HONOR PROGRAMMES

20BSTH01: ADVANCED ENGINEERING MATHEMATICS

Credits - 4 **Sessional Marks: 30**

(L: T: P :: 3:1:0) **University Exam Marks:70**

UNIT I

LINEAR ALGEBRA: Vector space, Basis, System of Linear equations, Linear Dependence and independence, Eigen values and Eigenvectors, Quadratic Forms.

UNIT II

SPECIAL FUNCTIONS: Legendre's Linear Differential Equations, Legendre's function of first kind $P_n(x)$, Legendre's function of second kind $Q_n(x)$, Legendre's polynomials, Generating functions, Recurrence relations, Bessel functions.

UNIT III

PARTIAL DIFFERENTIAL EQUATIONS: Lagrange's Partial Differential equations, Partial Differential equations nonlinear in p and q, Charpits method, Cauchy's method of characteristics.

UNIT IV

PROBABILITY: Random variables conditional probability, Baye's Theorem, BinomialDistribution,PoissonDistribution,NormalDistribution,Mean,Median,ModeandStandard deviation, Joint conditional distribution.

UNIT V

COMPLEX VARIABLES: Analytic functions, Cauchy-Reimann equations, Cauchy's Integral theorem, Cauchy's Integral formula, Cauchy's Residue theorem, Taylor's and Laurent's series.

Text books:

1.Grewal, B.S. Higher Engineering Mathematics, Khanna Publishers, 42nd Edition.

Reference Books:

1. T.K.V.Iyengar & B.Krishna Gandhi et., Engineering Mathematics – I, II, III; S.Chand & Company.
2. T.K.V.Iyengar & B.Krishna Gandhi et. al, “Probability and Statistics”, S.Chand & Company, Vol.III.
3. Irwin Miller, John E.Freund, “Probability and Statistics for Engineers”, PearsonGlobal edition, 9 th edition.
4. S C Gupta and V.K.Kapoor,”Fundamentals of Mathematical Statistics”, S. Chand& Son’s, 10 th edition 2000.
5. Shahnaz Bathul,”A text book of Probability and Statistics”, Ridge Publications,2nd edition.

20EETH01: Introduction to Smart Grid

Credits - 4 **Sessional Marks: 30**
L: T: P:: 3:1:0 **University Exam Marks: 70**

Course Objectives

1. To Impart Knowledge on Basic definitions, aims and main functions of Smart Grids.
2. To identify the main characteristics, structures and functions of power systems And electricity market.
3. To Learn about the role of actors in electricity distribution and electricity Market.
4. To summarize the main point of distributed energy resources from network point Of view and ICT solutions for Smart Grids.

Course Outcomes

At the end of this course, students will demonstrate the ability to

CO1. Understand the challenging issues and architecture of smart grid.
CO2. Explain the communication and wide area monitoring in smart grid.
CO3. Analyze rudimentary management issues in smart grid.
CO4. Acquire the knowledge in computational intelligence and security issues in smart grids.
CO5. Describe the role of power electronics and energy storage in smart grid.

UNIT-I

Introduction to Smart Grid: Evolution of Electric Grid, Concept, Definitions and Need for smart grid drives, Smart grid drives, 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.

UNIT-II

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

UNIT-III

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.

UNIT-IV

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, and Power Quality Audit.

UNIT-V

High Performance Computing For Smart Grid Applications: Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over power line (BPL), IP based protocols, Basics of web Service and CLOUD Computing to make Smart Grids smarter, Cyber Security for Smart Grid.

Text Book:

1. JanakaEkanayake, Liyanage, Wu, Akihiko Yokoyama, Jenkins ,"Smart Grid",Student Edition , Wiley Publications, 2012.
2. James Momoh, "Smart Grid: Fundamentals of Design and Analysis", Wiley, IEEE Press., 2012.

Referance Books:

1. A.B.M.ShawkatAli,"Smart Grid",Springer London Ltd.
2. M.D. FadlullahZubair,"Evalution of Smart Grid",Springer International Publishing AG.

Course Outcomes-Program outcomes- Program specific outcomes (CO-PO-PSO) Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**H**	**-**	**-**	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**H**	**-**	**-**
CO2	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**H**	**-**	**-**	**-**	**M**	**-**
CO3	**M**	**H**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**H**	**-**
CO4	**H**	**-**	**-**	**-**	**-**	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**H**	**-**	**-**
CO5	**M**	**-**	**-**	**H**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**H**	**-**

20EETH02: Introduction to Electric Vehicle

Credits - 4 **Sessional Marks: 30**
L: T: P:: 3:1:0 **University Exam Marks: 70**

Course Objectives:
1. This course introduces the fundamental concepts, principles, analysis and design of hybrid electric vehicles.

Expected Course Outcome:
On the completion of this course the student will be able to:
1. Infer the conventional vehicles performance.
2. Infer the hybrid electric vehicles and its impact on environment
3. Analyze the various hybrid vehicle configurations and its performance.
4. Interpret the electric components used in hybrid and electric vehicles
5. Design and Select of sizing the drive systems.
6. Choose proper energy storage systems for vehicle applications
7. Identify various communication protocols and technologies used in vehicle networks
8. Design a component or a product applying all the relevant standards with realistic constraints.

UNIT I

Introduction to Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance

Introduction to Electrical Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, future of electric vehicles, comparison with IC engine drive vehicles

UNIT II

Electric Vehicle Drive Train: Transmission configuration, Components, gears, differential, clutch, brakes, regenerative braking, motor sizing. Basic concept of electric traction, Introduction to various drive train topologies, power flow control in electric drive topologies, fuel efficiency analysis

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

UNIT III

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.

UNIT IV

Energy Storage: Introduction to energy storage requirements in hybrid and Electric vehicles, Battery based energy storage and its analysis, fuel cell based and super capacitor based energy storage and its analysis. Hybridization of different energy storage devices

UNIT V

Energy management strategies and Case :Introduction to energy management strategies used in hybrid and electric vehicle, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy strategies - Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Text Book(s)

1. Iqbal Hussain, "Electric and Hybrid Vehicles-Design Fundamentals", CRC Press, Second Edition, 2011.
2. Mehrdad Ehsani, Yimin Gao, and Ali Emadi, "Modern Electric, Hybrid and Fuel Cell Vehicles: Fundamentals", CRC Press, 2010.

Reference Books

1. Chris Mi, MA Masrur, and D W Gao, "Hybrid Electric Vehicles- Principles and Applications with Practical Perspectives", Wiley, 2011.
2. Davide Andrea, "Battery management Systems for Large Lithium-Ion Battery Packs", Artech House, 2010.

Course Outcomes-Program outcomes- Program specific outcomes (CO-PO-PSO) Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H	-	-	-	M	-	-	-	-	-	-	-	H	M	-
CO2	-	H	-	M	-	-	-	-	-	-	-	-	H	M	-
CO3	H	-	M	-	-	-	-	-	-	-	-	-	M	H	-
CO4	H	-	M	-	-	-	-	-	-	-	-	-	M	H	-
CO5	-	-	H	-	M	-	-	-	-	-	-	-	H	M	-
CO6	-	-	M	-	H	-	-	-	-	-	-	-	H	M	-
CO7	-	-	-	-	M	-	-	-	-	H	-	-	M	-	H
CO8	-	-	H	-	M	-	-	-	-	-	-	-	H	M	-

20EETH03: POWER SYSTEMS DYNAMICS & CONTROL

Credits - 4 **Sessional Marks: 30**
L: T: P:: 3:1:0 **University Exam Marks: 70**

Course Objectives

1. To Import Knowledge on Power System Operations and Control.
2. To understand Analysis of Linear System using Numerical Integration Techniques.
3. To know about Modeling of synchronous machine and Synchronization of Synchronous Machine to an Infinite Bus.
4. To Provide Operational Measures - Preventive Control-Emergency Control.
5. To Demonstrate Angular stability analysis in Single Machine Infinite Bus System.

Course Outcomes

At the end of this course, students will demonstrate the ability to

CO1. Understand Linear Dynamical system behaviour.
CO2. Analyze the modeling of synchronous machines and their controllers.
CO3. Understand the modeling of transmission line and loads.
CO4. Analyze Angular stability and Frequency stability Analysis.

UNIT I

Introduction to Power System Operations: Introduction to power system stability. Power System Operations and Control, Stability problems in Power System, Impact on Power System Operations and control.

UNIT II

Analysis of Linear Dynamical System and Numerical Methods: Analysis of dynamical System, Concept of Equilibrium, Small and Large Disturbance Stability, Modal Analysis of Linear System, Analysis using Numerical Integration Techniques. Issues in Modeling: Slow and Fast Transients, Stiff System.

UNIT III

Modeling of Synchronous Machines and Associated Controllers: Modeling of synchronous machine: Physical Characteristics, Rotor position dependent model, D-Q Transformation, Model with Standard Parameters, Steady State Analysis of Synchronous Machine, Short Circuit Transient Analysis of a Synchronous Machine, Synchronization of Synchronous Machine to an Infinite Bus, Modeling of Excitation and Prime Mover Systems, Physical Characteristics and Models, Excitation System Control, Automatic Voltage Regulator, Prime Mover Control Systems. Speed Governors.

UNIT IV

Modeling of other Power System Components: Modeling of Transmission Lines and Loads, Transmission Line Physical Characteristics, Transmission Line Modeling. Load Models - induction machine model, Frequency and Voltage Dependence of Loads.

UNIT V

Stability Analysis: Angular stability analysis in Single Machine Infinite Bus System, Angular Stability in multi-machine systems – Intra-plant, Local and Inter-area modes. Frequency Stability: Centre of Inertia Motion. Load Sharing: Governor droop. Single Machine Load Bus System: Voltage Stability. Introduction to Torsional Oscillations and the SSR phenomenon, Stability Analysis Tools: Transient Stability Programs, Small Signal Analysis Programs.

Enhancing System Stability: Planning Measures, Stabilizing Controllers (Power System Stabilizers).Operational Measures-Preventive Control, Emergency Control.

Text Books:

1. K.R. Padiyar, "Power System Dynamics, Stability and Control", B. S. Publications, 2002.
2. P. Kundur, "Power System Stability and Control", McGraw Hill, 1995.

Reference Books

3. P. Sauer and M. A. Pai, "Power System Dynamics and Stability", Prentice Hall.

Course Outcomes-Program outcomes- Program specific outcomes (CO-PO-PSO) Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**H**	**-**	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**M**	**H**	**-**
CO2	**H**	**-**	**-**	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**M**	**H**	**-**
CO3	**H**	**-**	**M**	**L**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**H**	**M**	**-**
CO4	**-**	**H**	**M**	**-**	**L**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**H**	**M**

20EETH04: SCADA SYSTEM AND APPLICATIONS

Credits - 3 **Sessional Marks: 30**
L: T: P:: 3:0:0 **University Exam Marks: 70**

Course Objectives

1. To understand the fundamentals of automations and various automation systems in industries
2. Todetermine hardware and software requirements of PLC and SCADA
3. To understand the safety requirements and design safety of instrumented systems
4. To use various SCADA system architectures
5. To design any application based on these systems

Course Outcomes

After completion of the course the student will able to

CO1. Define automation, its importance, expectations from automation and application in Industries
CO2. Describe the SCADA architecture, communication in SCADA
CO3. Understand the working of PLC, I/O Modules of PLC, Basics of PLC
CO4. Analyze the various standard communication protocols.
CO5. Develop any application based on SCADAs

UNIT I

Introduction to SCADA: Data acquisition systems, Evolution of SCADA, Communication technologies.

UNIT II

Monitoring and supervisory functions, SCADA applications in Utility Automation, Industries SCADA`

UNIT III

Industries SCADA System Components: Schemes- Remote Terminal Unit (RTU), Intelligent Electronic Devices (IED), Programmable Logic Controller (PLC), Communication Network, SCADA Server, SCADA/HMI Systems

UNIT IV

SCADA Architecture: Various SCADA architectures, advantages and disadvantages of each system - single unified standard architecture –International Electro-Technical Comission's (IEC))IEC 61850.

UNIT-V

SCADA Communication: various industrial communication technologies -wired and wireless methods and fiber optics. Open standard communication protocols.
SCADA Applications: Utility applications- Transmission and Distribution sector-operations, monitoring, analysis and improvement. Industries - oil, gas and water. Case studies, Implementation, Simulation Exercises.

Text Books

1. Stuart A. Boyer, "SCADA-Supervisory Control and Data Acquisition", Instrument Society of America Publications, USA, 2004.
2. Gordon Clarke, Deon Reynders, "Practical Modern SCADA Protocols: DNP3, 60870.5 and
3. Related Systems", Newness Publications, Oxford, UK, 2004.
4. William T. Shaw, "Cyber security for SCADA systems", Penn Well Books, 2006.

Reference

1. David Bailey, Edwin Wright, "Practical SCADA for industry", Newness, 2003.
2. Wiebe, Penn Well "A guide to utility automation: AMR, SCADA, and IT systems for electric Power", 1999.

Course Outcomes-Program outcomes- Program specific outcomes (CO-PO-PSO) Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**H**	**-**	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**M**	**H**	**-**
CO2	**H**	**-**	**-**	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**M**	**H**	**-**
CO3	**H**	**-**	**M**	**L**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**H**	**M**	**-**
CO4	**-**	**H**	**M**	**-**	**L**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**H**	**M**
CO5	**-**	**H**	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**H**	**-**

20EETH05: MODERN POWER SEMICONDUCTOR DEVICES

Credits - 3 **Sessional Marks: 30**
L: T: P:: 3:0:0 **University Exam Marks: 70**

Course Objectives

1. To Import Knowledge on Basics of Power Semiconductor devices.
2. To understand the static and dynamic characteristics of current controlled power Semiconductor Devices.
3. To understand the static and dynamic characteristics of voltage controlled power Semiconductor Devices.
4. To Analyze control and firing circuit for different devices.
5. To Study the selection of devices for Thermal Protection.

Course Outcomes

At the end of this course, students will be able to

CO1. Analyze the Basic Concept of Power Semiconductor Devices.
CO2. Demonstrate the static and dynamic characteristics of current controlled power Semiconductor Devices.
CO3. Understand the static and dynamic characteristics of voltage controlled power SemiconductorDevices.
CO4. Identify Various Means of Control & Firing Circuits for different devices.
CO5. Design and analyze the Thermal Protection systems.

UNIT I

Introduction : Power switching devices overview – Attributes of an ideal switch, application requirements, circuit symbols; Power handling capability – (SOA); Device selection strategy – On-state and switching losses – EMI due to switching - Power diodes -Types, forward and reverse characteristics, switching characteristics – ratings.

UNIT II

Current Controlled Devices: BJT's – Construction, static characteristics, switching characteristics; Negative temperature co-efficient and secondary breakdown; Power Darlington - Thyristors –Physical and electrical principle underlying operating mode,–concept of latching; Gate and switching characteristics; converter grade and inverter grade and other types; series and parallel operation; comparison of BJT and Thyristor –steady state and dynamic models of BJT &Thyristor.

UNIT III

Voltage Controlled Devices : Power MOSFETs and IGBTs – Principle of voltage controlled devices, construction, types, static and switching characteristics, steady state and dynamic models of MOSFET and IGBTs - Basics of GTO, MCT, FCT, RCT and IGCT.

UNIT IV

Firing and Protecting Circuits : Necessity of isolation, pulse transformer, optocoupler – Gate drives circuit: SCR, MOSFET, IGBTs and base driving for power BJT. - Over voltage, over current and gate protections; Design of snubbers.

UNIT V

Thermal Protection : Heat transfer – conduction, convection and radiation; Cooling – liquid cooling, vapour –phase cooling; Guidance for hear sink selection – Thermal resistance and impedance -Electrical analogy of thermal components, heat sink types and design – Mounting types.

Text Books

1. MD Singh and K.B Kanchandani,"Power Electronics" ,Tata McGraw Hill, 2005.
2. Ned Mohan", Power electronics", 2nd Edition, Wiley, 2013.

References

1. W.Shepherd, L.N.Huley and D.T.W.Liang,"Power Electronics and motor control", 2015
2. P S Bimbhra,"Power electronics", khanna publishers-2018.
3. Undeland, Robbins, Mohan ,"'Power Electronics: Converters Applications and Design", Wiley India pvt ltd- edition 2007

Course Outcomes-Program outcomes- Program specific outcomes (CO-PO-PSO) Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	H	L	-	-	M	-	-	-	-	-	-	H	M	-
CO2	M	-	-	-	-	H	-	-	-	-	-	-	M	M	-
CO3	M	-	H	-	-	M	-	-	-	-	-	-	M	H	-
CO4	M	H	L	-	-	-	-	-	-	-	-	-	M	-	-
CO5	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-

20EETH06: ANALYSIS OF POWER CONVERTERS

Credits - 3 **Sessional Marks: 30**
L: T: P:: 3:0:0 **University Exam Marks: 70**

Course Objectives

1. To impart basic knowledge of phase controlled converter operations in power electronic Engineering.
2. To provide knowledge on switched mode dc-dc converters.
3. To prepare students to analyses and design different power converter circuit.
4. To introduce the inverters and multilevel inverters
5. To know the design consideration of resonant pulse inverters

Course Outcomes

After completion of the course the student will able to

CO1. Analyze and design phase controlled rectifiers.
CO2. Describe the basic concepts of Choppers and switching mode regulators
CO3. Understand the working of inverters and multilevel inverters.
CO4. Apply the various methods of firing and harmonic reduction techniques.
CO5. Implement various methods of resonant inverters.

UNIT I

Phase Controlled Rectifiers: Introduction-Principles of phase controlled converter operations-single phase full converters-single phase dual converters-principle of operation of three phase-Half-wave & Full wave converters with RL load-Three phase dual converters-twelve-pulse converters. Numerical problems.

UNIT II

Switched Mode DC-DC Converters: Introduction-Principle of Step-up & step-down operation-performance parameters-Converters Classification-Switching mode regulators-Analysis of Buck-Boost-Buck Boost-Cuk Regulators- Multi output Boost Converters. Numerical Problems.

UNIT III

Inverters: Introduction-Principle of operation-Performance Parameters-single phase bridge inverters-Three phase Bridge inverter-180 Degree,120 Degree Conduction-Voltage Control of single phase inverters-Advanced Modulation Techniques-Voltage control of three phase inverters-Harmonics Reduction-Current Source Inverter-Variable DC link Inverter-Boost Inverter-Inverter Circuit Design. Numerical Problems.

UNIT IV

Multilevel Inverters: Multilevel concept-Types of Multi level Inverters-diode clamped-flying capacitor-cascade type multilevel inverters-Comparison of multilevel inverters-application of multilevel inverters-reactive power compensation-back to back intertie system-adjustable drives-switching device currents-dc link capacitor Voltage balancing-features of multilevel inverters. Numerical Problems.

UNIT-V

Resonant Pulse Inverters: Introduction-Series Resonant Inverters-Frequency Response of series-resonant Inverter-Parallel Resonant Inverters-Voltage control of resonant inverters-Class E resonant Rectifier Class E resonant Inverter-Zero Current Switching Resonant Converters-Zero Voltage Switching Resonant Converters- Comparison between ZCS & ZVS resonant Converters-Two Quadrant ZVS resonant Converters-Resonant DC link Inverters Numerical Problems.

Text Books

1. Rashid, "Power Electronics: Devices Circuits and Applications", 4th Edition, Pearson Education, 2017.
2. BimalK.Bose,"Modern Power Electronics and AC Drives",2nd Edition, Pearson Education, 2005.

References

1. P.C Sen"Modern Power Electronics",1st Edition, Wheeler publishing Company, New Delhi- 2005.
2. Mohan, "Power Electronics: Converters Applications and Design" Wiley Indiapvt ltd- edition 2007.
3. R. Krishnan,"Electric Motor Drives Modelling, Analysis, and Control", Prentice Hall India Learning Private Limited, 2002.

Course Outcomes-Program outcomes- Program specific outcomes (CO-PO-PSO) Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	H	M	L	-	-	-	-	-	-	-	-	H	M	L
CO2	H	L	-	-	-	M	-	-	-	-	-	-	H	L	-
CO3	H	M	L	-	-	-	-	-	-	-	-	-	H	-	L
CO4	L	L	-	H	-	-	-	-	-	-	-	-	M	L	-
CO5	H	-	L	M	-	-	-	-	-	-	-	-	H	L	-

20EETH07: SOLAR & ENERGY STORAGE SYSTEMS

Credits - 3 **Sessional Marks: 30**
L: T: P:: 3:0:0 **University Exam Marks: 70**

Course Objectives

1. To Import Knowledge on solar cells and its Characteristics.
2. To understand the Performance of PV System when connected to grid.
3. To Describe standalone PV Systems and its importance.
4. To Provide an insight in to the various modes of energy storage systems.
5. To Demonstrate various applications of solar and energy storage systems.

Course Outcomes

After completion of the course, the student will be able to:

CO1. Estimate and analyze the performance characteristics of Solar cells
CO2. Demonstrate an understanding of standalone PV systems design and protection
CO3. Select and Analyze suitable PV Systems for Grid Connection.
CO4. Identify Various Means of Energy Storage and Demonstrate Knowledge on energy storage modes.
CO5. Analyze various applications of solar and energy storage systems.

UNIT I

Introduction: Characteristics of Sunlight - Semiconductors and P-N junctions – PV cell- PV cell characteristics -behavior of solar cells- solar cell characteristics -cell properties - PV cell interconnection

UNIT II

Stand Alone PV Systems: Solar modules - storage systems - Power conditioning and regulation – protection – stand-alone PV systems design – sizing - International PV programs

UNIT III

Grid Connected PV Systems: PV systems in buildings - design issues for central power stations – safety - Economic aspect Efficiency and performance –International PV programs

UNIT IV

Energy Storage Systems: Impact of intermittent generation –Battery energy storage –Solar thermal energy storage-pumped hydroelectric energy storage

UNIT V

Applications: Water pumping –Battery chargers - solar car – direct - drive applications – space - Telecommunications.

Text Books:

1. James M. Eyer, Joseph J. Iannucci and Garth P. Corey “, “Energy Storage Benefit and Market Analysis”, Sandia National Laboratories, 2004.
2. The Electrical Energy Storage by IEC Market Strategy Board.
3. Edward T. Glasby,”Storage & Reliability of Electricity (Energy Science, Engineering and Technology)”, Nova Science Publications, 2011.

Reference Book:

1.“Jim Eyer, Garth Corey”, Energy Storage for the Electricity Grid: Benefits and
2. Market Potential Assessment Guide, Report, Sandia National Laboratories, Feb 2010
3. Adam Stienecker,”Hybrid Energy Storage Systems”VDMVerlag , 2009.
4. J K Kaldellis,”Stand-Alone and Hybrid Wind Energy Systems: Technology, Energy Storage and Applications”, Woodhead Publishing Series in Energy, 2010.

Course Outcomes-Program outcomes- Program specific outcomes (CO-PO-PSO) Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO 1	M	H	L	-	-	-	-	-	-	-	-	-	M	H	-
CO 2	-	-	M	-	-	-	H	-	-	-	-	-	H	M	-
CO 3	-	M	-	-	H	-	-	-	-	-	-	-	M	H	-
CO 4	M	H	-	-	-	-	-	-	-	-	-	-	M	H	-
CO 5	-	H	-	L	-	-	M	-	-	-	-	-	H	M	-

20EETH08: ENERGY CONSERVATION & AUDIT

Credits - 3 **Sessional Marks: 30**
L: T: P:: 3:0:0 **University Exam Marks: 70**

Course Objectives

1. To Import Knowledge on types and importance of Energy auditing.
2. To understand the Performance and optimal selection and sizing of energy efficient motors.
3. To know about Energy efficient light source, Energy conservation in Lighting Schemes and Power quality issues related to illumination.
4. To Provide insight into Reactive power management -Types of Industrial loads-Optimal Load Scheduling.
5. To demonstrate the advantages of co-generation for energy conservation.

Course Outcomes

After completion of the course, the student will be able to:

CO1. Understand the energy auditing methods and types of tariffs.
CO2. Apply the energy conservation techniques to power system elements.
CO3. Apply the energy conservation opportunities to air conditioning, refrigeration and air compressor systems.
CO4. Apply the energy conservation opportunities to heating and cogeneration systems.

UNIT I

System approach and End use approach to efficient use of Electricity: Electricity tariff types; Energy auditing; Types and objectives-audit instruments-ECO assessment and Economic methods-specific energy analysis-Minimum energy paths-consumption models- Energy auditing of a typical industrial unit-case study

UNIT II

Electric motors: Energy efficient controls and starting efficiency-Motor Efficiency and Load Analysis-Energy efficient / high efficient Motors-Case study; Load Matching and selection of motors. Variable speed drives; Pumps and Fans-Efficient Control strategies-optimal selection and sizing – Optimal operation and storage; Case study

UNIT III

Reactive power management: Transformer Loading/Efficiency analysis, feeder/cable loss evaluation, case study. Reactive power management-Capacitor Sizing-Degree of Compensation-Capacitor losses-Location-placement-maintenance, case study; Peak Demand controls-Methodologies-Types of Industrial loads-Optimal Load scheduling-case study;

UNIT IV

Lighting: Energy efficient light sources-Energy conservation in Lighting Schemes-Electronic ballast-Power quality issues-Luminaries, case study;

UNIT V

Cogeneration: Types and Schemes-Optimal operation of cogeneration plants-case study; Electric loads of Air conditioning & Refrigeration-Energy conservation measures-Cold storage, Types –Optimal operation –case study; Electric water heating-Gysers-Power Consumption in Compressors, Energy conservation measures; Electrolytic Process; Computer Controls-software's-EMS.

Text books:

1. Giovanni and Petrecca "Industrial Energy Management: Principles and Applications", The Kluwer international series-207 (1999)
2. Anthony J.Pansini, Kenneth D.Smalling "Guide to Electric Load Management", Pennwell pub (1988).

Reference books:

1. Howard E.Jordan "Energy-Efficient Electric Motors and their applications", Plenum pub corp; (1994).
2. Turner, Wayne C, Lilburn, "Energy Management Hand book" The Fairmont press, 2001.
3. Albert Thumann "Handbook of Energy Audits ",5th edition, Fairmont Pr; (1998).
4. Recommended practice for Energy Conservation and cost effective planning in Industrial facilities by IEEE Bronze book, IEEE Inc, USA.

Course Outcomes-Program outcomes- Program specific outcomes (CO-PO-PSO) Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO 1	**M**	**H**	**L**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**M**	**H**	**-**
CO 2	**-**	**-**	**M**	**-**	**-**	**-**	**H**	**-**	**-**	**-**	**-**	**-**	**H**	**M**	**-**
CO 3	**-**	**M**	**-**	**-**	**H**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**M**	**H**	**-**
CO 4	**M**	**H**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**M**	**H**	**-**