Total Contact Hours = 26 **Total Marks = 1000** **Total Credits = 26**

Semester 5TH		Contact Hours			Max Marks		Total Marks	Credits
Subject Code	Subject Name	L	T	P	Int.	Ext.		
BELES1-501	Power Systems – I (Transmission & Distribution)	3	1	0	40	60	100	4
BELES1-502	Control Systems	3	1	0	40	60	100	4
BELES1-503	Microcontrollers & PLC	3	0	0	40	60	100	3
BELES1-504	Power Systems - I Laboratory	0	0	2	60	40	100	1
BELES1-505	Control Systems Laboratory	0	0	2	60	40	100	1
BELES1-506	Microcontrollers & PLC Laboratory	0	0	2	60	40	100	1
BELES1-507	Institutional/Industrial Training (6-Week) *	0	0	--	60	40	100	3
Departmental Elective - I (Select any One)		3	0	0	40	60	100	3
BELED1-511	Electrical Drives							
BELED1-512	Electrical Machine Design							
BELED1-513	Electromagnetic Waves							
BELED1-514	Electrical Materials							
	Open-Elective	3	0	0	40	60	100	3
BHSMC0-019	Economics for Engineers	3	0	0	40	60	100	3
Total		**18**	**2**	**6**	**480**	**520**	**1000**	**26**

***Note:** During the summer vacation after 4th semester.

POWER SYSTEMS - I

(Transmission & Distribution)

Subject Code:	L	T	P	C	Duration: 60 (Hrs.)
BELES1-501	3	1	0	4	

Course Objectives:

1. To introduce the students to the structure of power and distribution systems.
2. To introduce them to overhead transmission lines and underground cables and make them to understand their operating characteristics.
3. To make them familiar with the components and the mechanical design aspects of overhead transmission lines.

Course Outcomes:

Students will be able:

1. To choose working voltage and economic size of conductors for transmission and distribution sytems.
2. To analyse performance of transmission lines and underground cables.
3. To select and design overhead line insulators and transmission lines.

UNIT-I (15 Hours)

Basics of Power Systems: Evolution and present-day scenario of a power system, Structure of a power system, Bulk power grids and micro-grids, Introduction to electrical energy generation, Distributed energy resources.

Transmission and Distribution Systems: Line diagrams, Transmission and distribution voltage levels and topologies (meshed and radial systems), Synchronous grids (AC) and Asynchronous (DC) interconnections, Comparison of cost of conductors, Choice of working voltage for transmission and distribution, Economic size of conductors, Kelvin's law, Radial and mesh distribution networks, Voltage regulation.

UNIT-II (15 Hours)

Transmission Line Parameters: Types of conductors; Solid, Stranded, ACSR, Hollow and Bundle conductors, Electrical and magnetic fields around conductors, Line parameters of single and double circuit transmission lines, Resistance of transmission lines, Inductance of single phase two wire line, concept of geometric mean distance (G.M.D.), Inductance of three phase lines, Use of bundle conductors, Transposition of power lines, Capacitance of 1-phase and 3-phase lines, Effect of earth on capacitance of conductors.

Performance of Transmission Lines: Sinusoidal steady state representation of lines by equivalent circuits; Representation of short transmission line and medium length line by nominal T & π circuits, Representation of long length line by hyperbolic equations and equivalent T & π circuits, Power flow through transmission lines, Generalized ABCD constants, Voltage regulation and efficiency of short, medium and long lines, Ferranti effect.

UNIT-III (15 Hours)

Circle Diagram and Line Compensation: Receiving end circle diagram for long transmission lines based on ABCD constants, equivalent T circuits, power loci, Surge impedance loading, Reactive power requirement of system, Series and shunt compensation, Synchronous phase modifiers, Rating of phase modifiers.

Cables: Classification of cables based upon voltage and dielectric material, Insulation resistance and Capacitance of single core cable, Dielectric stress, Capacitance of 3 core cables, Methods of laying, Heating effect, Maximum current carrying capacity, cause of failure, Comparison with overhead transmission lines.

UNIT-IV (15 Hours)

Overhead Line Insulators: Types of insulators, String efficiency, Voltage distribution in a string of suspended insulators, Grading ring, Preventive maintenance

Electrical Design Of Transmission Line: Choice of voltage, Selection of conductor size, Choice of span, No. of circuits, Conductor configuration, Insulation design, Selection of ground wire.

Mechanical Design of Transmission Lines: Supporting structures for overhead lines, Elementary ideas about transmission line construction and erection, Stringing of conductors, Spacing, Sag and Clearance from ground, Sag-tension calculations.

Recommended Text Books / Reference Books:

1. B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, "Electric Power Systems", Wiley, 2012.
2. C.L. Wadhwa, "Electric Power Systems", Second Edition, Wiley Eastern Limited, 1985.
3. Harder Edwin. I. "Fundamentals of Energy Production", John Wiley and Sons, 1982.
4. Burke James, J. "Power Distribution Engineering; Fundamentals and Applications" Marcel Dekk., 1996.
5. B.R. Gupta, "Generation of Electrical Energy", S. Chand (1998).
6. C.L. Wadhawa C.L, "A Course in Electrical Power", New Age international Pvt. Ltd
7. I. J. Nagrath and D. P. Kothari, "Power System Engineering", Tata McGraw Hill, 1995.
8. O. L. Elgerd, Electrical Energy System Theory - An introduction, Tata McGraw-Hill Publication

CONTROL SYSTEMS

Subject Code:	L	T	P	C	Duration: 60 (Hrs.)
BELES1-502	3	1	0	4	

Course Objectives:

To make the students:

1. To understand basic concepts of control systems, such as; mathematical modelling, transfer functions, signal flow graphs etc.
2. To learn basic goals of control systems in terms of transient/steady state time response behaviour and frequency response analysis.
3. To understand concept of stability and application of different analysis methods.
4. To introduce to the concept of state variable analysis.

Course Outcomes:

Students will be able:

1. To do modelling of linear-time-invariant systems using transfer function and state-space representations.
2. To do the stability assessment for linear-time invariant systems.
3. To design simple feedback controllers.

UNIT-I (15 Hours)

Introduction: Industrial control examples, Mathematical models of physical systems, Control hardware and their models, Transfer function models of linear time-invariant systems, Laplace transform.

Feedback Control: Open-Loop and closed-loop systems, Benefits of feedback, Block diagram algebra and signal flow graphs.

UNIT-II (15 Hours)

Time Response Analysis: Standard test signals, Time response of first and second order systems for standard test inputs, Application of initial and final value theorem, Design specifications for second-order systems based on the time-response, Steady state error and coefficients.

Concept of Stability: Routh-Hurwitz Criteria, Relative Stability analysis, Root-Locus technique, Construction of Root-loci.

UNIT-III (15 Hours)

Frequency Response Analysis: Relationship between time and frequency response, Polar plots, Bode plots, Nyquist stability criterion, Relative stability using Nyquist criterion, Gain and Phase margin, Closed-loop frequency response.

Introduction to Controller Design: Stability, Steady-state accuracy, Transient accuracy, Disturbance rejection, Methods of controller design in frequency domain, Lead and Lag compensation, Analog and Digital implementation of controllers, Application of Proportional, Integral and Derivative Controllers.

UNIT-IV (15 Hours)

State Variable Analysis: Concepts of state variables, State space model, Diagonalization of State Matrix, Solution of state equations, Eigen values and Stability Analysis, Concept of controllability and Observability, Pole-placement by state feedback, Discrete-time systems, Difference Equations, State-space models of linear discrete-time systems, Stability of linear discrete-time systems.

Recommended Text Books / Reference Books:

1. M. Gopal, "Control Systems: Principles and Design", McGraw Hill Education, 1997.
2. B. C. Kuo, "Automatic Control System", Prentice Hall, 1999.
3. K. Ogata, "Modern Control Engineering", Prentice Hall, 2011.
4. I. J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International, 2009.
5. Dorf Richard C. and Bishop Robert H., Modern Control System, Addison-Wesley, Pearson, 2009.
6. B. S. Manke, Linear Control Systems, 2002

MICROCONTROLLERS AND PLC

Subject Code:	L	T	P	C	Duration: 45 (Hrs.)
BELES1-503	3	0	0	3	

Course Objectives:

1. To introduce to the architecture of microprocessor and microcontroller.
2. To study 8051 microcontrollers in detail.
3. To interface peripheral devices with microprocessors and microcontrollers.
4. To introduce to PLCs and their applications.

Course Outcomes:

The students will;

1. Know about the architecture, operation and instruction set of 8051 microcontroller.
2. Be able to do programming of 8051 microcontrollers.
3. Be able to Interface 8051 with peripheral devices.
4. Be able to use PLCs.

UNIT-I (11 Hours)

Fundamentals of Microprocessors: Fundamentals of microprocessor architecture, 8-bit Microprocessor and Microcontroller architecture, Difference between microprocessor and microcontroller, Definition of embedded system and its characteristics, Role of microcontrollers in embedded Systems.

The 8051 Architecture: PIN diagram of 8051, Internal block diagram, CPU, ALU, address, data and control bus, Working registers, SFRs, Clock and RESET circuits, Stack and Stack Pointer, Program Counter, I/O ports, Memory Structures, Data and Program Memory, Timing diagrams and Execution Cycles.

UNIT-II (12 Hours)

Instruction Set and Programming of 8051

Addressing modes: Introduction, Instruction syntax, Data types, Subroutines Immediate addressing, Register addressing, Direct addressing, Indirect addressing, Relative addressing, Indexed addressing, Bit inherent addressing, Bit direct addressing,

8051 Instruction set: Instruction timings, Data transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Subroutine instructions, Bit manipulation instructions.

Assembly language programs, Assemblers and compilers, Programming and debugging tools.

UNIT-III (11 Hours)

Memory and I/O Interfacing: Memory and I/O expansion buses, control signals, memory wait states. Interfacing of peripheral devices such as General Purpose I/O such as LED, LCD, keyboard, ADC, DAC, timers, counters, memory devices.

External Communication Interface: Synchronous and asynchronous communication, RS232, SPI, I2C, Introduction and interfacing to protocols like Blue-tooth and Zig-bee.

Microcontroller Applications: Stepper motor interfacing, DC motor interfacing, Sensor interfacing, Application of microcontrollers in Arduino.

UNIT-IV (11 Hours)

Introduction to Programmable Logic Controllers

Introduction, Operation of PLC, Difference between PLC and Hardwired system, Difference between PLC and Computer, Relay logic and ladder logic, Ladder commands and examples of PLC ladder diagram realization, PLC timers, PLC counters, Applications of PLC, PLC interfacing with HMI/SCADA system.

Recommended Text Books / Reference Books:

1) M. A. Mazidi, The 8051 Microcontroller and Embedded System, Pearson Education (2008).
2) Kenneth J Ayola, The 8051 Micro Controller- Architecture, Programming and Application, Penram International Publication
3) R. S. Gaonkar, “, Microprocessor Architecture: Programming and Applications with the 8085”, Penram International Publishing (India) Pvt. Ltd., 2004.
4) D. V. Hall, “Microprocessors & Interfacing”, McGraw Hill Higher Education, 1991.
5) B. Ram, Fundamentals of Microprocessors and Microcomputers, Dhanpat Rai andSons.
6) Otter, Job Dan, *Programmable Logic Controller*, P.H. International, Inc, USA
7) Dunning Gary, *Introduction to PLCs*, Tata McGraw Hill
8) John B Peatman, *Design with Micro Controller*, Tata McGraw Hill
9) Udayashankara V. and Mallikarjunaswamy M.S., *8051 Microcontroller Hardware, Software and Applications*, TataMcGraw Hill Education Pvt. Ltd., (2010)

POWER SYSTEMS – I LABORATORY

Subject Code:	L	T	P	C
BELES1-504	0	0	2	1

Course Objectives:

To demonstrate the various equipment and concepts related to;

1. Transmission and distribution of power, such as cables, conductors, insulators, supporting structures etc.
2. To visit a power/substation.

Course Outcomes:

1. Students will have more detailed insight about the need of various equipment used for transmission and distribution of power.
2. They will be able to draw performance characteristics of these equipment.
3. To practically compute parameters and performance of transmission lines and feeders.

LIST OF EXPERIMENTS

1. To measure active power, reactive power and power factor of a three phase load by two-wattmeter method and power factor meter and verify through current, voltage and power measurement.
2. To compute the ABCD parameters of a transmission line.
3. To analyze the performance of short and medium length transmission lines and to determine efficiency and voltage regulation.
4. To analyze the performance of long transmission line and to determine its efficiency and voltage regulation and to demonstrate Ferranti effect.
5. To find the earth resistance using three spikes.
6. To study the radial feeder performance (i) fed at one end and (ii) fed at both ends.
7. To study and demonstrate different types of transmission and distribution conductors and models of cables.
8. To measure insulation resistance of a cable.

   OR

   To measure the capacitance of single-core and three-core cables.
9. To study and demonstrate the methods of fault location in cables.
10. To study different types of supporting structures and insulators for conductors. Also to determine the efficiency of a string of insulators.
11. Optimal capacitor placement on a system having variable reactive power and low voltage profile.
12. Design a transmission system for given power and distance.

    OR

    Design of a small distribution system.

Note: At least ten experiments should be performed in a semester.

CONTROL SYSTEMS LABORATORY

Subject Code:	L	T	P	C
BELES1-505	0	0	2	1

Course Objectives:

1. To understand the basics concepts of MATLAB software.
2. To introduce variety of control system strategies.
3. To comment about the stability of designed systems.

Course Outcomes:

1. To understand the basics of MATLAB software.
2. To understand variety of control system strategies.
3. To acquire skills to understand all types of control components.
4. Ability to analyse the stability of control systems.

LIST OF EXPERIMENTS

1. Familiarization with MATLAB and its control system toolbox. Familiarization with MATLAB Simulink toolbox.
2. Determination of step response for first order and second order system with unity feedback and their display on CRO. Calculation and verification of time constant, peak overshoot, setting time etc. from the response.
3. Simulation of step response and impulse response for type-0, type-1and type-2 systems with unity feedback using MATLAB.
4. Determination of Root Locus, Bode-Plot, Nyquist Plot using MATLAB-Control system toolbox for 2nd order system. Determination of different control system performance indices from the plots.
5. Determination of PI, PD, PID controller action of first order simulated process.
6. Experimental determination of approximate transfer function from Bode plot.
7. Evaluation of steady state error, setting time, percentage peak overshoot, gain margin, phase margin, with addition of lead compensator and by compensator in forward path transfer function for unity feedback control system.
8. Determination of control system specifications for variations of system parameters in practical position control system.
9. Design of a second order linear time invariant control system and study of system response with unit step input.

10. To study the characteristics of potentiometers and to use 2- potentiometers as an error detector in a control system.
11. To study the Synchro Transmitter-Receiver set and to use it as an error detector.
12. To study the Speed – Torque characteristics of a DC Servo Motor and explore its applications.
13. To obtain the transfer function of a D.C. motor – D.C. Generator set using Transfer Function Trainer.
14. To study the speed control of an A.C. Servo motor using a closed loop and open loop systems.
15. (i) To study the operation of a position sensor and study the conversion of position in to corresponding voltage (ii) To study a PI control action and show its usefulness for minimizing steady state error of time response.

Note: At least twelve experiments should be performed in semester.

MICROCONTROLLER AND PLC LABORATORY

Subject Code:	**L**	**T**	**P**	**C**
BELES1-506	**0**	**0**	**2**	**1**

Course Objectives:
To make the students:
1. Familiar with microprocessor and microcontroller kits.
2. To write and demonstrate assembly language programms for arithmatic and logical operations.
3. To interface peripheral devices to microcontrollers and to write programs to control their operation.
4. To demonstrate applications of PLCs.

Course Outcomes:
Students will:
1. Become familiar with the microcontrollers and PLCs.
2. Be able to write assembly language programms for various types of applications.
3. Become familiar with the use of PLCs in industry.

LIST OF EXPERIMENTS

1. Introduction to 8085 Microprocessor kit/simulator and 8051 Microcontroller kit/simulator.
2. Write a program to (i) Add (ii) Subtract (iii) Multiply and (iv) Divide, two 8-bit numbers

lying at two memory locations and display the result.

3. Write a program to check a number for being ODD or EVEN and show the result on display.

   OR

   Write a program to split a byte in two nibbles and show the two nibbles on display.
4. Write a program to arrange TEN numbers stored in memory location in ascending and descending order.
5. Write a program to
   (i) Find a factorial of a given number.
   (ii) Generate Fibonaci Series
   (i) Sum up a finite series
6. Study of interrupt structure of 8051 micro-controllers and to write a program to show the use of INT0 and INT1.
7. Write a program of flashing LED connected to port 1 of the micro-controller

   OR

   Write a program to develop rolling display.
8. Write a program to control a stepper motor in direction, speed and number of steps.
9. Write a program to control the speed of DC motor.
10. Implementation of different gates using PLC.
11. Implementation of DOL and star delta starter using PLC.
12. Implement basic logic operations, motor start and stop operation using
    (i) Timers (ii) Counters
13. Motor forward and reverse direction control using PLC.
14. Make a PLC based system (i) for rack feeder and/or (ii) for conveyor belt and/or (ii) for separating and fetching work pieces.

    OR

    Implement a PLC based traffic light control.

Note: At least Ten experiments should be performed in a semester.

ELECTRICAL DRIVES

Subject Code:	**L T P C**	**Duration: 45 (Hrs.)**
BELED1-511	**3 0 0 3**	

Course Objectives:

1. To review the characteristics of DC motors.
2. To know about the operation of DC drives and their speed control methods using power electronic converters.
3. To know about the various control stratigies of induction motors using power electronic control methods.

Course Outcomes:

Students will be able:

1. To draw the characteristics of DC motors and induction motors.

2. To control the speed of DC motors using power electronic converters.
3. To use power electronic converters for induction motor speed control.

UNIT-I (11 Hours)

DC Motor Characteristics

Review of e.m.f and torque equations of DC machine, review of torque-speed characteristics of separately excited DC motor, Change in torque-speed curve with armature voltage, Load torque-speed characteristics, Operating point, Armature voltage control for varying motor speed, Flux weakening for high speed operation.

Chopper Fed DC Drive

Review of DC chopper and duty ratio control, Chopper fed DC motor for speed control, Steady state operation of a chopper fed drive, Armature current waveform and ripple, Calculation of losses in DC motor and chopper, Efficiency of DC drive, Smooth starting.

UNIT-II (12 Hours)

Multi-Quadrant DC Drive

Review of motoring and generating modes operation of a separately excited DC machine, Four quadrant operation of DC machine; Single-quadrant, Two-quadrant and Four-quadrant choppers; Steady-state operation of multi-quadrant chopper fed DC drive, Regenerative braking.

Closed-loop Control of DC Drive

Control structure of DC drive, Inner current loop and outer speed loop, Dynamic model of DC motor, Dynamic equations and transfer functions, Modeling of chopper as gain with switching delay, Plant transfer function for controller design, Current controller specification and design, Speed controller specification and design.

UNIT-III (11 Hours)

Induction Motor Characteristics: Review of induction motor equivalent circuit and torque-speed characteristic, Variation of torque-speed curve with (i) applied voltage, (ii) applied frequency and (iii) applied voltage and frequency, Typical torque-speed curves of fan and pump loads, Operating point, Constant flux operation, Flux weakening operation.

Control of Slip Ring Induction Motor

Impact of rotor resistance of the induction motor torque-speed curve, Operation of slip-ring induction motor with external rotor resistance, Starting torque, Power electronic based rotor side control of slip ring motor, Slip power recovery.

UNIT-IV (11 Hours)

Scalar Control or Constant V/f Control of Induction Motor

Review of three-phase voltage source inverter, Generation of three-phase PWM signals, Sinusoidal modulation, Space vector theory, Conventional space vector modulation, Constant V/f control of induction motor, Steady-state performance analysis based on equivalent circuit, Speed drop with loading, Slip regulation.

Recommended Text Books / Reference Books:

1) G. K. Dubey, "Power Semiconductor Controlled Drives", Prentice Hall, 1989.
2) R. Krishnan, " Electric Motor Drives: Modeling, Analysis and Control", Prentice Hall, 2001.
3) G. K. Dubey, " Fundamentals of Electrical Drives", CRC Press, 2002.
4) W. Leonhard, "Control of Electric Drives", Springer Science & Business Media, 2001.

ELECTRICAL MACHINE DESIGN

Subject Code:	**L**	**T**	**P**	**C**	**Duration: 45 (Hrs.)**
BELED1-512	**3**	**0**	**0**	**3**	

Course Objectives:

1. Understand the principles of electrical machine design.
2. To know about the various factors which influence the design: electrical, magnetic and thermal loading of electrical machines
3. To design transformers and induction motors.
4. To introduce to use of computers in design.

Course Outcomes:

Students will:

1. Know the constructional features.
2. Be able to evaluate performance characteristics of electrical machines.
3. Be able to carry out a basic design of an ac machine.
4. Be able to use software tools to do design calculations.

UNIT-I (11 Hours)

Introduction: Major considerations in electrical machine design, Electrical engineering materials, Space factor, Choice of specific electrical and magnetic loadings, Thermal considerations, Heat flow, Temperature rise, Rating of machines.

UNIT-II (12 Hours)

Transformers:

Sizing of a transformer, Main dimensions, Output kVA for single- and three-phase transformers, Window space factor, Overall dimensions, Operating characteristics,

Regulation, No load current, Temperature rise in transformers, Design of cooling tank, Methods for cooling of transformers.

UNIT-III (11 Hours)

Induction Motors:

Sizing of an induction motor, Main dimensions, Length of air gap, Rules for selecting rotor slots of squirrel cage machines, Design of rotor bars & slots, Design of end rings, Design of wound rotor, Magnetic leakage calculations, Leakage reactance of poly-phase machines, Magnetizing current, Short circuit current, Circle diagram, Operating characteristics.

UNIT-IV (11 Hours)

Computer aided Design (CAD):

Limitations (assumptions) of traditional design, Need for CAD analysis, Synthesis and hybrid methods, Design optimization methods, Variables, Constraints and Objective function, Problem formulation.

Introduction to FEM based machine design.

Introduction to **c**omplex structures of modern machines: Permanent magnet synchronous motor (PMSM), Brushless DC motor (BLDC), Switched reluctance motor (SRM) and Claw-pole machines.

Recommended Text Books / Reference Books:

1) A. K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai and Sons, 1970.
2) M.G. Say, "Theory & Performance & Design of A.C. Machines", ELBS London.
3) S. K. Sen, " Principles of Electrical Machine Design with Computer Programmes", Oxford and IBH Publishing, 2006.
4) K. L. Narang, " A Text Book of Electrical Engineering Drawings", SatyaPrakashan, 1969.
5) A. Shanmugasundaram, G. Gangadharan and R. Palani, " Electrical Machine Design Data Book" , New Age International, 1979.
6) K. M. V. Murthy, " Computer Aided Design of Electrical Machines", B.S. Publications, 2008.
7) Electrical machines and equipment design exercise examples using Ansoft's Maxwell 2D machine design package.

ELECTROMAGNETIC WAVES

Subject Code:	L T P C	Duration: 45 (Hrs.)
BELED1-513	3 0 0 3	

Course Objectives:

1. Analyse transmission lines and estimate voltage and current at any point on transmission line for different load conditions.
2. Analyse the field equations for the wave propagation in special cases such as lossy and low loss dielectric media.
3. To analyse radiation by antennas.

Course Outcomes:

Students can:

1. Provide solution to real life plane wave problems for various boundary conditions.
2. Visualize TE and TM mode patterns of field distributions in a rectangular wave-guide.
3. Analyze wave-guides and understand radiation by antennas.

UNIT-I (15 Hours)

Transmission Lines: Introduction, Concept of distributed elements, Equations of voltage and current, Standing waves and impedance transformation, Lossless and low-loss transmission lines, Power transfer on a transmission line, Analysis of transmission line in terms of admittances, Transmission line calculations with the help of Smith chart, Applications of transmission line, Impedance matching using transmission lines.

Maxwell's Equations: Basic laws of Electromagnetics, Gauss's law, Ampere's Circuital law, Faraday's law of Electromagnetic induction. Maxwell's equations, Surface charge and surface current, Boundary conditions at media interface.

UNIT-II (15 Hours)

Uniform Plane Waves: Homogeneous unbound medium, Wave equation for time harmonic fields,Solution of the wave equation, Uniform plane wave, Wave polarization, Wave propagation in conducting medium, Phase velocity of a wave, Power flow and Poynting vector.

Plane Waves at Media Interface: Plane wave in arbitrary direction, Plane wave at dielectric interface, Reflection and refraction of waves at dielectric interface, Total internal reflection, Wave polarization at media interface, Brewster angle, Fields and power flow at media interface, Lossy media interface, Reflection from conducting boundary.

UNIT-III (15 Hours)

Waveguides: Parallel plane waveguide, Transverse Electric (TE) mode, Transverse Magnetic (TM) mode, Cut-off frequency, Phase velocity and dispersion. Transverse Electromagnetic (TEM) mode, Analysis of waveguide-general approach, Rectangular waveguides.

Antennas: Radiation parameters of antenna, Potential functions, Solution for potential functions, Radiations from Hertz dipole, Near field, Far field, Total power radiated by a dipole, Radiation resistance and radiation pattern of Hertz dipole, Hertz dipole in receiving mode.

Recommended Text Books / Reference Books:

1) R. K. Shevgaonkar, **"**Electromagnetic Waves**"**, Tata McGraw Hill, 2005.
2) D. K. Cheng, " Field and Wave Electromagnetics**"**, Addison-Wesley, 1989.
3) M. N.O. Sadiku, "Elements of Electromagnetics**"**, Oxford University Press, 2007.
4) C. A. Balanis, " Advanced Engineering Electromagnetics", John Wiley & Sons, 2012.
5) C. A. Balanis, " Antenna Theory: Analysis and Design**"**, John Wiley & Sons, 2005.

ELECTRICAL MATERIALS

Subject Code:	L	T	P	C	Duration: 45 (Hrs.)
BELED1-514	3	0	0	3	

Course Objectives:

1. Aware about various types of conducting materials and their applications.
2. Aware about various properties of insulating materials and their applications.
3. Aware about various types of magnetic materials and their applications.

Course Outcomes:

1. Analyze the characteristics of different types of materials viz. conductors, insulators, and magnetic materials etc.
2. Select a suitable material for manufacturing electrical equipment.

UNIT-I (15 Hours)

Conducting Materials: Classification of material into conducting, semi conducting and insulating materials, Factors affecting resistance such as alloying and temperature, Classification of conducting material as low resistivity and high resistivity materials, Low resistivity copper alloys and their practical applications, Applications of special metals, High resistivity materials and their applications, Super conductivity.

UNIT-II (15 Hours)

General Properties of Insulating Materials

Electrical Properties: Volume resistivity, Surface resistance, Dielectric loss, Dielectric strength (breakdown voltage), Dielectric constant,

Physical Properties: Hygro-scopicity, Tensile and Compressive strength, Abrasive resistance, Brittleness.

Thermal Properties: Heat resistance, Classification based on permissible temperature rise,

Effect of overloading on the life of an electrical appliance, Increase in rating with the use of insulating materials having higher thermal stability, Thermal conductivity, Electro-thermal breakdown in solid dielectrics.

Chemical Properties: Solubility, Chemical resistance, Weather-ability, Mechanical properties, Mechanical structure, Tensile structure.

Applications of Insulating Materials

Definition and classification of plastics, Thermosetting materials, Thermo-plastic materials, Natural insulating materials, Properties and their applications, Gaseous materials, Ceramics, properties and applications.

UNIT-III (15 Hours)

Magnetic Materials and Special Materials: Introduction and classification of ferromagnetic materials, Permeability, B-H curve, Magnetic saturation, Hysteresis loop (including) coercive force and residual magnetism, Concept of eddy current and Hysteresis loss, Curie temperature, Magneto-striction effect, Soft Magnetic Materials, Hard magnetic materials, Hall effect and its applications, Thermocouple, Bimetals, Leads, Soldering and Fuses material and their applications.

Recommended Text Books / Reference Books:

1) SK Bhattacharya, "Electrical and Electronic Engineering Materials"1st edition Khanna Publishers, New Delhi,2006.(Unit 1,2,3)
2) A.J. Dekker "Electrical Engineering Materials", PHI, 2006. (Unit 4,5)
3) Grover and Jamwal, "Electronic Components and Materials" DhanpatRai and Co., New Delhi.
4) Sahdev, "Electrical Engineering Materials", Unique International Publications
5) C. S. Indulkar& S. Thiruvengadam, "Electrical Engineering Materials", S. Chand & Com. Ltd, New Delhi -55
6) S.P. Seth, P.V. Gupta "A course in Electrical Engineering Materials", Dhanpat Rai& Sons.

ECONOMICS FOR ENGINEERS

Subject Code: BHSMC0-019 **L T P C** **Duration: 45 Hrs**
3 0 0 3

Course Objectives
The main aim of this course is:

1. To equip the students of management with time tested tools and techniques of managerial economics to enable them to appreciate its relevance in decision making.
2. To explore the economics of information and network industries and to equip students with an understanding of how economics affect the business strategy of companies in these industries.
3. To develop economic way of thinking in dealing with practical business problems and challenges

Course Outcomes
After completing this course, the students will be able to:

1. Able to analyze the demand and supply conditions of the market and accordingly assess the position of a company.
2. Understand the basic economic problems faced by the society and make effective decisions.
3. Design competition strategies which includes costing, pricing, product differentiation, and market environment according to the natures of products and the structures of the markets.
4. Analyze the market competitions and design strategies accordingly.

UNIT-I (12 Hrs.)

Micro Economics: Meaning, Nature, Scope and Limitations Basic concepts: Marginal and Incremental Principles, Opportunity Cost, Equilibrium Utility: Cardinal Utility Approach: Diminishing Marginal Utility; Ordinal Utility Approach, Indifference Curve, Properties, Consumer Equilibrium and Marginal Rate of Substitution.

UNIT-II (11 Hrs.)

Demand: Meaning, Determinants, Law of Demand and its Exceptions. Elasticity of Demand: Measurement, Degree of Elasticity. Price, Income and Cross Elasticity of Demand. Revenue: Total Revenue (TR), Average Revenue (AR), Marginal Revenue (MR) and their Relationship.

UNIT-III (12 Hrs.)

Production Function: Meaning, Short-Run Production Function and Law of Variable Proportions, Long Run Production and Laws of Returns. Cost of Production: Concept of Economic and Managerial Costs, Short Run and Long Run Cost Curves. Economies and Diseconomies of Scale

UNIT-IV (10 Hrs.)

Equilibrium of Firm and Industry: Perfect Competition, Monopoly and Discriminating Monopoly. Monopolistic Competition: Characteristics, Individual and Group Equilibrium, Concept of Selling Cost. Oligopoly: Characteristics, Cornet's Model, Kinked Demand Curve, Concepts of Cartel and Price Leadership. Distribution: Marginal Productivity and Modern Theory of Determination.

Recommended Books

1. D. Salvatore, 'Microeconomic Theory', Tata McGraw Hill.
2. R.H. Dholkia and A.N. Oza, 'Microeconomics for Management Students', Oxford University Press.
3. D.N. Dwivedi, 'Managerial Economics', Vikas Publishing
4. P.L. Mehta, 'Managerial Economics', Sultan Chand.