IPS Academy, Institute of Engineering & Science

(A UGC Autonomous Institute, Affiliated to RGPV, Bhopal)

Scheme Based on AICTE Flexible Curricula (B. Tech)

Electrical and Electronics Engineering Department

(For Batches admitted in 2022-23)

VII Semester

w.e.f. July 2023

S. No.	Subject Code	Category	Subject Name	Maximum Marks Allotted					Total Marks	Contact Hours/ Week			Total Credits
				Theory			Practical						
				End Sem.	Mid Sem. Exam	Quiz/ Assignment	End Sem.	Lab Work & Sessional		L	T	P	
1	PCC-EE17	PCC	Electrical Drives	60	25	15	-	-	100	2	1	-	3
2	PCC-EE18	PCC	Hybrid and Electrical Vehicle	60	25	15	-	-	100	2	1	-	3
3	PCC-EE19	PCC	Utilization of Electrical Energy	60	25	15	-	-	100	2	1	-	3
4	PEC-EE01	PEC	Departmental Elective-I	60	25	15	-	-	100	3	-	-	3
5	PEC-EE02	PEC	Departmental Elective-II	60	25	15	-	-	100	3	-	-	3
6	LC-EE17(P)	LC	Electrical Drives Lab	-	-	-	60	40	100	-	-	2	1
7	LC-EE18(P)	LC	Seminar and Group Discussion-II	-	-	-	-	100	100	-	-	2	1
8	PROJ-EE02	PROJ	Evaluation of Internship	-	-	-	60	40	100	-	-	4	2
9	PROJ-EE03	PROJ	Project Phase -I	-	-	-	60	40	100	-	-	8	4
Total				**300**	**125**	**75**	**180**	**220**	**900**				**23**

- **Departmental Elective-I, PEC-EE01* (Any One Course)**
  a) HVDC and FACTS
  b) Power Electronics Convertors for Renewable Energy
  c) Advanced Fluid Mechanics
  d) Electrical Energy Conservation and Auditing
  e) Computer Networks
  f) Special Machine

- **Departmental Elective-II, PEC-EE02* (Any One Course)**
  a) Smart Grid Technology
  Advance Control System
  b) Solar and Wind
  c) Embedded System
  d) Digital Signal Processing

1 Hr. Lecture	1 Hr. Tutorial	2 Hr. Practical
1 Credit	1 Credit	1 Credit

*Students can earn credits from the recognized MOOC courses also.

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Subject Code	Name of the Subject	L:T:P	Credits	Maximum Marks	
				Theory	
PCC-EE17	Electrical Drives	2:1:0	3	CIE	ESE
				40	60

Course Objective: Advance electrical drives course are give unified treatment of complete electrical drive systems, electrical machines, power converters and control system.

Pre Requisite:-Fundamental knowledge of electrical machine & Power Electronics.

Module 1(10hrs.)

Introduction, types and classification of Electric drives, components of load torque, load-drive speed torque characteristics, Constant power and constant torque drives, Selection of motor power capacity for continuous duty at constant load and variable loads, Selection of motor capacity for short time and intermittent periodic duty, permissible frequency of starting of squirrel cage motor for different duty cycles, Load equalization, Review of power converters used in drives, multi-quadrant operation of electric drive.

Module 2(10hrs.)

D.C. Drives-Introduction to closed loop control of drives, DC Drives Starting & Braking of conventional, Single-phase half controlled and fully controlled converter fed dc motor drives, operation of dc drives with continuous armature current, voltage and current waveforms, Operation of drive under discontinuous current, expression for speed-torque characteristic, Drives with current limit control, single-quadrant closed loop drive with inner current control loop, advantage of inner current control loop in drives.

Module 3 (10hrs.)

Chopper and Four quadrant operation of D.C. Drives: Motoring operation of chopper fed separately excited dc motor, steady state analysis of drive with time-ratio control, Introduction to Four quadrant operation, mode of chopper, motoring operations, Electric braking, Plugging, dynamic and regenerative braking operations.

Module 4 (10hrs.)

AC Drives:-Principles of speed control, Various methods of Induction motor drive, Variable voltage operation, Variable frequency operation, Constant flux operation, Torque-Slip characteristic, Constant Torque and Constant power operation, Implementation of V/f control with slip compensation scheme, Starting, Braking and transient analysis of Induction Motor Drives, Control of Induction Motor by AC Voltage controllers, Variable frequency control of induction motor by Voltage Source, Current Source inverters, cyclo-converters and PWM control, Closed loop operation of induction motor drives, Static rotor resistance control, Slip power recovery, static Scherbius Drive, Static Kramer Drive. Self-controlled synchronous motor drive, Vector control of synchronous motor, Permanent magnet drives and Industrial drives.

Module 5 (8hrs.)

Special Drives: Fundamentals of Switched reluctance motors, Stepper Motors, and Permanent Magnet Motor; Construction and working principle of Brushless DC Machines, Construction and working of PMSM Linear Induction Machines, Digital control of drives.

Energy Conservation in Electrical Drives: Concept of Energy efficient motor, Energy efficient motor standards, Energy efficient operation of drives, Efficiency evaluation technique, Efficiency evaluation factor, Losses in electrical drive system; Motor life cycle, Direct Savings and pay back analysis.

List of Experiments:

1. Study the starting and running characteristics of converter fed D.C. traction motor.
2. To study the energy recovery systems and braking of a D.C. drive.
3. To study the braking Methods of a three-phase induction motor.
4. To study the performance of VSI fed three-phase induction motor using PWM technique.
5. To control the speed of a three phase slip ring Induction motor using rotor impedance control.
6. To study the performance of Vector Controlled three phase Induction motor drive.
7. To Study frequency Controlled Synchronous motor drive.
8. To study the control and performance Characteristics of switched Reluctance motor.
9. To study the performance & control of a Stepper motor.
10. To Study the Performance of a permanent magnet Brushless dc motor drive.

Course Outcomes: After successful completion of course students will be able to

CO1: Understand basic drive system and theoretical concepts of dynamics of electrical drives.
CO2: Analyze the performance of D.C. drives during starting and braking.
CO3: Explain chopper and four quadrants operation for D.C. drives.
CO4: Analyze control strategies and controllers for A.C. drives.
CO5: Understand applications of special drives.

Text/ Reference Books:

1. G.K. Dubey "Fundamentals of Electrical Drives"-. Narosa Publications.
2. Vedam Subrahmaniam, Electric Drives (Concepts and Applications), Tata McGraw-Hill, 2010.
3. Mohammed A. El-Sharkawi, “Fundamentals of Electric Drives”, Thomson Asia, Pvt. Ltd. Singapore.
4. B.K. Bose "Power Electronic control of AC Drives", PHI Learning.

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Subject Code	Name of the Subject	L:T:P	Credits	Maximum Marks	
				Theory	
PCC-EE17	Hybrid and Electrical Vehicle	2:1:0	3	CIE	ESE
				40	60

Course Objective: The objective of this course is to provide fundamental knowledge in dynamics and control of Electric vehicles. The course justify the selection of Drives for various applications of Electric vehiclesand familiarize the various energy storage and Energy Management Strategies.

Pre Requisite: should have the knowledge of Electrical Machines and Power Electronics and IC engines .

Module 1(5 hrs.)

Introduction Conventional Vehicles: -History, Components of Electric Vehicle(EV),Comparison with Internal combustion Engine Technology, Benefits and Challenges, EV classification and their electrificationLevels.EV Terminology Introduction and History of hybrid andElectric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive trains on energy supplies.

Module 2 (8 hrs.)

Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Electric Trains Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

Module 3 (7 hrs.)

Electric Propulsion: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control Of Switch Reluctance Motor drives, drive system efficiency.

Module 4 (10 hrs.)

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems

Module 5 (8 hrs.)

Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.

Course Outcomes: After successful completion of course students will be able to

CO1: Describe about working principle and importance of hybrid and electric vehicles.
CO2: Explain the construction and working principle of various electric drive trains used in electric vehicles.
CO3: Describe the different types and working principle of hybrid vehicles.
CO4: Describe the different types of Energy Storage Requirements in Hybrid and Electric Vehicles
CO5: Illustrate the Management various types Energy Strategiesin Hybrid and Electric Vehicles.

Text/ Reference books

1. C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.
3. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
4. T. Denton, "Electric and Hybrid Vehicles", Routledge, 2016.

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PCC-EE19	**Utilization of Electrical Engineering**	**3L : 0T : 0P (3hrs.)**	**3 credits**

Course Objective: This subject gives a comprehensive idea in utilization of electrical power such as drives, electric heating, electric welding and illumination, electric traction, electrolysis, refrigeration air-conditioning and automobile electric system.

Pre Requisite: Fundamentals of electrical engineering and Electrical machine-I

Module 1 (08 hrs.) Illumination Engineering

Nature of light, units, sensitivity of the eye, luminous efficiency, glare. Production of Light; Incandescent lamps, arc lamps gas discharge lamps- fluorescent lamps polar curves, effect of voltage variation on efficiency and life of lamps, Distribution and control of light, lighting calculations, solid angle, inverse square and cosine laws, methods of calculations, factory lighting, flood lighting and street lighting, Direct diffused and mixed reflection & transmission factor, refractors, light fittings.

Module 2 (08 hrs.) Heating, Welding and Electrolysis

Electrical heating-advantages, methods and applications, resistance heating, design of heating elements, efficiency and losses control. Induction heating: core type furnaces, core less furnaces and high frequency eddy current heating, dielectric heating: principle and special applications, arc furnaces: direct arc furnaces, Indirect arc furnaces, electrodes, design of heating elements, power supply and control. Different methods of electrical welding, resistance welding, arc welding, energy storage welding, laser welding, electro beam welding, and electrical equipment for them. Arc furnaces transformer and welding transformers. Review of electrolytic principles, laws of electrolysis, electroplating, anodizing-electro-cleaning, extraction of refinery metals, power supply for electrolytic process, current and energy efficiency.

Module 3 (08 hrs.) Traction

Special features of Traction motors, selection of Traction Motor, Different system of electric traction and their Advantages and disadvantages, Mechanics of train movement: simplified speed time curves for different services, average and schedule speed, tractive effort, specific energy consumption, factors affecting specific energy consumption, acceleration and braking retardation, adhesive weight and coefficient of adhesion,

Module 4 (08 hrs.) Electric Drives

Individual and collective drives- electrical braking, plugging, rheostatic and regenerative braking load equalization use of fly wheel criteria for selection of motors for various industrial drives, calculation of electrical loads for refrigeration and air-conditioning, intermittent loading and temperature rise curve.

Module 5 (08 hrs.) Introduction to Electric and Hybrid Vehicles

Configuration and performance of electrical vehicles, traction motor characteristics ,tractive effort, transmission requirement, vehicle performance and energy consumption.

Course Outcomes:-After successful completion of course students will be able to:

CO1: Design an Illumination scheme.
CO2: Select a suitable scheme for the process. Methods of electrolysis and its applications,
CO3: Analyze specific power consumptions.
CO4: Apply the control and selection of drives for various industrial applications.
CO5: Evaluate performance of Electric Hybrid Vehicles.

Text/ References Books:

1. Open Shaw, Taylor, .Utilization of electrical energy. Orient Longmans, 1962.
2. H. Pratap, Art and Science of Utilization of Electrical Energy.
3. Gupta, J.B., Utilization of Elect. Energy, Katariya and sons, New Delhi.
4. Garg, G.C., Utilization of Elect. Power and Elect. Traction.
5. N V Suryanarayan, Utilization of Elect. Power including Electric Drives and Elect. Traction, New Age International.

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Subject Code	Name of the Subject	L:T:P	Credits	Maximum Marks	
				Theory	
Departmental Elective-I PEC-EE01	Electrical Energy Conservation and Auditing	3:0:0	3	CIE	ESE
				40	60

Course Objective: Understand the current energy scenario and the importance of energy conservation. Understand the methods of improving energy efficiency in different electrical systems. Realize energy auditing.

Pre Requisite: Fundamental knowledge of Electrical Engineering & Power Systems.

Module 1
Energy Scenario (6 hrs.)
Renewable and non-renewable energy, Indian energy scenario, integrated energy policy, energy intensity on purchasing power parity, Energy sector reforms, energy and environment, energy security, energy conservation and its importance, Energy Conservation Act-2001 and its features.

Module II
Energy Management & Audit (8 hrs.)
Definition, energy audit, need, types of energy audit and approach, understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies.

Module III
Energy Efficiency in Electrical Systems (8 hrs.)
Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement benefits, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses. Electric motors: motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.

Module IV
Energy Efficiency in Industrial Systems (10 hrs.)
Compressed Air System: Types of air compressors, compressor efficiency, efficient compressor operation, compressed air system components, capacity assessment, leakage test, factors affecting the performance and savings opportunities in HVAC, Fans and blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities.

Module V
Energy Efficient Technologies in Electrical Systems (10 hrs.)
Maximum demand controllers, automatic power factor controllers, energy efficient motors, soft starters with energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, energy saving potential of each technology.

Course Outcomes: After successful completion of course students will be able to

CO1 Understand the concepts of energy conservation and audit.
CO2 Apply the knowledge of energy scenario.
CO3 Analyze the theory of energy management and audit.
CO4 Apply the concepts of energy efficiency in electrical and industrial Systems.
CO5 Examine the different energy efficient technologies in electrical system.

Text/ Reference Books:

1. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects (available online)
2. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-3, Electrical Utilities (available online)
3. **Y.P. Abbi**; **Shashank Jain**, Handbook on Energy Audit and Environment Management, , **The Energy and Resources Institute, TERI**, 2009
4. Rakosh Das Begamudre, Energy conversion systems, New Age International Publishers 10th Edition,2000
5. Parag Diwan, Energy conservation, New Delhi Pentagon Energy Press, 2009
6. Tripathy, S.C., Electric energy utilization and conservation, Tata McGraw-Hill Publishing Co. Ltd., 1991
7. Success stories of Energy Conservation by BEE, New Delhi (www.bee-india.org)

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Subject Code	Name of the Subject	L:T:P	Credits	Maximum Marks	
				Theory	
PEC-EE02	Smart Grid Technology	2:1:0	3	CIE	ESE
				40	60

Course objective: To equip the students with the fundamental knowledge on the smart grid

Prerequisite: Power System, Electrical machines, Instrumentation

Module 1(8 hrs.)

Introduction to Smart Grid: Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and Benefits .Difference between conventional & Smart Grid, Concept of Resilient & Self-Healing Grid, Present development & International policies in Smart Grid, Diverse perspectives from experts and global Smart Grid initiatives.

Module 2(10 hrs.)

Smart Grid Technologies: Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation , Transmission systems: EMS, FACTS and HVDC, Wide area monitoring.

Module 3 (10 hrs.)

Protection and Control, Distribution Systems: DMS, Volt/Var control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV).

Module 4(8 hrs.)

Smart Meters and Advanced Metering Infrastructure: Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement, Unit (PMU), Intelligent Electronic Devices (IED) & their application for monitoring & protection

Module 5 (8 hrs.)

Power Quality Management in Smart Grid: Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Course Outcomes: After successful completion of course students will be able to

CO1 Students can understand Present development & International policies in Smart Grid
CO2 Students may familiar with Smart Grid Technologies and its protection
CO3 Students may familiar with Smart Grid protection and control
CO4 Understand about the Advanced Metering system.
CO5 Students can understand the importance of power quality management.

Reference Books/Text Books

1. Stuart Borlase: Smart Grid-Infrastructure, Technology and Solutions, CRC Press
2. D. P. Kothari and I. J. Nagrath, "Modern Power System Analysis", Tata McGraw Hill 2011.
3. A. J. Wood and B. F. Wollenberg, "Power generation, operation and control", second edition John Wiley and Sons 1996.
4. N. G. Hingorani and L. Gyugyi, "Understanding facts: Concepts and Technology of flexible AC transmission systems", Wiley Press 2000.

Reference

1. Vehbi C. Güngör, Dilan Sahin, TaskinKocak, SalihErgüt, ConcettinaBuccella, Carlo Cecati, and Gerhard P. Hancke: Smart Grid Technologies- Communication Technologies and Standards IEEE Transactions on Industrial Informatics, Vol. 7, No.4, November 2011.
2. Xi Fang, SatyajayantMisra, GuoliangXue, and Dejun Yang: Smart Grid – The New and Improved Power Grid- A Survey, IEEE Transaction on Smart Grids,2011