RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR

B.TECH. (Electrical Engineering) (CBCS)

7th Semester Electrical Engineering (CBCS)

Syllabus of Professional Elective : III

Advance Power Electronics

Subject Code : BTCHEE701T

Teaching Scheme
Theory-03Hours/Week

Examination Scheme
Th (U)=70 M (I)=30 M
Duration of University Exam:- 3 Hours

Course Objective:	
1	To review basic concepts of power electronics circuits
2	To implement converter circuit in the field of power control and drives.
3	To address the underlying concepts and methods behind Advanced Power Electronics
4	To impart knowledge of power semiconductor technologies .
5	To address advancement in the field of power conversion.

Course Outcome:	
After Successful Completion of this course students will be able to demonstrate the ability to have:	
CO 1	The student can identify different areas power conversion and related topology.
CO 2	Design and Analyze power converter circuits and learn to select suitable power electronic devices by assessing the requirements of application fields.
CO 3	Formulate and analyze a power electronic design at the system level and assess the performance
CO 4	Identify the critical areas in application levels and derive typical alternative solutions, select suitable power converters to control Electrical Motors and other industry grade apparatus.
CO 5	Recognize the role power electronics play in the improvement of energy usage efficiency and the applications of power electronics in emerging areas.

Unit-1 : DC-DC SWITCHED MODE CONVERTERS **8 Hours**

Various topologies, Buck, boost, buck-boost, and Cuk converters, Full Bridge DC-DC converter-detailed theory, working principles, modes of operation, with detailed circuits and wave forms, applications, merits and demerits.

Unit- 2: DC-AC SWITCHED MODE INVERTERS **7 Hours**

Single-phase inverters, three phase inverters. SPWM inverter, detailed theory, working principles, modes of operation with circuit analysis, applications, merits and demerits, problems based on input output voltage relationship.

Unit-3: MULTILEVEL INVERTERS **7 Hours**

Multilevel inverters: Diode Clamped MLI, Flying Capacitor MLI, Cascaded H-Bridge topology: operation with equal and unequal DC voltages, Carrier modulation schemes of multilevel inverter, SVPWM of Multilevel inverter, Neutral Point Balancing schemes.

Unit-4: RESONANT CONVERTERS **7 Hours**

Zero voltage and zero current switching, resonant switch converters, and comparison with hard switching, switching locus diagrams, and working principle.

Unit-5: POWER SUPPLIES **7 Hours**

Introduction, DC power supplies: fly back converter, forward converter, push-pull converter, half bridge converter, full bridge converter, AC power supplies: switched mode ac power supplies, resonant ac power supplies, bidirectional ac power supplies.

Text & Reference Books:

1. Rashid M.H., " Power Electronics Circuit , Devices & Applications " Prentice Hall of India Pvt.Ltd.
2. B.K.Bose , "Modern Power Electronics and AC drives' Prentice Hall of India Pvt.Ltd. New Delhi
3. Dubey G.K., "Power Semiconductor Controlled Drives' Prentice Hall, Eaglewood Cliffs, New Jersey, 2002
4. Ned Mohan, Tore M. , "Power Electronics Converters, Applications, and Design" , John Wiley Sons Inc, 2nd Edition.
5. Sen P.C. , "Power Electronics "John Wiley & Sons, New York

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B.TECH. (Electrical Engineering) (CBCS)

7th Semester Electrical Engineering (CBCS)

Syllabus of Professional Elective : III

HIGH VOLTAGE ENGINEERING

Subject Code : BTCHEE701T

Teaching Scheme
Theory-03Hours/Week

Examination Scheme
Th (U)=70 M (I)=30 M
Duration of University Exam:- 3 Hours

Course Objective:	
1	To Understand the Breakdown mechanism in Di-electric medium
2	To study Lighting and switching over voltages
3	To Study Generation of high voltage and. Currents
4	To Study Measurement of high voltage and current
5	To Study Non destructive and high voltage testing of electrical apparatus

Course Outcome: After Successful Completion of this course students will be able to	
CO 1	Understand breakdown mechanism in solid liquid and gaseous medium
CO 2	Knowledge of lightening and switching over-voltages
CO 3	Analyze different methods of generation of high voltage and currents in laboratory
CO 4	Analyze different methods of measurement of high voltage and currents in laboratory
CO 5	Analyze different methods of non destructive and High Voltage testing of Apparatus and cables in laboratory

Contents	**No. of Hours**
Unit 1 : Breakdown mechanism in Di-electric : Ionization process; Townsend's criterion for B.D. Break down in electro-negative gases, Streamer theory for B.D in gases, Paschen's law, Introduction of corona, post B.D. phenomenon and applications, Practical considerations in using gases for insulation purpose; vacuum insulation, Liquid as insulators, conduction and B.D. liquids. B.D. of solid di-electrics in practice; Intrinsic, electromechanical &.thermal.	**06**
Unit 2: Lighting and switching over voltages: Mechanism of lightening, types of strokes, parameter and characteristics of lightening strokes, characteristics of switching surges; power frequency over voltages. Control of O.V. due to switching. Protection of lines by ground wires, protection by lightning Arrester, gap type and Gapless L.A.., selection of L.A. ratings, surge-absorbers.	**06**

Unit 3: Generation of high voltage and. Currents: Generation of High D.C voltages by rectifiers, voltage doubler and multiplier, circuits (Derivations and expression 'not required), Generation of high AC voltages by Cascade transformers, Resonant transformers, generation high frequency AC high voltage. Generation of impulse voltages: Standard impulse wave shapes, Marx circuit, tripping and control of impulse generation, generation of switching surges generation of impulse current.	**08**
Unit 4: -Measurement of high voltage and current: Measurement of high AC and DC voltage by micro ammeter, generating voltmeter resistance and capacitance potential divider, CVT,. Peak reading AC voltmeter. Sphere gap arrangement. Measurement of impulse voltage by potential dividers and peak reading voltmeters. Measurement of High AC DC current; measurement of high frequency and impulse current.	**08**
Unit 5: Non destructive and high voltage testing of electrical apparatus: Non destructive testing measurement of Dielectric constant and loss-factor *(low* and power frequency only), Schering bridge for high charging circuits, for high dissipation factor for three terminal measurement, transformer ratio arm bridges, partial discharge measurements by straight detectors & by balance detectors . High voltage testing. Testing of insulators, bushings, Isolators, circuit. breakers, cables, transformer, lightning arresters and power capacitors.	**08**

Text Books:

1. Title of Book Name of Author/s Edition & Publisher
2. High Voltage Engineering, M.S. Naidu and V Kamaraju,TMG
3. High Voltage Engineering, C.L.Wadhwa New Age International

Reference Books:

Advances In high Voltage Engineering A.HaddatandD. Warne ,IET

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B.TECH. (Electrical Engineering) (CBCS)

7th Semester Electrical Engineering (CBCS)

Syllabus of Professional Elective : III

ENERGY MANAGEMENT AND AUDIT

Subject Code : BTCHEE701T

Teaching Scheme
Theory-03Hours/Week

Examination Scheme
Th (U)=70 M (I)=30 M
Duration of University Exam:- 3 Hours

Course Objective:	
1	To understand the need of energy audit.
2	To impart the knowledge about mechanism of energy audit.

Course Outcome:	
After Successful Completion of this course students will be able to :	
CO 1	Explain present energy scenario with need of energy audit and energy conservation.
CO 2	Recommend appropriate type of Energy Audit looking into user requirements.
CO 3	Prepare process flow, material and energy balance diagrams.
CO 4	Prepare energy action plan and strategy for monitoring and targeting as expected of Energy manager
CO 5	Select proper energy conservation mechanism for Electrical and Mechanical Systems.

Unit 1:Basics of Energy Management and Conservation (08 Hrs)

Global and Indian energy scenario, Global environmental concerns, Climate Change, Concept of energy management, energy demand and supply,Energy Conservation -Basic concepts, Energy conservation in household, transportation, agricultural, service and industrial sectors, Lighting & HVAC systems in buildings.

Unit2:EnergyAudit (07 Hrs)

Definition, need, and types of energy audit, Energy management (audit) approach, Understanding energy costs, bench marking, Energy performance, Energy audit instruments, Highlights of Energy Conservation Act.

Unit3 :Material and Energy balance (06 Hrs)

Facility as an energy system, Methods for preparing process flow, material and energy balance diagrams, Cogeneration and waste heat recovery.

Unit4: Energy Action Planning, Monitoring and Targeting (07Hrs)

Energy Action Planning –Key elements, Force field analysis, Energy policy, roles and responsibilities of energy manager and energy auditors.

Monitoring and Targeting - Defining monitoring & targeting, Elements of monitoring & targeting, Managerial fuctions in Monitoring and Targeting.

Unit 5: Electrical Energy and Thermal Energy Management (08Hrs)

Electrical Energy Management - Methods to minimize supply-demand gap, reactive power management, demand side management, energy conservation in electric motors.

Thermal Energy Management –Energy conservation in boilers ,steam turbines and furnaces.

Text Book:

1. Amit Kumar Tyagi, "Handbook on Energy Audits and Management", TERI Publication, 1st Edition, 2000.
2. Wayne C.Turner, "Energy Management Handbook", WileyInter Science Publication, 8th Edition, 2012.

Reference Books:

1. Refer '**Bureau of Energy Efficiency'** website**:** ***http://beeindia.gov.in/en/programmes***
2. Archie W.Culp, "Principles of Energy Conservation", McGrawHill, 1st Edition, 1979.
3. P.O'Callaghan, "Energy Management", McGraw-HillBookCompany,1st Edition, 1993.
4. Thuman A.and MehtaD.Paul, "Handbook of Energy Engineering", The Fairmount Press, 6th Edition, 2008.
5. Y.P.Abbi, ShashankJain, "Handbook of Energy Audit and Environment Management", 1st Edition, TERI Publication.

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B.TECH. (Electrical Engineering) (CBCS)

7th Semester Electrical Engineering (CBCS)

Syllabus of Professional Elective : IV

DIGITAL SIGNAL PROCESSING AND ITS APPLICATIONS

Subject Code : BTCHEE702T

Teaching Scheme
Theory-03Hours/Week

Examination Scheme
Th (U)=70 M (I)=30 M
Duration of University Exam:- 3 Hours

Course Objective:	
1	To learn discrete Fourier transform, properties of DFT and its application to linear filtering
2	To understand the characteristics of digital filters, design digital IIR and FIR filters and apply these filters to filter undesirable signals in various frequency bands.

Course Outcome:	
After Successful Completion of this course students will be able to :	
CO 1	Apply DFT for the analysis of digital signals and systems.
CO 2	Design IIR and FIR filters.
CO 3	Characterize the effects of finite precision representation on digital filters Design multirate filters
CO 4	Apply adaptive filters appropriately in communication systems
CO 5	Various application of DSP.

Unit I: DISCRETE FOURIER TRANSFORM **8 Hours**

Sampling Theorem, concept of frequency in discrete-time signals, summary of analysis & synthesis equations for FT & DTFT, frequency domain sampling, Discrete Fourier transform (DFT) - deriving DFT from DTFT, properties of DFT - periodicity, symmetry, circular convolution. Linear filtering using DFT.

Unit II: INFINITE IMPULSE RESPONSE FILTERS. **7 Hours**

Characteristics of practical frequency selective filters. characteristics of commonly used analog filters - Butterworth filters, Chebyshev filters. Design of IIR filters from analog filters (LPF, HPF, BPF, BRF) - Approximation of derivatives, Impulse invariance method, Bilinear transformation.

Unit III : FINITE IMPULSE RESPONSE FILTERS. **7 Hours**

Design of FIR filters - symmetric and Anti-symmetric FIR filters - design of linear phase FIR filters using Fourier series method - FIR filter design using windows (Rectangular, Hamming and Hanning window).

Unit IV : FINITE WORD LENGTH EFFECTS. 7 Hours

Fixed point and floating point number representation - ADC - quantization - truncation and rounding - quantization noise - input / output quantization - coefficient quantization error - product quantization error - overflow error.

Unit V : DSP APPLICATIONS. 7 Hours

Multirate signal processing: Decimation, Interpolation, Sampling rate conversion by a rational factor – Adaptive Filters: Introduction, Applications of adaptive filtering to equalization-DSP Architecture Fixed and Floating point architecture principles.

TEXT BOOKS:

1. John G. Proakis and Dimitris G.Manolakis, Digital Signal Processing – Principles, Algorithms and Applications, Fourth Edition, Pearson Education / Prentice Hall, 2007.

2. A. V. Oppenheim, R.W. Schafer and J.R. Buck, ―Discrete-Time Signal Processing", 8th Indian Reprint, Pearson, 2004.

REFERENCE BOOK :

1. Emmanuel C. Ifeachor & Barrie. W. Jervis, "Digital Signal Processing", Second Edition, Pearson Education / Prentice Hall, 2002.

2. Sanjit K. Mitra, "Digital Signal Processing – A Computer Based Approach", Tata Mc Graw Hill, 2007.
3. Andreas Antoniou, "Digital Signal Processing", Tata Mc Graw Hill, 2006.

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B.TECH. (Electrical Engineering) (CBCS)

7th Semester Electrical Engineering (CBCS)

Syllabus of Professional Elective : IV

ELECTRICAL INSTALLATION DESIGN

Subject Code : BTCHEE702T

Teaching Scheme
Theory-03Hours/Week

Examination Scheme
Th (U)=70 M (I)=30 M
Duration of University Exam:- 3 Hours

Course Objective:	
1	To learn methodology of electrical loads, types of electric loads & selection of busbar and cables
2	To study switching and protection devices along with short circuit calculations.
3	To study Power and control circuit for industrial application utilizing Reactive power Management.
4	To learn industrial installations and earthling system design.
5	To study design of substations used for industrial installations.

Course Outcome: After Successful Completion of this course students will be able to	
CO 1	Understand concept of electrical load assessment and basics of busbar and cables.
CO 2	Identify switches for smooth functioning of protective scheme utilized for short circuit calculations.
CO 3	Analyze Power and control circuit for industrial application utilizing Reactive power Management.
CO 4	Apply industrial installations and earthling system design.
CO 5	Inferring the design of 11kV and 33 kV substations for industrial installations .

Unit 1: **(08 Hrs)**

Electrical load assessment:

Categories of load, types of loads, connected load, demand factor, Maximum demand, diversity factor, load factor, power factor, TOD Tariff, Industrial Electric Bills.

Cables, conductors & bus-bars:

Construction, selection, installation, overload & short circuit ratings, rating factors; Overhead line conductors.

Unit 2: **(07 Hrs)**

Switching & protection devices:

Types, specifications; selections of isolators, switches, switch fuse units, MCB, ELCB, MCCB,ACB, VCB, SF6 breakers,

Symmetrical Short Circuit Calculations:

Determining symmetrical short circuit currents at various locations for selecting proper circuit breaker rating & determining value of series reactors for limiting short circuit current.

Unit 3: **(07 Hrs)**

Electric supply to Induction Motors in industries:

Types of motors, SLD and working of DOL/ Star-Delta/ Autotransformer starters; types, specifications,

Reactive power management in industries:

Reactive power compensation in industries using static capacitors, use of Power Triangle, Calculating payback period for capacitor investment due to reduced system currents.

Unit 4: **(07 Hrs)**

Design of Industrial Electrical Installations:

Preparing load list, assessing various factors associated with loads, selection of transformer, busbars, cables, switchgear, protective devices, earthling system, testing, commissioning.

Unit 5: **(07 Hrs)**

Substations:

11kV & 33 kV, indoor/ outdoor substations, plan/ elevations, Earthling Arrangement,, types of earthling, methods of measurement of earthings.IE Rules applicable to residential, commercial & industrial installations.

List of Books:

Text Book:

1. A.S.Pabla, "Electric Power Distribution system"Tata McGraw-Hill.
2. P. V. Gupta, M. L. Soni, U. S.Bhatnagar "Course in Electrical Power", Dhampat Rai and Sons.,1987.
3. S. Rao "Electrical Substation Engineering & Practice", Kanna Tech. Publ., 1992.

Reference Books:

1. V. K. Jain, Er. V.K. Jain & Er.Amitabh Bajaj, "Design of Electrical Installations", Laxmi Publications Pvt Limited, 01-Jan-1993.
2. C. L. Wadhwa, "Electrical Engineering Handbook".
3. Indian Electricity Regulation 1956.

RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR

B.TECH. (Electrical Engineering) (CBCS)

7th Semester Electrical Engineering (CBCS)

Syllabus of Professional Elective : IV

FLEXIBLE AC TRANSMISSION SYSTEM (FACTS)

Subject Code : BTCHEE702T

Teaching Scheme
Theory-03Hours/Week

Examination Scheme
Th (U)=70 M (I)=30 M
Duration of University Exam:- 3 Hours

Course Objective:	
1	To Understand the Problems and Constraints related with Stability and Large Interconnected System.
2	To familiarize students with Voltage Source Converters, Current Source Converters and Harmonic Elimination technique.
3	To Study different types of FACTS Controllers for the solution of Problems and Constraints related with Stability and Large Interconnected System
4	To Study Shunt and Series, FACTS Controllers
5	To Study Static Voltage Regulators ,Phase angle Regulators and Combined Compensators

Course Outcome:	
After Successful Completion of this course students will be able to demonstrate the ability to have:	
CO 1	Knowledge of Power Flow in AC system with different factors affecting stability
CO 2	Knowledge of Voltage and Current Source Converters
CO 3	Knowledge of Static Shunt Compensators
CO 4	Knowledge of Static Series Compensators
CO 5	Knowledge of Static Voltage and Phase angle Regulators and Basic Concept of Combined Compensators

Contents	**No. of Hours**
Unit-I: FACTS CONCEPT AND GENERAL SYSTEM CONSIDERATION: Transmission Interconnection, Flow of Power in an AC System, factors affecting the Loading Capability, Power Flow and Dynamic Stability Consideration of Transmission interconnection, relative importance of controllable Parameters, FACTS Controller.	**08**
Unit-II: VOLTAGE-SOURCE AND CURRENT. SOURCE CONVERTERS: Single phase three phase full wave bridge converters transformer connections for 12 pulse operation. Three level voltage source converter, Generalized Technique of Harmonic Elimination and Voltage Control, basic concept of current source Converters, and comparison of current source converters with voltage Source converters.	**07**
Unit-III: STATIC SHUNTS COMPENSATORS: SVC AND STATCOM: Objectives of shunt Compensation, midpoint voltage regulation voltage instability prevention, improvement of transient stability, Methods of Controllable VAR Generation, Static Var Compensators SVC and STATCOM, Comparison Between STATCOM and SVC.	**07**

Unit-IV: STATIC SERIES COMPENSATORS: GCS, TSSC, TCSC AND SSSC: Objectives of series Compensation, improvement of transient stability, Variable Impedance Type Series Compensators, Switching Converter Type Series Compensators (only SSSC).	**07**
Unit-V: STATIC VOLTAGE AND PHASE ANGLE REGULATORS; TCVR AND TCPAR, UPFC and IPFC: Objectives of Voltage and Phase Angle regulators, Approaches to Thyristor Controlled Voltage and Phase Angle Regulators (TCVR and TCPARs), Introduction and Operating principle of Unified Power Flow Controller (UPFC) and Interline Power Flow Controllers of UPFC and IPFC	**07**

Text Books:

1. Understanding FACTS Narayan G. Hingorani and Laszlo Gyigyi Standard Publishers
2. FACTS : Controllers in Power Transmission & Distribution K. R. Padiyar 1 st , New Age International

Reference Books:

1. HVDC and FACTS Controller – Application of Static Converters in Power System by V. K. Sood , New Age International Private Limited

2. Thyristor based FACTS Controller for Electrical Transmission System by R. Mohan Mathur, Rajiv K Verma Wiley Publishers

3. FACTS Modeling and Simulation in Power System by Enrique Acha, Claudio R. Fuerte-Esquivel, Hugo Ambriz- Perez, Cesar Angeles-Camacho Wiley Publishers

RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
B.TECH. (Electrical Engineering) (CBCS)
7th Semester Electrical Engineering (CBCS)
Syllabus of Professional Elective : V

ELECTRICAL MACHINE DESIGN
Subject Code : BTCHEE703T

Teaching Scheme
Theory-03Hours/Week

Examination Scheme
Th (U)=70 M (I)=30 M
Duration of University Exam:- 3 Hours

Course Objective:	
1	To study the basic concepts and applications of Electrical Machine Design.
2	To design the main dimensions of Electrical Machines and study the effect of design on Electrical machines' performance characteristics.

Course Outcome:	
After Successful Completion of this course students will be able to demonstrate the ability to have:	
CO 1	Design the overall dimensions of 1- phase and 3-phase core type transformer
CO 2	Estimate the performance characteristics of the transformer as per specified design requirements and constraints.
CO 3	Design the overall dimensions of 3 Phase Induction Motor.
CO 4	Design Rotor Design of 3-phase Induction Motor
CO 5	Design & Calculations of the volume of coolant required for the cooling of the alternator

Unit-1: Design of 1-phase and 3-phase core type transformer: (8Hrs.)

Classification of transformers based on construction and service conditions, Output equation, overall dimensions of 1-phase and 3-phase core type transformer, need of stepped core cross-section, selection of flux density and current density, design of the transformer for minimum cost, minimum weight, and minimum losses.

Unit-2:Performance characteristics of Transformer: (8Hrs.)

Type of windings used in transformer, Calculations of per unit leakage reactance and regulation for core type transformer (Derivation of leakage reactance is not expected) , No load current calculations.

Unit-3:Design of the stator core of 3-phase Induction Motor: (7Hrs.)

Output equation of 3-phase Induction motor, selection of specific magnetic loading & specific electric loading , Selection of number and type of stator slots, overall dimensions of the stator core.

Unit-4:Rotor Design of 3-phase Induction Motor: (7Hrs.)

Classification of 3-phase Induction motor based on rotor construction, selection of length of air gap and rotor slots, calculations of overall dimension and rotor speed of 3-phase squirrel cage rotor of 3-phase Induction motor.

Unit-5:Design of 3-phase alternator: (6Hrs.)

Classification of the alternators, peripheral speed and runaway speed, pitch factor and distribution factor . Effect of SCR on the performance of the alternator, overall dimensions of 3 phase alternator , Calculations of the volume of coolant required for the cooling of the alternator.

Text Books:

1. 1 Electrical Machine Design by A.K. Sawhney, Dhanpatrai and Sons, Delhi.
2. Electrical Machine Design by Balbir Singh Brite students Publication, Pune.
3. Principles of Electrical Machine Design by R.K.Agarwal ,S.K.Katariya& Sons , Delhi.

Reference Books:

1 Performance and Design of A.C. Machines by M.G. Say , CBS publishers.

2. Design and Testing of Electrical Machines by M.V. Deshpande , PHI publishers.

3. Electrical Machine Design by V. Rjini, V.S. Nagarjan, Pearson Publishers

Data Books:

1. Electrical Machine Design data book, A. Shanmugsundaram, G. Gangadharan, P. Palani, New Age International Publishers.

RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
B.TECH. (Electrical Engineering) (CBCS)
7th Semester Electrical Engineering (CBCS)
Syllabus of Professional Elective : V

ELECTRIC AND HYBRID VEHICLES
Subject Code : BTCHEE703T

Teaching Scheme
Theory-03Hours/Week

Examination Scheme
Th (U)=70 M (I)=30 M
Duration of University Exam:- 3 Hours

Course Objective: The students will be able to	
1	Choose a suitable drive scheme for developing an electric hybrid vehicle depending on Resources.
2	Design and develop basic schemes of electric vehicles and hybrid electric vehicles.
3	Choose proper energy storage systems for vehicle applications
4	Identify various communication protocols and technologies used in vehicle networks.

Course Outcome:	
After Successful Completion of this course students will be able to demonstrate the ability to have:	
CO 1	Explain electric vehicle characteristics and typologies.
CO 2	Identify and analyze the process of power management system
CO 3	Analyze various power electronics devices in electric vehicles.
CO 4	Outline the types and size of electric motors in electric and hybrid vehicles.
CO 5	Identifying electric motor and internal combustion engine match and energy management strategies.

Unit-I : Introduction to Electric Vehicle (EV) & Hybrid Vehicle(HV): (07Hrs)
A brief history of Electric and Hybrid vehicles, basic architecture of hybrid drive train and analysis of series drive train., vehicle motion and the dynamic equations for the vehicle, types of HV and EV, advantages over conventional vehicles, limitations of EV and HV, impact on environment of EV and HV technology, disposal of battery, cell and hazardous material and their impact on environment.

Unit-2 : Power Management and Energy Sources of EV and HV: (08Hrs)
Power and Energy management strategies and its general architecture of EV and HV, various battery sources, energy storage, battery based energy storage and simplified models of battery, Battery Management Systems (BMS), fuel cells, their characteristics and simplified models, Super capacitor based energy storage, its analysis and simplified models, flywheels and their modeling for energy storage in HV/BEV, hybridization of various energy storage devices, Selection of the energy storage technology.

Unit-3 :Power Converters: **(07 Hrs)**

Introduction, various power electronics converter typologies and its comparisons, Control of convertor operations in EV and HV, battery chargers used in EV & HV. DC-DC converters for EVs, Buck and Buck-Boost Converters, Multi-quadrant DC-DC converters, DC-DC converter applications, DC-AC converters for EVs, Three-phase DC-AC converters, Voltage control of DC-AC inverters using PWM.

Unit-4 : DC and AC Machines & Drives in EV & HV: **(07 Hrs)**

Various types of motors, selection and size of motors, Induction motor drives and control characteristics, Permanent magnet motor drives and characteristics, Brushed & Brush-less DC motor drive and characteristics, switched reluctance motors and characteristics, IPM motor drives and characteristics, mechanical and electrical connections of motors.

Unit-5 : Integration of Subsystems: **(07Hrs)**

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.

Energy Management Strategies: 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.

Text Books:

1. Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2nd Edition, 2003.
2. James Larminie, John Lowry, "Electric Vehicle Technology", Wiley publications, 1st Edition, 2003.

Reference Books:

1. B D McNicol, D A J Rand, "Power Sources for Electric Vehicles", Elsevier publications, 1st Edition, 1998.
2. Seth Leitman, "Build Your Own Electric Vehicle" MC Graw Hill, 1st Edition, 2013.

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B.TECH. (Electrical Engineering) (CBCS)

7th Semester Electrical Engineering (CBCS)

Syllabus of Professional Elective : V

INTRODUCTION TO SMART GRID

Subject Code : BTCHEE703T

Teaching Scheme
Theory-03Hours/Week

Examination Scheme
Th (U)=70 M (I)=30 M
Duration of University Exam:- 3 Hours

Course Objective: The students will be able to	
1	1. To provides overview of smart grid and its potential in different types of power sectors
2	To focus on background and fundamental building blocks of smart grid.
3	To emphasizes on renewable energy source integration in present grids as well as in micro andnano grid.

Course Outcome:	
After Successful Completion of this course students will be able to demonstrate the ability to have:	
CO 1	Present energy scenario and feature s of smart grid
CO 2	Identify components and computational tools for smooth functioning of smart grid.
CO 3	Analyze the various protection issues of smart grid.
CO 4	Design smart grid with options like automation.
CO 5	Sustainable energy options for the smart grid.

Unit 1: Introduction to Smart Grid **(06 Hrs)**

Introduction to Smart Grid, need and importance of Smart Grids compared to existing system, Architecture of Smart Grid, Elements and technologies of Smart Grid system, Indian Electricity Grid Codes and Indian energy scenario, smart grid market.

Unit 2: Smart grid Communication and Performance **(08 Hrs)**

Communication and measurement requirements, Network need for diverse Smart Grid applications, wired and wireless communication technologies with challenges, smart meters, Congestion management effect, Static Security assessment (SSA) and contingencies.

Unit 3: Smart Grid Protection **(07 Hrs)**

Introduction, Protection of micro grids and smart grids, different protection issues in Smart Grid, IEC 61850 & communication-aided protection systems

Unit 4: Computational Tools for Smart Grid Design **(07 Hrs)**

Introduction to computational tools, Decision support Tools (DS), Heuristic Optimization, Evolutionary Computational Techniques, Adaptive Dynamic Programming Techniques, Hybridizing optimization techniques and applications to the smart grid, Computational Challenges.

Unit 5: Renewable Energy and Storage: **(08 Hrs)**

Sustainable energy options for the smart grid, Penetration and variability issues associated with sustainable energy technology, Demand-response issue, Electric vehicles and Plug-in Hybrids, PHEV Technology, Environmental Implications, Storage Technologies, Tax Credits.

Text Book:

1. A Keyhani and M Marwali "Smart Power Grids", Springer Publication, 1st Edition, 2012.
2. Arun Phadke and James Thorp "Computer Relaying for Power Systems", John Wiley publication, 1st Edition 2009.

Reference Books:

1. Ramesh Bansal, "Power System Protection in Smart Grid Environment", CRC Press, 1st Edition, 2019.
2. Smart Grids, Infrastructure, Technology and Solutions, S. Borlase, "Smart Grid: Technology and Applications", Wiley 2012.

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B.TECH. (Electrical Engineering) (CBCS)

7th Semester Electrical Engineering (CBCS)

Syllabus of Open Elective : II

POWER PLANT ENGINEERING

Subject Code : BTCHEE704T

Teaching Scheme
Theory-03Hours/Week

Examination Scheme
Th (U)=70 M (I)=30 M
Duration of University Exam:- 3 Hours

Course Objective: The students will be able to	
1	To provide an overview various type of power plants.
2	To provide issues associated with energy conversion.

Course Outcome: Upon completion of the course, the students can understand	
CO 1	Electrical energy, economic and environmental issues
CO 2	Operation of Thermal power Plant.
CO 3	Subsystems of thermal power plants and cogeneration systems
CO 4	Operation of Hydroelectric Power Plants
CO 5	Operation of Nuclear Energy Conversion

UNIT – I :
Energy, Economic and Environmental Issues: Power tariffs, load distribution parameters, load curve. Pollution control technologies including waste disposal options for coal and nuclear plants. **8 Hours**

UNIT - II :
Coal Based Thermal Power Plants. Basic Rankine cycle and its modifications, layout of modern coal power plant, boilers, turbines, condensers, steam and heating rates. **7 Hours**

UNIT - III :
Subsystems of thermal power plants, fuel and ash handling, draught system, feed water treatment, binary cycles and cogeneration systems. **7 Hours**

UNIT – IV:

Hydroelectric Power Plants: Classification, typical layout and various components. **6 Hours**

UNIT – V :
Basics of Nuclear Energy Conversion: Layout and subsystems of nuclear power plants, gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants. **8 Hours**

TEXT BOOKS: 1. Nag P.K., Power Plant Engineering, 3rd ed., Tata McGraw Hill, 2008.

2. El Wakil M.M., Power Plant Technology, Tata McGraw Hill, 2010.

REFERENCE BOOK: 1. Elliot T.C., Chen K and Swanekamp R.C., Power Plant Engineering, 2nd ed., McGraw Hill, 1998.

RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
B.TECH. (Electrical Engineering) (CBCS)
7th Semester Electrical Engineering (CBCS)
Syllabus of Open Elective : II
FUNDAMENTAL OF CONTROL SYSTEMS
Subject Code : BTCHEE704T

Teaching Scheme
Theory-03Hours/Week

Examination Scheme
Th (U)=70 M (I)=30 M
Duration of University Exam:- 3 Hours

Course Objective: The students will be able to	
1	To introduce the components and their representation of control systems.
2	To learn various methods for analyzing the time response, frequency response and stability of the systems.
3	To learn the various approach for the state variable analysis.

Course Outcome: Upon completion of the course, the student should be able to	
CO 1	Identify the various control system components and their representations.
CO 2	Analyze the various time domain parameters
CO 3	Analysis the various frequency response plots and its system.
CO 4	Apply the concepts of various system stability criterions.
CO 5	Analysis and Implementation of State Variable Methods

Unit 1: Systems Components and Their Representation **8 Hours**

Control System: Terminology and Basic Structure, Feed forward and Feedback control theory, Introduction to Electrical and Mechanical Transfer Function Models, Basics of Signal flow graphs, Basics of DC and AC servo Systems.

Unit 2: Time Response Analysis **7 Hours**

Transient response-steady state response, Introduction toMeasures of performance of the standard first order and second order system, effect on an additional zero and an additional pole, steady error constant and system.

Unit 3: Frequency Response and System Analysis **6 Hours**

Closed loop frequency response, Performance specification in frequency domain, Frequency response of standard second order system, Bode Plot (Basic Concept only)

Unit 4: Concepts of Stability Analysis **7 Hours**

Concept of stability, Bounded - Input Bounded - Output stability, Introduction to Routh stability criterion, Relative stability, Root locus (basic concept only).

Unit 5: Control System Analysis Using State Variable Methods **8 Hours**

State variable representation, Controllability and observability by Kalman'Test , Methods of State Model: a) Physical Variable b) Phase Variable c) Diagonal Form .

List of Books:

Text Book:

3. M.Gopal, "Control System: Principles and Design", Tata McGraw Hill, 4th Edition, 2012.

Reference Books:

4. J.Nagrath and M.Gopal, "Control System Engineering", New Age International Publishers, 5th Edition, 2007.

5. K. Ogata, "Modern Control Engineering", 5thEdition, PHI, 2012.

6. S.K.Bhattacharya, "Control System Engineering", 3rdEdition, Pearson, 2013.

7. BenjaminC.Kuo, "Automatic Control Systems", Prentice Hall of India, 7th Edition,1995.

RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR

B.TECH. (Electrical Engineering) (CBCS)

7th Semester Electrical Engineering (CBCS)

Syllabus of Open Elective : II

TESTING & MAINTENANCE OF ELECTRICAL EQUIPMENTS

Subject Code : BTCHEE704T

Teaching Scheme	**Examination Scheme**
Theory-03Hours/Week	Th (U)=70 M (I)=30 M
	Duration of University Exam:- 3 Hours

Course Objective: The students must have	
1	Awareness about safety practices while handling electrical equipment.
2	To develop the skills for the testing and maintenance of the electrical equipment as per prevailing standard .

Course Outcome: Upon completion of the course, the student should be able to	
CO 1	Follow safe practices to prevent accidents while using electrical equipment
CO 2	Test and perform maintenance of transformer.
CO 3	Test and perform maintenance induction motor.
CO 4	Test and perform maintenance DC motor.
CO 5	Maintain insulation systems of electrical equipment.

Unit-I :Safety Practices : (06Hrs)

Safety, Electrical hazards, Electric shock, factors influencing severity of shock, rescuing persons, Precautions against electric fires, use of fire extinguishers,

Need of Earthling ,Factors affecting Earthling , types of Earthling.

Unit-2 :Testing & maintenance of transformer: (08Hrs)

Different components of transformer viz., conservator, breather, radiator, Buchholz's relay , tap changer etc. Type test, routine test and special test of transformer, Measurement of winding resistance; Measurement of voltage ratio, open circuit and short circuit test, Temperature-rise test, switching impulse test. Maintenance of transformer.

Unit-3 :Testing & maintenance of 3 phase induction motor: (08Hrs)

Routine, type and special test of three phase induction motor. No load test, Blocked rotor test, Vibration test, Temperature test, Phase sequence test, Insulation resistance test. Maintenance of 3 phase Induction Motor.

Unit-4 :Testing & maintenance of DC machines: (08Hrs)

Type test, routine test and special test of DC machines. The magnetization or open-circuit test. The load characteristic ,The determination of the efficiency curve. The temperature rise test. Maintenance of DC machines.

Unit-5 :Testing of insulation of electrical system: (06Hrs)

Classification of insulating material, factors affecting life of the insulation , measurement of insulation resistance, maintenance of insulations, Testing of physical and electrical properties of transformer oil

TextBooks:

1. Rao, S., "Testing, commissioning, operation and maintenance of electrical equipment", Khanna Publishers, New Delhi .
2.SinghTarlok, "Installation, commissioning and maintenance of Electrical equipment", S.K. Kataria and Sons, New Delhi.

Reference Books:

1. Paul Gill, "Electrical power equipment maintenance and testing", CRC Press, 2008.
2. Philip Kiameh, "Electrical Equipment Handbook: Troubleshooting and Maintenance", MacGraw-Hill, 2003.
3. Relevant Indian Standards (IS Code) and IEEE Standards for-Installation, maintenance and commissioning of electrical equipment/machines.