Vehicles. 5. Describe the function of battery in electric vehicle application.				
Course Content:					
Module 1	Introduction to Battery Management Systems	Assignment	Data Analysis		**6 Sessions**
Topics: Introduction to Battery Management Systems (BMS), important terminology used to describe battery cells, Architecture of BMS, Classification of BMS, principles of operation of standard electrochemical battery cells.					
Module 2	Lithium-ion cells				**8 Sessions**
Topics: Lithium-ion cells - Advantages of Lithium-ion cells over standard electrochemical battery cells, primary components of Lithium-ion cells, and their working. Equivalent circuit model Lithium – ion cells and the simulation					
Module 3	BMS requirements & BMS Topologies	Assignment	Problem Solving		**6 Sessions**
Topics: BMS requirements - Requirements for sensing and high-voltage control, requirements for protection, interface, performance management, and diagnostics, BMS Topologies - Distributed topology, modular topology and centralised topology					
Module 4	Algorithms used in BMS	Assignment	Problem Solving		**8 Sessions**
Topics: Algorithms used in BMS - Cell Balancing Algorithm, Communication Algorithms, Battery Pack Balancing and Power Estimation, numerical					

Module 5	BMS in Electric Vehicles	Assignment	Problem Solving	**6 Sessions**

Topics: BMS in Electric Vehicles- Functions of BMS in EVs and HEVs, IoT-Based Battery Management System for EVs

Targeted Application & Tools that can be used:

BMS is an integral part of smart phones, EVs and HEVs, Laptops etc.

Software tools: Matlab/Simulink can be used to model and test BMS model.

TextBooks

1. Davide Andrea, "Battery management Systems for Large Lithium-Ion Battery Packs", Artech House, 2010.
2. Battery Management Systems, Volume I: Battery Modeling **by Gregory L. Plett**

References

1. Iqbal Hussain, "Electric and Hybrid Vehicles-Design Fundamentals", CRC Press, Second Edition, 2011.
2. Chris Mi, MA Masrur, and D W Gao, "Hybrid Electric Vehicles- Principles and Applications with Practical Perspectives", Wiley, 2011
3. Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles; Fundamentals Theory and Design", Second Edition, CRC Press.

Online resources:

1. https://puniversity.informaticsglobal.com/openFullText.html?DP:2232/cgi-bin/koha/opac-detail.plbiblionumber=8072&query_desc=kw%2Cwrdl%3A%20Electronic%20Devices%20and%20Circuits
2. https://www.coursera.org/learn/battery-management-systems
3. https://www.youtube.com/watch?v=MZyY1dpka7c
4. https://www.youtube.com/watch?v=jFMvphaEiJs

Topics relevant to " ENTREPRENEURIAL SKILLS": BMS in Electric Vehicles, Functions of BMS in EVs and HEVs, IoT-Based Battery Management Systems for EVs for developing **Entrepreneurial Skills** through **Problem Solving** methodologies**.** This is attained through assessment components mentioned in the course handout.

Topics relevant to "ENVIRONMENT AND SUSTAINABILITY": Battery cells, Lithium-ion cells, Battery Pack Balancing and Power Estimation.

Catalogue prepared by	Ms. Ramya N
Recommended by the Board of Studies on	BoS No: 12th BoS held on 27/7/21
Date of Approval by the Academic Council	16th Academic Council Meeting held on 23/10/2021

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PRESIDENCY UNIVERSITY

(Established under the Presidency University Act, 2013 of the Karnataka Act 41 of 2013)

[2022-23 EVEN/ WINTER SEMESTER]

COURSE HANDOUT

SCHOOL: Engineering **DEPT: EEE** **DATE OF ISSUE:16-02-2023**

NAME OF THE PROGRAM :B.Tech

P.R.C.APPROVAL REF. : PU/AC-18.5/EEE15/EEE/2021-2025

SEMESTER/YEAR : **IV/II**

COURSE TITLE & CODE : **Battery Management Systems & EEE3036**

COURSE CREDIT STRUCTURE :**3-0-3**

CONTACT HOURS : **3 periods per week**

COURSE IC : **Mr. Sunil Kumar A V**

COURSE INSTRUCTOR(S) : **Mr. Sunil Kumar A V**

COURSE URL : **www.camu.in**

PROGRAM OUTCOMES :

PO1. **Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.**

PO2. **Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.**

PO3. **Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.**

PO4. **Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.**

PO5. **Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.**

PO6. **The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.**

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PO7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

COURSE PREREQUISITES:

NIL

COURSE DESCRIPTION:

This course will provide a firm foundation on the architecture and functioning of battery-management-system, how Lithium-ion batteries work and how to model their behaviors mathematically. It also gives an exposure to the role of battery management system in Electric Vehicles. The course is of analytic type which involves building the equivalent circuit models of batteries and learning various algorithms. The course develops analytical and problem-solving abilities.

COURSE OBJECTIVE: The objective of the course is to familiarize the learners with the concepts of Battery Management Systems and attain **Entrepreneurial Skills** through **Problem Solving** methodologies.

COURSE OUTCOMES: On successful completion of the course the students shall be able to:

TABLE 1: COURSE OUTCOMES

CO Number	CO	Expected BLOOMS LEVEL
CO1	Summarize the basic components and functionality of the Battery Management System	**Comprehension**
CO2	Discuss various requirements and topologies of Battery Management System	**Comprehension**
CO3	Explain various algorithms used in Battery Management System	**Application**
CO4	Describe the Battery Management System of Electric Vehicles.	**Application**
CO5	Describe the function of battery in electric vehicle application	**Application**

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MAPPING OF C.O. WITH P.O:

[H-HIGH , M- MODERATE, L-LOW]

TABLE 2: CO PO MappingARTICULATION MATRIX												
CO. No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	H	L	L		H	H	M	L		H	L	L
CO2	L	M	M							L	M	M
CO3	H									H		
CO4	H									H		L
CO5	H	L	H		L		H					M

COURSE CONTENT (SYLLABUS):

Module:1

Introduction to Battery Management Systems

Topics: Introduction to Battery Management Systems (BMS), important terminology used to describe battery cells, Architecture of BMS, Classification of BMS, principles of operation of standard electrochemical battery cells.

[06 Sessions][Blooms 'level selected: Comprehension]

Module 2

Lithium-ion cells

Topics: Lithium-ion cells - Advantages of Lithium-ion cells over standard electrochemical battery cells, primary components of Lithium-ion cells, and their working. Equivalent circuit model Lithium – ion cells and the simulation

[08 Sessions] [Blooms 'level selected: Comprehension]

Module :3

BMS requirements & BMS Topologies

Topics**:** BMS requirements - Requirements for sensing and high-voltage control, requirements for protection, interface, performance management, and diagnostics BMS Topologies - Distributed topology, modular topology and centralized topology

.

[06Sessions] [Blooms 'level selected: Comprehension]

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Module: 4

Algorithms used in BMS

Topics:Algorithms used in BMS - Cell Balancing Algorithm, Communication Algorithms
Battery Pack Balancing and Power Estimation, numerical

[8 Sessions] [Blooms 'level selected: Application]

Module: 5

BMS in Electric Vehicles
Topics: BMS in Electric Vehicles- Functions of BMS in EVs and HEVs, IoT-Based Battery Management System for EVs

[6 Sessions] [Blooms 'level selected: Application]

DELIVERY PROCEDURE (PEDAGOGY):

TABLE 3: SPECIAL DELIVERY METHOD/ PEDAGOGY PLANNED WITH TOPICS				
S. No	**Lecture Number**	**Subtopic as per lesson Plan**	**Pedagogy title/ short explanation of adopted pedagogy**	**** At end of semester please update whether activity was done**
1	**L-16**	Design of Lithium ion Battery Pack	**Mathematic Model**	**Done**
2	**L-22**	BMS Technology	**Animation type of video learning on BMS with Quiz n BMS**	**Done**
	L-36	Simulation model on Cell Balancing	**Self-learning: Students will be construct simulation model and submit the report,**	**Done**
3		Develop a Different parts of the BMS using MATLAB/Simulink	**Participative Learning: Students will be divided into groups and task will be given.**	**Done**
4	**L-37**	BMS in EVs and HEVs	**Technology Enabled Learning: Video link will be played and students will be asked to answer the questionnaire.**	**Done**

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5	**L41**	Battery Manufacturing Industry visit.	**Experiential Learning: Students will be taken to field visit and they are asked to submit the assignment.**	**Not Done But** **Shown Industry manufacturing process Video in Class hours.**

REFERENCE MATERIALS:

Text Book(s):

1. Davide Andrea, "Battery management Systems for Large Lithium-Ion Battery Packs",Artech House,2010.
2. Gregory L. Plett, “Battery Management Systems, Volume I: Battery Modeling”, Artech House, 2015.

Reference book(s):

4. Iqbal Hussain, "Electric and Hybrid Vehicles-Design Fundamentals", CRC Press, Second Edition, 2011.
5. Chris Mi, MA Masrur, and D W Gao, "Hybrid Electric Vehicles- Principles and Applications with Practical Perspectives", Wiley, 2011
6. Mehrdad Ehsani, Yimin Gao, Ali Emadi, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles; Fundamentals Theory and Design”, Second Edition, CRC Press.

Online resources

1. https://www.youtube.com/watch?v=K4sHbvpH5N0&list=PLTkAyZQDGrLaIbPapiWv55MTUn8b3nkKY
2. https://www.sciencedirect.com/science/article/pii/S2352484722005716
3. https://onlinelibrary.wiley.com/doi/10.1002/9781119682035.ch1
4. https://puniversity.informaticsglobal.com:2282/ehost/detail/detail?vid=3&sid=15d54a1f-070b- 4419-b1d2

SPECIFIC GUIDELINES TO STUDENTS:

1. Understand the importance of BMS for varies Application.
2. Different types of Batteries and latest technologies.
3. Refer to online videos in NPTEL and Battery University Documents.
4. Follow up classes/lecture regularly.
5. Practice the concept using simulink mode using Matlab/Simulink

COURSE SCHEDULE:

TABLE 4: COURSE BROAD SCHEDULE

Sl. No.	ACTIVITY	PLANNED STARTING DATE	PLANNED CONCLUDING DATE	TOTAL NUMBER OF PERIODS
01	**Programme/Course Integration-1**	**17-2-2023**	**17-2-2023**	**01**
02	**Module :01**	**20-2-2023**	**10-3-2023**	**10**
03	**Module:02**	**13-03-2023**	**29-03-2023**	**10**

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	QUIZ (Online)	**31-03-2023**	**31-03-2023**	**01**
04	**Mid Term**	**12-04-2023**	**15-04-2023**	
05	**Mid TermEvaluation**	**17-04-2023**	**17-04-2023**	**01**
06	**CourseIntegration-3**	**24-04-2023**	**24-04-2023**	
07	**Module:03**	**31-04-2023**	**21-05-2023**	**09**
08	**Module:04**	**24-04-2023**	**19-5-2023**	**11**
	Develop a Different parts of the BMS using MATLAB/Simulink	**19-5-2023**	**19-5-2023**	**01**
09	**Module:05**	**22-05-2023**	**02-06-2023**	**06**
	Field Visit	**31-05-2023**	**31-05-2023**	**-**
10	**EndtermExams**	**7-06-2023**	**24-06-2023**	**03**

DETAILED SCHEDULE OF INSTRUCTION:

1) **PPT+Chalk.**
2) **Group Discussion by students.**
3) **Participative learning by Simulink assignments**
4) **Technology enabled learning.**
5) **Problem based learning**
6) **Experiential learning by field visit.**

TABLE 5: DETAILED COURSE SCHEDULE/ LESSON PLAN

Session no	TOPIC	Subtopic	CONumber	Reference
1	Programmeintegration-1	Introduction and BMS functionality	CO1	T1
2	Courseintergration-1	Battery pack topology	CO1	T1
3	Introduction to Battery Management Systems	BMS Functionality	CO1	T1
4	Introduction to Battery Management Systems	BMS Functionality	CO1	T1,R3
5	Introduction to Battery Management Systems	Requirement 1d: High-voltage contactor control Requirements 1e–f: Isolation sensing and thermal control	CO1	T1

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6	Introduction to Battery Management Systems	Thermal control Revision	CO1	T1
7	Introduction to Battery Management Systems	Types of Batteries	CO1	T1
8	Introduction to Battery Management Systems	Classification of Batteries	CO1	T1
9	Introduction to Battery Management Systems	Parameters of Battries	CO1	T1
10	Introduction to Battery Management Systems	Parameters of Battries	CO1	T1
11	Lithium-ion cells	Advantages of Lithium-ion cells over standard electrochemical battery cells,	CO2	T1
12	Lithium-ion cells	Modeling approach #1: Equivalent-circuit models, Equivalent-circuit models (ECMs), Physics-based models (PBMs) Modeling approach #1: Empirical	CO2	T1
13	Lithium-ion cells	Simulation of lithium ion cells	CO2	T1,R1, R3
14	Lithium-ion cells	Simulation of lithium ion cells	CO2	T1
15	Lithium-ion cells	Discussion of code for simulating battery packs	CO2	T1
16	Lithium-ion cells	design of lithium ion battery pack	CO2	T1
17	Lithium-ion cells	practice session on how to make battery pack	CO2	T1
16	BMS requirements & BMS Topologies	BMS Development	CO3	T1
17	BMS requirements & BMS Topologies	Current Sensor	CO3	T1
18	BMS requirements & BMS Topologies	Current Sensor management, and diagnostics	CO3	T1,R3
19	BMS requirements & BMS Topologies	requirements for protection, interface BMS Topologies	CO3	T1
20	BMS requirements & BMS Topologies	BMS Topologies	CO3	T1

21	BMS requirements & BMS Topologies	distributed topology	CO3	T1
22	BMS requirements & BMS Topologies	modular topolgy	CO3	T1
23	BMS requirements & BMS Topologies	centralised topology	CO3	T1
17	Algorithms used in BMS	Algorithms used in BMS - Cell Balancing Algorithm	CO4	T1
18	Algorithms used in BMS	Algorithms used in BMS - Cell Balancing Algorithm	CO4	T1,R3
19	Algorithms used in BMS	Algorithms used in BMS - Cell Balancing Algorithm	CO4	T1,R3
20	Algorithms used in BMS	Communication Algorithms	CO4	T1,R3
21	Algorithms used in BMS	Communication Algorithms	CO4	T1,R3
22	Algorithms used in BMS	Communication Algorithms	CO4	T1,R3
23	Algorithms used in BMS	Mid Term	CO4	T1,R3
24	Algorithms used in BMS	Mid Term evaluation	CO4	T1,R3
25	Algorithms used in BMS	Battery Pack Balancing and Power Estimation	CO4	T1,R3
26	Algorithms used in BMS	Battery Pack Balancing and Power Estimation	CO4	T1,R3
27	Algorithms used in BMS	Battery Pack Balancing and Power Estimation	CO4	T1,R3
28	Algorithms used in BMS	Battery Pack Balancing and Power Estimation	CO3	T1
29	Algorithms used in BMS	Battery Pack Balancing and Power Estimation	CO3	T1
30	Algorithms used in BMS	Battery Pack Balancing and Power Estimation	CO3	T1
31	Algorithms used in BMS	Battery Pack Balancing and Power Estimation	CO3	T1

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32	Algorithms used in BMS	Battery Pack Balancing and Power Estimation	CO3	T1
33	Algorithms used in BMS	Battery Pack Balancing and Power Estimation	CO3	T1
34	BMS in Electric Vehicles	Functions of BMS in EVs and HEVs	CO5	T1
35	BMS in Electric Vehicles	Functions of BMS in EVs and HEVs	CO5	T1
36	BMS in Electric Vehicles	Functions of BMS in EVs and HEVs	CO5	R2
37	BMS in Electric Vehicles	Program Integration		
38	BMS in Electric Vehicles	Application of BMS	CO5	R2
39	BMS in Electric Vehicles	Program Integration	CO5	R2
40	BMS in Electric Vehicles	IOT-Based battery management System for EV	CO5	R2
41	Field visit	Field visit	CO5	R2
42	BMS in Electric Vehicles	IOT-Based battery management System for EV	CO5	R2

Topics relevant to "ENTREPRENEURIAL SKILLS": BMS in Electric Vehicles, Functions of BMS in EVs and HEVs, IoT-Based Battery Management Systems for EVs for developing **Entrepreneurial Skills** through **Problem Solving** methodologies . This is attained through the **Assignment** as mentioned in the assessment component.

Topics relevant to "ENVIRONMENT AND SUSTAINABILITY": Battery cells, Lithium-ion cells, Battery Pack Balancing and Power Estimation.

ASSESSMENT SCHEDULE:

TABLE 6 ASSESSMENT SCHEDULE

Sl.no	Assessment type[Include here assessment method for self-learning component also]	Contents	Course outcome Number	Duration In Hours	Marks	Weightage	Venue, DATE &TIME
1	**Assignment**	**Module-1**	**CO-1**	**0.5 Hours**	**20**	**5%**	**01.06.2023**

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	Problem Solving						
2	**Midterm**	**Module 1&2**	**CO-1 & CO-2**	**1.5Hours**	**50**	**25%**	**15.04.2023**
3	**Assignment on Simulink Model Development**	**Module-2 and Module-3**	**CO-2&CO-3**	**8 Hours**	**10**	**10%**	**02.06.2023**
4	**Assignment 2** Review of digital / e-resources from Pres. Univ. link given in the References Section -(Mandatory to submit the screenshot of accessing digital resource. Otherwise it will not be evaluated)	**Module-4** https://.puniversityinformaticsglobal.com/login?qurl=https://search.ebscohost.com%2flogin.aspx%3fdirect%3dtrue%26db%3dnlebk%26AN%3d1223875%26site%3dehost-live%26ebv%3dEB%26ppid%3dpp_xiii	**CO-3**		**10**	**5%**	Will be announced one week prior to Submission
5	**Field Visit**	**Module-5**	**CO-4**		**10**	**5%**	
6	**Endterm examination**	**Module1 to Module-4**	**CO-1 to CO-4**	**3 hours**	**100**	**50%**	

COURSE CLEARANCE CRITERIA:

"AS PER ACADEMICREGULATIONS OF THE UNIVERSITY"

https://presidencyuniversity.in/academic-regulations/

MAKEUP EXAM POLICY:

"AS PER ACADEMICREGULATIONS OF THE UNIVERSITY")

CONTACT TIMINGS IN THE CHAMBER FOR ANY DISCUSSIONS:

SAMPLE THOUGHT PROVOKING QUESTIONS:

SL NO	QUESTION	MARKS	COURSE OUTCOME NO.	BLOOM'S LEVEL
1.	A cell is different from a battery, but many people (including me at times!) use the term "battery" to describe any electrochemical energy source, even if it is a single cell, and this	8	CO1	Comprehension

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	can lead to confusion. A battery constructed from three 3 V, 20 Ah cells in series. Comment on the nominal voltage, nominal capacity and nominal energy capacity of the battery.			
2.	Specific energy and energy density measure the maximum stored energy per unit weight or volume (respectively). For a given weight, higher specific energy stores more energy. For a given storage capacity, higher specific energy cells are lighter. For a given storage capacity, higher energy density cells are smaller. In that context explain the advantages of Li-ion cells.	8	CO1	Comprehension
3.	Due to the limitations found on commercial available BMSs it was decided to develop a new BMS module from the scratch using available blocks from main IC manufacturers and add the required "intelligence" and flexibility to test different charge, discharge, cell balancing and parameter estimation algorithms. In that context discuss about all the preliminary requirements of BMS.	10	CO2	Comprehension
4.	Cell balancing is the process of equalizing the voltages and state of charge among the cells when they are at a full charge. No two cells are identical. There are always slight differences in the state of charge, self-discharge rate, capacity, impedance, and temperature characteristics. Referring to the above context, discuss the flowchart of cell balancing	8	C03	Comprehension
5.	Even the best battery cells will fail if they are abused. Bad things to do to a cell include (internal) overcharge, undercharge, overtemperature. Several possible failure modes associated with complete cell breakdown; rarely possible to predict which will occur. Explain all the failure modes associated with that of a battery	8	C04	Comprehension

TARGET SET FOR COURSE OUTCOME ATTAINMENT:

TABLE 8: TARGET SET FOR ATTAINMENT OF EACH CO and ATTAINMENT ANALYSIS					
Sl.no	C.O. No.	Course Outcomes	Target set for attainment in percentage	Actual C.O. Attainment in Percentage	Remarks on attainment & measures to enhance the attainment

01	C01	Summarize the basic components and functionality of the Battery Management System	60%		The students are new to the course, and it took time to understand the topic.
02	C02	Discuss various requirements and topologies of Battery Management System.	50%		Desired attainment is achieved
03	CO3	Explain various algorithms used in Battery Management System	60%		Desired attainment is achieved
04	CO4	Describe the Battery Management System of Electric Vehicles.	60%		Desired attainment is achieved
05	CO5	Describe the function of battery in electric vehicle application.	55%		Desired attainment is achieved

AFTER RESULTS

Sl.no	**C.O. No.**	**Course Outcomes**	**Threshold Set for the CO**	**Target set for attainment in percentage**	Actual C.O. Attainment In Percentage *	Remarks on attainment &Measures to enhance the attainment *

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01	CO1	Summarize the basic components and functionality of the Battery Management System	50%	60%		
02	CO2	Discuss various requirements and topologies of Battery Management System	60%	60%		
03	CO3	Explain various algorithms used in Battery Management System	55%	50%		
04	CO4	Describe the Battery Management System of Electric Vehicles.	60%	60%		
05	CO5	Describe the function of battery in electric vehicle application.	60%	60%		

Signature of the course Instructor In-Charge (s)

APPROVAL:

This course has been duly verified Approved by the D.A.C.

Signature of the Chairperson D.A.C.

Name and signature of theInstructor In-Charge (s):

Name and signature of the DAC Chairperson:

Course Code: EEE1005	**Course Title: Electric Vehicles & Battery Technology** **Type of Course: Open Elective and Theory only**	**L- T-P- C**	**3**	**0**	**0**	**3**
Version No.	1.0					
Course Pre-requisites	NIL					
Anti-requisites	NIL					
Course Description	The Course is designed with an objective of giving an overview of Electric Vehicles and battery technology. The Course discusses the history, configurations of Electric vehicles and the electrical characteristics of batteries. The Course is conceptual and analytical in nature and needs fair knowledge of mathematical computation. The course develops the critical thinking and analytical skills.					
Course objective	The objective of the course is to familiarize the learners with the concepts of Electric Vehicles & Battery Technology and attain **Entrepreneurial Skills** through **Problem Solving** methodologies.					
Course Outcomes	On successful completion of this course the students shall be able to: 1. Explain the working of Electric Vehicles and recent trends 2. Explain the working of Hybrid Electric Vehicles and recent trends 3. Describe about the battery characteristic & parameters. 4. Summarize the importance of battery management system.					
Course Content:						

Module 1	Electric Vehicles	Assignment	Computation and Data Analysis	11 Sessions
Topics: History of Electric vehicles, Configuration of Electric Vehicles, Performance of Electric Vehicles,Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving, Energy consumption.				
Module 2	Hybrid Electric Vehicles	Case Study	Data collection and Analysis	10 Sessions
Topics: Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains.				
Module 3	Energy storage for EV and HEV	Assignment	Any energy storage device	11 Sessions
Topics: Energy storage requirements, Battery parameters, Types of Batteries, Modelling of Battery, Fuel Cell basic principle and operation, Types of Fuel Cells.				
Module 4	Battery Management Systems (BMS	Assignment	Case study	12 Sessions
Topics: Introduction to Battery Management Systems (BMS), important terminology used to describe battery cells, Architecture of BMS, Classification of BMS, principles of operation of standard electrochemical battery cells.				

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Targeted Application & Tools that can be used:

Application: Automotive industry.

Software tools: Matlab-Simulink

Text Book

1. Mehrdad Ehsani, YiminGao, sebastien E. Gay and Ali Emadi, ―Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design‖, CRC Press, 2009.
2. Iqbal Husain, ―Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2011.

References

1. James Larminie and John Loury, ―Electric Vehicle Technology-Explained‖, John Wiley & Sons Ltd., 2003.

2.C.C. Chan and K.T. Chanu Modern Electric Vehicle Technology, OXFORD University, 2011

3.Sheldon S. Williamson,- Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Springer,2013

4. Chris Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.

Online resources:

1. https://nptel.ac.in/courses/108/102/108102121/
2. https://nptel.ac.in/courses/108/106/108106170/
3. Text book of Electric and Hybrid Vehicles : Power Sources, Models, Sustainability, Infrastructure and the Market, Gianfranco Pistoia, 1st ed. Amsterdam : Elsevier. 2010 https://puniversity.informaticsglobal.com:2284/ehost/detail/detail?vid=0&sid=52da4e6e- 8813-45d5-87f9- 73b9f493f358%40redis&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d#AN=342445&db=nlebk
4. Seminar https://puniversity.informaticsglobal.com:2069/search/searchresult.jsp?newsearch=true&queryText=electric%20vehicles
5. Case Study: Data collection/Quiz based on the basics of batteries and the characteristics of energy storage devices used in EVs.

Topics relevant to "ENTREPRENEURIAL SKILLS": Vehicle fundamentals, total tractive effort and design of drive train for different vehicle architectures for developing **Entrepreneurial Skills** through **Problem Solving methodologies**. This is attained through assessment component mentioned in course handout.

Topics relevant to "ENVIRONMENT AND SUSTAINABILITY": Types of Batteries, Materials of battery used, Fuel cell.

Catalogue prepared by	Mr. K Sreekanth Reddy
Recommended by the Board of Studies on	BoS No:14th BoS held on 22/2/2022
Date of Approval by the Academic Council	18th Academic Council meeting held on 03/8/2022

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PRESIDENCY UNIVERSITY

(Established under the Presidency University Act, 2013 of the Karnataka Act 41 of 2013)

A-2[2020] COURSE HAND OUT

SCHOOL: Engineering	**DEPT.: EEE**	**DATE OF ISSUE: 23/03/2022**

NAME OF THE PROGRAM : **B.TECH**

P.R.C. APPROVAL REF. : **PU/AC-16/EEE/2020-2024/2021**

SEMESTER/YEAR : **IV / 2nd**

COURSE TITLE & CODE : **Electric Vehicles and Battery Technology & EEE1005**

COURSE CREDIT STRUCTURE : **3-0-0-3**

CONTACT HOURS : **3 (Mon 5th hr, Wed 6th hr, Fri 7th hr)**

COURSE INSTRUCTOR : **Mr. K Sreekanth Reddy**

COURSE URL : **https://www.edhitch.com**

PROGRAM OUTCOMES:

Graduates of the B.Tech. Program in Electrical and Electronics Engineering will be able to:

PO1.Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.(H)

PO2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.(H)

PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.(L)

PO6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.(L)

PO11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.[L]

COURSE PREREQUISITES: NIL

COURSE DESCRIPTION:

The Course is designed with an objective of giving an overview of Electric Vehicles and battery technology. The Course discusses the history, configurations of Electric vehicles and the electrical characteristics of batteries. The Course is conceptual and analytical in nature and needs fair knowledge of mathematical computation. The course develops the critical thinking and analytical skills.

COURSE OBJECTIVES:

The objective of the course is to familiarize the learners with the concepts of Electric Vehicles & Battery Technology and attain **Entrepreneurial Skills** through **Problem Solving** methodologies.

COURSE OUTCOMES: On successful completion of the course the students shall be able to:

1. Explain the working of Electric Vehicles and recent trends

2. Explain the working of Hybrid Electric Vehicles and recent trends

3. Describe about the battery characteristics & parameters.

4. Summarize the importance of battery management system.

MAPPING OF C.O. WITH P.O. :
[H-HIGH, M- MODERATE, L-LOW]

C.O.N0.	P.O.01	P.O.02	P.O.05	P.O.10	P.O.12
1	H	H			L
2	H	H			L
3	H	M	L	L	
4	M	M	L	L	L

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COURSE CONTENT (SYLLABUS):

MODULE: 1: ELECTRIC VEHICLES

History of Electric vehicles, Configuration of Electric Vehicles, Performance of Electric Vehicles,Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving, Energy consumption. [10-Hrs] [Blooms 'level selected: Comprehension]

MODULE: 2: HYBRID ELECTRIC VEHICLES

Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains.

[8-Hrs] [Blooms 'level selected: Comprehension]

MODULE: 3: ENERGY STORAGE FOR EV AND HEVS

Energy storage requirements, Battery parameters, Types of Batteries, Modelling of Battery, Fuel Cell basic principle and operation, Types of Fuel Cells.**[10-Hrs] [Blooms 'level selected: Knowledge]**

MODULE: 4: BATTERY MANAGEMENT SYSTEMS (BMS)

Introduction to Battery Management Systems (BMS), important terminology used to describe battery cells, Architecture of BMS, Classification of BMS, principles of operation of standard electrochemical battery cells. **[8-Hrs] [Blooms 'level selected: Comprehension]**

DELIVERY PROCEDURE (PEDAGOGY):

Topics for Self-Learning:

9. Selection of wires for EVs.
10. Different types of batteries that are used in EVs.

Experiential Learning Topics:

5. Vehicle dynamics using MATLAB Simulink
6. SOC Modelling of Battery using MATLAB

Note:

8. All the Topics will be covered through **Lecture Method.**

I. E-materials :

II. Text book of Electric and Hybrid Vehicles : Power Sources, Models, Sustainability, Infrastructure and the Market, Gianfranco Pistoia, 1st ed. Amsterdam : Elsevier. 2010
https://puniversity.informaticsglobal.com:2284/ehost/detail/detail?vid=0&sid=52da4e6e-8813-45d5-87f9-73b9f493f358%40redis&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d#AN=342445&db=nl ebk

III. Seminar
   a. **https://puniversity.informaticsglobal.com:2069/search/searchresult.jsp?newsearch=true&queryText=electric%20vehicles**

IV. Case Study : Data collection/Quiz bas
   a. https://nptel.ac.in/courses/108/102/108102121/
   b. https://nptel.ac.in/courses/108/106/108106170/
   c. https://www.coursera.org/learn/electric-vehicles-mobility

REFERENCE MATERIALS:

Textbooks:

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T1: Mehrdad Ehsani, YiminGao, sebastien E. Gay and Ali Emadi, ―Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design‖, CRC Press, 2009.

T2: Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2011.2nd edition.

Reference book(s):

1. James Larminie and John Loury, ―Electric Vehicle Technology-Explained‖, John Wiley & Sons Ltd., 2003, Second Edition.

2.C.C. Chan and K.T. Chanu Modern Electric Vehicle Technology, OXFORD University, 2011

3.Sheldon S. Williamson,- Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Springer,2013

4. Chris Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011, Second Edition

Other resources:

IEEE Explore - School of Engineering
https://puniversity.informaticsglobal.com/login .

GUIDELINES TO STUDENTS: (Here mention a few tips to study this course effectively)

- The students are advised to be very much regular to the classes and sincerely attempt the learnings listed in the Pedagogical section.
- The students are advised to take down the notes legibly which serves as a firsthand information to study and revise lecture topics on day to day basis.
- The students are advised to visit the Edhitch portal and Microsoft teams on a regular basis to study the supporting materials shared by the course instructors.
- The students are advised to use the journals, technical magazines and other relevant materials.
- The students are advised to watch the video lectures available online to understand and review the concepts delivered in the class as well as problems assigned for self-learning topics.

COURSE SCHEDULE: (This is a macro level planning. Mention the unit wise expected starting and ending dates along with the tests/assignments/quiz and any other activities) [allot about 75% for delivary,about10 to 12% for Evaluation Discussion, about 10 to 15% on integrating the learning Modules within the course and to the program]

Sl. No.	ACTIVITY	STARTING DATE	CONCLUDING DATE	TOTAL NUMBER OF PERIODS
01	Program integration Over View of the course	23-03-2022	25-03-2022	02
02	**Module : 01**	28-03-2022	8-04-2022	06
03	Integration of module 2	11-4-2022	11-4-2022	01
04	**Module : 02**	13-04-2022	13-05-2022	08
05	**Test-1**	18-04-2022	20-04-2022	NA
06	Test-1 Paper Discussion	22-04-2022	22-04-2022	01
07	**Module : 02**	25-04-2022	13-05-2022	

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08	Course Integration of Module:3	16-05-2022	16-05-2022	01
09	**Module:03**	18-05-2022	6-6-2022	6
10	Test-II	23-05-2022	26-05-2022	NA
11	Discussion of Test-2 paper	27-05-2022	27-05-2022	01
12	**Module:03**	30-05-2022	6-06-2022	
13	Case Study / Mini Project	31/3/2022	02/6/2022	NA
14	**Module 4** Course Integration	08-06-2022	17-06-2022	05
15	Program integration	20/06/2022	20/6/2022	
16	Quiz	May 1st week		01 Extra class

SCHEDULE OF INSTRUCTION:

MODULE: 1: ELECTRIC VEHICLES

Sl. no	Session no	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	S1 23/3/2022	Program Integration				
2	S2 25/3/2022	Course Integration	Introduction to course			
3	S 3 28/3/2022	History of Modern Transportation	History of hybrid electric, electric and fuel cell vehicles	CO. 1	Lecture Mode	T1:Ch.1
4	S4 30-3-2022	Environmental Impact	History of hybrid electric, electric and fuel cell vehicles	CO. 1	Lecture Mode	T1:Ch.1
5	S5 1-4-2022	Electric Vehicles	Configurations of EVs	CO. 1	Lecture Mode	T1:Ch.5.1

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6	S6 4-4-2022		**Performance of Electric Vehicles,Tractive effort**	CO. 1	Lecture Mode	T1:Ch. 5.2
7	S7 6-4-2022	Vehicle Dynamics	**Transmission requirement, Vehicle performance,**	CO. 1	Lecture Mode	T1:Ch.2
8	S8 8-4-2022		**Tractive effort in normal driving,**	CO. 1	Lecture Mode	T1:Ch.5.3
9	S9 11-4-2022		Energy Consumption, range of the vehicle	CO. 1	Lecture Mode	Technical Papers
10	S10 13-4-2022		Problem solving			
			Vehicle dynamics using MATLAB Simulink			
Module 1 is completed						

MODULE: 2: HYBRID ELECTRIC VEHICLES

Sl. no	Session no	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	**S11** **22-4-2022**		**Test-1 Paper discussion**			
2	**S12** **25-4-2022**	Course Integration	Course Integration	CO. 2	Lecture Mode	T1:Ch.6.1
3	**S13** **27-4-2022**	**HEV**	Concept of Hybrid Electric Drive Trains,	CO. 2	Lecture Mode	T1:Ch.6.2

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	S14 **29-4-2022**		Architecture of Hybrid Electric Drive Trains,			
4	**S15** **4-5-2022**		Series Hybrid Electric Drive Trains	CO. 2	Lecture Mode	T1:Ch.6.2
	Self Learning Topic		Selection of wires for EVs.			IEEE Explore - School of Engineering https://puniversity.informaticsglobal.com/login_
5	**S16** **6-5-2022**		Series Hybrid Electric Drive Trains	CO. 2	Lecture Mode	T1:Ch.6.2
6	S17 9-5-2022		Parallel hybrid electric drive trains	CO. 2	Lecture Mode	T1:Ch.6.2
7	**S18** **11-05-2022**		Recent trends in EVs	CO. 2	Lecture Mode	Technical papers
Module 2 is completed						

MODULE: 3: ENERGY STORAGE FOR EVs AND HEVs

Sl. no	Session no	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	S19 13-5-2022	**Module 3**	Course Integration			
2	S19 16-5-2022	Energy storage	Energy storage requirements	CO. 3	Lecture Mode	Technical papers

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3	**S20** **18-5-2022**	Battery and its characteristics	Battery parameters	CO. 3	Lecture Mode	T1.Ch.13
4	**S21** **20-5-22**		Types of Batteries	CO. 3	Lecture Mode	T1.Ch.13
5	**S22** **27-5-2022**		Test-2 paper Discussion			
6	**S23** **30-5-2022**		Modelling of Battery	CO. 3	Lecture Mode	Technical papers
7	**S24** **1-06-2022**		Modelling of Battery	CO. 3	Lecture Mode	Technical papers
7	**S25** **3-6-2022**	Fuel Cell	Fuel Cell basic principle and operation	CO. 3	Lecture Mode	Technical papers
9	**S26** **6-6-2022**		Types of Fuel Cells	CO. 3	Lecture Mode	T1.Ch.15.1
			SOC	CO. 3		T1.Ch.15.2
			Case study/Mini project submission			
Module 3 is completed						

MODULE: 4: POWER CONVERTERS FOR BATTERY CHARGING

Sl. no	Session no	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	**S27** **8-6-2022**	Course Integration	Introduction to Battery Management Systems (BMS)	CO .4	Lecture Mode	Technical papers

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2	**S28** **10-6-2022**		important terminology used to describe battery cells	CO .4	Lecture Mode	Technical papers
3	S29 13-6-2022		Architecture of BMS	CO .4	Lecture Mode	Technical papers
4	S30 15-6-2022		Classification of BMS	CO .4	Lecture Mode	Technical papers
	Self Learning Topic		Different types of batteries that are used in EVs.			IEEE Explore - School of Engineering https://puniversity.informaticsglobal.com/login_
5	**S31** **17-6-2022**		principles of operation of standard electrochemical battery cells.	CO .4	Lecture Mode	Technical papers
6	**S32** **20-6-2022**		Program Integration		Lecture Mode	
Module 4 is completed						

Topics relevant to "ENTREPRENEURIAL SKILLS": Vehicle fundamentals, total tractive effort and design of drive train for different vehicle architectures for developing **Entrepreneurial Skills** through **Problem Solving methodologies**. This is attained through **Assignment** as mentioned in the assessment component.

Topics relevant to "ENVIRONMENT AND SUSTAINABILITY": Types of Batteries, Materials of battery used, Fuel cell.

ASSESSMENT SCHEDULE:

Sl.no	Assessment type[Include here assessment method for self-learning component also]	contents	Course outcome Number	Duration In Hours	marks	weightage	Venue, DATE &TIME

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1	Assignment Problem Solving	Topic can be selected from any Module	CO 1 and CO 4	-	20	10%	4th Week of May 2022
2	Test 1	Module-1	CO1	1 hr	30	15%	18-04-2022 to 20-04-2022
3	Test 2	Module-2&3	CO2	1 hr	30	15%	23-05-2022 to 26-05-2022
4	Assignement as self Learning topics Review of digital/e-resources from Pres. Univ.link given in the references section (Mandatory to submit the screenshots of accessing digital Resource. Otherwise it will not be evaluated	Mentioned	CO3	-	20	10%	1st Week of May 2022
5	End Term Final Examination	Module-1,2,3 & 4	CO1-CO4	3 hrs	100	50%	27-06-2022 to 09-07-2022

COURSE CLEARANCE CRITERIA: (Here mention the minimum requirements of attendance, marks in continuous assessment &term end examination, make up exam policy and other details as per the academic regulations & PRC):

- Minimum of 75% Attendance is must to take up examination.
- Minimum of 40% score is must in internal assessment.
- Minimum of 30% in the Final Examination.
- Minimum of 40% AGGREGATE is must combining continuous assessment and End Term Final Examination.
- Make up policy is applicable only as per academic regulation
- There will be no make-up for ASSIGNMENT and QUIZ.

MAKEUP POLICY:

If the student misses an evaluation component, he/she may be granted a make-up. In case of an absence that is foreseen, make-up request should be personally made to the Instructor-in-Charge, well ahead of the scheduled evaluation component. Reasons for unanticipated absence that qualify a student to apply for make-up include medical emergencies or personal exigencies. In such an event, the student should contact the Instructor-in-Charge as soon as practically possible.

CONTACT TIMINGS IN THE CHAMBER FOR ANY DISCUSSIONS:

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Interested students may contact the Instructor In-charge during the student free Hour and Wednesday, 3:00 – 4:00 pm to clear doubts.

SAMPLE THOUGHT PROVOKING QUESTIONS: (Here type sample typical questions for students 'reference)

SL NO	QUESTION	MARKS	COURSE OUTCOME NO.	BLOOM'S LEVEL
1	Compare the performance of following vehicle configurations a. Series HEV b. Parallel HEV c. Series-parallel HEV d. Pure EV Give the name of the vehicle in the market corresponding to the above configurations.	8 + 4	2	Comprehension
2	Draw the different configurations of drivetrains in electric vehicles. Briefly explain each configuration.	10	1	Comprehension
3	what are the different forces acting on the electric Two-wheeler moving on a flat road with a velocity of V m/sec. (assume necessary data related to vehicle model and road profile)	10	1	Comprehension
4	Name different types of energy sources used in electric vehicles and explain how to size the power supply for any given direct drive electric two or three wheelers?	10	3	Knowledge
5	Why an energy management control system is required in an HEV? Do you think an elaborate energy management system similar to that applied to a hybrid vehicle, is required in an electric vehicle? Explain.	10	4	Comprehension

Target set for course Outcome attainment:

Sl.no	C.O. No.	Course Outcomes	Target set for attainment in percentage
01	Co1	Explain the working of Electric Vehicles and recent trends	50

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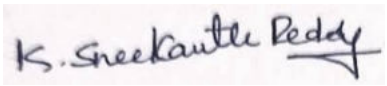
02	Co2	Explain the working of Hybrid Electric Vehicles and recent trends	50
03	Co3	Describe about the battery characteristic & parameters	65
04	Co4	Summarize the importance of battery management system	60



Signature of the course Instructor

This course has been duly verified Approved by the D.A.C.

Signature of the Chairperson D.A.C.

Course Completion Remarks &Self-Assessment.[This has to be filled after the completion of the course]

[Please mention about the course coverage details w.r.t. the schedule prepared and implemented. Any specific suggestions to incorporate in the course content. Any Innovative practices followed and its experience. Any specific suggestions from the students about the content, Delivery, Evaluation etc.]

Sl.no.	Activity As listed in the course Schedule	Scheduled Completion Date	Actual Completion Date	Remarks
01	Program integration Over View of the course	25-03-2022		02
02	**Module : 01**	8-04-2022		06
03	Integration of module 2	11-4-2022		01
04	**Module : 02**	13-05-2022		08
05	**Test-1**	20-04-2022	28-04-2022	Test-1 got postponed by 1 week.
06	Test-1 Paper Discussion	22-04-2022	30-04-2022	Because of test postponement.

07	**Module : 02**	13-05-2022	17-05-2022	Because of solving some more examples related to design parameters based on students request
08	Course Integration of Module:3	16-05-2022	19-05-2022	As one class delayed in module 2 and it followed the same.
09	**Module:03**	6-6-2022	9-6-2022	Because of getting one additional class as a adjustment of EEE212 course it covered as per the plan.
10	Test-II	26-05-2022	03-06-2022	Test-2 got postponed by 1 week.
11	Discussion of Test-2 paper	27-05-2022	04-06-2022	
12	**Module:03**	6-06-2022		
13	Case Study / Mini Project	02/6/2022		
14	**Module 4** Course Integration	17-06-2022	17-06-2022	2 extra classes got because of working Saturdays and could able to cover it
15	Program integration	20/6/2022	20/6/2022	

Any specific suggestion/Observations on content/coverage/pedagogical methods used etc.:

These course students should not study the DE: EEE3027 because 50% of the syllabus is same.

Course Outcome Attainment:

Sl.no	C.O. No.	Course Outcomes	Target set for attainment in percentage	Actual C.O. Attainment In Percentage	Remarks on attainment &Measures to enhance the attainment
01	Co1	Explain the working of Electric Vehicles and recent trends	50	44	As it was sudden offline exam and didn't practice the topics.
02	Co2	Explain the working of Hybrid Electric Vehicles and recent trends	50	53	As expected.
03	Co3	Describe about the battery characteristic & parameters	60	62	As expected.
04	Co4	Summarize the importance of battery management system	60	63	As Expected.

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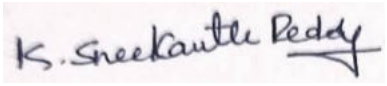

Signature of the course Instructor

This course has been duly verified Approved by the D.A.C.

Signature of the Chairperson D.A.C.

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Course Code: EEE3011	**Course Title:** Testing and Commissioning of Electrical Equipment's. **Type of Course:** 1]. Discipline Elective & 2]. Theory only	**L-T-P-C**	3	0		3
Version No.	2.0					
Course Pre-requisites	Electric Power Generation, Transmission and Distribution Switchgear and Protection Electrical and Electronics Measurements and Instrumentation Basic concepts of Power generation, transmission and distribution equipment's. Basics of indoor/outdoor substation equipment's.					
Anti-requisites	**NIL**					
Course Description	Power systems and industrial plants are made up of a variety of electrical drives, transformers, circuit breakers, and other equipment that must be installed, commissioned, and maintained on a regular basis to avoid permanent breakdown. It is required to carry out or supervise the installation, commissioning, and maintenance of various electrical equipment in power stations, substations, and industry. This course will enable to understand the concepts, and principles behind the installation, commissioning, and maintenance of electrical equipment in power stations, substations, and industry.					
Course Objectives	The objective of the course is to familiarize the learners with the concepts of Electrical Equipment Testing and Commissioning and attain **Entrepreneurial Skills** through **Participative Learning** techniques.					
Course Outcomes	**On successful completion of this course the students shall be able to** 1. Prepare of maintenance schedule of different equipment and machines 2. Interpret various electrical equipment, machines and domestic appliances. 3. Select procedure of different types of earthing for different types of electrical installations. 4. Distinguish about electrical safety regulations and rules during maintenance					
Course Content:						
Module 1	Safety Management	**Assignment**	**Case study**	**10 sessions**		
Topics: Objectives, Safety Management during Operation and Maintenance, Clearance and Creepages, Electric Shock, need of Earthing, different methods of Earthing, factors affecting the Earth Resistance, methods of measuring the Earth Resistance, Equipment Earthing and System Grounding, Earthing Procedure - Building installation, Domestic appliances, Industrial premises, earthing of substation, generating station and overhead line.						
Module 2	Installation of Electrical Equipment	**Assignment**	**Data collection**	**9 sessions**		
Topics: Inspection of Electrical Equipment at site, Storage Electrical Equipment at site, Foundation of Electrical Equipment at site, Alignment of Electrical Machines, Tools/Instruments necessary for installation, technical report, Inspection, storage and handling of transformer, switchgear and motors						
Module 3	Testing of Transformer, Plant and Equipment	**Assignment**	**Presentation**	**9 sessions**		

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Topics: General Requirements for Type, Routine and Special Tests, Measurement of winding resistance; Measurement of voltage ratio and check of voltage vector relationship; Measurement of impedance voltage/short-circuit impedance and load loss; Measurement of no-load loss and current; Measurement of insulation 13 28 resistance; Dielectric tests; Temperature-rise, insulation and HV test, dielectric absorption, switching impulse test. Testing of Current Transformer and Voltage Transformer, power transformer, distribution transformer

Module 4	Installation and Commissioning of Rotating Electrical Machines	**Assignment**	**Presentation**	**9 sessions**

Topics: Degree of protection, cooling system, installation, commissioning and protection of induction motor and rotating electric machine, insulation resistance measurement, site testing and checking, care, services and maintenance of motors, commissioning of synchronous generator, protection and automation

Targeted Application & Tools that can be used:

Application Area is Power System Data collection, Electricity Transmission and Distributed companies, Power Grid and State Electricity Boards.

Textbooks

1. Rao, S., "Testing, commissioning, operation and maintenance of electrical equipment", 6/E., Khanna Publishers, New Delhi

References

6. Paul Gill, "Electrical power equipment maintenance and testing", CRC Press, 2008.
7. Singh Tarlok, "Installation, commissioning and maintenance of Electrical equipment", S.K. Kataria and Sons, New Delhi,
8. Philip Kiameh, "Electrical Equipment Handbook: Troubleshooting and Maintenance", McGrawHill, 2003.
9. Relevant Indian Standards (IS Code) and IEEE Standards for-Installation, maintenance and commissioning of electrical equipments/machines.

Online resources:

10. https://www.iimu.ac.in/upload_data/Tender/SpecialConditionsWSequipment1.pdf
11. https://www.sciencedirect.com/topics/engineering/commissioning-process
12. Rao, S., "Testing, commissioning, operation and maintenance of electrical equipment", 6/E., Khanna Publishers, New Delhi
13. https://puniversity.informaticsglobal.com:2229/login.aspx? direct=true&db=nlebk&AN=2706929&site=ehost-live

5. https://puniversity.informaticsglobal.com

Topics relevant to "ENTREPRENEURIAL SKILLS": Inspection of Electrical Equipment, Earthing Procedure - Building installation inspection of Electrical Equipment, Earthing Procedure - Building installation for developing **Entrepreneurial Skills** through **Participative Learning techniques**. This is attained through the assessment component mentioned in course handout.

Topics relevant to "HUMAN VALUES & PROFESSIONAL ETHICS": Safety Management during Operation and Maintenance, electric tests, insulation and HV test.

Catalogue prepared by	**Mr. K Sreekanth Reddy**
Recommended by the Board of Studies on	BoS No: 15th held on 27/7/2022
Date of Approval by the Academic Council	18th Academic Council Meeting held on 3/08/2022

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PRESIDENCY UNIVERSITY

(Established under the Presidency University Act, 2013 of the Karnataka Act 41 of 2013)

A-2[2020] COURSE HAND OUT

SCHOOL: Engineering **DEPT: EEE** **DATE OF ISSUE: 27/08/2022**

NAME OF THE PROGRAM : B.TECH (EEE)

P.R.C. APPROVAL REF. : PU/AC-18.5/EEE 15/EEE/2020-2024

SEMESTER/YEAR : V/3rd

COURSE TITLE & CODE : Testing and Commissioning of Electrical Equipment's & EEE3011

COURSE CREDIT STRUCTURE : 3-0-0-3

CONTACT HOURS : 3 hrs/week

COURSE INSTRUCTOR :

COIURSE URL :

PROGRAM OUTCOMES:

Graduates of the B.Tech. Program in Electrical and Electronics Engineering will be able to:

PO1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.(H)

PO2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.(H)

PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.(L)

PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.(L)

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PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.(L)

PO11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

COURSE PREREQUISITES:
Electric Power Generation, Transmission and Distribution
Switchgear and Protection
Electrical and Electronics Measurements and Instrumentation
Basic concepts of Power generation, transmission and distribution equipment's. Basics of indoor/outdoor substation equipment's.

COURSE DESCRIPTION:
Power systems and industrial plants are made up of a variety of electrical drives, transformers, circuit breakers, and other equipment that must be installed, commissioned, and maintained on a regular basis to avoid permanent breakdown. It is required to carry out or supervise the installation, commissioning, and maintenance of various electrical equipment in power stations, substations, and industry. This course will enable to understand the concepts, and principles behind the installation, commissioning, and maintenance of electrical equipment in power stations, substations, and industry.

COURSE OBJECTIVE:
The objective of the course is to familiarize the learners with the concepts of Electrical Equipment Testing and Commissioning and attain **Entrepreneurial Skills** through **Participative Learning** techniques.

COURSE OUTCOMES: On successful completion of the course the students shall be able to:

1. Prepare of maintenance schedule of different equipment and machines
2. Interpret various electrical equipment, machines and domestic appliances.
3. Select procedure of different types of earthing for different types of electrical installations.
4. Distinguish about electrical safety regulations and rules during maintenance.

MAPPING OF C.O. WITH P.O. :
[H-HIGH, M- MODERATE, L-LOW]

C.O.N0.	P.O.01	P.O.02	P.O.04	P.O.08	P.O.10	P.O.12
1	H	H				L
2	H	H				L
3	M	M	L	L	L	
4	M	M	L	L	L	L

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COURSE CONTENT (SYLLABUS):

MODULE: 1: SAFETY MANAGEMENT

Objectives, Safety Management during Operation and Maintenance, Clearance and Creepages, Electric Shock, need of Earthing, different methods of Earthing, factors affecting the Earth Resistance, methods of measuring the Earth Resistance, Equipment Earthing and System Grounding, Earthing Procedure - Building installation, Domestic appliances, Industrial premises, earthing of substation, generating station and overhead line. **[11-Hrs] [Blooms 'level selected: Application]**

MODULE: 2: INSTALLATION OF ELECTRICAL EQUIPMENT

Inspection of Electrical Equipment at site, Storage Electrical Equipment at site, Foundation of Electrical Equipment at site, Alignment of Electrical Machines, Tools/Instruments necessary for installation, technical report, Inspection, storage and handling of transformer, switchgear and motors **[9-Hrs] [Blooms 'level selected: Application]**

MODULE: 3: TESTING OF TRANSFORMER, PLANT AND EQUIPMENT

General Requirements for Type, Routine and Special Tests, Measurement of winding resistance; Measurement of voltage ratio and check of voltage vector relationship; Measurement of impedance voltage/short-circuit impedance and load loss; Measurement of no-load loss and current; Measurement of insulation 13 28 resistance; Dielectric tests; Temperature-rise, insulation and HV test, dielectric absorption, switching impulse test. Testing of Current Transformer and Voltage Transformer, power transformer, distribution transformer. **[13Hrs] [Blooms 'level selected: Comprehension]**

MODULE: 4: INSTALLATION AND COMMISSIONING OF ROTATING ELECTRICAL MACHINES

Degree of protection, cooling system, installation, commissioning and protection of induction motor Indian Standard (IS). Ref: IS 4029:2010-Guide for Testing Three Phase Induction Motors; IS 7132:1973-Guide for Testing Synchronous Machines; IS 9320:1979-Guide for Testing of Direct Current (dc) Machines] rating and duties of CB, installation, commissioning tests, maintenance schedule, type & routine tests. **[13-Hrs] [Blooms 'level selected: Analysis]**

DELIVERY PROCEDURE (PEDAGOGY):

Topics for Self-Learning:

11. switchgear and motors
2. distribution transformer

Note:

9. All the Topics will be covered through **Lecture Method.**

E-materials :

1. https://nptel.ac.in/courses/108/104/108104013/
2. https://www.youtube.com/watch?v=pRZ2ygbbyTg
3. https://studymaterialz.in/hvdc-power-transmission-systems-by-padiyar/
4. https://puniversity.informaticsglobal.com:2282/ehost/detail/detail?vid=3&sid=15d54a1f-070b- 4419-b1d2
5. https://ieeexplore.ieee.org/abstract/document/4745240
6. https://presiuniv.knimbus.com/user#/home

REFERENCE MATERIALS:

Textbooks:

1. Rao, S., "Testing, commissioning, operation and maintenance of electrical equipment", 6/E., Khanna Publishers, New Delhi

Reference book(s):

1. Paul Gill, "Electrical power equipment maintenance and testing", CRC Press, 2008.
2. Singh Tarlok, "Installation, commissioning and maintenance of Electrical equipment", S.K. Kataria and Sons, New Delhi,
3. Philip Kiameh, "Electrical Equipment Handbook: Troubleshooting and Maintenance", McGrawHill, 2003.

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4. Relevant Indian Standards (IS Code) and IEEE Standards for-Installation, maintenance and commissioning of electrical equipments/machines.

GUIDELINES TO STUDENTS: (Here mention a few tips to study this course effectively)

- The students are advised to be very much regular to the online classes and sincerely attempt the learnings listed in the Pedagogical section.
- The students are advised to take down the notes legibly which serves as a firsthand information to study and revise lecture topics on day to day basis.
- The students are advised to visit the Edhitch portal and Microsoft teams on a regular basis to study the supporting materials shared by the course instructors.
- The students are advised to use the journals, technical magazines and other relevant materials.
- The students are advised to watch the video lectures available online to understand and review the concepts delivered in the class as well as problems assigned for self-learning topics.

COURSE SCHEDULE: (This is a macro level planning. Mention the unit wise expected starting and ending dates along with the tests/assignments/quiz and any other activities) [allot about 75% for delivary,about10 to 12% for Evaluation Discussion, about 10 to 15% on integrating the learning Modules within the course and to the program]

Sl. No.	ACTIVITY	STARTING DATE	CONCLUDING DATE	TOTAL NUMBER OF PERIODS
01	Program Integration Over View of the course			2
02	**Module : 01 Content**			11
03	Module:2 Course Integration & content			9
04	Mid Term **Test**			
05	Test Paper Discussion			1
06	**Module:03** Course Integration and content			13
07	**Module:04** Course Integration and content			13
08	Case Study			NA
10	Program integration			01

SCHEDULE OF INSTRUCTION:

MODULE: 1: SAFETY MANAGEMENT

Sl. no	Session no	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	**S1**	Program Integration	Objectives, Safety Management during Operation			

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2	S2	Course Integration	Maintenance, Clearance and Creepages			
3	S3		Electric Shock, need of Earthing, different methods of Earthing	CO. 1	Lecture Mode	T1
4	S4		factors affecting the Earth Resistance,	CO. 1	Lecture Mode	T1
5	S5		methods of measuring the Earth Resistance	CO. 1	Lecture Mode	T1
6	S6		Equipment Earthing and System Grounding	CO. 1	Lecture Mode	T1
7	S7		Earthing Procedure - Building installation,	CO. 1	Lecture Mode	T1
8	S8		Domestic appliances, Industrial premises, earthling of substation,	CO. 1	Lecture Mode	T1
9	S9		Domestic appliances, Industrial premises, earthling of substation	CO. 1	Lecture Mode	T1
10	S10		generating station and overhead line	CO. 1	Lecture Mode	T1
11	S11		generating station and overhead line	CO. 1	Lecture Mode	T1
Module 1 is completed						

MODULE: 2: INSTALLATION OF ELECTRICAL EQUIPMENT

Sl. no	Session no	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	S12	Course Integration	Inspection of Electrical Equipment at site,			
2	S13		Storage Electrical Equipment at site,	CO. 2	Lecture Mode	T1
3	S14		Foundation of Electrical Equipment at site,	CO. 2	Lecture Mode	T1
4	S15		Alignment of Electrical Machines,	CO. 2	Lecture Mode	T1

5	S16		Tools/Instruments necessary for installation,	CO. 2	Lecture Mode	T1
6	S17		technical report, Inspection,	CO. 2	Lecture Mode	T1
7	S18		storage and handling of transformer,	CO. 2	Lecture Mode	T1
8	S19		storage and handling of transformer,	CO. 2	Lecture Mode	T1
9	S20		switchgear and motors	CO. 2	Lecture Mode	T1
	Self-Learning Topic					IEEE Explore - School of Engineering https://punivesity.informaticsglobal.com/login
Module 2 is completed						

MODULE: 3: TESTING OF TRANSFORMER, PLANT AND EQUIPMENT

Sl. no	Session no	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	S21	Course Integration	General Requirements for Type,	CO. 3	Lecture Mode	T1
2	S22		Routine and Special Tests,	CO. 3	Lecture Mode	T1
3	S23		Measurement of winding resistance;	CO. 3	Lecture Mode	T1
4	S24		Measurement of voltage ratio and check of voltage vector relationship; Measurement of impedance voltage/short-circuit impedance and load loss;	CO. 3	Lecture Mode	T1

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5	S25		Measurement of voltage ratio and check of voltage vector relationship; Measurement of impedance voltage/short-circuit impedance and load loss;	CO. 3	Lecture Mode	T1
6	S26		Measurement of no-load loss	CO. 3	Lecture Mode	T1
7	S27		current; Measurement of insulation 13 28 resistance;	CO. 3	Lecture Mode	T1
8	S28		Dielectric tests; Temperature-rise,	CO. 3	Lecture Mode	T1
9	S29		insulation and HV test, dielectric absorption,	CO. 3	Lecture Mode	T1
10	S30		switching impulse test. Testing of Current	CO. 3	Lecture Mode	T1
11	S31		Transformer and Voltage Transformer,	CO. 3	Lecture Mode	T1
12	S32		power transformer, distribution transformer	CO. 3	Lecture Mode	T1
13	S33		power transformer, distribution transformer	CO. 3	Lecture Mode	T1
Module 3 is completed						

MODULE: 4: INSTALLATION AND COMMISSIONING OF ROTATING ELECTRICAL MACHINES

Sl. no	Session no	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	**S34**	Course Integration	Degree of protection, cooling system			
2	**S35**		installation, commissioning and protection of induction motor	CO .4	Lecture Mode	T1
3	**S36**		Indian Standard (IS). [Ref: IS 4029:2010-	CO .4	Lecture Mode	T1

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			Guide for Testing Three Phase Induction Motors;			
4	**S37**		Indian Standard (IS). [Ref: IS 4029:2010-Guide for Testing Three Phase Induction Motors;	CO .4	Lecture Mode	Technical papers
5	**S38**		IS 7132:1973-Guide for Testing	CO .4	Lecture Mode	Technical papers
6	**S39**		Synchronous Machines; IS 9320:1979-Guide for Testing of Direct Current (dc) Machines] rating and duties of CB	CO .4	Lecture Mode	Technical papers
7	**S40**		Synchronous Machines; IS 9320:1979-Guide for Testing of Direct Current (dc) Machines] rating and duties of CB,	CO .4	Lecture Mode	Technical papers
8	**S41**		installation, commissioning tests,	CO .4	Lecture Mode	Technical papers
9	**S42**		installation, commissioning tests, maintenance schedule, type & routine tests	CO .4	Lecture Mode	Technical papers
10	**S43**		installation, commissioning tests, maintenance schedule, type & routine tests	CO .4	Lecture Mode	Technical papers
11	**S44**		maintenance schedule, type & routine tests	CO .4	Lecture Mode	Technical papers
12	**S45**		maintenance schedule, type & routine tests	CO .4	Lecture Mode	Technical papers
Module 4 is completed						

Topics relevant to "ENTREPRENEURIAL SKILLS": Inspection of Electrical Equipment, Earthing Procedure - Building installation for developing **Entrepreneurial Skills** through **Participative Learning techniques**. This is attained through the **Presentation** as mentioned in the assessment component.

ASSESSMENT SCHEDULE:

S. No.	Assessment Type	Contents	CO Number	Duration In Hours	Marks	Weightage	Venue, DATE &TIME

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2.	Présentation	Topic can be selected from any Module	CO 2 and CO 4	-	30	15%	
3.	Mid Term Exam	M1,M2	CO1,2	90 Minutes	60	30%	
4.	Assignement as self-Learning topics Review of digital/e-resources from Pres. Univ.link given in the references section (Mandatory to submit the screenshots of accessing digital Resource. Otherwise it will not be evaluated)	https://presiuniv.knimbus.com/user#/home	CO3	-NA-	10	5%	
5.	End Term	All modules	CO 1,2,3,4	3 hours	100	50%	

COURSE CLEARANCE CRITERIA: (Here mention the minimum requirements of attendance, marks in continuous assessment &term end examination, make up exam policy and other details as per the academic regulations & PRC):

- Minimum of 75% Attendance is must to take up examination.
- Minimum of 40% score is must in internal assessment.
- Minimum of 30% in the Final Examination.
- Minimum 40% including internal assessment and Final Examination to clear the subject.
- Make up policy is applicable only as per academic regulation
- There will be no make-up for ASSIGNMENT and QUIZ.

MAKEUP POLICY:

If the student misses an evaluation component, he/she may be granted a make-up. In case of an absence that is foreseen, make-up request should be personally made to the Instructor-in-Charge, well ahead of the scheduled evaluation component. Reasons for unanticipated absence that qualify a student to apply for make-up include medical emergencies or personal exigencies. In such an event, the student should contact the Instructor-in-Charge as soon as practically possible.

CONTACT TIMINGS IN THE CHAMBER FOR ANY DISCUSSIONS:

Interested students may contact the Instructor In-charge during the student free Hour and Wednesday, Friday 3:00 – 4:00 pm to clear doubts.

SAMPLE THOUGHT PROVOKING QUESTIONS: (Here type sample typical questions for students 'reference)

SL NO	QUESTION	MARKS	COURSE OUTCOME NO.	BLOOM'S LEVEL

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1	Explain the importance of Transformer oil and its characteristics	8	1	Comprehension
2	Explain the terms Relay,Fuse, Circuit breaker, Isolator, Loadbreak Switch.	10	2	Comprehension
3	what are the steps used in Commissioning of transformers?	10	4	Comprehension
4	Explain why cooling is required and explain various type in cooling	10	3	Comprehension

Target Set For Course Outcome Attainment:

Sl.no	C.O. No.	Course Outcomes	Target set for attainment in percentage
01	Co1		
02	Co2		
03	Co3		
04	Co4		

Signature of the course Instructor

This course has been duly verified Approved by the D.A.C.

Signature of the Chairperson D.A.C.

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Course Code: EEE334	**Course Title: Battery Technology** **Type of Course: Discipline Elective and Theory only**	**L-T-P-C**	3	0	0	3
Version No.	1.0					
Course Pre-requisites	**NIL**					
Anti-requisites	**NIL**					
Course Description	The course provides fundamental knowledge on electrochemical energy storage systems considering the operation and design of various battery technologies and it enable to understand the requirement of batteries for automotive application combined with environment policy considerations.					
Course Objectives	The objective of the course is to familiarize the learners with the concepts of Battery Technology and attain **Entrepreneurial Skills** through **Participative Learning** techniques.					
Course Out Comes	After the completion of the course students shall be able to: 1. Recognize the basic physical concepts of thermodynamics and kinetics involved in electrochemical reactions. 2. Analyze the characterization methods of batteries and interpret concepts describing battery performance. 3. Describe the recent developments of battery systems. 4. Discuss the requirements of battery systems for automotive applications.					
Course Content:						
Module 1	Introduction to Electrochemical energy storage	Assignment	Data Analysis	**10 Sessions**		
Topics: Introduction to battery technologies, Electromotive force- Reversible cells-Reversible electrodes, Relation between electrical energy and energy content of a cell-Free energy changes and electromotive force in cell, Current challenges in Energy storage Technologies						
Module 2	Major Battery Chemistries	Assignment	Problem Solving	**12 Sessions**		
Topics: Battery performance evaluation, Primary battery Service time- Voltage data- Service life – ohmic load curve, Effect of operating temperature on service life – other characteristic curves, Secondary batteries- Discharge curves - Terminal voltages- Plateau voltage, Lead acid Batteries – Construction and application						
Module 3	Recent Technologies	Assignment	Problem Solving	**13 Sessions**		
Topics: Recent development of electrode materials in lithium-ion batteries, Recent development of solid electrolytes and their application to solid state batteries, Polymer solid electrolytes for lithium-ion conduction, Construction and state of art of Thin Film Batteries, Super Capacitors: Fundamental, Construction and application						
Module 4	Batteries for Automotives – Future prospect	Assignment	Quiz	**10 Sessions**		
Topics: Degrees of vehicle electrification, Battery size vs. application, USABC and DOE targets for vehicular energy storage systems, Analysis and Simulation of batteries - Equivalent circuit and life modeling, Environmental concern in battery production, Environmental concerns in recycling of batteries						

Targeted Application & Tools that can be used:

The battery technology focus on the fundamentals of electrochemical energy storage considering the operation and design of various battery technologies. The use of primary and rechargeable batteries such as Lead-acid, Li-ion, NiMH, NaS, metal-air etc., is widely used in the industry.

The Commercially available simulation software tools like MATLAB are utilized as professional tool for modeling the battery storage system.

TextBooks

1. T.Minami, M.Tatsumisago,M.Wakihara,C. Iwakura,S. Kohijiya, Solid state ionics for batteries, Springer Publication, 2009
2. Sandeep Dhameja, Electric Vehicle Battery Systems, Newnes publication, 2001.

References

1. Bard, Allen J., and Larry R. Faulkner. Electrochemical Methods: Fundamentals and Applications. 2nd ed.,Wiley– VCH, Verlag, GmbH, 2000.
2. Masataka Wakihara and Osamu Yamamoto, Lithium ion Batteries Fundamental and Performance,Wiley–VCH, Verlag GmbH, 1999.
3. Robert A.Huggins, Advanced Batteries – Materials science aspects, Springer, 2009.

Online resources

1. Case study: https://puniversity.informaticsglobal.com:2282/ehost/ebookviewer/ebook/bmxlYmtfXzEzNTY2MTdfX0FO0?sid=5ac3e684-9a30-45af-a5c4-a4c437d65a8c@redis&vid=32&format=EB
2. Seminar: https://puniversity.informaticsglobal.com:2282/ehost/ebookviewer/ebook/bmxlYmtfXzE2NjYwNV9fQU41?sid=5ac3e684-9a30-45af-a5c4-a4c437d65a8c@re
3. Ebook: https://puniversity.informaticsglobal.com/menu
4. https://nptel.ac.in/courses/107/106/107106088/

Topics relevant to "ENTREPRENEURIAL SKILLS": Ability to identify lead battery functional safety system, cell selection through battery system level for developing **Entrepreneurial Skills** through **Participative Learning techniques**. This is attained through assessment component mentioned in the course handout.

Catalogue prepared by	Dr. Snehaprabha T V
Recommended by the Board of Studies on	6th BoS held on 2/12/2017
Date of Approval by the Academic Council	8th Academic Council Meeting held on 14/06/18

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PRESIDENCY UNIVERSITY

(Established under the Presidency University Act, 2013 of the Karnataka Act 41 of 2013)

ACA-2

SCHOOL: School of Engineering **DEPT.: EEE** **DATE OF ISSUE: 29.07.2020**

NAME OF THE PROGRAM **: Electrical and Electronics Engineering**

P.R.C. APPROVAL REF. **: PU/AC-14/07/12_2020**

SEMESTER/YEAR **:**

COURSE TITLE & CODE **: Battery Technology /EEE334**

COURSE CREDIT STRUCTURE **: 3-0-0 -3**

CONTACT HOURS **: 3 Hrs/Week**

COURSE INSTRUCTOR **:**

COURSE URL **:**

PROGRAM OUTCOMES: [LIST ALL AND CIRCLE THE RELEVANT SELECTED OUTCOMES]

Graduates of the B. Tech. Program in Electrical and Electronics Engineering will be able to:

PO1. ENGINEERING KNOWLEDGE: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PO2. PROBLEM ANALYSIS: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. DESIGN/DEVELOPMENT OF SOLUTIONS: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. CONDUCT INVESTIGATIONS OF COMPLEX PROBLEMS: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. MODERN TOOL USAGE: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

PO6. THE ENGINEER AND SOCIETY: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. ENVIRONMENT AND SUSTAINABILITY: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. ETHICS: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. INDIVIDUAL AND TEAM WORK: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

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PO10. COMMUNICATION: communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. PROJECT MANAGEMENT AND FINANCE: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. LIFE-LONG LEARNING: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

COURSE PREREQUISITES: Nil

COURSE DESCRIPTION:

The course provides fundamental knowledge on electrochemical energy storage systems considering the operation and design of various battery technologies and it helps to understand the requirement of batteries for automotive application combined with environment policy considerations.

COURSE OBJECTIVE:

The objective of the course is to familiarize the learners with the concepts of Battery Technology and attain **Entrepreneurial Skills** through **Participative Learning** techniques.

COURSE OUTCOMES:

After the completion of the course students shall be able to:

1. Recognize the basic physical concepts of thermodynamics and kinetics involved in electrochemical reactions.
2. Analyze the characterization methods of batteries and interpret concepts describing battery performance.
3. Describe the recent developments of battery systems.
4. Discuss the requirements of battery systems for automotive applications.

MAPPING OF C.O. WITH P.O. :
[H-HIGH, M- MODERATE, L-LOW]

C.O.N0.	P.O. 01	P.O. 02	P.O. 03	P.O. 04	P.O. 10
C.O.1	L				L
C.O.2	L			L	L
C.O.3	M		M		
C.O.4		H			
C.O.5	L		L	M	

COURSE CONTENT (SYLLABUS):

Module:1: Introduction to Electrochemical energy storage

Introduction to battery technologies, Electromotive force- Reversible cells-Reversible electrodes, Relation between electrical energy and energy content of a cell-Free energy changes and electromotive force in cell, Current challenges in Energy storage Technologies

[06 Sessions] [Blooms 'level selected: Knowledge]

Module: 2: Major Battery Chemistries

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Battery performance evaluation, Primary battery Service time- Voltage data- Service life – ohmic load curve, Effect of operating temperature on service life – other characteristic curves, Secondary batteries- Discharge curves - Terminal voltages- Plateau voltage, Lead acid Batteries – Construction and application

[11 Sessions] [Blooms 'level selected: comprehension]

Module: 3: Recent Technologies

Recent development of electrode materials in lithium-ion batteries, Recent development of solid electrolytes and their application to solid state batteries, Polymer solid electrolytes for lithium ion conduction, Construction and state of art of Thin Film Batteries, Super Capacitors: Fundamental, Construction and application

[13 Sessions] [Blooms 'level selected: Application]

Module: 4: Batteries for Automotives – Future prospect

Degrees of vehicle electrification, Battery size vs. application, USABC and DOE targets for vehicular energy storage systems, Analysis and Simulation of batteries - Equivalent circuit and life modeling, Environmental concern in battery production, Environmental concerns in recycling of batteries **[11 Sessions] [Blooms 'level selected: Application]**

DELIVERY PROCEDURE (PEDAGOGY):

Topics for Self Learning:

a) Identify the current challenges in energy storage technologies.
b) Differences between lithium ion and lead-acid battery.
c) Types and effects of using different kinds of batteries in various applications.

Experiential Learning Topics:

a) Identifying the different types of batteries used in Electric Vehicle.

Participative Learning Topics:

a) Group Assignments on recent developments in the area of battery technologies for Electric vehicle application.
b) Group Assignments on standard parameters of lithium-ion batteries.

Technology Enabled Learning:

Problem solving ability topics:

Most of the topics are covered through lecture method.

REFERENCE MATERIALS:

(i)Text Books:

1. T.Minami, M.Tatsumisago,M.Wakihara,C. Iwakura,S. Kohijiya, Solid state ionics for batteries, Springer Publication, 2009
2. Sandeep Dhameja, Electric Vehicle Battery Systems, Newnes publication, 2001.

(ii) Reference Book:

1. Bard, Allen J., and Larry R. Faulkner. Electrochemical Methods: Fundamentals and Applications. 2nd ed.,Wiley–VCH, Verlag, GmbH, 2000.

2. Masataka Wakihara and Osamu Yamamoto, Lithium-ion Batteries Fundamental and Performance, Wiley–VCH, Verlag GmbH, 1999.

3. Robert A.Huggins, Advanced Batteries – Materials science aspects, Springer, 2009.

(iii) Online resources

1. https://puniversityinformaticsglobal.com/openFullText.html?DP=https://ieeexplore.ieee.org/document/7967241/
2. https://ieeexplore.ieee.org/document/712612
3. https://ieeexplore.ieee.org/document/5060940

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4. https://puniversity informaticsglobal.com/user#/home

GUIDELINES TO STUDENTS:

1. Try to identify challenges related to battery technology for various applications.

2. Try to differentiate between various kinds of battery technology such as lead acid battery, lithium-ion battery, solid state battery.

3. NPTEL web course by Prof. Kaushik Pal of IIT, Roorkee on Electrochemical Energy Storage.

COURSE SCHEDULE:

SL.NO	ACTIVITY	STARTING DATE	CONCLUDING DATE	TOTAL NUMBER OF PERIODS
01	**Introduction to the course**			**01**
02	**Course Integration of module-1**			**01**
03	**Module : 01**			**06**
04	**Course Integration of module-2**			**01**
05	**Module: 02**			**09**
06	**Mid-term**			**---**
07	**Quiz-1**			**01**
08	**Course Integration of module-3**			**01**
09	**Module: 03**			**13**
10	**ASSIGNMENT**			**01**
11	**Students Group Presentation**			**01**
12	**Course Integration of module-4**			**01**
13	**Module-04**			**08**
14	**TERM END EXAMINATIONS.**			**---**

SCHEDULE OF INSTRUCTION:

Sl. no	**Session no[date if possible]**	**Lesson Title**	**Topics**	**Course Outcome Number**	**Delivery Mode**	**Reference**
01	S-1	Program Integration	Job description and requisites to meet the same		PPT, Chalk & Board	

02	S-2	Course integration	Introduction to the course		PPT, Chalk & Board	
MODULE1: INTRODUCTION TO ELECTROCHEMICAL ENERGY STORAGE						
03	S-3		Need of battery technology	CO1	PPT, Chalk & Board	T1
04	S-4		Requirement of battery technology	CO1	PPT, Chalk & Board	T1
05	S-5	Introduction to battery technologies	Reversible cells- Reversible electrodes	CO1	PPT, Chalk & Board	T1
06	S-6	Relation between electrical energy and energy content of a cell	Free energy changes and electromotive force in cell	CO1	PPT, Chalk & Board	T1
07	S-7	Challenges in Battery Technology	Current challenges in Energy storage Technologies	CO2	PPT, Chalk & Board	T1
08	S-8		Challenges in electric vehicle application	CO2	PPT, Chalk & Board	T1
COMPLETION OF MODULE-1						
09	S-9	Course integration	Integration of unit-1 to unit-2		PPT, Chalk & Board	
MODULE: 2: MAJOR BATTERY CHEMISTRIES						
10	S-10	Performance evaluation	Battery performance evaluation	CO3	PPT, Chalk & Board	T2
11	S-11		Primary battery Service time- Voltage data- Service life –	CO3	PPT, Chalk & Board	T2

			ohmic load curve			
12	S-12		Effect of operating temperature on service life	CO3	PPT, Chalk & Board	T2
13	S-13		other characteristic curves			
14	S-14	**Midterm EVALUATION DISCUSSION**				
15	S-15	Secondary batteries	Discharge curves - Terminal voltages-	CO3	PPT, Chalk & Board	T2
16	S-16		Plateau voltage	CO3	PPT, Chalk & Board	T2
17	S-17	Lead acid Batteries	Construction	CO3	PPT, Chalk & Board	T2
18	S-18		application	CO3	PPT, Chalk & Board	T2
19	S-19	**QUIZ-1**				
COMPLETION OF MODULE-2						
20	S-20	Course integration	Integration of unit-2 to unit-3		PPT, Chalk & Board	
MODULE: 3: RECENT TECHNOLOGIES						
21	S-21	Lithium-ion batteries	Recent development	CO4	PPT, Chalk & Board	R1

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22	S-22		electrode materials used in Lithium-ion battery	CO4	PPT, Chalk & Board	R1
23	S-23	Solid state batteries	Introduction	CO4	PPT, Chalk & Board	R1
24	S-24		Recent development of solid electrolytes	CO4	PPT, Chalk & Board	R1
25	S-25		Application	CO4	PPT, Chalk & Board	R1
26	S-26	Polymer solid electrolytes	Introduction	CO4	PPT, Chalk & Board	R1
27	S-27		Polymer solid electrolytes for lithium ion conduction	CO4	PPT, Chalk & Board	R1
28	S-28	Thin Film Batteries	Construction	CO4	PPT, Chalk & Board	R1
29	S-29		State of art of Thin Film Batteries	CO4	PPT, Chalk & Board	R1
30	S-30		Application	CO4	PPT, Chalk & Board	R1
31	S-31	Super Capacitors	Fundamental	CO4	PPT, Chalk & Board	R1
32	S-32		Construction	CO4	PPT, Chalk & Board	R1
33	S-33		Application	CO4	PPT, Chalk & Board	R1
COMPLETION OF MODULE-3						
34	S-34	**GROUP ASSIGNMENT**			**PL**	

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35	S-35	**GROUP PRESENTATION**			**PL**	
36	S-36	Course integration	Integration of unit-3 to unit-4		PPT, Chalk & Board	
MODULE: 4: BATTERIES FOR AUTOMOTIVES – FUTURE PROSPECT						
37	S-37	Electric Vehicle	Degrees of vehicle electrification	CO5	PPT, Chalk & Board	T1
38	S-38		Battery size vs. application	CO5	PPT, Chalk & Board	T1
39	S-39		USABC and DOE targets for vehicular energy storage systems	CO5	PPT, Chalk & Board	T1
40	S-40	Simulation of batteries	Analysis	CO5	PPT, Chalk & Board	T1
41	S-41		Equivalent circuit	CO5	PPT, Chalk & Board	T1
42	S-42		Life modeling	CO5	PPT, Chalk & Board	T1
43	S-43	Environmental concern	Environmental concern in battery production	CO5	PPT, Chalk & Board	T1
44	S-44		Environmental concerns in recycling of batteries	CO5	PPT, Chalk & Board	T1
COMPLETION OF MODULE-4						
COMPLETION OF THE SYLLABUS						

Topics relevant to "ENTREPRENEURIAL SKILLS": Ability to identify lead battery functional safety system, cell selection through battery system level for developing **Entrepreneurial Skills** through **Participative Learning techniques**. This is attained through the **Presentation** as mentioned in the assessment component.

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ASSESSMENT SCHEDULE:

Sl.no	Assessment type[Include here assessment method for self-learning component also]	contents	Course outcome Number	Duration In Hours	marks	weightage	Venue, DATE &TIME
01	Quiz-1	Module-1&2	CO1,CO2,CO3	01	10	05%	Will be announced prior 1 week
02	Test 1	Module 1	CO1	1 Hour	30	20%	-
03	Test 2	Module 2	CO2	1 Hour	30	20%	
04	ASSIGNMENT (Presentation on research articles)		CO1,CO2,CO3	01	10	05%	Will be announced prior 1 week
05	Students Group Presentation on Field Visit		CO1,CO3	01	10	05%	Will be announced prior 1 week
06	Assignment Review of digital /e-resources from Pres. Univ. link given in the References Section-(Mandatory to submit the screenshot of accessing digital resource.	https://puniversity informaticsglobal.com /user#/home	CO3,CO4		10	05%	Will be announced prior 1 week

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	Otherwise it will not be evaluated)						
07	**End term Exam**	**Complete course contents**	**CO1,CO2,CO3 CO4**		**100**	**40%**	**-**

COURSE CLEARANCE CRITERIA:

- Minimum of 75% Attendance is most to take up examination.
- Minimum of 40% score is must in internal assessment.
- Minimum of 30% in the Final Examination.
- Make-up Policy: Make-up will be permitted for genuine cases only with prior permission from the Instructor In-charge and approval of Dean, SoE.

NOTE: There will be no make-up for ASSIGNMENT and QUIZ.

CONTACT TIMINGS IN THE CHAMBER FOR ANY DISCUSSIONS: Monday, 10:40 AM-11:30 AM

SAMPLE THOUGHT PROVOKING QUESTIONS

Sl. No.	**Q. No.**	**Question**	**Marks**	**C.O. NO.**	**Bloom's Level**
1	**1**	Mr. Kamlesh has a UPS system consisting of lead acid battery and he got tired of charging the lead acid battery for long hour. Kindly suggest him different kind of battery to reduces the charging time of battery to minimum.	**10M**	**CO1**	**Comprehension**
2	**2**	Dr. Ramesh wants to run his petrol engine Scooty Pep+ on battery to save petrol. Kindly suggest him the battery technology that helps him to achieve his objective.	**10M**	**CO1**	**Comprehension**

Target set for course Outcome attainment:

Sl.no	C.O. No.	Course Outcomes	Target set for attainment in percentage
01	CO1	Recognize the basic physical concepts of thermodynamics and kinetics involved in electrochemical reactions.	55%
02	CO2	Analyze the characterization methods of batteries and interpret concepts describing battery performance.	50%
03	CO3	Describe the recent developments of battery systems.	60%

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04	CO4	Discuss the requirements of battery systems for automotive applications.	55%

Signature of the course Instructor:

This course has been duly verified Approved by the D.A.C.

Signature of the Chairperson D.A.C.:

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Course Completion Remarks &Self-Assessment.[This has to be filled after the completion of the course]

[Please mention about the course coverage details w.r.t. the schedule prepared and implemented. Any specific suggestions to incorporate in the course content. Any Innovative practices followed and its experience. Any specific suggestions from the students about the content, Delivery, Evaluation etc.]

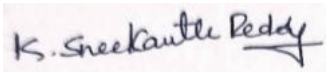
Sl.no.	Activity As listed in the course Schedule	Scheduled Completion Date	Actual Completion Date	Remarks
01	Program integration Over View of the course	28-03-2022	28-03-2022	As per the plan
02	**Module : 01**	7-04-2022	7-04-2022	As per the plan
03	Integration of module 2	11-4-2022	11-4-2022	As per the plan
04	**Module : 02**	12-05-2022	12-05-2022	As per the plan
05	**Test-1**	20-04-2022	27-04-2022	Test-1 got postponed by 1 week.
06	Test-1 Paper Discussion	21-04-2022	28-04-2022	Because of test postponement.
07	**Module : 02**	12-05-2022	16-05-2022	Because of solving some more examples related to design parameters based on students request
08	Course Integration of Module:3	16-05-2022	17-05-2022	As one class delayed in module 2 and it followed the same.
09	**Module:03**	09-6-2022	09-6-2022	Because of getting one additional class as a adjustment of EEE212 course it covered as per the plan.
10	Test-II	26-05-2022	02-06-2022	Test-2 got postponed by 1 week.
11	Discussion of Test-2 paper	30-05-2022	04-05-2022	Because of getting one additional class as a adjustment of EEE214 course it covered as per the plan.
12	**Module:03**	09-06-2022	09-06-2022	As per the plan
13	Case Study / Mini Project	02/6/2022	02/6/2022	As per the plan
14	**Module 4** Course Integration	20-06-2022	20-06-2022	As per the plan
15	Program integration	20/6/2022	20/6/2022	As per the plan

Any specific suggestion/Observations on content/coverage/pedagogical methods used etc.:

As the semester was too short because of that few examples solved in class and given them as exercise examples. Even only few MATLAB Simulink models were shown in class.

Course Outcome Attainment:

Sl.no	C.O. No.	Course Outcomes	Target set for attainment in percentage	Actual C.O. Attainment In Percentage	Remarks on attainment &Measures to enhance the attainment
01	Co1	Describe the importance of Electric Vehicles in recent trends	50	50.17	As expected
02	Co2	Discuss the components of Electric Vehicles and Hybrid Electric Vehicles	55	57.17	As expected
03	Co3	Summarize the properties of batteries and electric vehicle drive systems	60	62.98	As expected
04	Co4	Explain different charging methods of Electric vehicles	65	64.6	As expected



Signature of the course Instructor

This course has been duly verified Approved by the D.A.C.

Signature of the Chairperson D.A.C.

Course Code: EEE322	**Course Title: PLC's for Automation** **Type of Course: Discipline & Theory only**		**L-T- P-C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	**NIL**					
Anti-requisites	**NIL**					
Course Description	This course describes about PLC hardware/software and SCADA with the communication protocols and various control systems. The course is both conceptual and analytical in nature. It develops programming and simulation skills.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of PLC's for Automation and attain **Entrepreneurial Skills** through **Participative Learning** techniques.					
Course Outcomes	**On successful completion of this course the students shall be able to:** **1)**Evaluate network protocols that provide interoperability and communication technologies **2)** Write PLC codes for automation applications requiring special functions. **3)** Use PLC for an automatic control system confining to standards. **4)** Apply SCADA for various utilities.					
Course Content:						
Module 1	Introduction to Programmable Logic Controllers:	Assignment	Case study	**8 Sessions**		
Topics: Advantages & disadvantages of PLC with respect to relay logic, PLC architecture, Input Output modules, PLC interfacing with plant, memory structure of PLC.						
Module 2	PLC Programming Methodologies:	Quiz	Programming	**7 Sessions**		
Topics: Ladder diagram, STL, functional block diagram, SFC, Instruction List. Creating ladder diagram from process control descriptions, Introduction to IEC61131 international standard for PLC.						
Module 3	Data Manipulation and Math instructions	Assignment	Simulation	**7 Sessions**		
Topics: Math Instructions: Math Instructions, Addition Instruction, Subtraction Instruction, Multiplication Instruction, Division Instruction, Other Word-Level Math Instructions, File Arithmetic Operations. Data Manipulation Instructions: Data Manipulation, Data Transfer Operations, Data Compare Instructions, Data Manipulation Programs, Numerical Data I/O Interfaces, Closed-Loop Control.						
Module 4	Introduction to SCADA	Case study	Simulation	**11 Sessions**		
Topics: Data acquisition system, Evolution of SCADA, Communication Technologies, Monitoring and Supervisory Functions. Types of Processes, Structure of Control Systems, On/Off Control, PID Control, Motion Control						
Targeted Application: Siemens, ABB, Power-grid, Yokogawa Electric **Tools that can be used: NI Lab-VIEW**						
Text Books 1. W.Boldon, 'Programmable logic controllers', 5th Edition, Elsevier India Pvt. Ltd., New Delhi, 2011.						

2. Stuart A.Boyer, "SCADA: 'Supervisory control and Data Acquisition', 4th Edition, ISA, 2010.
References 1. Robert Radvanovsky, Jacob Brodsky, "Handbook of SCADA/Control Systems Security", 2nd edition, CRC press, 2016. 2. G. K. McMillan, Douglas Considine, "Process/Industrial Instruments Hand book", 5th edition, McGraw Hill, New York, 2009. **Online learning resources** 1. Seminar: https://puniversity.informaticsglobal.com 2. Case Study: https://www.plcacademy.com/ 3. Ebook: https://electrical-engineering-portal.com/download-center/books-and-guides/electrical-engineering/plc-book
Topics relevant to "Entrepreneurial Skills": PLC programming, SCADA for developing **Entrepreneurial Skills** through **Participative Learning techniques**. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Mrs. Jisha L K
Recommended by the Board of Studies on	BoS No: 12th. BoS held on 27/07/2021
Date of Approval by the Academic Council	Academic Council Meeting No.16, Dated 23/10/21

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PRESIDENCY UNIVERSITY

(Established under the Presidency University Act, 2013 of the Karnataka Act 41 of 2013)

A-2 [2020] COURSE HAND OUT [Revision 01- Nov/2020]

School	: Engineering
Department	: Electrical & Electronics Engineering.
Date of Issue	: 11.03.2022
Name of the Program	: B. Tech (EEE)
P.R.C. Approval Ref.	: PU/AC-16/EEE/2020-2024/2021
Name of the Course	: PLC's for Automation.
Course Code	: EEE 322
Semester	: 4th
Year	: 2nd
Course Credit Structure	: 3-0-0-3
Contact Hours	:
Course Instructor In charge	:
Course URL	:

PROGRAM OUTCOMES:

Graduates of the B. Tech. Program in Electrical & Electronics Engineering will be able to:

PO1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. [H].

PO2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. [H]

PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations [L].

PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions [L].

PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations [M].

PO6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. [L]

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PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. [L]

PO11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. [L]

COURSE PREREQUISITES:

Nil

COURSE DESCRIPTION:

This course describes about PLC hardware/software and SCADA with the communication protocols and various control systems. The course is both conceptual and analytical in nature. It develops programming and simulation skills.

COURSE OBJECTIVE:

The objective of the course is to familiarize the learners with the concepts of PLC's for Automation and attain **Entrepreneurial Skills** through **Participative Learning** techniques.

COURSE OUTCOMES:

After the completion of the course students shall be able to:

CO 1: **Explain** network protocols that provide interoperability and communication technologies
CO 2: **Write** PLC codes for automation applications requiring special functions.
CO 3: **Use** PLC for an automatic control system confining to standards.
CO 4: **Apply** SCADA for various utilities.

MAPPING OF C.O. WITH P.O.

CO NO.	PO 1	PO 2	PO 3	PO 4	PO 5	PO09	PO 10	PO12
1	H	H	L	L	M	M	L	L
2	H	H	L	L	M	M	L	L
3	M	M	M	M	M	L	L	L
4	M	L	L	L	L	L	L	L

COURSE CONTENT (SYLLABUS):

Module: 1:

Introduction to Programmable Logic Controllers: Advantages & disadvantages of PLC with respect to relay logic, PLC architecture, Input Output modules, PLC interfacing with plant, memory structure of PLC.

[10 Sessions] [Blooms 'level selected: Comprehension]

Module: 2

PLC Programming Methodologies: Ladder diagram, STL, functional block diagram, SFC, Instruction List. Creating ladder diagram from process control descriptions, Introduction to IEC61131 international standard for PLC. [10 Sessions] [Blooms 'level selected: Application]

Module: 3:

Math Instructions: Math Instructions, Addition Instruction, Subtraction Instruction, Multiplication Instruction, Division Instruction, Other Word-Level Math Instructions, File Arithmetic Operations.

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Data Manipulation Instructions: Data Manipulation, Data Transfer Operations, Data Compare Instructions, Data Manipulation Programs, Numerical Data I/O Interfaces, Closed-Loop Control

[12 Sessions] [Blooms 'level selected: Comprehension]

Module: 4:

Introduction to SCADA: Data acquisition system, Evolution of SCADA, Communication Technologies, Monitoring and Supervisory Functions.

[10 Sessions] [Blooms 'level selected: Application]

DELIVERY PROCEDURE (PEDAGOGY):

Self-Learning Topics:

1. Introduction to IEC61131 international standard for PLC.
2. Performance Criteria for automation tools.

Experiential Learning Topics

1. Selectable Timed Interrupt, Fault Routine.

Participative learning

1. Creating ladder diagram from process control descriptions

Technology Enabled Learning:

1.Subroutine Functions, Immediate Input and Immediate Output Instructions

Note:

a. Most of the Topics are covered through Offline Lecture Method with the necessary practical applications.

REFERENCE MATERIALS:

A). Textbooks:

T1: W.Boldon, 'Programmable logic controllers', 5th Edition, Elsevier India Pvt. Ltd., New Delhi, 2011.

T2: Stuart A.Boyer, "SCADA: 'Supervisory control and Data Acquisition', 4th Edition, ISA, 2010.

B). Reference books:

R1: Robert Radvanovsky, Jacob Brodsky, "Handbook of SCADA/Control Systems Security", 2nd edition, CRC press, 2016.

R2: G. K. McMillan, Douglas Considine, "Process/Industrial Instruments Hand book", 5th edition, McGraw Hill, New York, 2009.

C). Online learning resources

4. Seminar: https://puniversity.informaticsglobal.com
5. Case Study: https://www.plcacademy.com/
6. Ebook: https://electrical-engineering-portal.com/download-center/books-and-guides/electrical-engineering/plc-book

GUIDELINES TO STUDENTS:

v. Maintain a separate note book for class notes.
vi. Be regular to all the classes and maintain minimum 90% of attendance.
vii. Refer online study materials and videos are suggested to watch in the NTPEL site.

COURSE SCHEDULE:

Sl. No.	ACTIVITY	STARTING DATE	CONCLUDING DATE	TOTAL NUMBER OF PERIODS

01	Over View of the course	27.01.2022	27.01.2022	1
02	**Module : 01**	28.01.2022	12.02.2022	8
02	**Module: 02**	13.02.2022	13.02.2022	2
02	Assignment- I	10th to 14th April 2022	10th to 14th April 2022	NA
03	**Test-I**	18.02.2022	20.02.2022	NA
04	**Test I Paper Discussion**	21.02.2022	21.02.2022	1
07	**Module: 02**	26.02.2022	02.03.2022	5
08	**Module:03**	02.03.2022	19.03.2022	7
09	Quiz 1	20.03.2022	20.03.2022	NA
10	**Test-II**	23.03.2022	26.03.2022	NA
11	**Test II Paper Discussion**	31.03.2022	31.03.2022	1
12	Assignment- II	01.04.2022 to 07.04.2022	01.04.2022 to 07.04.2022	NA
13	**Module:04**	01.04.2022	20.04.2022	11

SCHEDULE OF INSTRUCTION:

Sl. No	Session No [date if possible]	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
50.	27.01.2022	Program Integration & Course Integration	Discussion on COs, POs, Course Handout	-	-	-
51.	S1 28.01.2022	**Module No. 1** Introduction to Programmable Logic Controllers**:**	Introduction	CO1	PPT, Chalk and Talk	T1
52.	S2 30.01.2022	Introduction to Programmable Logic Controllers	Advantages & disadvantages of PLC with respect to relay logic	CO1	PPT, Chalk and Talk	T1
53.	S3 31.02.2022	Introduction to Programmable Logic Controllers	PLC architecture	CO1	PPT, Chalk and Talk	T1
54.	S4 02.02.2022	Introduction to Programmable Logic Controllers	Input Output modules	CO1	PPT, Chalk and Talk	T1
55.	S5 03.02.2022	Introduction to Programmable Logic Controllers	PLC interfacing with plant	CO1	PPT, Chalk and Talk	T1
56.	S6 07.02.2022	Introduction to Programmable Logic Controllers	PLC interfacing with plant	CO1	PPT, Chalk and Talk	T1
57.	S7 11.02.2022	Introduction to Programmable Logic Controllers	memory structure of PLC**.**	CO1	PPT, Chalk and Talk	T1

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58.	S8 12.02.2022	Introduction to Programmable Logic Controllers	memory structure of PLC.	CO1	PPT, Chalk and Talk	T1
59.	CA1	Module 1	10th to 14th April 2022			
60.	Test-1					
61.	S9 21.02.2022	Test 1 QP Discussion **Module No. 2**	Question paper discussion & Course integration	CO2	PPT, Chalk and Talk	T1
62.	S10 25.02.2022	PLC Programming Methodologies	Ladder diagram, STL,	CO2	PPT, Chalk and Talk	T1
63.	S11 26.02.2022	PLC Programming Methodologies	functional block diagram, SFC,	CO2	PPT, Chalk and Talk	T1
64.	S12 28.02.2022	PLC Programming Methodologies	Creating ladder diagram from process control descriptions,	CO2	PPT, Chalk and Talk	T1
65.	S13 02.03.2022	PLC Programming Methodologies	Introduction to IEC61131 international standard for PLC.	CO2	Participative learning	T1
66.	S14 02.03.2022	PLC Programming Methodologies	Introduction to IEC61131 international standard for PLC.	CO2	Participative learning	T1
67.	S15 03.03.2022	PLC Programming Methodologies	Ladder diagram	CO2	Group Discussion	T1
68.	S16 05.03.2022	PLC Programming Methodologies	Ladder diagram	CO2	Group Discussion	T1
		Self study Topic	international standard for PLC.			https://puniversity.informaticsglobal.com
69.	S17 08.03.2022	Module 3: **Math Instructions and Data Manipulation Instructions**	Course Integration	CO3	PPT, Chalk and Talk	T2
70.	S18 09.03.2022	**Math Instructions**	Addition Instruction, Subtraction Instruction Data Manipulation, Data Transfer Operations, Data Compare Instructions, Data	CO3	PPT, Chalk and Talk	T2

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			Manipulation Programs, Numerical Data I/O Interfaces, Closed-Loop Control			
71.	S19 10.03.2022	**Math Instructions**	Multiplication Instruction, Division Instruction	CO3	PPT, Chalk and Talk	T2
72.	S20 12.03.2022	**Math Instructions**	Multiplication Instruction, Division Instruction	CO3	PPT, Chalk and Talk	T2
73.	S21 16.03.2022	**Math Instructions**	Other Word-Level Math Instructions	CO3	PPT, Chalk and Talk	T2
74.	S22 17.03.2022	**Math Instructions**	File Arithmetic Operations.	CO3	PPT, Chalk and Talk	T2
75.	S23 19.03.2022	**Data Manipulation Instructions**	Data Manipulation, Data Transfer Operations	CO3	PPT, Chalk and Talk	T2
76.	S24 30.03.2022	**Data Manipulation Instructions**	Data Compare Instructions	CO3	PPT, Chalk and Talk	T2
77.	S25 31.03.2022	**Data Manipulation Instructions**	Data Manipulation Programs,	CO3	PPT, Chalk and Talk	T2
78.	S26 02.04.2022	**Data Manipulation Instructions**	Numerical Data I/O Interfaces	CO3	PPT, Chalk and Talk	T2
79.	S27 04.04.2022	**Data Manipulation Instructions**	Numerical Data I/O Interfaces	CO3	PPT, Chalk and Talk	T2
80.	Test-2					
81.	CA2 Quiz 1	20.03.2022	20.03.2022	CO2,CO3	Online	
82.	S28 30.03.2022	Test 2 QP discussion			PPT, Chalk and Talk	
83.	S29 31.03.2022	**Data Manipulation Instructions**	Closed-Loop Control	CO3	PPT, Chalk and Talk	T2
84.	S30 02.04.2022	**Data Manipulation Instructions**	Programming practices	CO3	PPT, Chalk and Talk	T2
85.	S31 04.04.2022	**Data Manipulation Instructions**	Programming practices Control	CO3	PPT, Chalk and Talk	T2
86.	S32 07.04.2022	**Module: 4 Introduction to SCADA:**	Course Integration	CO4	PPT, Chalk and Talk	T2

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87.	S33 09.04.2022	Introduction to SCADA	Data acquisition system	CO4	PPT, Chalk and Talk	T2
88.	S34 13.04.2022	Introduction to SCADA	Data acquisition system	CO4	PPT, Chalk and Talk	T2
89.	S35 14.04.2022	Introduction to SCADA	Evolution of SCADA	CO4	PPT, Chalk and Talk	T2
90.	S36 16.04.2022	Introduction to SCADA	Evolution of SCADA	CO4	PPT, Chalk and Talk	T2
91.	S37 20.04.2022	Introduction to SCADA	Communication Technologies	CO4	PPT, Chalk and Talk	T2
92.	S38 16.04.2022	Introduction to SCADA	Monitoring and Supervisory Functions.	CO4	PPT, Chalk and Talk	T2
		Self study Topic	Performance Criteria for automation tools.			https://puniversity.informaticsglobal.com
93.	S39 26.04.2022		Performance Criteria for DCS and other automation tools.	CO4	PPT, Chalk and Talk	T2
94.	S40 01.05.2022	Revision	Module 1	CO1	PPT, Chalk and Talk	T1
95.	S40 03.05.2022	Revision	Module 2	CO2	PPT, Chalk and Talk	T1
96.	S40 06.05.2022	Revision	Module 3	CO3	PPT, Chalk and Talk	T2
97.	07.05.2022	Revision	Module 4	CO4	PPT, Chalk and Talk	T2

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Topics relevant to "ENTREPRENEURIAL SKILLS": Statistical evaluation of measurement data, Principle and types of analog and digital voltmeters, ammeters. for Developing **Entrepreneurial Skills** through **Participative Learning Techniques.** This is attained through **Presentation** as mentioned in the Assessment Component.

ASSESSMENT SCHEDULE:

Sl.no	26Assessment type	contents	Course outcome Number	Duration In Minutes	Marks	Weightage	Venue, Date & Time
1	Presentation-1	Module-1	CO1	60	20	5%	10th to 14th April 2022
2	Test 1	Module-1	CO 1	60	20	15%	18th to 20th April 2022
3	Quiz	Module-2,3	CO2, CO3	60	10	5%	20th May 2022
4	Test 2	Module- 2 & 3	CO 2& CO 3	60	20	15%	23rd to 26th May.2022
5	Presentation-2	Module-3	CO 3	60	20	5%	1st to 7th June 2022
6	**Assignment Review of digital / e-resources from Pres. Univ. link given in the References Section -(Mandatory to submit screenshot accessing digital resource. Otherwise it will not be evaluated**	international standard for PLC. Performance Criteria for automation tools.	CO2, CO4	-	10	5%	Second week of June 2022
7	End Term Final Examination	Module-1,2,3 & 4	CO1, CO2, CO3, CO4	180	100	50%	27th June 2022 to 9th July 2022

COURSE CLEARANCE CRITERIA:

vi. Minimum of 75% Attendance is most to take up examination.
vii. Minimum of 40% score is must in internal assessment.
viii. Minimum of 30% in the Final Examination.
ix. Minimum of 40% AGGREGATE is must combining continuous assessment and End Term Final Examination.

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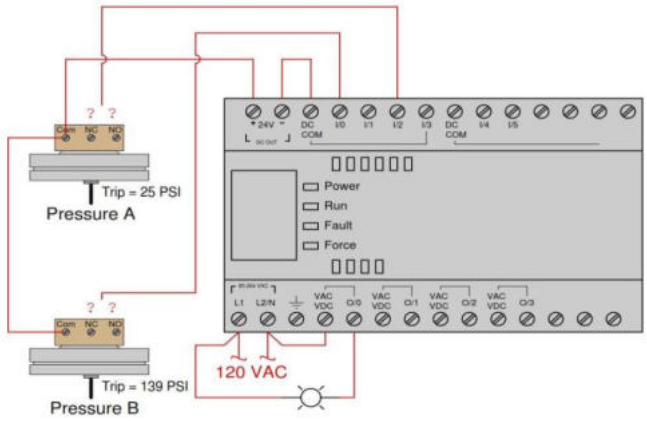
x. Make-up policy will be only as per academic regulation.
xi. There will be no make-up for ASSIGNMENT and QUIZ

CONTACT TIMINGS IN THE CHAMBER FOR ANY DISCUSSIONS:

It will be announced in the class. Interested students may meet the Instructor In-charge during the Chamber Consultation Hour to clear doubts.

SAMPLE THOUGHT PROVOKING QUESTIONS

Sl. No	Question	Marks	CO No	Bloom's Level
1	Suppose we have an Allen-Bradley MicroLogix 1000 PLC and two pressure switches we need to connect to it.  Determine the necessary contacts on each pressure switch (NO versus NC).	10	CO1	**Apply**
2	A engineer needs to write a PLC program to control a water pump driven by an electric motor. This water pump will be manually started and stopped by pushbutton switches, and shutdown automatically by any one of several "permissive" switches. The operating statuses of these switches are listed here: Start pushbutton (normally-open): open when unpressed, closed when pressed Stop pushbutton (normally-open): open when unpressed, closed when pressed Low water level (normally-closed): closed when level is low, open when level is adequate Low oil pressure (normally-open): open when pressure is low, closed when pressure is adequate High vibration (normally-closed): closed when still, open when vibrating Water leak detector (normally-open): open when dry, closed when wet (leak detected)	10	CO2	**Apply**

Signature of the course Instructor

This course has been duly verified Approved by the D.A.C.

Signature of the Chairperson D.A.C.

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Course Code: EEE3028	**Course Title:** Power System Planning **Type of Course:** Discipline Elective & Theory only	**L-P- C**	3	0	3
Version No.	**1.0**				
Course Pre-requisites	Basic concepts of Electrical Power Generation, transmission and distribution				
Anti-requisites	**NIL**				
Course Description	This course covers power system planning,Economics,operation and management issues as well as reliability in deregulated environment. The course will give a compreshensive overview of power system relaibility. Evaluation of generation , transmission and distribution system relaibility and their impacts on system planning will be dealt with.The course is designed to develop conceptual and analytical ability.				
Course Objective	The objective of the course is to familiarize the learners with the concepts of Power System Planning and attain **Entrepreneurial Skills** through **Participative Learning** techniques.				
Course Outcomes	**On successful completion of this course the students shall be able to:** 1. Discuss primary components of power system planning, planning methodology for optimum power system expansion and load forecasting. 2. Explain economic appraisal to allocate the resources efficiently and appreciate the investment decisions 3. Discuss expansion of power generation and planning for system energy in the country, evaluation of operating states of transmission system, their associated contingencies and the stability of the system. 4. Discuss principles of distribution planning, supply rules, network development and the system studies				
Course Content:					
Module 1	Power System & Electricity Forecasting	Assignment	Simulation/Modelling and analysis	**10 Sessions**	
Topics: Planning Principles, Planning Process, Project Planning, Power Development, National and Regional Planning, Enterprise Resources Planning, Planning Tools, Power Planning Organization, Scenario Planning. Load Requirement, System Load, Electricity Forecasting, Forecasting Techniques, Forecasting Modelling, Spatial – Load Forecasting, Peak Load - Forecast, Reactive – Load Forecast, Unloading of a System.					
Module 2	Power-System Economics	Case Study	data Collection task	**8 Sessions**	
Topics: Financial Planning, Techno – Economic Viability, Private Participation, Financial Analysis, Economic Analysis, Transmission, Rural Electrification Investment, Total System Analysis, Credit - Risk Assessment. Generation Expansion: Generation Capacity and Energy, Generation Mix, Clean Coal Technologies Renovation and Modernization of Power Plants.					
Module 3	Transmission Planning	Case study	Data Collection and Analysis	**8 Sessions**	
Topics:					

Transmission Planning Criteria, Right – of – Way, Network Studies, High – Voltage Transmission, HVDC Transmission, Conductors, Sub – Stations, Power Grid, Reactive Power Planning, Energy Storage

Module 4	Distribution Planning	Assignment/ Presentation	Simulation/Data Analysis	**12 Sessions**

Topics: Distribution Deregulation, Planning Principles, Electricity – Supply Rules, Criteria and Standards, Sub – Transmission, Basic Network, Low Voltage Direct Current Electricity, Up gradation of Existing Lines and Sub – Stations, Network Development, System Studies, Urban Distribution, Rural Electrification.

Reliability and Quality: Reliability Models, System Reliability, Reliability and Quality Planning, Functional Zones, Generation Reliability Planning Criteria, Transmission Reliability Criteria, Distribution Reliability, Reliability Evaluation, Grid Reliability, Quality of Supply

Targeted Application & Tools that can be used:

Application Area is Power System Data collection, Electricity Transmission and Distributed companies, Power Grid and State Electricity Boards

Professionally Used Software: Mi Power/ PS CAD

Textbooks

1. "Power System Planning Technologies and Applications: Concepts, Solutions, and Management" Fawwaz Elkarmi Engineering Science Reference (an imprint of IGI), 2012.
2. "Power System Planning" by Udit Mamodiya, Dr.Piyush Kumar Shukla
3. "Electric Power Planning" A. S. Pabla , McGraw Hill, 2 nd Edition, 2016

Reference Books

1. "Power Systems Analysis and Design (Analysis and Design)" by Dr. B. R. Gupta.
2. "Operation and control in power system" by P S R Murthy, B S Publications

Online Resources:

1. https://www.youtube.com/watch?v=gqgKNVXLf7g&ab_channel=CUSP
2. https://www.pdfdrive.com/electric-power-system-planning-e39893329.html
3. https://nptel.ac.in/courses
4. https://puniversity.informaticsglobal.com

Topics relevant to " ENTREPRENEURIAL SKILLS ": Planning Principles, Planning Process, Project Planning Financial Planning, Techno – Economic Viability, Reliability and Quality for developing **Entrepreneurial Skills by** using **Participative Learning techniques**. This is attained through assessment component mentioned in course handout.

Topics relevant to "HUMAN VALUES AND PROFESSIONAL ETHICS": Transmission Planning Criteria, Right – of – Way, Network Studies, Distribution Deregulation, Planning Principles, Reliability and Quality

Catalogue prepared by	Mr Bishakh Paul
Recommended by the Board of Studies on	BoS No: 12th BoS held on 27/7/2021
Date of Approval by the Academic Council	16th Academic Council meeting held on 23/10/2021

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PRESIDENCY UNIVERSITY

(Established under the Presidency University Act, 2013 of the Karnataka Act 41 of 2013)

A-8[2022] COURSE HAND OUT [Theory Course]

SCHOOL: Engineering **DEPT.: EEE** **DATE OF ISSUE:**

NAME OF THE PROGRAM : **B. Tech EEE**

P.R.C. APPROVAL REF. : **PU/AC-16/EEE/2021-2025/2021**

SEMESTER/YEAR : **5th/3rd**

COURSE TITLE & CODE : **Power System Planning & EEE3028**

COURSE CREDIT STRUCTURE : **3-0-3**

CONTACT HOURS :

COURSE INSTRUCTOR :

\COIURSE URL :

PROGRAM OUTCOMES:

PO1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

PO6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

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PO11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

COURSE PREREQUISITES:

Basic concepts of Electrical Power Generation, transmission and distribution.

COURSE DESCRIPTION:

This course covers power system planning, Economics, operation and management issues as well as reliability in deregulated environment. The course will give a comprehensive overview of power system reliability. Evaluation of generation, transmission and distribution system reliability and their impacts on system planning will be dealt with. The course is designed to develop conceptual ability and an in depth understanding of key economic and other concepts related to electric utility planning and provide exposure to modern approaches of electricity planning..

COURSE OBJECTIVES:

The objective of the course is to familiarize the learners with the concepts of Power System Planning and attain **Entrepreneurial Skills** through **Participative Learning** techniques.

COURSE OUTCOMES:

On successful completion of this course the students shall be able to:

5. Discuss primary components of power system planning, planning methodology for optimum power system expansion and load forecasting.
6. Understand economic appraisal to allocate the resources efficiently and appreciate the investment decisions
7. Discuss expansion of power generation and planning for system energy in the country, evaluation of operating states of transmission system, their associated contingencies and the stability of the system.

4. Discuss principles of distribution planning, supply rules, network development and the system studies

MAPPING OF C.O. WITH P.O: [H-HIGH, M- MODERATE, L-LOW]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	L	H	L	L	M	M	L	L	M	M	M
CO 2	M	L	H	L	L	M	L	L	L	M	L	M
CO 3	M	L	H	L	H	L	M	M	M	M	M	L
CO 4	M	L	H	L	H	L	L	M	L	M	L	L

COURSE CONTENT (SYLLABUS):

Module: 1: Power System & Electricity Forecasting

Planning Principles, Planning Process, Project Planning, Power Development, National and Regional Planning, Enterprise Resources Planning, Planning Tools, Power Planning Organization, Scenario Planning. Load Requirement, System Load, Electricity Forecasting, Forecasting Techniques, Forecasting Modelling, Spatial – Load Forecasting, Peak Load - Forecast, Reactive – Load Forecast, Unloading of a System.

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[10 Hrs.] [Blooms level selected: Application]

Module: 2: Power-System Economics

Topics:

Financial Planning, Techno – Economic Viability, Private Participation, Financial Analysis, Economic Analysis, Transmission, Rural Electrification Investment, Total System Analysis, Credit - Risk Assessment. Generation Expansion: Generation Capacity and Energy, Generation Mix, Clean Coal Technologies Renovation and Modernization of Power Plants.

[8 Hrs.] [Blooms level selected: Application]

Module: 3: Transmission Planning

Topics:

Transmission Planning Criteria, Right – of – Way, Network Studies, High – Voltage Transmission, HVDC Transmission, Conductors, Sub – Stations, Power Grid, Reactive Power Planning, Energy Storage.

[8 Hrs.] [Blooms level selected: Application]

Module: 4: Distribution Planning

Topics: Distribution Deregulation, Planning Principles, Electricity – Supply Rules, Criteria and Standards, Sub – Transmission, Basic Network, Low Voltage Direct Current Electricity, Up gradation of Existing Lines and Sub – Stations, Network Development, System Studies, Urban Distribution, Rural Electrification.
Reliability and Quality: Reliability Models, System Reliability, Reliability and Quality Planning, Functional Zones, Generation Reliability Planning Criteria, Transmission Reliability Criteria, Distribution Reliability, Reliability Evaluation, Grid Reliability, Quality of Supply.

[12 Hrs.] [Blooms level selected: Comprehension]

DELIVERY PROCEDURE (PEDAGOGY):

Self-learning topics: Prepare an exhaustive report on important aspects and issues related to power system planning in developing countries like India
Participative Learning: Prepare a report on methodologies adopted for small power system planning and highly mesh interconnected large grid planning.
Problem Based Learning: Prepare a report on methodologies adopted for small power system planning and highly mesh interconnected large grid planning.

REFERENCE MATERIALS:

Textbooks

4. "Power System Planning Technologies and Applications: Concepts, Solutions, and Management" Fawwaz Elkarmi Engineering Science Reference (an imprint of IGI), 2012.
5. "Power System Planning" by Udit Mamodiya, Dr.Piyush Kumar Shukla
6. "Electric Power Planning" A. S. Pabla , McGraw Hill, 2 nd Edition, 2016

References

3. "Power Systems Analysis and Design (Analysis and Design)" by Dr. B. R. Gupta.
4. "Operation and control in power system" by P S R Murthy, B S Publications

Online Resources:

5. https://www.youtube.com/watch?v=gqgKNVXLf7g&ab_channel=CUSP
6. https://www.pdfdrive.com/electric-power-system-planning-e39893329.html
7. https://nptel.ac.in/courses
8. https://puniversity.informaticsglobal.com

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GUIDELINES TO STUDENTS:

1. Those candidates who have expertise in resolving problems and can come up with creative and innovative solutions to potential issues and design work likewise are beneficial for it.
2. Those students who have a natural interest in Power System can come up with innovative ideas that will be appreciated.

COURSE SCHEDULE FOR THEORY COMPONENT:

Sl. No.	Activity	Starting Date	Concluding Date	Total Number of Periods
01	**Over View of the course**			
02	**Module : 01**			
03	**Module: 02**			
04	**Mid-Term Examination**			
05	**Module:03**			
06	**Assignment/Quiz**			
07	**End-term examination**			

SCHEDULE OF INSTRUCTION FOR THE THEORY COMPONENT:

S. No.	Session no[date if possible]	Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	L1	Program Integration		CO1	Lecture	T1, T2
2	L2	Power System & Electricity Forecasting	Planning Principles, Planning Process, Project Planning, Power Development, National and Regional Planning,	CO1	Lecture	T1, T2
3	L3	Power System & Electricity Forecasting	Planning Principles, Planning Process, Project Planning, Power Development, National and	CO1	Lecture	T1, T2

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			Regional Planning,			
4	L4	Power System & Electricity Forecasting	Enterprise Resources Planning, Planning Tools, Power Planning Organization, Scenario Planning	CO1	Lecture	T1, T2
5	L5	Power System & Electricity Forecasting	Enterprise Resources Planning, Planning Tools, Power Planning Organization, Scenario Planning	CO1	Lecture	T1, T2
6	L6	Power System & Electricity Forecasting	Load Requirement, System Load, Electricity Forecasting, Forecasting Techniques, Forecasting Modelling	CO1	Lecture	T1, T2
7	L7	Power System & Electricity Forecasting	Load Requirement, System Load, Electricity Forecasting, Forecasting Techniques, Forecasting Modelling	CO1	Lecture	T1, T2
8	L8	Power System & Electricity Forecasting	Spatial – Load Forecasting, Peak Load - Forecast, Reactive – Load Forecast, Unloading of a System.	CO1	Lecture	T1, T2
9	L9	Power System & Electricity Forecasting	Spatial – Load Forecasting, Peak Load - Forecast, Reactive – Load Forecast, Unloading of a System.	CO1	Lecture	T1, T2
10	L10	Power System & Electricity Forecasting	Spatial – Load Forecasting, Peak Load - Forecast, Reactive – Load Forecast, Unloading of a	CO1	Lecture	T1, T2

			System.			
Module I completed						
11	L11	Power-System Economics	Financial Planning, Techno – Economic Viability	CO 2	Lecture	T1, T2
12	L12	Power-System Economics	Financial Planning, Techno – Economic Viability	CO 2	Lecture	T1, T2
13	L13	Power-System Economics	Private Participation, Financial Analysis, Economic Analysis	CO 2	Lecture	T1, T2
14	L14	Power-System Economics	Private Participation, Financial Analysis, Economic Analysis	CO 2	Lecture	T1, T2
15	L15	Power-System Economics	Transmission, Rural Electrification Investment analysis, Dynamic Response-Uncontrolled case	CO 2	Lecture	T1, T2
16	L16	Power-System Economics	Transmission, Rural Electrification Investment	CO 2	Lecture	T1, T2
17	L17	Power-System Economics	Total System Analysis, Credit - Risk Assessment.	CO 2	Lecture	T1, T2
18	L18	Power-System Economics	Total System Analysis, Credit - Risk Assessment.	CO 2	Lecture	T1, T2
Module II completed						
19	L19	Transmission Planning	Transmission Planning Criteria, Right – of – Way, Network Studies	CO 3	Lecture	T1, T2
20	L20	Transmission Planning	Transmission Planning Criteria, Right – of – Way, Network Studies	CO 2	Lecture	T1, T2
21	L21	Transmission Planning	High – Voltage Transmission, HVDC	CO 2	Lecture	T1, T2

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			Transmission			
22	L22	Transmission Planning	High – Voltage Transmission, HVDC Transmission	CO 2	Lecture	T1, T2
23	L23	Transmission Planning	Conductors, Sub – Stations, Power Grid, Reactive Power Planning, Energy Storage	CO 2	Lecture	T1, T2
24	L24	Transmission Planning	Conductors, Sub – Stations, Power Grid, Reactive Power Planning, Energy Storage	CO 2	Lecture	T1, T2
25	L25	Transmission Planning	Conductors, Sub – Stations, Power Grid, Reactive Power Planning, Energy Storage	CO 2	Lecture	T1, T2
26	L26	Revision		CO 2	Lecture	T1, T2
Module III completed						
27	L27	Distribution Planning	Distribution Deregulation, Planning Principles, Electricity – Supply Rules	CO 2	Lecture	T1, T2
28	L28	Distribution Planning	Distribution Deregulation, Planning Principles, Electricity – Supply Rules	CO 2	Lecture	T1, T2
29	L29	Distribution Planning	Criteria and Standards, Sub – Transmission, Basic Network, Low Voltage Direct Current Electricity,	CO 2	Lecture	T1, T2
30	L30	Distribution Planning	Criteria and Standards, Sub – Transmission, Basic Network, Low Voltage Direct Current Electricity,	CO 2	Lecture	T1, T2
31	L31	Distribution Planning	layout & schematic diagram for Up gradation of Existing	CO 2	Lecture	T1, T2

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			Lines and Sub – Stations, Network Development, System Studies, Urban Distribution, Rural Electrification.			
32	L32	Distribution Planning	Up gradation of Existing Lines and Sub – Stations, Network Development, System Studies, Urban Distribution, Rural Electrification.	CO 2	Lecture	T1, T2
33	L33	Distribution Planning	Reliability and Quality: Reliability Models, System Reliability, Reliability and Quality Planning	CO 2	Lecture	T1, T2
34	L34	Distribution Planning	Reliability and Quality: Reliability Models, System Reliability, Reliability and Quality Planning	CO 2	Lecture	T1, T2
35	L35	Distribution Planning	Reliability and Quality: Reliability Models, System Reliability, Reliability and Quality Planning	CO 2	Lecture	T1, T2
36	L36	Distribution Planning	Functional Zones, Generation Reliability Planning Criteria, Transmission Reliability Criteria, Distribution Reliability, Reliability Evaluation, Grid Reliability,	CO 2	Lecture	T1, T2

			Quality of Supply			
37	L37	Distribution Planning	Functional Zones, Generation Reliability Planning Criteria, Transmission Reliability Criteria, Distribution Reliability, Reliability Evaluation, Grid Reliability, Quality of Supply	CO 2	Lecture	T1, T2
38	L38	Distribution Planning	Functional Zones, Generation Reliability Planning Criteria, Transmission Reliability Criteria, Distribution Reliability, Reliability Evaluation, Grid Reliability, Quality of Supply	CO 2	Lecture	T1, T2
Module IV completed						

Topics relevant to "ENTREPRENEURIAL SKILLS ": Planning Principles, Planning Process, Project Planning Financial Planning, Techno – Economic Viability, Reliability and Quality for developing **Entrepreneurial Skills** **by** using **Participative Learning techniques**. This is attained through the **Presentation** as mentioned in the assessment component.

ASSESSMENT SCHEDULE FOR THEORY COMPONENT:

Sl. No.	**Assessment type [Include here assessment method for self-learning component also]**	**Contents**	**Course outcome Number**	**Duration (In Hours)**	**Marks**	**Weightage**	**Venue, Date & Time**

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1	Quiz 1	Enterprise Resources Planning, Planning Tools, Power Planning Organization, Scenario Planning	**3**	**0.5**	**20**	**5%**	
2	Student Presentation	Load Requirement, System Load, Electricity Forecasting, Forecasting Techniques, Forecasting Modelling	2	0.5	20	10%	
3	**Assignment** **(Review of Digital/e-resources from Pres. Univ. link given in the References section- (Mandatory to submit the screenshot of accessing digital resource.** **Otherwise it will not be evaluated.)**	https://puniversity.informaticsglobal.com	CO1, CO2, CO3	**1/2**	**10**	**5%**	
4	**Midterm**			**1.5**	**50**	**25%**	
5	**Endterm**			**3**	**100**	**50%**	

COURSE CLEARANCE & EVALUATION CRITERIA:

i. Minimum of 75% Attendance is must to take up examination.
ii. Minimum of 30% score is must in Midterm and Final End Term Examination.
iii. However a minimum of 40% of grand total marks or F-grade limit under relative grading, whichever is lower.

MAKEUP POLICY:

If the student misses an evaluation component, he/she may be granted a make-up. In case of an absence that is foreseen, make-up request should be personally made to the Instructor-in-Charge, well ahead of the scheduled evaluation component. Reasons for unanticipated absence that qualify a student to apply for make-up include medical emergencies or personal exigencies. In such an event, the student should contact the Instructor-in-Charge as soon as practically possible.

CONTACT TIMINGS IN THE CHAMBER FOR ANY DISCUSSIONS:

It will be announced in the class. Interested students may meet the Instructor In-charge during the Chamber Consultation Hour to clear doubts.

Sample Thought Provoking Questions [For Theory Component]:

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Sl No.	Question	Marks	Course Outcome No.	Bloom's Level
1	Describe the structure of power system indicating the power system components and types	10	1	Application
2	With the help of block diagram, explain distributed power generation planning. List planoptions, uncertainties and attributes.	10	2	Application
3	What is co-generation? Describe the two techniques of cogeneration	10	3	Comprehension
4	Discuss in brief rational tariff	10	4	Comprehension

Target set for course Outcome attainment:

Sl. No	C.O. No.	Course Outcomes	Target set for attainment in percentage
01	1	Discuss primary components of power system planning, planning methodology for optimum power system expansion and load forecasting.	50%
02	2	Understand economic appraisal to allocate the resources efficiently and appreciate the investment decisions	50%
03	3	Discuss expansion of power generation and planning for system energy in the country, evaluation of operating states of transmission system, their associated contingencies and the stability of the system.	50%
04	4	Discuss principles of distribution planning, supply rules, network development and the system studies	50%

Signature of the Course Instructor

This course has been duly verified Approved by the D.A.C.

Signature of the Chairperson D.A.C.

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Course Code: EEE3027	**Course Title: Electric Vehicle Technology** **Type of Course: 1]. Discipline Elective, 2]. Theory only**	**L-P-C**	3	0	3
Version No.	2.0				
Course Pre-requisites	Basics of Electric circuits, Fundamentals of DC and AC motors				
Anti-requisites	NIL				
Course Description	This course introduces the fundamental concepts, principles, analysis and design of hybrid and electric vehicles. This course helps students to understand vehicle mechanics and working of Electric Vehicles and recent trends. The course enables them to analyze different power converter topology used for electric vehicle applications. Also, it provides the ability to develop the electric propulsion unit and its control for application of electric vehicles through assignments. The course is both conceptual and analytical in nature and needs fair knowledge of mathematical and computing. The course develops the critical thinking and analytical skills.				
Course Objective	The objective of the course is to familiarize the learners with the concepts of Electric Vehicles and attain **Entrepreneurial Skills** through **Participative Learning** techniques.				
Course Out Comes	**On successful completion of the course the students shall be able to:** 1. Describe the fundamental laws and vehicle mechanics. 2. Explain the basics of electric and hybrid electric vehicles, their architecture, technologies and fundamentals. 3. Analyze DC and AC drive topologies used for electric vehicle application. 4. Discuss different energy storage technologies used for hybrid electric vehicles and their control.				
Course Content:					
Module 1	Introduction and Vehicle Fundamentals	Assignment	Computation and Data Analysis	**o. of Sessions: 6**	
Introduction : Environmental Impact and History of Modern Transportation ,Vehicle fundamentals: General Description of Vehicle Movement, Vehicle Resistance, dynamic equation, tractive force Determination; vehicle parameters and performance metrics.					
Module 2	Electric and Hybrid Electric Vehicles	Quiz	Data collection and Analysis	**of Sessions: 10**	
Electric Vehicles: Architecture of an electric vehicle, essentials and performance of electric vehicles – Traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption, advantage and limitations Hybrid electric drivetrains: Concepts, architecture, design, control strategies, merits and demerits, Sizing of major components.					
Module 3	Electric Propulsion Systems	Case study	Simulation and data analysis	**o. of Sessions:8**	
Electric Propulsion Systems: DC motor drives, induction motor drives and permanent magnet motor drives, switched and synchronous reluctance					
Module 4	Energy storage Devices	Assignment	Data collection	**o. of Sessions:8**	

Energy storage Devices: Electrochemical batteries – Reactions, thermodynamic voltage, lead-acid batteries, nickel based batteries, lithium based batteries, flywheel and ultra-capacitors, Battery management systems.

Targeted Application & Tools that can be used:

Application: Automotive industry.

Software tools: Matlab-Simulink

Text Book

1.Mehrdad Ehsani, YiminGao, sebastien E. Gay and Ali Emadi, ―Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design‖, CRC Press, 2009.

2. Iqbal Husain, ―Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2011, Second Edition.

References

1. James Larminie and John Loury, ―Electric Vehicle Technology-Explained‖, John Wiley & Sons Ltd., 2003, Second Edition.
2. C.C. Chan and K.T. Chanu Modern Electric Vehicle Technology, OXFORD University, 2011
3. Sheldon S. Williamson,- Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Springer,2013
4. Chris Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011, Second Edition

Online resources:

1. https://nptel.ac.in/courses/108/102/108102121/
2. https://nptel.ac.in/courses/108/106/108106170/
3. IEEE Explore - School of Engineering
4. https://www.coursera.org/learn/electric-vehicles-mobility
5. Seminar:https://puniversity.informaticsglobal.com:2069/search/searchresult.jsp?newsearch=true&queryText=ELECTRIC%20VEHICLES
6. Video: https://www.youtube.com/watch?v=GHGXy_sjbgQ
7. Text book of Electric and Hybrid Vehicles : Power Sources, Models, Sustainability, Infrastructure and the Market, Gianfranco Pistoia, 1st ed. Amsterdam : Elsevier. 2010 https://puniversity.informaticsglobal.com:2284/ehost/detail/detail?vid=0&sid=52da4e6e-8813-45d5-87f9-73b9f493f358%40redis&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d#AN=342445&db=nlebk

Case Study:

I. https://www.simpli.com/answers
II. https://www.upgrad.com/ev_technology/iit-delhi
III. https://www.coursera.org/

Topics relevant to "ENTREPRENEURIAL SKILLS": Vehicle fundamentals, total tractive effort calculation and design of drive train for different vehicle architectures for developing **Entrepreneurial Skills** through **Participative Learning techniques.** This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Ms. Ragasudha C P
Recommended by the Board of Studies on	BoS No: 14th BoS held on 22/2/2022
Date of Approval by the Academic Council	18th Academic Council meeting held on 3/8/2022

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PRESIDENCY UNIVERSITY

(Established under the Presidency University Act, 2013 of the Karnataka Act 41 of 2013)

A-2[2020] COURSE HAND OUT

SCHOOL: Engineering **DEPT.: EEE DATE OF ISSUE: 11/03/2022**

NAME OF THE PROGRAM : B.TECH (EEE)

P.R.C. APPROVAL REF. : PU/AC-16/EEE/2021-2025/2021

SEMESTER/YEAR : II / 1st

COURSE TITLE & CODE : Electric Vehicle Technology & EEE3027

COURSE CREDIT STRUCTURE : 3-0-3

CONTACT HOURS : 3 (Mon 2nd hr, Wed 3rd hr, Thu 4th hr)

COURSE INSTRUCTOR : Mr. K Sreekanth Reddy

COIURSE URL : https://www.edhitch.com

PROGRAM OUTCOMES:

Graduates of the B.Tech. Program in Electrical and Electronics Engineering will be able to:

PO1.Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.(H)

PO2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.(H)

PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.(L)

PO6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.(L)

PO11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

COURSE PREREQUISITES:

Basics of Electric circuits, Fundamentals of DC and AC motors

COURSE DESCRIPTION:

This course introduces the fundamental concepts, principles, analysis and design of hybrid and electric vehicles. This course helps to understand vehicle mechanics and working of Electric Vehicles and recent trends. The course enables them to analyze different power converter topology used for electric vehicle applications. Also, it provides the ability to develop the electric propulsion unit and its control for application of electric vehicles through assignments. The course is both conceptual and analytical in nature and needs fair knowledge of mathematical and computing. The course develops the critical thinking and analytical skills.

COURSE OBJECTIVE: The objective of the course is to familiarize the learners with the concepts of Electric Vehicles and attain **Entrepreneurial Skills** through **Participative Learning** techniques.

COURSE OUTCOMES: On successful completion of the course the students shall be able to:

1. Describe the fundamental laws and vehicle mechanics.
2. Explain the basics of electric and hybrid electric vehicles, their architecture, technologies and fundamentals.
3. Summarize DC and AC drive topologies used for electric vehicle application.
4. Discuss different energy storage technologies used for hybrid electric vehicles and their control.

MAPPING OF C.O. WITH P.O. :
[H-HIGH, M- MODERATE, L-LOW]

C.O.N0.	P.O.01	P.O.02	P.O.05	P.O.10	P.O.12
1	H	H			L
2	H	H			L
3	M	M	L	L	

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4	**M**	**M**	**L**	**L**	**L**

COURSE CONTENT (SYLLABUS):

MODULE: 1: INTRODUCTION AND VEHICLE FUNDAMENTALS

Introduction: Environmental Impact and History of Modern Transportation Vehicle fundamentals: General Description of Vehicle Movement, Vehicle Resistance, dynamic equation , tractive force Determination; vehicle parameters and performance metrics. **[6-Hrs] [Blooms 'level selected: Knowledge]**

MODULE: 2: ELECTRIC AND HYBRID ELECTRIC VEHICLES

Electric Vehicles: Architecture of an electric vehicle, essentials and performance of electric vehicles – Traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption, advantage and limitations

Hybrid electric drivetrains: Concepts, architecture, design, control strategies, merits and demerits, Sizing of major components. **[9-Hrs] [Blooms 'level selected: Comprehension]**

MODULE: 3: ELECTRIC PROPULSION SYSTEMS

Electric Propulsion Systems: DC motor drives, induction motor drives and permanent magnet motor drives**,** switched reluctance **and** BLDC motor drives

[7Hrs] [Blooms 'level selected: Comprehension]

MODULE: 4: ENERGY STORAGE DEVICES

Energy storage Devices: Electrochemical batteries – Reactions, thermodynamic voltage, lead-acid batteries, nickel based batteries, lithium based batteries, flywheel and ultra-capacitors, Battery management systems.

[7-Hrs] [Blooms 'level selected: Comprehension]

DELIVERY PROCEDURE (PEDAGOGY):

Topics for Self-Learning:

12. Selection of wires for EVs.
13. SOC of Battery

Experiential Learning Topics:

7. Vehicle dynamics using MATLAB Simulink

Note:

All the Topics will be covered through **Lecture Method.**

10. E-materials :

8. https://nptel.ac.in/courses/108/102/108102121/
9. https://nptel.ac.in/courses/108/106/108106170/
10. IEEE Explore - School of Engineering
11. https://www.coursera.org/learn/electric-vehicles-mobility
12. Seminar**:**https://puniversity.informaticsglobal.com:2069/search/searchresult.jsp?newsearch=true&queryText=ELECTRIC%20VEHICLES
13. Video: https://www.youtube.com/watch?v=GHGXy_sjbgQ
14. Text book of Electric and Hybrid Vehicles : Power Sources, Models, Sustainability, Infrastructure and the Market, Gianfranco Pistoia, 1st ed. Amsterdam : Elsevier. 2010 **https://puniversity.informaticsglobal.com:2284/ehost/detail/detail?vid=0&sid=52da4e6e-8813-45d5-87f9-73b9f493f358%40redis&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d#AN=342445&db=nlebk**

Case Study:

IV. **https://www.simpli.com/answers**

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V. https://www.upgrad.com/ev_technology/iit-delhi
VI. https://www.coursera.org/

REFERENCE MATERIALS:

Textbooks:

T1: Mehrdad Ehsani, YiminGao, sebastien E. Gay and Ali Emadi, —Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design‖, CRC Press, 2009.

T2:Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2011.2nd edition.

Reference book(s):

1. James Larminie and John Loury, —Electric Vehicle Technology-Explained‖, John Wiley & Sons Ltd., 2003, Second Edition.

2.C.C. Chan and K.T. Chanu Modern Electric Vehicle Technology, OXFORD University, 2011

3.Sheldon S. Williamson,- Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Springer,2013

4. Chris Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011, Second Edition

Other resources:

IEEE Explore - School of Engineering
https://puniversity.informaticsglobal.com/login .

GUIDELINES TO STUDENTS: (Here mention a few tips to study this course effectively)

- The students are advised to be very much regular to the online classes and sincerely attempt the learnings listed in the Pedagogical section.
- The students are advised to take down the notes legibly which serves as a firsthand information to study and revise lecture topics on day to day basis.
- The students are advised to visit the Edhitch portal and Microsoft teams on a regular basis to study the supporting materials shared by the course instructors.
- The students are advised to use the journals, technical magazines and other relevant materials.
- The students are advised to watch the video lectures available online to understand and review the concepts delivered in the class as well as problems assigned for self-learning topics.

COURSE SCHEDULE: (This is a macro level planning. Mention the unit wise expected starting and ending dates along with the tests/assignments/quiz and any other activities) [allot about 75% for delivary,about10 to 12% for Evaluation Discussion, about 10 to 15% on integrating the learning Modules within the course and to the program]

Sl. No.	ACTIVITY	STARTING DATE	CONCLUDING DATE	TOTAL NUMBER OF PERIODS
01	Program Integration Over View of the course	23-03-2022	24-03-2022	2
02	**Module : 01 Content**	28-03-2022	8-04-2022	8
03	Module:2 Course Integration & content	11-04-2022	05-05-2022	10

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04	Mid Term **Test**	09-05-2022	12-05-2022	
05	Test Paper Discussion	16-05-2022	16-05-2022	1
06	**Module:03** Course Integration and content	18-05-2022	08-06-2022	8
07	**Module:04** Course Integration and content	09-06-2022	20-02-2022	6
08	Case Study	02-04-2022	02-06-2022	NA
09	Program integration	20/6/2021	20/6/2022	01

SCHEDULE OF INSTRUCTION:

MODULE: 1: INTRODUCTION AND VEHICLE FUNDAMENTALS

Sl. no	Session no	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	**S1** **23-03-22**	Program Integration	Introduction to course			
2	S2 24-03-22	Course Integration	**Environmental Impact**			
3	S3 28-3-22	History of Modern Transportation	**History of Modern Transportation Vehicle**	CO. 1	Lecture Mode	T1:Ch.1
	S4 30-3-22		**General Description of Vehicle Movement**			
4	S5 31-3-22		**Vehicle Resistance,**	CO. 1	Lecture Mode	T1:Ch.2
5	S6 4-4-22	General Description of Vehicle Movement	**Dynamic equation.**	CO. 1	Lecture Mode	T1:Ch.2
6	S7 6-4-22		tractive force Determination;	CO. 1	Lecture Mode	T1:Ch.2
7	S8 7-4-22		vehicle parameters and performance metrics**.**	CO. 1	Lecture Mode	T1:Ch.2

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8	S9 8-4-22		vehicle parameters and performance metrics, **problem solving**	CO. 1	Lecture Mode	T1:Ch.2
Module 1 is completed						

MODULE: 2: ELECTRIC AND HYBRID ELECTRIC VEHICLES

Sl. no	**Session no**	**Lesson Title**	**Topics**	**Course Outcome Number**	**Delivery Mode**	**Reference**
1	**S10** **11-4-22**	Course Integration				
2	S11 13-4-22		Electric Vehicles: Architecture of an electric	CO. 2	Lecture Mode	T1.Ch.5
3	S12 18-4-22	Design parameters	essentials and performance of electric vehicles	CO. 2	Lecture Mode	T1.Ch.5
	S13 20-4-22		Traction motor characteristics, tractive effort,			T1.Ch.4
4	S14 21-4-22		vehicle–transmission requirements, vehicle performance, energy consumption, advantage and limitations	CO. 2	Lecture Mode	Technical papers
5	S15 25-4-22		Hybrid electric drivetrains: Concepts, architecture	CO. 2	Lecture Mode	T1.Ch.6
6	S16 27-4-22		Hybrid electric drivetrains: Concepts, architecture	CO. 2	Lecture Mode	T1.Ch.6
7	S17 28-4-22		tractive effort, transmission requirement	CO. 2	Lecture Mode	T1.Ch.10

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8	S18 4-5-22		tractive effort, transmission requirement	CO. 2	Lecture Mode	T1.Ch.10
8	S19 5-5-22		merits and demerits, Sizing of major components	CO. 2	Lecture Mode	T1.Ch.6
9	S20 16-5-22		Mid Term Paper Discussion			
10	S21 18-5-22		Problem Solving	CO. 2	Lecture Mode	Technical papers
	Self-Learning Topic		Selection of wires for EVs.			IEEE Explore - School of Engineering https://puniversity.informaticsglobal.com/login
Module 2 is completed						

MODULE: 3: ELECTRIC PROPULSION SYSTEMS

Sl. no	Session no	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	S22 19-5-22	Course Integration	Electric Propulsion Systems:			
2	S23 23-5-22	Electric Propulsion Systems	Electric Propulsion Systems:			
3	S24 25-5-22		DC motor basics	CO. 3	Lecture Mode	T1.Ch.7
4	S25 26-5-22		DC motor basics	CO. 3	Lecture Mode	Text Book

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5	S26 30-5-22		induction motor drives	CO. 3	Lecture Mode	T1.Ch.7
6	S27 1-06-22		permanent magnet motor drives	CO. 3	Lecture Mode	T1.Ch.7
7	S28 02-06-22		permanent magnet motor drives	CO. 3	Lecture Mode	T1.Ch.7
8	S29 4-6-22		Motors used in Different cars	CO. 3	Lecture Mode	Technical papers
9	S30 5-6-2022		switched and synchronous reluctance	CO. 3	Lecture Mode	T1.Ch.7
10	S31 6-6-2022		BLDC motor drives	CO. 3	Lecture Mode	T1.Ch.7
			Case study submission			
Module 3 is completed						

MODULE: 4: ENERGY STORAGE DEVICES

Sl. no	Session no	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	S32 8-6-22	Course Integration	Batteries			
2	S33 9-6-22	Energy storage Devices:	Electrochemical batteries – Reactions, thermodynamic voltage	CO .4	Lecture Mode	T1.Ch.13
3	**S34** **13-6-22**		lead-acid batteries, nickel based batteries	CO .4	Lecture Mode	T1.Ch.13

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4	**S35** **15-6-22**		lithium based batteries	CO .4	Lecture Mode	Technical papers
5	**S36** **16-6-22**		flywheel and ultra-capacitors	CO .4	Lecture Mode	Technical papers
	Self Learning Topic		SOC of Battery			IEEE Explore - School of Engineering https://puniversity.informaticsglobal.com/login
6	**S37** **20-6-22**		Battery management systems.	CO .4	Lecture Mode	Technical papers
7	**S38** **20-6-22**		Battery management systems. Program Integration	CO .4	Lecture Mode	Technical papers
Module 4 is completed						

Topics relevant to "ENTREPRENEURIAL SKILLS": Vehicle fundamentals, total tractive effort calculation and design of drive train for different vehicle architectures for developing **Entrepreneurial Skills** through **Participative Learning techniques.** This is attained through the **Presentation** as mentioned in the assessment component.

ASSESSMENT SCHEDULE:

S. No.	Assessment Type	Contents	CO Number	Duration In Hours	Marks	Weightage	Venue, DATE &TIME
1	Case Study - Presentation	Topic can be selected from any Module	CO 2 and CO 4	-	30	15%	4th Week of May 2022
2	Midterm	M1, M2	CO1,2	90 Minutes	50	25%	9-5-2022 to 12-05-2022

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3	Assignement as self-Learning topics Review of digital/e-resources from Pres. Univ.link given in the references section (Mandatory to submit the screenshots of accessing digital Resource. Otherwise it will not be evaluated	Mentioned.	CO3	-NA-	20	10%	May 3rd week
4	End Term Exam	All modules	CO 1,2,3,4	3 hours	100	50%	27-06-2022 to 09-07-2022

COURSE CLEARANCE CRITERIA: (Here mention the minimum requirements of attendance, marks in continuous assessment &term end examination, make up exam policy and other details as per the academic regulations & PRC):

- Minimum of 75% Attendance is must to take up examination.
- Minimum of 40% score is must in Midterm and Final End Term Examination.
- However a minimum of 50% of grand total marks or F-grade limit under relative grading, whichever is lower.
- Make up policy is applicable only as per academic regulation
- There will be no make-up for ASSIGNMENT and QUIZ.

MAKEUP POLICY:

If the student misses an evaluation component, he/she may be granted a make-up. In case of an absence that is foreseen, make-up request should be personally made to the Instructor-in-Charge, well ahead of the scheduled evaluation component. Reasons for unanticipated absence that qualify a student to apply for make-up include medical emergencies or personal exigencies. In such an event, the student should contact the Instructor-in-Charge as soon as practically possible.

CONTACT TIMINGS IN THE CHAMBER FOR ANY DISCUSSIONS:

Interested students may contact the Instructor In-charge during the student free Hour and Wednesday, Friday 3:00 – 4:00 pm to clear doubts.

SAMPLE THOUGHT PROVOKING QUESTIONS: (Here type sample typical questions for students 'reference)

SL NO	QUESTION	MARKS	COURSE OUTCOME NO.	BLOOM'S LEVEL

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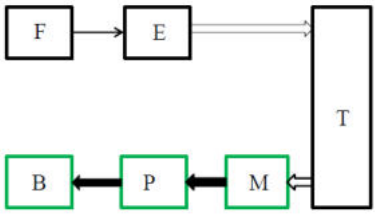
1	What would happen to the rolling resistance (Frr) and the aerodynamic resistance(Fad) if the vehicle mass increase 50% and frontal area decrease 20%?	8	1	Knowledge
2	Let us assume a EV which is operating at a vehicle speed of 100 kilometer per hour with the drag coefficient of 0.2, frontal area of 3 meter square, air density of 1.2 kg per meter cube and the energy available in the batteries is 20 kilo Watt hour. So what will be range if we having this kind of system parameters with no wind and with a opposing wind at 10 kilometer per hour.	10	2	Comprehension
3	Due to the variations in HEV configurations, different power control strategies are necessary to regulate the power flow to or from different components. Identify the operating mode of the following parallel hybrid system  Comment on your answer.	10	2	Comprehension
4	Name different types of energy sources used in electric vehicles and explain how to size the power supply for any given direct drive electric two or three wheelers?	10	3	Comprehension
5	Can you think of a problem in storing liquid hydrogen inside a car? Justify your answer.	10	4	Comprehension

Target set for course Outcome attainment:

Sl.no	C.O. No.	Course Outcomes	Target set for attainment in percentage
01	Co1	Describe the importance of Electric Vehicles in recent trends	50

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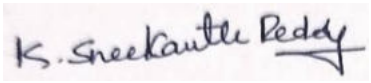
02	Co2	Discuss the components of Electric Vehicles and Hybrid Electric Vehicles	50
03	Co3	Summarize the properties of batteries and electric vehicle drive systems	50
04	Co4	Explain different charging methods of Electric vehicles	50



Signature of the course Instructor

This course has been duly verified Approved by the D.A.C.

Signature of the Chairperson D.A.C.

Course Completion Remarks &Self-Assessment.[This has to be filled after the completion of the course]

[Please mention about the course coverage details w.r.t. the schedule prepared and implemented. Any specific suggestions to incorporate in the course content. Any Innovative practices followed and its experience. Any specific suggestions from the students about the content, Delivery, Evaluation etc.]

Sl.no.	Activity As listed in the course Schedule	Scheduled Completion Date	Actual Completion Date	Remarks
01	Program Integration Over View of the course	24-03-2022	24-03-2022	As per the plan
02	**Module : 01 Content**	7-04-2022	8-4-2022	Because of solving numerical it took one class extra.
03	Module:2 Course Integration & content	05-05-2022	05-05-2022	Got additional class because of adjustment of class from other faculty and could able to complete as per the schedule.
04	Mid Term **Test**	12-05-2022	14-05-2022	There were no classes in the extended days
05	Test Paper Discussion	16-05-2022	16-05-2022	Completed as per the schedule
06	**Module:03** Course Integration and content	08-06-2022	08-06-2022	Though planned for sessions and 1 Saturday came as working and spent 9 session to cover the topics
07	**Module:04** Course Integration and content	20-06-2022	20-06-2022	Completed as per the plan.

08	Case Study	02-06-2022	08-06-22	As per the students request the date of submission extended.
09	Program integration	20/6/2022		As per the plan

Any specific suggestion/Observations on content/coverage/pedagogical methods used etc.:

1. Few students were able to do the MATLAB programming for the characteristics, calculation of design parameters also.

2. As it is offered for the first semester, some content may not be able to deliver at the higher pace or in depth,

3. Content was covered with limited classes because of the semester working days were less.

Course Outcome Attainment:

Sl.no	C.O. No.	Course Outcomes	Target set for attainment in percentage	Actual C.O. Attainment In Percentage	Remarks on attainment &Measures to enhance the attainment
01	Co1	Describe the importance of Electric Vehicles in recent trends	50	47.92%	Majority of the students didn't understand the questions and wrote different answers. This subject is at first year level became difficult for them.
02	Co2	Discuss the components of Electric Vehicles and Hybrid Electric Vehicles	50	52.43%	As per the expectation.
03	Co3	Summarize the properties of batteries and electric vehicle drive systems	50	58.91%	May be expected less and can keep little higher side.
04	Co4	Explain different charging methods of Electric vehicles	50	59.84%	May be expected less and can keep little higher side.

K. Sreekanth Reddy

Signature of the course Instructor

This course has been duly verified Approved by the D.A.C.

Signature of the Chairperson D.A.C.

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SCHOOL of ENGINEERING
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Year: 2022-2023 **Semester: 4th** **Section: 4-EEE-1** **02.06.2023**

Course Title: Battery Management System

Course Code: EEE3036

Type of Skill: Entrepreneurial Skills
Type of Activity: Simulation and hardware based Learning

Instructor in Charge: Mr. Sunil Kumar A V

Instructor for Section: Mr. Sunil Kumar A V

Details about the activity: Students were able to Simulate and develop a hardware model of Battery Management System in group wise to enhance the Entrepreneurial Skill. Students Learn the model of BMS and its problem analysis, Product development.

Topic of Activity: Problem Analysis and product development of BMS using Matlab Simulation Model presented by Students.

Details of the students involved in the activity: All the students of 4EEE-1.

Details of the students involved in the activity: 4EEE1 Students

Sl. No	Student Id No.	Name of the Student
1.	20211EAE0027	DUSHANTH B
2.	20211EEE0001	PENUGONDA CHARAN
3.	20211EEE0002	SHAIK AHAMMAD
4.	20211EEE0003	SUMAN
5.	20211EEE0004	YAMUNA M N
6.	20211EEE0005	HARIKRISHNA
7.	20211EEE0006	PIYUSH NISHAD
8.	20211EEE0007	GAGANMURTHY
9.	20211EEE0008	HRUTHIK H B
10.	20211EEE0009	ANUSHA B
11.	20211EEE0010	SUPRITH D L
12.	20211EEE0011	NITHISH U
13.	20211EEE0012	VIDYA SHREE G N
14.	20211EEE0013	R V GANESH
15.	20211EEE0014	SINCHANA M
16.	20211EEE0015	BINDHU R C
17.	20211EEE0016	GAGAN SAI A S

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18.	20211EEE0017	KAVYA N
19.	20211EEE0018	ROHAN R
20.	20211EEE0019	BHARATH H D
21.	20211EEE0020	RUDRAGOUDA K POLICE PATIL
22.	20211EEE0021	HARSHITHA B S
23.	20211EEE0023	MASROOR AHMED
24.	20211EEE0024	ANIRUDH S
25.	20211EEE0025	RATHISH HOMBALE N
26.	20211EEE0026	MOHAMMED AIMAN KHAN
27.	20211EEE0027	YASHWANTH KUMAR S
28.	20211EEE0028	ADARSH A
29.	20211EEE0029	CHETHAN S KATTI
30.	20211EEE0030	JATIN SHARMA
31.	20211EEE0031	TEJASHWINI ANNAPPAGOUDA PATIL
32.	20211EEE0032	MANTHU NANDHINI
33.	20211EEE0033	MOHAMMAD NABEEL ABBAS
34.	20211EEE0034	RAJANEESH B S
35.	20211EEE0035	V RAHUL BALAJIGA
36.	20211EEE0036	DEEPAK DANIEL F
37.	20211EEE0037	KHALEEL H TELSUNG
38.	20211EEE0038	HEMANT PANDIT
39.	20211EEE0039	AKASH K
40.	20211EEE0040	MOHAMED THABISH .
41.	20211EEE0041	NAYANI POORNACHANDAN ROYAL
42.	20211EEE0042	ABHISHEK BASAVARAJ HAMPANNAVAR
43.	20211EEE0043	RISHIKA R
44.	20211EEE0044	MOHAMMED ABRAR .
45.	20211EEE0046	BASIL BINU
46.	20211EEE0047	G KIRAN KUMAR
47.	20211EEE0048	SAGAR D M
48.	20211EEE0050	YASWANTH BUDURI
49.	20211EEE0051	MADIVADA HEMANTH
50.	20211EEE0052	YENNABOINA RAHUL
51.	20211EEE0053	KARRI GOWRI ESWAR
52.	20211EEE0055	SETTIPALLI SAINATH
53.	20211EEE0056	SHREYAS E
54.	20211EPE0002	SIRICHAPALA UDAY MALIK
55.	20221LEE0001	NANDYALA SIVA MANOJ REDDY
56.	20221LEE0002	CHINTHA MANJUNATH
57.	20221LEE0003	K TUNISH

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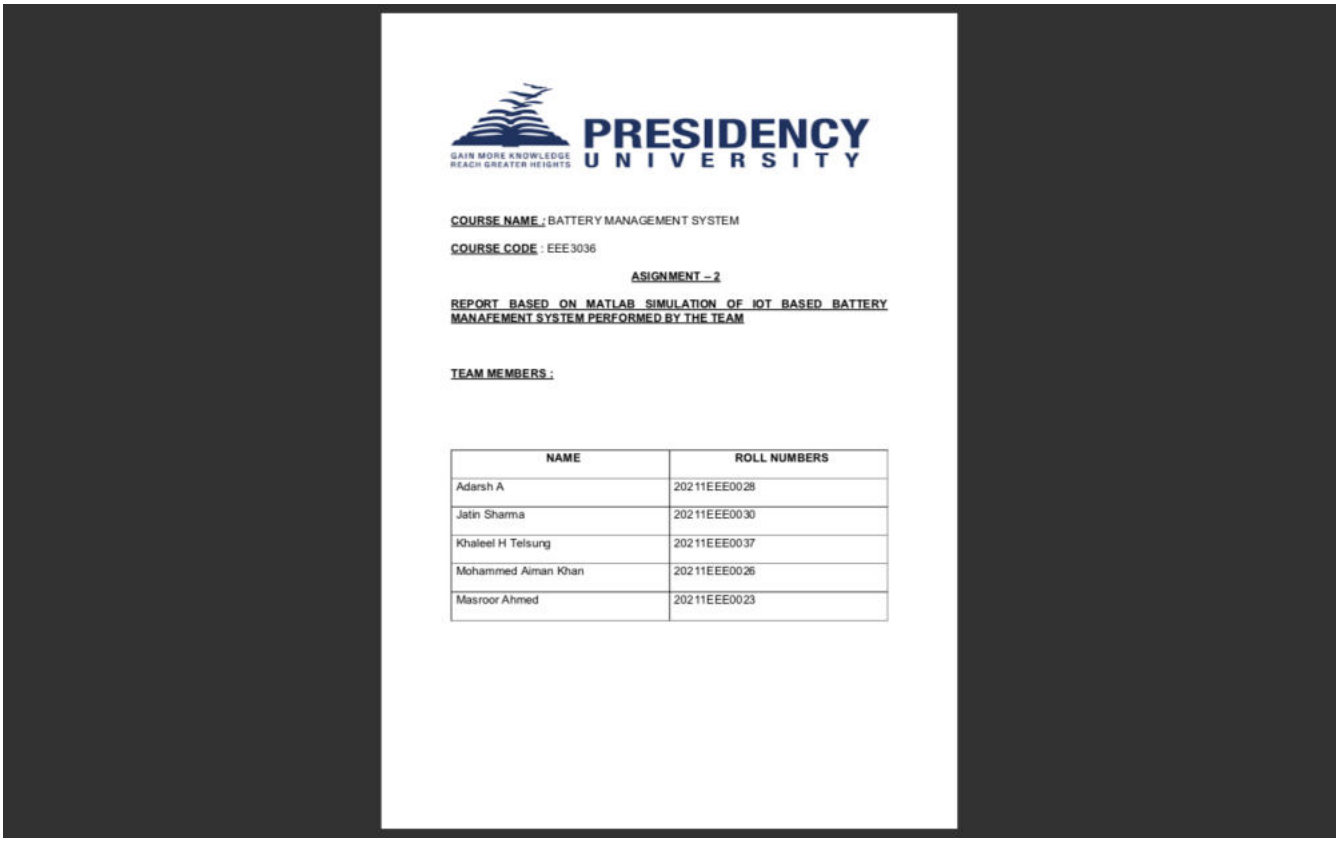
58.	20221LEE0004	KUPPAM MANJUNATHA
59.	20221LEE0005	RITHIKA RAJ
60.	20221LEE0006	BHUVAN B U
61.	20221LEE0007	RAGHU M

Sample Presentation as mentioned in the topic.

COURSE NAME : BATTERY MANAGEMENT SYSTEM
COURSE CODE : EEE3036

REPORT BASED ON MATLAB SIMULATION OF IOT BASED BATTERY MANAFEMENT SYSTEM PERFORMED BY THE TEAM



PRESIDENCY UNIVERSITY

COURSE NAME : BATTERY MANAGEMENT SYSTEM

COURSE CODE : EEE3036

ASIGNMENT – 2

REPORT BASED ON MATLAB SIMULATION OF IOT BASED BATTERY MANAFEMENT SYSTEM PERFORMED BY THE TEAM

TEAM MEMBERS :

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Abstract

This report presents a Matlab simulation of an IoT-based battery management system for the effective monitoring and maintenance of batteries in IoT devices. The objective of this study is to develop and evaluate a battery management system that

leverages the power of IoT technology to optimize battery performance, extend battery life, and improve overall device reliability. The simulation methodology involves the design and implementation of a system architecture comprising sensors, microcontrollers, and communication modules for data acquisition and transmission. A battery model based on an equivalent circuit model is used to simulate battery behavior. Communication protocols and data pre-processing techniques are employed to facilitate efficient data collection and analysis.

The simulation results demonstrate the effectiveness of the proposed IoT-based battery management system. The system accurately estimates battery parameters such as state of charge and state of health, enabling real-time monitoring of battery performance. Moreover, prediction models for estimating the remaining useful life of batteries provide valuable insights into battery degradation and facilitate proactive maintenance strategies.

Comparative analysis with existing battery management techniques reveals the superior performance of the IoT-based system in terms of battery monitoring accuracy, efficiency, and reliability. The simulation study highlights the potential benefits of IoT technology in revolutionizing battery management practices and enhancing the overall performance and lifespan of batteries in IoT devices. The findings of this study contribute to the growing body of knowledge in the field of IoT-based battery management systems and provide a foundation for future research and development in this area. The proposed system has the potential to address the challenges associated with battery management in IoT applications and pave the way for more efficient and reliable IoT deployments.

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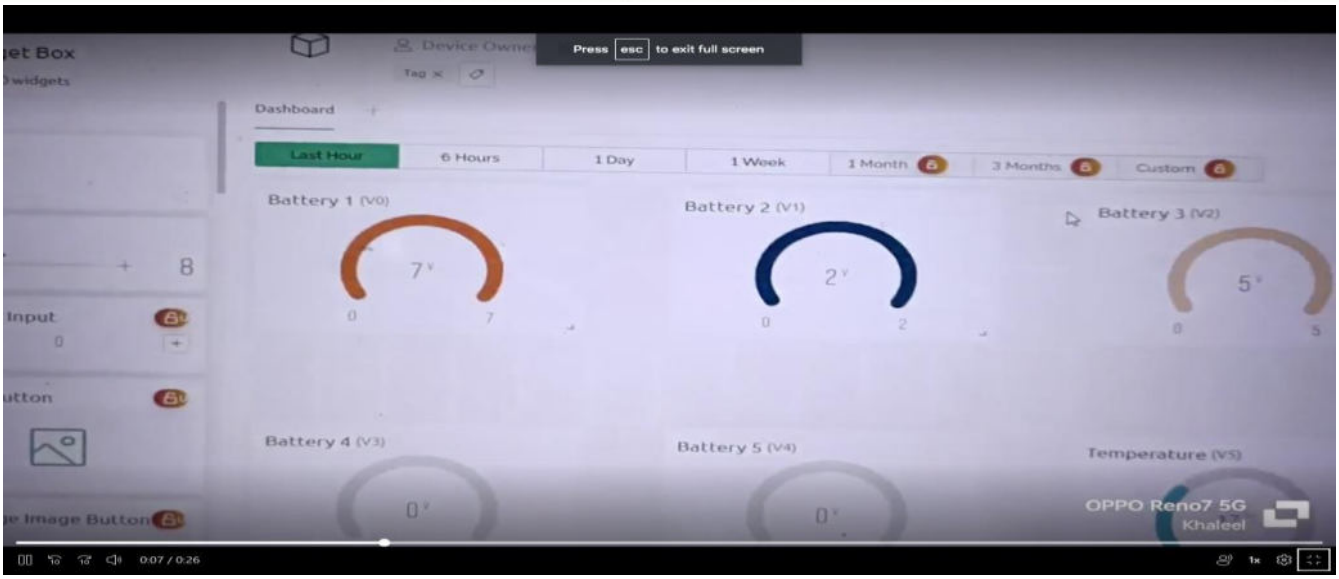

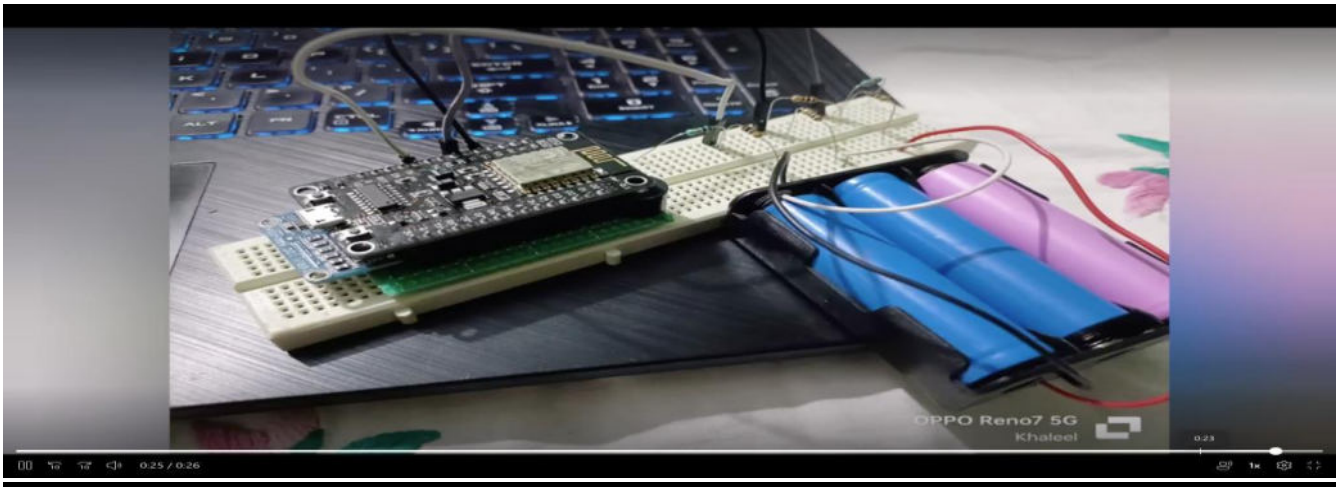

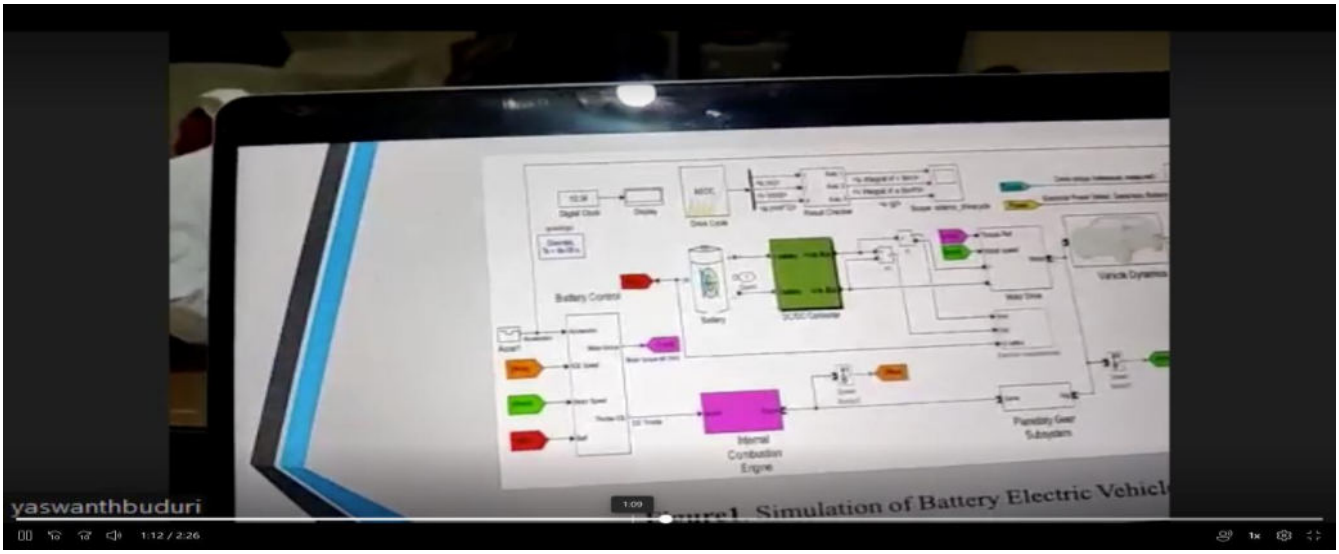

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Signature of Instructor: 

Signature of Instructor In-Charge : 

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