Total Credits = 20

Semester 7TH		Contact Hours			Max Marks		Total Marks	Credits
Subject Code	Subject Name	L	T	P	Int.	Ext.		
BELES1-701	Power System Analysis	3	0	0	40	60	100	3
BELES1-702	Introduction to Industry 4.0	2	0	0	40	60	100	2
BELES1-703	Power System Analysis Lab	0	0	2	60	40	100	1
BELES1-704	Minor Project	0	0	4	60	40	100	2
BELES1-705	Summer Internship (6-Week)	0	0	--	60	40	100	3
Departmental Elective - IV (Select any One)		3	0	0	40	60	100	3
BELED1-711	High Voltage Engineering							
BELED1-712	Electrical & Hybrid Vehicles							
BELED1-713	Introduction to Digital Protection							
BELED1-714	Digital Signal Processing							
XXXXX	**Open-Elective***	3	0	0	40	60	100	3
BHSMC0-024	Project Management & Entrepreneurship	3	0	0	40	60	100	3
	Total	-	-	-	**380**	**420**	**800**	**20**

*Open Electives (OE) can also be taken from existing lists of Open Elective-I, Open Elective-II and Open Elective-III subject lists.

POWER SYSTEM ANALYSIS

Subject Code:	L T P C	Duration: 45 (Hrs.)
BELES1-701	3 0 0 3	

Course Objectives:

1. To understand the importance of per unit system, single line diagram and impedance diagrams of electric networks in power system analysis.
2. To gain the information about various types of buses in the electric network and the type of data required for power flow studies.
3. To understand the different types of faults in the system and methods to analyze these faults.
4. To understand the issues related to power system stability.

Course Outcomes:

1. Develop per unit system models of synchronous machines, transformers, transmission lines and static loads for power system studies.
2. Perform load flow studies by using bus admittance matrix and to do fault analysis by bus impedance matrix.
3. Compare features of Gauss-Siedel, Newton-Raphson and Decoupled methods of load flow analysis.
4. Analyze the effect of symmetrical and unsymmetrical faults on power system.
5. Analyze the effect of small and large disturbances on power system stability.

UNIT-I (11Hours)

System Modeling:

Single-phase representation of balanced three-phase networks, Single line impedance diagrams, Per unit system of a power system, Per-unit representation of a transformer, Steady state model of synchronous machine and its performance characteristics, Operation when connected to infinite bus, Real and Reactive power capability curve of synchronous generators, System modeling of transformer, and different Load types.

UNIT-II (12 Hours)

Load Flow Studies: Network model formulation, Formulation of bus admittance matrix for the electricalnetworks, Data for the load flow studies, Bus types, Swing bus,
Formulation of power flow equations, An approximate load flow (LF) solution, Iterative solutions of load flow equations by the Gauss-Seidal (GS) method and Newton-Raphson (NR) Method, Algorithms and flow charts of these methods, Line flows and line losses calculations, Decoupled Newton (DLF) method, Comparison among GS, NR and DLF methods.

UNIT-III (11 Hours)

Symmetrical Fault Analysis:

Transients on a transmission line, Short circuit of a synchronous machine (both on no load and on load), Symmetrical fault analysis using Thevenin's theorem, Selection of circuit

breakers, Algorithm for short circuit studies, Formulation of bus impedance matrix.

Symmetrical Components:

Symmetrical component transformation, Sequence impedances and networks of; Transmission lines, Synchronous machine and Transformers, Construction of sequence networks of a power system.

Unsymmetrical Fault Analysis:

Analysis of unsymmetrical LG (line to ground) fault, LL (line to line) fault, LLG (double line to ground) fault using symmetrical components, Symmetrical and unsymmetrical fault analysis using Bus Impedance Matrix with algorithm and flow chart.

UNIT-IV (11 Hours)

Power System Stability:

Steady state stability, Dynamics of a synchronous machine, Power angle equation, Transient stability, Equal area criterion and its application to study the effect on transient stability of; Sudden change in mechanical input, Effect of clearing time on stability, Sudden loss of one of parallel lines, Sudden short circuit on one of parallel lines, Numerical solution of swing equation, Factors effecting transient stability.

Recommended Text Books / Reference Books:

1. D. P. Kothari and I. J. Nagrath, "Modern Power System Analysis", McGraw Hill Education, 2003.
2. D.P. Kothari & J.S. Dhillon, Power System Optimization, Prentice-Hall of India
3. J. Grainger and W. D. Stevenson, "Power System Analysis", McGraw Hill Education, 1994.
4. R. Bergen and V. Vittal, "Power System Analysis", Pearson Education Inc., 1999
5. J. Arrillaga and C. P. Arnold, Computer Aided Power System, John Wiley and Sons, 1994.
6. Stagg Glenn W. and Ei-Abiad Ahmed H., Computer Methods in Power System Analysis,Tata McGraw Hill
7. Kusic G.L., Computer Aided Power System analysis, Prentice Hall,India
8. Nagsarkar T.K. and Sukhija M.S., Power System Analysis, Oxford University Press, 2016.

INTRODUCTION TO INDUSTRY 4.0

Subject Code:	L	T	P	C	Duration: 30 (Hrs.)
BELES1-702	2	0	0	2	

Course Objectives:

1. To train the students to cope up with the upcoming demand of the industry.
2. To introduce the students to the emerging areas of importance like Internet of Things (IoT), Cloud, Big Data, Robotics, Block Chain, Artificial Intelligence (AI), Machine Learning etc.

Course Outcomes:

1. Understanding about the emerging demands of the industry.
2. To develop an insight about the better human-machine interface.

UNIT-I (07 Hours)

Various Industry Revolutions:

Define Data, Meaning of going digital**,** Difference between Digitisation & Digitalisation, Interdependence of technologies in the digital world**,** Role of Digital, Digitisation and Digitalisation in our lives.

Internet of Things (IoT):

Definition and working of IoT**,** Integration of different components of IoT**,** Impact of IoT on Industries, Machine to Machine communication(M2M), Limitations of IoT.

UNIT-II (08 Hours)

Cloud:

Definition of cloud computing**,** Laas, PaaS, SaaS & Bpaas**,** Importance of cloud, Advantages and disadvantages of cloud**,** Meaning of a Cloud-based Open IoT Operating System (PaaS).

Big Data:

Difference between data and bigdata**,** Characteristic of bigdata**;** Volume, Velocity, Variety, Veracity and Value**.**

Data Analysis: Descriptive analysis, Predictive analysis, Prescriptive analysis

Blockchain: Mechanism of Cryptocurrency**,** Working of blockchain technology**,** Mining and miner.

UNIT-III (08 Hours)

Artificial Intelligence (AI):

Tasks of AI: visual perception, speech recognition, decision making, translation between languages**,** Subfields of Artificial Intelligence, such as; Machine Learning, Neural Network, Deep Learning, Cognitive Computing, Computer vision, Natural Language Processing**,** Benefits of Artificial Intelligence in Industries**.**

Machine Learning (ML):

Relationship between ML and AI**,** Importance of ML for individuals and companies, **Use of ML for;** Interpretation of past customer behaviour, Simplification of product marketing, Accurate sales forecasting, Accurate medical prediction and diagnosis**,** Simplification in documentation and data entry, Improvement in precision of financial rules and models**,** Detection of Spam, Increasing the efficiency of predictive maintenance in manufacturing industry**,** Better customers egmentation and accurate lifetime value prediction**,** Recommendation of the right product**.**

MachineLearningAlgorithmsCategories: Supervised,UnsupervisedandReinforcement

UNIT-IV (07 Hours)

Plant Integration:

Standardization; Open network Interface**,** M2M communication**,** Combination of individual machines in to asynchronized production line**,** Manage of dark data i.e. Complex data Management.

Virtual Commissioning/Digital Twin:

End-to-end engineering, Mechanical design to electrical layout and automation, Detecting mechanical problems/ software errors at an early stage?

Industrial Edge:

Local and cloud computing/on-premise and off-premise**,** Industrial Edgeandits Benefits to Industry

Recommended Text Books / Reference Books:

1. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress Publishers, June 2016.
2. Sudip Misra, "Introduction to Industry 4.0 and Industrial Internet of Things" SWAYAM Course.
3. Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat, "Industrial Internet of Things: Cybermanufacturing Systems", Springer.
4. Research papers

POWER SYSTEM ANALYSIS LAB

Subject Code:	L	T	P	C
BELES1-703	0	0	2	1

Course Objectives:

To enable the students:

1. To develop and execute software programs to formulate bus matrices.
2. To develop software programs or use dedicated programming tools for execution of load flow analysis.
3. To develop or use software programs for fault analysis.

Course Outcomes:

1. Ability to develop software programs for bus matrices.
2. Capability to develop or use software programs for load flow analysis.
3. Ability to compute fault currents.

List of Experiments

1. Introduction to software tools for power system studies like MiPower, ETAPetc. and/or some high level programming language such asMATLAB, C++ etc.
2. To develop a program for formation of bus admittance matrix.
3. To develop a program for approximate load flow analysis.
4. To develop a program for load flow analysis by Gauss Seidal method.
5. To develop a program for load flow analysis by Newton Raphson method.
6. To develop a program for formation of bus impedance matrix using building algorithm.
7. To calculate short circuit current and circuit breaker ratings for a power system network.
8. Fault analysis for line-to-line (L-L) fault, Line-to-Ground (L-G)fault etc.
9. To find synchronous reactances (Transient, sub-transient) during faultanalysis.
10. To develop a program for economic load dispatch of power systems.
11. Power system stability studies on a single machine system.

Note: Atleast eight experiments must be performed from the given list.

MINOR PROJECT

Subject Code:	L	T	P	C
BELES1-704	0	0	4	2

Course Objective:

To enable the students to take up investigative study (theoretical and /or practical) in the broad field of Electrical Engineering.

Course Outcomes:

1. Student will be able to apply the theoretical and practical knowledge gained so far, by taking up the study in the form of a project work.
2. This study is expected to provide a good initiation for the students in R&D work.

The aim of the Minor Projects to enable the student to take up an investigative study in the broad field of Electrical Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on an individual basis or two/three students in a group, under the guidance of a Supervisor. The assignment to normally include:

1. Survey and study of published literature on the assigned topic;
2. Working out a preliminary Approach to the Problem relating to the assigned topic;
3. Conducting preliminary Analysis/Modelling/Simulation/Experiment/Design/Feasibility;
4. Preparing a Written Report on the Study conducted for presentation to the Department;
5. Final Seminar, as oral Presentation before a departmental committee.

HIGH VOLTAGE ENGINEERING

Subject Code:	L	T	P	C	Duration: 45 (Hrs.)
BELED1-711	3	0	0	3	

Course Objectives:

1. To understand the basic physics related to various breakdown processes in solid, liquid and gaseous insulating materials.
2. To know about generation and measurement of D. C., A.C., & Impulse voltages.
3. To know about causes of over-voltages and protection against them.
4. To make familiar with high voltage testing of electrical apparatus.

Course Outcomes:

1. Knowledge of generation and measurement of D. C., A.C., & Impulse voltages.
2. Knowledge of tests on H. V. equipment and on insulating materials, as per the standards.
3. Knowledge of how over-voltages arise in a power system, and protection against these

over-voltages.

UNIT-I (14 Hours)

Breakdown in Gases: Ionization and de-ionization processes, Types of discharge, Gases as insulating materials, Breakdown in uniform gap, Non-uniform gaps, Townsend's theory, Streamer mechanism, Corona discharge

Breakdown in Liquid and Solid Insulating Materials: Breakdown in pure and commercial liquids, Solid dielectrics, Composite dielectrics, Intrinsic breakdown, Electromechanical breakdown, Thermal breakdown, Partial discharge, Applications of insulating materials.

UNIT-II (16 Hours)

Generation of High Voltages: Generation of high voltages, generation of high D. C. and A.C. voltages, Generation of impulse voltages, Generation of impulse currents, Tripping and control of impulse generators.

Measurements of High Voltages and Currents: Peak voltage, Impulse voltage and high direct current measurement method, Cathode ray Oscillo graphs for impulse voltage and current measurement, Measurement of dielectric constant and loss factor, Partial discharge measurements.

Lightning and Switching Over-voltages: Charge formation in clouds, Stepped leader, Dart leader, Lightning Surges, Switching over- voltages, Protection against over-voltages, Surge diverters, Surge modifiers.

UNIT-III (15 Hours)

High Voltage Testing of Electrical Apparatus and High Voltage Laboratories: Various standards for HV Testing of electrical apparatus, IS, IEC standards, Testing of insulators and bushings, Testing of isolators and circuit breakers, Testing of cables, Power transformers and some high voltage equipment, High voltage laboratory layout, Indoor and outdoor laboratories, Testing facility requirements, Safety precautions in H. V. Labs.

Recommended Text Books / Reference Books:

1. M. S. Naidu and V. Kamaraju, " High Voltage Engineering", McGraw Hill Education, 2013.
2. C.L.Wadhwa,"HighVoltage Engineering",NewAge InternationalPublishers,2007.
3. D. V. Razevig (Translated by Dr. M. P. Chourasia), " High Voltage Engineering Fundamentals", Khanna Publishers,1993.
4. E. Kuffel, W. S. Zaengl and J. Kuffel, " High Voltage Engineering Fundamentals", Newnes Publication,2000.
5. R. Arora and W. Mosch " High Voltage and Electrical Insulation Engineering", John Wiley & Sons,2011.
6. Various IS standards for HV Laboratory Techniques andTesting

ELECTRICAL & HYBRID VEHICLES

Subject Code:	L	T	P	C	Duration: 45 (Hrs.)
BELED1-712	3	0	0	3	

Course Objectives:

1. To study about concept of hybrid electric vehicles, their configurations and control.
2. To know about different possible ways of energy storage.
3. To understand different strategies related to energy management in hybrid and electric drive systems.

Course Outcomes:

Students will be able to:

1. Develop mathematical models to describe vehicle performance.
2. Analyse fuel efficiency of hybrid and electric drive trains.
3. Control various types of drives.
4. Analyse different types of energy storage systems.
5. Select the size of a drive system and Implement energy management strategies.

UNIT-I (11 Hours)

Conventional Vehicles: Basics of vehicle performance, Vehicle power source characterization, Transmission characteristics, Mathematical models to describe vehicle performance.

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, Social and environmental importance of hybrid and electric vehicles, Impact of modern drive-trains on energy supplies.

UNIT-II (11 Hours)

Hybrid Electric Drive-Trains: Basic concept of hybrid traction, Introduction to various hybrid drive-train topologies, Power flow control in hybrid drive-train topologies, Fuel efficiency analysis.

Electric Drive Trains: Basic concept of electric traction, Introduction to various electric drive- train topologies, Power flow control in electric drive-train topologies, Fuel efficiency analysis.

Electric Propulsion Unit: Introduction to electric components used in hybrid and electric vehicles.

UNIT-III (12 Hours)

Configuration and Control of Various Types of Drives: DC motor drives, Induction motor drives, Permanent magnet motor drives, Switch reluctance motor drives, Drive system efficiency.

Energy Storage: Introduction to energy storage requirements in hybrid and electric vehicles, Battery based energy storage and its analysis, Fuel cell based energy storage and its analysis, Super capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices.

UNIT-IV (11 Hours)

Sizing the Drive System: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, Sizing the power electronics, Selecting the energy storage technology, Communications, Supporting subsystems.

Energy Management Strategies*:* Introduction to energy management strategies used in hybrid and electric vehicles, Classification and comparison of different energy management strategies, Implementation issues of energy management strategies.

Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Recommended Text Books / Reference Books:

1. C. Mi, M. A. Masrur and D. W. Gao, " Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons,2011.
2. S. Onori, L. Serrao and G. Rizzoni, " Hybrid Electric Vehicles: Energy Management Strategies" , Springer,2015.
3. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press,2004.
4. T. Denton, "Electric and Hybrid Vehicles", Routledge, 2016.

INTRODUCTION TO DIGITAL PROTECTION

Subject Code:	L	T	P	C	Duration: 45 (Hrs.)
BELED1-713	3	0	0	3	

Course Objectives:

1. To know about the evolution of static relays and numerical relays.
2. To know about the basic principle and the interfacing elements required for the digital protection.

Course Outcomes:

Students will be able:

1. To classify relays, such as; electromechanical, static and numerical relays and describe their merits and de-merits.
2. To explain the need of numerical relaying algorithms.
3. To explain the basic block diagram of a digital protection system.
4. To interface elements with microprocessor to develop digital relays.

UNIT-I (11 Hours)

Introduction: Need for protective systems, Evolution of protective relays, Essential qualities of protection, Classification of protective relays, Electromechanical relays, Static relays, Numerical relays, Comparison between Electromechanical relays and Numerical relays.

Static Relays: Merits and demerits, use of Amplitude and phase comparators in static relays, Types of amplitude comparators such as; circulating current type Rectifier bridge comparators, Phase splitting type comparators, Sampling comparators, Types of phase comparators such as; Vector product phase comparators, Coincidence phase comparators.

UNIT-II (11 Hours)

Numerical Protection: Introduction to numerical relay, its generalized Block diagram, Advantages and Disadvantages of numerical relays, components of Data acquisition system such as; Signal conditioner, Aliasing, Sampling, Analog interface.

Numerical Relaying Algorithms: Mann-Morrison technique, Differential equation technique, Fourier representation of signals, Discrete Fourier transform (DFT) technique, Extraction of fundamental frequency components, Computation of the apparent impedance.

UNIT-III (12 Hours)

Interfacing Elements of Microprocessor-Based Relays: Introduction, IC elements and circuits for interfaces; Operational amplifier, Zero-crossing detector, Phase shifter, Current to voltage converter, Summing amplifier, Differential amplifier, Precision rectifier, Active low-pass filter, Bipolar to unipolar converter.

A/D converter (ADC 0800, ADC 0808), Analog multiplexer (AM 3705), Sample & Hold (S/H) circuit (LF 398), Interfacing of ADC 0800, AM 3705 and LF 398 to microprocessor 8085.

UNIT-IV (11 Hours)

Microprocessor-Based Numerical Relays: Digital relay as a unit consisting of hardware and software, Block schematic diagram of Over current relay, Program flowchart and Program, Block schematic diagram of Impedance relay, Program flowchart and Program, Block schematic diagram of generalized interface for Distance relays and its generalized program flowchart.

Recommended Text Books / Reference Books:

1. Badri Ram and Vishwakarma D.N., Power system Protection and Switchgear, Tata McGraw Hill
A. T. Johns and S. K. Salman, “Digital Protection of Power Systems”, IET Press
2. S.R. Bhide, ‘Digital Power System Protection’, PHI Learning Pvt. Ltd., 2014.
3. T.S. Madhava Rao, ‘Power System Protection: Static Relays: with Microprocessor Applications’, 2017.
4. G. Phadke & J. S. Thorp, “Computer Relaying for Power Systems”, John Wiley &Sons,1988.
5. G. Phadke and J. S. Thorp, “Synchronized Phasor Measurements and their Applications”,Springer,2008.

DIGITAL SIGNAL PROCESSING

Subject Code:	L	T	P	C	Duration: 45 (Hrs.)
BELED1-714	3	0	0	3	

Course Objectives:

1. To familiarize the students with the basics of signal processing for analysis of discrete signals.
2. To acquaint the students with the application of different tools required for the analysis of discrete signals.
3. Application of digital signals to real-life problems.

Course Outcomes:

Students will be able:

1. To represent signals mathematically in discrete-time, and in the frequency domain and analyse them using Z-transform.
2. To implement Discrete Time Systems using the Discrete-Fourier Transform (DFT) and the FFT algorithms.
3. To design digital filters for various applications.
4. To apply digital signal processing for the analysis of real-life signals.

UNIT-I (12 Hours)

Discrete-Time Signals and Systems: Discrete time signals and systems, Sequences; Representation of signals on orthogonal basis; Representation of discrete systems using difference equations, Sampling and reconstruction of signals - aliasing; Sampling theorem and Nyquest rate.

Z-transform: Z-transform, Region of Convergence, Analysis of Linear shift invariant systems using Z- transforms, Properties of Z-transform for causal signals, Interpretation of stability in Z-domain, Inverse Z-transforms, Introduction to bilateral Z-transforms.

UNIT-II (10 Hours)

Discrete Fourier Transform: Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT, Convolution of signals, Fast Fourier Transform Algorithm, Parseval's Identity, Implementation of Discrete Time Systems.

UNIT-III (12 Hours)

Digital Filter Structure: Describing equation, Structures for FIR systems and structure for IIR Systems, Representation of structures using signal flow graph.

Design of Digital filters: Design of FIR digital filters, Window method, Park-McClellan's method, Design of IIR digital filters: Butterworth, Chebyshev and Elliptic approximations, Low-pass, Band-pass, Band-stop and High-pass filters, Effect of finite register length in FIR filter design, Finite Word-length Effects, Parametric and non-parametric spectral estimation. Introduction to multi-rate signal processing.

UNIT-IV (11 Hours)

Applications of Digital Signal Processing: Correlation Functions and Power Spectra, Stationary Processes, Optimal filtering using ARMA Model, Linear Mean-Square Estimation, Wiener Filter.

Hardware Architecture of DSP Processor: Introduction, Desirable features of DSP processors, Types of architectures, Internal architecture of ADSP-21xx family, Features of ADSP-21xx family processors.

Recommended Text Books / Reference Books:

1. S. K. Mitra, "Digital Signal Processing: A computer based approach", McGraw Hill, 2011.
2. A.V. Oppenheim and R. W. Schafer, "Discrete Time Signal Processing", Prentice Hall,1989.
3. J. G. Proakis and D.G. Manolakis, " Digital Signal Processing: Principles, Algorithms And Applications", Prentice Hall,1997.
4. L. R.Rabiner and B. Gold, "Theory and Application of Digital Signal Processing" , Prentice Hall, 1992.
5. J.R. Johnson,"IntroductiontoDigitalSignalProcessing",PrenticeHall,1992.
6. D. J. DeFatta, J. G. Lucas andW. S. Hodgkiss, " Digital Signal Processing" , John Wiley & Sons, 1988.

PROJECT MANAGEMENT & ENTREPRENEURSHIP

Subject Code: BHSMC0-024 **L T P C** **Contact Hrs. 45 (Hrs.)**
3 0 0 3

Course Objectives:

The aim of this course is:

1. To provide the conceptual clarity about project organization and feasibility analyses
2. To develop the entrepreneurial intent among students
3. To build the necessary competencies and motivation for a career in Entrepreneurship.
4. To provide insights about network analysis tools for cost and time estimation.

Course Outcomes:

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

1. Understand project characteristics and various stages of a project.
2. Analyze the learning and understand techniques for Project planning, scheduling and Execution Control.
3. Know the parameters to assess opportunities and constraints for new business ideas.
4. Understand the systematic process to select and screen a business idea
5. Understand various funding opportunities available for start-up and new ventures

UNIT-I (10 Hrs.)

Project Management: Concepts Attributes of a Project, Project Life Cycle, The Project Management Process, Benefits of Project Management, Needs Identification, Project Selection, Impact of Delays in Project Completions, Roles and Responsibilities of Project Manager.

Relationship between Project Management and Line management, Ethical issues in Project Management

UNIT-II (13 Hrs.)

Project Planning and Scheduling

Project Planning: Introduction, Project Planning, Need of Project Planning, Project Life Cycle, Roles, Responsibility and Team Work, Project Planning Process, Work Breakdown Structure (WBS)

PERT and CPM: Introduction, Development of Project Network, Time Estimation, Determination of the Critical Path, PERT Model, Measures of variability, CPM Model, Network Cost System

Project Implementation - Stages - Bottlenecks in project implementation

UNIT-III (12 Hrs.)

Foundations of Entrepreneurship: Concept, Need, Definition & Role of Entrepreneurship, Definition, Characteristics & Scope of Entrepreneur, Reasons for The Failure of Entrepreneurial Ventures,

Business Opportunity Identification: Business ideas, methods of generating ideas, and opportunity recognition

Preparing a Business Plan: Meaning and significance of a business plan, components of a business plan, and feasibility study

UNIT-IV (10 Hrs.)

Institutional support to Entrepreneurship: Role of Central Government and State Government in Promoting Entrepreneurship, Role of Directorate of Industries, District Industries, Centers (DICs), Industrial Development Corporation (IDC), State Financial corporation (SFCs), Commercial banks Small Scale Industries Development Corporations (SSIDCs), National Small Industries Corporation (NSIC), Small Industries Development Bank of India (SIDBI),

Introduction to various Incentives, Subsidies and Grants - Export Oriented Units - Fiscal and Tax concessions available. Women Entrepreneurs Reasons for low / no women Entrepreneurs their Role, Problems and Prospects

Recommended Books

1. N.P.Srinivasan & G.P.Gupta,'Entrepreneurial Development', Sultanchand &Sons.
2. Angadi, Cheema, Das, 'Entrepreneurship, Growth, and Economic Integration', Himalaya Publication.
3. Rizwana and Janakiran, 'Entrepreneurship Development', Excel Books.
4. Kanda, 'Project Management – A Life Cycle Approach', PHI.
5. Gido, 'Project Management', Cengage COURSEs.
6. Vasant Desai, 'Project Management' Himalaya Publications.
7. Maylor, 'Project Management', Pearson Education.
8. Prasanna Chandra, 'Projects, Preparation, Appraisal Budgeting & Implementation', Tata McGraw Hills.

Total Credits = 16

Semester 8TH		Contact Hours			Max Marks		Total Marks	Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**		
BELES1-801	Generation & Economics of Electric Power	3	0	0	40	60	100	3
BELES1-802	Major Project	0	0	8	60	40	100	4
Departmental Elective - V (Select any One)		3	0	0	40	60	100	3
BELED1-811	Electrical Energy Conservation & Auditing							
BELED1-812	Power System Dynamics & Control							
BELED1-813	Control Systems Design							
BELED1-814	Advanced Electric Drives							
BELED1-815	Restructuring of Power Industry							
XXXXX	**Open-Elective***	3	0	0	40	60	100	3
XXXXX	**Open-Elective ***	3	0	0	40	60	100	3
	Total	**-**	**-**	**-**	**220**	**280**	**500**	**16**

*Open Electives (OE) can also be taken from existing lists of Open Elective-I, Open Elective-II and Open Elective-III subject lists.

GENERATION & ECONOMICS OF ELECTRIC POWER

Subject Code:	L	T	P	C	Duration: 45 (Hrs.)
BELES1- 801	3	0	0	3	

Course Objectives:

1. To familiarize the students with different types of loads and load curves.
2. To apprise them with different types of costs involved in power plant and tarriffs imposed on the electricity consumers.
3. To impart knowledge about selection and economic operation of steam plants.
4. To impart knowledge about hydrothermal coordination.

Course Outcomes:

1. Students will be able to differentiate among types of loads and related terminology.
2. They will be able toestimate various costs involved in the power plants and tariffs imposed on different categories of consumers.
3. They can select the size and location of a power plant.
4. They will be enabled to co-operate hydro and steam power plants.

UNIT-I (12 Hours)

Introduction: Electrical energy sources, Organization of power sector in India, Single line diagram of thermal, hydro and nuclear power stations, Classification of power plants in base load and peak load plants.

Loads and Load curves: Fixed voltage loads, Resistive loads, Inductive motor loads, Mechanical load, effect of supply Voltage and Frequency on load, Maximum demand, Group diversity factor, Peak diversity factor,

Classification of loads: Domestic, Industrial, Commercial, Urban,Traction, Municipal, Irrigation, Chronological load curves, Load-duration curve, Mass curves, Energy-load curve, Demand factor, Load factor, Capacity factor, Utilization factor, Base load, Peak load, Load forecasting and its types.

UNIT-II (12 Hours)

Power Plant Economics: Cost of electrical energy,Capital cost of plants, Annual fixed, operating and Annual plant cost, Generation cost, Effect of load factor on unit cost of energy,Depreciation and its types.

Tariffs: Objectives of tariff, Types of tariff,General tariff form,Flat meter rate, Block meter rate, Two part, Maximum or Flat demand, Power factor tariff, Three part tariff, Wright demand rate.

Availability Based Tariff (ABT): Introduction to ABT and its necessity, Various components of ABT, Unscheduled interchange rate, Implementation of ABT in India.

Power Factor Improvement: Causes and effect of low power factor, Improvement of power factor using capacitors and synchronous condenser, Determination of economic power factor.

UNIT-III (10 Hours)

Selection of Plant: Plant location considerations, Plant size, Number and size of units in

plants, Selection of plant based on;Annual cost, Rate of return, Present worth and Capitalized cost methods, Operating and Spinning Reserve.

Economic Operation of Steam Plants: Introduction,Methods of loading turbo-generators, Input-output curve, Heat rate, Incremental cost, Economic loading neglecting transmission losses, Method of Lagrangian multiplier, Economic loading including transmission losses, Co-ordination equations, Iterative procedure to solve co-ordination equations.

UNIT-IV (11 Hours)

Hydro-Thermal Co-ordination: Introduction, Advantages of combined operation, Base load and Peak load operation, Combined working of Run-off River plant and steam plant, reservoir hydro plants and thermal plants,Long-term operational aspects, Short term Hydro-Thermal coordination, Coordination Equations, Scheduling methods and its applications.

Cogeneration: Definition and scope, Topping and Bottoming cycles, Benefits, Cogeneration technologies, Industries suitable for cogeneration.

Captive Power Generation: Introduction, Advantages and Constraints, Types of captive power plants, Financing of captive power plants, Energy banking and energy wheeling, Future prospects in India.

Recommended Text Books / Reference Books:

1. Deshpande M.V., "Power Plant Engineering", Tata McGraw Hill (2004).
2. EI-Wakit M.M., "Power Plant Engineering", McGraw Hill, USA, 2010
3. Kothari D.P. and Nagrath I.J., "Power System Engineering", Tata McGraw Hill, 2008.
4. Arora S.C. and Dom Kundwar S., "A course in Power Plant Engineering", Dhanpat Rai, Sixth Revised Edition 2011-12.
5. Nag, P.K., "Power Plant Engineering", Tata McGraw Hill, 2014.
6. Gupta B.R., "Generation of Electrical Energy", S. Chand 2017.
7. Rajput R.K., "Power Plant Engineering", LuxmiPublications
8. Sharma P.C., "Power Plant Engineering", Kataria andSons
9. Skrotzki B.G.A. and Vapot W.A., "Power Station Engineering and Economy", TataMcGraw-Hill
10. Nagrath I.J. and Kothari D.P., "Power System Analysis" Tata McGraw-HillPublication

MAJOR PROJECT

Subject Code:	L	T	P	C
BELES1-802	0	0	8	4

Course Objective:

To enable the students to extend further the investigative study (theoretical and /or practical)(taken up under Minor Project in the previous semester or a new study), so as to explore their knowledge and technical skills in a more comprehensive way by working in a groupas a team.

Course Outcomes:

1. Student will be trained to apply the theoretical knowledge and practical experience gained so far, by conducting the study in the form of a project work.
2. Students will get a good trainingin R&D work and technical leadership.

The object of Major Projectand Dissertation is to enable the student to either extend further the investigative study taken up under Minor Project or take up a new study either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory/Industry. The assignment to normally include:

1. In depth study of the topic assigned in the light of the Report prepared under Minor Project or on a new topic (if it is not possible to extend the study of minor project).
2. Review and finalization of the Approach to the Problem related to the assigned topic;
3. Preparing an Action Plan for conducting the investigation, including team work;
4. Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed;
5. Final development of product/process, testing, results, conclusions and future directions;
6. Preparing a Dissertation in the standard format for being evaluated by the Department.
7. Final Seminar Presentation before a Departmental Committee.

ELECTRICAL ENERGY CONSERVATION & AUDITING

Subject Code:	L	T	P	C	Duration: 45 (Hrs.)
BELED1- 811	3	0	0	3	

Course Objectives:

1. To understand the importance of energy management and Audit.
2. To sudy various types of energy dissipating systems such as electrical, compressed air system, HVAC and refrigeration systems.
3. To understand energy audit processes of these systems used in the industry.

Course Outcomes:

Students will be able:

1. To do management and audit of energy.
2. To calculate different types of losses and hence evaluate and improve energy efficiency of electrical systems.
3. To evaluate performance and efficiency of HVAC systems, fans, blowers, pumps, compressed air systems and cooling towers.

UNIT-I (15 Hours)

Energy Scenario: Commercial and non-commercial energy, Primary energy resources, Commercial energy production, Final energy consumption, Energy needs of growing economy, Long term energy scenario, Energy pricing, Energy sector reforms, Energy and environment, Energy security, Energy conservation and its importance, Restructuring of the energy supply sector, Energy strategy for the future, Air pollution, Climate change, Energy Conservation Act-2001 and its features.

Energy Management & Audit: Definition, Energy audit, Need, Types of energy audit, Energy management (audit) approach, Energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel & energy substitution, Energy audit instruments.

Material and energy balance, Facility as an energy system, Methods for preparing process flow, Material and energy balance diagrams.

UNIT-II (15 Hours)

Energy Efficiency in Electrical Systems: Electrical system, Electricity tariffs, Electricity billing, Electrical load management and maximum demand control, Power factor improvement and its benefit, Selection and location of capacitors, Performance assessment of PF capacitors.

Distribution and transformer losses.

Electric Motors: Types, Losses in induction motors, Motor efficiency, Factors affecting motor performance, Rewinding and motor replacement issues, Energy saving opportunities with energy efficientmotors.

Energy Efficient Technologies in Electrical Systems: Maximum demand controllers, Automatic power factor controllers, Energy efficient motors, Soft starters with energy saver, Variable speed drives, Energy efficient transformers, Electronic ballast, Occupancy sensors, Energy efficient lighting controls, Energy saving potential of each technology.

UNIT-III (15 Hours)

Energy Efficiency in Industrial Systems:

Compressed Air System: Types of air compressors, Compressor efficiency, Efficient compressor operation, Compressed air system components, Capacity assessment, Leakage test, Factors affecting the performance and efficiency.

Saving Opportunities in HVAC, Fans and Blowers: Types, Performance evaluation, Efficient system operation, Flow control strategies and energy conservation opportunities.

Pumps and Pumping System: Types, Performance evaluation, Efficient system operation, Flow control strategies and energy conservation opportunities.

Cooling Tower: Types and performance evaluation, Efficient system operation, Flow control strategies and energy saving opportunities, Assessment of cooling towers.

Recommended Text Books / Reference Books:

1. Abbi Y.P. and Jain S., Handbook on Energy Audit and Environment Management, T E R I Press, 2006.
2. Doti Steve, PE, CEM, Commercial Energy Auditing Reference Handbook, CRC Press, Taylor & Francis Group, 2010.
3. Desai Sonal, Handbook of Energy Audit, McGraw Hill Education, New Delhi, 2017.
4. Al-Shemeri Tarik, Energy Audits, A workbook for Energy Management in Buildings, John Wiley & Sons, 2011.
5. Capehart, Turner and Kennedy, Guide to Energy Management, CRC Press, Taylor & Francis Group, 2008.
6. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects (availableonline)
7. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-3, Electrical Utilities (availableonline)
8. S.C.Tripathy,“UtilizationofElectricalEnergyandConservation”,McGrawHill,1991.

POWER SYSTEM DYNAMICS & CONTROL

Subject Code:	L	T	P	C	Duration: 45 (Hrs.)
BELED1- 812	3	0	0	3	

Course Objectives:

1. To understand the problem of power system stability, its impact, analysis and methods to control it.
2. To model synchronous machine, its associated controllers, and other power systemcomponents for the study ofstability.
3. To know about different types of stability measures.

Course Outcomes:

Students will be able:

1. To evaluate the impact of stabilityon theoperation and control of power system.
2. To analyse linear dynamical systems and can applynumerical integrationmethods.
3. To model different power system components for the study ofstability.
4. To use methods to improvestability.

UNIT-I (15 Hours)

Introduction to Power System Operations:

Introduction to power system stability, Power system operations and control, Stability problems in Power System, Impact on power system operations and control.

Analysis of Linear Dynamical System and Numerical Methods:

Analysis of dynamical System, Concept of equilibrium, Small and large disturbance sability, Modal analysisoflinear system, Analysis using numerical integration techniques, Issues in modeling, Slow and fast transients, Stiffsystem.

UNIT-II (15 Hours)

Modeling of Synchronous Machines and Associated Controllers:

Modeling of synchronous machine, Physical characteristics, Rotor position dependent model, D-Q transformation, Model with standard parameters, Steady state analysis of synchronous machine, Short circuit transient analysis of a synchronous machine, Synchronization of synchronous machine to an infinite bus, Modeling of excitation and prime mover systems, Physical characteristics and models, Excitation system control, Automatic voltage regulator, Prime mover control systems, Speedgovernors.

Modeling of Other Power System Components:

Transmission line physical characteristics, Transmission line modeling, Load models, Induction machine model, Frequency and voltage dependence of loads, Other Sub-systems, HVDC and FACTS controllers, Wind energy systems.

UNIT-III (15 Hours)

Stability Analysis: Angular stability analysis in single machine infinite bus system, Angular stability in multi- machine systems, Intra-plant, Local and Inter-area modes, Frequency Stability, Centre of inertia motion, Load sharing, Governor droop, Single machine load bus system, Voltage stability, Torsional oscillations and the SSR phenomenon, Stability analysis tools, Transient stability programs, Small signal analysis programs.

Enhancing System Stability: Planning measures, Power system stabilizers, Operational measures, Preventive control, Emergency control.

Recommended Text Books / Reference Books:

1. K.R. Padiyar, " Power System Dynamics, Stability and Control", B. S. Publications, 2002.
2. P.Kundur,"PowerSystemStabilityandControl",McGrawHill,1995.
3. P.Sauerand M.A.Pai,"PowerSystemDynamicsand Stability",Prentice Hall,1997.

CONTROL SYSTEMS DESIGN

Subject Code:	**L**	**T**	**P**	**C**	**Duration: 45 (Hrs.)**
BELED1- 813	**3**	**0**	**0**	**3**	

Course Objectives:

1. To understand various designspecifications.
2. To learn to design controllers to satisfy the desired design specifications.
3. To design controllers using the state-spaceapproach.

Course Outcomes:

Students will be able to:

1. Design classical control systems intimedomain.
2. Design classical control systems in frequency domain.
3. Designcontroller structures (P, PI, PID, compensators).
4. Examine thecontrollability & observability and can design controllers using state-spaceapproach.

UNIT-I (15 Hours)

Design Specifications:

Introduction to design problem and philosophy, Introduction to time domain and frequency domain design specifications and their physical relevance, Effect of gain on transient and steady state response, Effect of addition of pole on system performance, Effect of addition of zero on systemresponse.

Design of Classical Control System in Time Domain:

Introduction to compensator, Design of Lag, lead, and lag-lead compensator in time domain, Feedback and Feed forward compensator design, Feedback compensation, Realization of compensators.

UNIT-II (15 Hours)

Design of Classical Control System in Frequency Domain:

Compensator design in frequency domain to improve steady state and transient response, Feedback and Feed forward compensator design using Bode diagram.

Design of PID controllers:

Design of Proportional (P), Proportional-Integral (PI), Proportional-Derivative (PD) and PID controllers in time domain and frequency domain for first, second and third order systems, Control loop with auxiliary feedback, Feed forward control.

UNIT-III (15 Hours)

Control System Design in State Space:
Review of state space representation, Concept of controllability &observability, Effect of pole zero cancellation on the controllability &observabilityof the system, Pole placement design through state feedback, Ackerman's Formula for feedback gain design, Design of Observer, Reduced order observer, SeparationPrinciple.

Effect of Nonlinearities on System Performance:
Types of non-linearities, Effect ofnon-linearities on system performance, Singular points, Phase plot analysis.

Recommended Text Books / Reference Books:

1. N.Nise,"ControlSystemEngineering", JohnWiley,2000.
2. I.J.NagrathandM.Gopal,"ControlSystemEngineering",Wiley,2000.
3. M.Gopal,"DigitalControlEngineering", WileyEastern,1988.
4. K.Ogata,"ModernControlEngineering",PrenticeHall,2010.
5. B. C. Kuo, " Automatic Control system", Prentice Hall,1995.
6. J. J. D'Azzo and C. H. Houpis, " Linear Control System Analysis and Design (conventional and modern)" , McGraw Hill,1995.
7. R. T. Stefani and G. H. Hostetter, "Design of Feedback Control Systems", Saunders College Pub,1994.

ADVANCED ELECTRIC DRIVES

Subject Code:	L	T	P	C	Duration: 45 (Hrs.)
BELED1- 814	3	0	0	3	

Course Objectives:

1. To understand the operation of power electronic converters and their controlstrategies.
2. To understand the different control strategies used for AC motordrives.
3. To understandthe control strategies using digital signal processors.

Course Outcomes:

Students will be able to:

Understanding about the control of powerconverters and their controlmethods.

1. Control power converters for controlling AC drives.
2. Apply the various control techniquesfor induction motordrives and synchronous motor drives.
3. Control motion using digital signal processors.

UNIT-I (15 Hours)

Power Converters for AC Drives: Pulse width modulation (PWM) control of inverter, Selected harmonic elimination, Space vector modulation (SVM), Current control of VSI, Three level inverter, Different topologies, SVM for 3 level inverter, Diode rectifier with boost chopper, PWM converter as line side rectifier, Current source inverters (CSI) with self-commutated devices, Control of CSI, H bridge as a four quadrant (4-Q) drive.

UNIT-II (15 Hours)

Induction Motor Drives: Different transformations and reference frame theory, Modeling of induction machines, Voltage fed inverter control-v/f control, Vector control, Direct torque and flux control (DTC).

Synchronous Motor Drives: Modeling of synchronous machines, Open loop v/f control, Vector control, Direct torque control, CSI fed synchronous motor drives.

UNIT-III (15 Hours)

Permanent Magnet (PM) Motor Drives: Introduction to various PM motors, BLDC (Brushless DC) motor and PMSM (Permanent magnet synchronous motor) drive configuration, Comparison, Block diagrams, Speed and torque control in BLDC and PMSM.

Switched Reluctance Motor (SRM) Drives: Evolution of switched reluctance motors, various Topologies for SRM drives, Their comparison, Closed loop speed control and torque control of SRM.

DSP based Motion Control: Use of DSPs in motion control, various DSPs available, Realization of some basic blocks in DSP for implementation of DSP based motion control.

Recommended Text Books / Reference Books:

1. B. K. Bose, "Modern Power Electronics and AC Drives", Pearson Education, Asia, 2003.
2. P. C. Krause, O. Wasynczuk and S. D. Sudhoff, " Analysis of Electric Machinery and Drive Systems", John Wiley & Sons,2013.
3. H.A.TaliyatandS.G.Campbell,"DSPbasedElectromechanicalMotionControl", CRC press,2003.
4. R. Krishnan, " Permanent Magnet Synchronous and Brushless DC motor Drives" , CRC Press,2009.

RESTRUCTURING OF POWER INDUSTRY

Subject Code:	L	T	P	C	Duration: 45 (Hrs.)
BELED1- 815	3	0	0	3	

Course Objectives:

1. To understand about the restructuring of the electricitymarket.
2. To understand about transmission network congestion management and it's pricing.
3. To know about ancillary service management.

Course Outcomes:

1. Students will be enabled to Identify the need of restructuring and deregulation of power industry.
2. They will be able to manage congestion of transmission network.
3. They will be able to estimate pricing of transmission network.
4. Define and describe the Technical and Non-technical issues in restructured powerindustry.

UNIT-I (15 Hours)

Introduction to Restructuring of Power Industry: Introduction,Reasons for restructuring/ deregulation of power industry, Understanding the restructuring process, Reasons and objectives of deregulation of various power systems across the world.

Trading Arrangement: Pool model, Pool and bilateral trades, Multi-lateral trades model

UNIT-II (15 Hours)

Transmission Congestion Management: Transmission congestion management, Classification of congestion management mechanisms, Calculation of available transfer capability (ATC), Non-market methods of congestion management, Nodal pricing: OPF based congestion management, Inter-zonal congestion management, Price area congestion management, Comparison and conclusion.

Pricing of Transmission Network: Pricing of transmission network usage, Principles of transmission pricing, Classification of transmission pricing, Rolled in transmission pricing methods, Marginal transmission pricing methods.

UNIT-III (15 Hours)

Locational Marginal Prices (LMPs): Locational marginal pricing fundamentals, LMP

formulations and implementation, Locational marginal pricing formulation and implementation using AC optimal power flow (ACOPF), Locational Pricing using DC optimal power flow (DCOPF).

Ancillary Service Management: Ancillary services, Types of ancillary services, Load generation balancing related services, Voltage control and Reactive power support service, Black start capability service.

Recommended Text Books / Reference Books:

1. Loi Lei Lai, Power System Restructuring and Deregulation, John Wiley & Sons Ltd. 2001
2. National Digital Library of India
3. A.R. Abhyankar and S. A. Khaparde, Restructured Power Systems, Alpha Science International Ltd. 2016.
4. M Shahidehpour, M Alomoush, Restructured electrical power systems: Operation: Trading, and volatility, Marcel Dekker Inc. New York 2017