SUBJECT STRUCTURE

For

UNDERGRADUATE DEGREE COURSE

IN

ENGINEERING & TECHNOLOGY

2018-19

ELECTRICAL ENGINEERING

UG IN Electrical Engineering

I SEMESTER [FIRST YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	BS	BBSBS1010	Engineering Mathematics-I	3	1	0	4
2	BS	BBSBS1021	Engineering Physics	3	0	0	3
		BBSBS1022	Engineering Chemistry				
3	ES	BBSES1031	Basics of Mechanics	3	0	0	3
		BBSES1032	Basics of Thermodynamics				
4	ES	BBSES1041	Basics of Electronics	3	0	0	3
		BBSES1042	Basics of Electrical Engineering				
5	ES	BBSES1050	Programming for Problem Solving	3	0	0	3
6	HS	BBSHS1060	Communicative English and Soft Skills	2	0	0	2
PRACTICAL / SESSIONAL							
7	BS	BBSBS1121	Engineering Physics Laboratory	0	0	2	1
		BBSBS1122	Engineering Chemistry Laboratory				
8	ES	BBSES1141	Basics of Electronics Laboratory	0	0	2	1
		BBSES1142	Basics of Electrical Engineering Laboratory				
9	ES	BBSES1150	Programming for Problem SolvingLaboratory	0	0	2	1
10	HS	BBSHS1160	Communicative English and Soft Skills Laboratory	0	0	2	1
11	ES	BBSES1171	Engineering Drawing	0	0	2	1
		BBSES1172	Engineering Workshop				
12	MC	BBSHS1180	NSS	-	-	-	0
TOTAL				**17**	**1**	**10**	**23**

II SEMESTER [FIRST YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	C
THEORY							
1	BS	BBSBS2010	Engineering Mathematics-II	3	1	0	4
2	BS	BBSBS1021	Engineering Physics	3	0	0	3
		BBSBS1022	Engineering Chemistry				
3	ES	BBSES1031	Basics of Mechanics	3	0	0	3
		BBSES1032	Basics of Thermodynamics				
4	ES	BBSES1041	Basics of Electronics	3	0	0	3
		BBSES1042	Basics of Electrical Engineering				
5	ES	BBSES2050	Data Structure using 'C++'	3	0	0	3
6	HS	BBSHS2060	Communicative English-II	2	0	0	2
PRACTICAL / SESSIONAL							
7	BS	BBSBS1121	Engineering Physics Laboratory	0	0	2	1
		BBSBS1122	Engineering Chemistry Laboratory				
8	ES	BBSES1141	Basics of Electronics Laboratory	0	0	2	1
		BBSES1142	Basics of Electrical Engineering Laboratory				
9	ES	BBSES2150	Data Structures using 'C++' Laboratory	0	0	2	1
10	HS	BBSHS2160	Communicative English-II Laboratory	0	0	2	1
11	ES	BBSES1171	Engineering Drawing	0	0	2	1
		BBSES1172	Engineering Workshop				
12	MC	BBSHS2180	YOGA	-	-	-	0
TOTAL				**17**	**1**	**10**	**23**

UG IN Electrical Engineering

III SEMESTER [SECOND YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	C
THEORY							
1	BS	BBSBS3010	Engineering Mathematics-III	3	1	0	4
2	PC	BELPC3020	Electrical Machines – I	3	0	0	3
3	PC	BELPC3030	Network Theory	3	1	0	4
4	PC	BELPC3040	Analog Electronic Circuits	3	0	0	3
5	ES	BCSES3050	Object Oriented Programming through JAVA	3	0	0	3
6	BS / HS	BBSBS3061	Environmental Engineering and Safety	3	0	0	3
		BMSHS3062	Engineering Economics and Costing				
PRACTICAL / SESSIONAL							
7	PC	BELPC3120	Electrical Machines – I lab	0	0	2	1
8	PC	BELPC3130	Network Theory Lab	0	0	2	1
9	PC	BELPC3140	Analog Electronic Circuits Lab	0	0	2	1
10	ES	BCSES3150	Object Oriented Programming through JAVA Lab	0	0	2	1
TOTAL				**18**	**2**	**8**	**24**

UG IN Electrical Engineering

IV SEMESTER [SECOND YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	C
THEORY							
1	PC	BELPC4010	Electrical Machines – II	3	1	0	4
2	PC	BELPC4020	Control Systems	3	0	0	3
3	PC	BELPC4030	Digital Electronic Circuits	3	0	0	3
4	PC	BELPC4040	Electromagnetic Fields	3	1	0	4
5	ES	BELES3050	Database Management Systems	3	0	0	3
6	BS / HS	BBSBS3061	Environmental Engineering and Safety	3	0	0	3
		BMSHS3062	Engineering Economics and Costing				
PRACTICAL / SESSIONAL							
7	PC	BELPC4110	Electrical Machines – II Lab	0	0	2	1
8	PC	BELPC4120	Control Systems Lab	0	0	2	1
9	PC	BELPC4130	Digital Electronic Circuits Lab	0	0	2	1
10	ES	BELES4140	Database Management Systems lab	0	0	2	1
TOTAL				**18**	**2**	**8**	**24**

UG IN Electrical Engineering

V SEMESTER [THIRD YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	C
THEORY							
1	PC	BELPC5010	Power Electronics	3	1	0	4
2	PC	BELPC5020	Micro Processors and Micro Controllers	3	0	0	3
3	PC	BELPC5030	Electrical Power Transmission & Distribution	3	0	0	3
		Professional Elective – I ((Any One)					
4	PE	BELPE5041	Wind and Solar Energy Systems	3	0	0	3
		BELPE5042	Electrical Machine Design				
		BELPE5043	Industrial Electrical Systems				
5	OE	B**OE50**	Open Elective**(Any One)**	3	0	0	3
PRACTICAL / SESSIONAL							
6	PC	BELPC5110	Power Electronics lab	0	0	2	1
7	PC	BELPC5120	Micro Processors and Micro Controllers lab	0	0	2	1
8	PC	BELPC5130	Electrical Power Transmission & Distribution lab	0	0	2	1
9	EC	BELLC5150	*Skill Development Project and Hands on Training	0	0	2	1
10	EC	BELEC5170	^Summer Internship-I	0	0	2	1
TOTAL				**15**	**1**	**10**	**21**

*College should conduct at least one NSDC program under this category.

^ Four (4) weeks duration summer internship either in industry or in an R&D organization, including educational institutes with excellent research culture. The student is expected to submit a formal report at the end of the programme.

- On-line MOOC courses may contribute up to 20% of the credits, with in-house examination being conducted.

UG IN Electrical Engineering

VI SEMESTER [THIRD YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	C
THEORY							
1	PC	BELPC6010	Switch Gear & Protection	3	1	0	4
2	PC	BELPC6020	Electrical& Electronics Measurements	3	0	0	3
3	PC	BELPC6030	Electrical Drives	3	0	0	3
	Professional Elective – II (Any One)						
4	PE	BELPE6041	Communication Engineering	3	0	0	3
		BELPE6042	Computer aided Design of Electrical Machines				
		BELPE6043	Advanced Power Electronics				
5	OE	B**OE60**	Open Elective **(Any One)**	3	0	0	3
PRACTICAL / SESSIONAL							
6	PC	BELPC6110	Energy management & Auditing Lab	0	0	2	1
7	PC	BELPC6120	Electrical& Electronics Measurements Lab	0	0	2	1
	PC	BELPC6130	Electrical Drives Lab	0	0	2	1
9	PC	BELPC6140	Advanced Laboratory-I: Internet of Things Lab	0	0	2	1
10	EC	BTPEC6160	#Soft Skill and Employability Skill	0	0	2	1
TOTAL				**15**	**1**	**10**	**21**

#To be conducted by the Training & Placement Department of the College

VII SEMESTER [FOURTH YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	C
THEORY							
1	PC	BELPC7010	Power System operation & Control	3	0	0	3
		Professional Elective – III(Any One)					
2	PE	BELPE7021	Flexible AC Transmission Systems	3	0	0	3
		BELPE7022	Satellite Communication Systems				
		BELPE7023	Advanced Power Systems				
		BELPE7024	Electrical Power Quality				
		Professional Elective – IV(Any One)					
3	PE	BELPE7031	Power Station Engineering & Economy	3	0	0	3
		BELPE7032	Neural Networks & Fuzzy logic				
		BELPE7033	HVDC Transmission				
		BELPE7034	Digital Signal Processing				
		Professional Elective – V(Any One)					
4	PE	BELPE7041	Industrial automation and control	3	0	0	3
		BELPE7042	Generalized Theory of Electrical Machines				
		BELPE7043	Bio medical Instrumentation				
		BELPE7044	Advanced Control Systems				
5	OE	B**OE*70**	Open Elective **(Any One)**	3	0	0	3
PRACTICAL / SESSIONAL							
6	PC	BELPC7110	Renewable Energy Lab	0	0	2	1
7	PC	BELPC7140	Advanced Laboratory-II: Simulation Lab	0	0	2	1
8	EC	BELPC7150	Mini Project	0	0	4	2
10	EC	BELPC7170	^Summer Internship-II	0	0	2	1
TOTAL				**15**	**0**	**10**	**20**

UG IN Electrical Engineering

VIII SEMESTER [FOURTH YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	C
THEORY							
Professional Elective – VI (Any One)							
1	PE	BELPE8011	Smart Grid Technology	3	0	0	3
		BELPE8012	Digital Image Processing				
		BELPE8013	Computer Networks				
		BELPE8014	Power system Dynamics and Control				
		Professional Elective – VII(Any One)					
2	PE	BELPE8021	High Voltage Engineering	3	0	0	3
		BELPE8022	Industrial Electrical Systems				
		BELPE8023	Illumination Engineering				
		BELPE8024	Energy Management & Auditing				
3	OE	B**OE80**	Open Elective **(Any One)**	3	0	0	3
PRACTICAL / SESSIONAL							
4	EC	BELEC8150	Major Project / Industrial Project / Startup Training cum Project	0	0	10	5
5	EC	BELEC8180	Seminar and Technical Writing	0	0	2	1
6	EC	BELEC8190	Comprehensive Viva-Voce	0	0	2	1
TOTAL				**9**	**0**	**14**	**16**

SCHEME OF INSTRUCTION SUMMARY

S.N.	COURSE WORK - SUBJECTS AREA	CREDITS / SEMESTER								TOTAL CREDITS	%
		I	II	III	IV	V	VI	VII	VIII		
1	Humanities, Social & Management Study (HS)	3	3	-	3	-	-	-	-	**9**	**5**
2	Basic Sciences (BS)	8	8	7	-	-	-	-	-	**23**	**14**
3	Engineering Sciences (ES) / Basic Engineering (BE)	12	12	4	3	-	-	-	-	**31**	**18**
4	Professional Core (PC)	-	-	12	17	13	14	5	-	**61**	**36**
5	Professional Electives (PE)	-	-	-	-	3	3	9	6	**21**	**12**
6	Open Electives (OE)	-	-	-	-	3	3	3	3	**12**	**7**
7	Project Work, Seminar and/or Internship in Industry or elsewhere (EC)	-	-	-	-	2	1	3	7	**13**	**8**
8	Mandatory Courses (MC)	-	-	-	-	-	-	-	-	**0**	**0**
	TOTAL	**23**	**23**	**23**	**23**	**21**	**21**	**20**	**16**	**170**	**100**

UG IN Electrical Engineering

III SEMESTER [SECOND YEAR] [52-68]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	C	QP
THEORY								
1	BS	BBSBS3010	Engineering Mathematics-III	3	1	0	4	A
2	PC	BELPC3020	Electrical Machines – I	3	0	0	3	A
3	PC	BELPC3030	Network Theory	3	1	0	4	A
4	PC	BELPC3040	Analog Electronic Circuits	3	0	0	3	A
5	ES	BCSES3050	Object Oriented Programming through JAVA	3	0	0	3	A
6	BS / HS	BBSBS3061	Environmental Engineering and Safety	3	0	0	3	A
		BMSHS3062	Engineering Economics and Costing					
PRACTICAL / SESSIONAL								
7	PC	BELPC3120	Electrical Machines – I lab	0	0	2	1	
8	PC	BELPC3130	Network Theory Lab	0	0	2	1	
9	PC	BELPC3140	Analog Electronic Circuits Lab	0	0	2	1	
10	ES	BCSES3150	Object Oriented Programming through JAVA Lab	0	0	2	1	
TOTAL				**18**	**2**	**8**	**24**	

Subject Code	Name of the Subject	L	T	P	C	QP
BBSBS3010	**ENGINEERING MATHEMATICS - III**	3	1	0	4	A

Course Educational Objectives

CEO1	Understand special functions and its applications
CEO2	Analyse complex analytic functions

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Understand special functions and its applications
CO2	Analyse complex analytic functions
CO3	Applying Taylors series and other functions for evaluation
CO4	Applying and analysing numerical methods

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2													
CO2	2	2													
CO3	2	2													
CO4	2	2													
Avg.	2	2													

SYLLABUS

Unit – I **[12 Hrs]**

SPECIAL FUNCTIONS :

Beta and Gamma functions, relation between Beta and Gamma functions, Error function, Series solution of differential equations (up to second order), Legendre equation, Legendre polynomials and their properties, Bessel's function.

Unit - II[12Hrs]

Complex Analysis:

Analytic function, Cauchy-Riemann equations, Laplace equation, Complex integration: Line integral in the complex plane, Cauchy's integral theorem, Cauchy's integral formula, Derivatives of analytic functions

Unit – III[12Hrs]

Taylor's series, Laurent's series, Singularities and zeros, Residue integration, evaluation of real integrals.

Unit – IV **[14Hrs]**

Numerical methods:

Approximation and round of errors, Roots of equation: fixed point iteration, the Newton-Raphson method.

Interpolation: Lagrange Interpolation, Newton divided difference interpolation, Newton's forward and backward interpolation. Numerical Differentiation, Numerical integration: The trapezoidal rule, The Simpson's rules, Ordinary differential equation: Euler's method, modified Euler's method,

Teaching Methods: Chalk& Board/ PPT/Video Lectures
Text Book: 1. E. Kreyszig," Advanced Engineering Mathematics:, Eighth Edition, Wiley India 2. Numerical method for Engineers by M. K. Jain and Iyenger.
Reference Book: 1. Higher Engineering Mathematics by B S Grewal : Khanna Publishers, New Delhi. 2. Numerical Analysis by Dutta and Jena

Subject Code	Name of the Subject	L	T	P	C	QP
BELPC3020	**Electrical Machines-I**	3	0	0	3	A

Course Educational Objectives	
CEO1	To know basic construction of DC generators, motors and transformers
CEO2	To analyze the working principle the DC generators, motors and transformers.
CEO3	Draw the different characteristic curves of DC generators and motors.
CEO4	To conduct various types test on DC generators, motors and transformers.
Course Outcomes: ***Upon successful completion of this course, students should be able to:***	
CO1	Analyze the constructional features and operation of DC machines
CO2	Investigate the characteristics of DC generators and motors
CO3	Analyze the differences in operation of different DC machine configurations.
CO4	Understand the concepts of single phase and three phase transformers
CO5	Conduct different tests on DC generators, motors and transformers.
CO6	Understand the concepts of 3-phase transformers and various configuration of connections

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	1											1		
CO2	1	1											2		
CO3	2	1											1		
CO4	1	2													
CO5	2	2													
CO6	2	2											2		
Avg.	1.67	1.5											1.5		

SYLLABUS

UNIT:1 **(10 Hours)**

Basic construction and operation of a DC machine, induced EMF in an armature coil. Armature winding– Elementary armature coil and commutator, lap and wave windings, construction features of commutator, linear commutation, Derivation of back EMF equation, armature, armature reaction, air gap flux density distribution with armature reaction

UNIT:2 **(12 Hours)**

Armature circuit equation for motoring and generation, Types of field excitations - separately excited, shunt and series. Open circuit characteristic of separately excited DC generator, back EMF with armature reaction, voltage build-up in a shunt generator, critical field resistance and critical speed. V-I characteristics and torque-speed characteristics of separately excited, shunt and series motors. Speed control through armature voltage. Losses, load testing and back-to-back testing of DC machines

UNIT:3 **(14 Hours)**

Principle, construction and operation of single-phase transformers, equivalent circuit, phasor diagram, voltage regulation, losses and efficiency Testing - open circuit and short circuit tests, polarity test, back-to-back test, separation of hysteresis and eddy current losses Three-phase transformer - construction, 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, Magnetizing current, effect of nonlinear B-H curve of magnetic core material, harmonics in magnetization current, Phase conversion - Scott connection, three-phase to six-phase conversion, Tap-changing transformers - No-load and on-load tap-changing of transformers, Three-winding transformers. Cooling of transformers.

UNIT:4 **(14 Hours)**

Three phase transformers: Constructional features, As a single unit and as a bank of three single phase transformers. Three-Phase Transformer connections, The per unit system for Three Phase Transformer, Transformer Ratings and Related problems, Two Single-Phase Transformers connected in Open Delta (V-Connection) and their rating. T-Connection (Scott Connection) of Two Single-Phase Transformers. Transformer Three phase Connections: Various Phase Displacements (0o, 180o, +30o and -30o), Connection Diagrams and Phasor Diagrams of various Vector Groups (Yy0, Dd0, Dz0, Yy6, Dd6, Dz6, Yd1, Dy1, Yz1, Yd11, Dy11, and Yz11)

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Books/References:

1. *A. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 2013.*
2. *A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2004.*
3. *M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.*
4. *P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.*

5. *I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.*

Subject Code	Name of the Subject	L	T	P	C	QP
BELPC3030	**Network Theory**	3	1	0	4	A

Course Educational Objectives

CEO1	Prepare the students to have a basic knowledge in the analysis of Electric Networks.
CEO2	Solve the given circuit with various theorems and methods.

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Solve complex networks by using various Network Theorems
CO2	Analyzing Laplace transformation and two port networks with steady state and transient analysis
CO3	Identifying the significance of Poles and Zeros in Network functions
CO4	Solving Fourier series analysis and designing the Filter circuits
CO5	Evaluating the electrical networks with Network synthesis

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2											1		
CO2	3	3											1		
CO3	2	2											2		
CO4	3	3											1		
CO5	2	2											1		
Avg.	2.4	2.4											1		

SYLLABUS

Unit – I **[11Hrs]**

Network Theorems: Superposition theorem, Thevenin's theorem, Norton's Theorem, Reciprocity Theorem, Maximum Power transfer theorem, Tellegen's theorem, Millman's theorem, Compensation theorem.

Coupled Circuits: Coupled Circuits, Dot Convention for representing coupled circuits, Coefficient of coupling.

Resonance: Band Width and Q-factor for series and parallel resonant circuits.

Unit - II **[12Hrs]**

Laplace Transform & its Application: Introduction to Laplace Transform, Laplace transform of some basic functions, Laplace transform of periodic functions, Inverse Laplace transform, Application of Laplace transform: Circuit Analysis (Steady State and Transient).

Two Port Network Functions& Responses: z, y, ABCD and h-parameters, Reciprocity and

Symmetry, Interrelation of two-port parameters, Interconnection of two-port networks.
Network Functions: Significance of Poles and Zeros, Restriction on location of Poles and Zeros, Time domain behaviour from Pole-Zero plots.

Unit – III [12 Hrs]

Fourier Series& its Application: Fourier series, Fourier analysis and evaluation of coefficients, Steady state response of network to periodic signals, Fourier transform and convergence, Fourier transform of some functions.
Passive Filter: Brief idea about network filters (Low pass, High pass, Band pass and Band elimination) and their frequency response

Unit – IV **[12 Hrs.]**

Network Synthesis: Realizability concept, Hurwitz property,
positive realness, properties of positive real functions, Synthesis of R-L, R-C and L-C driving point functions in Foster and Cauer forms.
Network Topology: Graph of a network, Concept of tree, Incidence matrix, Tie-set matrix, Cut-set matrix, Formulation and solution of network equilibrium equations on loop and node basis

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Book:

1. *Fundamentals of Electric Circuits – Alexander &Sadiku– Tata McGraw Hil,5th Editionl.*
2. *Circuits & Networks: Analysis, Design and Synthesis- Sukhija&Nagsarkar- Oxford*

Reference Book:

1. *Network Analysis – M E Van Valkenburg – Pearson Education, 3rd Edition.*
2. *Network Synthesis – M E Van Valkenburg – Pearson Education.*
3. *Network Analysis and Synthesis – Franklin F. Kuo – Wiley Student Edition.*
4. *Linear Circuits Analysis and Synthesis – A Ramakalyan – Oxford University Press.*
5. *Problems & Solutions in Electric Circuit Analysis – Sivananda&Deepa – Jaico Book.*
6. *Theory and problem of electrical circuits, Schaum's Outline Series, TMH – Joseph A. Edminister, MahmoodMaqvi.*
7. *Electric Circuits – David A.Bell – Oxford, 7th Edition, 2015.*

Sub. Code	Name of the Subject	L	T	P	C	QP
BELPC3040	**ANALOG ELECTRONICS CIRCUITS**	3	0	0	3	A

Pre -Requisite: A student should have basic idea on electronic components and also should have clear concept on KCL & KVL

Course Educational Objectives

CEO1	Prepare the students to perform the analysis of analog electronic circuits.
CEO2	Empower the students to understand the design and working of different types of amplifiers.

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Understand the characteristics of transistors.
CO2	Design and analyze various amplifier circuits.
CO3	Describe the effect of negative feedback, low & high frequency response and gain-bandwidth relationship for amplifier scheme.
CO4	Understand the functioning of OP-AMP and design OP-AMP based circuits.
CO5	Use the effect of positive feedback to model oscillators.
CO6	Examine the efficiency of different class of power amplifiers.

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	1													
CO2	2	2													
CO3	2	2													
CO4	2	1													
CO5	2	1													
CO6	2	2													
Avg.	2	1.5													

SYLLABUS

UNIT:1 **(12 Hours)**

Biasing of BJTs: Introduction; Operating Point; Fixed Bias; Emitter Bias; Voltage-Divider Bias; DC Bias with Voltage Feedback; Miscellaneous Bias Configurations; Design Operations; Bias Stabilization.

Field-Effect Transistors: Introduction; Basic Construction, Operation and Characteristics of JFETs and MOSFETs; CMOS.

Biasing of FETs: Fixed-Bias Configuration; Self-Bias Configuration; Voltage-Divider Biasing; Design.

UNIT:2 **(12 Hours)**

Small Signal Analysis of BJTs: BJT Transistor Modeling; The r_e Transistor model; The Hybrid Equivalent Model: Small-Signal Analysis of CE, CB, and CC Amplifiers; Emitter Follower

Configuration; Effect of R_L and R_S; Two-Port Systems Approach; Cascaded Systems; Darlington Connection; Current Mirror Circuits. (6 Hours)

Small Signal Analysis of FETs: FET Small-Signal Model, Small-Signal Analysis of CS, CD, CG Amplifiers. Effect of R_L and R_{sig}; Cascade Configuration.

UNIT:3 **(5 Hours)**

Frequency Response of BJTs and FETs: Low and High Frequency Response of BJTs and FETs; Frequency Response of CE Amplifier; Frequency Response of CS Amplifier; Miller Effect Capacitance; Multistage Frequency Effects; Square Wave Testing.

UNIT:4 **(12 Hours)**

Operational Amplifiers: Differential Amplifier Circuit; Op-Amp Basics; Practical Op-Amp Circuits; Op-Amp Parameters; Op-Amp Parameters; Op-Amp Applications; Instrumentation Amplifier; Active Filters. (5Hours)

Power Amplifiers: Classifications; Class-A and Class-B Amplifier Circuits, Transfer Characteristics, Power Dissipation and Conversion Efficiency of Power Amplifiers.(3 Hours)

Feedback Amplifiers and Oscillators: Feedback Concepts; Feedback Connection Types; Practical Feedback Circuits; Feedback Amplifier Stability using Nyquist Plot; Basic Principle of Sinusoidal Oscillator; Phase-Shift, Wien-Bridge and Crystal Oscillator.(4 Hours)

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Books:

1. *Electronic Devices and Circuit Theory, R. L. Boylestad and L. Nashelsky, Pearson Education, New Delhi, 9th/10th Edition, 2013. (Selected portions of Chapter 4, 5, 6, 7, 8, 9, 10, 11, 12, and 14)*
2. *Milliman's Electronics Devices and Circuits, J. Milliman, C. Halkias, S. Jit., Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2nd Edition, 2008.*
3. *Microelectronics Circuits, 5th Edition, International Student Edition Sedra and Smith, Oxford University Press, New Delhi.*

Reference Books:

1. *Electronic Devices and Circuits, 3rd Edition, Jimmie J. Cathey adapted by Ajay Kumar Singh, Tata McGraw Hill Publishing Company Ltd., New Delhi.*
2. *Electronics Circuits Analysis and Design, 3rd Edition, Donald A. Neamen, Tata McGraw Hill Publishing Company Ltd., New Delhi.*
3. *Microelectronic Circuits: Analysis and Design, India Edition, M.H. Rashid, PWS Publishing Company, a division of Thomson Learning Inc.*

Subject Code	Name of the Subject	L	T	P	C	QP
BCSES3050	**Object Oriented Programming using JAVA**	3	0	0	3	A

Course Educational Objectives

CEO1	Programming in the Java programming language
CEO2	Knowledge of object-oriented paradigm in the Java programming language, the use of Java in a variety of technologies and on different platforms.

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Knowledge of the structure and model of the Java programming language, (knowledge)
CO2	Use the Java programming language for various programming technologies (understanding)
CO3	Propose the use of certain technologies by implementing them in the Java programming language to solve the given problem (synthesis)
CO4	Choose an engineering approach to solving problems, starting from the acquired knowledge of programming and knowledge of operating systems. (evaluation)

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			2		2										
CO2			2		2										
CO3			2		2										
CO4			2		2										
Avg.			2		2										

SYLLABUS

Unit – I **[11Hrs]**

An introduction Object Oriented Programming, Features of Object Oriented Programming Introduction to Java. Difference between C/C++ and Java, Features of Java, First Java Program, Writing the java program, Compiling the program, JVM and its significance in executing a program?, Architecture of JVM. Understanding, Java Tokens, Datatypes, Operators, Control Structures and Arrays, Conditional Statements, Loops/ Iterators, Jumping Statements, Java Arrays, Multidimensional Arrays, Taking Input from keyboard, Command Line Arguments, Using Scanner Class, Using Buffered Reader class.

Unit - II **[12Hrs]**

Introduction to Classes and Objects. Constructors, static Keyword, this Keyword, Array of Objects, Access Modifiers (Public, Private, Protected, Default). Inheritance, Types of Inheritance and Java supported Inheritance, super, Polymorphism, Method Overloading, Constructor Overloading, Method Overriding, Dynamic Method Dispatching. String Manipulations. Wrapper

classes, Auto boxing and unboxing. Abstract classes, Interfaces, Multiple Inheritance Using Interfaces, Java API Packages, User-Defined Packages, Accessing Packages, Error and Exception Handling, Types of exceptions Hierarchy of Exception classes, try, catch, finally, throw, throws, Commonly used Exceptions and their details ,User defined exception classes.

Unit – III [12 Hrs]

Multithreading , Thread in Java, Thread execution prevention methods. (yield(), join(), sleep()), Concept of Synchronization, Inter Thread Communication, Basics of Deadlock, Demon Thread, Improvement in Multithreading, Inner Classes, Introduction, Member inner class, Static inner class, Local inner class, Anonymous inner class. IO Streams (java.io package) ,Byte Stream and Character Stream, Files and Random Access Files, Serialization, Collection Frame Work (java.util), Util Package interfaces, List, Set, Map.

Unit – IV **[12 Hrs]**

Applet Introduction, Life Cycle of an Applet, GUI with an Applet, Abstract Window Toolkit (AWT), Introduction to GUI, Description of Components and Containers, Component/Container hierarchy, Understanding different Components/Container classes and their constructors, Event Handling, Different mechanisms of Event Handling, Listener Interfaces, Adapter classes.

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Book:

1. Programming in Java. Second Edition. Oxford higher education. (Sachin Malhotra/ SauravChoudhary)
2. Core Java for beginners. (RashmiKanta Das), Vikas Publication

Reference Book:

1. *JAVA Complete Reference (9th Edition) HerbaltSchelidt.*

Subject Code	Name of the Subject	L	T	P	C	QP
BBSBS3061	**ENVIRONMENTAL ENGINEERING & SAFETY**	3	0	0	3	A

Course Educational Objectives

CEO1	Understanding the concepts of Ecological Concepts and Biotic components
CEO2	Analysing the concepts of Water Treatment and its standards and parameters

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Understanding the concepts of Ecological Concepts and Biotic components
CO2	Analysing the concepts of Water Treatment and its standards and parameters
CO3	Understanding the concept of Solid Waste Management and its practical implementation
CO4	Know the Occupational Safety and Health Acts, Safety procedures, Type of Accidents and its preventive actions

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1						1	2								
CO2						2	2								
CO3						1	2								
CO4						2	2								
Avg.						1.5	2								

SYLLABUS

Unit – I **[11Hrs]**

Ecological Concepts: Biotic components, Ecosystem Process: Energy, Food Chain, Water cycle, Oxygen cycle, Nitrogen cycle etc., Environmental gradients, Tolerance levels of environment factors, Indian Environmental Law. Chemistry in Environmental Engineering: Atmospheric chemistry, Soil chemistry. Biodiversity and its conservation

Unit - II **[12Hrs]**

Water Treatment: water quality standards and parameters, DO and BOD of water. Water treatment processes: Pre-treatment of water, Conventional process, advanced water treatment process.

Waste Water Treatment: pretreatment, primary and secondary treatment of waste water, Activated sludge treatment: Anaerobic digestion, Reactor configurations and methane production.

Air Pollution: Air pollution and pollutants, criteria pollutants, Acid deposition, Global climate change –greenhouse gases, non-criteria pollutants, Air pollution meteorology, Atmospheric dispersion. Industrial Air Emission and Control. Flue gas desulphurization, NOx removal, Fugitive emissions. Noise pollution- Noise standards, measurement and control.

Unit – III [12 Hrs.]

Solid Waste Management: Source, classification and composition of MSW, Separation, storage and transportation, Reuse and recycling, Waste Minimization Techniques. Hazardous Waste Management: Hazardous waste and their generation, Treatment: Incinerators, Inorganic waste

treatment. E.I.A., Environmental auditing

Unit – IV **[12 Hrs.]**

Occupational Safety and Health Acts, Safety procedures, Type of Accidents, Chemical and Heat Burns, Prevention of Accidents involving Hazardous substances, Human error. Hazard Control Measures in steel industry, Petroleum Refinery, Pharmaceutical industry. Fire Prevention - Detection, Extinguishing Fire safety, Handling and Storage of Hazardous Materials. Personal Protective Equipment's.

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Book:

1. Environmental Engineering, Irwin/ McGraw Hill International Edition, 1997, G. Kiely,
2. Environmental Engineering by Prof B.K. Mohapatra, Seven Seas Publication, Cuttack
3. Environmental Engineering and Safety ,Raut&Sen Scientific Publishers.
4. Industrial Safety ,Desmukh

Reference Book:

1. Environmental Engineering by Arcadio P. Sincero&Gergoria A. Sincero PHI Publication
2. Principles of Environmental Engineering and Science, M. L. Davis and S. J. Masen, McGrawHill International Edition, 2004
3. Environmental Science, Curringham&Saigo, TMH,
4. Man and Environment by Dash & Mishra
5. An Introduction to Environmental Engineering and Science by Gilbert M. Masters &WendellP. Ela - PHI Publication.
6. Industrial Safety Management and Technology, Colling. D A – Prentice Hall, New Delhi.

Subject Code	Name of the Subject	L	T	P	C	QP
BMSHS3062	**Engineering Economics & costing**	3	0	0	3	A

Course Educational Objectives

CEO1	Analysing the engineering projects with Engineering economics principles
CEO2	Evaluating the projects with financial analysis and its financial viability

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Analysing nature, Scope, Basic problems of an economy, Micro Economics and Macro Economics
CO2	Understanding Cost and revenue concepts, Basic understanding of different market structures,
CO3	Evaluating time value of money- Interest - Simple and compound, nominal and effective rate of interest,Cash flow diagrams, Principles of economic equivalence
CO4	Understanding the concepts of Depreciation and its implementation approaches

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1											2				
CO2											2				
CO3											2				
CO4											1				
Avg.											1.75				

SYLLABUS

Unit – I **[11Hrs]**

Engineering Economics- Nature, Scope, Basic problems of an economy, Micro Economicsand Macro Economics.

Demand- Meaning of demand, Demand function, Law of Demand and its exceptions,Determinants of demand, Elasticity of demand & its measurement (Simple numericalproblems to be solved), Supply-Meaning of supply, Law of supply and its exception,Determinants of supply, Elasticity of supply, Determination of market equilibrium (Simplenumerical problems to be solved).

Production-Production function, Laws of returns: Law of variable proportion, Law of returnsto scale

Unit - II **[12Hrs]**

Cost and revenue concepts, Basic understanding of different market structures, Determinationof equilibrium price under perfect competition (Simple numerical problems to be solved),Break Even Analysis-linear approach (Simple numerical problems to be solved).

Banking -Commercial bank, Functions of commercial bank, Central bank, Functions ofCentral Bank.

Inflation-Meaning of inflation, types, causes, measures to control inflation.National Income-Definition, Concepts of national income, Method of measuring nationalincome.

Unit – III [12 Hrs]

Time value of money- Interest - Simple and compound, nominal and effective rate of interest, Cash flow diagrams, Principles of economic equivalence. Evaluation of engineering projects-Present worth method, Future worth method, Annualworth method, Internal rate of return method, Cost benefit analysis for public projects.
Unit – IV **[8 Hrs.]** Depreciation- Depreciation of capital assert, Causes of depreciation, Methods of calculatingdepreciation (Straight line method, Declining balance method), After tax comparison ofproject.
Teaching Methods: Chalk& Board/ PPT/Video Lectures
Text Book: 1. *Riggs, Bedworth and Randhwa, "Engineering Economics", McGraw HillEducation India* 2. *Principles of Economics, DevigaVengedasalam; KarunagaranMadhavan,Oxford University Press.* 3. *Engineering Economy by William G.Sullivan, Elin M.Wicks, C. PatricKoelling, Pearson* 4. *R.PaneerSeelvan, " Engineering Economics", PHI* 5. *Ahuja,H.L., "Principles of Micro Economics" , S.Chand& Company Ltd* 6. *Jhingan,M.L., "Macro Economic Theory*

PRACTICAL / SESSIONAL

Subject Code	Name of the Laboratory	L	T	P	C	QP
BELPC3120	**Electrical machines-ILab**	0	0	2	1	

Prerequisites: Calculus, differential equations, and electric and magnetic circuit analysis. Knowledge of KCL and KVL and ability of analyzing Electric Circuits.

Course Educational Objectives	
CEO1	To determine efficiency by various types test on DC generators, motorsand transformers.
CEO2	To plot characteristics curve of different machines.
CEO3	To perform different speed control methods of DC motors.
Course Outcomes: ***Upon successful completion of this course, students should be able to:***	
CO1	Analyzelosses of different Electrical machines.
CO2	Understand the characteristics curve of different machines
CO3	Analyze the different speed control methods of DC motors.

CO4	Examine the efficiencies of DC generators, motors and transformers
CO5	Observe the connections of Single phase transformers

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		2	1											2	
CO2		1	1											1	
CO3		2	2											3	
CO4		2	1											3	
CO5		1	1											2	
Avg.		1.6	1.2											2.2	

List of Experiments

Select any 8 experiments from the list:

1. Determination of critical resistance & critical speed from no load test of a DC shunt generator.
2. Plotting of external and internal characteristics of a DC shunt generator.
3. Speed control of DC shunt motor by armature voltage control and flux control method.
4. Determination of efficiency of DC machine by Swinburne's Test
5. Determination of efficiency of DC machine by Brake test
6. Determination of efficiency of DC machine by Hopkinson's Test.
7. Determination of Efficiency and Voltage Regulation by Open Circuit and Short Circuit test on single phase transformer.
8. Polarity test and Parallel operation of two single phase transformers.
9. Back-to Back test on two single phase transformers.
10. Load Test on 1-phase transformer
11. Scott Connection of Single phase Transformers

Subject Code	Name of the Laboratory	L	T	P	C	QP
BELPC3130	**Network Theory Lab**	0	0	2	1	

Course Educational Objectives

CEO1	Verification of Network Theorems.
CEO2	Study of resonance in R-L-C circuits using oscilloscope.
CEO3	Study of input and output of different filters.
CEO4	Study of DC and AC Transients for R-L, R-C & R-L-C circuits.

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Design a circuit with various theorems and methods.
CO2	Determine open circuit and short circuit parameters.
CO3	Design different filter circuits.

CO4	Examine transient circuits with various loads
CO5	Design different R-L-C resonance circuits.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	1	3										3		
CO2	1	1	1										2		
CO3	2	1	3										3		
CO4	1	1	1										3		
CO5	1	1	3										3		
Avg.	1.4	1	2.2										2.8		

List of Experiments

Select any 8 experiments from the list:

1. Verification of Network Theorems using AC circuits. (Superposition, Thevenin, Norton, Maximum Power Transfer).
2. Study of DC and AC Transients for R-L, R-C & R-L-C circuits using storage oscilloscope.
3. Determination of circuit parameters: Open Circuit and Short Circuit parameters.
4. Determination of circuit parameters: Hybrid and Transmission parameters.
5. Frequency response of Low pass and High Pass Filters.
6. Frequency response of Band pass and Band Elimination Filters.
7. Determination of self-inductance, mutual inductance and coupling coefficient of a single phase two winding transformer representing a coupled circuit.
8. Study of resonance in R-L-C series circuit using oscilloscope.
9. Study of resonance in R-L-C parallel circuit using oscilloscope.
10. Spectral analysis of a non-sinusoidal waveform.

Subject Code	Name of the Laboratory	L	T	P	C	QP
BELPC3120	**ANALOG ELECTRONIC LABORATORY**	0	0	2	1	

Pre -Requisite: A student should have basic idea on electronic components

Course Outcomes

CO1	Define the VI characteristics of biasing circuits using project boards
CO2	Identify different analog circuits and their behaviours.
CO3	Compare the practical results with the assumed data values.
CO4	Design and test of different amplifier and oscillator circuits

CO-PO & PSO Mapping: ***Upon successful completion of this course, students should be able to:***

Cos	PROGRAMME OUTCOMES	PSOs

	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		1	1												
CO2		2	1												
CO3		1	2												
CO4		1	2												
Avg.		1.25	1.5												

List of Experiments

(At least 10 out of 12 experiments should be done)

1. BJT Bias Circuit - design, assemble and test.
2. JEET/MOSFET Bias Circuit - design, assemble and test.
3. Design, assemble and test of BJT Common-Emitter Circuit: DC and AC performance.
4. Study of Darlington Connection and Current Mirror Circuits.
5. Design, assemble and test of JFET/MOSFET Common-Source Circuit: DC and AC performance.
6. Frequency Response of a Common-Emitter Amplifier: low frequency, high frequency and mid frequency response.
7. Differential Amplifiers Circuit: DC bias and AC operation without and with current source.
8. Op-Amp Frequency Response and Compensation.
9. Application of Op-Amp as differentiator, integrator, square wave generator.
10. Square wave testing of an amplifier.
11. R-C Phase Shift oscillator/Wien-Bridge Oscillator using OP-Amp/Crystal Oscillator.
12. Class A and Class B Power Amplifier.

Subject Code	Name of the Laboratory	L	T	P	C	QP
BCSES3150	**Object Oriented Programming using JAVA**	0	0	2	1	

Prerequisites:

Course Educational Objectives

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Understand the Loop control structures: do, while, for etc.
CO2	Know the Classes and objects.
CO3	Know the Data abstraction & data hiding, inheritance, polymorphism.
CO4	AnalyseThreads, exception handlings and applet programs

CO-PO & PSO Mapping:

COs	**PROGRAMME OUTCOMES**	PSOs

	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			1		2										
CO2			1		2										
CO3			2		2										
CO4			2		2										
Avg.			1.5		2										

List of Experiments

1. Introduction, Compiling & executing a java program.
2. Data types & variables, decision control structures: if, nested if etc.
3. Loop control structures: do, while, for etc.
4. Classes and objects.
5. Data abstraction & data hiding, inheritance, polymorphism.
6. Threads, exception handlings and applet programs
7. Interfaces and inner classes, wrapper classes, generics

IV SEMESTER [SECOND YEAR] [69-83]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	C
THEORY							
1	PC	BELPC4010	Electrical Machines – II	3	1	0	4
2	PC	BELPC4020	Control Systems	3	0	0	3
3	PC	BELPC4030	Digital Electronic Circuits	3	0	0	3
4	PC	BELPC4040	Electromagnetic Fields	3	1	0	4
5	ES	BELES3050	Database Management Systems	3	0	0	3
6	BS / HS	BBSBS3061	Environmental Engineering and Safety	3	0	0	3
		BMSHS3062	Engineering Economics and Costing				
PRACTICAL / SESSIONAL							
7	PC	BELPC4110	Electrical Machines – II Lab	0	0	2	1
8	PC	BELPC4120	Control Systems Lab	0	0	2	1

9	PC	BELPC4130	Digital Electronic Circuits Lab	0	0	2	1
10	ES	BELPC4140	Database Management Systems lab	0	0	2	1
TOTAL				**18**	**2**	**8**	**24**

Subject Code	Name of the Subject	L	T	P	C	QP
BELPC4010	**Electrical Machines -II**	3	1	0	4	A

Course Educational Objectives

CEO1	To understand the concept of three phase synchronous generator
CEO2	To study about the characteristics and parameters of cylindrical rotor type and salient pole type three phase synchronous generators
CEO3	To get concept of parallel operation of three phase synchronous generator
CEO4	To study about principle and properties of synchronous motor
CEO5	To acquire knowledge about working principle and properties of three phase and single phase induction motors

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Working principle and characteristics of synchronous machines
CO2	Interpreting the concept and difference between cylindrical rotor and salient pole type three phase synchronous generator.
CO3	Understand the concept of parallel operation of alternator and its synchronization with infinite bus bar
CO4	Acquiring knowledge about properties and concept of synchronous motor.
CO5	Differentiate properties and concept between three phase and single phase induction motor.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2											2		
CO2	2	3											1		
CO3	1	1											2		
CO4	1	2											2		
CO5	2	2											2		
Avg.	1.6	2											1.8		

SYLLABUS

Unit – I **[14Hrs]**

Three Phase Synchronous Generators: Synchronous Generator Construction (both Cylindrical Rotor and Salient Pole type), the Speed of Rotation of a Synchronous Generator, Induced voltage in A.C Machines, The Internal Generated Voltage of a Synchronous Generator, The Equivalent Circuit of a Synchronous Generator (Armature Reaction Reactance, Synchronous Reactance and Impedance).

Cylindrical Rotor type Three Phase Synchronous Generators: The Phasor Diagram of a Synchronous Generator, Power and Torque in Synchronous Generators (Power Angle Equation and Power Angle Characteristic), Measuring Synchronous Generator Model Parameters (Open Circuit and Short Circuit Tests and Determination of Synchronous Impedance and Reactance,

The Short Circuit Ratio), Voltage Regulation and Speed Regulation. Voltage Regulation by Synchronous Impedance Method

Unit - II **[12Hrs]**

Salient Pole type Three Phase Synchronous Generators: Two Reaction Concept, Development of the Equivalent Circuit of a Salient Pole type Three Phase Synchronous Generator (Direct axis and Quadrature axis Reactance, Phasor Diagram for various load power factors,), Torque and Power Equations of Salient Pole Synchronous Generator (Power Angle Equation and Power Angle Characteristic with stator resistance neglected). Slip Test for determination of direct axis and Quadrature axis Reactance.

Parallel operation of Three Phase A.C. Synchronous Generators

The Conditions Required for Paralleling, The General Procedure for Paralleling Generators,

Three Phase Synchronous Motors: Basic Principles of Motor operation, Steady State Synchronous Motor operation, Starting Synchronous Motors, Operation of synchronous motors connected to bus and phasor diagrams for normal, under and over excited conditions, V and Λ curves, Synchronous Motor Applications.

Unit – III [14 Hrs.]

Three phase induction machines:

Constructional features and types; 3-phase distributed winding production of rotating magnetic field, Principle of Operation, The Effect of Coil Pitch and distribution factor on A.C. Machines, winding factor, Concept of Slip, Slip Speed; Phasor diagram and Development of equivalent circuit and derivation of torque equation; Typical torque-slip characteristic and influence of different parameters on it, No-Load and Blocked Rotor tests,

Determination of Parameters, power flow diagram, Losses and Efficiency, Methods of starting and speed control. Cogging, Crawling.

Unit – IV **[8 Hrs.]**

Single phase induction machines: Double field revolving theory, Methods of starting using auxiliary winding, development of equivalent circuit. No-Load and Blocked Rotor tests,

Determination of Parameters Speed Control of Single Phase Induction Motors.

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Books:

1. *Stephen J. Chapman-'Electric Machinery and Fundamentals'- McGraw HillInternational Edition, (Fourth Edition), 2015.*
2. *M.G.Say-'Alternating Current Machines', English Language Book Society(ELBS)/ Longman, 5th Edition, Reprinted 1990.*

Reference Books:

1. *B.S.Guru&H.R.Hiziroglu-'Electric Machinery & Transformers'-3rd Ed-OxfordPress, 2014.*
2. *P.C.Sen-'Principles of Electric Machines and Power Electronics'-2nd Edition, JohnWiley and Sons, Wiley India Reprint, 2014.*

3. *A.E.Fitgerland, Charles Kingslay Jr. & Stephen D. Umans -Electric machinery – 6th Edition McGraw Hill – Reprint 2015.*
4. *D.P. Kothari & I.J. Nagrath - Electric Machines – 4th Edition McGraw Hill – Reprint2015.*
5. *P S Bimbhra– Electrical Machinery –Khanna Publishers.*

Subject Code	Name of the Subject	L	T	P	C	QP
BELPC4020	**Control Systems**	3	0	0	3	A

Course Educational Objectives

CEO1	To know the performance of different control system through design in state space.
CEO2	To understand the stability of linear and nonlinear systems.
CEO3	To understand the principle of digital control system and to analyse it's stability

Course Outcomes: : *Upon successful completion of this course, students should be able to:*

CO1	Acquiring knowledge about theoretical concept of control system and its application.
CO2	Analysis the concept of control stability of a system in frequency domain and time domain
CO3	Understand the time response analysis and feedback characteristics of control system.
CO4	Analyze about state variable analysis and PID controller.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		2	3										2		
CO2		3	2										3		
CO3		3	2										2		
CO4		1	2										3		
Avg.		2.25	2.3										2.5		

SYLLABUS

Unit – I **[12 Hrs.]**

Introduction to Control Systems: Basic Concepts of Control Systems, Open loop and closedloop systems, Servo Mechanism/Tracking System.

Mathematical Models of Physical Systems: Differential Equations of Physical Systems, Transfer functions, Block Diagram Algebra, Signal flow Graphs.

Feedback characteristics of Control Systems: Feedback and Non-feedback System, Reduction of parameter variation by use of feedback, control over System Dynamics by use of feedback, Control of the Effects of disturbance signals by use of feedback, linearizing effect offeedback, regenerative feedback, Regenerative feedback.

Unit - II **[12 Hrs.]**

Time response Analysis: Standard Test Signals, Time response of first order systems, Time

Response of Second order systems, Steady State Errors and Static Error Constants of different types of systems, Effect of adding a zero to a system, Design specification of second order system, Performance indices.
Concepts of Stability: The concept of stability, Necessary conditions for stability, Hurwitz Stability Criterion, Routh Stability Criterion, Relative Stability Analysis, More on Routh Stability Criterion.
The Root locus Technique: Introduction, Root locus Concepts, Construction of Root locus, Rout Contours, Systems with transportation lag.

Unit – III [12 Hrs.]
Frequency Response Analysis: Correlation between Time and Frequency Response, Polar plots, Bode plots
Stability in Frequency Domain: Mathematical Preliminaries, Nyquist Stability Criterion, Assessment of Relative stability using Nyquist Criterion, Closed loop

Unit – IV[8 Hrs.]
Control System and Components: Stepper motor, AC & DC Servomotor, Synchros, AC Tachometer
Design Specifications of a control system: Proportional Derivative Error Control (PD Control), Proportional Integral Controller (PI Control), Proportional, Integral and Derivative Controller (PID Control), Derivative Output Control.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Book:

1. *Control Systems Engg. by I.J. Nagrath and M.Gopal, 5th Edition, New Age International Publishers (2010)*
2. *Modern Control Engineering by K. Ogata, 5th edition PHI.*
3. *Automatic Control Systems by Benjamin C. Kuo, 7th Edition, Prentice-Hall India publication (1995)*

Reference Book:

1. *Design of Feedback Control Systems by R.T. Stefani, B. Shahian, C.J. Savator, G.H. Hostetter, Fourth Edition (2009), Oxford University Press.*
2. *Control Systems (Principles and Design) by M.Gopal 3rd edition (2008), TMH.*
3. *Analysis of Linear Control Systems by R.L. Narasimham, I.K. InternationalPublications*
4. *Control Systems Engineering by S.P. Eugene Xavier and J. Josheph Cyril Babu,1stEdition (2004), S. Chand Co. Ltd.*
5. *Problems and solutions in Control System Engineering by S.N. Sivanandam and S.N. Deepa, Jaico Publishing House.*
6. *Modern Control Systems by Richard C.Dorf and Robert H. Bishop, 11thEd (2009),Pearson.*

Subject Code	Name of the Subject	L	T	P	C	QP
BELPC4030	**DIGITAL ELECTRONIC CIRCUITS**	3	0	0	3	A

Course Educational Objectives

Pre -Requisite: A student should have basic idea on logic gates

CEO 1	To acquire the basic knowledge of digital logic levels and implements it in digital electronics.
CEO 2	Prepare the students to perform the analysis and design of various digital electronic circuits.
CEO4	Understand the frequency response analysis and stability in Frequency Domain

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Understand working of logic families and logic gates.
CO2	Recognize and study various number systems and their application in digital design.
CO3	Design and implement combinational logic circuits.
CO4	Design and analyze sequential logic circuits.
CO5	Employ PLDs to execute the given logical problem.
CO6	Establish the process of analog to digital conversion and digital to analog conversion.

CO-PO & PSO Mapping:

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	1												
CO2	1	2	1												
CO3	1	2	2												
CO4	2	2	2												
CO5	2	1	2												
CO6	1	1	1												
Avg.	1.5	1.67	1.5												

SYLLABUS

UNIT: I **8 Hours**

1. **Number Systems and Codes:** Binary, Octal, Hexadecimal and Decimal Number System and their Conversion; Representation of Signed Binary and Floating Point Number; Binary Arithmetic using 1's and 2's Complements, Binary Codes - BCD Code, Gray Code, ASCII Character Code. (5 Hours)
2. **Boolean Algebra and Logic Gates:** Axioms and Laws of Boolean Algebra; Reducing Boolean Expressions; Logic levels and Pulse Waveforms; Logic Gates; Boolean Expressions and Logic Diagrams. (3 Hours)

UNIT: II **9 Hours**

3. **Gate-level Minimization:** Canonical and Standard Forms; K-maps - Two, Three and

Four Variable K-maps, Don't-Care Conditions; NAND and NOR Implementation; Other Two-Level Implementations, Exclusive-OR Function. (4 Hours)

4. **Combinational Logic:** Combinational Circuits; Analysis Procedure; Design Procedure; Adders; Subtractors; Parallel Binary Adders; Binary Adder-Subtractor; Binary Multiplier; Magnitude Comparator; Decoders; Encoders, Multiplexers; De-multiplexers. (5 Hours)

UNIT: III **14 Hours**

5. **Synchronous Sequential Logic:** Sequential Circuits; Latches, Flip-Flops; Master-Slave Flip-Flop; Conversion of Flip-Flops; Analysis of Clocked Sequential Circuits; Mealy and Moore Models of Finite State Machines. (6 Hours)
6. **Registers and Counters:** Shift Registers; Data Transmission in Shift Registers; SISO, SIPO, PISO and PIPO Shift Registers; Counters; Asynchronous Counters; Design of Asynchronous Counters; Synchronous Counters; Design of Synchronous Counters; Ring Counter. (8 Hours)

UNIT: IV **14 Hours**

7. **Memory and Programmable Logic:** Introduction; Random-Access Memory; Memory Decoding; Error Detection and Correction; Read-Only Memory; Programmable Logic Array; Programmable Array Logic; Sequential Programmable Devices. (5 Hours)
8. **Analog-to-Digital and Digital-to-Analog Converters:** Digital-to-Analog Converters - R-2R Ladder D/A Converter, Weighted Resistor D/A Converter; Analog-to-Digital Converters - Counter-type A/D Converter, Parallel Comparator A/D Converter, Dual-Slope A/D Converter, Successive-Approximation A/D Converter, A/D Converter using Voltage-to-Frequency. (5 Hours)
9. **IC Logic Families:** Special Characteristics; RTL, DTL, TTL, ECL, IIL, MOS and CMOS Logic Circuits. (4 Hours)

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Books:

1. *Digital Design, 3rd Edition, M. Morris Mano, Pearson Education.*
2. *Digital Fundamentals, 5th Edition, T. L. Floyd and R. P. Jain, Pearson Education, New Delhi.*
3. *Fundamentals of Digital Circuits, 8th Edition, A. Anand Kumar, PHI.*

Reference Books:

1. *Digital Systems – Principles and Applications, 10th Edition, Ronald J. Tocci, Neal S. Widemer and Gregory L. Moss, Pearson Education.*
2. *A First Course in Digital System Design: An Integrated Approach, India Edition, John P. Uyemura, PWS Publishing Company, a division of Thomson Learning Inc.*
3. *Digital Systems – Principles and Applications, 10th Edition, Ronald J. Tocci, Neal S. Widemer and Gregory L. Moss, Pearson Education.*
4. *Digital Design, Robert K. Dueck, CENGAGE Learning.*
5. *Digital Principles and Applications, 6th Edition, Donald P. Leach, Albert Paul Malvino and Goutam Saha, Tata McGraw Hill Publishing Company Ltd., New Delhi.*

Subject Code	Name of the Subject	L	T	P	C	QP
BELPC4040	**Electromagnetic Fields**	3	1	0	4	A

Course Educational Objectives

CEO1	To study about the concept of Co-ordinate systems & Transformation.
CEO2	To study about Vector Calculus
CEO3	To get theoretical concept of calculation and derivation of electrostatic field.
CEO4	Understand the theoretical derivation of magnatostatic field.
CEO5	To acquire knowledge about electromagnetic field and wave propagation

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Relate the vector calculus with electric and magnetic field in space.
CO2	Employ mathematical tools like integral & differential calculus to study electric and magnetic behaviour through a medium.
CO3	Solve electromagnetic relation using Maxwell formulae and analyze moving charges on magnetic fields.
CO4	Formulate the idea of applying properties of electromagnetic waves in transmission lines and design circuits using conductors as well as dielectrics.
CO5	Measure and decide the nature of a wave to propagate in a particular medium

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2											2		
CO2	1	2											2		
CO3	2	1											2		
CO4	2	2											2		
CO5	3	2											2		
Avg.	2	1.8											2		

SYLLABUS

Unit – I **(12 hours)**

Co-ordinate systems & Transformation: Cartesian co-ordinates, circular cylindrical co-ordinates, spherical co-ordinates.

Vector Calculus: Differential length, Area & volume, Line surface and volume Integrals, Del operator, Gradient of a scalar, Divergence of a vector & divergence theorem, curl of a vector &Stoke's theorem, laplacian of a scalar

Unit - II **[12Hrs]**

Electrostatic Fields: Coulomb's Law, Electric Field Intensity, Electric Fields due to point, line, surface

and volume charge, Electric Flux Density, Gauss's Law – Maxwell's Equation, Applications of Gauss's Law, Electric Potential, Relationship between E and V –Maxwell's Equation An Electric Dipole & Flux Lines, Energy Density in Electrostatic Fields., Electrostatic Boundary – Value Problems: Possion's& Laplace's Equations, Uniqueness theorem, General procedures for solving possion's or Laplace's Equation.
Unit – III **[12 Hrs]** Magnatostatic Fields: Magnetic Field Intensity, Biot-Savart's Law, Ampere's circuit law-Maxwell Equation, applications of Ampere's law, Magnetic Flux Density-Maxwell's equations. Maxwell's equation for static fields, Magnetic Scalar and Vector potentials.
Unit – IV **(12 hours)** Electromagnetic Fields and Wave Propagation: Faraday's Law, Transformer & Motional Electromagnetic Forces, Displacement Current, Maxwell's Equation in Final forms, Time Varying Potentials, Time-Harmonic Field. Electromagnetic Wave Propagation: Wave Propagation in loss Dielectrics, Plane Waves in loss less Dielectrics, Power & pointing vector.
Teaching Methods: Chalk& Board/ PPT/Video Lectures
Text Books: *1. Matthew N. O. Sadiku, Principles of Electromagnetics, 4th Ed., Oxford Intl. Student Edition.*
Reference Books: *1. C. R. Paul, K. W. Whites, S. A. Nasor, Introduction to Electromagnetic Fields, 3rd, TMH.* *2. W.H. Hyat, Electromagnetic Field Theory, 7th Ed, TMH.*

Subject Code	Name of the Subject	L	T	P	C	QP
BELES3050	**Data Base Management Systems**	3	0	0	3	A

Course Educational Objectives	
CEO1	To understand the different issues involved in the design and implementation of a database system
CEO2	To study the physical and logical database designs, database modeling, relational, hierarchical, and network models.
CEO3	To understand and use data manipulation language to query, update, and manage a database
CEO4	To develop an understanding of essential DBMS concepts such as: database security, integrity, concurrency, distributed database, and intelligent database, Client/Server (Database Server), Data Warehousing.
Course Outcomes: ***Upon successful completion of this course, students should be able to:***	
CO1	Interpreting the Database Management concepts, different Data models and architectures with ER to Relational mapping
CO2	Applying and executing the SQL, relational algebra and calculus commands to create and manipulate Database
CO3	Differentiate normal forms for normalization process to construct the consistent Database.
CO4	Design the Database by inspecting concurrency and recovery strategies to make complete DB

	without confliction and consistent DB in concurrent environment

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			1		2										
CO2			1		2										
CO3			1		2										
CO4			2		2										
Avg.			1.25		2										

SYLLABUS

UNIT:1 **(15 Hours)**

Introduction to database Systems, advantages of database system over traditional file system, Basic concepts & Definitions, Database users, Database Language, Database System Architecture, Schemas, Sub Schemas, & Instances, database constraints, 3-level database architecture, Data Abstraction, Data Independence, Mappings, Structure, Components & functions of DBMS, Data models

UNIT:2 **(13 Hours)**

Entity relationship model, Components of ER model, Mapping E-R model to Relational schema, Relational Algebra, Tuple & Domain Relational Calculus, Relational Query Languages: SQL and QBE. Database Design :-Database development life cycle (DDLC), Automated design tools, Functional dependency and Decomposition, Join strategies, Dependency Preservation & lossless Design, Normalization, Normal forms:1NF, 2NF,3NF, and BCNF, Multi-valued Dependencies, 4NF & 5NF. Query processing and optimization: Evaluation of Relational Algebra Expressions, Query optimization, Query cost estimation.

UNIT:3 **(10 Hours)**

Network and Object Oriented Data models, Storage Strategies: Detailed Storage Architecture, Storing Data, Magnetic Disk, RAID, Other Disks, Magnetic Tape, Storage Access, File & Record Organization, File Organizations & Indexes, Order Indices, B+ Tree Index Files, Hashing Data Dictionary.

UNIT:4 **(12 Hours)**

Transaction processing and concurrency control: Transaction concepts, properties of transaction, concurrency control, locking and Timestamp methods for concurrency control schemes. Database Recovery System, Types of Data Base failure & Types of Database Recovery, Recovery techniques. Fundamental concepts on Object-Oriented Database, Object relational database, distributed database, Parallel Database, introduction to Data warehousing & Data Mining.

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Book:

1. Sudarshan, Korth: Database System Concepts, 6th edition, McGraw-Hill Education

Reference Books:

1. Elmasari&Navathe: Fundamentals of Database System, Pearson Education.
2. Ramakrishnan: Database Management Systems, McGraw-Hill Education.
3. Andrew S. Tanenbaum: Modern Operating Systems, 3rd Edition, Pearson Education.
4. Terry Dawson, Olaf Kirch: Linux Network Administrator's Guide, 3rd Edition O'Reilly edia

PRACTICAL / SESSIONAL

Subject Code	Name of the Laboratory	L	T	P	C	QP
BELPC4110	**Electrical Machines -II lab**	0	0	2	1	

Course Educational Objectives

CEO1	To study the voltage regulation and characteristics of alternator
CEO2	To acquire knowledge of characteristics of synchronous motor
CEO4	To study working principle of different type of single phase induction motor
CEO4	To understand the concept of synchronization of an alternator with infinite bus bar

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Acquire practical concept of synchronization of an alternator with infinite busbar
CO2	Apply the knowledge of alternator in generation field.
CO3	Implement the characteristics of three and single phase induction motors in different drives
CO4	Understand the concept and application of synchronous motor in various industrial field.

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		2	2										2		
CO2		2	2										2		
CO3		2	2										2		
CO4		2	2										2		
Avg.		2	2										2		

List of Experiments

1. Determination of the voltage regulation of an alternator by synchronous impedance method and zero power factor (zpf) method
2. Study of parallel operation of two alternators
3. Measurement of direct and quadrature axis reactance of a salient pole synchronous machine
4. Determination of the V and inverted V curves of a synchronous motor
5. Determination of parameters of synchronous machine
   a. Positive sequence reactance
   b. Negative sequence reactance
   c. Zero sequence reactance
6. Determination of parameter of a single phase induction motor and study of
   (a) Capacitor start induction motor
   (b) Capacitor start and capacitor run induction motor
   (c) Universal motor
   (d) Shaded pole motor
   (e) Repulsion motor
7. Determination of Efficiency, Plotting of Torque-Slip Characteristics of Three Phase

Induction motor by Brake Test.
8. Determination of parameters of three phase induction motor from No load Test and Blocked Rotor Test
9. Speed control of a three phase induction motor using variable frequency drives
10. Performance of grid connected induction generator.

Subject Code	Subject Code	L	T	P	C	QP
BELPC4120	**Control Systems Lab**	0	0	2	1	

Course Educational Objectives

CEO1	To study the characteristics of AC servomotor
CEO2	To understand the concept of P,PI,PID controller
CEO3	To acquire knowledge of characteristics of different type of transducers.

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Acquire practical concept and application of various transducers in the field of industrial automation and feedback system
CO2	Apply the knowledge of various control system components in automation.
CO3	Implement the characteristics of P , PI , PID controller in advanced control system .
CO4	Understand the concept and application of lag lead compensator.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1				2	2								**2**		
CO2				2	1								**2**		
CO3				1	1								**2**		
CO4				1	1								**2**		
Avg				1.5	1.25								2		

LIST OF EXPERIMENTS

1. Study of a dc motor driven position control system
2. Study of speed torque characteristics of two phase ac servomotor and determination of its transfer function
3. Obtain the frequency response of a lag and lead compensator
4. To observe the time response of a second order process with P, PI and PID control and apply PID control to servomotor
5. To study and validate the controllers for a temperature control system
6. To study the position control system using Synchros
7. To plot the displacement-voltage characteristics of the given LVDT
8. To study the characteristics of J-type thermocouple and thermistors
9. Use a strain gauge to plot the curve between strain applied to a beam and the output

voltage

10. To study on the interface of PLC with PC for data acquisition applications
11. Measurement of speed by using magnetic pick up.

Subject Code	Name of the Laboratory	L	T	P	C	QP
BELPC4130	**DIGITAL ELECTRONIC CIRCUITS LABORATORY**	0	0	2	1	

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	List the truth tables of all the Logic Gates and their behaviours/Boolean expression.
CO2	Explain all the combinational logic circuits and verification of their truth tables.
CO3	Demonstrate different types of memory elements.
CO4	Differentiate different types of flip-flops.
CO5	Simulate the logic circuits using VHDL and Verilog HDL.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		1	1												
CO2		2	2												
CO3		2	2												
CO4		2	2												
CO5		2	2												
Avg.		1.8	1.8												

List of Experiments

(At least 10 experiments should be done, Experiment No. 1 and 2 are compulsory and out of the balance 8 experiments at least 3 experiments has to be implemented through both Verilog/VHDL and hardware implementation as per choice of the student totaling to 6 and the rest 2 can be either through Verilog/VHDL or hardware implementation.)

1. Digital Logic Gates: Investigate logic behavior of AND, OR, NAND, NOR, EX-OR, EXNOR, Invert and Buffer Gates, use of Universal NAND/NOR Gate.

2. Gate-Level Minimization: Two level and multi level implementation of Boolean functions.

3. Combinational Circuits: Design, assemble and test: adders and subtractors, code converters, gray code to binary and 7 segment displays.

4.	Design, implement and test a given design example with (i) NAND Gates only (ii) NOR Gates only and (iii) using minimum number of Gates.
5.	Design with Multiplexers and De-multiplexers.
6.	Flip-Flop: Assemble, test and investigate operation of SR, D & JK flip-flops.
7.	Shift Registers: Design and investigate the operation of all types of shift registers with parallel load.
8.	Counters: Design, assemble and test various ripple and synchronous counters -decimal counter, Binary counter with parallel load.
9.	Memory Unit: Investigate the behavior of RAM unit and its storage capacity – 16×4 RAM: testing, simulating and memory expansion.
10.	Clock-Pulse Generator: Design, implement and test.
11.	Parallel Adder and Accumulator: Design, implement and test.
12.	Binary Multiplier: Design and implement a circuit that multiplies 4-bit unsigned numbers to produce an 8-bit product.
13.	Verilog/VHDL simulation and implementation of Experiments listed at Sl. No. 3 to 12.

Subject Code	Name of the Laboratory	L	T	P	C	QP
BELPC4140	Data Base Management Systems lab	0	0	2	1	

Course Outcomes: : ***Upon successful completion of this course, students should be able to:***

CO1	Know the procedures and functions of SQL
CO2	Understand the ODBC using either VC++
CO3	Write the programs on database triggers
CO4	Understand the lock operations

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		2			2										
CO2		2			2										
CO3		2			3										
CO4		2			2										
Avg.		2			2.25										

List of Experiments

1. Use of SQL syntax: insertion, deletion, joins, updating using SQL.
2. Programs on join statements and SQL queries including where clause.
3. Programs on procedures and functions.
4. Programs on database triggers.
5. Programs on packages.
6. Programs on data recovery using check point technique.
7. Concurrency control problem using lock operations.
8. Programs on ODBC using either VC++.
9. Programs on JDBC.
10. Programs on embedded SQL using C / C++ as host language.

UG IN Electrical Engineering

V SEMESTER [THIRD YEAR] [84-104]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	C
THEORY							
1	PC	BELPC5010	Power Electronics	3	1	0	4
2	PC	BELPC5020	Micro Processors and Micro Controllers	3	0	0	3
3	PC	BELPC5030	Electrical Power Transmission & Distribution	3	0	0	3
4	PE	BELPE5041	Wind and Solar Energy Systems	3	0	0	3
		BELPE5042	Electrical Machine Design				
		BELPE5043	Industrial Electrical Systems				
5	OE	BELOE5051	Optimization Engineering	3	0	0	3
		BELOE5052	Process Utility and Industrial Safety				
		BELOE5053	Operating Systems				
PRACTICAL / SESSIONAL							
6	PC	BELPC5110	Power Electronics lab	0	0	2	1
7	PC	BELPC5120	Micro Processors and Micro Controllers lab	0	0	2	1
8	PC	BELPC5130	Electrical Power Generation, Transmission & Distribution lab	0	0	2	1
9	EC	BELEC5150	*Skill Development Project and Hands on Training	0	0	2	1
10	EC	BELEC5170	^Summer Internship-I	0	0	2	1
TOTAL				**15**	**1**	**10**	**21**

Subject Code	Name of the Subject	L	T	P	C	QP

BELPC5010	**POWER ELECTRONICS**	3	1	0	4	A

Course Educational Objectives

CEO1	To get knowledge about various power electronics devices
CEO2	To study about the operation of various converters
CEO3	To analyse the different control circuits

Course Outcomes: : *Upon successful completion of this course, students should be able to:*

CO1	Understand the basic characteristics of Power Electronic devices
CO2	Analyse the AC to DC and AC to AC converter circuits with various loads
CO3	Evaluate the performance and operation of DC-DC converters with various applications
CO4	Analyse the operation of voltage source inverters.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3											2		
CO2	3	2											1		
CO3	2	1											2		
CO4	1	1											1		
Avg.	2.25	1.75											1.5		

SYLLABUS

Unit – I **[14Hrs]**

Power semiconductor devices:

Switching and V-I characteristic of devices: power diode, Thyristor family: SCR, TRIAC, GTO, Transistor Family: BJT, IGBT, and MOSFET, Series and parallel grouping of SCR.

Triggering Methods:

SCR: (Cosine Firing Scheme), BJT gate drive, IGBT gate drive, TRIAC firing circuit, Isolation of gate and base drive

Protection of Devices:

SCR: Over voltage, Over Current, dv/dt, di/dt, Gate Protection. Transistor: protection of power BJT, IGBT and power MOSFET, dv/dt& di/dt limitation.

Unit - II **[12Hrs]**

AC to DC converter:

Un-controlled Diode rectifier: Single phase half wave and full wave rectifiers with R-L and R -L-E load, 3 phase bridge rectifier with R-L and R-L-E load. Phase Controlled Converter: Principle of phase controlled converter operation, single phase full converter with R-L and R-L-E load,3 phase full converter with R-L and R-L-E load ,single phase semi converter with R-L and R-L-E load, 3 phase semi-converter with R-L and R-L-E load and effect of source inductance.

AC –AC converter:

AC voltage controller: Single phase bi-directional controllers with R and R-L load, single phase

cycloconverters.

Unit – III **[14 Hrs.]**

DC to DC converter:

Classification: First quadrant, second quardrant, first and second quardrant, third and fourth quardrant, fourth quardrant converter. Switching mode regulators: Buck regulators, Boost regulators, Buck-Boost regulators, Cuk regulators, Isolated Types: Fly Back Converters, Forward converters, Push Pull Converters, Bridge Converter

Unit – IV **[8 Hrs.]**

DC to AC converter:

Inverters: Single phase Bridge Inverters, 3-Phase Inverters-180^0 mode conduction, 120^0 mode conduction. Voltage control of 3-Phase Inverters by Sinusoidal PWM, Current Source Inverter

Applications:

UPS, SMPS, Battery Chargers, SVC.

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Books:

1. *Power Electronics: Circuits, Devices and Applications by M H Rashid, 3rd Edition, Pearson*
2. *Power Electronics: By P. C. Sen, Tata McGraw Hill Education, 12th Edition*
3. *Power Electronics, V R Moorthi, Oxford University Press*

Reference Books:

1. *Power Electronics Converters, Applications & Design: by N. Mohan, 2nd Edition, John Wiley & Sons*
2. *Elements Of Power Electronics: Philip T. Krein, Oxford University Press*
3. *Power Converter Circuits: by W Shepherd and L Zhang, CRC, Taylor and Francis, Special Indian Edition*

Subject Code	Name of the Subject	L	T	P	C	QP
BELPC5020	**Microprocessors and Microcontrollers**	3	0	0	3	A

Course Educational Objectives

CEO1	To get the knowledge of microchips and assembly level language.
CEO2	To understand the concept of interfacing with i/o devices.
CEO3	To get the idea of using micro controllers for controlling the operation of different physical devices.

Course Outcomes: : *Upon successful completion of this course, students should be able to:*

CO1	Understand the architecture of 8085 and 8051
CO2	Impart the knowledge about the instruction set
CO3	Understand the basic idea about the data transfer schemes and its applications
CO4	Develop skill in simple program writing for 8051 & 8085 and applications

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			2		1										
CO2			2		2										
CO3			2		1										
CO4			2		2										
Avg.			2		1.5										

SYLLABUS

Unit:1 **(10hrs)**

Introduction to 8 bit and 16 bit Microprocessors-H/W architecture

Introduction to microprocessor, computer and its organization, Programming system; Address bus, data bus and control bus, Tristate bus; ALU, clock generation; Connecting Microprocessor to I/O devices; Data transfer schemes; addressing modes , Architectural advancements of microprocessors. Introductory System design using microprocessors; 8086 – Introduction, Hardware Architecture; External memory addressing; Bus cycles; some important Companion Chips; Maximum mode bus cycle; 8086 system configuration; Memory Interfacing; Minimum mode system configuration, Interrupt processing.

Unit:2 **(11hrs)**

16-bit microprocessor instruction set and assembly language programming:

Programmer's model of 8086; operand types, operand addressing; assembler directives, instruction Set-Data transfer group, Arithmetic group, Logical group.

Unit:3 **(12hrs)**

Microprocessor peripheral interfacing:

Introduction; Generation of I/O ports; Programmable Peripheral Interface (PPI)-Intel 8255; Sample-and-Hold Circuit and Multiplexer; Keyboard and Display Interface; Keyboard and Display Controller (8279).

Unit:4 **(11hrs)**

8-bit microcontroller- H/W architecture instruction set and programming:

Introduction to 8051 Micro-Controllers, Architecture; Memory Organization; Special Function register; Port Operation; Memory Interfacing, I/O Interfacing; Programming 8051 resources, interrupts; Programmer's model of 8051; Operand types, Operand addressing; Data transfer instructions, Arithmetic instructions, Logic instructions, Control transfer instructions; Programming.

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Books:

1. *Microprocessor Architecture, Programming and application with 8085, R.S. Gaonkar, PRI Penram International publishing PVT. Ltd., 5th Edition*
2. *Microprocessors and Interfacing, Programming and Hardware, Douglas V Hall, TMH Publication, 2006.*
3. *Microprocessors and Interfacing, N. Senthil Kumar, M. Saravanan, S. Jeevananthan and S.K. Shah, Oxford University Press.*
4. *The 8051 Microcontroller and Embedded Systems, Muhammad Ali Mazidi, Janice GillispieMazidi, Rolin D.M C Kinlay, Pearson Education, Second Edition, 2008.*

Reference Books:

1. *Microcontrollers: Principles and Application, Ajit Pal, PHI Publication*
2. *Microprocessors and Microcontrollers Architecture, programming and system design using 8085, 8086, 8051 and 8096, Krishna Kant, PHI Publication, 2007.*
3. *Advanced Microprocessors and Peripherals, A.K. Ray, K M Bhurchandi, TMH*
4. *Textbook of Microprocessor and Microcontroller, Thyagarajan, Scitech Publication*
5. *The 8088 and 8086 Microprocessors Programming, Interfacing, Software, Hardware and Application; by Walter A. Triebel&AvtarSingh ; Pearson India*

Subject Code	Name of the Subject	L	T	P	C	QP
BELPC5030	**Electrical PowerTransmission & Distribution**	3	0	0	3	A

Course Educational Objectives

CEO1	To train the students about both the transmission and distribution substations.
CEO2	To engage the students in different software designing tools and to engage them to visit the college campus for different overhead lines during their laboratory hours.
CEO3	To provide knowledge about transmission and distribution through workshops and training by industrial experts.
CEO4	To involve the students in maintenance work in college 11kV transformer and also to detect the fault in the distribution station.

Course Outcomes: : ***Upon successful completion of this course, students should be able to:***

CO1	Calculate inductance, capacitance in overhead lines also design overhead conductors for single phase and three phase transmission lines.
CO2	Analyse the performance of different transmission lines and required calculations.
CO3	Configure different types of distribution systems.
CO4	Illustrate the design consideration of underground and overhead lines

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		3	2											2	
CO2		2	3											3	
CO3		2	3											3	
CO4		3	2											2	
Avg.		2	2.5											2.2	

SYLLABUS

Unit – I **[14Hrs]**

Line Constant Calculations: Introduction to per unit system and calculation for transmission system. Magnetic flux Density, Inductors and Inductance Magnetic field Intensity due to long current carrying conductors, Inductance of two wire transmission line, Flux linkages with one conductor in a group of conductors, Transposition of power lines, Composite Conductors, Inductance of Composite Conductors, Inductance of double circuit three phase line, Concept of GMD, Bundled conductors, Skin and Proximity effect.

Capacitance of Transmission Lines: Electric Field of a Line of charge, Straight Conductor, The Potential Difference between Two Points due to a line Charge, Two infinite lines of charge, Capacitance of a Two Wire Line, Capacitance of a Three Phase Line with Unsymmetrical Spacing, Capacitance of a double circuit line, Inductance of three phase un symmetrically spaced transmission, Effect of Earth on the Capacitance of conductors.

Unit - II **[12Hrs]**

Performance of Lines: Representation of Lines, Short Transmission Lines, The Medium Transmission Lines, The Long Transmission Line: The Long Transmission Line, ABCD constants, Ferranti Effect Hyperbolic Form of The Equations, The Equivalent Circuit of a Long Line, Power Flow Through

Transmission Line, Reactive Compensation of Transmission Line. Series and shunt compensation.

Unit – III **[14 Hrs.]**

Overhead Line Insulators: Insulator Materials, Types of Insulators, Voltage Distribution over Insulator String, Methods of Equalizing the potential Mechanical Design of Overhead Transmission Lines: The catenary curve, Sag Tension calculation, supports at different levels, Stringing chart, sag Template, Equivalent span, Stringing of Conductors, Vibration and Vibration Dampers

Distribution: Comparison of various Distribution Systems, AC three-phase four-wire Distribution System, Types of Primary Distribution Systems, Types of Secondary Distribution Systems, Voltage Drop in DC Distributors, Voltage Drop in AC Distributors, Kelvin's Law, Limitations of Kelvin's Law, General Design Considerations

Unit – IV **[8 Hrs.]**

Insulated Cables: The Insulation, Extra High Voltages Cable, Insulation Resistance of Cable, Grading of Cables, Capacitance of Single Core Cables, Heating of cables, Current rating of cables, Overhead lines Vs Underground Cables, Types of cable

Power System Earthing: Soil Resistivity, Earth Resistance, Tolerable Step and Touch Voltage, Actual Touch and Step Voltages, Design of Earthing Grid.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Books:

Power System Analysis- By John J. Grainger & W. D. Stevenson, Jr, Tata Mcgraw-Hill, 2003 Edition, 15th Reprint, 2010**.**

Reference Books:

1. Weedy B.M. and Cory B.J., "Electric Power Systems", 4th Ed., 2008 Wiley India.
2. Electrical Power Systems-C.L.Wadhwa, New Age International Publishers, Sixth Edition.
3. Power System Analysis & Design- By B. R. Gupta, S. Chand Publications, 3rd Edition,Reprint, 2003.

Subject Code	Name of the Subject	L	T	P	C	QP
BELPE5041	Wind and Solar Energy Systems	3	0	0	3	A

Course Educational Objectives

CEO1	To analyse solar PV and Solar thermal systems
CEO2	Analyse operating conditions like stand alone and grid connected of renewable sources
CEO3	Reproduce different Storage Systems, concept of Integration and Economics of Renewable Energy System

Course Outcomes: : ***Upon successful completion of this course, students should be able to:***

CO1	Develop fundamental understanding about Solar Thermal and Solar Photovoltaic systems.
CO2	Provide knowledge about development of Wind Power plant and various operational as well as performance parameter/characteristics.
CO3	Explain the contribution of Biomass Energy System in power generation.
CO4	Analyse different Storage systems, Integration and Economics of Renewable Energy

	System.

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		3	3				3							3	
CO2		2	1				1							3	
CO3		1	1				1							2	
CO4		1	1				1							2	
Avg.		1	1.75				1.75							2.5	

SYLLABUS

UNIT-I **[12 Hours]**

Solar Thermal

Solar radiation at the earth's surface, Solar constant, Spectral distribution, Extraterrestrial Radiation, Solar Terrestrial Radiation, Solar radiation geometry, Computation of cosθ for any location having any orientation, Empirical equations for predicting the availability of solar radiation: Monthly average daily and hourly global and diffuse radiation, Beam and Diffuse radiation under cloudless skies, Solar radiation on tilted surfaces : a)Beam radiation, b)Diffuse radiation, c)Reflected radiation, d)Flux on tilted surface.

Instruments for measuring solar radiation, Devices for thermal collection and storage, Thermal applications, designing and Performance analysis of liquid flat plate collector for given heat removal factor and loss coefficient. Introduction to concentrating solar power (CSP) plants using technologies like a) Parabolic troughs b) Linear Fresnel reflector, c) Paraboloid Dish, etc.

UNIT-II **[10 Hours]**

Solar Photovoltaic

Introduction to family of solar film technology, Single c-Si, Poly c-Si PV Cell, Module and Array, Array Design (factors influencing the electrical design of the solar array) : a) Sun Intensity, b)Sun Angle, c) Shadow Effect, d) Temperature Effect, e) Effect of Climate, f) Electrical Load Matching, g) Sun Tracking, Peak Power Point Operation, Electrical characteristics of Silicon PV Cells and Modules, PV System Components, Efficiency of PV system, MPPT of solar system, PV system designing, PV powered water pumping.

UNIT-III **[12 Hours]**

Wind Energy System

Power Contained in Wind, Thermodynamics of Wind Energy, Efficiency Limit for Wind Energy Conversion, Maximum Energy obtained for a Thrust-operated converter (Efficiency limit), Design of Wind Turbine Rotor, Power-Speed Characteristics, Torque-Speed Characteristics, Wind Turbine Control Systems: a) Pitch Angle Control, b) Stall Control, c) Power Electronics Control, d) Yaw Control, Control Strategy, Wind Speed Statistics, Statistical Wind Speed Distributions, Site and Turbine Selection, Extraction of wind energy and wind turbine power. Introduction to Offshore Wind Energy System and its comparison with Wind Energy System

UNIT -IV **[8 Hours]**

Hybrid Systems
a) Fuel Cells: Operating principles of Fuel Cell, Fuel and Oxidant Consumption, Fuel Cell System Characteristics, Introduction to Fuel Cell Technology and its type, application and limits.
b) Storage systems: Hydrogen storage: Hydrogen production, relevant properties, Hydrogen as an Engine Fuel, methods of Hydrogen storage.
Batteries: Introduction to Batteries, Elements of Electro Chemical Cell, Battery classification, Battery Parameters, Factors affecting battery performance.
Introduction to other storage technologies: pump storage, SMES, compressed air storage

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Books:

1. S.*P. Sukhatme, "Solar Energy", Tata McGraw Hill*
2. *Mukund R. Patel, "Wind and Power Solar System", CRC Press*
3. *Tony Burton, Nick Jenkins, David Sharpe, "Wind Energy Hand Book-Second Edition", John Wiley & Sons, Ltd., Publication*
4. *Godfrey Boyle, "Renewable Energy", Third edition, Oxford University Press*
5. *Gilbert M. Masters, "Renewable and Efficient Electrical Power Systems", Wiley - IEEE Press, August 2004*
6. *Chetan Singh Solanki, "Solar Photovoltaics-Fundamentals, Technologies and Applications", PHI Second Edition.*
7. *H. P. Garg, J. Prakash, "Solar Energy-Fundamentals and Applications", Tata McGraw hill Publishing Co. ltd., First Revised Edition.*

Reference Books:

1. *D.P.Kothari, K.C.Singal, RakeshRajan,"Renewable Energy Sources and Emerging Technologies", PHI Second Edition*
2. *Paul Gipe, "Wind Energy Comes of Age", John Wiley & Sons Inc.*
3. *Donald L. Klass, "Biomass for Renewable Energy, Fuels, and Chemicals, Elsevier, Academic Press*

Subject Code	Name of the Subject	L	T	P	C	QP
BELPE5042	Electrical Machine Design	3	0	0	3	A

Course Educational Objectives

Course Outcomes: : *Upon successful completion of this course, students should be able to:*

CO1	Understand the construction and performance characteristics of electrical machines.
CO2	Understand the various factors which influence the design: electrical, magnetic and thermal
CO3	loading of electrical machines
CO4	Understand the principles of electrical machine design and carry out a basic design of an ac

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3											2		
CO2	3	2											1		
CO3	2	1											2		
CO4	1	1											1		
Avg.	2.25	1.75											1.5		

SYLLABUS

Unit – I **[14Hrs]**

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.

Transformers

Sizing of a transformer, main dimensions, kVA output 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 - II **[12Hrs]**

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 polyphase machines, magnetizing current, short circuit current, circle diagram, operating characteristics

Unit – III **[14 Hrs.]**

Synchronous Machines

Sizing of a synchronous machine, main dimensions, design of salient pole machines, short circuit ratio, shape of pole face, armature design, armature parameters, estimation of air gap length, design of rotor, design of damper winding, determination of full load field mmf,
design of field winding, design of turbo alternators, rotor design.

Unit – IV **[8 Hrs.]**

Computer aided Design (CAD):

Limitations (assumptions) of traditional designs, 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-PMSMs, BLDCs, SRM and claw-pole machines.

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text / References:

1. A. K. Sawhney, "A Course in Electrical Machine Design", DhanpatRai 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.

Subject Code	Name of the Subject	L	T	P	C	QP
BELPE5043	Industrial Electrical Systems	3	1	0	4	A

Course Educational Objectives

Course Outcomes: : *Upon successful completion of this course, students should be able to:*

CO1	Understand the electrical wiring systems for residential, commercial and industrial consumers, representing the systems with standard symbols and drawings, SLD.
CO2	Understand various components of industrial electrical systems.
CO3	Analyze and selectthe proper size of various electrical system components.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3											2		
CO2	3	2											1		
CO3	2	1											2		
CO4	1	1											1		
Avg.	2.25	1.75											1.5		

SYLLABUS

Unit – I **[14Hrs]**

Electrical System Components

LT system wiring components, selection of cables, wires, switches, distribution box, metering system, Tariff structure, protection components- Fuse, MCB, MCCB, ELCB, inverse current characteristics, symbols, single line diagram (SLD) of a wiring system, Contactor, Isolator, Relays, MPCB, Electric shock and Electrical safety practices

Residential and Commercial Electrical Systems

Types of residential and commercial wiring systems, general rules and guidelines for installation, load calculation and sizing of wire, rating of main switch, distribution board and

protection devices, earthing system calculations, requirements of commercial installation, deciding lighting scheme and number of lamps, earthing of commercial installation, selection and sizing of components.

Unit - II **[12Hrs]**

Illumination Systems

Understanding various terms regarding light, lumen, intensity, candle power, lamp efficiency, specific consumption, glare, space to height ratio, waste light factor, depreciation factor, various illumination schemes, Incandescent lamps and modern luminaries like CFL, LED and their operation, energy saving in illumination systems, design of a lighting scheme for a residential and commercial premises, flood lighting.

Unit – III **[14 Hrs.]**

Industrial Electrical Systems I

HT connection, industrial substation, Transformer selection, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design, Power factor correction – kVAR calculations, type of compensation, Introduction to PCC, MCC panels. Specifications of LT Breakers, MCB and other LT panel components.

Industrial Electrical Systems II

DG Systems, UPS System, Electrical Systems for the elevators, Battery banks, Sizing the DG, UPS and Battery Banks, Selection of UPS and Battery Banks.

Unit – IV **[8 Hrs.]**

Industrial Electrical System Automation

Study of basic PLC, Role of in automation, advantages of process automation, PLC based control system design, Panel Metering and Introduction to SCADA system for distribution automation.

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Book/ Reference Books:

1. S. L. Uppal and G. C. Garg, “Electrical Wiring, Estimating & Costing”, Khanna
2. publishers, 2008.
3. K. B. Raina, “Electrical Design, Estimating & Costing”, New age International, 2007.
4. S. Singh and R. D. Singh, “Electrical estimating and costing”, DhanpatRai and Co., 1997.
5. Web site for IS Standards.
6. H. Joshi, “Residential Commercial and Industrial Systems”, McGraw Hill Education,2008.

Subject Code	Name of the Subject	L	T	P	C	QP
BELOE5051	**OPTIMIZATION IN ENGINEERING**	3	0	0	3	A

Course Educational Objectives

CEO1	To know the formulation of different optimization problems.
CEO2	To solve the optimization problems by different conventional methods.
CEO3	To apply basic techniques in solving the real life optimization problems

Course Outcomes: : *Upon successful completion of this course, students should be able to:*

CO1	Understand the theory of optimization methods and algorithms developed for solving various types of optimization problems.
CO2	Understand and apply the concept of optimality criteria for various types of optimization problems.
CO3	Solve various constrained and unconstrained problems in single variable as well as multivariable.
CO4	Apply the methods of optimization in real life situation.
CO5	To develop and promote research interest in applying optimization techniques in problems of Engineering and Technology.

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		2	1	2											
CO2		2	1	2											
CO3		2	2	1											
CO4		2	2	2											
CO5		2	2	2											
Avg.		2	1.6	1.8											

SYLLABUS

UNIT-I **[10 Hours]**

Idea of Engineering optimization problems, Classification of optimization algorithms, modelling of problems and principle of modelling.

Linear programming: Formulation of LPP, Graphical solution, Simplex method, Big-M method, Revised simplex method, Duality theory and its application, Dual simplex method , Sensitivity analysis in linear programming

UNIT-II **[10 Hours]**

Transportation problems: Finding an initial basic feasible solution by Northwest Corner rule, Least Cost rule, Vogel's approximation method, Degeneracy, Optimality test, MODI method, Stepping stone method

Assignment problems: Hungarian method for solution of Assignment problems Integer

Programming: Branch and Bound algorithm for solution of integer Programming Problems

UNIT-III **[12 Hours]**

Non-linear programming: Introduction to non-linear programming. Unconstraint optimization: Fibonacci and Golden Section Search method.

Constrained optimization with equality constraint: Lagrange multiplier, Projected gradient method

Constrained optimization with inequality constraint: Kuhn-Tucker condition, Quadratic programming.

UNIT -IV **[8 Hours]**

Queuing models: General characteristics, Markovian queuing model, M/M/1 model, Limited queue capacity, multiple server, Finite sources, Queue discipline.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Books:

1. *Operations Research- Principle and Practice, A. Ravindran, D. T. Philips, J. Solberg, Second edition, Wiley India Pvt Ltd.*
2. *Operation Research, PrabhakarPai ,Oxford University Press*
3. *Optimization for Engineering Design, Kalyanmoy Deb, PHI Learning Pvt Ltd.*
4. *OperationsResearch, H.A.Taha, A.M.Natarajan, P.Balasubramanie, A.Tamilarasi, Pearson Education, Eighth Edition.*
5. *Engineering Optimization, S S Rao, New Age International (P) Ltd, 2003.*

Reference Books:

1. *Linear and Non-linear Optimization, Stephen G. Nash, A. Sofer, McGraw Hill, 2ndEdition.*
2. *Engineering Optimization, A.Ravindran, K.M.Ragsdell, G.V.Reklaitis, Wiley India Pvt. Ltd, Second edition.*
3. *Operations Research, F.S.Hiller, G.J.Lieberman, Tata McGraw Hill, Eighth Edition, 2005.*
4. *Operations Research, P.K.Gupta, D.S.Hira, S.Chand and Company Ltd, 2014.*

Subject Code	Name of the Subject	L	T	P	C	QP
BELOE5052	**Process utility and industrial safety**	3	0	0	3	A

Course Outcomes: : *Upon successful completion of this course, students should be able to:*

CO1	Explain the different types of safety precaution to be taken in working environment.
CO2	Describe the various safety rules and regulation
CO3	Understand new safety methods
CO4	Study the different hazardous effect of accident inside the plant.

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	1											1		
CO2	1	2											1		
CO3	2	1											1		
CO4	2	2											1		
Avg.	1.5	1.5											1		

SYLLABUS

UNIT-I **[10 Hours]**

Hard and Soft water, Requisites of Industrial Water and its uses. Methods of water Treatment such as Chemical Softening and Demineralization, Resins used for Water Softening and Reverse Osmosis. Effects of impure Boiler Feed Water.

UNIT-II **[10 Hours]**

Properties of Steam, problems based on Steam, Types of Steam Generator such as Solid Fuel Fired Boiler, Waste Gas Fired Boiler and Fluidized Bed Boiler. Scaling and Trouble Shooting. Steam Traps and Accessories.

UNIT-III **[12 Hours]**

Refrigeration Cycles, Methods of Refrigeration used in Industry and Different Types of Refrigerants such as Mono chlorodifluro Methane, Chlorofluro Carbons and Brins. Refrigerating Effects and Liquefaction Processes.

Compressed air: Classification of Compressor, Reciprocating Compressor, Single Stage and Two Stage Compressor, Velocity Diagram for Centrifugal Compressor, Slip Factor, Impeller Blade Shape. Properties of Air –Water Vapours and use of Humidity Chart. Equipment's used for Humidification, Dehumidification and Cooling Towers.

UNIT -IV **[8 Hours]**

History of Safety movement–Evolution of modern safety concept-general concepts of management–planning for safety for optimization of productivity-productivity, quality and safety-line and staff functions for safety-budgeting for safety-safety policy. Incident Recall Technique (IRT), disaster control, job safety analysis, safety survey, safety inspection, safety sampling, evaluation of performance of supervisors on safety

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books:

1. *Eckenfelder, W. W, Jr. "Industrial Water Pollution Control" McGraw-Hill: New York,*
2. *P. L. Ballaney, "Thermal Engineering", Khanna Publisher New Delhi, 1986.*

Reference Books:

1. *P. N. Ananthanarayan, "Basic Refrigeration & Air conditioning", Tata McGraw Hill, New Delhi, 2007*

Subject Code	Name of the Subject	L	T	P	C	QP
BELOE5053	**Operating Systems**	3	0	0	3	A

Course Educational Objectives

CEO1	To understand main components of OS and their working
CEO2	To study the operations performed by OS as a resource manager
CEO3	To understand the different scheduling policies of OS
CEO4	To understand the different memory management techniques
CEO5	To understand process concurrency and synchronization

Course Outcomes: : *Upon successful completion of this course, students should be able to:*

CO1	Apply optimization techniques for the improvement of system performance.
CO2	Ability to understand the synchronous and asynchronous communication mechanisms in their respective OS.
CO3	Learn about minimization of turnaround time, waiting time and response time and also maximization of throughput with keeping CPU as busy as possible.
CO4	Ability to compare the different OS

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			2												
CO2			2		2										
CO3			3		2										
CO4			2		3										
Avg.			2.25		2.33										

SYLLABUS

UNIT:1 **(10 Hours)**

Operating System Introduction: Operating Systems Objectives and functions, Computer System Architecture, OS Structure, OS Operations, Evolution of Operating Systems - Simple Batch, Multi programmed, time shared, Personal Computer, Parallel, Distributed Systems, Real-Time Systems, Special - Purpose Systems, Operating System services, user OS Interface, System Calls, Types of System Calls, System Programs, Opening System Design and Implementation, OS Structure, Virtual machines.

UNIT:2 **(12 Hours)**

Process and CPU Scheduling - Process concepts - The Process, Process State, Process Control Block, Threads, Process Scheduling - Scheduling Queues, Schedulers, Context Switch, Pre-emptive Scheduling, Dispatcher, Scheduling Criteria, Scheduling algorithms, Multiple-Processor Scheduling, Real-Time Scheduling, Thread scheduling, Case studies: Linux, Windows. Process Coordination - Process Synchronization, The Critical section Problem, Peterson's solution, Synchronization Hardware, Semaphores, and Classic Problems of Synchronization, Monitors, Case Studies: Linux, Windows.

UNIT:3 **(14 Hours)**

Memory Management and Virtual Memory - Logical & physical Address Space, Swapping, Contiguous Allocation, Paging, Structure of Page Table. Segmentation, Segmentation with Paging, Virtual Memory, Demand Paging, Performance of Demanding Paging, Page Replacement Page Replacement Algorithms, Allocation of Frames, Thrashing.

Deadlocks - System Model, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection and Recovery from Deadlock.

UNIT:4 **(14 Hours)**

File System Interface - The Concept of a File, Access methods, Directory Structure, File System Mounting, File Sharing, Protection, File System Implementation - File System Structure, File System Implementation, Allocation methods, Free-space Management, Directory Implementation, Efficiency and Performance. Mass Storage Structure - Overview of Mass Storage Structure, Disk Structure, Disk Attachment, Disk Scheduling, Disk Management, Swap space Management.

Protection - System Protection, Goals of Protection, Principles of Protection, Domain of Protection, Access Matrix, Implementation of Access Matrix, Access Control, Revocation of Access Rights, Capability-Based Systems, Language-Based Protection.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Books:

1. *Operating System Principles, Abraham Silberchatz, Peter B. Galvin, Greg Gagne 8th Edition, Wiley Student Edition.*
2. *Operating systems - Internals and Design Principles, W. Stallings, 6th Edition, Pearson.*

Reference Books:

1. *Modern Operating Systems, Andrew S Tanenbaum 3rd Edition PHI.*
2. *Operating Systems A concept - based Approach, 2nd Edition, D. M. Dhamdhere, TMH.*
3. *Principles of Operating Systems, B. L. Stuart, Cengage learning, India Edition.*
4. *Operating Systems, A. S. Godbole, 2nd Edition, TMH*
5. *An Introduction to Operating Systems, P.C.P. Bhatt, PHI.*
6. *Operating Systems, S, Haldar and A. A. Arvind, Pearson Education.*
7. *Operating Systems, R. Elmasri, A. G. Carrick and D. Levine, McGraw Hill.*

PRACTICAL / SESSIONAL

Subject Code	Subject Code	L	T	P	C	QP
BELPC5110	**Power Electronics Lab**			2	1	

Course Educational Objectives

CEO1	This course aims at obtaining characteristics of power electronic devices.
CEO2	To understand the commutation techniques used in power electronics circuits and to test different power electronics converters.

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Elucidate the basic operation of various power semiconductor devices and passive components.
CO2	Analyze power electronics circuits
CO3	Apply power electronic circuits for different loads
CO4	Design various power electronic circuits

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1				2	2									2	
CO2				2	1									1	
CO3				1	1									1	
CO4				1	1									1	
Avg				1.5	1.25									1.25	

LIST OF EXPERIMENTS

1.Study of Characteristics of SCR, MOSFET & IGBT
2. Gate firing circuits for SCR's
3. Single Phase AC Voltage Controller with R and RL Loads
4. Single Phase fully controlled bridge converter with R and RL loads
5. Forced Commutation circuits (Class A, Class B, Class C, Class D & Class E)
6. DC Jones chopper with R and RL Loads
7. Single Phase Parallel, inverter with R and RL loads
8. Single Phase Cycloconverter with R and RL loads
9. Single Phase Half controlled converter with R load
10. Three Phase half controlled bridge converter with R-load
11. Single Phase series inverter with R and RL loads
12.Single Phase Bridge converter with R and RL loads 13.Single Phase dual converter with RL loads

Subject Code	Subject Code	L	T	P	C	QP
BELPC5120	**Microprocessors and Micro controllers Lab**	**0**	**0**	**2**	**1**	A

Course Educational Objectives

CEO1	To become familiar with the architecture and Instruction set of Intel 8085 microprocessor
CEO2	To provide practical hands on experience with Assembly Language Programming.
CEO3	To familiarize the students with interfacing of various peripheral devices with 8085 microprocessors.

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Familiar with the architecture and Instruction set of Intel 8085 microprocessor
CO2	Interfacing of microcontroller to various applications
CO3	Study of microcontroller accessories
CO4	Initialize data to registers and memory using immediate, register, direct and indirect Addressing mode

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			2		2										
CO2			2		2										
CO3			1		2										
CO4			2		2										
Avg.			1.75		2										

LIST OF EXPERIMENTS

8085

1. Addition, subtraction, multiplication and division of two 8 bit numbers
2. Smallest/largest number among n numbers in a given data array, Binary to Gray code, Hexadecimal to decimal conversion

Interfacing

1. Generate square wave on all lines of 8255 with different frequencies
2. Study of stepper motor and its operations

Optional (any two)

1. Study of traffic light controller
2. Study of elevator simulator
3. Generation of square, triangular and saw tooth wave using D to A Converter
4. Study of 8253 and its operation(Mode0, Mode2, Mode3)
5. Study of Mode0,Mode1 and BSR Mode operation of 8255
6. Study of 8279 (keyboard and display interface)
7. Study of 8259 Programmable Interrupt Controller
8. 8051 Microcontroller: Initialize data to registers and memory using immediate, register, direct and indirect Addressing mode

Optional (any two)

1. Addition and subtraction of 16 bit numbers
2. Multiplication and division of two 16 bit numbers

3. Transfer a block of data to another memory location using indexing
4. Operation of 8255 using 8051 microcontroller 8086
5. Addition , subtraction ,multiplication and division of 16 bit numbers, 2's complement of a 16 bit number

Subject Code	Subject Code	L	T	P	C	QP
BELPC5130	**Electrical power transmission & distribution lab**	0	0	2	1	

Course Educational Objectives

CEO1	To learn the usage of passive elements in various Power Transmission Systems... Calculations such as transverse loading, conductor clearances, pole buckling and guying will be discussed in detail.
CEO2	To understand the factors affecting Insulators and also in Under Ground cables.
CEO3	To calculate the various parameters in Distribution System

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Apply power system fundamentals to the design of a system that meet specific needs.
CO2	Design a power system solution based on the problem requirements and realistic Constraints
CO3	Develop a major design experience in power a system that prepares them for engineering practice.
CO4	Design a Transmission and distribution electric power system

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			2	2									**1**		
CO2			2	2									**1**		
CO3			1	2									**1**		
CO4			2	3									**1**		
Avg			1.75	2.25									1		

LIST OF EXPERIMENTS (Any 8 Experiments)

1. Study and of Ferranti Effect.
2. Determination of ABCD Parameter.
3. Determination of string efficiency.
4. Earth resistance measurement.
5. Series and shunt capacitance computation in transmission line.
6. Transformer oil test.
7. Study of various lightning arresters.
8. Distribution system power factor improvement using switched capacitor.
9. Software based design of the transmission & distribution network of a city.
10. Measurement of ground resistivity and ground electrode resistance.
11. To simulate a small Hydro Plant.
12. Study and Operation of HVDC Link.
13. Study and operation of Static VAR compensator

Subject Code	Subject Code	L	T	P	C	QP

BELEC5150	**Skill development project & Hands on training**	0	0	2	1	A

Course Educational Objectives

CEO1	To improve students' Employability skills and make them industry ready.
CEO2	To Develop Group and team thinking skills of the students.

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Identify the benefits of developing 'soft skills'
CO2	Understand how soft skills complement hard skills
CO3	Identify the emotional richness of an asset
CO4	Develop Group and Team thinking skills

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1									2	2					
CO2									2	1					
CO3									0	2					
CO4									2	2					
Avg									1.5	1.75					

LIST OF EXPERIMENTS

Competency 1: Career View

Introduction to the EES Course- Importance of career, industry watch etc.
Statement of Purpose-1
Statement of Purpose-2
Presentation Techniques-1
Presentation Techniques-2
Attitude-1: Required for Job or Entrepreneurial Career
Attitude-2: How to Improve Attitude: Case Studies

Competency 2: Principles of effective communication

Business Vocabulary-1
Business Vocabulary-2
Resume Preparation-1: Layout, Format, Power Verbs etc
Resume Preparation-2: Discussion of How to- Incorporate Attributes, Analysis
Business Correspondence-1 Technical report Writing-1- Layout, Format
Business Correspondence-2 Technical report writing- 2-Language
Business Correspondence-3 Business/ Technical Proposal writing
Business Correspondence - 4
Adaptability: Cases and Workouts

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

UG IN Electrical Engineering

VI SEMESTER [THIRD YEAR] [105-125]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	C	QP
THEORY								
1	PC	BELPC6010	Switch Gear & Protection	3	1	0	4	A
2	PC	BELPC6020	Electrical& Electronics Measurements	3	0	0	3	A
3	PC	BELPC6030	Electrical Drives	3	0	0	3	A
4	PE	BELPE6041	Communication Engineering	3	0	0	3	A
		BELPE6042	Computer aided Design of Electrical Machines					
		BELPE6043	Advanced Power Electronics					
5	OE	BELOE6051	Organizational behavior	3	0	0	3	A
		BELOE6052	Green buildings and Energy Conversion					
		BELOE6053	Computer Organisation					
		BELOE6054	Power plant Engineering					
PRACTICAL / SESSIONAL								
6	PC	BELPC6110	Energy Management & Auditing Lab	0	0	2	1	
7	PC	BELPC6120	Electric & Electronic Measurements Lab	0	0	2	1	
	PC	BELPC6130	Electrical Drives Lab	0	0	2	1	
9	PC	BELPC6140	Advanced Laboratory-I: Electrical Simulation Lab	0	0	2	1	
10	EC	BTPEC6160	#Soft Skill and Employability Skill	0	0	2	1	
TOTAL				**15**	**1**	**10**	**21**	

#To be conducted by the Training & Placement Department of the College

Subject Code	Subject Code	L	T	P	C	QP
BELPC6010	**Switch gear & Protection**	3	1		4	A

Course Educational Objectives

CEO1	To introduce students to power system protection and switchgear.
CEO2	To teach students theory and applications of the main components used in power system protection for electric machines, transformers, bus bars, overhead and underground feeders.
CEO3	To teach students the theory, construction, applications of main types Circuit breakers, Relays for protection of generators, transformers and protection of feeders from over- voltages and other hazards. It emphasis on neutral grounding for overall protection
CEO4	To develop an ability and skill to design the feasible protection systems needed for each main part of a power system in students.

Course Outcomes: : *Upon successful completion of this course, students should be able to:*

CO1	Know about various protective systems
CO2	Analyze different applications of the relays, circuit breakers; grounding for different elements of power system is also discussed in the subject.
CO3	Ability to discuss recovery and Restricting.
CO4	Analyse the characteristics of Oil circuit Breaker, Air Blast circuit Breakers, SF6 Circuit Breaker.
CO5	Analyse the characteristics of lighting arresters

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			2	2			1							2	
CO2			3	2			1							2	
CO3			3	2			1							1	
CO4			1	3			2							2	
CO5			3	2			2								
Avg.			2.4	2.2			1.4							1.75	

SYLLABUS

Unit – I **[12 Hrs]**

Circuit Breakers: Elementary principles of arc interruption, Recovery, Restriking Voltage andRecovery voltages. - Restriking Phenomenon, Average and Max. RRRV, Numerical Problems. CurrentChopping and Resistance Switching. CB ratings and Specifications: Types and Numerical Problems. –Auto-reclosures.

Description and Operation of following types of circuit breakers: Minimum Oil Circuit breakers, AirBlast Circuit Breakers, Vacuum and SF6 circuit breakers.

Unit - II **[12Hrs]**

Electromagnetic and Static Relays

Principle of Operation and Construction of Attracted armature, Balanced Beam, induction Disc

andInduction Cup relays. Relays Classification: Instantaneous, DMT and IDMT types. Application of relays: Over current/ under voltage relays, Direction relays, Differential Relays and Percentage Differential Relays.
Universal torque equation, Distance relays: Impedance, Reactance and Mho and Off-Set Mho relays,Characteristics of Distance Relays and Comparison. Static Relays: Static Relays verses electromagnetic Relays.

Unit – III **[12 Hrs.]**

Protection

Generator Protection: Protection of generators against Stator faults, Rotor faults, and Abnormal Conditions. Restricted Earth fault and Inter-turn fault Protection. Numerical Problems on % Winding Unprotected.
Transformer Protection: Percentage Differential Protection, Numerical Problem on Design of CT sRatio, Buchholtz relay Protection.
Feeder and Bus-Bar Protection: Over Current, Carrier Current and Three-Zone distance relay protection using Impedance relays. Translay Relay. Protection of Bus bars – Differential protection.

Unit – IV **[12 Hrs.]**

Neutral Grounding & Protection against over voltages

Grounded and Ungrounded Neutral Systems.- Effects of Ungrounded Neutral on system Performance. Methods of Neutral Grounding: Solid, Resistance, Reactance –Arcing Grounds and Grounding Practices.
Generation of Over Voltages in Power Systems.-Protection against Lightning over Voltages – Valve type and Zinc-Oxide Lighting Arresters. Insulation and Coordination -BIL, Impulse Ratio, Standard Impulse Test Wave, Volt-Time Characteristics and Insulation Co-ordination

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Book:

1. *Sunil S Rao "Switchgear Protection & Power Systems", Khanna Publishers*
2. *Badari Ram & D.N Viswakarma "Power System Protection and Switchgear", TMH publications*

Reference Book:

1. *Paithankar and S.R.Bhide, "Fundamentals of Power System Protection", PHI, 2003.*
2. *T S Madhav Rao, "Power System Protection : Static Relays", Tata McGraw-Hill, 2nd edition*
3. *C R Mason, "Art & Science of Protective Relaying", Wiley Eastern Ltd.*
4. *4.Cl Wadhwa, "Electrical Power Systems", New Age international (P) Limited, Publishers, 3rd editon*
5. *"Hand Book of Switchgears by BHEL", TMH Publications*

Subject Code	Name of the Subject	L	T	P	C	QP
BELPC6020	**Electrical and Electronics Measurements**	3			3	A

Course Educational Objectives

CEO1	To introduce students to monitor, analyze and control any physical system.
CEO2	To understand students how different types of meters work and their construction
CEO3	To provide a student a knowledge to design and create novel products and solutions for real life problems.
CEO4	To introduce students a knowledge to use modern tools necessary for electrical projects

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Test and troubleshoot electronic circuits using various measuring instruments.
CO2	Understand the construction and working of different measuring instruments.
CO3	Understand the construction and working of different AC and DC bridges and its applications.
CO4	Analyze different type of interferences, its causes and methods for its reduction.
CO5	Relate and apply the appropriate measuring techniques to real time applications
CO6	Study the storage of digital signal and analyzers for analyzing digital signal to provide with meaning full information

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2													
CO2	2	2													
CO3	1	2													
CO4	2	2													
CO5	1	1													
CO6	2	1													
Avg.	1.5	1.67													

SYLLABUS

Unit – I **[12 Hrs]**

Measurement and Error: Definition, Accuracy and Precision, Significant Figures, Types of Errors, Standards of Measurement: Classification of Standards, Electrical Standards, IEEE Standards

Types of measuring instrument: (Ammeter and Voltmeter: Derivation for Deflecting Torque of; PMMC, MI (attraction and repulsion types), Electro Dynamometer and Induction type Ammeters and Voltmeters. Energy meters and wattmeter, Construction, Theory and Principle of operation of Electro-Dynamometer and Induction type wattmeter, compensation, creep, error, testing, Single Phase and Poly-phase Induction type Watt-hour meters. Frequency Meters: Vibrating reed

type, electrical resonance type, Power Factor Meters.

Unit - II **[14 Hrs]**

Measurement of Resistance, Inductance and Capacitance: Resistance: Measurement of Low Resistance by Kelvin's Double Bridge, Measurement of Medium Resistance, Measurement of High Resistance, Measurement of Resistance of Insulating Materials, Portable Resistance Testing set (Meg ohmmeter), Measurement of Insulation Resistance when Power is ON, Measurement of Resistance of Earth Connections. Inductance: Measurement of Self Inductance by Ammeter and Voltmeter, and AC Bridges(Maxwell's, Hay's, & Anderson Bridge), Measurement of Mutual Inductance by Felici's Method, and as Self Inductance. Capacitance: Measurement of Capacitance by Ammeter and Voltmeter, and AC Bridges (Owen's, Schering & Wien's Bridge), Screening of Bridge Components and WagnorEarthing Device, Transducer: Strain Gauges, Thermistors, Thermocouples, Linear Variable Differential Transformer (LVDT), Capacitive Transducers, Peizo-Electric transducers, Optical Transducer, Torque meters, inductive torque transducers, electric tachometers, photo-electric tachometers, Hall Effect Transducer.

Unit – III **[12 Hrs]**

Galvanometer: Construction, Theory and Principle of operation of D'Arsonval, Vibration (Moving Magnet & Moving Coil types), and Ballistic Galvanometer, Influence of Resistance on Damping, Logarithmic decrement, Calibration of Galvanometers, Galvanometer Constants, Measurement of Flux and Magnetic Field by using Galvanometers, Potentiometer: Construction, Theory and Principle of operation of DCPotentiometers (Crompton, Vernier, Constant Resistance, & Deflection Potentiometer),and AC Potentiometers (Drysdale-Tinsley & Gall-Tinsley Potentiometer)

Unit – IV **[12 Hrs]**

Current Transformer and Potential Transformer : Construction, Theory, Characteristics and Testing of CTs and PTs, Electronic Instruments for Measuring Basic Parameters: Amplified DC Meters, AC Voltmeters using Rectifiers, True RMS Voltmeter, Considerations for choosing an Analog Voltmeter, Digital Voltmeters (Block Diagrams only), Q-meter, Oscilloscope: Block Diagrams, Delay Line, Multiple Trace, Oscilloscope Probes, Oscilloscope Techniques, Introduction to Analog and Digital Storage Oscilloscopes, Measurement of Frequency, Phase Angle, and Time Delay using Oscilloscope.

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Books:

1. *Electrical Measurements and Measuring Instruments – Golding &Widdis – 5th Edition, Reem Publication.*
2. *Modern Electronic Instrumentation and Measurement Techniques – Helfrick& Cooper – Pearson Education.*

Reference Books:

1. *A Course in Electrical and Electronic Measurements and Instrumentation – A K Sawhney – DhanpatRai& Co.*

2. *Electronic Instrumentation – H C Kalsi – 2nd Edition, Tata McGraw Hill.*
3. *Electronic Measurement and Instrumentation – Oliver & Cage – Tata McGraw Hill.*

Subject Code	Name of the Subject	L	T	P	C	QP
BELPC6030	**ELECTRIC DRIVES**	3	0	0	3	A

Course Educational Objectives

CEO1	To provide students with a strong back ground in different types of electrical drives.
CEO2	To train the students to have the solid foundation in mathematical and technical concepts required to engineering problems.
CEO3	To prepare the students to excel in post graduate programs or to succeed in industry.
CEO4	To provide a foundation in the theory and applications of electrical machinery and their different types with respect to their control

Course Outcomes: : *Upon successful completion of this course, students should be able to:*

CO1	Understand the stable steady state operation and transient dynamics of motor-load system
CO2	Analyze characteristics and different control strategies of solid state DC motors drives
CO3	Classify the role of power electronic converters in the control of DC motors drives
CO4	Distinguish the characteristics and control of various Induction motor drives
CO5	Determine the applications of various synchronous motor drives used in Industries
CO6	Develop the digital control methodology of AC and DC drives

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			2	2									1		
CO2			3	3									2		
CO3			2	2									2		
CO4			2	2									2		
CO5			2	2									2		
CO6			2	1									1		
Avg.			2.16	2									1.67		

SYLLABUS

UNIT I- REVIEW OF ELECTRIC DRIVES **08 HOURS**

Fundamentals of Electric Drives-Advantage of Electric Drives-selection of Motor power rating-Thermal model of motor for heating and cooling - Classes of duty cycle-Determination of motor rating -control of Electric drives- modes of operation - speed control and drive classifications - closed loop control of drives.

UNIT II- CONTROL OF DC DRIVES **10 HOURS**

DC Motor Drives:-DC motor and their performance-Braking - Transient analysis - Ward Leonard drives - Transformer and uncontrolled rectifier control – controlled rectifier fed DC drives - Chopper controlled DC drives - Time ratio control and current limit control - Single, two and four quadrant operations - Effect of ripples on the DC motor performance.

UNIT III- CONTROL OF AC DRIVES **14 HOURS**

Induction Motor Drives-Stator control-Stator voltage and frequency control-VSI,CSI and cyclo converter fed induction motor drives –open loop and closed VVVF control - Rotor resistance control and slip power recovery schematic control of rotor resistance using DC chopper-Vector Control basic concepts.

Synchronous Motor Drives: - Speed control of three phase synchronous motors Voltage and current source fed synchronous motor-Cyclo converter fed synchronous motors-Effects of harmonics on the performance of AC motors

UNIT-IV: DIGITAL TECHNIQUE IN SPEED CONTROL **08 HOURS**

Digital Control and Drive Applications-Digital technique in speed control of electric drive system-Advantages and limitations - microcontroller based control of drives- selection of drives and control schemes for electrical vehicle Application, paper mills, lifts and cranes.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Books:

1. *Dubey.G.K. "Fundamentals of Electrical drives", Narora publications, 1995.*
2. *Bose. B.K. "Power Electronics and Variable frequency drives", 1st edition, IEEE Press Standard Publications 2002.*

Reference Books:

1. *Mazidi and Mazidi, "Intel 8051 Microcontrollers", Pearson education, India, 2006.*
2. *R. Krishnan, "Electric motor drives Modeling, Analysis and Control", 1st edition, Pearson Publications, 2009.*
3. *Gaekward, "Analog and Digital control systems", Wiley Eastern Ltd, 1989.*
4. *VedamSubramanyan, "Thyristor control of Electrical Drives", Tata McGraw Hill, Publications, 1996.*
5. *Bimal K. Bose, "Modern Power Electronics and AC Drives", Prentice Hall of India, 2005*

Subject Code	Name of the Subject	L	T	P	C	QP
BELPE6041	**Communication Engineering**	3	0	0	3	A
Course Outcomes: : *Upon successful completion of this course, students should be able to:*						
CO1	Derive time domain and frequency domain equations for all forms of amplitude modulation					

	Schemes.
CO2	Student understand the basic knowledge necessary for transmitting and receiving information
CO3	Student understand different types of modulation and demodulation
CO4	Student can solve analog and digital modulation problems
CO5	Explain various methods of generating and detecting different forms of amplitude modulation.
CO6	Compare the performance of communication system by evaluating the figure of merit for different schemes of modulation.

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			2	2											
CO2			2	3											
CO3			2	2											
CO4			2	2											
CO5			2	2											
CO6			1	1											
Avg.			1.83	2											

SYLLABUS

Unit:1 **(10hrs)**

INTRODUCTION:

Elements of an Electrical Communication System, Communication Channels and their Characteristics, Mathematical Models for Communication Channels

FREQUENCY DOMAIN ANALYSIS OF SIGNALS AND SYSTEMS:

Signals and their classifications, Fourier series, Fourier Transforms, Properties of Fourier transform, Power and Energy, Energy Spectral Density, Power Spectral Density, Sampling and Band limited signals, Band pass signals

Unit - II **[12Hrs]**

ANALOG SIGNAL TRANSMISSION AND RECEPTION: Introduction to modulation, Amplitude Modulation (AM), Angle Modulation, Radio and Television broadcasting

Unit – III **[10 Hrs.]**

PULSE MODULATION SYSTEMS: Introduction, Sampling Theorem, Pulse amplitude modulation, Pulse Time Modulation

Unit – IV **[8 Hrs.]**

PULSE MODULATION SYSTEMS: Introduction, Sampling Theorem, Pulse amplitude modulation, Pulse Time Modulation

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Books:

1. *John G.Proakis,M. Salehi, COMMUNICATION SYSTEMS ENGINEERING, 2nd ed. New Delhi,India: PHI Learning Private Limited, 2009.; Selected portion from Chapter 1,2 and 3 for module MODULE-I and MODULE-II of the course.*
2. *R.P Singh and S.D Sapre, COMMUNICATION SYSTEMS Analog & Digital, 2nd ed. New Delhi,*

India: Tata McGraw Hill Education Private Limited, 2009; Selected portions from Chapter 7 and 8 of the book for MODULE-III.

3. *3.Simon Haykin, An Introduction to Analog and Digital Communications, John Wiley and Sons*
4. *4. B.P. Lathi, Modern Digital and Analog Communication Systems, Oxford*

Reference Books:

1. *Taub, Schilling, Saha, Taub's Principles of Communication Systems, TMH.*
2. *Modern Digital and Analog Communication Systems, by B.P. Lathi, Oxford*
3. *A.B. Carlson and P.B.Crilly, " Communication Systems An Introduction to Signals and Noise in Electrical Communication", 5th Edn., TMH*

Subject Code	Name of the Subject	L	T	P	C	QP
BELPE6042	**Computer Aided Analysis and Design of Machines**	3			3	A

Course Educational Objectives

CEO1	To lay the foundation of efficient design and operation of motors & generators in modern day automotive, domestic and renewable energy systems.
CEO2	To make the students to investigate the principles of structural assessment, electromagnetic analysis, dimensional and thermal constraints.
CEO3	To deploy the students on Finite Element Analysis (FEA) software-based design projects which will be used to model the performance and operation of electric machines

Course Outcomes: : *Upon successful completion of this course, students should be able to:*

CO1	Acquired knowledge about computer aided design of machines.
CO2	Theoretically able to investigate and assess design peculiarities and properties according their specific working conditions.
CO3	Able to Formulate and solve the optimum design problems with computers.
CO4	Able to plan and carry out Finite Element analysis using software
CO5	To apply one`s knowledge and understanding for the formulation and analysis of electrical engineering problems

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			1	1	2										
CO2			3	2	3										
CO3			2	2	3										
CO4			3	3	3										
CO5			3	2	2										
Avg.			2.4	2	2.6										

SYLLABUS

Unit I: [10 Hrs.]

CONCEPT OF COMPUTER-AIDED DESIGN AND OPTIMIZATION

Introduction; Computer Aided Design; Explanation of details of flow chart; Input data to be fed into the program; Applicable constraints Max or Minimum permissible limits; Output data to be

printed after execution of program; Various objective parameters for optimization in an electrical machine; Selection of optimal design; Explanation of lowest cost and significance of "Kg/KVA"; Flowcharts.

UNIT II: BASIC CONCEPTS OF DESIGN [12 Hrs.]

Introduction: Specification; Output coefficient; Importance of specific loadings; Electrical **Materials:** Conducting Materials, Insulating Materials and Magnetic Materials; Magnetic circuit calculations; General procedure for calculation of Amp-Turns; Heating and Cooling; **Modes of heat dissipation:** Standard ratings of Electrical machines; Ventilation schemes in static machines (Transformers) and in rotating machines; Quantity of cooling medium; Types of enclosures; General design procedure; Steps to get optimal design.

UNIT III: [08 Hrs.]

APPLICATION OF FINITE ELEMENT METHOD IN DESIGN:

Introduction: Basics of Finite element, Shape functions, Single element computation. Assembly of elemental coefficient matrix, Global coefficient matrix, Application of FEM technique for design problems. Use of open source FEM software for 2D design. Computation of Capacitance of capacitor, cable, multi dielectric cable through FEM, Computation of electrostatic field for various geometry, skin and proximity effect in conductors

UNIT IV: [14 Hrs.]

COMPUTER AIDED DESIGN OF ELECTRICAL APPARATUS:

Introduction: Flowcharts and programs for computer aided design of Starters, field regulators, small transformers, choke coils. 2D FEM open source software based electrical apparatus design

COMPUTER AIDED DESIGN OF DC MACHINES: Introduction; Flowcharts and programs for computer aided design of DC machines. 2D FEM open source software based DC machine part design

COMPUTER AIDED DESIGN OF TRANSFORMERS: Introduction; Flowcharts and programs for computer aided design of transformers. 2D FEM open source software based transformer part design.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text books / Reference Books:

1. *Computer aided design of electrical machines - K M Vishnu Murthy, B S Publications*
2. *Computer aided design of electrical machines – Maurya, Jallan, Shukla, Kataria publication*
3. *An Introduction to the Finite Element Method – J Reddy, TMH Publication*

Subject Code	Name of the Subject	L	T	P	C	QP
BELPE6043	**Advanced Power electronics**	3	0	0	3	A
Course Educational Objectives						
To develop different types of skills so that students are able to acquire following competency:						
CEO1	to provide exposure of some power electronic converters that are utilized by the industries					

CEO2	To provide utilities that are not taught in the basic courses on Power Electronics
Course Outcomes: : *Upon successful completion of this course, students should be able to:*	
CO1	Evaluate different dc-dc voltage regulators
CO2	Simulate and analyze resonant converters
CO3	Select appropriate phase shifting converter for a multi-pulse converter
CO4	Evaluate various multi-level inverter configurations
CO5	Compare various FACTS devices for VAR compensation

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2		2										2		
CO2	1		2										1		
CO3	1		2										2		
CO4	2		1										1		
CO5	1.5		1.75										2		
Avg.	2		2										1.5		

SYLLABUS

UNIT I: 12 hrs

Switching Voltage Regulators

Introduction; Linear power supply (voltage regulators); Switching voltage regulators; Review of basic dc-dc voltage regulator configurations -Buck, Boost, Buck-Boost converters and their analysis for continuous and discontinuous mode; Other converter configurations like Flyback converter, Forward converter, Half bridge, Full bridge configurations, Push-pull converter, C'uk converter, Sepic Converter; Design criteria for SMPS; Multi-output switch mode regulator

UNIT II: 8 hrs

Resonant Converters

Introduction, Need of resonant converters, Classification of resonant converters, Load resonant converters, Resonant switch converters, zerovoltage switching dc-dc converters, zero current switching dc-dc converters, clamped voltage topologies

UNIT III: 7hrs

Multi-level converters

Need for multi-level inverters, Concept of multi-level, Topologies for multi-level: Diode Clamped, Flying capacitor and Cascaded H-bridge multilevel Converters configurations; Features and relative comparison of these configurations applications, Introduction to carrier based PWM technique for multi-level converters

UNIT IV: 7hrs

Multipulse Converters

Concept of multi-pulse, Configurations for m-pulse (m=12,18,24 ….) converters, Different phase shifting transformer (Y-1, Y-2, Y-Z1 and Y-Z2) configurations for multi-pulse converters, Application

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Books:

1. Ned Mohan, Tore M. Undeland and William P. Robbins, "Power Electronics – Converters, Applications and Design", John Willey & sons, Inc., 3rd ed., 2003.

2. 2. Muhammad H. Rashid, "Power Electronics - Circuits, Devices and Applications", Prentice Hall of India, 3rd ed., 2009.
3. Bin Wu, "High Power Converters and AC Drives", John Willey & sons, Inc., 2006.
4. 4. Derek A. Paice "Power Electronic Converter Harmonics – Multipulse Methods for Clean Power", IEEE Press, 1996.

Subject Code	Name of the Subject	L	T	P	C	QP
BELOE6051	**Organisational Behaviour**	3	0	0	3	A

Course Educational Objectives

CEO1	To develop an understanding of the behaviour of individuals and groups inside organizations
CEO2	To enhance skills in understanding and appreciating individuals, interpersonal, and group process for increased effectiveness both within and outside of organizations.
CEO3	To develop theoretical and practical insights and problem-solving capabilities for effectively managing the organizational processes.

Course Outcomes: : *Upon successful completion of this course, students should be able to:*

CO1	Define, explain and illustrate a range of organizational behaviour theories.
CO2	Analyse the behaviour of individuals and groups in organizations in terms of organizational behaviour theories, models and concepts.
CO3	To explain group dynamics and demonstrate skills required for working in groups (team building)
CO4	Communicate effectively in oral and written forms about organizational behaviour theories and their application using appropriate concepts, logic and rhetorical conventions.
CO5	To explain organizational culture and describe its dimensions and to examine various organizational designs

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1							2	2							
CO2							2	3							
CO3							2	3							
CO4							2	2							
CO5							2	2							
Avg.							2	2.4							

SYLLABUS

Unit – I **[14Hrs]**

Fundamentals of OB: Definition, scope and importance of OB, Relationship between OB and the individual, Evolution of OB, Theoretical framework (cognitive), behaviouristic and social cognitive), Limitations of OB.

Attitude: Importance of attitude in an organization, Right Attitude, Components of attitude, Relationship between behaviour and attitude, Developing Emotional intelligence at the workplace, Job attitude, Barriers to changing attitudes.

Personality and values: Definition and importance of Personality for performance, The Myers-Briggs Type Indicator and The Big Five personality model, Significant personality traits suitable to the workplace (personality and job – fit theory), Personality Tests and their practical applications.

Perception: Meaning and concept of perception, Factors influencing perception, Selective perception, Attribution theory, Perceptual process, Social perception (stereotyping and halo effect).

Motivation: Definition & Concept of Motive & Motivation, The Content Theories of Motivation (Maslow's Need Hierarchy & Herzberg's Two Factor model Theory), The Process Theories (Vroom's expectancy Theory & Porter Lawler model), Contemporary Theories – Equity Theory of Work Motivation.

Unit - II **[12Hrs]**

Foundations of Group Behaviour: The Meaning of Group & Group behaviour & Group Dynamics, Types of Groups, The Five – Stage Model of Group Development.

Managing Teams: Why Work Teams, Work Teams in Organization, Developing Work Teams, Team Effectiveness & Team Building.

Leadership: Concept of Leadership, Styles of Leadership, Trait Approach Contingency Leadership Approach, Contemporary leadership, Meaning and significance of contemporary leadership, Concept of transformations leadership, Contemporary theories of leadership, Success stories of today's Global and Indian leaders.

Unit – III **[14 Hrs.]**

Organizational Culture : Meaning & Definition of Organizational Culture, creating & Sustaining Organizational Culture, Types of Culture (Strong vs. Weak Culture, Soft Vs. Hard Culture & Formal vs. Informal Culture), Creating Positive Organizational Culture, Concept of Workplace Spirituality.

Unit – IV **[8 Hrs.]**

Organizational Change: Meaning, Definition & Nature of Organizational Change, Types of Organizational Change, Forces that acts as stimulants to change.

Implementing Organizational Change : How to overcome the Resistance to Change, Approaches to managing Organizational Change, Kurt Lewin's-Three step model, Seven Stage model of Change &Kotter's Eight-Step plan for Implementing Change, Leading the Change Process, Facilitating Change, Dealing with Individual & Group Resistance, Intervention Strategies for Facilitating Organizational Change, Methods of Implementing Organizational Change,

Developing a Learning Organization.
Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert
Text Books/Reference books: 1. *Understanding Organizational Behaviour, Parek, Oxford* 2. *Organizational Behaviour, Robbins, Judge, Sanghi, Pearson.* 3. *Organizational Behaviour, K. Awathappa,HPH.* 4. *Organizational Behaviour, VSP Rao, Excel* 5. *Introduction to Organizational Behaviour, Moorhead, Griffin, Cengage.* 6. *Organizational Behaviour, Hitt, Miller, Colella, Wiley*

Subject Code	Name of the Subject	L	T	P	C	QP
BELOE6053	**Green Buildings & Energy Conversion**	3			3	A

Course Educational Objectives

CEO1	This course is designed to enlighten students to the current green building trend and to help them realize the impact and applications of green building as a practice not just a trend. Upon completion of the course:
CEO2	Students should have an understanding of core building science fundamentals.

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Importance of the green buildings and its site selection
CO2	Environmentally friendly building materials and technologies
CO3	Integrating renewable energy technologies
CO4	Analyze different renewable source with case study.
CO5	Impacts of climatic conditions on green building design

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1				2			2								2
CO2				2			2								2
CO3				3			2								2
CO4				2			2								2
CO5				2			1								2
Avg.				2.2			1.8								2

SYLLABUS

Unit – I **[14Hrs]**

Green Buildings: Definition of Green Buildings, typical features of green buildings, benefits of Green Buildings- Sustainable site selection and planning of buildings to maximize comfort, day lighting, ventilation, planning for storm water drainage

Environmentally friendly building materials and technologies: Natural Materials like bamboo, timber, rammed earth, stabilized mud blocks, hollow blocks, lime & lime-pozzolanacements, materials from agro and industrial waste, ferro-cement and ferro-concrete, alternative roofing systems, various paints reducing the heat gain of the building, etc.

Unit - II **[12Hrs]**

Energy and resource conservation: Need for energy conservation, various forms of energy used in buildings, embodied energy of materials, energy used in transportation and construction processes- water conservation systems in buildings-water harvesting in buildings – waste to energy management in residential complexes or gated communities.

Use of renewable energy resources: Wind and Solar Energy Harvesting, potential of solar energy in India and world, construction and operation of various solar appliances, success case studies of fully solar energy based buildings in India.

Unit – III **[14 Hrs.]**

Climate Design: Local climatic conditions – temperature, humidity, wind speed and direction-impact of climate change on built environment – comforts: the desirable conditions – Principles of thermal design – means of thermal –light and lighting-building acoustics- energy efficient lighting, Ventilation and air quality requirement, various techniques for passive cooling, garden roofs, case studies for passive cooling and thermal comfort.

Unit – IV **[8 Hrs.]**

Green Building Rating Systems: Introduction to Leadership in Energy and Environment Design (LEED), Green Rating systems for Integrated Habitat Assessment – Modular wastewater treatment systems for built environment – Building automation and building management systems.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Books:

1. Alternative building materials and technologies' by K.S. Jagadish, B.V. Venkatarama Reddy and K.S. Nanjunda Rao.
2. Non-Conventional Energy Resources' by G. D. Rai, Khanna Publishers.

Subject Code	Name of the Subject	L	T	P	C	QP
BELOE6053	**Computer Organization**	3	0	0	3	A

Course Educational Objectives

Course Outcomes: : *Upon successful completion of this course, students should be able to:*

CO1	Draw the functional block diagram of a single bus **architecture of a computer andDescribe the function of the** instruction execution cycle, RTL interpretation ofinstructions, addressing modes, instruction set.
CO2	**Write** assembly language program for specified microprocessor for computing 16 bit multiplication, division and I/O device interface (ADC, Control circuit, serial port communication).
CO3	Write a flowchart for Concurrent access to memory and cache coherency in **Parallel Processors** and describe the process.
CO4	Given a CPU organization and instruction, design a memory module and analyze its operation by interfacing with the CPU.
CO5	Given a CPU organization, assess its performance, and apply design techniques to enhance performance using pipelining, parallelism and RISC methodology

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3													
CO2	3	2													
CO3	2	1													
CO4	1	1													
Avg.	2.25	1.75													

SYLLABUS

Unit – I **[14Hrs]**

Functional blocks of a computer: CPU, memory, input-output subsystems, control unit. Instruction set architecture of a CPU – registers, instruction execution cycle, RTLinterpretation of instructions, addressing modes, instruction set. Case study – instructionsets of some common CPUs.

Data representation: signed number representation, fixed and floating pointrepresentations, character representation. Computer arithmetic – integer addition andsubtraction, ripple carry adder, carry look-ahead adder, etc. multiplication – shift-andadd,Booth multiplier, carry save multiplier, etc. Division restoring and non-restoring techniques,floating point arithmetic.

Unit - II **[12Hrs]**

CPU control unit design: hardwired and micro-programmed design approaches, Case study – design of a simple hypothetical CPU.

Memory system design: semiconductor memory technologies, memory organization. **Peripheral devices and their characteristics**: Input-output subsystems, I/O device interface, I/O transfers – program controlled, interrupt driven and DMA, privileged and non-privileged instructions, software interrupts and exceptions. Programs and processes – role of interrupts in process state transitions, I/O device interfaces – SCII, USB

Unit – III **[14 Hrs.]**

Pipelining: Basic concepts of pipelining, throughput and speedup, pipeline hazards.
Parallel Processors: Introduction to parallel processors, Concurrent access to memory and cache coherency.

Unit – IV **[8 Hrs.]**

Memory organization: Memory interleaving, concept of hierarchical memory organization, cache memory, cache size vs. block size, mapping functions, replacement algorithms, write policies.

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Books:

1. "Computer Organization and Design: The Hardware/Software Interface", 5th Edition by David A. Patterson and John L. Hennessy, Elsevier.
2. "Computer Organization and Embedded Systems", 6th Edition by CarlHamacher,McGraw Hill Higher Education.

Reference Books:

1. "Computer Architecture and Organization", 3rd Edition by John P. Hayes, WCB/McGraw-Hill
2. "Computer Organization and Architecture: Designing for Performance", 10th Edition by William Stallings, Pearson Education.
3. "Computer System Design and Architecture", 2nd Edition by Vincent P. Heuring and Harry F. Jordan, Pearson Education.

Subject Code	Name of the Subject	L	T	P	C	QP
BELOE6054	**Power plant Engineering**	3	0	0	3	A

Course Educational Objectives

Course Outcomes: : *Upon successful completion of this course, students should be able to:*

CO1	Principles of operation for different power plants and their economics.
CO2	Know the operation of gas power plants
CO3	Understand the operation of nuclear power plants
CO4	Understand the operation of hydro power plants

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3											2		
CO2	3	2											1		

CO3	2	1											2		
CO4	1	1											1		
Avg.	2.25	1.75											1.5		

SYLLABUS

Unit – I **[14Hrs]**

Coal based thermal power plants, basic Rankine cycle and its modifications, layout of modern coal power plant, super critical boilers, FBC boilers, turbines, condensers, steam and heating rates, subsystems of thermal power plants, fuel and ash handling, draught system, feed water treatment, binary cycles and cogeneration systems

Unit - II **[12Hrs]**

Gas turbine and combined cycle power plants, Brayton cycle analysis and optimization, components of gas turbine power plants, combined cycle power plants, Integrated Gasifier based Combined Cycle (IGCC) systems.

Unit – III **[14 Hrs.]**

Basics of nuclear energy conversion, Layout and subsystems of nuclear power plants, Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANDU Reactor, Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactors (FBR), gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants.

Unit – IV **[8 Hrs.]**

Hydroelectric power plants, classification, typical layout and components, principles of wind, tidal, solar PV and solar thermal, geothermal, biogas and fuel cell power systems
Energy, economic and environmental issues, power tariffs, load distribution parameters, load curve, capital and operating cost of different power plants, pollution control technologies including waste disposal options for coal and nuclear plants

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Books:

1. Nag P.K., Power Plant Engineering, 3rd ed., Tata McGraw Hill, 2008.
2. El Wakil M.M., Power Plant Technology, Tata McGraw Hill, 2010

PRACTICAL / SESSIONAL

Subject Code	Name of the Subject	L	T	P	C	QP
BELPC6110	**Energy Management & Auditing Lab**	0	0	2	1	

Course Educational Objectives

List of Experiments

1. Calculation of Energy performance Index (EPI) of a building
2. Identifying various parameters and calculation of HT consumer Electricity bill
3. Measuring the power factor of 3 – phase induction motor and procedure for power factor correction
4. Preparing an Energy audit report of domestic load

5. Calculation procedure of ECBC standards and comparison
6. Assessment of Lighting Systems with ILER Calculation
7. Comparison analysis of DC and AC loads
8. Energy management and auditing analysis of a typical consumer load

Text Books:

1. Lab Manual

Subject Code	Subject Code	L	T	P	C	QP
BELPC6120	Electrical& Electronics Measurements Lab			**2**	**1**	

Course Educational Objectives

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Test and troubleshoot electronic circuits using various measuring instruments.
CO2	Understand the construction and working of different measuring instruments.
CO3	Understand the construction and working of different AC and DC bridges and its applications.
CO4	Analyze different type of interferences, its causes and methods for its reduction.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			2	2											
CO2			2	2											
CO3			1	2											
CO4			2	3											
Avg			1.75	2.25											

LIST OF EXPERIMENTS (Any 8 Experiments)

1. Measurement of Low Resistance by Kelvin's Double Bridge Method.
2. Measurement of Self Inductance and Capacitance using Bridges.
3. Study of Galvanometer and Determination of Sensitivity and Galvanometer Constants.
4. Calibration of Voltmeters and Ammeters using Potentiometers.
5. Testing of Energy meters (Single phase type).
6. Measurement of Iron Loss from B-H Curve by using CRO.
7. Measurement of R, L, and C using Q-meter.
8. Measurement of Power in a single phase circuit by using CTs and PTs.
9. Measurement of Power and Power Factor in a three phase AC circuit by two-wattmeter method.
10. Study of Spectrum Analyzers.

Subject Code	Subject Code	L	T	P	C	QP
BELPC6130	**Electrical drives Lab**			**2**	**1**	

Course Educational Objectives

CEO1	To impart knowledge on Performance of the fundamental control practices associated with AC and DC machines using power electronics
CEO2	To impart industry-oriented learning
CEO3	To evaluate the use of computer-based analysis tools to review the major classes of Machines

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Identify relevant information to supplement to the Electric Drives course.
CO2	Set up control strategies to synthesize the voltages in dc and ac motor drives.
CO3	Develop testing and experimental procedures applying basic knowledge in electronics, electrical circuit analysis, electrical machines and microprocessors
CO4	An ability to use standard methods to determine accurate modeling/simulation parameters for various general- purpose electrical machines and power electronics devices required for designing a system and solve drives related problems

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1				2	0										
CO2				2	3										
CO3				2	0										
CO4				1	0										

LIST OF EXPERIMENTS (Any 8 Experiments)

1. Speed Control of Single Phase Induction Motor by using Single Phase AC to ACConverter.
2. Speed Control of Separately Excited DC Shunt Motor using Single Phase FullyControlled AC to DC Converter.
3. Speed Control of Separately Excited DC Shunt Motor using Four-Quadrant Chopper.
4. Speed Control of Separately Excited DC Shunt Motor using Single Phase DualConverter.
5. Speed Control of Three Phase Squirrel Cage Induction Motor using Three Phase ACto AC Controller.
6. Speed Control of Three Phase Squirrel Cage Induction Motor using Three PhasePWM Inverter.
7. Speed Control of Three Phase Slip Ring Induction Motor using RheostaticControlMethod.
8. Speed Control of DC Shunt Motor using Three Phase AC to DC Converter.
9. Determination of the Transfer Function of DC Shunt Motor.
10. Determination of the Moment of Inertia of DC Shunt Motor Drive System by Retardation Test.
11. PWM Inverter fed 3 phase Induction Motor control using PSPICE / MATLAB / PSIM Software
12. VSI / CSI fed Induction motor Drive analysis using MATLAB/DSPICE/PSIM Software
13. Study of permanent magnet synchronous motor drive fed by PWM Inverter using Software
14. Regenerative / Dynamic braking operation for DC Motor - Study using software

15. Regenerative / Dynamic braking operation of AC motor - study is using software PC/PLC based AC/DC motor control operation

Subject Code	Subject	L	T	P	C	QP
BELPC6140	Advanced Lab – I- Electrical Simulation	3	0	0	3	A

Course Educational Objectives

CEO1	Acquire skills of using computer packages MATLAB coding and SIMULINK in power electronics and power system studies.
CEO2	Acquire skills of using software for power system studies

Course Outcomes

CO1	Acquire skills of using computer packages MATLAB /SIMULINK in power electronics
CO2	Acquire skills of using computer packages using MATLAB in power systems
CO3	Acquire skills of using for power system studies
CO4	An ability to identify, formulate, and solve engineering problems
CO5	An ability to design and conduct experiments, as well as to analyze and interpret results.
CO6	An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic,environmental,social, political, ethical, health and safety, manufacturability, and sustainability

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	0	1										0	3	
CO2	3	2	3										0	3	
CO3	3	3	3										2	3	
CO4	3	3	3										2	2	
CO5	3	2	3										1	3	
CO6	2	2	3										1	3	
Avg.	2.83	2.4	2.66										1.5	2.83	

LIST OF EXPERIMENTS

1) Use of MATLAB for the following 1. Single phase half controlled converter with R and RL load. 2. Single phase fully controlled converter with R and RL load 3. Three phase fully controlled converter with R and RL load. 4. Single phase AC voltage controller with R and RL load. **2) Use of MATLAB coding for solving the following** 1. Formation of Y-Bus by inspection method/analytical method. 2. Formation of Z-Bus matrix. 3. Load flow analysis for GS, NR and FDLF methods 4. Load flow solution for GS, NR and FDLF 5. Symmetrical and unsymmetrical fault analysis 6. 3. Transient stability analysis
Teaching Method(s): Chalk & Board/ PPT/Video Lectures
Text Books 1. Power electronics – P.S.Bimbhra 2. Power system analysis-Nagrath and Kothari
Ref. Books Laboratory Manual

UG IN Electrical Engineering

VII SEMESTER [FOURTH YEAR] [126-155]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	C	QP
THEORY								
1	PC	BELPC7010	Power System operation & Control	3	0	0	3	A
2	PE	BELPE7021	Flexible AC Transmission Systems	3	0	0	3	A
		BELPE7022	Satellite Communication Systems					
		BELPE7023	Advanced Power Systems					
		BELPE7024	Electrical Power Quality					
3	PE	BELPE7031	Power Station Engineering & Economy	3	0	0	3	A
		BELPE7032	Neural Networks & Fuzzy logic					
		BELPE7033	HVDC Transmission					
		BELPE7034	Digital Signal Processing					
4	PE	BELPE7041	Industrial automation and	3	0	0	3	

			control					
		BELPE7042	Generalized Theory of Electrical Machines					A
		BELPE7043	Bio medical Instrumentation					
		BELPE7044	Advanced Control Systems					
5	OE	BELOE7051	Introduction to Robotics	3	0	0	3	A
		BELOE7052	Internet of Things					
		BELOE7053	Principles of Entrepreneurship					
PRACTICAL / SESSIONAL								
6	PC	BELPC7110	Renewable Energy Lab	0	0	2	1	
7	PC	BELPC7140	Advanced Laboratory-I: Internet of things Lab	0	0	2	1	
8	EC	BELPC7150	Mini Project / Projects on Internet of Things	0	0	4	2	
10	EC	BELPC7170	^Summer Internship-II	0	0	2	1	
TOTAL				**15**	**0**	**10**	**20**	

Subject Code	Subject Code	L	T	P	C	QP
BELPC7010	**POWER SYSTEM OPERATION & CONTROL**	3	0	0	3	A

Course Educational Objectives	
CEO1	To understand the economics of power system operation with thermal and hydro units
CEO2	To provide students the knowledge of optimization techniques used in the power system and Load Frequency Control (LFC).
CEO3	To provide a solid foundation in mathematical and engineering fundamentals required to control the governing system in Turbine models.
CEO4	To realize the requirements and methods of real and reactive power control in power system
Course Outcomes: : *Upon successful completion of this course, students should be able to:*	
CO1	Define p.u. system and represent the power system components in single line diagram.
CO2	Explain how to find the bus admittance matrix and the network incidence matrix
CO3	Choose the best method for load flow analysis for power system operation
CO4	Solve the unit commitment problems and understand the economic operation of power system.
CO5	Analyze operation of single area and two area load frequency control
CO6	Create mathematical models for dynamic and stability analysis of power systems
CO-PO & PSO Mapping	

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	1	1										2	0	
CO2	2	1	1										2	2	
CO3	3	2	3										2	2	
CO4	2	2	1										2	2	
CO5	3	3	3										3	2	
CO6	3	3	2										2	2	
Avg.	2.33	2	1.83										2.23	2	

SYLLABUS

Unit-I: **[14 Hrs.]**

Fundamentals of Power System: Introduction, Single Subscript Notation, Double Subscript Notation, Power in Single Phase AC Circuit, Complex Power, The Power Triangle, Direction of Power Flow, Voltage and Current in Balanced Three Phase Circuits, Power in Balanced Three Phase Circuits, Per-Unit Quantities, Changing the Base in Per- Unit Quantities, Node Equations, The Single Line or One Line Diagram, Impedance and Reactance Diagrams.

The Admittance Models & Network Calculations: Branch and Node Admittances, Mutually Coupled Branches in Ybus, an Equivalent Admittance Network, Modification of Ybus, the Network Incidence Matrix and Ybus.

Power Flow Solutions: The Power-Flow Problem, the Gauss-Seidal Method, the Newton-Raphson Method, the Newton-Raphson Method, Power-Flow Studies in System Design and Operation, Regulating Transformers, the Decoupled Method.

Unit-II: **[12 Hrs.]**

Economic Operation of Power System: Distribution of Load between Units within a Plant, Distribution of Load between Plants, The Transmission-Loss Equation, An interpretation of Transformation C, Classical Economic Dispatch with Losses, Automatic Generation Control, Unit Commitment, Solving the Unit Commitment Problems.

Load Frequency Control, Control Area Concept: Automatic Load-Frequency Control of Single Area Systems: Speed-Governing System, Hydraulic Valve Actuator, Turbine-Generator Response, Static Performance of Speed Governor, Closing the ALFC Loop, Concept of Control Area, Static Response of Primary ALFC Loop, Dynamic Response of ALFC Loop, Physical Interpretation of Results, The Secondary ("Reset") ALFC Loop, Economic Dispatch Control.

Unit-III: **[12 Hrs.]**

Two Area Systems: ALFC of Multi-Control-Area Systems (Pool Operation): The Two Area Systems, Modelling the Tie-Line, Block Diagram Representation of Two Area System, Mechanical Analog of Two Area System, Dynamic Response of Two Area System, Static System Response, Tie-Line Bias Control of Multi-area Systems.

Unit-IV: **[12 Hrs.]**

Power System Stability: The Stability Problem, Rotor Dynamics and the Swing Equation, Further Considerations of the Swing Equations, The Power-Angle Equation, Synchronizing Power Coefficients, Equal- Area Criterion for Stability, Further Applications of the Equal-Area Criterion, Multi-machine Stability Studies: Classical Representation, Step-By-Step Solution of the Swing Curve, Computer Programs for Transient Stability Studies, Factors Affecting Transient Stability

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Books:

1. *Power System Analysis- By John. J. Grainger & W. D. Stevenson, Jr., TMH, 2003 Edition, Fifteenth Reprint.*
2. *An Introduction to Electric Energy System Theory- By O. I. Elgerd, TMH, Second Edition.*
3. *Power System Analysis, T K Nagsarkar and M S Sukhija, Oxford University Press*

Reference Book:

1. *Power System Analysis- By HadiSaadat, TMH, 2002 Edition, Eighth Reprint.*
2. *Power System Analysis Operation and Control- By A. Chakrabarti and S. Haldar, Third Edition, PHI Publications, 6th Reprint, 2010.*

Subject Code	Subject	L	T	P	C	QP
BELPE7021	Flexible AC Transmission Systems	3	0	0	3	A

Course Educational Objectives

CEO1	This course introduces the application of a variety of high power-electronic controllers for active and reactive power in transmission lines.
CEO2	Students are exposed to the basics, modelling aspects, control and scope for different types of FACTS controllers

Course Outcomes: *Upon successful completion of this course, students should be able to:*

CO1	**Understand** the importance of controllable parameters and benefits of different FACT controllers.
CO2	Ability to design a Compensators within realistic constraints
CO3	**Know** the significance of shunt, series compensation and role of FACTS devices on system control
CO4	**Analyze** the functional operation and control of GCSC, TSSC and TCSC
CO5	**Describe** the principles, operation and control of UPFC and IPFC.

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			2	2										2	
CO2			3	2										3	
CO3			2	1										3	
CO4			3	2										2	

CO5			2	2										2	
Avg.			2.4	1.8										2.4	

SYLLABUS

Unit – I **[11Hrs.]**

FACTS concept and General System Considerations: Transmission Interconnections, Flow of Power in an AC System, What limits the Loading Capability, Power Flow and Dynamic Stability Considerations of a Transmission Interconnection, Relative Importance of Controllable Parameters, Basic Types of FACTS Controllers, Basic Description and Definitions of FACTS Controllers.

Unit – II **[8 Hrs.]**

Static Shunt Compensation: Objectives of Shunt Compensation, Methods of Controllable VAR Generation, Static VAR Compensators, SVC and STATCOM.

Unit – III **12 Hrs.]**

Static Series Compensators: Objective of Series Compensation (GCSC, TSSC, TCSC), Variable Impedance Type Series Compensators, Switching Converter Type Series Compensators (SSSC) Static Voltage and Phase Angle Regulators: Objectives of Voltage and Phase Angle Regulators, Approaches to Thyristor-Controlled Voltage and Phase Angle Regulators (TCVRs and TCPARs).

Unit – IV **[12 Hrs.]**

Combined Compensators: Introduction Unified Power Flow Controller (UPFC), TheInterline Power Flow Controller (IPFC), Generalized and Multifunctional FACTS Controllers.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Book:

1. *"Understanding FACTS: Concepts & Technology of Flexible AC Transmission Systems" By N.G.Hingorani&L.Gyugyi, IEEE Press, Standard Publishers Distributors, Delhi*.

Reference Book:

1. Facts Controllers in Power Transmission & Distribution by K.R.Padiyan, New Age Intermational.
2. Modelling & Simulation in Power Networks, Enrique Acha, ClandioEsquival&H.A.Perez, CACamcho , John Wiley & Sons.

Subject Code	Subject	L	T	P	C	QP
BELPE7022	**Satellite Communication Systems**	3	0	0	3	A

Course Educational Objectives

CEO1	Explain the principles, concepts and operation of satellite communication systems
CEO2	Describe the concepts of signal propagation affects, link design, rain fading and link availability and perform interference calculations
CEO3	Understand modulation techniques and error correction codes for satellite communication
CEO4	Critically analyse the design requirements and the performance of satellite communication

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Understand the motion of satellite in the orbit and its link design.

CO2	Compute the coverage angle, angle of visibility and consequently determine the coverage area.
CO3	Demonstrate the impacts of GPS, Navigation, constellation design for tracking and launching with various multiple access techniques like TDMA, CDMA, FDMA, and DAMA
CO4	Relate the coverage area with the beam width of satellite antenna and analyze the propagation on satellite with hydrometric and non-hydrometric effect.
CO5	Design antenna systems to accommodate the needs of a particular satellite system.
CO6	Able to study the design of Earth station and tracking of the satellites.

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			3	2											
CO2			3	2											
CO3				2											
CO4			3												
CO5			2	3											
CO6			2	2											
Avg.			2.6	2.2											

SYLLABUS

Unit:1 (12 hrs)

INTRODUCTION TO SATELLITE COMMUNICATION: Orbital mechanics and parameters look angle determination, Launches and Lunch vehicle, Orbital effects in communication system performance. Attitude and orbit control system (AOCS), TT&C, Description of spacecraft System ; Transponders, SATELLITE LINK DESIGN: Basics of transmission theory, system noise temperature and G/T ratio, Uplink and Downlink design, design of satellite links for specified (C/N) performance.

Unit:2 **(10 hrs)**

ANALOG TELEPHONE AND TELEVISION TRANSMISSION: Energy dispersal, digital transmission MULTIPLE ACCESSES: Multiplexing techniques for satellite links, Comprehensive study on FDMA, TDMA and CDMA; Spread Spectrum Transmission and Reception; Estimating Channel requirements, SPADE, Random access

Unit:3 (11hrs)

PROPAGATION ON SATELLITE: Earth paths and influence on link design; Quantifying attenuation and depolarization, hydrometric & non hydrometric effects, ionosphere effects, rain and ice effects. SATELLITE ANTENNAS: Types of antenna and relationships; Basic Antennas Theory – linear, rectangular & circular aperture; Gain, pointing loss,

Unit:4 (7hrs)

EARTH STATION TECHNOLOGY: Earth station design; Design of large antennas – Cassegrain antennas, optimizing gain of large antenna, antenna temperature, feed system for large cassegrain antennas,

DESIGN OF SMALL EARTH STATION ANTENNAS: Front fed parabolic reflector antennas, offset fed

antennas, beam steering, Global Beam Antenna, equipment for earth station
Teaching Method(s): Chalk & Board/ PPT/Video Lectures
Text Books 1. Satellite Communication, T. Pratt, C. Bostian, John Wiley Co, 2nd Edition. 2. Satellite Communication, Principles & Applications, R.N.Mutagi, Oxford University Press, 1st Edition, 2016
Ref. Books 1. Digital Communication with Satellite and Fiber Optic Application, HarlodKolimbins, PHI 2. Satellite Communication, Robert M. Gagliardi, CBS Publishers 3. Satellites Communication Systems, Richharia. BSP BOOKS PVT LTD. **4.** Satellites Communication Engg., MichealKolawole, BSP BOOKS PVT LTD

Subject Code	Subject Code	L	T	P	C	QP
BELPE7023	**Advanced Power Systems**	3	0	0	3	A

Course Educational Objectives

CEO1	To introduce different techniques of dealing with sparse matrix for large scale power systems.
CEO2	To impart in-depth knowledge on different methods of power flow solutions.
CEO3	To perform optimal power flow solutions in detail.
CEO4	To perform short circuit fault analysis and understand the consequence of different type of faults.
CEO5	To Illustrate different numeric al integration methods and factors influencing transient stability

Course Outcomes: *Upon successful completion of this course, students should be able to:*

CO1	Apply the concepts of sparse matrix for large scale power system analysis
CO2	Analyse power system studies that needed for the transmission system planning.
CO3	**Formulate** the incidence, network matrices and **model** the power system components.
CO4	**Perform** steady state power flow analysis of power system networks using Gauss-Seidel, Newton-Raphson and Fast decoupled iterative methods

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			3	2									2	2	
CO2			3	3									1	3	
CO3			2	3									2	2	
CO4			3	3									2	2	
Avg.			2.75	2.75									1.83	2.33	

SYLLABUS

Unit – I **[13Hrs]**

SOLUTION TECHNIQUE: Sparse Matrix techniques for large scale power systems: Optimal ordering schemes for preserving sparsity. Flexible packed storage scheme for storing matrix as compact arrays – Factorization by Bi factorization and Gauss elimination methods; Repeat solution using Left and Right factors and L and U matrices.

POWER FLOW ANALYSIS: Power flow equation in real and polar forms; Review of Newton‟s method for solution; Adjustment of P-V buses; Review of Fast Decoupled Power Flow method; Sensitivity factors for P-V bus adjustment

Unit - II **[10Hrs]**

OPTIMAL POWER FLOW: Problem statement; Solution of Optimal Power Flow (OPF) – The gradient method, Newton "method, Linear Sensitivity Analysis; LP methods – With real power variables only – LP method with AC power flow variables and detailed cost functions; Security constrained Optimal Power Flow; Interior point algorithm; Bus Incremental costs.

Unit – III **[12 Hrs]**

SHORT CIRCUIT ANALYSIS: Formation of bus impedance matrix with mutual coupling (single phase basis and three phase basis) - Computer method for fault analysis using ZBUS and sequence components. Derivation of equations for bus voltages, fault current and line currents, both in sequence and phase – symmetrical and unsymmetrical faults.

Unit – IV **[10 Hrs]**

TRANSIENT STABILITY ANALYSIS:

Introduction, Numerical Integration Methods: Euler and Fourth Order Runge-Kutta methods, Algorithm for simulation of SMIB and multi-machine system with classical synchronous machine model; Factors influencing transient stability, Numerical stability and implicit Integration methods.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Book:

1. *A.J.Wood and B.F.Wollenberg, "Power Generation Operation and Control", John Wiley and sons, New York, 1996.*
2. *W.F.Tinney and W.S.Meyer, "Solution of Large Sparse System by Ordered Triangular Factorization" IEEE Trans. on Automatic Control, Vol : AC-18, pp:333- 346, Aug 1973.*

Reference Book:

1. *K.Zollenkopf, "Bi-Factorization: Basic Computational Algorithm and Programming Techniques ; pp:75-96 ; Book on "Large Sparse Set of Linear Systems" Editor: J.K.Rerd,Academic Press, 1971.*
2. *M.A.Pai," Computer Techniques in Power System Analysis",Tata McGraw-Hill Publishing Company Limited, New Delhi, 2006.*
3. *G W Stagg , A.H El. Abiad, "Computer Methods in Power System Analysis", McGraw Hill, 1968.*
4. *P.Kundur, "Power System Stability and Control", McGraw Hill, 1994.*

Subject Code	Subject Code	L	T	P	C	QP
BELPE7024	**Electrical Power Quality**	3	0	0	3	A

Course Educational Objectives

CEO1	To introduce the concepts and phenomenon of different sources effecting power quality
CEO2	To give an idea about the fundamental concepts of various voltage imbalances

Course Outcomes: : *Upon successful completion of this course, students should be able to:*

CO1	Learn to distinguish between the various categories of power quality problems
CO2	Understand the root of the power quality problems in industry and their impact on performance and economics
CO3	Learn to apply appropriate solution techniques for power quality mitigation based on the type of problem
CO4	Introduce the importance of grounding on power quality
CO5	Introduce power distribution protection techniques and its impact on voltage quality

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	1	1											2	
CO2	2	1	1											2	
CO3	3	2	3											2	
CO4	2	2	1											2	
CO5	3	3	3											2	
Avg.	2.33	2	1.83											2	

SYLLABUS

Unit-I: [14 Hrs.]

Terms & Definitions: General Classes of Power Quality Problems, Transients, Long Duration Voltage Variations, Short-Duration Voltage Variations, Voltage Imbalance, Waveform Distortion, Voltage Fluctuations, Power Frequency Variations, Power Quality Terms. Voltage Sags & Interruptions: Sources of Sags and Interruptions, Estimating Voltage Sag Performance, Fundamental Principles of Protection, Solutions at the End-User Level, Evaluating the Economics of Different Ride-Through Alternatives, Motor Starting Sags, Utility System Fault-Clearing Issues

Unit-II: [12 Hrs.]

Transient Over Voltages: Sources of Transient Over Voltages, Principle of Over Voltage Protection, Devices for Over Voltage Protection, Utility Capacitor-Switching Transients, Utility System Lightning Protection, Managing Ferro-resonance, Switching Transient Problems with Loads, Computer Tools for Transient Analysis. Fundamentals of Harmonics: Harmonic Distortion, Voltage Versus Current Distortion, Harmonics Versus Transients, Power System Quantities under Non-sinusoidal Conditions, Harmonic Indices, Harmonic Sources from Commercial Loads, Locating Harmonic Sources, System

Response Characteristics, Effects of Harmonic Distortion, Inter-harmonics

Unit-III: **[8 Hrs.]**

Long Duration Voltage Variations: Principles of Regulating the Voltage, Devices for Voltage Regulation, Utility Voltage Regulator Application, Capacitors for Voltage Regulation, End-User Capacitor Application, Regulating Utility Voltage with Distributed resources, Flicker.

Unit-IV: **[8Hrs.]**

Power Quality Monitoring: Monitoring Considerations, Historical Perspective of Power Quality Measuring Instruments, Power Quality Measurement Equipments, Assessment of Power Quality Measurement Data, Application of Intelligent Systems, Power Quality Monitoring Standards.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Books:

1."Electrical Power Systems Quality" By Roger C. Dugan, Mark F. Mcgranaghan, Surya Santoso&H.WayneBeaty, 2nd Edition, TMH Education Private Ltd., New Delhi.

Reference Book:

1. Power System Quality Assesment, J.Arrilaga, N.R.Watson, S.Chen, John Wiley & Sons.
2. Understanding Power Quality Problems: Voltage Sags & Interruptions, M.H.J. Boller IEEE, 1999

Subject Code	Subject Code	L	T	P	C	QP
BELPE7031	Power Station Engineering & Economy	3	0	0	3	A

Course Educational Objectives

CEO1	Describe sources of energy and types of power plants
CEO2	List types, principles of operations, components and applications of steam turbines, steam generators, condensers, feed water and circulating water system
CEO3	Calculate present worth depreciation and cost of different types of power pla

Course Outcomes: : ***Upon successful completion of this course, students should be able to:***

CO1	Discuss the energy resources and energy conversion methods available for the production of electric power in India
CO2	Explain the basic principles of thermal-fission and fast-breeder nuclear power plants, such as pressurized-water, boiling-water, and heavy-water reactor
CO3	Calculate the heat rate, fan power consumption, flame temperature and combustion air requirements of conventional steam generators (boilers)
CO4	Able to analyze the various characteristic of hydel power plant
CO5	Able to analyze the various economic costs of different power plants

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	1	1											0	

CO2	2	1	1											2	
CO3	3	2	3											2	
CO4	2	2	1											2	
CO5	3	3	3											2	
Avg.	2.33	2	1.83											2	

SYLLABUS

Unit-I: **[6Hrs.]**

Introduction to different sources of energy and general discussion on their application to generation, Indian Energy Scenario. (Nag-1.5) Load duration curves, Load Factor, Capacity Factor, Reserve Factor, Demand Factor, Diversity Factor, Plant Use Factor, Base Load, Intermediate Load and Peak Load Plants. (Nag-1.2)

Unit-II: [9 Hrs.]

ECONOMICS OF POWER GENERATION: Construction costs, Fixed cost and Depreciation, Fuel cost, Economic scheduling principle, Annual Operating Costs, Effect of Load Factor on cost per kWh. (Vopat- 29.2- 29.5, 29.13-29.22, Nag-1.4)

NUCLEAR POWER STATION: Introduction to fission & fusion, reactor construction, controlled chain reaction, operational control of reactors, Brief study of various types of reactors (Boiling water, pressurized water, heavy water, breeder) , Location and layout of nuclear power plant (Nag- 9.5, 9.6, 9.13, 9.15 - 9.21

Unit-III: **[12 Hrs.]**

HYDEL POWER STATION: Selection of site for hydro-electric power plant. (Nag-10.4) Hydrology: Hydrological cycle, precipitation, run-off and its measurement, hydrograph, flow duration and mass curves, Estimation of amount stored by a dam across the river, Storage and Pondage. (Vopat- 25.2, 25.3, 25.5, Nag – 10.5 - 10.7) Turbines: Operational principle of Kaplan and Francis Turbine and Pelton wheel, Speed and Pressure Regulation, Work done, efficiency (Vopat – Chapter-26, Nag- 10.10 – 10.15, 10.24 - 10.25) Essential Elements of a Hydro-electric Power Plant: Catchment area, Reservoir, Dam, Head Gate, Spillways, Pen stock, Surge Tanks, Scroll case, Draft tubes and Tail Race, Power House, Classification of Hydroelectric Power Plants. (Vopat- 25.6 – 25.9, Nag- 10.8, 10.9) Governors, Plant auxiliaries (Nag – 10.21

Unit-IV: **[12 Hrs.]**

THERMAL POWER STATION: Selection of site for thermal power plant. (Vopat-31.3, Nag-1.3) Overall Block Diagram indicating the air circuit, coal and ash circuit, water and steam circuit, various types of steam turbines, ash and coal handling system, High Pressure and High capacity water tube boilers, Economizer, Superheaters, De-Superheater, Reheater, Air Pre-heater. (Vopat – 7.4, Chap-8, Chap-10, Nag-2.15, 6.3.1, 6.3.2, 6.4-6.6, 6.8, 6.12 - 6.15) Draft System: Natural, Induced Forced and Balance Draft, PA fan, FD fan, ID fan, Chimney. (Vopat – 9.1, 9.4, Nag- 4.14.1, 4.14.3, 4.15) Condensers, Feed water heaters, Evaporators, Make-up water, Bleeding of steam, Cooling water system. (Vopat- 14.1, 14.6, 18.2, 18.13, Nag – 8.1- 8.6), Electrostatic Precipitator: Basic working Principle and constructional details (Nag-6.10) Governors, Plant auxiliaries (Vopat- 12.14)

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Books:

1. P. K. Nag, “Power Plant Engineering”, 3rd Edition, Tata McGraw Hill Publication
2. Bernhardt G. A. Skrotzki, William A. Vopat, ‘Power Station Engineering and Economy’, 2nd

Edition, Tata McGraw Hill Publication
3. M. V. Deshpande, Elements of Electrical Power Station Design, PHI
4. Arora &Domkundwar, 'A Course in Power Plant Engineering', DhanpatRai and sons.
5. R. K. Rajput, 'A Text Book of Power Plant Engineering', 3rd Edition, Laxmi Publishing

Subject Code	Subject	L	T	P	C	QP
BELPE7032	**Neural Networks and Fuzzy Logic**	3	0	0	3	A

Course Educational Objectives

CEO1	It deals with Introduction and different architectures of neural network
CEO2	It deals with the Application of Neural Networks
CEO3	It deals with Fuzzy Logic Controller
CEO4	It deals with applications of Fuzzy logic

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	The student will be able to obtain the fundamentals and types of neural networks.
CO2	The student will have a broad knowledge in developing the different algorithms for neural Networks.
CO3	Student will be able analyze neuralcontrollers
CO4	Student will have a broad knowledge in Fuzzy logic principles.
CO5	Student will be able to determine different methods of Deffuzification

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			2	3										2	
CO2			3	3										3	
CO3			2	3										3	
CO4			3	3										2	
CO5			1	2										2	
Avg.			2.2	2.8										2.4	

SYLLABUS

Unit – I **[11Hrs.]**

ARCHITECTURES: Introduction –Biological neuron-Artificial neuron-Neuron modeling Learning rules-Single layer-Multi layer feed forward network-Back propagation-Learning factors.

Unit – II **[8 Hrs.]**

NEURAL NETWORKS FOR CONTROL: Feedback networks-Discrete time hop field networks-Schemes of neuro –control, identification and control of dynamical systems-case studies

Unit – III **12 Hrs.]**

FUZZY SYSTEMS: Classical sets-Fuzzy sets-Fuzzy relations-Fuzzification – Defuzzification- Fuzzy

rules FUZZY LOGIC CONTROL: Membership function – Knowledge base-Decision –making logic – Optimizations of membership function using neural networks-Adaptive fuzzy systems-Introduction to genetic algorithm
Unit – IV **[12 Hrs.]** APPLICATION OF FLC: Fuzzy logic control-washing machines-Image processing-Home Heating system-energy efficient fans-Introduction to neuro fuzzy controller.
Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert
Text Book: 1. Kosko, B, "Neural Networks and Fuzzy Systems: A Dynamical Approach to Machine Intelligence", PrenticeHall, New Delhi, 2004. 2. Timothy J Ross, "Fuzzy Logic with Engineering Applications", John Willey and Sons, West Sussex, England, 2005
Reference Book: 1. Jack M. Zurada, "Introduction to Artificial Neural Systems", PWS Publishing Co., Boston, 2002. 2. Klir G.J. &Folger T.A., "Fuzzy sets, Uncertainty and Information", Prentice –Hall of India Pvt. Ltd., New Delhi, 2008. 3. Zimmerman H.J., "Fuzzy set theory and its Applications", Kluwer Academic Publishers Dordrecht, 2001. 4. Driankov,Hellendroonb, "Introduction to fuzzy control", Narosa Publishers,2001. ***5.*** LauranceFausett, Englewood cliffs, N.J., "Fundamentals of Neural Networks", PearsonEducation, New Delhi, 2008

Subject Code	Name of the Subject	L	T	P	C	QP
BELPE7033	**HVDC Transmission**	3	0	0	3	A

Course Educational Objectives	
CEO1	To know about the fundamentals of HVDC Transmission systems.
CEO2	Investigate the various types of HVDC equipment with their characteristics.
CEO3	To carry out the analysis of operation of HVDC equipment in power system.
CEO4	Understand the various controls used in HVDC transmission system.
Course Outcomes: ***Upon successful completion of this course, students should be able to:***	
CO1	Understand the concept of HVDC Transmission system over the existing AC transmission and Basic principle and operation of different HVDC converters.
CO2	Analyze and apply the different power Converters and control methods to control the transmission system and distribution system
CO3	Design filters to eliminate the harmonics to improve the power quality.
CO4	Analyze different faults in HVDC system.
CO5	Use modern tools including MATLAB, PSPICE tools to simulate the High transmission system

	Engage in independent and lifelong learning in the context of HVDC technological changes

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			2	3										2	
CO2			2	2										2	
CO3			1	2										2	
CO4			1	2										2	
CO5			2	2										2	
CO6			2	1										3	
Avg.			1.7	2										2.25	

SYLLABUS

Unit – I **[14Hrs]**

HVDC Transmission: Introduction To HVDC Transmission HVDC Transmission: Technical And Economical Comparison of HVAC and HVDC Transmission, Types of DC Links, Power Handling Capabilities of HVDC Lines, Basic Conversion Principles, Static Converter Configuration. Unit II Static Power Converter **6-Pulse Converter Operation and Analysis:** 6 Pulse & 12 Pulse Converters, Converter Station and Terminal Equipment Commutation Process, Rectifier and Inverter Operation, Equivalent Circuit for Rectifier, Inverter and HVDC Link- Special Features of Converters..

Unit - II **[12Hrs]**

Control of HVDC Converter and Systems: Mechanism of AC Power Transmission, Principle ofControl, Necessity of Control in case of a DC link, Rectifier Control, Compounding of Rectifiers,Power Reversal in a DC Link, Voltage Dependent Current Order Limit (VDCOL)-Characteristics ofthe Converter, System Control Hierarchy and Basic Philosophy, Inverter Extinction Angle Control(EAG), Pulse Phase Control, Starting and Stopping of a DC Link, Constant Power Control, ControlSystems for HVDC Converters, Inverter Operation Problems, Control of VSC Converters.

Unit – III **[8 Hrs]**

Harmonics in HVDC Systems: Importance of Harmonic Study, Generation of Harmonics byConverters, Characteristic Harmonics on the DC Side, Characteristic Current Harmonics,Characteristic variations of Harmonic Currents with Variation of α & μ, Effect of Control modes onHarmonics, Non-Characteristic Harmonics, Harmonics in VSC Converters.

Harmonic Suppression in HVDC System-Filters: Harmonic Model & Equivalent Circuit, Use ofFilters, Filter Configurations, Design of a Band-Pass Filter, Design of High-Pass Filters, Protection ofFilters, DC Filters.

Unit – IV **[8 Hrs]**

Faults and Protection Schemes in HVDC Systems: Nature and Types of Faults, Faults on AC Side ofConverter Stations, Converter Faults, Faults on DC Side of the System, Protection against OverCurrents/ Over Voltages, Protection of Filter Units.

Multi-terminal HVDC Systems : Types of Multi-terminal (MTDC) Systems, Parallel OperationAspects of MTDC, Paralleling (Disconnecting) of Units or Converter, Control of Power in MTDC, VSCMulti-level DC Systems.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Book:

1. "***HVDC Transmission***" *By S. Kamakshaiah& V. Kamaraju, TMH Education Private Ltd., 2011, New Delhi.*

Reference Book:

1. *HVDC Power Transmissions Systems: Technology & Systems Interaction, K.R.Padiyar, New Age Publication, 2005*

Subject Code	Subject Code	L	T	P	C	QP
BELPE7034	**DIGITAL SIGNAL PROCESSING**	3	0	0	3	A

Course Educational Objectives

CEO1	To understand the key theoretical principles underpinning DSP in a design procedure through design examples and case studies
CEO2	To learn how to use a powerful general-purpose mathematical package such as MATLAB to design and simulate a DSP systems
CEO3	To understand the architecture of a digital signal processor and some programming issues in fixed-point digital signal processor in real-time implementation.
CEO4	To learn to design a real-time signal processing algorithms using the latest fixed-point processor.

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Identify time domain and frequency domain sequences
CO2	Calculate the DFT of the time domain sequence
CO3	Apply the FFT algorithm to optimize the calculation process for DFT.
CO4	Determine the type of Filter to be used
CO5	Apply the proper filter characteristics and compute the filter coefficients
CO6	Describe the real-life applications based on the fundamental theory.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			3	2											
CO2			3	2											
CO3			0	2											
CO4			3	0											
CO5			2	3											
CO6			2	2											
Avg.			2.6	2.2											

SYLLABUS

Unit – I **[15 Hrs]**

THE Z-TRANSFORM AND ITS APPLICATION TO THE ANALYSIS OF LTI SYSTEMS: The Z-Transform: The Direct Z-Transform, The Inverse Z-Transform; Properties of the Z-Transform; Inversion of the Z-Transforms: The Inversion of the Z-Transform by Power Series Expansion, The Inversion of the Z-Transform by Partial-Fraction Expansion; Analysis of Linear Time-Invariant Systems in the z-Domain:

Response of Systems with rational System Functions, Transient and Steady-State Responses, Causality and Stability, Pole-Zero Cancellations.
THE DISCRETE FOURIER TRANSFORM: ITS PROPERTIES AND APPLICATIONS: Frequency Domain Sampling: Frequency-Domain Sampling and Reconstruction of Discrete-Time Signals, The Discrete Fourier Transform, The DFT as a Linear Transformation, Relationship of the DFT to other Transforms; Properties of the DFT: Periodicity, Linearity, and Symmetry Properties, Multiplication of Two DFTs and Circular Convolution, Additional DFT Properties; Linear Filtering Methods Based on the DFT: Use of the DFT in Linear Filtering, Filtering of Long Data Sequences; Frequency Analysis of Signals using the DFT; The Discrete Cosine Transform: Forward DCT, Inverse DCT, DCT as an Orthogonal Transform.

Unit- II **[12Hrs]**

IMPLEMENTATION OF DISCRETE-TIME SYSTEMS: Structure for the Realization of Discrete-Time Systems, Structure for FIR Systems: Direct-Form Structure, Cascade-Form Structures, Frequency-Sampling Structures; Structure for IIR Systems: Direct-Form Structures, Signal Flow Graphs and Transposed Structures, Cascade-Form Structures, Parallel-Form Structures.
DESIGN OF DIGITAL FILTERS: General Considerations: Causality and Its Implications, Characteristics of Practical frequency-Selective Filters; Design of FIR Filters: Symmetric and Ant symmetric FIR Filters, Design of Linear-Phase FIR Filters by using Windows, Design of Linear-Phase FIR Filters by the Frequency-Sampling Method; Design of IIR Filters from Analog Filters: IIR Filter Design by Impulse Invariance, IIR Filter Design by the Bilinear Transformation.

Unit – III **[12 Hrs]**

EFFICIENT COMPUTATION OF THE DFT: FAST FOURIER TRANSFORM ALGORITHMS: Efficient Computation of the DFT: FFT Algorithms: Direct Computation of the DFT, Radix-2 FFT Algorithms: Decimation-In-Time (DIT), Decimation-In-Time (DIF); Applications of FFT Algorithms: Efficient Computation of the DFT of two Real Sequences, Efficient Computation of the DFT a 2N-Point Real Sequence, Use of the FFT Algorithm in Linear Filtering and Correlation.

Unit IV[8Hrs]

ADAPTIVE FILTERS: Application of Adaptive Filters: System Identification or System Modeling, Adaptive Channel Equalization, Adaptive Line Enhancer, Adaptive Noise Cancelling; Adaptive Direct-Form FIR Filters-The LMS Algorithm: Minimum Mean Square Error Criterion, The LMS Algorithm.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Book:

1. *Digital Signal Processing – Principles, Algorithms and Applications by J. G.Proakis and D. G. Manolakis, 4th Edition, Pearson.*

Reference Book:

1. *Digital Signal Processing: a Computer-Based Approach – Sanjit K. Mitra, TMH*
2. *Digital Signal Processing – S. Salivahan, A. Vallavraj and C. Gnanapriya, TMH.*
3. *Digital Signal Processing – Manson H. Hayes (Schaum's Outlines) Adapted by SubrataBhattacharya, TMH.*
4. *Digital Signal Processing: A Modern Introduction – Ashok Ambardar, Cengage Learning.*
5. *Modern Digital Signal Processing – Roberto Cristi, Cengage Learning.*
6. *Digital Signal Processing: Fundamentals and Applications – Li Tan, Academic Press, Elsevier*

Subject Code	Subject Code	L	T	P	C	QP
BELPE7041	Industrial automation and control	3	0	0	3	A

Course Educational Objectives

CEO1	Provides an overall exposure to the technology of Industrial Automation and Control as widely seen in factories of all types both for discrete and continuous manufacturing
CEO2	Identify Safety in Industrial Automation
CEO3	Identify Practical Programmable Logic Controller Applications
CEO4	Identify Types of Industrial Sensors

Course Outcomes: : *Upon successful completion of this course, students should be able to:*

CO1	Explain the General function of Industrial Automation
CO2	Explain Fundamentals of Process Control Including
CO3	Distinguish Types of Process Control Devic
CO4	Identify Practical Programmable Logic Controller Applications
CO5	Demonstrate Proper control Procedures in Industrial Envir
CO6	Apply Process Control Devices to Practical Level, Flow, and Temperature Control Systems

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	1	1											0	
CO2	2	1	1											2	
CO3	2	2	3											2	
CO4	2	2	1											2	
CO5	2	3	2											2	
CO6	2	3	2											2	
Avg.	1.83	2	1.66											2	

SYLLABUS

Unit-I: [12 Hrs.]

Process Control: Introduction: Process Definition, Feedback Control, PID Control, Multivariable Control. (Chapter 1 of Text Book 1) PID Controller Tuning: Introduction, Zeigler-Nichols Tuning Method (Based on Ultimate Gain and Period, and Process Reaction Curve), Digital PID Controllers. (Chapter 13 of Text Book 2)

Unit-II: [12 Hrs.]

Special Control Structures: Cascade Control, Feedfroward Control, FeedfrowardFeedback Control Configuration, Ratio Control, Selective Control, Adaptive Control, Adaptive Control Configuration. (Chapter 10 and 11 of Text book 3) Actuators: Introduction, Pneumatic Actuation, Hydraulic Actuation, Electric Actuation, Motor Actuators and Control Valves. (Chapter 8 of Text Book 1)

Unit-III: [8 Hrs.]

Industrial Automation: Programmable Logic Controllers: Introduction, Principles of operation,

Architecture, Programming (Programming Languages, Ladder Diagram, Boolean Mnemonics) (Chapter 5 of Text Book 1)

Unit-IV: **[12 Hrs.]**

Distributed Control: Distributed vs. Centralized, Advantages, Functional Requirements, System Architecture, Distributed Control Systems (DCS), Communication options in DCS. (Chapter 6 of Text Book 1) Real-time Programming: Multi-tasking, Task Management, Inter-task Communication, Real-time Operating System. (Chapter 9 of Text Book

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Books:

1. Krishna Kant, "Computer-Based Industrial Control", PHI, 2009.
2. M. Gopal, "Digital Control and State Variable Methods" Tata McGraw Hill, 2003.
3. SurekhaBhanot, Process Control: Principles and Applications, Oxford university Press, 2010

Reference Book:

1. Smith Carlos and Corripio, "Principles and Practice of Automatic Process Control", John Wiley & Sons, 2006.
2. Jon Stenerson, "Industrial Automation and Process Control", Prentice Hall, 2003.
3. C. Johnson, "Process Control Instrumentation Technology", PHI, New Delhi
4. D.R. Coughnowr, "Process System analysis and Control", McGraw Hill.

Subject Code	Subject Code	L	T	P	C	QP
BELPE7042	**Generalized Theory of Electrical Machines**	3	0	0	3	A

Course Educational Objectives

CEO1	Represent the electric machines in their non linear models
CEO2	Represent any rotating electric machines in d-q model.
CEO3	Analysis any global rotating machine into perpendicular d and q axes
CEO4	Extract the output power either electrical or mechanical from the model.
CEO5	Analysis and monitor the machine performance in both transient and steady state modes
CEO6	Construct a complete model for the whole system and study the effect of disturbances

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Derive Kron's Primitive machine as an unified electrical machine model.
CO2	Derive the mathematical model of a separately excited DC motor & DC Series Motor
CO3	Analyze a three phase synchronous/ PM machine under transient conditions.
CO4	Derive the mathematical model and control a 3- phase Induction motor under transient /steady
CO5	Analyze asymmetrical 2-phase / 1-phase induction motor under transient /steady state conditions

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		2	1	1									3		

CO2		2	1	1									3		
CO3		1	2	1									3		
CO4		1	1	2									3		
CO5		1	2	1									2		
Avg.		1.4	1.4	1.2									2.8		

SYLLABUS

Unit–I **[11Hrs]**

MODELING CONCEPTS Basic Two-pole machine representation of commutator machines, 3- phase synchronous machine without damper bars and 3-phase induction machine, Kron's primitive machine-voltage, current and torque equations. Real time model of a two phase induction machine transformation to obtain constant matrices-three phase to two phase transformation- power invariance.

Unit -II **[12Hrs]**

REFERENCE FRAME THEORY & PM AC MACHINE Introduction–Background–Equations of Transformation–Stationary Circuit variables transformed to the Arbitrary Reference Frame– Commonly Used Reference Frames–Balanced Steady -State Phasor Relationships– Balanced Steady-State Voltage Equations. PM AC Machine: Voltage & Torque equations in Machine Variables and Rotor Reference Frame Variables

Unit – III **[12 Hrs]**

DC MACHINE MODELLING Mathematical model of a separately excited DC motor- Steady state and transient analyses - Transfer function of a separately excited DC machine – Mathematical model of a DC series motor, shunt motor linearization techniques for small perturbations

Unit – IV **[12 Hrs]**

AC MACHINE MODELLING: ANALYSIS OF SYNCHRONOUS MACHINE: Synchronous machine inductances – voltage equations in the rotor's dq0 reference frame- electromagnetic torque-current in terms of linkages. Dynamic performance of synchronous machine, three-phase fault, comparison of actual and approximate transient torque characteristics, Equal area criteria– simulation of three phase synchronous machine – Dynamic performance during a sudden change in input torque– Torque vs. rotor angle characteristics

MODELING OF THREE PHASE SYMMETRICAL INDUCTION MACHINE Generalized model in an arbitrary reference frame- Electromagnetic torque– Derivation of commonly used induction machine models– Stator reference frame model- Rotor reference frame model- Synchronously rotating frame model– Equations in flux linkages - per unit model Dynamic Simulation- Small signal equations of induction machine – derivation of dq flux linkage model – Control principles of Induction machine, Analysis under steady state operation.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Book:

1. Dr. P. S. Bimbhra, "Generalized Theory of Electrical Machines" – Fifth edition, Khanna publishers (for UNIT- I: Chapters 1 & 2))
2. P.C.Krause, Oleg Wasynczuk, Scott D. Sudhoff "Analysis ofElectrical Machinery and Drive systems", 3rd Edition, IEEE Press (for UNIT – II, III, IV & V: Chapters 3,4,5 ,6, 9, part of 10)

Reference Book:

1. Chee Mun Ong "Dynamic simulation of Electric machinery usingMatlab / Simulink" –Prentice Hall
2. C.V. Jones: "The Unified Theory of Electrical Machines" Butterworth, London.

Subject Code	Subject Code	L	T	P	C	QP
BELPE7043	**Biomedical Instrumentation**	3	0	0	3	A

Course Educational Objectives

CEO1	Interpret technical aspects of medicine
CEO2	Solve Engineering Problems related to medical field
CEO3	Understand medical diagnosis and therapy

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Define and recognize several signals which are drawn out from the human body.
CO2	Employ quality assurance, risk assessment, and ethical issues in the context of instrumentation
CO3	Examine & interpret the simulated and experimental data.
CO4	Set up the students to familiarize with various medical equipments and their technical aspects
CO5	Appraise independent thinking & learning for decision making in complex and unpredictable

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			0	0											
CO2			1	0											
CO3			2	2											
CO4			3	2											
CO5			0	0											
Avg.			2	2											

SYLLABUS

Unit – I **[14Hrs]**

Introduction to Bioengineering, Biochemical Engineering, Biomedical Engineering, Sources of Biomedical Signals, Basic medical Instrumentation system, Performance requirements of medical Instrumentation system, use of microprocessors in medical instruments, PC based medical Instruments, general constraints in design of medical Instrumentation system & Regulation of Medical devices. Bioelectrical Signals & Electrodes: Origin of Bioelectric Signals, Electrocardiogram, Electroencephalogram, Electromyogram, Electrode-Tissue Interface, Polarization, Skin Contact Impedance, Motion Artifacts.

Unit - II **[12Hrs]**

Electrodes for ECG: Limb Electrode, Floating Electrodes, Propelled disposable Electrodes, Electrodes for EEG, Electrodes for EMG. Physiological Transducers: Introduction to Transducers, Classification of

Transducers, Performance characteristics of Transducers, Displacement, Position and flow and pressure Transducers. Strain gauge pressure transducers, Thermocouples, Electrical Resistance Thermometer, The mister, Photovoltaic transducers, Photo emissive Cells & Biosensors or Biochemical sensor

Unit – III **[08 Hrs]**

Recording Systems: Basic Recording systems, General considerations for Signal conditioners, Preamplifiers, Differential Amplifier, Isolation Amplifier, Electrostatic and Electromagnetic Coupling to AC Signals, Proper Grounding (Common Impedance Coupling)

Unit – IV **[05 Hrs]**

Transformation techniques in biomedical signals ie. Laplace transform, Z-transform, DFT, DTFT, STFT, Wavelet transform, Effects of noise in biomedical instruments- filtering in biomedical instruments.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Book:

1. Hand Book of Biomedical Instrumentation-2nd Ed by R.S.Khandpur, Tata McGraw Hill, 2003
2. Introduction to Biomedical Engineering by Michael M. Domach, Pearson Education Inc,-2004

Reference Book:

1. Introduction to Biomedical equipment technology, 4e. By JOSEPH.J.CAAR& JOHN M.BROWN (Pearson education publication)
2. Medical Instrumentation-application & design. 3e – By JOHN.G.WEBSTER John Wiley & sons publications

Subject Code	Name of the Subject	L	T	P	C	QP
BELPE7044	**Advanced Control Systems**	3			3	A

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Develop mathematical models and understand the mathematical relationships between the sensitivity functions and how they govern the fundamentals in control systems.
CO2	Design and fine tune PID controllers and understand the roles of P, I and D in feedback control
CO3	Design pole-assignment controller and the specific design procedures
CO4	Develop state-space models

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2													
CO2	3	1		2											
CO3	3	2													
CO4	3	2													
Avg.	3	1.75		2											

SYLLABUS

Unit - I **[12Hrs]**

State Variable Analysis & Design:

Introduction: Concepts of State, State Variables and State Model (of continuous time systems): State Model of Linear Systems, State Model for Single-Input-Single-Output Linear Systems, Linearization of the State Equation. State Models for Linear Continuous – Time Systems: State-Space Representation Using Physical Variables, State – space Representation Using Phase Variables, Phase variable formulations for transfer function with poles and zeros, State – space Representation using Canonical Variables, Derivation of Transfer Function for State Model. Diagonalization: Eigenvalues and Eigenvectors, Generalized Eigenvectors. Solution of State Equations: Properties of the State Transition Matrix, Computation of State Transition Matrix, Computation by Techniques Based on the Cayley-Hamilton Theorem, Sylvester's Expansion theorm. Concepts of Controllability and Observability: Controllability, Observability, Effect of Pole-zero Cancellation in Transfer Function. Pole Placement by State Feedback, Observer Systems.

Unit – II [14Hrs]

Introduction: Discrete Time Control Systems and Continuous Time Control Systems, Sampling Process. Digital Control Systems: Sample and Hold, Analog to digital conversion, Digital to analog conversion.
The Z-transform: Discrete-Time Signals, The Z-transform, Z-transform of Elementary functions, Important properties and Theorms of the Z-transform. The inverse Z-transform, Z-Transform method for solving Difference Equations.
Z-Plane Analysis of Discrete Time Control Systems: Impulse sampling & Data Hold, Reconstruction of Original signals from sampled signals: Sampling theorm, folding, aliasing. Pulse Transfer function: Starred Laplace Transform of the signal involving Both ordinary and starred Laplace Transforms; General procedures for obtaining pulse Transfer functions, Pulse Transfer function of open loop and closed loop systems. Mapping between the s-plane and the z-plane, Stability analysis of closed loop systems in the z-plane: Stability analysis by use of the Bilinear Transformation and Routh stability critgion, Jury stability Test.

Unit – III [10 Hrs.]

Nonlinear Systems :

Introduction :Behaviour of Non linear Systems, Investigation of nonlinear systems.
Common Physical Non Linearities: Saturation, Friction, Backlash, Relay, MultivariableNonlinearity.
The Phase Plane Method: Basic Concepts, Singular Points: Nodal Point, Saddle Point, Focus Point, Centre or Vortex Point, Stability of Non Linear Systems: Limit Cycles, Construction of Phase Trajectories: Construction by Analytical Method, Construction by Graphical Methods.

Unit – IV [8 Hrs.]

The Describing Function Method: Basic Concepts: Derivation of Describing Functions: Dead-zone and Saturation, Relay with Dead-zone and Hysteresis, Backlash. Stability Analysis by Describing Function Method: Relay with Dead Zone, Relay with Hysteresis, Stability Analysis by Gain-phase Plots. Jump Resonance. Liapunov's Stability Analysis: Introduction, Liapunov's Stability Critrion: Basic Stability Theores, Liapunov Functions, Instability. Direct Method of Liapunov& the Linear System: Methods of constructing Liapunov functions for Non linear Systems.

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Books:

1. *Discrete-Time Control System, by K.Ogata, 2nd edition (2009), PHI.*
2. *Control Systems Engineering, by I.J. Nagrath and M.Gopal., 5th Edition (2007 / 2009), New Age International (P) Ltd. Publishers.*

Reference Books:

1. *Design of Feedback Control Systems-Stefani,Shahian, Savant,Hostetter, 4th Ed, OxfordPress.*
2. *Modern Control Systems by K.Ogata, 5th Edition (2010), PHI.*
3. *Modern Control Systems by Richard C. Dorf. And Robert, H.Bishop, 11th Edition (2008), Pearson Education Inc. Publication.*
4. *Control Systems (Principles & Design) by M.Gopal, 3rd Edition (2008), Tata Mc.Graw Hill Publishing Company Ltd.*
5. *Control Systems Engineering by Norman S.Nise, 4th Edition (2008), Wiley India (P) Ltd.*

Subject Code	Name of the Subject	L	T	P	C	QP
BELOE7051	**Introduction to Robotics**	3			3	A

Course Educational Objectives

CEO1	The participants will learn the basic concepts of information theory and coding, including information, source coding, channel model, channel capacity, channel coding and so on.
CEO2	The main purpose of this course is to help students to complete the understanding of the wireless communication system with other advanced courses in wireless communication.

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Familiar with the history, concept development and key components of robotics technologies.
CO2	Familiar with various robot sensors and their perception principles that enable a robot toanalyse their environment, reason and take appropriate actions toward the given goal.
CO3	Understand and able to analyse and solve problems in spatial coordinate representation and spatial transformation, robot locomotion design, kinematics, motion control, localization and mapping, navigation and path planning.
CO4	Apply and demonstrate the learned knowledge and skills in practical robotics laboratories and experiments.
CO5	Design and implement a robotic project on a physical mobile robot platform, with tasks involving project specification, algorithm design, software programming, simulation and modelling, control and obstacle avoidance in a complex and interactive environment.
CO6	Enhancing communication skills through project report and seminar presentation.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			2		2										
CO2			3		2										
CO3			2		2										
CO4			2		2										
CO5			2		2										

Avg.			2.2		2										

SYLLABUS

Unit – I **[14Hrs]**

Elements of robots -- joints, links, actuators, and sensors

Position and orientation of a rigid body, Homogeneous transformations, Representation of joints, link representation using D-H parameters, Examples of D-H parameters and link transforms, different kinds of actuators – stepper, DC servo and brushless motors, model of a DC servo motor, Types of transmissions, Purpose of sensors, internal and external sensors, common sensors – encoders, tachometers, strain gauge based force-torque sensors, proximity and distance measuring sensors, and vision.

Unit - II **[12Hrs]**

Kinematics of serial robots

Introduction, Direct and inverse kinematics problems, Examples of kinematics of common serial manipulators, workspace of a serial robot, Inverse kinematics of constrained and redundant robots, Tractrix based approach for fixed and free robots and multi-body systems, simulations and experiments, Solution procedures using theory of elimination, Inverse kinematics solution for the general 6R serial manipulator.

Unit – III **[14 Hrs.]**

Velocity and statics of robot manipulators

Linear and angular velocity of links, Velocity propagation, Manipulator Jacobians for serial and parallel manipulators, Velocity ellipse and ellipsoids, Singularity analysis for serial and parallel manipulators, Loss and gain of degree of freedom, Statics of serial and parallel manipulators, Statics and force transformation matrix of a Gough-Stewart platform, Singularity analysis and statics.

Unit – IV **[8 Hrs.]**

Motion planning and control

Joint and Cartesian space trajectory planning and generation, Classical control concepts using the example of control of a single link, Independent joint PID control, Control of a multi-link manipulator, Non-linear model based control schemes, Simulation and experimental case studies on serial and parallel manipulators, Control of constrained manipulators, Cartesian control, Force control and hybrid position/force control, Advanced topics in non-linear control of manipulators

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Books:

1*Robotics: Fundamental Concepts and Analysis*, Oxford University Press, Second reprint, May 2008.

2) Research work of my students and recent papers as mentioned in modules.

3) Material from other textbooks and robotics journals as mentioned.

4) All modules have **Additional Material** for self-study and reference

Reference Books:

1. Microcontrollers: Principles and Application, Ajit Pal, PHI Publication

2. Microprocessors and Microcontrollers Architecture, programming and system design using 8085, 8086, 8051 and 8096, Krishna Kant, PHI Publication, 2007.
3. Advanced Microprocessors and Peripherals, A.K. Ray, K M Bhurchandi, TMH
4. Textbook of Microprocessor and Microcontroller, Thyagarajan, Scitech Publication
5. The 8088 and 8086 Microprocessors Programming, Interfacing, Software, Hardware and Application; by Walter A. Triebel&AvtarSingh ; Pearson India

Subject Code	Name of the Subject	L	T	P	C	QP
BELOE7052	**Internet of Things**	3			3	A

Course Educational Objectives

CEO1	To know the applications of IOT devices
CEO2	To examine IOT devices in various platforms

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Understand the basics of Embedded systems & 8051 Programming.
CO2	Understand the basic principles of IoT.
CO3	Differentiate the features of various IoT platforms.
CO4	Design simple IoT applications using Ardunio.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			1		2										2
CO2			2		2										2
CO3			2		2										2
CO4			2		2										2
Avg.			1.75		2										2

SYLLABUS

Unit – I **[14Hrs]**

INTRODUCTION TO EMBEDDED SYSTEMS:

Embedded systems, embedded processors, embedded hard ware units, embedded software, Examples of embedded systems, embedded Systems on chip, complex systems design and processors, design process in embedded systems.

8051 PROGRAMMING:

Addressing Modes, External data moves, code memory read only data moves, PUSH and POP op codes, data exchanges, byte level and bit levellogical operations rotate and swap operations,

jump and call program range, jumps, calls & subroutines Interrupts & returns.

Unit - II **[12Hrs]**

IoT: OVERVIEW

Internet of Things (IoT): vision, definition, conceptual framework, architectural view, technology behind IoT, Sources of the IoT, M2M Communication, Examples of IoT.

DESIGN PRINCIPLES FOR CONNECTED DEVICES:

IoT/M2M systems layers and design standardization, communication technologies, data enrichment and consolidation, ease of designing and affordability.

Unit – III **[14 Hrs.]**

HARDWARE FOR IOT:

Sensors, digital sensors, actuators, radio frequency identification (RFID) technology, wireless sensor networks, participatory sensing technology.

EMBEDDED PLATFORMS FOR IOT:

Embedded computing basics**,** Overview of IOT supported Hardware platforms such as Arduino, NetArduino, Raspberry pi, Beagle Bone, Intel Galileo boards and ARM cortex.

Unit – IV **[8 Hrs.]**

PROGRAMMING THE ARDUNIO:

Ardunio platform boards anatomy, ardunio IDE, coding, using emulator, using libraries, additions in ardunio, programming the ardunio for IoT.

IoT APPLICATIONS:

Smart metering, e-health, city automation, automotive applications, home automation, smart cards, Communicating data with H/W units, mobiles, tablets, Designing of smart street lights in smart city.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text books:

1. *Raj kamal, Embedded Systems Architecture, Programming and Design. 2 ed, McGraw-Hill,2008*
2. *Kenneth J. Ayala, "8051 MICRO CONTROLLER ARCHITECTURE" Thomson Delmar Learning, 3RD Edition, 2005*
3. *Raj Kamal "INTERNET OF THINGS", McGraw-Hill, 1ST Edition, 2016*

Reference books:

1. *ArshdeepBahga, Vijay Madisetti" Internet of Things(A hands on approach)" 1ST edition, VPI publications,2014*

Subject Code	Name of the Subject	L	T	P	C	QP
BELOE7053	**Principles of Entrepreneurship**	3			3	A

Course Educational Objectives

CEO1	Explore the entrepreneurial mindset and culture that has been developing in companies of all sizes in virtually every industry
CEO2	Examine the entrepreneurial process involved in both pursuing an entrepreneurial venture within a large company and the creating and managing a new enterprise for implementation of an entrepreneurial venture.
CEO3	Discuss the dynamics of participating on a business team and the power inherent in a team relative to individual effort
CEO4	Provide the background and tools necessary to understand and participate in the entrepreneurial process within a large company, in a new venture or as an investor
Course Outcomes: ***Upon successful completion of this course, students should be able to:***	
CO1	Understanding the dynamic role of entrepreneurship and small businesses
CO2	Examine and Organizing a Small Business
CO3	Predict the Financial Planning and Control
CO4	Understand the Forms of Ownership for Small Business
CO5	Create New Product or Service Development
CO6	Illustrate the Business Plan Creation

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1									1		2				
CO2									1		2				
CO3									2		2				
CO4									1		2				
CO5									2		2				
Avg.									1.4		2				

SYLLABUS

Unit- I **[10Hrs]**

Introduction to Entrepreneurship: Definition of Entrepreneur Entrepreneurial Traits. Entrepreneur vs. Manager, Creating and Starting the venture: Sources of new ideas, methods of generating ideas, creative problem solving – Writing Business Plan, Evaluating Business Plans. Launching formalities
Financing and Managing the new venture: Sources of capital, Record keeping, recruitment, motivating and leading teams, financial controls. Marketing and sales controls. E-commerce and entrepreneurship, Internet advertising- New venture Expansion Strategies and Issues.

Unit - II **[10Hrs]**

Institutional/financial support: Schemes and functions of Directorate of Industries, District Industries Centres (DICs), Industrial Development Corporation (IDC), State Financial Corporation (SFCs), Small Scale Industries Development Corporations (SSIDCs). Khadi and Village Industries Commission (KVIC), Technical Consultancy Organisation (TCO), Small Industries Service Institute (SISI), National Small Industries Corporation (NSIC), Small Industries Development Bank of India (SIDBI).

Unit – III **[08 Hrs]**

Production and Marketing Management: Thrust areas of production management, Selection of production Techniques, Plant utilization and maintenance, Designing the work place, Inventory control , material

handling and quality control. Marketing functions, market segmentation, market research and channels of distribution, Sales promotion and product pricing

Unit – IV **[06 Hrs]**

Labour legislation, Salient Provisions of Health, Safety, and Welfare under Indian Factories Act, Industrial Disputes Act, Employees State Insurance Act, Workmen's Compensation Act and Payment of Bonus Act.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Book:

1. *Robert Hisrich, & Michael Peters: Entrepreneurship, TMH, 2009.Dollinger: Entrepreneurship, Pearson, 2009.*

Reference Book:

1. *Agarwal: Indian Economy, WishwaPrakashan 2009.*
2. *Dutt&Sundaram: Indian Economy,S.Chand, 2009*
3. *B D Singh.:Industrial Relations &Labour Laws, Excel, 2009.*
4. *ArunaKaulgud: Entrepreneurship Management by, Vikas publishing house, 2009.*
5. *Essential of entrepreneurship and small business management by Thomas W.Zimmerer& Norman M.Searborough, PHI-2009.*
6. *ND Kapoor: Industrial Law, Sultan Chand & Sons, 2009*

PRACTICAL / SESSIONAL

Subject Code	Subject Code	L	T	P	C	QP
BELPC7110	Renewable Energy Lab	**0**	**0**	**2**	**1**	

Course Educational Objectives

CEO1	To analyse the basic components of Solar PV systems operation
CEO2	To Understand the characteristics of Solar PV modules

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Know the principles that underlie the ability of various natural phenomena to deliver solar energy
CO2	Outline the technologies that are used to harness the power of solar energy
CO3	Discuss the positive and negative aspects of solar energy in relation to natural and human aspects of the environment.
CO4	Examine the Solar PV system output with various options

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1				1	3									2	
CO2				1	3									2	
CO3				2	3									3	
CO4				2	2									2	
Avg				1.6	2.8									2.2	

LIST OF EXPERIMENTS
1. I-V and P-V characters tics of PV module with varying temperature and radiation level 2. PV panel testing setup 3. Performance characteristics of mono-crystalline and poly-crystalline PV panels 4. Fill factor calculations of mono-crystalline and poly-crystalline PV panels 5. Series and Parallel combination of PV modules 6. Tilt angle calculations of PV modules 7. I-V and P-V characters tics of PV panel at various tilt angles 8. Testing and characters tics of solar batteries charging and discharging 9. Demonstration and effect of shading on PV modules **10.** Testing of Solar inverter and load characteristics

Subject Code	Subject Code	L	T	P	C	QP
BELPC7140	**Advanced Lab 1: IOT LAB**	**0**	**0**	**2**	**1**	

Course Educational Objectives	
CEO1	Extend existing testbeds through crowdsourcing, enabling richer and more distributed experiments
CEO2	Bring the researcher and the end-user together, with closer interactions between the experiments and the society

Course Outcomes: ***Upon successful completion of this course, students should be able to:***	
CO1	Understand the basic principles of IoT.
CO2	Differentiate the features of various IoT platforms
CO3	Design simple IoT applications using Ardunio
CO4	Design simple IoT applications using Raspberry pi

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1				1	1										1
CO2				2	2										2
CO3				2	1										1
CO4				1	2										2
Avg				1.66	1.83										1.66

LIST OF EXPERIMENTS
1. Interfacing DHT11 Humidity Sensor with Arduino Uno Board. 2. Intruder Detection using PIR Motion sensor and Arduino Uno Board.

3. Distance Measurement using Ultra Sonic Sensor (HC-SR04) and Arduino Uno Board.
4. ESP8266 WI-FI Module Interface with Arduino and DHT11 data upload to the cloud server.
5. Voice – Activated Arduino Bluetooth Android.3
6. Configuring Raspberry pi and sensor interfacing
7. Installation of NodeJS on Rasp
8. Raspberry Pi and simple Hello World Program
9. Complete study on ARM Cortex processor
10. Installation and testing of Intel Galileo and interfacing

Text books:

1. Kenneth J. Ayala, "8051 MICRO CONTROLLER ARCHITECTURE" Thomson Delmar Learning, 3rd Edition, 2005
2. Raj Kamal "INTERNET OF THINGS", McGraw-Hill, 1ST Edition, 2016

UG in Electrical Engineering

VIII SEMESTER [FOURTH YEAR] [156-177]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	C	QP
THEORY								
1	PE	**Professional Elective (Any One)**		3	0	0	3	A
		BELPE8011	Smart Grid Technology					
		BELPE8012	Digital Image Processing					
		BELPE8013	Computer Networks					
		BELPE8014	Power system Dynamics and Control					
2	PE	BELPE8021	High Voltage Engineering	3	0	0	3	A
		BELPE8022	Industrial Electrical Systems					
		BELPE8023	Illumination Engineering					
		BELPE8024	Energy Management & Auditing					
3	OE	B**OE80**	Open Elective – IV (Any one)	3	0	0	3	A
PRACTICAL / SESSIONAL								
4	EC	BELEC8150	Major Project / Industrial Project / Startup Training cum	0	0	10	5	

			Project					
5	EC	BELEC8180	Seminar and Technical Writing	0	0	2	1	
6	EC	BELEC8190	Comprehensive Viva-Voce	0	0	2	1	
TOTAL				**9**	**0**	**14**	**16**	

Subject Code	Subject Code	L	T	P	C	QP
BELPE8011	Smart Grid Technology	3	0	0	3	A

Course Educational Objectives

CEO1	Able to understand the complete structure and design of smart grid
CEO2	Able to identify the different sensing devices used in the smart grid
CEO3	Able to identify the various smart appliances and measuring devices used in smart grid
CEO4	To gain knowledge on the various distributed energy resources

Course Outcomes: : *Upon successful completion of this course, students should be able to:*

CO1	Know what a function of smart grid is, what is the futuristic grid
CO2	Issues while implementing the smart grid approach.
CO3	Concept of Microgrid and distributed generation.
CO4	Able to identify the different sensing devices, control and automation
CO5	Able to gain knowledge on the microgrid
CO6	Able to analyze the different types of distributed generation

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		1	1												3
CO2		1	1												2
CO3		2	3												2
CO4		2	1												2
CO5		3	3												2

CO6		3	2												2
Avg.		2	1.83												2.83

SYLLABUS

Unit-I: **[14 Hrs.]**

Introduction to Smart Grid: Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient & Self-Healing Grid, Present development & International policies in Smart Grid. Case study of Smart Grid ,CDM opportunities in Smart Grid.

Unit-II: [12 Hrs.]

Sensing, Measurement, Control and Automation Technologies: Smart metering and demand-side integration, Introduction, Smart metering, Evolution of electricity metering, Key components of smart metering, Smart meters: An overview of the hardware used Signal acquisition, Signal conditioning, Analogue to digital conversion, Computation, Input/output, Communication, Communications infrastructure and protocols for smart metering, Home-area network, Neighborhood area network, Data concentrator, Meter data management system, Protocols for communications, Demand-side integration, Services provided by DSI, Implementations of DSI, Hardware support to DSI implementations, Flexibility delivered by prosumers from the demand side, System support from DSI

Unit-III: **[12 Hrs.]**

Smart Appliances, Automatic Meter Reading (AMR), OutageManagementSystem(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Grid to Vehicle, Coordination of PHEV charging and discharging cycle, Smart Sensors, Home & Building Automation, Phase Shifting Transformers. Smart Substations: Substation Automation equipment, Current transformers. Voltage transformers, Intelligent electronic devices, Bay controller, Remote terminal units, Faults in the distribution system, Components for fault isolation and restoration, Fault location, isolation and restoration, Voltage regulation

Unit-IV: **[12 Hrs.]**

Micro Grids And Distributed Energy Resources: Concept of micro grid, need & applications of micro grid, formation of micro grid, issues of interconnection, protection & control of micro grid. Islanding, need and benefits, different methods of islanding detection.

Distributed Energy Resources: Small scale distributed generation, Distributed Generation Technology, Internal Combustion Engines, Gas Turbines, Combined Cycle Gas Turbines, Micro turbines, Fuel Cells, Solar Photovoltaic, Solar thermal, Wind power, Geothermal, - all sources as a DG. Advantages and disadvantages of DG.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Books:

1. Ali K., M.N. Marwali, Min Dai, “Integration of Green and Renewable Energy in Electric Power Systems”, Wiley.
2. Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand Response”, CRC Press.
3. JanakaEkanayake, N. Jenkins, K. Liyanage, J. Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, Wiley.
4. Jean Claude Sabonnadiere, NouredineHadjsaid, “Smart Grids”, Wiley Blackwell.
5. Tony Flick and Justin Morehouse, “Securing the Smart Grid”, Elsevier In

Reference Book:

1. Peter S. Fox-Penner, "Smart Power: Climate Change, the Smart Grid, and the Future of Electric Utilities", Island Press.
2. SMART GRID Fundamentals of Design and Analysis, James Momoh, IEEE press, A John Wiley & Sons, Inc., Publication.
3. BhaveshBhalja, R. P. Maheshwari and N. G. Chothani, "Protection and Switchgear, Oxford University Press, New Delhi, India, 2nd Edition, 2015.
4. Smart Grid: Technology and ApplicationsbyJanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama wiley India

Subject Code	Subject Code	L	T	P	C	QP
BELPE8012	Digital Image Processing	3	0	0	3	A

Course Educational Objectives	
CEO1	To study the image fundamentals and mathematical transforms necessary for image processing
CEO2	To study the image enhancement techniques
CEO3	To study image restoration procedures.
CEO4	To study the image compression procedures
Course Outcomes: : *Upon successful completion of this course, students should be able to:*	
CO1	In this module we look at images and videos as 2-dimensional (2D) and 3-dimensional (3D) signals, and discuss their analog/digital dichotomy
CO2	We will also see how the characteristics of an image changes depending on its placement over the electromagnetic spectrum, and how this knowledge can be leveraged in several applications.
CO3	In this module we cover the important topic of image and video enhancement, i.e., the problem of improving the appearance or usefulness of an image or video
CO4	In this module we introduce the problem of image and video compression with a focus on lossless compression
CO5	we discus video compression with an emphasis on motion-compensated hybrid video encoding and video compression standards including H.261, H.263, H.264, H.265, MPEG-1, MPEG-2, and MPEG-4.
CO6	

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		2		2											
CO2		2		2											

CO3		2		3											
CO4		1		2											
CO5		2		2											
CO6		2		2											
Avg.		1.8		2.2											

SYLLABUS

Unit-I: **[14 Hrs.]**

INTRODUCTION:Digital images definition & formation, - Human visual system,Low-level image representation - the Pixel: Pixel-based model: Luminance and color, Practical study 1: VisualisationEqualisation Practical study 2: Image search

Unit-II: **[12 Hrs.]**

Space-frequency representation of images: Image filtering, 2D convolution and correlation. Practical study: RestorationFourier analysis DCT, DFT. Practical study 2: Resolution Multiresolution: Pyramid & Wavelet. Practical study: Noise reduction

IMAGE RESTORATION AND RECONSTRUCTION: Image restoration/degradation model, noise models, restoration in the presence of noise only, estimating the degradation function

Unit-III: **[12 Hrs.]**

. Shape and image - geometric structures: Geometrical transforms, Practical study 1: Image registration Hough transform, Practical study 2: Road detection in remote sensing, Soccer field analysis ,Mathematical morphology, Practical study 3: Biomedical and industrial applications

Unit-IV: **[12 Hrs.]**

Region-based processing:Contour-texture image model, SegmentationPractical study: Biomedical applications, Photography, Unsupervised segmentation, object interaction,Video processing: Pixel-based model. Practical study 1: Surveillance system. Space-frequency model. Practical study 2: Mosaic creation. Geometrical model. Practical study 3: Video restorationRegion-based model. Practical study 4: Shot detección, object tracking

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Books:

1. González, R.C.; Woods, R.E. Digital image processing. 3rd ed. Harlow: Pearson Prentice Hall, 2008. ISBN 9780131687288.
2. Pratt, W.K. Digital image processing: PIKS scientific inside. 4th ed. New York: John Wiley, 2007. ISBN 9780471767770.

Reference Book:

1. S.Sridhar, Digital Image Processing, Oxford University Press, 2011

Subject Code	Subject Code	L	T	P	C	QP

BELPE8013	**COMPUTER NETWORKS**	3			3	A

Course Educational Objectives

CEO1	To discuss the digital data communication techniques
CEO2	Gain knowledge on basic concepts of data communication layers, protocols and performance
CEO3	Understand a few representative protocols and network components
CEO4	To introduce the functions of different layers from deployed examples
CEO5	To introduce standards employed in computer networking
CEO6	To introduce the fundamentals of security in data communication

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	At the end of the course the students will be able to:
CO2	Describe the hardware and software commonly used in data communications
CO3	Analyze the services and features of various layers of data networks
CO4	Design, implement and analyze simple networks that need data communication.
CO5	Analyze the features and operations of application protocols like TCP/UDP, FTP, HTTP etc.
CO6	Have read a couple of published papers and appreciate the contemporary issues and solution in area of data communication

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1				2	1										
CO2				2	2										
CO3				2	3										
CO4					3										
CO5				2	3										
CO6					3										
Avg.				2	2.3										

SYLLABUS

UNIT:1 **(12 Hours)**

Overview of Data Communications and Networking.

Networks models – TCP/IP Protocol Suite , OSI model – Layers in OSI Digital Transmission: Line coding, Block coding, Sampling, Transmission mode. Analog Transmission: Modulation of Digital and Analog Data; Transmission Media: Guided Media, Unguided media (wireless) Circuit switching: Circuit switching (Data gram Networks and Virtual circuit networks)

UNIT:2 **(12 Hours)**

Data Link Layer

Error Detection and correction: Types of Errors, Detection, Error Correction Data Link Control and Protocols: Flow and Error Control, Stop-and-wait ARQ. Go-Back-N ARQ, Selective Repeat ARQ, HDLC. Point-to –Point Access: PPP Point –to- Point Protocol, PPP Stack, Multiple Access Random Access, Controlled Access, Channelization.

UNIT:3 **(10 Hours)**

Local area Network: Ethernet. Traditional Ethernet, Fast Ethernet, Gigabit Ethernet. Token bus, token ring Wireless LANs: IEEE 802.11, Bluetooth virtual circuits: Frame Relay and ATM.

Network Layer:

Host to Host Delivery: Internetworking, addressing and Routing Network Layer Protocols: ARP, IPV4, ICMP, IPV6 ad ICMPV6

UNIT:4 **(10 Hours)**

Transport Layer: Process to Process Delivery: UDP; TCP congestion control and Quality of service. Application Layer:Client Server Model, Socket Interface, Domain Name System (DNS): Electronic Mail (SMTP) and file transfer (FTP) HTTP and WWW.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

TEXT BOOKS:

1. Data Communications and Networking - Behrouz A. Forouzan, Fifth Edition TMH, 2013.
2. Computer Networks - Andrew S Tanenbaum, 4th Edition, Pearson Education.

Reference Books:

1 Computer Networks:A system Approach:Larry L, Peterson and Bruce S. Davie,Elsevier, 4th Ed

2 Computer Networks: Natalia Olifer, Victor Olifer, Willey India

3 Data and Computer Communications: William Stallings, Prentice Hall, Imprint of Pearson, 9th Ed.

4 Data communication & Computer Networks: Gupta, Prentice Hall of India Network for Computer Scientists & Engineers: Zheng, Oxford University Press

Subject Code	Subject Code	L	T	P	C	QP
BELPE8014	Power system Dynamics and Control	3	0	0	3	A

Course Educational Objectives

CEO1	Derive multi-machine power system dynamic models
CEO2	Derive single machine two-axis and flux-decay dynamic models and study their underlying hypotheses
CEO3	Analyze methods of small-signal stability analysis of multi-machine power systems
CEO4	Design power system stabilizers to dampen inter-area modes of oscillation

Course Outcomes: : *Upon successful completion of this course, students should be able to:*

CO1	Understand the problem of power system stability and its impact on the system.
CO2	Analyse linear dynamical systems and use of numerical integration methods
CO3	Model different power system components for the study of stability.
CO4	Understand the methods to improve stability

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2		1											2	

CO2	2		3											3	
CO3	2		2											2	
CO4	2		2											2	
Avg.	2		2											2.2	

SYLLABUS

Unit-I: **[10 Hrs.]**

Introduction to Power System Operations (3 hours) 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 (5 hours) Analysis of dynamical System, Concept of Equilibrium, Small and Large Disturbance Stability. Modal Analysis of Linear System. Analysisusing Numerical Integration Techniques. Issues in Modeling: Slow and Fast Transients, Stiff System

Unit-II: **[12 Hrs.]**

Modeling of Synchronous Machines and Associated Controllers (12 hours) 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. Speed Governors

Unit-III: **[12 Hrs.]**

Modeling of other Power System Components (10 hours) Modeling of Transmission Lines and Loads. Transmission Line Physical Characteristics. Transmission Line Modeling. Load Models - induction machine model. Frequency and Voltage Dependence of Loads. Other Subsystems – HVDC and FACTS controllers, Wind Energy Systems.

Unit-IV: **[12 Hrs.]**

Stability Analysis (11 hours) Angular stability analysis in Single Machine Infinite Bus System. Angular Stability in multimachine systems – Intra-plant, Local and Inter-area modes. Frequency Stability: Centre of Inertia Motion. Load Sharing: Governordroop. Single Machine Load Bus System: Voltage Stability. Introduction to Torsional Oscillations and the SSR phenomenon. Stability Analysis Tools:Transient Stability Programs, Small Signal Analysis Programs.

Enhancing System Stability (4 hours) Planning Measures. Stabilizing Controllers (Power System Stabilizers). Operational Measures-Preventive Control. Emergency Control.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Books:

1. K.R. Padiyar, “Power System Dynamics, Stability and Control”, B. S. Publications, 2002.
2. P. Kundur, “Power System Stability and Control”, McGraw Hill, 1995.
3. P. Sauer and M. A. Pai, “Power System Dynamics and Stability”, Prentice Hall, 1997

Subject Code	Subject Code	L	T	P	C	QP
BELPE8021	High Voltage Engineering	3	0	0	3	A

Course Educational Objectives

CEO1	Students should skillfully master the methods for analyzing various discharges, which include the gas, liquid and solid discharge
CEO2	Students are in touch with the experiment equipment, such as power source and voltage regulator
CEO3	Students should get the general idea about a certain number of terminologies, which will be used repeatedly in the successive learning and studying
CEO4	

Course Outcomes: : *Upon successful completion of this course, students should be able to:*

CO1	Understand the basic physics related to various breakdown processes in solid, liquid and gaseous insulating materials.
CO2	Knowledge of generation and measurement of D. C., A.C., & Impulse voltages.
CO3	Knowledge of tests on H. V. equipment and on insulating materials, as per the standards.
CO4	Knowledge of how over-voltages arise in a power system, and protection against these over-voltages

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2		3											2	
CO2	3		2											2	
CO3	2		2											2	
CO4	2		2											2	
CO5	2		3											3	
CO6	2		2											2	
Avg.	2.25		2.25											2.16	

SYLLABUS

Unit-I:

Breakdown in Gases (8 Hours) Ionization processes 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 (7 Hours) Breakdown in pure and commercial liquids, Solid dielectrics and composite dielectrics, intrinsic breakdown, electromechanical breakdown and thermal breakdown, Partial discharge, applications of insulating materials

Unit-II:

Generation of High Voltages (7 Hours) 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 (7 Hours) Peak voltage, impulse voltage and high direct

current measurement method, cathode ray oscillographs for impulse voltage and current measurement, measurement of dielectric constant and loss factor, partial discharge measurements.
Unit-III: Lightning and Switching Over-voltages (7 Hours) Charge formation in clouds, Stepped leader, Dart leader, Lightning Surges. Switching overvoltages, Protection against over-voltages, Surge diverters, Surge modify
Unit-IV: High Voltage Testing of Electrical Apparatus and High Voltage Laboratories (7 Hours) 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.
Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert
Text Books: 1. M. S. Naidu and V. Kamaraju, "High Voltage Engineering", McGraw Hill Education, 2013. 2. C. L. Wadhwa, "High Voltage Engineering", New Age International Publishers, 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 and Testing

Subject Code	Name of the Subject	L	T	P	C	QP
BELPE8022	Industrial Electrical systems	3	0	0	3	A
Course Educational Objectives						
CEO1	To impart knowledge on measuring of process variables, analytical instrumentation, automatic process controls.					
Course Outcomes: : *Upon successful completion of this course, students should be able to:*						
CO1	Able to understand about the equipments used to control the production process of a chemical factory and the mechanism of control through automation and computers.					
CO2	Able to understand the various measuring devices					
CO3	Able to understand and analyze the conductivities of various instruments					
CO4	To design the algorithms for controlling the process industries					
CO-PO & PSO Mapping						

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	1												
CO2	2	2	2												
CO3	2	2	2												
CO4	2	2	1												
Avg.	1.7	2	1.5												

SYLLABUS

UNIT-I **[15 Hours]**

Introduction – Variables, Units & standards of measurement, Measurement terms – characteristic. Data Analyse

Process Variables Measurement–Temperature systems– Thermocouples, Thermo resistive system, Filled-system thermometers, Radiation thermometry, Location of temperature measuring devices in equipments, Pressure system – Mechanical pressure elements Pressure Transducers and Transmitters, Vacuum measurement, Resonant wire pressure Transducer, Flow system – Differential producers, Variable area flow meters, Velocity, vortex, mass, ultrasonic & other flow meters, positive displacement flow meters, Open – channel flow measurements, Force systems, Strain gauges Humidity Moisture system, Humidity Measurement, Moisture measurement system, Rheological system, Viscosity measurement, Radiation system, Nuclear radiation instrumentation

UNIT-II **[10 Hours]**

Analytical instrumentation – Analysis instruments, Sample conditioning for process analyzers, X-ray Analytical methods, Quadrupole mass spectrometry, Ultra violet Absorption Analysis, Infra red process analyzers, Photometric reaction product analysers Oxygen analyzers, Oxidation – reduction potential measurements, pH measuring systems, Electrical conductivity and Resistivity measurements, Thermal conductivity, gas analysis, Combustible, Total hydro carbon, and CO analyzer, Chromatography.

UNIT-III **[12 Hours]**

Fundamentals of Automatic process control – Control algorithms-Automatic controllers – Electronic controllers -Electric controllers (Traditional) – Hydraulic controllers – Fluidics – Programmable controllers.

UNIT -IV **[8 Hours]**

Sensors, Transmitters and control valves – Pressure, Flow, Level, Temperature and Composition sensors, Transmitters, Pneumatic and electronic control valves, Types, Actuator, accessories, Instrumentation symbols and Labels.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Books:

1. Fribance, “Industrial Instrumentation Fundamentals” ,Mc Graw Hill Co. Inc. New York 1985
2. Eckman D.P. “Industrial Instrumentation”, Wiley Eastern Ltd., 1989.

3. Considine D M and Considine G D "Process Instruments Controls" Handbook 3rd Edition, McGraw – Hill Book Co., NY, 1990.
4. Scborg D E,.Edgar T.F and Mellichamp D.A, "Process Dynamics and Control" John Wiley 1989.

Reference Books:

1. Ernest Doebelin, Measurement systems, McGraw – Hill Book, Co., NY, 1975.
2. Astrom K.J., Bjonwittenmark, Computer controlled systems, Prentice- Hall of India, New Delhi 1994.
3. Cartis Johnson, Process Control Instrumentation Technology, Prentice-Hall of India, New Delhi 1993.

Subject Code	Subject	L	T	P	C	QP
BELPE8023	**Illumination engineering**	3	0	0	3	A

Course Educational Objectives

CEO1	To get the detailed information about modern lamps and their accessories.
CEO2	To get detailed insight of indoor and outdoor illumination system components, its controls and
CEO3	To know the requirements of energy efficient lighting.
CEO4	To introduce the modern trends in the lighting

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Able to analyze the performance characteristics of human visual system
CO2	Define and reproduce various terms in illumination.
CO3	Identify various parameters for illumination system design.
CO4	Design indoor and outdoor lighting systems.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			2	1										0	
CO2			2	1										0	
CO3			1	2										0	
CO4			2	2										2	
Avg.			1.75	1.5										2	

SYLLABUS

Unit – I

Importance of Lighting in Human Life: [12 hrs]

Optical systems of human eye ,Dependence of human activities on light, performance characteristics of human visual system, External factors of vision-visual acuity, contrast, sensitivity, time illuminance, colour, visual perception, optical radiation hazards, Good and bad effects of lighting & perfect level of illumination, Artificial lighting as substitute to natural light, Ability to control natural light, Production of light, physics of generation of light, Properties of light, Quantification & Measurement of Light.

Lamp materials: Filament, glass, ceramics, gases, phosphors and other metals and non-metals. Discharge Lamps: Theory of gas Discharge phenomena, lamp design considerations, characteristics of low and high mercury and Sodium vapour lamps, Low Vapour Pressure discharge lamps - Mercury Vapour lamp, Fluorescent Lamp, Compact Fluorescent Lamp (CFL) High Vapour Pressure discharge lamps - Mercury Vapour lamp, Sodium Vapour lamp, Metal halide Lamps, Solid Sodium Argon Neon lamps, SOX lamps, Electro luminescent lamps, Induction lamps.

Unit - II [6Hrs]

Electrical Control of Light Sources:

Ballast, igniters and dimmers for different types of lamps, Photometric Control of Light Sources and their Quantification: Types of Luminaries, factors to be considered for designing luminaries Types of lighting fixtures. Optical control schemes, design procedure of reflecting and refracting type of luminaries. Lighting Fixture types, use of reflectors and refractors, physical protection of lighting fixtures, types of lighting fixtures according to installation type, types of lighting fixtures according to photometric usages, luminaries standard (IEC-598-Part I).

Unit – III [10 Hrs]

Zonal cavity method for general lighting design, determination for zonal cavities and different shaped ceilings using COU (coefficient of utilization), beam angles and polar diagrams. Factors to be considered for design of indoor illumination scheme Indoor illumination design for following installations, Residential (Numerical), Educational institute, Commercial installation, Hospitals, Industrial lighting Special purpose lighting schemes, Decorative lighting, Theatre lighting, Aquarium, swimming pool lighting

Unit – IV [12 Hrs]

Factors to be considered for design of outdoor illumination scheme Outdoor Lighting Design: Road classifications according to BIS, pole arrangement, terminology, lamp and luminaire selection, different design procedures, beam lumen method, point by point method, isolux diagram, problems on point by point method.

Outdoor illumination design for following installations, Road lighting (Numerical), Flood lighting (Numerical), Stadium and sports complex, Lighting for advertisement/hoardings , Modern trends in illumination, LED luminary designs, Intelligent LED fixtures, Natural light conduiting, Organic lighting system, LASERS, characteristics, features and applications, non-lighting lamps, Optical fiber, its construction as a light guide, features and applications

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Book:

1. *H. S. Mamak, "Book on Lighting", Publisher International lighting Academy*
2. *Joseph B. Murdoch, "Illumination Engineering from Edison's Lamp to Lasers" Publisher -York, PA : Visions Communications*
3. *M. A. Cayless, A. M. Marsden, "Lamps and Lighting", Publisher-Butterworth-Heinemann(ISBN 978-0-415-50308-2)*
4. *Designing with light: Lighting Handbook., Anil Valia; Lighting System 2002*

Reference Book:

1. *"BIS, IEC Standards for Lamps, Lighting Fixtures and Lighting", ManakBhavan, New Delhi*
2. *D. C. Pritchard, "Lighting", 4th Edition, Longman Scientific and Technical, ISBN 0-582-23422- 0.*
3. *"IES Lighting Handbook", (Reference Volume 1984), Illuminating Engineering Society of North America.*
4. *"IES Lighting Handbook", (Application Volume 1987), Illuminating Engineering Society of North America*
5. *IESNA lighting Handbook., Illuminating Engineering Society of North America 9th edition 2000*
6. *Applied Illumination Engineering, Jack L. Lindsey FIES (Author), Scott C. Dunning PHD PE CEM (Author) ,ISBN-13: 978-0824748098 ISBN-10: 0824748093, 3 rd Edition.*
7. *IS 3646: Part I: 1992, Code of practice for interior illumination.*
8. *Organic Light Emitting Diodes (OLEDs): Materials, Devices and Applications, Alastair Buckley, University of Sheffieid, UK, ISBN: 978-0-85709-425-4.*

Subject Code	Name of the Subject	L	T	P	C	QP
BELPE8024	**Energy Management & Auditing**	3			3	A

Course Educational Objectives	
CEO1	To gather knowledge on energy auditing techniques used for non-conventional energy systems,
CEO2	To work on efficient energy systems used in various non-conventional energy generation Techniques
Course Outcomes: : *Upon successful completion of this course, students should be able to:*	
CO1	Understand the current energy scenario and importance of energy conservation.
CO2	Understand the concepts of energy management.

CO3	Analysethe methods of improving energy efficiency in different electrical systems.
CO4	Perform the energy auditing with different energy efficient devices.
CO5	Perform energy auditing tasks in different fields & development of energy efficient systems,
CO6	Design and develop consumer products for the betterment of human kind.

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			3	2											
CO2			2	2											
CO3			3	2											
CO4			2	2											
CO5			2	3											
CO6			2	2											
Avg.			2.33	2.16											

SYLLABUS

Unit 1: Energy Scenario (12 Hours)

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.

Basics of Energy and its various forms

Electricity tariff, load management and maximum demand control, power factor improvement, selection & location of capacitors, Thermal Basics-fuels, thermal energy contents of fuel, temperature & pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity & heat transfer, units and conversion.

Unit – 2: Energy Management & Audit (10 Hours)

Definition, energy audit, need, types of energy audit. Energy management (audit) approach understanding 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 – 3:Energy Efficiency in Electrical Systems (15 Hours)

Electrical system: 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 efficient motors.

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 savings 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.

Unit – 4: Energy Efficient Technologies in Electrical Systems (8Hours)

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.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Books:

1. *LC Witte, PS Schmidt and DR Brown: Industrial Energy Management and Utilization (Hemisphere Publishing Corporation, Washington, 1998).*
2. *W Trinks, MH Mawhinney, RA Shannon, RJ Reed, JR Garvey: Industrial Furnaces, Sixth Edition, (John Wiley & Sons, 2003)*
3. *JL Threlkeld: Thermal Environmental Engineering, Second Edition (Prentice Hall, 1970)*
4. *YP Abbi and Shashank Jain: Handbook on Energy Audit and Environment Management, (TERI Press, 2006)*
4. *WC Turner: Energy Management Handbook, Seventh Edition, (Fairmont Press Inc., 2007)*
5. *6. S. C. Tripathy, "Utilization of Electrical Energy and Conservation", McGraw Hill, 1991.*

Reference Books:

1. *Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects (available online)*
2. *Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-3, Electrical Utilities (available online)*

Subject Code	Subject	L	T	P	C	QP
BELOE8031	Electrical and Hybrid Vehicles	3	0	0	3	A

Course Educational Objectives

CEO1	To present a comprehensive overview of Electric and Hybrid Electric Vehicles
CEO2	To make understand the Technology and sizing of the components – electric machines, power electronics, and energy storage

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Choose a suitable drive scheme for developing an electric hybrid vehicle depending on resources.
CO2	Design and develop basic schemes of electric vehicles and hybrid electric vehicles
CO3	Choose proper energy storage systems for vehicle applications
CO4	Identify various communication protocols and technologies used in vehicle networks.
CO5	Understanding the Vehicle characteristics, driving cycles, and performance parameters of the vehicle

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2					1								2
CO2	3	2					1								2
CO3	3	2					1								3
CO4	1	3					2								3
CO5	3	2					1								2
Avg.	2	2					1								2

SYLLABUS

Unit: 1 **[10 Hours]**

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. Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance

Unit: 2 **[13 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

Unit: 3 **[10 Hours]**

Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives

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, Hybridization of different energy storage devices

Unit :4 **[8 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: In vehicle networks- CAN, Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Book:

1. *Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003*

Reference Book:

1. *James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.*
2. *MehrdadEhsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004*

Subject Code	Subject Code	L	T	P	C	QP
BELOE8032	**Mobile Computing**	3	0	0	3	A

Course Educational Objectives

CEO1	To understand CDMA, GSM, Mobile IP, and Mobile OS.
CEO2	To understand various Mark-up Languages
CEO3	Student will able to differentiate between various wireless communication technologies.
CEO4	Mobile communication features will be appreciated

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Gain knowledge of GSM architecture.
CO2	Able to understand mobility management.
CO3	Able to understand working of wireless architectures and their applications.
CO4	Students will be able to understand recent trends and emerging technologies.
CO5	Merits and demerits of various technologies will be understood by the student
CO6	Student will acquire the knowledge regarding mobile OS

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			3		3										
CO2			3		3										
CO3			3		1										
CO4			3		2										
CO5			3		1										
CO6			3		2										
Avg			3		2										

SYLLABUS

UNIT:1 **(12 Hours)**

Introduction to Personal Communications Services (PCS): PCS Architecture, mobility management, Networks signalling, Global System for Mobile Communication (GSM) and Short Service Messages (SMS): GSM Architecture, Entities, Call routing in GSM, PLMN Interface, GSM Addresses and Identities, Network Aspects in GSM, Mobility Management, and GSM Frequency allocation. Introduction to SMS, SMS Architecture, General Packet Radio Services (GPRS): GPRS Architecture, GPRS Network Nodes, Mobile Data Communication; WLANs

(Wireless LANs) IEEE 802.II standard, Mobile IP.

UNIT:2 **(14 Hours)**

Mobile Client: overview of Mobile handset, Mobile phones and their features, PDA, Design Constraints in applications for hand-held devices. Mobile IP: Introduction, discovery, Registration, Tunneling, Cellular IP, Mobile IP with IPv6Wireless Third Generation (3G) Mobile Services: Wideband Code Division Multiple Access (W-CDMA), and CDMA 2000 Global Mobile Satellite Systems; case studies of the IRIDIUM, ICO and GLOBALSTAR systems

UNIT:3 **(10 Hours)**

Wireless Enterprise Networks: Introduction to Virtual Networks, Blue tooth technology, Blue tooth Protocols. Server-side programming in Java, Pervasive web application architecture.

Mobile Operating Systems: WinCE, Palm OS, Symbian OS, Linux and Proprietary OS Client Development: The development process, Need analysis phase, Design phase, Implementation and Testing phase, Deployment phase, Development Tools, Device Emulators

UNIT:4 **(12 Hours)**

Mobile Device Operating System, Commercial mobile operating systems, Software development kit, iOS, Android, Windows phones, M-Commerce, Mobile transaction system, related security issues, 4G technology, fundamental concepts of mobile cloud computing and different application instances.

Application Protocol (WAP): The Mobile Internet standard, WAP Gateway and Protocols, Wireless Local Loop (WLL):Introduction to WLL Architecture, wireless mark-up Languages (WML): HDML, WML, HTML, cHTML, XHTML, Voice XML,Mobile Internet

Applications: Thin client: Architecture, the client, Middleware, messaging Servers, Processing a Wireless request, introduction to J2ME

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Books

1. P.K. Patra, S.K. Dash: Mobile Computing, SciTech Publications.
2. Rajkamal: Mobile Computing, Oxford University Press.

Ref. Books

1. Ashok Talukder, RoopaYavagal, Hasan Ahmed (2010), Mobile Computing, Technology, Applications and Service Creation, 2nd Edition, Tata McGraw Hill

Subject Code	Subject Code	L	T	P	C	QP

BELOE8033	**Big Data analytics**	3	0	0	3	A

Course Educational Objectives

CEO1	Provide an overview of Apache Hadoop
CEO2	Understand the Big Data Platform and its Use cases
CEO3	Provide HDFS Concepts and Interfacing with HDFS and understand Map Reduce Jobs
CEO4	Provide hands on Hodoop Eco System
CEO5	Apply analytics on Structured, Unstructured Data
CEO6	Exposure to Data Analytics with R.

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Identify Big Data and its Business Implications.
CO2	List the components of Hadoop and Hadoop Eco-System
CO3	Access and Process Data on Distributed File System
CO4	Manage Job Execution in Hadoop Environment
CO5	Develop Big Data Solutions using Hadoop Eco System
CO6	Analyze Info sphere Big Insights Big Data Recommendations

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1				3	2										3
CO2				3	2										3
CO3				1	3										2
CO4				2	1										3
CO5				2	3										2
CO6				1	2										3
Avg.				2	2.16										2.67

SYLLABUS

Unit– I **[11Hrs]**

INTRODUCTION TO BIG DATA AND HADOOP

Types of Digital Data, Introduction to Big Data, Big Data Analytics, History of Hadoop, Apache Hadoop, Analysing Data with Unix tools, Analysing Data with Hadoop, Hadoop Streaming, Hadoop Echo System, IBM Big Data Strategy, Introduction to InfosphereBigInsights and Big Sheets

Unit - II **[12Hrs]**

HDFS(Hadoop Distributed File System)

The Design of HDFS, HDFS Concepts, Command Line Interface, Hadoop file system interfaces, Data flow, Data Ingest with Flume and Scoop and Hadoop archives, Hadoop I/O: Compression, Serialization, Avro and File-Based Data structures

Map Reduce

Anatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features

Unit – III **[12 Hrs]** Hadoop Eco System Pig :Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators. Hive :Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, HiveQL, Tables, Querying Data and User Defined Functions. Hbase :HBasics, Concepts, Clients, Example, Hbase Versus RDBMS. Big SQL : Introduction
Unit – IV **[12 Hrs]** Data Analytics with R Machine Learning: Introduction, Supervised Learning, Unsupervised Learning, Collaborative Filtering. Big Data Analytics with BigR.
Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS
Text Books: 1. Tom White "Hadoop: The Definitive Guide" Third Edit on, O'reily Media, 2012. 2. Seema Acharya, SubhasiniChellappan, "Big Data Analytics" Wiley 2015
Reference Book: 1. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007. 2. Jay Liebowitz, "Big Data and Business Analytics" Auerbach Publications, CRC press (2013) 3. Tom Plunkett, Mark Hornick, "Using R to Unlock the Value of Big Data: Big Data Analytics with Oracle R Enterprise and Oracle R Connector for Hadoop", McGraw-Hill/Osborne Media (2013), Oracle press. 4. AnandRajaraman and Jefrey David Ulman, "Mining of Massive Datasets", Cambridge University Press, 2012. 5. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", John Wiley & sons, 2012. 6. Glen J. Myat, "Making Sense of Data", John Wiley & Sons, 2007 7. Pete Warden, "Big Data Glossary", O'Reily, 2011. 8. Michael Mineli, Michele Chambers, AmbigaDhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley Publications, 2013. 9. ArvindSathi, "BigDataAnalytics: Disruptive Technologies for Changing the Game", MC Press, 2012 ***10.*** Paul Zikopoulos ,DirkDeRoos , Krishnan Parasuraman , Thomas Deutsch , James Giles , David Corigan , "Harness the Power of Big Data The IBM Big Data Platform ", Tata McGraw Hill Publications, 2012.

Subject Code	Subject Code	L	T	P	C	QP
BELOE8034	Automobile Engineering	3	0	0	3	A
Course Educational Objectives						

CEO1	Emissions, ignition, controls, electrical systems and ventilation
CEO2	The anatomy of the automobile in general
CEO3	The location and importance of each parameter
CEO4	The functioning of the engine and its accessories, gear box, clutch, brakes, steering, axles and wheels
CEO5	Suspension, frame, springs and other connections

Course Outcomes: : *Upon successful completion of this course, students should be able to:*

CO1	Identify the different parts of the automobile
CO2	Explain the working of various parts like engine, transmission, clutch, brakes
CO3	Describe how the steering and the suspension systems operate.
CO4	Understand the environmental implications of automobile emissions
CO5	Develop a strong base for understanding future developments in the automobile industry

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2			2											
CO2	2			3											
CO3	2			3											
CO4	2			2											
CO5	3			2											
Avg.	2.16			2.2											

SYLLABUS

Unit-I: [12 Hrs.]

Types of automobiles, vehicle construction and layouts, chassis, frame and body, vehicle aerodynamics, IC engines- components, function and materials, variable valve timing (VVT). Engine auxiliary systems, electronic injection for SI and CI engines, unit injector system, rotary distributor type and common rail direct injection system, transistor based coil ignition & capacitive discharge ignition systems, turbo chargers (WGT, VGT), engine emission control by 3-way catalytic converter system, Emission norms (Euro & BS).

Unit-II: [8 Hrs.]

Transmission systems, clutch types & construction, gear boxes- manual and automatic gear shift mechanisms, Over drive, transfer box, flywheel, torque converter, propeller shaft, slip joints, universal joints, differential and rear axle, Hotchkiss drive and Torque tube drive.

Unit-III: [8Hrs.]

Steering geometry and types of steering gear box, power steering, types of front axle, types of suspension systems, pneumatic and hydraulic braking systems, antilock braking system (ABS), electronic brake force distribution (EBD) and traction control.

Unit-IV: [10 Hrs.]

Alternative energy sources, natural gas, LPG, biodiesel, bio-ethanol, gasohol and hydrogen fuels in automobiles, modifications needed, performance, combustion & emission characteristics of alternative fuels in SI and CI engines, Electric and Hybrid vehicles, application of Fuel Cells

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Books:

1. Kirpal Singh, Automobile Engineering, 7th ed., Standard Publishers, New Delhi, 1997.
2. Jain K.K. and Asthana R.B., Automobile Engineering, Tata McGraw Hill, New Delhi, 2002.
3. Heitner J., Automotive Mechanics, 2nd ed., East-West Press, 1999.
4. Heisler H., Advanced Engine Technology, SAE International Publ., USA, 1998