SPPU B.E./B.Tech EE Sem 6 syllabus

Energy Audit and Management

303150 : Energy Audit and Management

Unit 01: Energy Scenario (6 Hrs.)
Classification of Energy resources, Commercial and noncommercial sources, primary and
secondary sources, commercial energy production, final energy consumption. Energy needs
of growing economy, short terms and long terms policies, energy sector reforms, energy
security, importance of energy conservation, energy and environmental impacts, emission
check standard, salient features of Energy Conservation Act 2001 and Electricity Act 2003.
Indian and Global energy scenario. Introduction to IE Rules. Study of Energy Conservation
Building Code (ECBC).

Unit 02: Energy Management (6 Hrs.)
Definition and Objective of Energy Management, Principles of Energy management, Energy
Management Strategy, Energy Manager Skills, key elements in energy management, force
field analysis, energy policy, format and statement of energy policy, Organization setup and
energy management. Responsibilities and duties of energy manager under act 2001. Energy
Efficiency Programs. Energy monitoring systems.

Unit 03: Demand Management (6 Hrs.)
Supply side management (SSM), Generation system up gradation, constraints on SSM.
Demand side management (DSM), advantages and barriers, implementation of DSM. Use of

demand side management in agricultural, domestic and commercial consumers. Demand
management through tariffs (TOD). Power factor penalties and incentives in tariff for demand
control. Apparent energy tariffs. Role of renewable energy sources in energy management,
direct use (solar thermal, solar air conditioning, biomass) and indirect use (solar, wind etc.)
Introduction to Net Metering.

Unit 04: Energy Audit (6 Hrs.)
Definition, need of energy audits, types of audit, procedures to follow, data and information
analysis, energy audit instrumentation, energy consumption – production relationship, pie
charts. Sankey diagram, Cusum technique, least square method and numerical based on it.
Outcome of energy audit and energy saving potential, action plans for implementation of
energy conservation options. Bench- marking energy performance of an industry. Report
formats

Unit 05: Energy Conservation in Applications (6 Hrs.)
a) Motive power (motor and drive system). b) Illumination c) Heating systems (boiler and
steam systems) d) Ventilation(Fan, Blower and Compressors) and Air Conditioning systems
e) Pumping System f) Cogeneration and waste heat recovery systems g) Utility industries (T
and D Sector)

Unit 06: Financial analysis (6 Hrs.)
Financial appraisals; criteria, simple payback period, return on investment, net present value
method, time value of money, break even analysis, sensitivity analysis and numerical based
on it, cost optimization, cost of energy, cost of generation.

Text Books:
[T1] Guide books for National Certification Examination for Energy Managers/Energy
Auditors Book , 1-General Aspects (available on line)
[T2] Guide books for National Certification Examination for Energy

Managers/Energy
Auditors Book 2 – Thermal Utilities (available on line)
[T3] Guide books for National Certification Examination for Energy Managers/Energy
Auditors Book 3- Electrical Utilities (available on line)
[T4] Guide books for National Certification Examination for Energy Managers/Energy
Auditors Book 4 (available on line)

Reference Books:

[R1] Success stories of Energy Conservation by BEE (www. Bee-india.org)
[R2] Utilization of electrical energy by S.C. Tripathi, Tata McGraw Hill.
[R3] Energy Management by W.R. Murphy and Mackay, B.S. Publication.
[R4] Generation and utilization of Electrical Energy by B.R. Gupta, S. Chand Publication.
[R5] Energy Auditing made simple by Balasubramanian, Bala Consultancy Services.

Websites:

[W1] www.energymanagertraining.com
[W2] www.em-ea.org
[W3] www.bee-india.org

Control system 1

303147 : Control System-I

Credits:04

Unit 01 : General

Basic concepts of control system, classification of control systems. Types of control system: Feedback, tracking, regulator system, feed forward system. Transfer function, Pole and zero concept. Modeling and representation of control system-Basic concept.
Mechanical, Electrical and equivalent system, Electromechanical. Block diagram Algebra, signal flow graph, Mason’s gain formula.

Unit 02 : Time domain analysis

Standard test signal –step, ramp, parabolic and impulse signal, type and order of control system, time response of first and second order systems to unit impulse, unit step input. steady state errors – static error coefficients. Time domain specifications of second order

systems. Importance of dominant closed loop poles of higher order systems Derivation of time domain specifications for second-order under-damped system for unit step input.

Unit 03 : Stability analysis and Root Locus
Concept of stability- Absolute, Asymptotic, relative and marginal. Nature of system response for various locations of roots in S-plane of characteristics equation. Routh's- Hurwithz criterion. Root Locus: Basic properties of root locus. Construction of root locus.

Angle and magnitude condition for stable system.

Unit 04 : Frequency domain analysis-I
Introduction, relation between time and frequency response for second order system.
Frequency domain specifications, Polar Plot, Nyquist plot, stability analysis using Nyquist plot.

Unit 05 : Frequency domain analysis-II
Introduction to Bode plot, Asymptotic approximation: Sketching of Bode plot, stability, stability analysis using Bode plot.

Unit 06 : PID controllers
Basic concept of P, PI, PID controller, Design specifications in time domain and frequency domain. Design of PID controller by Root-Locus. Tuning of PID controllers. Ziegler-Nichol Method.
Control System Components: Working principle and transfer function of Lag network, lead network, potentiometer, AC and DC servo motors. Working principle of synchros.

Text Books:
[T1] I.J. Nagrath, M. Gopal, "Control System Engineering", New Age International Publishers, 5th edition, 2007.

[T2] Katsuhiko Ogata, "Modern control system engineering", Prentice Hall, 2010.
[T3] Nise N. S. "Control Systems Engineering", John Wiley & Sons, Incorporated,2011
Reference Books:
[R1] B. C. Kuo, "Automatic Control System", Wiley India, 8th Edition, 2003.
[R2] Richard C Dorf and Robert H Bishop, "Modern control system", Pearson Education, 12th edition, 2011.

[R3] D. Roy Choudhary, "Modern Control Engineering", PHI Learning Pvt. Ltd., 2005.

Power System II

303146 : Power System II

Unit 01: Performance of Transmission Lines (08 Hrs.)

Evaluation of ABCD constants and equivalent circuit parameters of Long transmission line. Concept of complex power, power flow using generalized constants, receiving end power circle diagram for transmission line (assuming ABCD constants are already given), surge impedance loading, Line efficiency, Regulation and compensation, basic concepts. Numerical based on: ABCD constants of Long transmission line, Power flow, circle diagram.

Unit 02: EHV-AC transmission: (08 Hrs.)

Role of EHV-AC transmission, standard transmission voltages, average values of line parameters, power handling capacity and line losses, phenomenon of corona, disruptive critical voltages, visual critical voltages, corona loss, factors and conditions affecting corona loss, radio and television interference, reduction of interference, Numerical Based on Corona, Corona loss and power handling capacity.

Unit 03: Per unit system and Load Flow Analysis (08 Hrs.)

Per unit system: Single line diagram, Impedance and reactance diagrams and their uses, per unit quantities, relationships, selection of base, change of base, reduction to common base, advantages and application of per unit system. Numerical based on network reduction by using per unit system.
Load Flow Analysis: Network topology, driving point and transfer admittance, concept of Z-bus and formulation of Y-bus matrix using Direct method, singular transformation method, Introduction to load flow analysis, power- flow equations generalization to n bus systems, classification of buses, Newton- Raphson method (using polar coordinates - Descriptive treatment only) Numerical based on Y bus Matrix.

Unit 04: Symmetrical Fault Analysis (08 Hrs.)

3-phase short-circuit analysis of unloaded alternator, sub-transient, transient and steady state current and impedances, D.C. Offset, and effect of the instant of short-circuit on the waveforms, estimation of fault current without pre-fault current for simple power systems,

selection of circuit- breakers and current limiting reactors and their location in power system (Descriptive treatment Only) Numerical Based on symmetrical fault analysis

Unit 05: Unsymmetrical Fault Analysis: (08 Hrs.)
Symmetrical components, transformation matrices, sequence components, power in terms of symmetrical components, sequence impedances of transmission line and zero sequence networks of transformer, solution of unbalances by symmetrical components, L-L, L-G, and L-L-G fault analysis of unloaded alternator and simple power systems with and without fault impedance.
Numerical based on symmetrical components and unsymmetrical fault calculation.

Unit 06: HVDC Transmission (Descriptive treatment only) (08 Hrs.)
Classification and components of HVDC system, advantages and limitations of HVDC transmission, comparison with HVAC system, introduction to HVDC control methods - constant current, constant ignition angle and constant extinction angle control, HVDC systems in India, recent trends in HVDC system.

Text Books:
[T1] I.J. Nagrath and D.P. Kothari – Modern Power System Analysis – Tata McGraw Hill, New Delhi.
[T2] B R Gupta , “Power System Analysis and Design”, S.Chand.
[T3] Ashfaq Hussain, “Electrical Power Systems”, CBS Publication 5th Edition.
[T4] J.B.Gupta. “A course in power systems” S.K. Kataria Publications.
[T5] P.S.R. Murthy, “Power System Analysis”, B.S. Publications

Reference Books :
[R1] H. Hadi Sadat: Power System Analysis, Tata McGraw-Hill New Delhi.
[R2] G. W. Stagg and El- Abiad – Computer Methods in Power System Analysis – Tata McGraw Hill, New Delhi.
[R3] M.E.El-Hawary, Electric Power Systems: Design and Analysis, IEEE Press, New York.
[R4] Rakash Das Begamudre, “Extra High voltage A.C. Transmission Engineering”, New age publication.
[R5] M.A.Pai, Computer Techniques in Power System Analysis, Tata McGraw Hill Publication.
[R6] Stevenson W.D. Elements of Power System Analysis (4th Ed.) Tata McGraw Hill, New Delhi.

[R7] K.R.Padiyar: HVDC Transmission Systems, New Age International Publishers Ltd, New Delhi.
[R8] Olle I. Elgard – Electric Energy Systems Theory – Tata McGraw Hill, New Delhi.
[R9] V. K. Chandra, Power Systems, Cyber tech Publications.
[R10] NPTEL Web course and video course on power system analysis.

Utilization of Electrical Energy

303148 : Utilization of Electrical Energy

Credit 03

Unit 01: Electric Heating (06 Hrs.)

Modes of heat transfer, mathematical expressions
Electric heating: Introduction to electric heating, Advantages of electrical heating
Heating methods: - Resistance heating – Direct resistance heating, indirect resistance heating, electric ovens, different types of heating element materials, temperature control of resistance furnaces, and design of heating element (Numerical).
Applications of resistance heating
Induction heating : Principle, core type and coreless induction furnaces, Ajax Wyatt furnace, Numerical on melting furnaces
Applications of induction heating Electric arc heating – Direct and indirect arc heating, types of arc furnaces, equivalent circuit of arc furnace, condition for maximum output, power factor at maximum output (Numerical), Heat control in arc furnace, Applications of arc heating Dielectric heating –Principle, choice of voltage and frequency for dielectric heating (Numerical), Applications of dielectric heating
Electric Welding -Welding m e t h o d s –Electric arc welding and resistance welding, Equivalent circuit of arc furnace (Numerical)
Modern welding techniques like ultrasonic welding and laser welding

Unit 02: Electrochemical Process (04 Hrs.)

Need of electro-deposition. Applications of Faraday’s laws in electro-deposition. Factors governing electro-deposition. Objectives of electroplating. Equipments and accessories for electroplating plant, Electroplating on non-conducting materials, Principle of anodizing and its applications Electrical Circuits Used in Refrigeration, Air Conditioning
Brief description of vapour compression refrigeration cycle.
Description of electrical circuits used in Refrigerator, Air Conditioner

Unit 03: Illumination (04 Hrs.)

Definitions of luminous flux, solid angle, luminous intensity, illumination, luminous efficacy, depreciation factor, coefficient of utilization, space to height ratio, reflection factor; Laws of illumination.

Design of illumination schemes-Factors to be considered for design of illumination scheme, Calculation of illumination at different points, considerations involved in simple design problems for indoor installation, illumination schemes, standard illumination level.

Natural day light illumination (brief information)

Different sources of light: Incandescent lamp, fluorescent lamp, comparison between them.

Incandescent and discharge lamps – their construction and characteristics; mercury vapour lamp, sodium lamp, halogen lamp, compact fluorescent lamp, metal halide lamp, neon lamps

Electroluminescent lamp-LEDs, types, LASERs Comparison of all above luminaries.

Unit 04: Electric Traction (06 Hrs.)

History of Indian railways.

Traction systems - Steam engine drive, electric drive, diesel electric drive, types of diesel locomotives, Advantages of electric traction, Brief treatment to - Indian railway engine coding terminology, WDM,WDP,WDG series and their capacity . Introduction to metro system, mono rail system.

Systems of track electrification: D.C. system, single phase low frequency A.C. system, 3 phase low frequency A.C. systems, composite systems – kando systems, single phase A.C. to D.C. system

Different accessories for track electrification -overhead wires, conductor rail system, current collector-pentograph, catenary

Electric locomotive- Block diagram with description of various equipment and accessories.

Supply system constituents-Layout and description of -Traction substation, feeding post(25kV), feeding and sectioning arrangement,sectioning and paralleling post, neutral section.

Details of major equipment in traction substation-transformer, circuit breaker, interrupter

Unit 05: Traction Mechanics (08 Hrs.)

Types of services- Urban, Sub-urban, Main line Speed time curves, trapezoidal and quadrilateral speed-time curves, average and schedule speed (Numerical), Tractive effort. Specific energy consumption. Factors affecting specific energy consumption (Numerical), Mechanics of train movement, coefficient of adhesion

(Numerical).

Unit 06: Traction Motors, Control of Traction Motors, Train Lighting (08 Hrs.)

Desirable characteristic of traction motors. Suitability of D.C. series motor, A.C. series motor, 3 phase induction motor and linear induction motor for traction. Control of traction motors -Series-parallel control, Shunt and bridge transition (Numerical), Electrical breaking, Regenerative breaking in traction, Suitability of different motors for braking. Train lighting system.

Railway signalling: - History, necessity, block system route relay interlock and necessity. Metro signalling, Electromechanical system for route relay interlock. Introduction to train tracking system, types. Anti-collision system-brief treatment only.

Text Books:

[T1] E. O. Taylor 'Utilization of Electrical Energy' – Revised in S.I. Units by V.V.L. Rao, Orient Longman

[T2] J.B. Gupta, 'Utilization of Electric Power and Electric Traction', S.K. Kataria and sons, Delhi

[T3] C. L. Wadhwa, 'Generation, Distribution and Utilization of Electrical Energy', Eastern Wiley Ltd.

[T4] A. Chakraborti, M. L. Soni, P. V. Gupta, U.S. Bhatnagar, 'A text book on Power System Engineering', Dhanpat Rai and Co.(P) Ltd – Delhi

[T5] Clifford F. Bonntt 'Practical Railway Engineering', (Imperial college press)

Reference Books:

[R1] 'Art and science of Utilization of Electrical Energy' by H. Partab, Dhanpat Rai and Co.(P) Ltd –Delhi

[R2] 'Modern Electric Traction' by H. Partb, Dhanpat Rai and Co. (P) Ltd – Delhi

[R3] 'Lamps and lighting' by M. A. Cayless, J.R. Coaton and A. M. Marsden

[R4] 'BIS, IEC standards for Lamps, Lighting Fixtures and Lighting' By Manak Bhavan, New Delhi

[R5] 'Illumination Engineering from Edison's Lamp to the Laser' Joseph B. Murdoch

[R6] 'Two centuries of Railway signalling' by Geoffrey, Kichenside and Alan Willims (Oxford Publishing Co-op)

[R7] 'Generation and Utilization of Electrical Energy' S. Sivanagaraju, M. Balsubba Reddy, D. Srilatha (Pearson)

[R8] 'Electrical Powers' S. L. Uppal, Khanna Publication

Design of electrical machines

303149: Design of Electrical Machines

Credit:04

Unit 01: Transformer
Modes of heat dissipation. Heating and cooling curves. Calculations of heating and cooling time constants. Types and constructional features of core and windings used in transformer.
Transformer auxiliaries such as tap changer, pressure release valve, breather and conservator.
Specifications of three phase transformers as per IS 2026(Part I).

Unit 02: Transformer Design
Output equation with usual notations, optimum design of transformer for minimum cost and loss. Design of main dimensions, core, yoke and windings of transformer. Methods of cooling and tank design. Estimation of resistance and leakage reactance of transformer.

Unit 03: Performance parameters of Transformer
Estimation of no-load current, losses, efficiency and regulation of transformer. Calculation of mechanical forces developed under short circuit conditions, measures to overcome this effect.
Introduction to Computer aided design of transformer, generalized flow chart for design of transformer.

Unit 04: Three phase Induction Motor Design : Part I
Specification and Constructional features. Design of ac windings. Output equation with usual notations, specific electrical and magnetic loadings, ranges of specific loadings, turns per phase, number of stator slots.

Unit 05: Three phase Induction Motor Design : Part II
Suitable combinations of stator and rotor slots .Calculations for main dimensions and stator design parameters. Selection of length of air gap, factors affecting length of air gap, unbalanced magnetic pull. Design of rotor slots, size of bars, end rings for cage rotor and rotor slots, turns and area of cross section of conductor for wound rotor.

Unit 06: Performance parameters of Three Phase Induction motor
Leakage flux and leakage reactance: Slot leakage, tooth top leakage, zig-zag leakage, overhang leakage, leakage reactance calculation for

three phase machines. MMF Calculation for air gap, stator teeth, stator core, rotor teeth and rotor core, effect of saturation, effects of ducts on calculations of magnetizing current, calculations of no-load current. Calculations of losses and efficiency. Calculation of short time and continuous rating of electrical machine.

Text Books:

[T1] M.G. Say – Theory and Performance and Design of A.C. Machines, 3rd Edition, ELBS London.
[T2] A.K.Sawhney – A Course in Electrical Machine Design, 10th Edition, - Dhanpat Rai and sons New Delhi.
[T3] K. G. Upadhyay- Design of Electrical Machines, New age publication
[T4] R. K. Agarwal – Principles of Electrical Machine Design, S. K.Katariya and sons.
[T5] Indrajit Dasgupta – Design of Transformers – TMH

Reference Books:

[R1] K.L. Narang , A Text Book of Electrical Engineering Drawings, Reprint Edition : 1993 / 94 – Satya Prakashan, New Delhi.
[R2] A Shanmugasundaram, G. Gangadharan, R. Palani, - Electrical Machine Design Data Book, 3rd Edition, 3rd Reprint 1988 - Wiely Eastern Ltd., - New Delhi
[R3] Vishnu Murti, “Computer Aided Design for Electrical Machines”, B.S. Publications.
[R4] Bharat Heavy Electricals Limited, Transformers - TMH.