JECRC™ UNIVERSITY

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School of Engineering

Syllabi and Course Structure

B. Tech. (Electrical Engineering)

Academic Programmes

July, 2015

Faculty of Engineering and Technology
B.Tech. in Electrical Engineering – Semester III
Contact Hrs per week (L-T-P): 3-1-0

Course Outlines

BEL001A- Field Theory and Circuits

OBJECTIVES: In this course one can understand

- Various laws and equations with respect to electric and magnetic fields.
- In its second part one can learn various network theorems and transient response under different excitation.

Field Theory

Unit 1: **Review of Vector Analysis**- Coordinate Systems, Vectors, gradient, divergence, curl, Laplacian, divergence theorem, Stoke's theorem.

Unit 2: **Electric and Magnetic fields**- Electric fields due to distributed charges configurations, line(s) of charges, uniform plane surface and spherical volume charge distributions; behaviour of conductors and dielectrics in electrostatic fields, boundary conditions, applications of ampere's law and Biot- Savart's law; capacitance and inductance calculations for simple configurations; time varying fields – displacement current, Maxwell's equations; Laplace's and Poisson's equations.

Circuit Theory

Unit 3: **Classification and Graph Theory**-Classification of circuits, sources and signals, standard signals, source transformations. Network topology, graph matrices, formulation and solution of circuit equations based on graph theory using different analysis techniques- circuit, cut set and mixed. Concept of duality.

Unit 4: **Network theorems**-Network theorems and their applications-Superposition, reciprocity, Thevenin, Norton, Maximum power transfer, Millman theorem. Analysis of circuits subject to periodic and non-periodic excitations using Fourier Series and Laplace transforms.

Unit 5: **Transient response-**Concept of free and forced response of circuits. Time constants and Transient response under DC and AC excitation. Analysis of magnetically coupled circuits. Analysis of circuits with dependent sources.

OUTCOMES:

- Students can now apply the knowledge to solve different networks involving electric and/or magnetic field.
- Also with the knowledge of different circuit theorem one can calculate the drop or power consumed/supplied by the load or source etc.

Text Books:

Field Theory

1.N.N. Rao, "Basic Electromagnetics with applications", PHI

Circuit Theory

1. Roy Chaudhary, “Networks and systems”, Wiley.

Reference Books:

Field Theory

1. D.J. Griffith, “Introduction to Electrodynamics”, PHI.
2. Guru and Hiziroglu, “Electromagnetic field theory fundamentals”, Vikas Publishing House
3. E.C. Jordan and K.G. Balmain, “Electromagnetic waves and radiating systems”, PHI

Circuit Theory

1. Valkenberg and Kinariwala, “Linear Circuits”, PHI.
2. Trick, “Introduction to circuit Analysis”, Wiley.
3. Van Valkenberg, “Network Analysis”, PHI.
4. Desoer and Kuh, “Basic Circuit theory”, McGraw Hill.

Faculty of Engineering and Technology

B.Tech. in Electrical Engineering – Semester III

Contact Hrs per week (L-T-P): 3-1-0

Course Outlines

BEL002A- Electrical Machines I

OBJECTIVES: To study

- The working principles of electrical machines using the concepts of electromechanical energy conversion principles.
- Derive expressions for generated voltage and torque developed in various Electrical Machines.

Unit 1: **Electromechanical Energy Conversion**- Magnetic field energy and co-energy, coupling-field reaction for energy conversion, mechanical work, mechanical forces and torques in singly and doubly-excited systems. Concepts of reluctance and electromagnetic torques. Singly excited electric –field systems.

Unit 2: **Transformers-**
(a) Principle, construction and operation of single phase transformers, phasor diagram, equivalent circuit, voltage regulation, losses and efficiency.
(b) Testing- Open and short circuit tests, Polarity test, Sumner’s test, Separation of hysteresis and eddy current losses.

Unit 3: **Three phase Transformer-** Construction, various types of connection and their comparative features. Parallel operation of single phase and three phase transformers. Autotransformers- Construction, Principle, Applications and Comparison with two winding transformer. Excitation phenomenon in transformers, Harmonics in single phase and three phase transformers, Suppression of harmonics. Phase conversion-Scott connections, three phase to six phase conversion. Tap changing Transformers- No load and on load tap changing of transformers. Three winding Transformers. Cooling methods of transformers.

Unit 4: **DC Machines-**
(a) Working principle, construction and methods of excitation.
(b) Armature Winding- Detailed study of simple lap and wave windings.
(c) DC Generators-emf equation. Circuit models, Armature reaction, Effect of brush shift. Compensating winding, Characteristics of various types of generators, applications.

Unit 5: **DC Motors**- Torque equation, Circuit models Characteristics of DC shunt, series and compound motors, applications. Starting and Speed Control- Starting methods and speed control of DC shunt and series motors. Commutation- Causes of bad commutation, Methods of improvement. Testing- Direct and regenerative methods to test DC machines.

OUTCOMES:

- Students can now apply the knowledge of transformer and DC machines in testing them for the study of speed control, efficiency calculation and their various characteristics.

Text Books:

1. PS Bimbhra, "Electrical Machinery", Khanna Publishers.

Reference Books:

1. George Mcphersion ,"An Introduction to Electrical Machines and Transformers", John Wiley and Sons, NY
2. BL Theraja, A textbook of electrical technology, Volume- II, S.Chand and Company. LTD.
3. Nagrath and Kothari, "Electric Machines", Tata McGraw Hill.
4. MG Say, Theory, Performance and Design of AC Machines, CBS Publishers.
5. Clayton. A.E., "Performance and Design of Direct Current Machines" UBS Publishers.
6. Irving L. and Kosow, "Electric Machinery and Transformers", PHI

Faculty of Engineering and Technology
B.Tech. in Electrical Engineering – Semester III
Contact Hrs per week (L-T-P): 3-0-0

Course Outlines
BEL003A- Measurements and Instruments

OBJECTIVES:

- To introduce the students to the standards which are available for measurement of different physical quantities.
- To introduce the students to the instruments which are available for measurement of different physical quantities.

Unit 1: **Units, Standards and Errors**: S.I. units, Absolute standards (International, Primary, and Secondary Standards), True Value, Errors (Gross, Systematic, Random); Static Characteristic of Instruments (Accuracy, Precision, Sensitivity, Resolution and threshold). Generalized Instrument (Block diagram, description of blocks), three forces in Electromechanical indicating instrument (Deflecting, controlling and damping forces), Comparison between gravity and spring controls; Comparison of damping methods and their suitability, bearing supports, pivot-less supports (Simple and taut-band), Scale information, Instrument cases or Covers.

Unit 2: **Measuring System Fundamentals**: Classification of Instruments (Absolute and Secondary Instruments; Indicating, Recording and Integrating instruments; Based upon Principle of operation),
Measuring Instruments: Construction, operating principle, Torque equation, Shape of scale, applications, Use on AC/DC or both, Advantages and disadvantages, Errors of PMMC types, Moving iron type (attraction and repulsion).

Unit 3: **Wattmeters And Energy Meters:** Construction, operating principle, Torque equation, Shape of scale, Errors, Advantages and Disadvantages of Induction type Wattmeters; and single phase induction type Energy meter, Compensation and creep in energy meter.
Power Factor And Frequency Meters: Construction, operation, principle, Torque equation, Advantages and disadvantages of Single phase power factor meters (Electrodynamic and Moving Iron types) and Frequency meters (Electrical Resonance Type).

Unit 4: **Low And High Resistance Measurements**: Introduction, sensitivity and limitations of Wheatstone bridge; Kelvin's double bridge method, Difficulties in high resistance measurements, Measurement of high resistance by direct deflection, loss of charge method, Megohm bridge and Megger.

Unit 5: **AC Bridges**: General balance equation, circuit diagram, Phasor diagram, Advantages, disadvantages, applications of Maxwell's inductance, inductance-capacitance, Hays, Anderson, Owens, De-Sauty's, Schering and Wien's bridges.

OUTCOMES:

- Students can now select different instruments (based on type, range and accuracy) to measure different physical quantities.
- Also they can compare different instruments to ascertain which is best for a particular condition and requirement.

Text Books:

1. A.K. Sawhney, "Electrical and Electronic Measurement and Instrument", Dhanpat Rai and Sons

Reference Books:

1. Rajendra Prasad, "Electrical Measurement and Measuring Instrument" Khanna Publications.
2. EW Golding and F.C. Widdis, "Electrical Measurement and Measuring Instrument", AH Wheeler and Co. India.
3. Forest K. Harries,"Electrical Measurement",Willey Eastern Pvt. Ltd. India .
4. M.B. Stout ,"Basic Electrical Measurement" Prentice hall of India.
5. W.D. Cooper," Electronic Instrument & Measurement Technique " Prentice Hall International.

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Course Outlines
BEL004A- Network Analysis and Synthesis

OBJECTIVES:

- The objective is to familiarize the students with electric circuits and to make them learn to solve them.

Unit 1: **Introduction:** Introduction to circuit elements and their characteristics. Response of single element, double element and triple element circuits. Resonance, selectivity and Q-factor in AC circuits.

Unit 2: **Poly phase Circuits:** Power and Reactive Volt-Amperes in a 3-Phase System. Power in AC Circuits, Apparent Power, Reactive Power, Power Triangle, Complex Power. Power Factor.

Unit 3: **Non-Sinusoidal Waves:** Complex Periodic Waves and Their Analysis by Fourier Series. Different kinds of Symmetry; Determination of Coefficients. Average and Effective values of a Non-Sinusoidal Wave;

Unit 4: **Power in a Circuit of Non-Sinusoidal Waves**: Power in a Circuit of Non-Sinusoidal Waves of Current and Voltage, Form Factor, Equivalent Sinusoidal Wave and Equivalent Power Factor. Response of Linear Networks to Non-Sinusoidal Periodic Waves.

Unit 5: **Time Domain and Frequency Domain Analysis:** Response of networks to step, ramp, impulse, pulse and sinusoidal inputs. Time domain and frequency domain analysis of circuits. Shifting theorem, initial and final value theorems. Special signal waveforms with Laplace transforms & their applications to circuit analysis.

OUTCOMES:

- Students can now apply the knowledge of circuit theorems to solve the electrical problems.

Text Books:

1. Ravish R Singh "Network analysis and synthesis" Mc Graw Hill Education.

Reference Books:

1. B.R.Gupta and Vandana Singhal-Fundamentals of electrical Networks, Wheeler's Pub.
2. K.A Gangadhar-Circuit theory.
3. J Edminster and M.Nahvi: Theory and Problems of electric circuits, Schaum's series.
4. Hayt and Kemmerly: Engineering circuit Analysis, TMH
5. Van Valkenegburg-Network Analysis.

Faculty of Engineering and Technology

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Course Outlines

BAS003A-Multivariate Analysis, Linear Algebra and Special Functions

OBJECTIVES:

- This course aims at providing the necessary basic concepts of a few numerical methods and give procedures for solving numerically different kinds of problems occurring in engineering and technology.

Unit 1: Multivariable functions, limits, continuity and differentiability, partial derivatives, maximum-minimum problems, Lagrange Multiplier, triple integrals.

Unit 2: Vectors covering, laws of vector algebra, operations- dot, cross, triple products; Vector function – limits, continuity and derivatives, geometric interpretation; Gradient, divergence and curl – formulae.

Unit 3: Line integrals, simple connected regions, Green's theorem; Path independence, surface integrals, Stokes theorem; Fourier series and integral, Dirichlet conditions, Parseval's identity. The convolution theorem.

Unit 4: Orthogonal curvilinear coordinates; Jacobians, Laplacian in curvilinear coordinates; Special curvilinear coordinates.

Unit 5: Gama Beta and other Special Functions: the Gama function, values and graph, asymptotic formula for T(n)l The Beta function – Dirichlet integral; Other special functions – Error function, exponential integral, sine and cosine integrals, Bessel's differential equation and function (first and second kind), Legendre differential equation and polynomials; Some applications.

OUTCOMES:

- The students will have a clear perception of the power of numerical techniques, ideas and would be able to demonstrate the applications of these techniques to problems drawn from industry, management and other engineering fields.

Text Books:

1. Advance Engineering Mathematics by Erwin Kreyszig, Wiley India.

Reference Book:

1. Advance Engineering Mathematics by H.K Das, S.Chand.
2. Higher Engineering Mathematics by B.V Ramana, MGH.

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Course Outlines
BEE008A Electronic Devices and Systems

OBJECTIVES:

- To study the basic concepts, working and utility of electronic devices such as transistors, OPAMPs.
- Basic concepts of digital electronics such as Logic gates and its families, sequential circuits and A/D and D/A converters.

Analog*:*
Unit 1: **Transistor biasing circuits:** CE, CC and CB amplifiers, Darlington amplifier. H-parameters and their application in analysis. Class A, B, C and D amplifiers.

Unit 2: **OP-AMP:** OP-AMP, Differential amplifier and its DC, AC analysis, OP-AMP characteristics, Non-Inverting/Inverting Voltage and Current feedback. Regulated power supplies; Oscillators.

Digital*:*
Unit 3: **Logic gates and Logic Families:** Logic gates, Universal gates, transistor as a switching element, Combinational Logic gates, arithmetic and logical operation, design of Half adder and full adder, subtract or circuits, parity generator and checker, code converter, decoders, multiplexers, demultiplexers, comparators.

*Unit 4****:*** **Sequential Circuits**- Flip-flops, bi-stable circuits: RS, JK, D, T, Master/Slave Flip-flop, race around condition, latches, synchronous and asynchronous counters up and down counters, shift registers, state transition diagram.

*Unit 5****:*** **A/D and D/A Converters**- D/A converter, accuracy, resolution and precision, variable resistor network, binary ladder, A/D converter, accuracy and resolution, simultaneous conversion, counter method, continuous A/D converter, dual slope, successive approximation method.

OUTCOMES:

- Students can now apply the knowledge of analog and digital circuits and components to make different projects.

Text Books:
Analog:

1. S.Salivahanan, NS Kumar, A Vallavaraj "Electronic Devices & circuits" Vikas Pub house.

Digital:

1. Digital Design – Morris Mano, PHI, 3rd Edition, 2006.

Reference Books:
Analog:

1. Millman and Halkias, "Integrated Electronics", Mc Graw Hill.
2. R. Boylested and L. Nashelsky, "Electronics Devices and Circuits", Prentice Hall India.
3. Millman and Halkias, "Electronics Devices and Circuits", TMH Edition.
4. Malvino, "Electronics Principles", TMH Edition.

Digital:

1. RP Jain, "Modern Electronics" TMH
2. AP Malvino and DP Leach, "Digital Principles and applications".
3. H. Taub and D. Schilling, "Digital Integrated Electronics".

Faculty of Engineering and Technology
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Contact Hrs per week (L-T-P): 0-0-2

Course Outlines
BEL005A Basic Programming and Simulation Lab

OBJECTIVES:

- To expose the students to learn programming and simulation on MATLAB / Sci Lab software.

List of experiments (Perform any 12):

1. Introduction to simulation software for e.g. MATLAB, Sci Lab, including its installation, applications, opening of software, extensions used for programming and simulation, storage of file in hard disk, heaviness of file, saving and running the files, role of different colours reflected in programs, error identification and rectification etc.
2. To learn and calculate the results using different mathematical functions in command window.
3. Write a program to calculate the area of triangle and rectangle using definite input values in the program made in editor window.
4. Write a program to calculate the area of triangle and rectangle using input values from command window.
5. Write a program using the knowledge of DC machine in such a manner that there is graphical output plotting between two parameters of DC machine (for e.g. speed control of DC machine), thereby learning graphic window functions.
6. Write a program to calculate the efficiency of the transformer using the knowledge of open circuit and short circuit test.

7. Simulate using MATLAB software to learn the application of different mathematical blocks.
8. Simulate using MATLAB software to learn the application of different control system blocks.
9. Simulate using MATLAB software to learn the application of different measurement blocks.
10. Simulate half wave rectifier (uncontrolled) using MATLAB software with R Load.
11. Simulate half wave rectifier (controlled) using MATLAB software with R Load.
12. Simulate half wave rectifier (uncontrolled) using MATLAB software with RL Load.
13. Simulate half wave rectifier (controlled) using MATLAB software with RL Load.
14. Simulate half wave rectifier (uncontrolled) using MATLAB software with RLC Load.
15. Simulate half wave rectifier (controlled) using MATLAB software with RLC Load.

OUTCOMES:

- Students can now use programming skills to get output on any mathematical objective function.
- They can also simulate the electric circuit by connecting different components and tools available in different block sets.

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Contact Hrs per week (L-T-P): 0-0-2

Course Outlines
BEL006A- Measurements and Instruments Lab

OBJECTIVES:

- To introduce the basic functional elements of instrumentation and to learn the comparison between various measurements techniques and display devices.

List of Experiments (Perform any 12):

1. To perform the working of CRO and to learn to take readings of frequency, unknown voltage etc using divisions method and using plotting paper method.
2. To perform the working of a) Megger to calculate unknown high resistance, b) Tong-tester to calculate unknown and c) pf meter to calculate unknown pf.
3. To perform the working of single phase energy meter and take readings at unknown load.
4. To measure power and power factor by three voltmeter method.
5. To measure power and power factor by three ammeter method.
6. To calibrate an ammeter using DC slide wire potentiometer.
7. To calibrate a voltmeter using Crompton potentiometer.
8. To measure low resistance by Crompton potentiometer.
9. To measure Low resistance by Kelvin's double bridge.
10. To measure earth resistance using fall of potential method.
11. To measure resistance using Wheatstone bridge.
12. To measure inductance by Maxwell’s bridge.
13. To measure unknown inductance by Hay’s bridge.
14. To measure self-inductance using Anderson's bridge.
15. To measure capacitance using De Sauty Bridge.
16. To measure frequency using Wien’s bridge.
17. To measure frequency using vibrating reed type frequency meter.

OUTCOMES:

- Students can now use the above instruments to measure unknown quantity or verify the given known physical quantity.

Faculty of Engineering and Technology

B.Tech. in Electrical Engineering – Semester III

Contact Hrs per week (L-T-P): 0-0-2

Course Outlines

BEL007A- Electrical Machines Lab I

OBJECTIVES:

- To expose the students to the operation of DC machines and transformers and give them experimental skill.

List of Experiments (Perform any 12):

1. To separate hysteresis and eddy current losses of a single phase transformer at rated voltage, frequency by conducting no load tests at different frequencies keeping V/f constant.
2. To operate two single phase transformers of different kVA ratings in parallel and plot the variation of currents shared by each transformer versus load current.
3. To conduct Sumpner's test on two identical single phase transformers and determine their efficiency at various loads.
4. To perform direct load test on a DC shunt motor and plot variation of (a) Input current (b) Speed(c) Torque (d) Efficiency versus output power.
5. To obtain magnetization characteristics of a DC machine and hence estimate field circuit resistance of a DC shunt generator at rated speed.
6. To obtain magnetization characteristics of a DC machine and hence measure field winding and armature winding resistance.
7. To obtain magnetization characteristics of a DC machine and hence plot the external characteristics of DC shunt generator.
8. To make SCOTT connection of two single phase transformer and to verify the current relation by drawing phasor diagrams for balanced resistive loads.
9. To make SCOTT connection of two single phase transformer and to verify the current relation by drawing phasor diagrams for unbalanced resistive loads.
10. To conduct open circuit and short circuit test on a three phase three winding transformer and determine the equivalent circuit parameters
11. To conduct direct load test on a DC compound generator with shunt field.
12. To conduct load test on a cross field machine for different degrees of compensation and plot the variation of terminal voltage versus load current.
13. To conduct direct load test on a DC compound generator with cumulative and differential compounding for short and long shunt connections.
14. To determine the efficiency of two identical DC Machines by Hopkinson's regenerative test.
15. Speed control of DC shunt motor by:

(a) Flux control method and plot the curve for speed Vs field current.

(b) Armature voltage control method and plot the curve for speed Vs armature voltage.

16. To determine the efficiency of DC Shunt motor by Swinburne's method.
17. To perform open circuit and short circuit test on a single phase transformer and to determine the parameters of its equivalent circuit and hence calculate the voltage regulation and efficiency.
18. Speed control of a DC Motor by Ward Leonard method and to plot the curve for speed Vs applied armature voltage.

OUTCOMES:

- Students can now analyze the efficiency and characteristics of different electrical machines.

B.Tech. in Electrical Engineering – Semester III
Contact Hrs per week (L-T-P):3-0-0

Course Outlines

BMC009A- Energy Studies

OBJECTIVES:

- To know how various energy sources (renewable and nonrenewable) are generated and to enhance their contribution to the socio-economic development.
- Awareness of different treaties, energy scenario and Energy policy related to India.

Unit 1: Energy Sources - Fossil fuels, Nuclear fuels, hydel, solar, wind and bio fuels in India, Energy conservation, Nuclear energy through fission and fusion processes.

Unit 2: Energy Conversion- Energy conversion from source to utility, Solar, Nuclear, Geothermal, Tide and Wind Energies.

Unit 3: Global Energy Scenario- Role of energy in economic development and social transformation, Overall energy demand, availability and consumption, Depletion of energy resources and its impact on economy, Non proliferation of nuclear energy. International energy policies of G-8, G-20, OPEC and European Union Countries.

Unit 4: Indian Energy Scenario- Commercial and non-commercial forms of energy, Utilization pattern in the past, present and also future prediction, Sector wise energy consumption.

Unit 5: Energy Policy: Energy policy issues at global level, national level and state level, Energy conservation act 2001, Electricity act 2003, Energy pricing and its impact on global variations.

OUTCOMES:

- Knowing the various generation processes, energy demand and energy policy; everyone is more inclined to energy conservation and can contact different government agencies for energy projects.

Text Books:

1. B.H.Khan, "Non Conventional Energy Resources" TMH.

Reference Book:

1. Bukhootsow, B., Energy Policy and Planning, PHI New Delhi, 2003.
2. Dr.A.N Mathur-Non Conventional resources of Energy.
3. International Energy Outlook, EIA Annual Publication, 2011.
4. Charles E. Brown, World Energy Resources, Springer Publication, New York, 2002.
5. Culp, A.W., Principles of Energy Conversion, McGraw Hill New York, 2004.

Faculty of Engineering and Technology

B.Tech. in Electrical Engineering – Semester IV
Contact Hrs per week (L-T-P): 3-1-0

Course Outlines

BEL009A- Power Electronics

OBJECTIVES:

- To be familiar with the working, characteristics and applications of different power electronic devices.

Unit 1: **Basic power electronics devices:** Characteristics and switching behaviour of different solid-state devices namely Power Diode, SCR, UJT, TRIAC, DIAC, GTO, MOSFET, IGBT, MCT and power transistor. Two-transistor analogy of SCR, Firing circuits of SCR and TRIAC, SCR gate characteristics,

Unit 2: **SCR***:* SCR ratings. Protection of SCR against over current, over voltage, high d*v*/dt, high d*i*/dt. Thermal protection, methods of commutation. Series and Parallel operation of SCR.

Unit 3: **Rectifier:** Classification of rectifiers, Phase controlled rectifiers: Single phase half wave controlled. Fully controlled and half controlled rectifiers and their performance parameters.

Unit 4: **Three phase rectifiers:** Three phase half wave, full wave and half controlled rectifiers and their performance parameters. Effect of source impedance on the performance of single phase and three phase controlled rectifiers. Single-phase and three phase Dual Converter.

Unit 5: **Choppers:** Introduction of choppers, principle of operation of choppers, classification of choppers (type A chopper, type B chopper, type C chopper and type D chopper,) and applications of choppers.

OUTCOMES:

- Students can now apply the knowledge of working of different power electronic devices to control electrical and electronic systems.

Text Books:

1. PS Bhimbra. “Power Electronics”, Khanna Publishers.

Reference Book:

1. AK Gupta and LP Singh, “Power Electronics”, Dhanpat Rai Publishing Co.
2. Rama Reddy, “Fundamental of Power Electronics”, Narosa Publishing.
3. MD Singh and KB Khanchandani, “Power Electronics” TMH Edition.
4. G.K. Dubey and C.R. Kasarbada “Power Electronics and Drives”, Tata McGraw-Hill

Faculty of Engineering and Technology
B.Tech. in Electrical Engineering – Semester IV
Contact Hrs per week (L-T-P): 3-1-0

Course Outlines

BEL010A- Electrical Machines II

OBJECTIVES:

- To study the working principles of electrical machines using the concepts of electromechanical energy conversion principles.
- Derive expressions for generated voltage and torque developed in various AC Machines.

Unit 1: **Basic concepts of Electrical Machines**-Winding factors, generated emf, mmf of distributed AC winding, rotating magnetic field.

Unit 2: **Induction Machines**- (a) Constructional features, production of torque, phasor diagram, equivalent circuit, performance analysis, torque-slip characteristics. (b) Testing-Running light and blocked rotor test, load test. (c) Effect of rotor resistance, deep bar and double cage induction motor. (d) Generator Operation (e) Starting- Starting methods of squirrel cage and wound rotor induction motor. (f) Speed Control- Various methods of speed control of squirrel cage and wound rotor induction motor. (g) Effects of space harmonics.

Unit 3: **Single phase Induction Motors**- Constructional features, double revolving field theory, equivalent circuit, determination of parameters. Split phase starting methods and applications.

Unit 4: **Synchronous Machines**- (a) Constructional features. (b) Cylindrical rotor machine-I) Synchronous Generator- Generated emf, circuit model and phasor diagram, armature reaction, synchronous impedance, voltage regulation and different methods for its estimation. II) Synchronous Motor- Operating principle, circuit model, phasor diagram, effect of load. III) Operating characteristics of synchronous machines, V-curves, starting methods of synchronous motors.

Unit 5: **Salient pole Machine**- Two reaction theory, analysis of phasor diagram, power angle characteristics, determination of X_d and X_q. Parallel operation of Alternators-Synchronization and load division.

OUTCOMES:

- Students can now apply the knowledge of AC machines in testing them for the study of speed control, efficiency calculation and their various characteristics.

Text Books:

1. PS Bhimbra, "Electrical Machinery", Khanna Publishers.

Reference Book:

1. Nagrath and Kothari," Electric Machines" TMH
2. BL Theraja, A textbook of electrical technology, Vol-II, S.Chand & Co. LTD.
3. Fitzgerald and Kingsley, "Electric Machinery" McGraw Hill
4. Alexander S. Langsdorf, "AC Machines", Tata McGraw Hill.
5. MG Say, "Theory Performance and Design of AC Machines" CBS Publisher

Faculty of Engineering and Technology

B.Tech. in Electrical Engineering – Semester IV

Contact Hrs per week (L-T-P): 3-1-0

Course Outlines

BCO009A-Computer Organization and Design

OBJECTIVES:

- To understand the combinational and sequential logical circuits, basics of assembly language, and main concepts of computer architecture.
- Design and analysis of the main functional units of a computer.

Unit 1: **Basic organization**: Basic organization of computers, Block level description of the functional units as related to the execution of a program; Fetch, decode and execute cycle.

Unit 2: **Machine instructions**: Machine instructions, Instruction set architectures, Assembly language programming, addressing modes, instruction cycles, registers and storage, addressing modes; discussions about RISC versus CISC architectures.

Unit 3: **Information representation**: Introduction to Information representation, Floating point representation (IEEE 754), computer arithmetic and their implementation; Fixed-Point Arithmetic: Addition, Subtraction, Multiplication and Division, Arithmetic Logic Units control and data path, data path components, design of ALU and data path, controller design; Hardwired and Micro programmed Control.

Unit 4: **Memory Technology**: Memory Technology, static and dynamic memory, Random Access and Serial Access Memories, Cache memory and Memory Hierarchy, Address Mapping, Cache updation schemes, Virtual memory and memory management unit.

Unit 5: **I/O subsystems**: Input-Output devices such as Disk, CD-ROM, Printer etc.; Interfacing with IO devices, keyboard and display interfaces; Basic concepts Bus Control, Read Write operations, Programmed IO, Concept of handshaking, Polled and Interrupt-driven I/O, DMA data transfer.

OUTCOMES: After completing this course the student must demonstrate the knowledge and ability to:

- Describe the basic structure and operation of digital computers
- Design of arithmetic and logic unit and implementation of fixed point and flouting point arithmetic operation.
- Understand the two types of control unit techniques and concept of pipelining.
- Use the concept of hierarchical memory system including cache memory and virtual memory.

Text Book:

1. Computer Organization by V. Carl Hamacher, Safwat G. Zaky and Zvonko G. Vranesic , McGraw-Hill series (2002)

Reference Books:

1. Computer Organization and Design, by David Patterson and John Hennessey," Elsevier. 2008.
2. Computer System Architecture by Mano, M.M., Prentice Hall of India, New Delhi, 1992
3. Computer Systems Design and Architecture (2nd Edition) by Vincent P. Heuring and Harry F. Jordan (Dec 6, 2003)
4. Computer Architecture and Organization, by Hayes, J.P.1998, McGraw-Hill

Faculty of Engineering and Technology

B.Tech. in Electrical Engineering – Semester IV

Contact Hrs per week (L-T-P): 3-0-0

Course Outlines
BES019A Basic Thermodynamics

OBJECTIVES:

- To familiarize the students with different laws of thermodynamics and their applications.

Unit 1: **Introduction**- Basic Concepts: System, Control Volume, Surrounding, Boundaries, Universe, Types of Systems, Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic Equilibrium, State, Property, Process, Exact & Inexact Differentials, Cycle – Reversibility – Quasi – static Process, Irreversible Process, Causes of Irreversibility – Energy in State and in Transition, Types, Displacement & Other forms of Work and Heat, Point and Path functions, Zeroth Law of Thermodynamics – Concept of quality of Temperature – Principles of Thermometry –Reference Points – Constant Volume gas Thermometer – Scales of Temperature, Ideal Gas Scale.

Unit 2: **PMM I** - Joule's Experiments – First law of Thermodynamics – Corollaries – First law applied to a Process –applied to a flow system – Steady Flow Energy Equation. Limitations of the First Law – Thermal Reservoir, Heat Engine, Heat pump, Parameters of performance, Second Law of Thermodynamics, Kelvin-Planck and Clausius Statements and their Equivalence / Corollaries, PMM of Second kind, Carnot's principle, Carnot cycle and its specialties, Thermodynamic scale of Temperature, Clausius Inequality, Entropy, Principle of Entropy Increase – Energy Equation, Availability and Irreversibility – Thermodynamic Potentials, Gibbs and Helmholtz Functions, Maxwell Relations –Elementary Treatment of the Third Law of Thermodynamics.

Unit 3: Pure Substances, p-V-T- surfaces, T-S and h-s diagrams, Mollier Charts, Phase Transformations – Triple point at critical state, properties during change of phase, Dryness Fraction – Clausius Clapeyron Equation, Property tables. Mollier charts – Various Thermodynamic processes and energy Transfer – Steam Calorimetry. Perfect Gas Laws – Equation of State, specific and Universal Gas constants – various Non-flow processes, properties, end states, Heat and Work Transfer, changes in Internal Energy – Throttling and Free Expansion Processes – Flow processes.

Unit 4: Deviations from perfect Gas Model – Vander Waals Equation of State –Compressibility charts – variable specific Heats – Gas Tables. Mixtures of perfect Gases – Mole Fraction, Mass Fraction, Gravimetric and Volumetric Analysis – Dalton's Law of partial pressures, Avogadro's Laws of additive volumes – Mole fraction , Volume fraction and partial pressure, Equivalent Gas constant and Molecular Internal Energy, Enthalpy, Specific Heats and Entropy of Mixture of Perfect Gases and Vapour, Atmospheric air - Psychometric Properties – Dry Bulb Temperature, Wet Bulb Temperature, Dew point Temperature, Thermodynamic Wet Bulb Temperature, Specific Humidity, Relative Humidity, Saturated Air, Vapour pressure, Degree of saturation – Adiabatic Saturation, Carrier's Equation – Psychrometric chart.

Unit 5: Power Cycles- Otto, Diesel, Dual Combustion cycles, Sterling Cycle, Atkinson Cycle, Ericsson Cycle, Joule Cycle – Description and representation on P–V and T-S diagram, Thermal Efficiency, Mean Effective Pressures on Air standard basis – comparison of Cycles. Refrigeration Cycles- Brayton and Rankine cycles – Performance Evaluation – combined cycles, Bell-Coleman cycle, Vapour compression cycle-performance Evaluation.

OUTCOMES:

- Students can now apply the knowledge for model making where thermodynamics concepts are used with the help of different associated laws and cycles.

Text Books:

1. Engineering Thermodynamics / PK Nag /TMH, 4th Edition, 2008.

Reference Book:

1. Fundamentals of Thermodynamics - Sonntag, Borgnakke and Van Wylen - John Wiley 2010.
2. Thermodynamics – An Engineering Approach – Yunus Cengel and Boles/TMH, New Delhi 2008.
3. Fundamentals of Engineering Thermodynamics, P. Yadav, Central Publishing, Allahabad, 2009.

Faculty of Engineering and Technology

B.Tech. in Electrical Engineering – Semester IV

Contact Hrs per week (L-T-P): 2-0-0

Course Outlines
BAS005A-Complex Analysis

OBJECTIVES:

- This course aims at providing the necessary basic concepts of a few numerical methods and give procedures for solving numerically different kinds of problems occurring in engineering and technology.

Unit 1: Complex Analysis including limits and continuity, derivatives; Analytic Functions; Cauchy Riemann Equations; Integrals, Cauchy theorem and Cauchy integral formulae; Taylor's series.

Unit 2: Singular points and poles; Laurent's Series, Residues, Residue Theorem.

Unit 3: Evaluation of definite integrals, Conformal mapping, Riemann's mapping theorem; Some general transformations, mapping a half plane into a circle; The Schwarz- Christoffel transformation; The solution of Laplace equation by conformal mapping.

Unit 4: The complex inverse formula, the Bromwich contour, the use of Residue theorem in finding Laplace transforms; A sufficient condition for the integral around T to approach zero; The case of infinitely many singularities.

Unit 5: Analytic Continuation, Application to boundary value problems.

OUTCOMES:

- The students will have a clear perception of the power of numerical techniques, ideas and would be able to demonstrate the applications of these techniques to problems drawn from industry, management and other engineering fields.

Text Books:

1. Advance Engineering Mathematics by Erwin Kreyszig, Wiley India.

Reference Book:

1. Advance Engineering Mathematics by H.K Das, S.Chand.
2. Higher Engineering Mathematics by B.V Ramana, MGH.

Faculty of Engineering and Technology

B.Tech. in Electrical Engineering – Semester IV

Contact Hrs per week (L-T-P): 3-0-0

Course Outlines
BES011A Materials Science

OBJECTIVES:

- Materials Engineers are experts on the entire life cycle of materials, including recovery of materials from minerals, making engineered materials, manufacturing materials into products, understanding and evaluating materials performance, proper disposal and recycling of materials, and evaluating societal and economic benefits.

Unit 1: Crystal Structure covering, Atomic structure and inter-atomic bonding; Structure of crystalline solids; Lattices, unit cells; Crystal systems, Bravais lattices; Indexing of directions and planes, notations, Inter-planar spacings and angles, co- ordination number, packing factors;

Unit 2: Defects in Crystals covering, Point defects; Dislocations, Types of dislocations, Burgers vector and its representation; Planar defects, stacking faults, twins, grain boundaries;

Unit 3: Ceramic Materials covering, Introduction, ceramic structures, silicate structures, processing of ceramics; Properties, glasses; Composite Materials- Introduction, classification, concrete, metal-matrix and ceramic –matrix composites; Electrical & Electronic Properties of Materials: Electrical Conductivity, Electronic and Ionic Conductivity, Intrinsic and Extrinsic Semi conductivity, Semiconductor Devices, Dielectric Properties, Piezo-electricity.

Unit 4: Mechanical Properties of Materials covering, Concepts of stress and strain, Stress-Strain diagrams; Properties obtained from the tensile test; Elastic deformation, Plastic deformation. Impact Properties, Strain rate effects and Impact behaviour. Hardness of materials;

Unit 5: Magnetic Materials covering, Introduction, Magnetic fields or quantities, types of magnetism, classification of magnetic materials, soft magnetic materials, H magnetic materials, Ferrites, Ferro, Para Magnetic materials; Nano Materials covering, Introduction – Nano material preparation, purification, sintering nano particles of Alumina and Zirconia, Silicon carbide, nano-op, nano-magnetic, nano-electronic, and other important nano materials.

OUTCOMES:

- Students will be able to apply core concepts to solve engineering problems knowledgeable of contemporary issues relevant to Materials Science and Engineering.
- They will be able to select materials for design and construction.

Text Books:

1. Krishnamoorthy, C.S- Material Science and Metallurgy- Dhanpat Rai

Reference Book:

1. Gottstein, G - Physical Foundations of Material Science – Springer
2. Yesudian, C Daniel - Materials Science and Metallurgy - Scitech Publications
3. Raghavan, V. - Materials Science & Engineering - Phi Learing Pvt ltd.
4. Sharma, Dr. Ashish dutt - Material Science and Engineering - Vardhman Pubilcation.

Faculty of Engineering and Technology

B.Tech. in Electrical Engineering – Semester IV

Contact Hrs per week (L-T-P): 3-0-0

Course Outlines
BAS006A-Probability and Statistics

OBJECTIVES:

- This course aims at providing the necessary basic concepts of probability and statistics to give procedures for solving numerically different kinds of problems occurring in engineering and technology.

Unit 1: Mathematical Statistics, Sample space, Events, Random Variables; Definitions of probability, conditional Probability, expectation and higher order moments, distributions (pdf), examples of (discrete and continuous).

Unit 2: Normal, Poisson, Binomial distributions. Characteristic functions (mean and standard deviation); *Correlation and Regression*, Curve Fitting (Linear, Parabolic and Exponential).

*Unit 3:*OLS (single and multivariate cases), Estimators and their properties (unbiased, consistent), Gauss-Markov Theorem; Limitations of OLS- Hetero-sckedasticity, multi-collinearity; Limit theorems and convergence of random variables.

Unit 4: Sampling Theory, Hypothesis testing, Types of Error, Power of a test, Goodness of a fit, Student t and Chi square; Sufficient Statistic and MLEs; *(10 Lectures)*

Unit 5: Limit theorems and convergence of random variables; Elementary concepts related to stochastic processes; Forecasting and Modeling applications.

OUTCOMES:

- The students will have a clear perception of the power of probability and statistics, ideas and would be able to demonstrate the applications of these techniques to problems drawn from industry, management and other engineering fields.

Text Books:

1. Advance Engineering Mathematics by Erwin Kreyszig, Wiley India.

Reference Book:

1. Advance Engineering Mathematics by H.K Das, S.Chand.
2. Higher Engineering Mathematics by B.V Ramana, MGH.

Faculty of Engineering and Technology
B.Tech. in Electrical Engineering – Semester IV
Contact Hrs per week (L-T-P): 0-0-2

Course Outlines
BEL011A Power Electronics Lab

OBJECTIVES:

- To enable the students to verify the behavior of power electronics devices based on experimentation.

List of Experiments (Perform any 12):

1. To perform the comparison of following power electronics devices regarding ratings, performance characteristics and applications: Power Diode, Power Transistor, Thyristor, DIAC, TRIAC, GTO, MOSFET, MCT and SIT.
2. To plot V-I characteristics of SCR and measure forward breakdown voltage, latching and holding currents.
3. To plot the V-I characteristics of TRIAC and DIAC.
4. To draw output characteristics of MOSFET and IGBT.
5. To draw transfer characteristics of MOSFET and IGBT.
6. To draw UJT static emitter characteristics and study the variation in peak point and valley point.
7. To test firing circuits for SCR-R, RC and UJT firing circuits.
8. To test three phase diode bridge rectifier with R and RL loads.
9. To obtain waveforms of single-phase half wave controlled rectifier with and without Filters and also find the variation of output voltage with respect to firing angle.
10. To obtain waveforms of single-phase half controlled bridge rectifier with R and RL loads. To test the effect of freewheeling diode.
11. To obtain waveforms of single-phase full controlled bridge converter with R and RL loads.

12. To perform the rectification and inversion operations on single-phase full controlled bridge converter with R and RL loads with and without a freewheeling diode.
13. To control the speed of a DC motor using single-phase half controlled bridge rectifier and full controlled bridge rectifier and plot armature voltage versus speed characteristics.
14. To perform the forced commutation circuits of SCR.
15. To perform the experiment on protection circuits of SCR: (i) d*v*/dt (ii) d*i*/dt (iii) Over voltage (iv) Over current.
16. To perform the firing circuit of SCR using ramp-comparator scheme.
17. To perform the firing circuit of SCR using cosine-wave scheme.
18. To perform the firing circuit of SCR using Op-amps and Gates.
19. To perform the digital firing circuit of SCR.

OUTCOMES:

- Students can now compare the effect of different power electronic devices on the basis of their applications and performance characteristics.

Faculty of Engineering and Technology
B.Tech. in Electrical Engineering – Semester IV
Contact Hrs per week (L-T-P): 0-0-2

Course Outlines
BEL012A- Electrical Machines Lab II

OBJECTIVES:

- To expose the students to the operation of transformers, synchronous machines and induction motors and give them experimental skill.

List of Experiments (Perform any 12):

1. Separation of transformer core losses and to determine the hysteresis and eddy current losses at rated voltage and frequency.
2. To plot the OCC and SCC of an alternator and to determine its regulation by synchronous impedance method.
3. To synchronize an alternator across the infinite bus (RSEB) and summarize the effects of variation of excitation on load sharing.
4. To plot the V-curve for a synchronous motor for different values of loads.
5. To perform Sumpner's back-to-back test on 3 phase transformers, find its efficiency & parameters for its equivalent circuits.
6. To perform the heat run test on a delta/delta connected 3-phase transformer and determine the parameters for its equivalent circuit.
7. To perform no load and blocked rotor test on a 3 phase induction motor and to determine the parameters of its equivalent circuits. Draw the circle diagram and compute the following (i) Max. Torque (ii) Current (iii) slip (iv) p.f (v) Efficiency.
8. To perform the load test on a 3-phase induction motor and determine its performance characteristics (a) Speed vs load curve (b) p.f Vs load curve (c) Efficiency Vs load curve (d) Speed Vs torque curve
9. Determination of losses and efficiency of an alternator.
10. To find Xd and Xq of a salient pole synchronous machine by slip test.
11. To conduct running light test on a three phase squirrel cage induction motor and measure and plot input current, power, power factor at different values of applied voltage.

12. Draw complete equivalent circuit of the three phase squirrel cage induction motor and compute the performance at rated voltage and at a slip of 5 %.
13. To conduct direct load test on a three phase squirrel cage induction motor and measure and plot input current, torque, power factor, speed efficiency against output power.
14. To run a slip ring induction motor with variable rotor resistance and plot speed versus external resistance.
15. To run a slip ring induction motor with variable rotor resistance and plot braking time versus external resistance.
16. To determine the resistance of squirrel cage induction motor by performing variable frequency test.
17. To run a three phase Schharge motor plots the variation of (a) Injected voltage versus brush separation. (b) No load speed versus brush separation. (c) No load speed versus injected voltage.
18. To run the induction motor as a SEIG (separately excited induction generator) and plot the variation of terminal voltage with speed, frequency with speed at different excitation capacitance.

OUTCOMES:

- Students can now analyze the efficiency and characteristics of different electrical machines.

Faculty of Engineering and Technology
B.Tech. in Electrical Engineering – Semester IV
Contact Hrs per week (L-T-P): 0-0-2

Course Outlines
BCO0072A Web designing techniques Lab

OBJECTIVES:

- To familiarize the students with the website designing techniques with the help of HTML, CSS and javascript.
- Introduction to PHP.

List of Experiments (Perform any 12)

1. Introduction of various tags of HTML.

(i) Create a webpage using textbox, radio button, and drop down list, button and label.

(ii) Create your resume by using the different HTML table tags, hyperlink and other tags. Add a page to show your academics in a table and add a page containing 5 links to your favourite website.

2. Create a webpage same as the GMAIL registration page, by using the various tags of HTML.
3. Create a website by using the different HTML tags.
4. Create webpages in which Cascading Style Sheet is used.
5. Create a HTML page by using CSS, which shows how to position a background image.
6. Create a CSS in which all the font properties are in one declaration.
7. Create a "Contact Me" page - Ask user to enter his name, email ID, Use Java-Script to verify entered email address.
8. Explain for and while loop using javascript.
9. Write a java script code for the string introduction.
10. Write a java script code for calculating the length of the string.
11. Write a java script code for ON/OFF mouse over event.

12. Write a program to create a calculator, which can support add, subtraction and multiply and division operation by using java script.
13. Write a program to calculate the factorial of a number, by using JavaScript.
14. Write a PHP code using different PHP functions and create a web page using it.

OUTCOMES:

- Students can now apply the knowledge to make their own static webpage using different html tags.
- Software development skills of students will improve.
- Students will understand the importance of web as a medium of communication.

Faculty of Engineering and Technology

B.Tech. in Electrical Engineering – Semester V

Contact Hrs per week (L-T-P): 3-1-0

Course Outlines
BEL013A Control Systems

OBJECTIVE:

- The objective of any design problem is a statement of what the final system is to achieve, and this applies to control system design as well.
- This course deals with techniques to meet out above objective.

Unit 1: **Introduction to Control Systems**- Concept of control, control system terminology, classification of Control Systems. Mathematical Models of Systems- Differential equations of physical systems, transfer function of linear systems, block diagram models, signal flow graph.

Unit 2: **Feedback Control System Characteristics**- Time domain and frequency domain responses and characteristics, steady state error, performance indices, concept of stability.

Unit 3: **Analysis of Linear Feedback Systems**- R-H stability criterion, Nyquist criterion, Bode plot, Root locus and Lyapunov's criterion.

Unit 4: **State Variable Models**- State variables of a dynamic system, state equation, transfer function from the state equation and vice-versa.

Unit 5: **Design using State variable Feedback**- Controllability, observability, pole placement using state feedback, Ackerman's formula, limitations of state variable feedback. Introduction to P/I/D and ON-OFF control actions.

OUTCOMES:

- Student will be able to analyze the transient and steady state performance of different systems and can also verify the stability of an electrical, electronics and other physical systems.

Text books:

2. BS Manke, "Linear control systems", Khanna Publishers.

Reference Books:

1. I.J Nagrath and M.Gopal, "Control System Engg", TMH
2. M.Gopal, "Control Systems: Principles and Design", TMH
3. Ogata, "Control System Engg", PHI
4. BC Kuo, "Automatic Control System", PHI
5. RC Dorf and RH Bishop, "Modern Control Systems", Addison-Wesley Publishers

Faculty of Engineering and Technology
B.Tech. in Electrical Engineering – Semester V
Contact Hrs per week (L-T-P): 3-1-0

Course Outlines
BEL014A- Power Systems I

OBJECTIVE:

- To make the students understand the concepts of generation, transmission and distribution of power.

Unit 1: **Generation of Electric Power-** Brief description of Thermal, hydro and gas power plants. Tariffs and Load Curves- Definition and different tariffs for domestic, commercial, industrial application, Different Load and Load duration curves.

Unit 2: **Transmission and Distribution Systems**- DC 2–wire and 3–wire systems, AC single phase, three phase and 4-wire systems, comparison of copper efficiency. Distribution Systems: primary and secondary distribution systems, concentrated and uniformly distributed loads on distributors fed at one and both ends, ring distribution, sub-mains and tapered mains, voltage drop and power loss calculations, voltage regulators.

Unit 3: **Overhead Transmission Lines-** Types of Conductors, Line parameters; calculation of inductance and capacitance of single and double circuit transmission lines, three phase lines with stranded and bundle conductors, Generalized ABCD constants and equivalent circuits of short, medium and long lines. Line Performance: regulation and efficiency of short, medium and long lines, Series and shunt compensation.

Unit 4: **Overhead Line Insulators**- Type, string efficiency, voltage distribution in string of suspended insulators, grading ring, preventive maintenance.

Unit 5: **Mechanical Design of Transmission Lines**- Different types of tower, sag-tension calculations, vibrations and damaging Corona-corona losses, radio and audio noise, transmission line – communication line interference.

OUT COMES:

- Students will be able to analyze the different factors which affect the design and performance of transmission and distribution lines along with the generation of power.

Text books:

1. BR Gupta, “Power System Analysis and Design”, S.Chand.

Reference Books:

1. Grainger John, J. and Stevenson, Jr. W.D., “Power System Analysis”, McGraw Hill, 1994.
2. Harder Edwin, I., “Fundamentals of Energy Production”, John Wiley and Sons, 1982.
3. Deshpande, M.V., “Elements of Electric Power Station Design”, A.H. Wheeler and Co. Allahabad, 1979.
4. Wadhwa, C.L., “Electric Power Systems”, Second Edition, Wiley Eastern Limited, 1985.
5. Nagrath, I.J. and Kothari, D.P., “Power System Engineering”, TMH, 1995.

Faculty of Engineering and Technology
B.Tech. in Electrical Engineering – Semester V
Contact Hrs per week (L-T-P): 3-1-0

Course Outlines
BEE020A Microprocessor and Microcontroller System

OBJECTIVE:

- The course emphasizes on basic structure, programming and advancement in the field of microprocessor and microcontrollers.

Unit 1: Evolution of microprocessors, technological trends in microprocessor development. The Intel family tree. CISC Versus RISC. Applications of Microprocessors. 8086 Block diagram; description of data registers, address registers, pointer and index registers, PSW, Queue, BIU and EU. 8086 Pin diagram descriptions. Microprocessor BUS types and buffering techniques, 8086 minimum mode and maximum mode CPU module. Instruction formats, addressing modes.

Unit 2: Data transfer instructions, string instructions, logical instructions, arithmetic instructions, transfer of control instructions, process control instructions; Assembler directives. Writing assembly Language programs for logical processing, arithmetic processing, timing delays; loops, data conversions. Writing procedures, Data tables, modular programming, Macros.

Unit 3: 8086 Interrupt types and interrupt vector table. DOS interrupt INT 21 h functions. INT 10h and INT 16h functions. Intel 8086 bus cycles, instruction queue, 8086 CPU Read/Write timing diagrams in minimum mode and maximum mode, reset operation, wait state, halt state, hold state, lock operation, interrupt processing. Address decoding techniques.

Unit 4: Intel's 8255 description, 8255 different modes operation and interfacing with 8086. Interfacing ADC(0808/0809),DAC-(0808) using 8255. Wave form generation. Intel's 8251 description and operation. Intel's 8259. DMA operation. Intel's 8237. Intel's 8279. Intel's 8253. Introduction to i3, i5, i7 processors.

Unit 5: 8051 microcontroller pin diagram, Block diagram, Flag, RAM configuration, Register Banks, addressing modes, instruction set, 8051 programming and interfacing.

OUTCOMES:

- Students will be able to verify assembly-language instructions which are used in microprocessor, cache memories, and parallel execution.
- They can now understand the parts of a computer and the workings of each part buses and memories.

Text Books:

1. DouglasHall Microprocessors Interfacing, Tata McGraw Hill, 1991.
2. The 8051 Microcontroller and Embedded systems by Muhammad Ali Mazidi Pearson Education Asia.

Reference Books:

1. Computer Organization and Design, The hardware and software interface by D A Patterson and J H Hennessy, Morgan Kaufman Publishers.
2. The 8051 Microcontroller Architecture, programming and Applications by Kenneth Ayala, Penram International.

Faculty of Engineering and Technology

B.Tech. in Electrical Engineering – Semester V

Contact Hrs per week (L-T-P): 3-0-0

Course Outlines
BAS004A-Optimization and Calculus of Variations

OBJECTIVE:

- This course deals with the extremely important topics under the broad umbrella of optimization.
- This is synonymous with efficiency which is the underlying prime rationale for all scientific and technological advances and progress.

Unit 1: **First and second order conditions**: First and second order conditions for local interior optima (concavity and uniqueness), Sufficient conditions for unique global optima; Constrained optimization with Lagrange multipliers; Sufficient conditions for optima with equality and inequality constraints; Kuhn Tucker conditions, duality; *(10 Lectures)*

Unit 2: **Mathematical Programming:** Integer Programming, Quadratic Programming; Complimentary Slackness Theorem, Fundamental theorem of Duality; Degenerate solutions, Cycling; Applications; *(10 Lectures)*

Unit 3: **Dynamic Programming:** Elements of Dynamic Programming including Hamiltonian, Bellman's Optimality Principle, Replacement theory, Inventory, Game Theory; *(10 Lectures)*

Unit 4: **Calculus of Variations:** Basic definition, Simplest problem, Isoperimetric problem, Problems with Higher order derivatives; *(8 Lectures)*

Unit 5: **Miscellaneous topics:** Euler Lagrange Equation, Weierstrass-Erdmann conditions; Pontryagin Maximum Principle; Transversality condition; Applications; *(10 Lectures)*

OUTCOMES:

- Students will be able to design any physical, electrical, mechanical etc problem to get best results (for e.g., minimum losses, maximum efficiency, least weight etc.)

Text Books:

1. Advance Engineering Mathematics by Erwin Kreyszig, Wiley India.

Reference Book:

1. Advance Engineering Mathematics by H.K Das, S.Chand.
2. Higher Engineering Mathematics by B.V Ramana, MGH.

Faculty of Engineering and Technology

B.Tech. in Electrical Engineering – Semester V

Contact Hrs per week (L-T-P): 0-0-2

Course Outlines

BEL015A- Control Systems Lab

OBJECTIVE:

- To learn the different order systems in controls circuits, plotting different steady state and transient responses.
- Study the frequency response of different damping networks.

List of Experiments (Perform any 12):

1 Introduction to MATLAB Computing Control Software for programming and simulation.
2 Defining Systems in TF, ZPK form.
(a) Plot step response of a given TF and system in state-space. Take different values of damping ratio and ω_n natural undamped frequency. (b) Plot ramp response.
3 For a given 2^{nd} order system plot step response and obtain time response specification.
4 To design 1^{st} order R- C circuits and observe its response with the following inputs and trace the curve. (a) Step (b) Ramp (c) Impulse
5 To design 2^{nd} order electrical network and study its transient response for step input and following cases. (a) Under damped system (b) Over damped System. (c) Critically damped system.
6 To Study the frequency response of following compensating Networks, plot the graph and final out corner frequencies. (a) Lag Network (b) Lead Network (c) Lag-lead Network.
7 To draw characteristics of AC servomotor.
8 To perform experiment on Potentiometer error detector.
9 Check for the stability of a given closed loop system.
10 Plot bode plot for a 2^{nd} order system and find GM and PM.
11 Error detector characteristics and control applications of the following. (i) LVDT (ii) Potentiometer.
12 Performance analysis of thermal system and design using PID/Relay control.
13 To obtain the position control performance of DC Servo Motor.
14 Comparisons of different Control Action (P/I/D/Relay) on Industrial Process (Pneumatic/ Simulated System.)

OUTCOMES:

- Students will be able to analyze the response characteristics of different physical systems with the transient and steady state performances of a standard system.
- It will help them in understanding the stability of an Electrical, Electronics and other physical systems.

Faculty of Engineering and Technology
B.Tech. in Electrical Engineering – Semester V
Contact Hrs per week (L-T-P): 0-0-2

Course Outlines
BEL016A- Power Systems Lab I

OBJECTIVE:

- The power system laboratory is responsible for getting the line parameters and other power system quantities using hardware, panels and simulated results.

List of Experiments (Perform any 12):

1 To perform various test on transmission line hardware / software model, to determine the ABCD parameters.
2 To perform various test on transmission line hardware / software model, to determine the surge impedance load.
3 To perform various test on transmission line hardware / software model, to determine the efficiency at various load.
4 Write a program in MATLAB to calculate sending end voltage and regulation in a short transmission line.
5 Write a program in MATLAB to apply Kelvin's law to determine the economic cross-section of the conductor of over head transmission line.
6 To measure (PPS and NPS) sequence components of supply voltages by segregating networks and verify graphically using hardware / software.

7 To determine negative and zero sequence reactance's of an alternator using software programming tool such as MATLAB.
8 To test the given AC energy meter by phantom loading at (i). Unity power factor (ii). 0.8 power factor lagging (iii). 0.8 power factor leading.
9 To find the string efficiency (i). Without the guard ring (ii). With guard ring using hardware or software programming tool such as MATLAB.
10 To study the negative phase sequence protection scheme on testing kit or using software programming tool such as MATLAB.
11 To find the zero sequence impedance of a given three phase transformer using software programming tool such as MATLAB.
12 Write a MATLAB program for sag calculation with supports at same level.
13 Write a MATLAB program for sag calculation with supports at different level.
14 Write a MATLAB program for sag calculation with supports at same level considering the ice and wind load (given the wind velocity in km/hr).

OUTCOMES:

- Students will be able to verify the principle of protective schemes and various faults in the power system scenario.
- They can also analyze the extrapolated results arrived through simulation / programming output.

Faculty of Engineering and Technology
B.Tech. in Electrical Engineering – Semester V
Contact Hrs per week (L-T-P): 0-0-2

Course Outlines

BEE022A Microprocessor and Microcontroller System Lab

OBJECTIVE: To understand the internal organization of INTEL 8086 Microprocessors, 8051 microcontroller and Assembly Language Programs using the instruction sets of processors and to study the interfacing of the processor with various peripheral devices.

List of Experiments (Perform any 12):

1. a) Write a program using Microprocessor 8086 to add two 8 bits numbers.
   b) Write a program using Microprocessor 8086 to subtract two 8 bits numbers.
   c) Write a program using Microprocessor 8086 to add two 16 bits numbers.
   d) Write a program using Microprocessor 8086 to add ten 16 bits numbers with carry.
2. (a) Write an assembly language program to find whether the given number is even or odd.
   (b) Write an assembly language program to find the number of even and odd numbers from given series of 16 bit numbers.
   (c) Write an assembly language program to find the number of 1's in a given number.
   (d) Write an assembly language program to find whether the given number has even parity or odd parity.

3. (a) Write an assembly language program to find the largest number from an array of 16 bit numbers.
(b) Write an assembly language program to find the smallest number from an array of 16 bit numbers.
(c) Write an assembly language program to arrange the given array of 16 bit numbers in ascending order.
(d) Write an assembly language program to arrange the given array of 16 bit numbers in descending order.
4. (a) Write an assembly language program to find the number of +ve and -ve numbers from given series of 16 bit numbers.
(b)Write an assembly language program to perform 1 byte BCD addition

(c) Write an assembly language program to perform addition, subtraction, Multiplication and Division of given operands. Perform BCD addition and subtraction.
(d) Write an assembly language program to move 16 bytes from the offset 0200H to 0300H.

5. (a) Write an assembly language program to find whether the given byte is present in the string or not.
(b) Write an assembly language program to compare two given strings.
(c) Write an assembly language program to find square of the given number.
(d) Write an assembly language program to find square of the given array of 16 bit number.
6. (a) Display a message " very large scale integration"
(b) Write an assembly language program to convert BCD number 0 to 9 to their 7 segment codes, using look up table.
(c) Write an ALP for (i) addition and (ii) Multiplication of two 3x3 Matrices.
7. a) Write a program to calculate squares of BCD number 0 to 9 and store then sequentially from 2000H offset onward in the current data segment. The number and their square are in BCD format. Write a subroutine for the calculation of square of number.
b) Write a program to change a sequence of 16 two byte number from ascending to descending order and store them in same data segment.
8. a) Write a program to generate a delay of 100ms using an 8086 system that runs on 10MHz frequency.
(b) Write a program to generate delay of 1Minutes.
9. (a) Write a program in 8051
(i) to clear the accumulator and add 3 to accumulator 10 times.
(ii) to load accumulator with the value 55H and complement the accumulator 700Times.
(b) Write a program to toggle all the bits of port1. put a time delay in between each issuing of data to port 1.
10. (a) Write a program to generate a delay of 1µsec. assuming that crystal frequency is 11.05 MHz.
(b) Write a program in 8051 to perform the following
(i) Keep monitoring the port P2.2 bit until it becomes high
(ii) When it becomes high write a value 45H to port 0 send a high to low pulse to P3.3.
11. (a) Write a program to get X value from P1 and send X^2 to P2 continuously.
(b) Assume P1 is I/P port and connected to a temperature sensor. Write a program to read the temperature and test it for the value 75. according to test result place the temperature value into the registers indicated by the following
If T = 75 then A = 75
If T < 75 then R1 = T
If T > 75 then R2 = T
12. (a) Write a program to find number of 1's in given number.
(b) Write a program tfor conversion of packed BCD to ASCII
13. Write a program to Interface 7-segment LED displays to a microprocessor and displaying a real-time clock.
14. Write a program for the implementation of a traffic signal controller.
15. Write a program for implementation of a programmable frequency synthesizer using timers.
16. Write a program to interfacing ADC & DAC -capturing a waveform from signal generator and CRO display.
17. Write a program to interfacing a stepper motor to a 8051 microcontroller.

OUTCOMES: The whole conclusion of this lab is that now the students can make their final year projects based on microprocessor and microcontroller.

Contact Hrs per week (L-T-P): 3-0-0

Course Outlines
BEL017A Power System Reliability

OBJECTIVE:

- This course covers power system planning, operation and management issues as well as reliability in a regulated and deregulated environment.

Unit 1: **System Reliability**: Introduction, definition of reliability, failure, probability, concepts, power quality variation, reliability measurements, power supply quality survey, Reliability aids, and recent development.

Unit 2: **Reliability Concepts**: Measure of reliability rules for combining probabilities, Mathematical expectation. Distributions, reliability theory series and parallel systems, Markov processes. Static generating capacity reliability.

Unit 3: **Outage Definition**: Loss of load probability methods, loss of energy probability method. Load forecast, System Design and planning, Strategies for generation, Transmission and Distribution networks. Transmission system reliability evaluation-Average interruption rate method. The frequency and duration method.

Unit 4: **Interconnected System**: Generating capacity reliability evaluation introduction. The loss of load approach, reliability evaluation in two and more than two interconnected systems, Interconnection benefits.

Unit 5: **Load Forecasting**: Necessity short-term forecasting by preliminary analysis control, medium term forecasting by field survey method, and long-time forecasting by statistical method. Regression analysis. Analysis of time series. Factors in power system loading.

OUTCOMES:

- One can now effectively plan a power system which is reliable and meet out the power demands of present and future.

Text Books:

1. A.S. Pabla-Electric power distribution. (Text Book).
2. Roy Billinton and Ronald N.Allan-Reliability Evaluation of power system volume-I

Reference Books:

1. Roy Billinton and Ronald N.Allan-Reliability evaluation of power System volume-II
2. J Endreny-Reliability modelling in electric power system.

Faculty of Engineering and Technology
B.Tech. in Electrical Engineering – Semester V
Contact Hrs per week (L-T-P): 3-0-0

Course Outlines
BEL018A- Switchgear and Relaying

OBJECTIVE:

- This course helps in understanding the principle and working of protective schemes, equipments used and various faults in the power system.

Unit 1: **Switchgear-** Introduction, functions of a circuit breaker, contacts separation and arc phenomenon, theory of arc formation and its extinction, recovery voltage, restriking voltage, interruption of capacitive and inductive currents, resistance switching, double frequency transients, circuit breaker ratings, clearing time, reclosing time.

Unit 2: **Classification of circuit breakers:** Classification of circuit breakers, detailed principle, working, advantages and disadvantages of oil, air-blast, vacuum and SF_6 circuit breakers.

Unit 3: **Relays**: Introduction, basic requirements, operating principles and characteristics of electromagnetic type over-current, differential, impedance and admittance relays. Detail of protection against abnormal conditions for alternators, transformers, feeders transmission lines, and bus-bars. Carrier current protection for long lines.

Unit 4: **Static Relays**: Introduction, comparison with electromagnetic relays, working of instantaneous, definite time, inverse time and directional over current relays, introduction to digital relays.

Unit 5: **Sub-Stations**: Types of sub-stations, sub-station equipments and outdoor yard layout, types of bus-bars, key diagrams and bus-bar arrangements.

OUTCOMES:

- Students will now be able to design a protective power system which is able to meet out any contingency and they will be in position for fault detection and removal therein.

Text Books:

1. Sunil S. Rao, "Switchgear, Protection and Power Systems", Khanna Publishers.

Reference Books:

1. CL Wadhwa, "Electric Power Systems", Wiley Eastern Limited.
2. IJ Nagrath and DP Kothari,"Power System Engineering" Tata McGraw-Hill.
3. Badriram and DN Vishwakarma, "Power System Protection and Switchgear", TMH
4. JBGUPTA: Switchgear protection. Kataria Publications, New Delhi.
5.

Faculty of Engineering and Technology
B.Tech. in Electrical Engineering – Semester V
Contact Hrs per week (L-T-P): 3-0-0

Course Outlines
BEL019A-Mathematical modelling of Electrical Machine

OBJECTIVE:

- This course helps in understanding the components and dynamics involved in electrical drive, thereafter in deals with modeling of different electrical machines.

Unit 1: **Review of Electrical drive**: Dynamics of Electrical drive, Conventions and multi-quadrant operation, Transient and steady state stability of Electrical drive, Control of Electrical drive.
Unit 2: **Modelling of DC machine**: Theory of operation, Induced EMF, Equivalent circuit and Electromagnetic torque, Electromechanical modelling, State-space modelling, Block diagram and Transfer functions. DC motor drives: DC motor and their performance, starting, braking, transient analysis, speed

control, Ward-Leonard drives, controlled rectifier fed DC drives, control of fractional HP motors, Chopper controlled DC drives.

Unit 3: **Dynamic modelling of induction machine**: Real-Time model of a two-phase induction machine, Transformation to obtain constant matrices, Three-phase to two phase transformation, Generalized model in arbitrary reference frames, Derivation of commonly used induction motor models, Per unit model. Induction motor drives: Three-phase I.M. braking, transient operation, variable frequency control from voltage and current source, single phase I.M. and Linear I.M. and its control.

Unit 4: **Synchronous motor drives**: synchronous motors operation from fixed frequency supply, Synchronous motor variable speed drives, starting large synchronous machines.

Unit 5: **Miscellaneous Drives**: Brushless DC motor, stepper motor and switched reluctance motor traction drives, Energy Conservation in Electric Drives. Introduction to vector control scheme.

OUTCOMES:

- Students will now be able to design different electric machine projects.

Text Books:

1. GK Dubey, Electrical Drives, Narosa Publication.

Reference Books:

1. S.K.Pillai, Electrical Drives, II Edition, New Age International(P) Ltd.
2. J.M.D. Murphy and F.G. Turnbull, Power Electronic control of AC Motors, Pergamon Press.
3. P.Lloyed & Conard AC Drives, AC Machines.
4. R.Krishnan, Electric Motor Drives, Pearson Education,
5. B.K. Bose, Power Electronics & AC Drives, Prentice Hall, England wood cliffs.
6. Generalized Electrical Machines by Atkinson.
7. Electrical Drives Concept & Application, Vedam Subrahmanyam, TMH

Faculty of Engineering and Technology

B.Tech. in Electrical Engineering – Semester V

Contact Hrs per week (L-T-P): 3-0-0

Course Outlines

BEL020A- Advanced Theory and Analysis of AC machines

OBJECTIVE:

- This course helps in understanding the components and dynamics involved in electrical drive, thereafter in deals with modeling of different AC machines.

Unit 1: **Introduction:** Physical model, Different reference frame, Transformations, Primitive Machine, Dynamic variable, Formulation of dynamic equations of a generalized machine.

Unit 2: **Maxwell equations:** Introduction to Maxwell equations**,** Electric field of Transformers, Shaft voltages and fluxes, bearing currents.

Unit 3: **Induction machines:** Induction motor modelling, oscillations In Induction machines, Asymmetries in stator and rotor windings.

Unit 4: **Synchronous machine:** Asynchronous-synchronous Operation of synchronous machine; Modelling, Operational Impedances, Time constants, Stability, Power angle characteristics.

Unit 5: **Short circuit analysis:** Symmetrical and Asymmetrical short circuit analysis, Measurement of Reactance, Power Systems.

OUTCOMES:

- Students will now be able to design different AC machine projects.

Text Books:

1. P.S Bimbhra, Generalised Theory of Electrical Machines, Khanna Publishers.
2. MG Say, "Theory Performance and Design of AC Machines" CBS Publisher

Reference Books:

1. Alexander S. Langsdorf, "AC Machines", Tata McGraw Hill.
2. C.V Jones Unified Theory of Electrical Machines, Butterworths, London 1967.
3. A.E Fitzgerald, Charles Kingsley, Jr. and S D Umans, Electrical Machinery, 4th Ed., MGH Publishers.

Faculty of Engineering and Technology
B.Tech. in Electrical Engineering – Semester VI
Contact Hrs per week (L-T-P): 3-1-0

Course Outlines
BEL023A- Power Systems II

OBJECTIVE:

- This course helps in formulating a single line, impedance and reactance diagram of power system network with the help of per unit system which helps in calculating the power system components during faulty and healthy conditions.
- It also gives information about load flow studies.

Unit 1: **Representation of Power System Components**- Synchronous machines, Transformers, Transmission lines, one line diagram, Impedance and reactance diagram, per unit System

Unit 2: **Symmetrical components**- Symmetrical Components of unbalanced phasors, power in terms of symmetrical components, sequence impedances and sequence networks.

Unit 3: **Symmetrical fault analysis**- Transient in R-L series circuit, calculation of 3-phaseshort circuit current and reactance of synchronous machine, internal voltage of loaded machines under transient conditions

Unit 4: **Unsymmetrical faults**-Analysis of single line to ground fault, line-to-line fault and Double Line to ground fault on an unloaded generators and power system network with and without fault impedance. Formation of Z_{bus} using singular transformation and algorithm, computer method for short circuit calculations

Unit 5: **Load Flow**- Introduction, bus classifications, nodal admittance matrix (Y bus), development of load flow equations, load flow solution using Gauss Siedel and Newton Raphson method, approximation to N-R method, line flow equations and fast decoupled method.

OUTCOMES:

- Students will now be able to design different power system network using different representations.
- Also they can select as to which load flow method is suited for which condition.

Text Books:

1. BR Gupta, "Power System Analysis and Design", S.Chand.

Reference Books:

1. CL Wadhwa, "Electrical Power System", New Age International.
2. W.D. Stevenson, Jr. "Elements of Power System Analysis", McGraw Hill.
2. T.K Nagsarkar and M.S. Sukhija, "Power System Analysis" Oxford University Press,2007.
3. L. P. Singh; "Advanced Power System Analysis and Dynamics", New Age International
4. Hadi Sadat; "Power System Analysis", Tata McGraw Hill.
5. Stagg and El-Abiad, "Computer Methods in Power System Analysis" Tata Mc Graw Hill
6. Kothari and Nagrath, "Modern Power System Analysis" Tata McGraw Hill.

Faculty of Engineering and Technology

B.Tech. in Electrical Engineering – Semester VI

Contact Hrs per week (L-T-P): 3-1-0

Course Outlines
BEL024A- Electric Drives

OBJECTIVE:

- This course helps in explaining the design, function, operation and control of all major components of a typical electric vehicle power train / drives (AC and DC both).

Unit 1: **Introduction**- Classifications of Electric Drives, components of electric drives, advantages of electric drives, Review of characteristics and speed control of DC and AC motors. Dynamics of Electric Drives:- Fundamental torque equation, speed-torque conventions and multi-quadrant operation, equivalent values of drive parameters, components of load torques, nature and classification of load torques, calculation of time and energy-loss in transient operations, criteria for steady state stability, load equalization.

Unit 2: **Rectifier Control of DC Drives**- Controlled rectifier circuits, 1-phase fully controlled rectifier-fed separately excited DC motor, 1-phase half-controlled rectifier-fed separately excited DC motor, 3-phase fully controlled rectifier-fed separately excited DC motor, multi quadrant operation of fully-controlled rectifier-fed DC motor.

Unit 3: **Chopper Control of DC Drives**- Principle of operation and control techniques, motoring operation of separately excited and series excited motors, multi quadrant control of chopper-fed motors.

Unit 4: **Induction Motor (IM) Drives**:- 3-phase AC voltage controller-fed IM drive, voltage source inverter (VSI) and current source inverter (CSI) variable frequency drives, comparison of VSI and CSI drives, cyclo-converter-fed IM drive, static rotor resistance control of 3-phase slipring IM Synchronous Motor Drives-VSI drive, CSI drive, CSI drive with load commutation, cyclo-converter drive,

Unit 5: **Braking methods**- Various methods of braking DC and AC motors, regenerative braking of DC motors during chopper control, static Scherbius drive, commutator less Kramer drive. Introduction to Microprocessor Control of Electric Drives.

OUTCOMES:

- Students will now be able to describe the structure of electric drive systems and their role in various applications such as flexible production systems, energy conservation, renewable energy, transportation etc.

Text Books:

1. G.K. Dubey, "Fundamentals of Electrical Drives" Narosa Publishing House, 1995.

Reference Books:

1. V. Subrahmanyam, " Electric Drives: Concepts and Applications", TMH 1994.

2. GK Dubey, " Power Semiconductor Controlled Drives, Prentice Hall.
3. EL- Sharkawi & A Mohamad "Fundamental of Electric Drive", Vikas Pub. House
4. SK Pillai, "A First course on Electrical Drives" Wiley Eastern Ltd.

Faculty of Engineering and Technology

B.Tech. in Electrical Engineering – Semester VI

Contact Hrs per week (L-T-P): 3-0-0

Course Outlines

BEL021A- Energy Auditing

OBJECTIVE:

- This course helps in understanding the components and process involved in energy auditing.

Unit 1: **Introduction to Audit**: Introduction to industrial energy auditing, Definition of energy auditing, Objectives , Types of energy audits, Overview of energy audit procedures, Preparation for the energy audit, Defining the audit criteria, Defining the audit scope, Selection of energy audit team, Making an audit plan, Preparing an audit checklist.

Unit 2: **Survey**: Conducting the initial walk-through visit, Collecting energy bills and available data and information, Conducting the preliminary analysis, Analyzing energy bills, Electricity bills, Natural gas bills, Coal and fuel oil bills, Graphical analysis of historical energy use.

Unit 3: **Inventory and production patterns**: Inventory and measurement of energy use, Electrical load inventory, Thermal energy use inventory, Energy system-specific measurements, Energy balance, Analyzing energy use and production patterns, Load/Demand profile, Scatter diagram for presenting the dynamics of the energy-production relationship, Interpretation of energy-production data pattern on a scatter diagram, Benchmarking and comparative energy performance analysis, Identifying energy efficiency and energy cost reduction opportunities.

Unit 4: **Analysis of data**: Electrical demand control, Cross-cutting energy-efficiency improvement options, Energy-efficiency improvement opportunities in *electric motors*, Energy-efficiency improvement opportunities in *compressed air* systems, Energy-efficiency improvement opportunities in *pumping* systems, Energy-efficiency improvement opportunities in *fan* systems, Energy-efficiency improvement opportunities in *lighting* system, Energy-efficiency improvement opportunities in *steam* systems, Energy-efficiency improvement opportunities in *process heating* systems, Sector-specific energy-efficiency improvement opportunities for selected industrial sectors, Cost-benefit analysis of energy-efficiency , Life-cycle cost analysis (LCCA), Life cycle cost (LCC) method, Net present value (NPV) method, Internal rate of return (IRR) method, Simple payback period (SPP) method.

Unit 5: **Audit preparation**: Preparing an energy audit report, Post-audit activities, Create an action plan for the implementation of energy-efficiency measures, Conversion factors, Energy audit instruments, Safety considerations, Measuring electrical parameters, Temperature measurement, Flow measurements, Exhaust gas measurements, Measurement of the speed of rotating equipment, energy-efficiency improvement opportunities for selected industrial sectors.

OUTCOMES:

- Students will now be able to perform the energy audit of any industry or institution, residential / commercial colony etc.

Text Books:

1. Energy Conservation Hand Book, Bureau of Energy Efficiency, Ministry of Power, Govt. of India.
2. Industrial Energy Audit Guidebook: Guidelines for Conducting an Energy Audit in Industrial Facilities, Ali Hasanbeigi, Lynn Price, China Energy Group, Energy Analysis Department., Environmental Energy Technologies Division.

Faculty of Engineering and Technology
B.Tech. in Electrical Engineering – Semester VI
Contact Hrs per week (L-T-P): 3-0-0

Course Outlines
BEL022A- Programmable Logic Controllers and SCADA

OBJECTIVE:

- This course helps in understanding the various instructions, components and programming of PLC and features and applications of SCADA systems.

Unit 1: **Programmable Logic Introduction:** programmable Logic structures Programmable Logic Arrays (PLAs), Programmable Array Logic (PALs), Programmable Gate Arrays (PGAs), Field Programmable Gate Arrays (FPGAs) Sequential network design with Programmable Logic Devices (PLDs) Design of sequential networks using ROMs and PLAs Traffic light controller using PAL.

Unit 2: **Programmable Logic Controllers**: (PLCs) Introduction Parts of PLC Principles of operation PLC sizes PLC hardware components I/O section Analog I/O section Analog I/O Units, digital I/O Units CPU Processor memory Unit Programming devices Diagnostics of PLCs with Computers.

Unit 3: **PLC programming**: Simple instructions Programming EXAMINE ON and EXAMINE OFF instructions Electromagnetic control relays Motor starters Manually operated switches Mechanically operated and Proximity switches Output control devices Latching relays PLC ladder diagram Converting simple relay ladder diagram in to PLC relay ladder diagram.

Unit 4: **Timer instructions & Application**: ON DELAY timer and OFF DELAY timer counter instructions Up/Down counters Timer and Counter applications program control instructions Data manipulating instructions math instructions. Simple materials handling applications Automatic control of warehouse door Automatic lubricating oil supplier Conveyor belt motor control Automatic car washing machine Bottle label detection Process control application, PID control of continuous processes.

Unit 5 : **SCADA**: Introduction to Supervisory Control and Data Acquisition, SCADA Functional requirements and Components, General features, Functions and Applications, Benefits, Configurations of SCADA, RTU (Remote Terminal Units) Connections, Power Systems SCADA and SCADA in Power System Automation.

OUTCOMES:

- This course will be an excellent opportunity to network with your peers, as well as to gain significant new information and techniques for SCADA / PLC project.

Text Books:

1. William I. Fletcher, An Engineering Approach to Digital Design, PHI Ltd., ND (1999).

Reference Books:

1. Chareles H. Roth, Jr, Fundamentals of Logic Design, 4th Ed., Jaico Pub. House (1999).
2. Siemens, PLC Handbook.
3. Frank D. Petruzella, Programmable Logic Controllers, McGraw- Hill (1989).
4. Wood, AJ & Wollenberg, BF, Power Generation Operation & Control, 2nd Ed. John Wiley.

Faculty of Engineering and Technology
B.Tech. in Electrical Engineering – Semester VI
Contact Hrs per week (L-T-P): 0-0-2

Course Outlines
BEL025A- Electric Drives Lab

OBJECTIVE:

- This course helps in practically explaining the design, function, operation and control of all major components of a typical electric vehicle power train / drives (AC and DC both).

List of Experiments (Perform any 12):

1. Perform the speed control of separately excited DC motor by varying armature voltage using single-phase fully controlled bridge converter.
2. Perform the speed control of separately excited DC motor by varying armature voltage using single phase half controlled bridge converter.
3. Perform the speed control of self excited DC motor by varying armature voltage using single-phase fully controlled bridge converter.
4. Perform the speed control of self excited DC motor by varying armature voltage using single phase half controlled bridge converter.
5. Perform the speed control of separately excited DC motor using GTO.
6. Perform the speed control of separately excited DC motor using single phase dual converter (Static Ward-Leonard Control)
7. Perform the speed control of separately excited dc motor using MOSFET/IGBT chopper.
8. Perform the speed control of fan using DIAC or TRIAC.
9. Perform the speed control of separately excited DC generator using MOSFET/IGBT chopper.
10. Perform the closed loop control of separately excited DC motor.
11. Perform the speed control of single phase induction motor using single phase AC voltage controller.
12. Perform the speed control of three phase induction motor using three phase AC voltage controller
13. Perform the speed control of three phase induction motor using three phase current source inverter
14. Perform the speed control of three phase induction motor using three phase voltage source inverter

OUTCOMES:

- Students will now be able to describe the structure of electric drive systems and their role in various applications such as transportation.

Faculty of Engineering and Technology
B.Tech. in Electrical Engineering – Semester VI
Contact Hrs per week (L-T-P): 3-0-0

Course Outlines
BEL026A- Computer Analysis and Design Lab

OBJECTIVE:

- This course helps in learning the tools associated with different software and hardware available in the market for computer aided design to help them solve different design issues.

Perform any 12 experiments.

Design of transformer

1. Write a program to design the rating of a single phase transformer in kVA using various physical parameters.
2. Write a program to design the out equation for voltage per turn of a single phase transformer using various physical parameters.
3. Write a program to design the ratio of iron losses to copper losses of a single phase

transformer using various physical parameters.

4 Write a program to design the relation between core area and weight of iron and copper of a single phase transformer using various physical parameters.

5 Write a program to design a single phase transformer for minimum cost using various physical parameters.

6 Write a program to design a single phase transformer for minimum loss using various physical parameters.

7 Write a program to design window width of a single phase transformer for optimum output using various physical parameters.

8 Write a program for yoke design and overall dimensions of a single phase transformer for optimum output using various physical parameters.

Design of DC Machine

9 Write a program to design the output equation of a DC machine using various physical parameters.

10 Write a program to design the maximum permissible core length of a DC machine using various physical parameters.

11 Write a program to design the minimum permissible core diameter of a DC machine using various physical parameters.

12 Write a program to design the minimum number of coils required for a DC machine using various physical parameters.

Design of rotating AC Machine

13 Write a program to design the output equation of a AC machine using various physical parameters.

14 Write a program to design a 3 phase squirrel cage induction motor (calculating its main dimensions, turns per phase, number of stator slots and winding details) using various physical parameters.

OUTCOMES:

- Students will now be able to make different computer aided design projects related to electrical machines.

Faculty of Engineering and Technology
B.Tech. in Electrical Engineering – Semester VI
Contact Hrs per week (L-T-P): 0-0-2

Course Outlines
BEL027A- Power Systems Lab II

OBJECTIVE:

- This course helps in formulating a reactance diagram of power system network with the help of per unit system and to calculate different types of faults.

List of Experiments (Perform any 12):

1. To determine direct and sub transient axis reactance (X_d) of a salient pole alternator using hardware/panel/model or simulate using MATLAB.
2. To determine quadrature axis reactance (X_q) of a salient pole alternator using hardware/panel/model or simulate using MATLAB.
3. To determine negative and zero sequence reactance of an alternator.
4. To determine fault current for L-G faults at the terminals of an alternator at very low excitation using hardware/panel or simulate using MATLAB.
5. To determine fault current for L-L faults at the terminals of an alternator at very low excitation using hardware/panel or simulate using MATLAB.
6. To determine fault current for L-L-G faults at the terminals of an alternator at very low excitation using hardware/panel or simulate using MATLAB.

7. To determine fault current for L-L-L faults at the terminals of an alternator at very low excitation using hardware/panel or simulate using MATLAB.
8. To study the IDMT over current relay and determine the time current characteristics using electrical panels.
9. To study percentage differential relay, Impedance, MHO and Reactance type distance relays using electrical panels.
10. To determine location of fault in a cable using cable fault locator.
11. To study Ferranti effect and voltage distribution in HV long transmission line using transmission line model or using programming or simulation tool of MATLAB/similar software.
12. To obtain steady state, transient and sub-transient short circuit currents in an alternator using programming or simulation tool of MATLAB/similar software.
13. To obtain formation of Y-bus and perform load flow analysis using Gauss-Siedel method using programming or simulation tool of MATLAB/similar software.
14. To perform symmetrical and unsymmetrical fault analysis in a power system using programming or simulation tool of MATLAB/similar software.
15. Write a program for a load flow solution in a power system problem using Gauss Siedel method.
16. Write a program for a load flow solution in a power system problem using Newton Raphson method.
17. Write a program for a load flow solution in a power system problem using Fast decoupled method.

OUTCOMES:

- Students will now be able to practically verify the different fault calculations and different load flow solution methods.

Faculty of Engineering and Technology

B.Tech. in Electrical Engineering – Semester VI

Contact Hrs per week (L-T-P): 3-0-0

Course Outlines
BEL028A- Power Systems Engineering

OBJECTIVE:

- This course helps in designing a power system network in which there is optimum utilization of available power generation resources.
- It also considers various stabilities associated with power system.

Unit 1: **Economic Operation of Power Systems:** Introduction, system constraints, optimal operation of power systems. Input output, heat rate and incremental rate curves of thermal generating units. Economic distribution of load between generating units within a plant. Economic distribution of load between power stations, transmission loss equation. Introduction to unit commitment and dynamic programming.

Unit 2: **Power Angle equations and curves:** Power angle equations and power angle curves under steady state, and transient conditions. Rotor dynamics and swing equation (solution of swing equation not included), synchronizing power coefficient.

Unit 3: **Equal Area Criterion:** Equal area criterion and its application to transient stability studies under basic disturbances, critical clearing angle and critical clearing time.

Unit 4: **Stabilities**: Introduction to steady state and dynamic stabilities, steady state stability limit. Introduction to transient stability. Factors affect transient stability and methods to improve stability.

Unit 5: **Miscellaneous Topics:** Tap Changing transformer, phase angle control and phase shifting transformer. Series compensation of transmission lines, location and protection of series capacitors, advantages and problems.

OUTCOMES:

- Students will now be able to find the solution to the problem related to power system security and voltage stability issues.

Text book

1. BR Gupta, "Power System Analysis and Design", S.Chand.

Reference book

1. Power System Engineering by Nagrath and Kothari, TMH
2. Power System Engineering by C.M Arora,
3. Power System Engineering by B.R Gupta, wheeler publication
4. Electrical Power System by C.LWadhwa, New Age Publisher

Faculty of Engineering and Technology

B.Tech. in Electrical Engineering – Semester VI

Contact Hrs per week (L-T-P): 3-0-0

Course Outlines

BEL029A- FACTS (Flexible AC Transmission Systems)

OBJECTIVE:

- The objective of this course is to introduce participants to the transmission challenges of modern electrical power systems.
- The course will present the basic concepts, principles and operation of fast high power electronic controllers known as Flexible AC Transmission Systems (FACTS) that enhance power system stability and effectively increase transmission capacity thus yielding significantly higher flexibility of operation.

Unit 1: **Introduction to AC transmission systems***:* Problems of AC transmission systems, power flow in parallel paths and meshed system, factors limiting loading capability, stability consideration. Power flow control of an AC transmission line. Basic types of facts controllers. Advantages of FACTS technology.

Unit 2: **Static Shunt Compensators:** Mid-point and end point voltage regulation of transmission line, and stability improvement. Basic operating principle of Static Synchronous Compensators (STATCOM).Comparison between STATCOM and SVC.

Unit 3: **Static Series Compensators:** Concept of series capacitive compensation, voltage and transient stabilities, power oscillation and sub synchronous oscillation damping. Introduction to thyristor switched series capacitor (TSSC), thyristor controlled series capacitor (TCSC), and static synchronous series compensator, - operation, characteristics and applications.

Unit 4: **Static Voltage and Phase Angle Regulators:** (i) Voltage and phase angle regulation. Power flow control and improvement of stability by phase angle regulator. Introduction to thyristor controlled voltage and phase angle regulators (TCVR and TCPAR) (ii) Introduction to thyristor controlled braking resistor and thyristor controlled voltage limiter.

Unit 5: **UPFC and IPFC:** Unified Power Flow Controller (UPFC), basic operating principles, conventional transmission control capabilities. Comparison of UPFC to series compensators and phase angle regulator. Applications of UPFC.

IPFC: Interline Power Flow Controller (IPFC), basic operating principles and characteristics. Applications of IPFC.

OUTCOMES:

- Students will now know in depth the problems associated with AC transmission system which limits its loading capacity and stability.
- And hence possible solutions to the above addressed problem.

Text Books:

1. D. P. Kothari, I. J. Nagrath: Modern Power System Analysis

Reference Books:

1. Yong-Hua Song, Allan Johns: Flexible AC Transmission Systems (FACTS).
2. Narain G. Hingorani: Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems

2. Narain G. Hingorani, Laszlo Gyugyi: Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems

Faculty of Engineering and Technology

B.Tech. in Electrical Engineering – Semester VI

Contact Hrs per week (L-T-P): 3-0-0

Course Outlines

BEL030A- Indian Electricity Standards and their Applications

OBJECTIVE:

- The objective of this course is to give knowledge about various standards and rules associated in power system (transmission and distribution) in India.

Unit 1: **Introduction**: Various definitions used in Indian electricity rule 1956 i.e., appointment and authority of Inspectors and officers under government, licence and contents of draft licence. Service lines and apparatus on consumer's premises. Cut-out on consumer's premises, Identification of earthed and earthed neutral conductors and position of switches and cut-outs, Earthed terminal on consumer's premises, Accessibility of bare conductors, Danger Notices, Handling of electric supply lines and apparatus, Cables for portable or transportable apparatus, Cables protected by bituminous materials, Street boxes, Distinction of different circuits, Accidental charge, Provisions applicable to protective equipment, Instructions for restoration of persons suffering from electric shock, Precautions to be adopted by consumers, Periodical inspection and testing of consumer's installation,

Unit 2: **General Conditions Relating To Supply And Use Of Energy:** Testing of consumer's installation, Precautions against leakage before connection, Leakage on consumer's premises, Supply and use of energy, Provisions applicable to medium, high or extra-high voltage installations, Cost of inspection and test of consumer's installation, Declared voltage of supply to consumer, Declared frequency of supply to consumer, Sealing of meters, and cut-outs, Precautions against failure of supply: Notice of failures.

Unit 3: **Electric Supply Lines, Systems And Apparatus For Low And Medium Voltages:** Test for resistance of insulation, Connection with earth.

Unit 4: **Electric Supply Lines, Systems And Apparatus For High And Extra-High Voltages**: Approval by Inspector, Use of energy at high and extra-high voltage, Testing, Operation and Maintenance, Metal sheathed electric supply lines, Connection with earth, General conditions as to transformation and control of energy, Supply to X-ray and high frequency installation.

Unit 5: **Overhead Lines, Under Ground Cables And Generating Stations**: Material and strength, Maximum stresses, Clearance above ground of the lowest conductor, Clearance between conductors and trolley wires, Clearances from buildings of low and medium voltage lines and service lines, Clearances from buildings of high and extra-high voltage lines, Conductors at different voltages on same supports, Erection of or alternation to buildings, structures, flood banks and elevation of roads, Clearances, Routes, Maximum interval between supports, Conditions to apply where telecommunication lines and power lines are carried on same supports, Lines crossing or approaching each other, Service-lines from Overhead lines, Earthing, Safety and protective devices, Protection against lightning, Unused overhead lines. Additional rules for electric traction, Introduction to electric supply in mines and oil fields.

OUTCOMES:

- Students will now know how to get a new connection and enhancement or reduction of load, recovery of electricity charges and intervals for billing of electricity charges, disconnection, reconnection and restoration of supply of electricity.
- Authority and responsibility associated with power inspectors.
- They can also educate others about the safety precautions which a common man should take care of while usage of electrical appliances, cables etc. in and around their houses.

Text Books:

1. Indian Electricity Rules, 1956, Manak Bhavan, New Delhi.
2. Substation Design and Practice, P.S. Satnam, Dhanpat Rai and Sons

Faculty of Engineering and Technology

B.Tech. in Electrical Engineering – Semester VI

Contact Hrs per week (L-T-P): 3-0-0

Course Outlines

BEL031A - Electrical Machines Design

OBJECTIVE:

- The objective of this course is to give knowledge about various factors and limitations associated with the design of electric machines such as transformers, three phase induction motors and alternators.

Unit 1: **Principles of design of Machines**: Factors and limitations in design, specific magnetic and electric loadings, output, real and apparent flux densities, separation of main dimensions for DC, induction and synchronous machines.

Unit 2: **Heating, Cooling and Ventilation**: Temperature rise calculation, continuous, short-time and intermittent ratings, types of ventilation, hydrogen cooling and its advantages.

Unit 3: **Design of Transformers**: General considerations, output equation, main dimensions, leakage reactance, winding design, tank and cooling tubes, calculation of magnetizing current, losses, efficiency and regulation.

Unit 4: **Design Three-phase induction motors**: General considerations, output equation, choice of specific electric and magnetic loadings, No. of slots in stator and rotor, elimination of harmonic torques, design of stator and rotor windings, leakage reactance, equivalent resistance of squirrel cage rotor, magnetizing current, temperature rise and efficiency.

Unit 5: **Design of Alternators**: Classification and their comparison, specific loadings, output coefficient, main dimensions, short circuit ratio, elimination of harmonics in generated EMF, stator winding design.

OUTCOMES:

- Students will now be able design an electrical machine project for given output requirement.

Text Books:

1. Sawhney AK, “Electrical Machine Design”, Dhanpat Rai and Sons.

Reference Books:

1. Clayton A.E., “The performance and design of DC Machines”, Pitman (ELBS).
2. Say MG, “The performance and design of AC Machines”, Pitman (ELBS).

3. Design of Electrical Machines by VN Mittle and A Mittal. Standard publishers and distributors.

Faculty of Engineering and Technology
B.Tech. in Electrical Engineering – Semester VI
Contact Hrs per week (L-T-P): 3-0-0

Course Outlines
BEL032A–Materials for Electrical Machines

OBJECTIVE:

- The objective of this course is to give knowledge about various types of materials (for e.g conducting materials, dielectric materials, magnetic materials etc.) used in different parts of the machine for a specific purpose.

Unit 1: **Conductor Materials**: Electrical, thermal and mechanical properties of conductive and resistive materials. Important characteristics and applications of specific conductor materials like copper, aluminium, AAC, ACSR, silver and gold. Study of important resistance materials, carbon and nichrome, standard resistance materials. Soldering alloys.

Unit 2: **Superconducting Materials**: Introduction, critical field and critical current density, type I and type II superconductors, intermediate state, penetration depth and thin films. Super conductivity at high frequencies, applications of superconductivity. Advancement in superconducting materials.

Unit 3: **Dielectric Materials**: Dielectric behaviour of materials under static and dynamic field. Polarization, induced and permanent dipole moments. Surface resistivity. Breakdown processes. Thermal and electrical properties of important dielectric materials.

Unit 4: **Magnetic Materials**: Characteristics of diamagnetic, paramagnetic, ferromagnetic, ferromagnetic and anti-ferromagnetic materials. Properties and applications of common non retentive and retentive magnetic materials including various alloys, ferrites and power cores. Eddy current and hysteresis losses. Curie point.

Unit 5: a) **Semiconductor Materials**: Electric properties of semiconducting elements and compounds and their applications.
b) **Miscellaneous Materials**: Important electronic properties of electron emitting materials, photo sensitive materials and luminescent materials.

OUTCOMES:

- Students will now be able to use the properties and behavior of different materials for the design of electrical machines.

Text book
1. Electrical Engineering materials by S.P. Seth and P.V. Gupta.

Reference book
1. Electrical Engineering materials by A.J. Dekker.
2. Electrical Engineering materials by J.B. Gupta.
3. Electrical Engineering Materials by G.P. Chhalotra.

Faculty of Engineering and Technology
B.Tech. in Electrical Engineering – Semester VI
Contact Hrs per week (L-T-P): 3-0-0

Course Outlines
BEL033A - Advanced Control Systems

OBJECTIVE:

- This subject provides an introduction to modern control theory with a particular focus on state-space analysis of continuous system, analysis of discrete system and stability concerns of control system.

Unit 1: **State Space Analysis of Continuous System**: Review of state variable representation of continuous system, conversion of state variable models to transfer function and vice-versa, solution of state equations and state transition matrix, controllability and observability, design of state observer and controller

Unit 2: **Analysis of Discrete System**: Discrete system and discrete time signals, state variable model and transfer function model of discrete system, conversion of state variable model to transfer function model and vice-versa, modelling of sample hold circuit, solution of state difference equations, steady state accuracy, stability on the z-plane and Jury stability criterion, bilinear transformation

Unit 3: **Stability:** Lyapunov's stability theorems for continuous and discrete systems, methods for generating Lyapunov function for continuous and discrete system, Popov's criterion.

Unit 4: **Non linear Systems**: Types of non linearities, phenomena related to non –linear systems. Analysis of non linear systems-Linearization method, second order non-linear system on the phase plane, types of phase portraits, singular points, system analysis by phase-plane method, describing function and its application to system analysis.

Unit 5: **Adaptive Control**: Introduction, modal reference adaptive control systems, controller structure, self tuning regulators. Introduction to neural network, fuzzy logic and genetic algorithms.

OUTCOMES:

- Student should be able to apply fundamental state-space techniques in the analysis and design of linear feedback control systems, as they arise in a variety of contexts.
- Students can now formulate and control of engineering problems in terms of optimising an objective function subject to different constraints.
- Use software tools to simulate and design the linear control systems.

Text Books:

1. M.Gopal, "Digital Control and State variable Methods", Tata Mc Graw Hill.

Reference Books:

1. D. Landau, "Adaptive Control", Marcel Dekker Inc.
2. S.Rajasekaran and G.A.VjayalakshmiPai, "Neural Networks, Fuzzy Logic and Genetic Alogorithms: Synthesis and Applications" Prentice Hall of India

2. Donald E. Kiv, “Optimal Control Theory: An Introduction” Prentice Hall
3. B.C. Kuo, “Digital Control Systems” Sounders College Publishing
4. CH Houpis and G.B.Lamont, “Digital Control Systems: Theory, Hardware, Software”, MGH.
5. Ajit K.Madal, “Introduction to Control Engineering: Modelling, Analysis and Design” New Age International.

Faculty of Engineering and Technology
B.Tech. in Electrical Engineering – Semester VII
Contact Hrs per week (L-T-P): 3-1-0

Course Outlines
BEL034A - High Voltage Engineering

OBJECTIVE:

- Introduction to conduction and breakdown of solids, liquids and gases.
- It also gives information regarding process and application with respect to generation of high (AC and DC) voltages.

Unit 1: **Conduction and Breakdown in Gases, Liquid and Solid Dielectrics:** Gases –Ionization process, Townsend’s current growth equation. 1st and 2nd ionisation coefficients. Townsend criterion for breakdown. Streamer theory of breakdown. Paschen’s law of gases. Gases used in practice.

Unit 2: **Liquid Dielectrics**-Conduction and breakdown in pure and commercial liquids, suspended particle theory, stressed oil volume theory, liquid dielectrics used in practice; Solid Dielectrics-Intrinsic, electromechanical, and thermal breakdown, composite dielectric, solid dielectrics used in practice; Applications of Insulating Materials: Application of insulating materials in power transformers, rotating machines, circuit breakers, cables and power capacitors.

Unit 3: **Generation of High Voltages and Currents**: Generation of high DC, AC, impulse voltage and impulse currents. Tripping and control of impulse generators; Measurement of High Voltages and Currents: Measurement of high DC, AC (Power frequency and high frequency) voltages, various types of potential dividers, generating voltmeter, peak reading AC voltmeter, Digital peak voltmeter, electrostatic voltmeter. Sphere gap method, factors influencing the spark voltage of sphere gaps.

Unit 4: **High Voltage Testing of Electrical Apparatus**: Testing of insulators, bushings, circuit breakers power capacitors and power transformers.

Unit 5: **Over voltage Phenomenon and Insulation Co-ordination**: Theory of physics of lightning flashes and strokes. Insulation co-ordination, volt-time and circuit time characteristics. Horn gap, single diverters, ground wires, surge absorbers.

OUTCOMES:

- Student should be able to select a particular dielectric for circuit breakers and other insulation requirement in the machine.
- They also know how ill effects of over voltages and lightening strokes can be averted by suitably installing the required equipments.

Text Books:

1.M. S. Naidu and V. Kamaraju, “High Voltage Engineering, TMH.

Reference Books:

1. CL. Wadhwa, “High Voltage Engineering”, Wiley Eastern Ltd.
2. E. Kuffel and W. S. Zacngal, High Voltage Engineering”, Pergamon Press.
3. M.P Chaurasia , “High Voltage Engineering”, Khanna Publishers
4. R. S. Jha, “High Voltage Engineering”, Dhanpat Rai and sons

5. M. Khalifa, " High Voltage Engineering Theory and Practice", Marcel Dekker.

Faculty of Engineering and Technology
B.Tech. in Electrical Engineering – Semester VII
Contact Hrs per week (L-T-P): 3-0-0

Course Outlines
BEL035A – Non Conventional Sources of Energy and applications

OBJECTIVE:

- This course provides information regarding working and applications of different non conventional sources of energy.

Unit 1: **Introduction**: Limitations of conventional energy sources, need and growth of alternate energy sources, basic schemes and applications of direct energy conversion.

Unit 2: **MHD Generators and Solar energy**: Basic principles and Hall Effect, generator and motor effect, different types of MHD generators, conversion effectiveness. Practical MHD generators, applications and economic aspects. Solar Energy: Photovoltaic effect, characteristics of photovoltaic cells, conversion efficiency, solar batteries and applications. Solar energy in India, solar collectors, solar furnaces and applications.

Unit 3: **Wind Energy and Thermo-electric Generators**: History of wind power, wind generators, theory of wind power, characteristics of suitable wind power sites, scope in India, advantages and limitations. Thermo-electric Generators: Seeback effect, peltier effect, Thomson effect, thermoelectric convertors, brief description of the construction of thermoelectric generators, applications and economic aspects.

Unit 4: **Fuel Cells**: Principle of action, Gibbs free energy, general description of fuel cells, types, construction, operational characteristics and applications.

Unit 5: **Miscellaneous Sources**: Geothermal system, characteristics of geothermal resources, choice of generators, electric equipment and precautions. Low head hydro plants, definition of low head hydro power, choice of site and turbines.

OUTCOMES:

- Student will be aware of the energy crisis gripping the world and how non conventional energy sources are helpful in meeting that demand.
- They can also now compare different sources of energy with respect to output, availability of raw material, installing and running cost etc.

Text Books:

1. B.H.Khan, "Non Conventional Energy Resources" TMH.

Reference Books:

1. D.S.Chauhan, "Non Conventional Energy Resources" New Age Publication.
2. G.D Rai, "Non-conventional energy sources", Khanna Publishers.
3. H.P.Garg and Jai Prakash, "Solar Energy Fundamentals and Applications", TMH

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Contact Hrs per week (L-T-P): 3-1-0

Course Outlines

BEL036A - Utilization of Electrical Energy and Electric Traction

OBJECTIVE:

- This course provides information regarding working and applications of different sources of illumination, electric heating and electrolytic processes.
- It also in looks the characteristics and control of DC and AC traction motors.

Unit 1: **Illumination**- Nature of light, important definitions, laws of illumination, principle of production of light- discharge through gases under pressure – incandescence/sources of light-filament lamp, halogen lamp-discharge lamp-sodium discharge lamp, high pressure mercury discharge lamp, dual lamps, fluorescent lamps, lamp efficiency, requirements of good lighting, illumination level, absence of contrasts, shadows, glare, colour rendering-lamp fittings. Lighting schemes, design of indoor and outdoor lighting system-street lighting, flood lighting, photometers.

Unit 2: **Electric Heating**- Advantages of electric heating, classification of heating methods, detailed study of resistance heating, arc heating, electron bombardment heating, induction heating and dielectric heating and their control.

Unit 3: **Electrolytic Processes**- Fundamentals of electro deposition-laws of electrolysis applications of electrolysis, electro deposition, manufacture of chemicals, anodizing, electro-polishing, electro-cleaning, electro-parting, electrometallurgy, electric supply.

Unit 4: **Train Mechanics**- Types of services, characteristics of each type of service, speed time curve, simplified speed time curve, average speed, schedule speed, factors affecting schedule speed, tractive effort for propelling a train, power of the traction motor, specific energy output, specific energy consumption, factors affecting specific energy consumption, mechanics of train movement, coefficient of adhesion, factors affecting slip.

Unit 5: **Electric Traction**- DC and AC traction motors, their characteristics Traction Motor Control: Starting and speed control of DC series motors, shunt transition, bridge transition, drum controller employing shunt transition, energy saving with series parallel starting, metadyne control, multiple unit control, braking of traction motors.

OUTCOMES:

- Student should be able to verify why a particular illumination source is chosen for lighting industrial, commercial and residential premises.
- They also know how different traction motors operate.

Text Books:

1.H. Partap, “Art and Science of Utilization of Electrical Energy”.

Reference Books:

1. BR Sharma, “Utilization of Electrical. Energy”.
2. E. Openshan Taylor, “Utilization of Electric Energy”, Orient Longmans.
3. N.V Suryanarayana, “Utilization of Electric Power”.
4. AT Dover, “Electric Traction”, Pitman.

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B.Tech. in Electrical Engineering – Semester VII

Contact Hrs per week (L-T-P): 3-0-0

Course Outlines

BEL037A-Power System Security and Smart Grid

OBJECTIVE:

- The objective of this course is to give knowledge about power system security, voltage stability.
- It also gives information as to how smart grid is helpful in present scenario.

Unit 1: **Power system Security**: Introduction to power system security, System state classification, Security analysis, Contingency analysis, Sensitivity factors and power system voltage stability.

Unit 2: **Voltage Stability I**: Introduction to voltage stability. Comparison of angle and voltage stability. Reactive power flow and voltage collapse. Mathematical formulation of voltage stability problem.

Unit 3: **Voltage Stability II**: Voltage stability analysis. Prevention of voltage collapse. State of the art, future trends and challenges.

Unit 4: **State estimation of Power systems**: An introduction to state estimation of power systems, least squares estimation, static state estimation of power systems. Computational considerations. External system equivalencing. Treatment of bad data. Network observability and Pseudo measurements.

Unit 5: **Smart Grid**: Introduction about smart grid. Aims of the smart grid. Pathways to a smart grid. Components of a smart grid. Optimizing grid operation and use. Optimizing grid infrastructure. Information and communication technologies. New market places, users and energy efficiency. Micro grid and smart micro grid.

OUTCOMES:

- Student should be able to detect the contingencies associated with power system security and about voltage collapse and hence how these can be prevented.
- They now know how optimized grid structure can be established.

Text Books:

1. Modern power system analysis by DP Kothari and IJ Nagrath, 4th Ed.TMH.
2. T.K Nagsarkar and M.S.Sukhija, "Power System Analysis" Oxford Uni. Press.

Reference Books:

1.BR Gupta, "Power System Analysis and Design", S.Chand.
2.P.S.R. Murty, "Operation and control in Power Systems" B.S. Publications.
3.J. Wood and B.F. Wollenburg," Power Generation, Operation and Control " John Wiley
4.P. Kundur, "Power System Stability and Control Mc Graw Hill.

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Contact Hrs per week (L-T-P):0-0-2

Course Outlines
BEL038A - Advanced Simulation Lab

OBJECTIVES:

- To expose the students to learn programming and simulation on MATLAB / Sci Lab software to realize electrical and electronic circuits.

List of Experiments (Perform any 12):

1. Perform various commands of PSPICE/MATLAB/Sci Lab.
2. Determine node voltages and branch currents in a resistive network.
3. Obtain Thevenin's equivalent circuit of a resistive network.

4. Obtain Norton's equivalent circuit of a resistive network.
5. Obtain transient response of a series R-L-C circuit for step voltage and current input and for alternating square voltage waveform.
6. Obtain transient response of a parallel R-L-C circuit for step voltage and current input and for alternating square voltage waveform.
7. Obtain frequency response of a series R-L-C circuit for sinusoidal voltage input.
8. Obtain frequency response of a parallel R-L-C circuit for sinusoidal voltage input.
9. Determine line and load currents in a three phase delta circuit connected to a 3-phase balanced AC supply.
10. Determine z,y,g,h and transmission parameters of a two part network.
11. Obtain transient response of output voltage in a single phase half wave rectifier circuit using capacitance filter.
12. Obtain output characteristics of CE NPN transistor.
13. Obtain frequency response of a R-C coupled CE amplifier.
14. Obtain frequency response of an op-Amp integrator circuit.
15. Verify truth tables of NOT, AND or OR gates implemented by NAND gates by plotting their digital input and output signals.

OUTCOMES:

- Students can now use programming / simulation skills to get output on any electrical and electronic circuits.

Faculty of Engineering and Technology
B.Tech. in Electrical Engineering – Semester VII
Contact Hrs per week (L-T-P):3-0-0

Course Outlines
BEL040A - EHV AC/DC Transmission

OBJECTIVE:

- This course explains the need and application of EHV AC and DC transmission, load frequency control (and its methods) and voltage control.

*Unit 1***: EHV AC Transmission:** Need of EHV transmission lines, power handling capacity and surge impedance loading. Problems of EHV transmission, bundled conductors: geometric mean radius of bundle, properties of bundle conductors. Electrostatic fields of EHV lines and their effects, corona effects: Corona loss, audio and radio noise.

Unit 2: **Load Frequency Control:** Introduction to control of active and reactive power flow, turbine speed governing system. Speed governing characteristic of generating unit and load sharing between parallel operating generators.

Unit 3: **Method of Load Frequency Control:** Flat frequency, flat tie line and tie line load bias control. Automatic generation control

Unit 4: **Voltage Control:** No load receiving end voltage and reactive power generation. Methods of voltage control. Synchronous phase modifier, shunt capacitors and reactors, saturable reactors, Thyistorised static VAR compensators- TCR, FC-TCR and TSC- TCR.

Unit 5: **HVDC Transmission:** Types of DC links, advantages and disadvantages of HVDC transmission. Basic scheme and equipment of converter station. Ground return. Basic principles of DC link control and basic converter control characteristics. Application of HVDC transmission.

OUTCOMES:

- Students will now be able to compare EHV AC and DC transmission.
- They will also be in position realize the problems and precautions associated with EHV transmission.

Text Books:

1. R.D. Begamudre-EHV AC Transmission Engineering.
2. K.R. Padiyar-HVDC Power Transmission System

Reference Books:

1. J.J Grainger and W.D. Stevenson-Power system analysis.
2. B.R Gupta-Generation of Electrical Engineering.

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Contact Hrs per week (L-T-P): 3-0-0

Course Outlines
BEL041A- Power Systems Stability

OBJECTIVE:

- This course helps in modelling of synchronous machine. It also gives information regarding various stabilities methods.

Unit :1 **Modelling of synchronous machines:** Modelling of cylindrical rotor salient pole synchronous machines, flux linkage equations, voltage equations, Park's transformation, various inductances and time constraints of synchronous machines, vector diagrams for steady state and transient conditions, power angle curves.

Unit :2 **Swing equation:** Development of Swing equation including various factors which effect it.

Unit :3 **Machine Systems:** Steady state stability of single machine connected to an infinite bus by the method of small oscillations. Two machine systems. Coherent and non-coherent machines.

Unit :4 S**tudy of various stability methods:** Fault clearing time and critical clearing angle. Solution of Swing equation by step by step method. Euler's Method and Runga-Kutta Method, Application of Computers in the study of transient stability using these methods. Introduction to steady state and transient Stability using these methods. Introduction to steady state and transient stabilities of multi-machine system without controller.

Unit 5: **Methods and equipments affecting Stabilities:** High speed circuit breakers, auto-reclosing circuit breaker, single pole operation, excitation control, and bypass valving.

OUTCOMES:

- Students will now be able to compare different stabilities methods to find the best for a particular situation.

Text book:

1. BR.Gupta: “Power system Analysis and Design”, S.Chand.

Reference Books:

1. P.S.R. Murty, “Operation and control in Power Systems” B.S. Publications.

2. J. Wood and B.F. Wollenburg," Power Generation, Operation and Control " John Wiley
3. P. Kundur, "Power System Stability and Control Mc Graw Hill.
4. CL Wadhwa, Electrical power system.New Age international publishers.

Faculty of Engineering and Technology
B.Tech. in Electrical Engineering – Semester VII
Contact Hrs per week (L-T-P): 3-0-0

Course Outlines
BEL042A- Operation and Control of Power System

OBJECTIVES:

- To learn to optimized allocation of generating unit to a load centre and controlling of real and reactive power of generator.

Unit 1: **Optimal Power System Operation:** System constraints. Generator operating cost. Input- Output and incremental fuel characteristics of a generating unit. Optimal operation of generators on a bus bar, algorithm and flow chart. Optimal unit commitment, constraints in unit commitment, spinning reserve, thermal and hydro constraints.

Unit 2: **Unit Commitment Solution Methods:** Priority list method and dynamic programming method. Reliability consideration, Patton's security function, security constrained optional unit commitment, start- up considerations

Unit 3: **Optimal Generation Scheduling:** Development of transmission loss and incremental loss equations. Optimal generation scheduling including transmission losses, algorithm and flow chart. Optimal load flow solution. Hydrothermal coordination

Unit 4: **Load Frequency Control:** Control of real and reactive power of generator. Turbine speed governing system, Modelling of speed governing system. Methods of frequency control: flat frequency, flat tie line and tie line load bias control. Block diagram representation of load frequency control of an isolated system, steady state analysis, dynamic response. Introduction to Two – area load frequency control

Unit 5: **Automatic Generation Control:** Speed governing characteristic of a generating unit. Load sharing between parallel operating generators. Introduction to automatic generation control of an area by computer (description of block diagram).

OUTCOMES:

- Students can now know how the control the flow of power to the load centres takes place using turbine governing system and hence load frequency control.

Text book:

1. S Sivanagaraju, G Sreenivasan, "Power System Operation & Control" 1st ed., Pearson Pub.
2. D.P. Kothari, I.J. Nagrath, "Modern Power System Analysis"4th Edition, TMH, 2011

Reference Books:

1. C.L. Wadhwa "Electrical Power Systems", 6th Edition, New Age International, 2012
2. BR.Gupta: "Power system Analysis and Design", S.Chand.

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Contact Hrs per week (L-T-P): 3-0-0

Course Outlines
BEL043A- Excitation of Synchronous Machines and their Control

OBJECTIVES: Students will understand the principle, operation, control and characteristics of different excitation systems of synchronous machines.

Unit 1: **Excitation Systems:** Principle Controls of a generating unit. Arrangement of excitation components, voltage response-ratio. Excitation specifications. Ceiling voltage, time constant and response of excitation systems. Requirements of excitation systems: Classification of excitation systems.

Unit 2: **DC Excitation Systems:** configuration of DC excitation system with main and pilot exciters. Amplidyne and magnetic amplifier.Automatic voltage regulator with magnetic amplifier and Amplidyne. Limitation and problems of DC excitation systems. Improvement in DC excitation system.

Unit 3: **AC Shunt Excitation Systems (Static Rectifier Excitation Systems):** Static thyristor rectifier schemes. Transient Response during fault condition. Use of booster transformer. Application for shunt excitation systems.

Unit 4: **AC Separately Excitation Systems. (Alternator- Rectifier Excitation System):** Scheme of alternator-rectifier excitation system with (i) Diode rectifier and (ii) Thyristor rectifier. Comparison and Application of these schemes. Harmful effects of static excitation systems or system machine components, means of prevention.

Unit 5: **Brushless Excitation Systems:** Brush-slip ring problem. Scheme of Brushless excitation system with rotating diode. Control, protection and monitoring of Brushless excitation system. Introduction to brushless excitation system with rotating thyristors. Introduction to Superconducting Exciter.

OUTCOMES:

- Students can now compare different excitation systems of synchronous machines.

Text book:

1. AE Fitzgerald, Charles Kingsley, & SD Umans, Electrical Machinery, 4th Ed., MGH Pub.

Reference book:

1. MG Say, Theory, Performance and Design of AC Machines, CBS Publishers.
2. C V Jones Unified Theory of Electrical Machines, Butterworths, London 1967
3. Clayton. A.E., "Performance and Design of Direct Current Machines" UBS Publishers.

Faculty of Engineering and Technology
B.Tech. in Electrical Engineering – Semester VII
Contact Hrs per week (L-T-P): 3-0-0

Course Outlines
BEL044A- Turbines and their Control

OBJECTIVES:

- To give information regarding different types of turbines associated with power generation and their control.

Unit 1: **Steam turbines**: Introduction, classification and working of steam turbines. Compounding of steam turbines, steam nozzles.

Unit 2: **Hydro turbines**: Introduction of hydro turbines. Classification of water turbines:
a) Based on type of flow of water.
b) Based on action of water on moving blades.
c) Based on head and quantity of water available.
d) Based on name of originator.
Operation and control of hydro turbines. Characteristics and governing of water turbine. Selection of water turbine

Unit 3: **Hydroelectric power plants**: Run of the river, storage and pumped storage. Working of hydroelectric power plants.

Unit 4: **Gas turbines**: Introduction to gas turbine and gas turbine plants. Elements and working of simple gas turbine power plants, closed cycle gas turbine power plants and combines steam and gas turbine power plants. Comparison of gas turbine power plants with diesel engine and steam power plants. Merits, demerits and applications of gas power plants

Unit 5: **Wind turbines**: Construction, working and application of Horizontal axis wind turbine (HAWT) and Vertical axis wind turbine (VAWT). Comparison of Horizontal axis wind turbine and Vertical axis wind turbine. Speed control for wind turbine. Power versus wind speed characteristics.

OUTCOMES:

- Students will now be able to understand the working and applications of different turbines used in power plants.

Text Books

1. JB Gupta - A course in Power systems, Katson Books.

Reference book:

1. B.R. Gupta-Generation of Electrical Engineering, S.Chand and Co Ltd.
2. B.H.Khan, "Non Conventional Energy Resources" TMH.

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B.Tech. in Electrical Engineering – Semester VII

Contact Hrs per week (L-T-P): 3-0-0

Course Outlines
BEL045A-Advanced Power Electronics

OBJECTIVES:

- The objective of this course is to get knowledge regarding principle, working and application of different converters (DC to DC, AC to AC and DC to AC).

Unit 1: **DC to DC Converter**: Classification of choppers. Principle of operation, steady state analysis of class A chopper, step up chopper, switching mode regulators: Buck, Boost, Buck-Boost, Cuk regulators. Current commutated and voltage commutated chopper.

Unit 2: **AC to AC Converter**: Classification, principle of operation of step up and step down cycloconverter. Single phase to single phase cycloconverter with resistive and inductive load. Three phase to single phase cyclo converter: Half wave and full wave. Cosine
wave crossing technique. Three phase to three phase cyclo converter. Output voltage equation of cyclo converter.

Unit 3: **DC to AC Converter**: Classification, basic series and improved series inverter, parallel inverter, single phase voltage source inverter, steady state analysis, Half bridge and full bridge inverter: Modified Mc Murray and Modified Mc Murray Bedford inverter, voltage control in single phase inverters, PWM inverter, reduction of harmonics, current source inverter, three phase bridge inverter.

Unit 4: **Power Supplies**: Switched mode DC and AC power supplies. Resonant DC and AC power supplies.

Unit 5: **Applications**: Dielectric and induction heating. Block diagram of DC and AC motor speed control.

OUTCOMES:

- Students can now apply the knowledge of these converters to make different power electronic models and applications.

Text Books:

1. M.H. Rashid, Power Electronics: Circuits, devices and applications , PHI.
2. P.S. Bimbhra, "Power Electronics", Khanna Publishers.

Reference Books:

1. Ned Mohan, Tore M. Undeland, William P. Robbins, Power Electronics : Converters, Applications and Design , John Wiley and Sons.
2. M. Ramamoorthy An Introduction to Thyristors and their applications East-West Press.
3. Jacob, Michael Power Electronics: Principles and Application, Vikas Pub. House
4. M.D. Singh and K.B. Khanchandani, Power Electronics, Tata McGraw-Hill.
5. AK Gupta & LP Singh, Power Electronics & Introduction to Drives Dhanpat Rai Pub.