JSS MAHAVIDYAPEETHA
JSS SCIENCE AND TECHNOLOGY UNIVERSITY
SRI JAYACHAMARAJENDRA COLLEGE OF ENGINEERINGMYSURU

Department of Electrical and Electronics EngineeringPh. D Course Work

Syllabus (2022-23)

JSS Science and Technology University, Mysuru		
Course Code	**Course Title**	**Teaching Hours**
EEED01	EHV Power Transmission	

UNIT:1 – Introduction to EHV AC Transmission: Role of EHV transmission, energy resources and development, choice of voltage for transmission, line losses and power-handling capacity, the problems of EHV and future scope. Calculation of Line and Ground Parameters : Calculation of line resistance,inductance, capacitance, and ground- return parameters, modes of propagation, charge distribution, surface voltage gradients.

UNIT:2 – Electric and magnetic fields: Corona loss and Audible Noise from EHV lines, Radio Interference, corona pulses, frequency spectrum, lateral profile of RI from lines, modern concept of 'Excitation Function' pre- determination of the RI level of a line, The power frequency electrostatic field near EHV lines, causes, harmful effects to human beings, animals, vehicles, plant life, limitations on the design, magnetic Field Effects of E.H.V.Lines.

UNIT:3 - High transient overvoltages on EHV lines: Lightning and switching overvoltages, possible conditions of internal overvoltages on EHV lines , travelling waves caused by lightning and switching operations,the method of standing waves, comparison, Laplace-Transform and Fourier-Transform Methods for handling transients on EHV lines.

UNIT:4 - Over voltage protection: Arresters - Metal Oxide Varistor, gapless Zinc Oxide arrester,conventional gap- type SiC arresters, non current-limiting and current-limiting types, outage level, factors affecting it.

UNIT:5 – Design and testing: Flashover and withstand characteristics of long air gaps- basicmechanisms statistical nature of insulation design, power-frequency over voltage for the design of line compensation, EHV laboratories, equipment and testing methods for design of EHV lines,examples

TEXT BOOKS / REFERENCES:

Text books:

1. Rakosh Das Begamudre–Extra High Voltage ACTransmission Engg. New age international (P)Ltd, New Delhi. Publisher: New Age International Pvt Ltd Publishers(January 30, 2009)
2. S.Rao– EHV-AC,HVDC Transmission and Distribution Engineering, Khanna Publishers,Delhi.
3. K.R.Padiyar – HVDC Power Transmission Systems: Technology and SystemInteractions,New ageInternational (p) Ltd.

Reference books:

1. Kuffel, Zangle, Kuffle – High Voltage Engineering,Newnes Publications
2. M.S.Naidu and V.Kamaraju – High Voltage Engineering,TMH Publications

JSS Science and Technology University, Mysuru		
Course Code	**Course Title**	**Teaching Hours**
EEED02	Solar and Wind Energy	

UNIT:1 – Solar Radiation and Its Measurement

Solar energy systems –overview, Solar constant. Spectral distribution of extraterrestrial radiation. Terrestrial radiation. Solar radiation geometry. Computation of angle of incidence of solar radiation on a surface at any location and orientation. Sun rise, sunset and day length. Empirical formulas for estimating the availability of solar radiation. Solar radiation measurement. Solar radiation data for India**.**

UNIT:2 – 2 Solar PV Fundamentals and Technologies

Introduction to semiconductor physics. Theory of P-N junction, operation of P-N junction as solar cells, parameters of solar cells, design of solar cells, solar cell materials and technologies,fabrication of crystalline Si solar cells, solar PV modules, PV module output as function of temperature and solar radiation. Aspects of practical design of solar PV systems – case studies, battery charging, pumping, lighting, Peltier cooling. Grid connected solar PV systems, aspects ofUniversal Intelligent Transformers (UIT). Solar PV-based power generation plants in India.

UNIT:3 - Applications of Solar PV Technologies

Introduction to power electronics devices. Off-grid and grid-connected PV systems, componentsof solar PV systems, charge controller, DC-DC converter, DC-AC inverter, maximum power point tracking, energy storage options for solar PV systems, availability of solar radiation at a given location, design of off-grid PV systems, design of grid-connected PV systems. Life cycle cost analysis.

UNIT:4 - Wind Energy System & Fundamentals

Introduction. Classification of wind turbines. Types of rotors. Terms used in wind energy systems. Wind energy extraction. Extraction of wind turbine power. Wind characteristics. Mean wind speed and energy estimation. Power density duration curve. Weibull Probability Density Function and Wind Turbine Capacity Factor (WTCF). Field wind data analysis. Annual percentage frequency distribution of wind speed. Direction of wind and windrose data. Air density calculation. Variation of wind speed with elevation. Energy pattern factor in wind power studies. Beaufort Wind Scale. Land for wind energy.

UNIT:5 - Wind Turbine Design and Wind Energy system Connection

System Components: Tower, Turbine, Blades, Speed Control. Turbine Rating, Power vs Speed and TSR , Maximum Energy Capture ,Maximum Power Operation, Constant-TSR Scheme Peak-Power-Tracking. System Control Requirements: Speed Control, Rate Control. Environmental Aspects Noise , Electromagnetic Interference (EMI) .Factors affecting design of wind turbine rotor. Regulating system for rotor. Wind power generation curve. Sub-systems of a horizontal axis wind turbine generator. Modes of wind power generation. Advantages and disadvantages of wind energy systems. Wind energy farms. Wind resource surveys. Assessment of wind

availability from meteorological data. Estimation of wind energy potential. Wind resource assessment in India. Status of wind energy systems in India. Methods of grid connection. Doubly-fed and full-converter based wind electric generators. Pooling of windfarms and grid interconnection. Economics of wind farms.

TEXT BOOKS / REFERENCES:

Text book:

1. D P Kothari, "Renewable Energy Sources and Emerging Technologies",2nd Edition,2013.

Reference books:

1. Chethan S. Solanki, "Solar Photovoltaics: Fundamentals, Technologies andApplications" PHI, 2009, New Delhi.
2. Mukund R Patel, **"Wind and Solar Power Systems"**, 2nd Edition, Taylor and FrancisGroup, 2006.

JSS Science and Technology University, Mysuru		
Course Code	**Course Title**	**Teaching Hours**
EEED03	Solid State Power Devices and Applications	

UNIT:1 – Solid-State Devices: Upcoming power electronic devices- SiC and GaN devices, Design of power electronic converter. Modern semiconductor devices: MOSFET, GTO, IGBT,GTO, SIT, SITH, MCT, their operating characteristics.

UNIT:2 – DC-DC Converters: Analysis and design of Buck, boost, buck-boost and Cukconverters. Switched-capacitor converters. Fly-back, forward, push-pull and full-bridge converters. Power factor correction, pSpice simulation of converters. Power supply Control, PWM control and AC line filter.

UNIT:3 - Inverters: Review of three-phase voltage source inverters, voltage and frequency control; Harmonic reduction techniques, PWM inverters, Space Vector Modulation; Multi-levelinverters, configurations: Diode clamped, flying capacitor and cascade multilevel inverters, applications; Current source inverter, commutation circuits, transient voltage suppressing techniques; DC link resonant converters, operation and control.

UNIT:4 - Adjustable speed DC motor drives and AC motor drives' Vector control of AC motor Drives

UNIT:5 – Practical converter design considerations: Snubber circuits, Gate and base drive circuits, component temperature control and heat sinks, Design of magnetic components.

TEXT BOOKS / REFERENCES:

Text books:

1. Mohan N., Underland T.M. and Robbins W.P., "Power Electronics – Converters,Applications and Design", 3rd Edition. 2008
2. Daniel W. Hart., "Power Electronics", 2nd Edition, McGraw-Hill International BookCompany. 2012
3. Joseph Vithayathil., "Power Electronics – Principles and Applications", sixthreprint.,McGraw-Hill Education (India) Edition. 2010

Reference books:

1. Lander C. W., "Power Electronics", 3rd Ed., McGraw-Hill International Book Company.2007
2. Dubey G. K., Doradla S. R., Joshi A. and Sinha R. M. K., "Thyristorised Power Controllers", New Age International Private Limited. 2008
3. Rashid M., "Power Electronics- Circuits, Devices and Applications", 3rd Edition, PearsonEducation. 2008

JSS Science and Technology University, Mysuru		
Course Code	**Course Title**	**Teaching Hours**
EEED04	**Power Quality Enhancement using CustomPower Devices**	

UNIT:1 Introduction and Characterization of Electric Power Quality: Electric Power Quality, PowerElectronic applications in Power Transmission Systems, Power Electronic applications in Power Distribution Systems. Power Quality terms and Definitions, Power Quality Problems.

UNIT:2 Analysis and Conventional Mitigation Methods: Analysis of Power Outages, Analysis of Unbalance , Analysis of Distortion, Analysis of Voltage Sag, Analysis of Voltage Flicker, Reduced Durationand Customer impact of Outages, Classical Load Balancing Problem, Harmonic Reduction, Voltage Sag or Dip Reduction.

UNIT:3 Custom Power Devices: Introduction, Utility-Customer Interface, Custom Power Devices, Custom Power Park, Status of Application of CP Devices.

Structure and Control of Power Converters: Inverter topology, High voltage inverters, Combining inverters for increased power, Open loop voltage control, Closed-Loop Switching Control, Second and higher order Systems.

UNIT:4 Load Compensation using DSTATCOM: Compensating Single Phase loads, Ideal Three phaseshunt compensator structure, Generating Reference Currents using Instantaneous Symmetrical Components, General algorithm for generating reference currents and Generating reference currents when the source is unbalanced.

UNIT:5 Series Compensation of Power Distribution System: Rectifier supported DVR, DC CapacitorSupported DVR, DVR Structure, Voltage Restoration and Series Active Filter **Unified Power Quality Compensators:** Introduction, Classification of UPQC, Principle of operation and control of UPQC

TEXT BOOKS / REFERENCES:

Text Book:

Arindam Ghosh and Gerard Ledwich, "Power Quality Enhancement Using Custom Power Devices",Springer, 2002.

Reference books:

1. Bhim Singh, Ambrish Chandra and Kamal Al-Haddad "Power Quality Problems andMitigationTechniques", Wiley, John Wiley and Sons Ltd, 2015.
2. Math Hj Bollen, "Understanding Power Quality Problems; Voltage Sags and Interruptions",JohnWiley & Sons Inc (Sea) Pte Ltd, 2014.
3. Roger C Dugan, Mark F Mcgranaghan and Surya Santoso, "Electrical Power SystemsQuality",Tata Mcgraw Hill Publishing Co Ltd, 2014.
4. G T Heydt, "Electric Power Quality", Stars in Circle Publications, 1991.
5. Ewald F Fuchs, et., "Power Quality in Power System and Electrical Machines", AcademicPress,Elsevier, 2009.
6. C. Shankaran, "Power Quality", CRC Press, 2013.

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Course Code	**Course Title**	**Teaching Hours**
EEED05	Electric Mobility	

Unit 1: Vehicle Dynamics and Systems

Energy consumption by the automotive industry, role of automotive industry in economic development, need for electric vehicles, general description of vehicle movement, vehicle resistances, vehicle performance – maximum speed, gradeability and acceleration, systems and sub-systems associatedwith a four-wheeled vehicle

Unit 2: Electric and Hybrid Electric Drivetrains

General configuration of EVs, traction motor characteristics, tractive effort and transmissionrequirement, vehicle performance, energy consumption,regenerative braking, concept of hybridelectric vehicles, architectures of HEVs – series, parallel, series-parallel and complex hybriddrivetrains (blockdiagram approach only), torque-coupling and speed-coupling in parallel HEVs and concept of mild hybrids

Unit 3: Electric Propulsion, Energy Storage and Control

Working principle of electric motors and generators, DC and AC machines – operation, types, pros and cons, motor selection for EV/ HEVs, battery parameters, lithium batteries, idea of supercapacitor, hybridization of energy storages, max. SoC of peaking power source control strategy and thermostat control strategy for series hybrid electric drivetrain, max. SoC of peakingpower source control strategy and engine turn-on turn-off control strategy forparallel hybrid drivetrain

Unit 4: EV Charging Infrastructure

Battery specifications for different EV segments, charging methods and power ratings, battery swapping, interoperability, classification of EV charging infrastructure, assessing EV charging demand, location planning and land allocation for charging stations, electricity supply for chargingstations, multi-stakeholder governance of EV charging, EV charging models, challengesin implementation of charging infrastructure

Unit 5: Advanced Automotive Technologies

Driver and vehicle safety – air bags, anti-lock braking system (ABS), electronic stability control (ESC), automatic and emergency braking and roll-over mitigation, advanced driver assistance systems (ADAS) and introduction to autonomous vehicles

TEXT BOOKS / REFERENCES:

Text Book:

1. Mehrdad Ehsani, Yimin Gao, Ali Emadi, (2010), -Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design‖ (2nd Edition), CRC Press
2. Handbook of Electric Vehicle Charging Infrastructure Implementation‖, (1st Edition), NITIAayog, Ministry of Power, Government of India

Reference Books:

1. Iqbal Hussain, (2005), -Electric and Hybrid Electric Vehicles: Design Fundamentals‖ (Latest Edition), CRC Press

JSS Science and Technology University, Mysuru		
Course Code	**Course Title**	**Teaching Hours**
EEED06	***Battery Management Systems***	

Introduction to Battery Technology

Introduction to battery terminologies: Cell voltage, Cell nominal charge capacity, Cell nominal energy capacity, Specific energy and energy density, Classification of Batteries, Working of a cell, Working of Li-ion Cells: Negative electrode, Positive electrode, Electrolyte, Separator, Current Collectors, Charging and Discharging.

Manufacturing of Li-ion cells, Ageing, Uncontrolled operating conditions and abuses of Battery.

Battery Management System Design Requirements

Purpose of a battery management system, Battery-pack sensing of Voltage, Temperature and Current, High-voltage contactor control, Isolation sensing, Thermal control, Protection, Charger control, Communication via CAN bus. State of charge estimation, Energy estimation, Power estimation, SOH estimation.

Battery State of Charge Estimation

Definition of State of Charge, SOC estimation: Voltage-based methods toestimate SOC, Current-based method to estimate SOC. Model-based SOC estimation, SOC estimation using Linear Kalman Filter

Battery State of Health Estimation

Effect of ageing on Total capacity and Equivalent Series Resistance, Negative-electrode aging, Positive electrode aging, Sensitivity of voltage to Equivalent Series Resistance, Sensitivity of voltage to total capacity. Estimating SOH parameters via Kalman filters.

Cell Balancing and Power Limit Estimation

Causes of imbalance, Balancer design choices, Circuits for balancing-Fixed shunt resistor, Switched shunt resistor, Multiple switched capacitors, One switched capacitor, Switched transformer, Shared transformer, Shared bus. Power Limit estimation :- Terminal-voltage-based power limits, Voltage-based power limits using a simple cell model, Rate limits based on SOC, Maximum
current and power, Voltage based power limits using a full cell model..

TEXT BOOKS / REFERENCES:

Text Books:

1. Gregory L. Plett, (2015) -Battery Management Systems, Volume I, Battery Modeling ‖ , Artech House.
2. Gregory L. Plett, (2016) -Battery Management Systems, Volume II, Equivalent-Circuit Methods ‖ , Artech House.

Reference Books:

1 Rui Xiong, (2020) -Battery Management Algorithm for Electric Vehicles ‖ , Springer Publisher.

2 Iqbal Hussein, (2003) -Electric and Hybrid Vehicles: Design Fundamentals ‖ , CRC Press.

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