SCHEME & SYLLABUS

(Choice Based Credit System)

for

B. TECH.

in

ELECTRICAL ENGINEERING

(w.e.f. Session 2022-23)

Program Code: EE-301

DEPARTMENT OF ELECTRICAL ENGINEERING

SCHOOL OF ENGINEERING

RIMT UNIVERSITY, MANDI GOBINDGARH, PUNJAB

TABLE OF CONTENTS

SECTION 1

Vision & Mission of the University

VISION

To become one of the most preferred learning places a centre of excellence to promote and nurture future leaders who would facilitate in desired change in the society.

MISSION

- To impart teaching and learning through cutting edge technologies supported by the world class infrastructure
- To empower and transform young minds into capable leaders and responsible citizens of India instilled with high ethical and moral values

SECTION 2

Vision and Mission of the Department

VISION

The Department of Electrical Engineering will provide programs of the high quality to produce world class competent engineers who can address challenges and are successfully involved in innovative research. It commits itself to impart the skills, knowledge and attitudes to create, interpret, apply and disseminate engineering to build better future for humankind.

MISSION

- To create the environment that facilitates learning fundamentals of Electrical Engineering
- To impart the knowledge in Electrical Circuits, Power Systems electrical machines, power electronics non conventional energy
- Providing better understanding of the domain of study, including wider social issues, corporate social responsibility and ethical decision making.
- To ensure continuous interaction of the students through MOU's and collaborative research projects.

SECTION 3

About the Program

B. Tech. **(Electrical Engineering)** or Bachelor of Technology in Electrical Engineering is an Under-Graduate Electrical Engineering course. Electrical engineering is a field of engineering that generally deals with the study and application of electricity, electronics, and electromagnetism.

Our B. Tech. Program is an Outcome Based Education model which is a 4 year, 8 Semester Full time Program of 133* credit hours with a Choice Based Credit System (CBCS) and Grading Evaluation System. B.TECH EE course is structured semester wise and includes theory and Practical to impart the students a holistic understanding of B. Tech. EE subjects. After successfully completing the course, B. Tech. Electrical Engineering job scope includes Electrical engineer, Application Engineer and many more.

SECTION 4

Program Educational Objectives, Program Outcomes and Program Specific Outcomes

PROGRAMME EDUCATION OBJECTIVES

PEO1	To establish the careers of the students in the field of Electrical Engineering and related areas, providing innovative and effective solutions.
PEO2	To provide students with a solid foundation in mathematical, scientific and engineering fundamentals required to solve engineering problems and also to pursue higher studies.
PEO3	To train students with good scientific and engineering breadth so as to understand, analyze, design, and create novel products and solutions for the real-life problems
PEO4	To provide students with an academic environment aware of excellence, leadership, ethical code and guidelines, and the life-long learning needed for a successful professional career.

PROGRAMME OUTCOMES

PO 1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO 3	**Design/Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO 6	**The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7	**Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
PO 9	Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES

PSO 1	Apply principles of Engineering, Electronics and Computer Science; physics, chemistry, environmental science, mathematics (including differential equations, discrete mathematics, linear algebra and complex variables) and laboratory skills for building, testing, operation and maintenance of high currents electrical systems, such as, electrical machines, power and energy systems.
PSO 2	Model, analyse, design, and realize physical systems, components or processes related to high current electrical engineering systems.

SECTION 5

Curriculum / Scheme with Examination Scheme

Semester Wise Summary of the program: B.TECH.
(ELECTRICAL ENGINEERING)

S.No.	Semester	No. of Contact Hours	Marks	Credits
1.	I	28	900	22
2.	II	28	900	22
3.	III	25	900	24
4.	IV	27	900	24
5.	V	24	800	24
6.	VI	27	900	27
7.	VII	29	700	21
8.	VIII	00	500	10
	Total	188	6500	174

EXAMINATION GRADING SCHEME

Marks Percentage Range	Grade	Grade Point	Qualitative Meaning
80-100	O	10	Outstanding
70-79	A^+	9	Excellent
60-69	A	8	Very Good
55-59	B^+	7	Good
50-54	B	6	Above Average
45-49	C	5	Average
40-44	P	4	Fail
0-39	F	0	Fail
ABSENT	AB	0	Fail

Percentage Calculation: CGPA *10

FIRST SEMESTER

Course		Contact Hours/Week			Credit	Contact Hrs.	Evaluation Scheme (% of Total Marks)			Exam Duration (Hours)
Course Code	Course Title	L	T	P			Internal	External	Total	
BPHY 1122	Applied Physics	3	1	0	4	4	40	60	100	3 Hrs
BMAT-1111	Engineering Mathematics-I	3	1	0	4	4	40	60	100	3 Hrs
BENG-1101	Communicative English	3	0	0	3	3	40	60	100	3 Hrs
BELE-1101	Basics of Electrical & Electronics Engg.	3	0	0	3	3	40	60	100	3 Hrs
BEVS-1001	Environmental Science	2	0	0	2	2	40	60	100	3 Hrs
BPHY-1185	Applied Physics Lab	0	0	2	1	2	50	50	100	3 Hrs
BENG-1172	Communicative English Lab	0	0	2	1	2	50	50	100	3Hrs
BELE-1171	Basics of Electrical & Electronics Engg. Lab	0	0	2	1	2	50	50	100	3Hrs
BMEC-1171	Manufacturing Practice	0	0	6	3	6	50	50	100	3 Hrs
TOTAL		**14**	**2**	**12**	**22**	**28**			**900**	

SECOND SEMESTER

Subject		Contact Hours/Week			Credit	Contact Hrs.	Evaluation Scheme (% of Total Marks)			Exam Duration (Hours)
Code	Title	L	T	P			Internal	External	Total	
BELE-1001	Energy Management	2	0	0	2	2	40	60	100	3 Hrs
BCHM-1206	Applied Chemistry	3	1	0	4	4	40	60	100	3 Hrs
BMAT-1211	Engineering Mathematics-II	3	1	0	4	4	40	60	100	3 Hrs
BCSE-1201	Programming for Problem Solving	3	0	0	3	3	40	60	100	3 Hrs
BMEC-1201	Elements of Mechanical Engg.	3	0	0	3	3	40	60	100	3 Hrs
BMEC-1202	Engineering Drawing with CAD*	0	0	6	3	6	50	50	100	3 Hrs
BCHM-1273	Applied Chemistry Lab	0	0	2	1	2	50	50	100	3 Hrs
BCSE-1271	Programming for Problem Solving Lab	0	0	2	1	2	50	50	100	3 Hrs
BENG-1001	Soft Skills-I Lab	0	0	2	1	2	50	50	100	3 Hrs
Total		**14**	**2**	**12**	**22**	28			**900**	**27 Hrs**

THIRD SEMESTER

COURSE			Contact Hours/Week			Exam Duration (Hours)	Credit	Relative Weight					
S.No	**Code**	**Course Title**	**L**	**T**	**P**			**CWA**	**LWA**	**MTE**	**ETE**	**ETP**	**Total**
1	**BMAT -2311**	**Mathematics-III**	3	1	-	3	4	10	-	30	60	-	100
2	**BELE-2302**	**Electrical & Electronics Measurement & Instrumentation**	3	1	0	3	4	10	-	30	60	-	100
3	**BELE-2303**	**Network Analysis and Synthesis**	3	1		3	4	10	-	30	60	-	100
4	**BELE-2304**	**Electronic Devices & Circuits**	3	1	-	3	4	10	-	30	60	-	100
5	**BELE-2305**	**Python Programming**	3		-	3	4	10	-	30	60	-	100
6	**BELE-2371**	**Python Programming Lab**	0	0	2	-	1	-	50	-	-	50	100
7	**BELE -2372**	**Programming in MATLAB**	0	0	2	-	1	-	50	-	-	50	100
8	**BELE -2373**	**Electrical& Electronics Measurement & Instrumentation Lab**	0	0	2	-	1	-	50	-	-	50	100
9	**BELE-2374**	**Training #**	0	0	0	-	2	-	100	-	-	-	100
	Total		**15**	**4**	**6**		**24**		**-**	**-**	**-**	**-**	**900**

#Institutional training will be imparted in the institution at the end of 2nd semester for four- week duration (Minimum 36 hrs. per week) industrialTour will also from the part of this training

FOURTH SEMESTER

COURSE			Contact Hours/Week			Exam Duration (Hours)	Credit	Relative Weight					
S.No.	Code	Course Title	L	T	P			CWA	LWA	MTE	ETE	ETP	Total
1	BELE-2401	Electrical Machines I	3	1	0	3	4	10	-	30	60	-	100
2	BELE-2402	Digital Electronics	3	1	0	3	4	10	-	30	60	-	100
3	BELE-2403	Power System-I	3	1	0	3	4	10	-	30	60	-	100
4	BELE-2404	Linear Control System	3	-	-	3	4	10	-	30	60	-	100
5	BELE-2405	Power Plant Engineering	3	1	0	3	4	10	-	30	60	-	100
6	BELE - 2471	Electrical Machines I Lab	0	0	2	-	1	-	50	-	-	50	100
7	BELE - 2472	Digital Electronics Lab	0	0	2	-	1	-	50	-	-	50	100
8	BELE - 2473	Control System Lab	0	0	2	-	1	-	50	-	-	50	100
9	BTPD-3421	Soft Skills-I	-	-	2	-	1		50	-	-	50	100
	Total		15	4	8	-	24		-		-	-	900

FIFTH SEMESTER

COURSE			Contact Hours/Week			Exam Duration (Hours)		Credit	Relative Weight					
S.No.	Code	Course Title	L	T	P				CWA	LWA	MTE	ETE	ETP	Total
1	BELE -3501	Electrical Machines -II	3	1	-	3	4	4	10	-	30	60	-	100
2	BELE -3502	Power Electronics & Drives	3	1	-	3	4	4	10	-	30	60	-	100
3	BELE -3503	Generation and Economics of Electric Power	3	1	-	3	4	4	10	-	30	60	-	100
4	BELE -3504	Electromagnetic Field Theory	3	1	-	3	4	4	10	-	30	60	-	100
5	BELE -3505	Microprocessors and Interfacing	3	1	-	3	4	4	10	-	30	60	-	100
6	BELE -3571	Electrical Machines -II Lab	0	0	2	-	1	1	-	50	-	-	50	100
7	BELE -3572	Power Electronics Lab	0	0	2	-	1	1	-	50	-	-	50	100
8	BELE -3574	Training #	0	0	0	-	2	2	-	50	-	-	50	100
	Total		15	5	4			24	-	-	-	-	-	800

SIXTH SEMESTER

COURSE			Contact Hours/Week			Exam Duration (Hours)	Credit	Relative Weight					
S.No.	Code	Course Title	L	T	P			CWA	LWA	MTE	ETE	ETP	Total
1	BELE-3601	Power System-II (Switchgear and Protection)	4	0	0	3	4	10	-	30	60	-	100
2	BELE-3602	Electrical Power Utilization	4	0	0	3	4	10	-	30	60	-	100
3	BELE-3603	Microcontroller and PLC	3	1	0	3	4	10	-	30	60	-	100
4	BELE-3604	Electrical Machines -III	3	0	0	3	4	10	-	30	60	-	100
5	BELE-3671	Electrical Power System- Lab	0	0	2	-	1	-	50	-	-	50	100
6	BELE-3672	Microcontroller and PLC Lab	0	0	2	-	1	-	50	-	-	50	100
7	BELE-3674	Minor Project	-	-	3	-	1		50	-	-	50	100
8	Department Elective – I (Select any one BELE-36XX)												
	BELE-3611	Signals and Systems	3	0	0	3	3	10		30	60	-	100
	BELE-3612	Flexible AC Transmission System Devices											
	BELE-3613	Instrumentation in Power System											
9	BTPD-3622	Soft Skill-II	-	-	2	-	1	-	50	-	-	50	100
	Total		17	1	9		27						900

SEVENTH SEMESTER

	COURSE		Contact Hours/Week			Exam Duration (Hours)	Credit	Relative Weight					
S.NO.	**Code**	**Course Title**	**L**	**T**	**P**			**CWA**	**LWA**	**MTE**	**ETE**	**ETP**	**Total**
1	**BELE-4701**	**Power System Analysis and Design**	3	1	0	3	4	10	-	30	60	-	100
2	**BELE-4702**	**Non-linear and Digital Control System**	3	1	0	3	4	10	-	30	60	-	100
3	**BELE-4703**	**Non-conventional Energy Sources**	3	0	0	3	3	10	-	30	60	-	100
4	**BELE-4771**	**Power System Analysis and Design Lab**	0	0	2	-	1	-	50	-	-	50	100
5	**BELE-4772**	**Major Project**	0	0	6	-	3	-	50	-	-	50	100
6	**Department Elective – II (Select any one BELE-47XX)**												
	BELE - 4711	**Power System Operation and Control**	3	0	0	3	3	10	-	30	60		100
	BELE - 4712	**Power Quality Monitoring and Conditioning**											
	BELE - 4713	**High Voltage Engineering**											
7	**Open Elective**		3	0	0	-	3	16	10	-	30	60	100
	Total		**15**	**6**	**8**		**21**						**700**

EIGHTH SEMESTER

COURSE			Contact Hours/Week			Exam Duration (Hours)	Credit	Relative Weight					
S.NO.	**Code**	**Course Title**	**L**	**T**	**P**			**CWA**	**LWA**	**MTE**	**ETE**	**ETP**	**Total**
1	**BELE-4801**	**Industrial Training**	0	0	0	-	10	0	250	0	0	250	500
	Total		**0**	**0**	**0**		**10**						**500**

CWA: Class Work Assessment

LWA: Lab Work Assessment

MTE: Mid Term Examination

ETE: End Term Examination

EPE: End Practical Examination

SUBJECT TITLE: MATHEMATICS-III
SUBJECT CODE: BMAT-2311
SEMESTER: III
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	2	0	4

Internal Assessment: 40

End Term Exam: 60

Duration of Exam; 3 Hrs

Objective and outcome of course:

The course is designed in such a way to make student aware of mathematical subjects and their uses. After completion of the course they will get expertise in solving practical problems using mathematical aids.

Contents of Syllabus:

Sr. No	Contents	Contact Hours
UNIT-I	**Fourier Series** Periodic functions, Euler's formula. Even and odd functions, half range expansions, Fourier series of different wave forms.	**10**
UNIT-II	**Laplace Transforms** Laplace transforms of various standard functions, properties of Laplace transforms, inverse Laplace transforms, transform of derivatives and integrals, Laplace transform of unit step function, impulse function, periodic functions, applications to solution of ordinary linear differential equations with constant coefficients, and simultaneous differential equations.	**15**
UNIT-III	**Partial Differential Equations & Applications of PDEs** Formation of partial differential equations, Linear partial differential equations, homogeneous partial differential equations with constant coefficients. Wave equation and Heat conduction equation in one dimension. Two dimensional Laplace equation in Cartesian Coordinates, solution by the method of separation of variables.	**15**
UNIT-IV	**Functions of Complex Variable** Limits, continuity and derivative of the function of complex variable, Analytic function, Cauchy-Riemann equations, conjugate functions, harmonic functions; Conformal Mapping: Definition, standard transformations, translation, rotation, inversion, bilinear. Complex Integration: Line integrals in the complex plane, Cauchy's theorem, Cauchy's integral formula and derivatives of analytic function. Taylor's and Laurent's expansions (without proofs), singular points, poles, residue, Integration of function of complex variables using the method of residues.	**20**

Course Outcomes:

CO1	**BMAT-2311.1**	Students will be able to comprehensive understanding of Fourier series, Laplace transforms and various mathematical functions in engineering analysis
CO2	**BMAT-2311.2**	To make students able to select various Engineering models for optimization and implementation with aforesaid applications
CO3	**BMAT-2311.3**	To implement the various Mathematic equation for evaluating the results
CO4	**BMAT-2311.4**	To understand the function of Partial differential equation and complex variables

Recommended Books:

1. Kreyszing, E., Advanced Engineering Mathematics, Eighth edition, John Wiley, New Delhi.
2. Grewal, B. S., Higher Engineering Mathematics, Khanna Publishers, New Delhi.
3. Ian N. Sneedon, Elements of Partial Differential Equations, McGraw- Hill, Singapore, 1957.
4. Peter. V. O'Nil, Advanced Engineering Mathematics, Wadsworth Publishing Company.
5. Taneja, H. C., Engineering Mathematics, Volume-I & Volume-II, I. K. Publisher.
6. Babu Ram, Advance Engineering Mathematics, Pearson Education.
7. Bindra, J. S., Applied Mathematics, Volume-III, Kataria Publications.
8. Advanced Engineering Mathematics, O'Neil, Cengage Learning

SUBJECT TITLE: ELECTRICAL & ELECTRONICS MEASUREMENT & INSTRUMENTATION
SUBJECT CODE: BELE-2302
SEMESTER: 3rd
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Course Objectives

1. To aware the students about the basics of measurements and instrumentation systems.
2. To impart knowledge about different instruments for electrical measurements.
3. To provide them basic concepts of different types of sensors and transducers.

S.No.	Contents	Contact Hours
UNIT-I	**Measuring Instruments:** Introduction to measuring techniques, necessity of measurements, block diagram of measurement system, types of instruments, classification of standards, fundamental and derived units. Instrument characteristics; accuracy, precision, repeatability and sensitivity. Different types of errors in measurement. Principle of operation and constructional features; D'Arsonval galvanometer, Moving Coil PMMC and Moving Iron instrument (Repulsion and Attraction type), Electrodynamics instruments Digital Voltmeter and Multimeter	**17Hrs**
UNIT-II	**Measurement of Resistance**: Low, Medium and High resistance measurement using Kelvin Double Bridge, Ammeter-Voltmeter method, Wheat Stone Bridge, Loss of Charge and Megger. **Measurement of Inductance and Capacitance**: Maxwell Inductance, Hay's, Anderson and Schering Bridges, Measurement of frequency by Wein bridge method.	**11 Hrs**
UNIT-III	**Oscilloscope:** Basic principle and construction of Analog CRO, sweep modes, applications in measurement of voltage, frequency (Lissajous pattern), Introduction to Dual Trace Oscilloscope, Digital Storage Oscilloscope, sampling oscilloscope. Comparison between analog and	**12 Hrs**

	digital oscilloscope.	
UNIT-IV	**Transducers:** Transducer and its classifications, basic requirements of Transducer/Sensors. Displacement Transducers: LVDT, RVDT and Piezo Electric. Resistance Thermometer, Thermistors, Thermocouples and Strain Gauge Transducer: Basic principle of operation of Resistance strain gauge.	**10Hrs**

Course Outcomes

On successful completion of this course, the student will able to .

CO1	**BELE-2302.1**	Design, analyse various instruments.
CO2	**BELE-2302.2**	Classify various errors present in measuring instruments.
CO3	**BELE-2302.3**	Understand construction, working principle and types of oscilloscopes.
CO4	**BELE-2302.4**	Application of various transducers used in measurement system.

Recommended Books:

1. H. Cooper, 'Modern Electronic Instrumentation and Measurement Techniques',PHI,.
2. A.K. Sawhney, Electronic Instrumentation and Measurement', DhanpatRai& Sons.
3. Jones and Chin, 'Electronic Instruments and Measurement.
4. J. Toppin, 'Theory of Errors', Wessely Publishing,.

SUBJECT TITLE: NETWORK ANALYSIS AND SYNTHESIS
SUBJECT CODE: BELE-2303
SEMESTER: 3
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal Assessment: 40

End Term Exam: 60

Duration of Exam; 3 Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Course Objectives

1. To prepare students to perform the analysis of any electromechanical system.
2. To empower students to understand the working of electrical equipment used in everyday lifeparts

S.No.	Contents	Contact Hours
UNIT-I	**Circuits Concepts:** Independent and dependent sources, Standard test signals: Step, ramp, impulse, and doublet. Mesh and nodal analysis. Network Theorems: Superposition, Thevenin's, Norton's, Maximum Power Transfer, Millman's, Tellegen's and Reciprocity, Network Topology Introduction, Network Graph, Tree and Co-tree, Twigs and Links, Incidence Matrices and its properties, Link currents: Tie-Set Matrix, Cut-Set and Tree Branch Voltages, Solution of Problems	**15 Hrs**
UNIT-II	Introduction, graph of a network, trees, co-trees and loops, incidence matrix, Cut-set matrix, Tie-set matrix and loop currents, Analysis of networks using graph theory, duality, and general network transformations. **Time and Frequency Domain Analysis:** Representation of basic circuits in terms of generalized frequency and their response, Laplace transform, transient and steady response, transfer function, poles and zeros, pole zero diagram, time domain behaviors from poles and zeros, Convolution Theorem.	**6 Hrs**
UNIT-III	**Network Synthesis:** Network functions, Impedance and admittance function, Transfer functions. Network function for two port network, Sinusoidal network in terms of poles and zeros, Real liability condition for impedance synthesis of	**14 Hrs**

	RL, LC and RC circuits, network synthesis techniques for 2-terminal network, foster and cauer forms	
UNIT-IV	**Filters Synthesis:** Classification of filters, characteristics impedance and propagation constant of pure reactive network, Ladder network, T-section, π-section, terminating half section, pass bands and stop bands, Design of Constant-K, m-derived filters, Composite filters.	**10 Hrs**

Course Outcomes:

On successful completion of this course, the student will be able to

CO1	**BTEE-2303.1**	Apply network topology concepts in the formulation and simulation of electrical network problem.
CO2	**BTEE-2303.2**	Apply two-port network analysis in the design and analysis of filter and attenuator network.
CO3	**BTEE-2303.3**	Knowledge of mathematical forms such as Laplace transforms and designing of filters circuits.
CO4	**BTEE-2303.4**	Synthesis passive one-port networks using standard Foster and cauer forms.

Recommended Books:

1. Bird John, 'Electrical Circuit Theory and Technology', Newnes,.
2. AbhijitChakraborty, 'Circuit Theory', DhanpatRai,.
3. D. Roy Chaudhury, 'Networks and Synthesis', New Age International.
4. T.S.K. VIyer, 'Circuit Theory', Tata McGraw Hill,
5. Mohan, Sudhakar Sham, 'Circuits and Networks Analysis and Synthesis', TMH.
6. Van Valkenberg, 'Network Analysis and Synthesis', PHI Course.

SUBJECT TITLE: ELECTRONICS DEVICES AND CIRCUITS
SUBJECT CODE:BELE-2304
SEMESTER: 3
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Course Objectives

1. To aware the students about basic electronic components.
2. To update the knowledge about amplification circuits to amplify the signal.
3. Various types of circuits to generate signals.
4. How electronic components are specified and selected for industrial applications.

S.No.	Contents	Contact Hours
UNIT-I	**Introduction:** Introduction to semiconductors theory, P type and N-Type semiconductors, different types of diodes, Drift current, diffusion current. Rectifiers.Review of p-n junction diode and special purpose diodes - Zener diode, Tunnel diode, Varactor diode, Photo diode; Clippers-single and two level, clampers, their analysis with ideal and practical diodes	10Hrs
UNIT-II	**Bipolar Junction Transistor:** Working action of NPN and PNP. CE, CB and CC configurations, Current components, Concept of D.C. and A.C. load line and operating point, Q point selection, bias stability, various biasing circuits- fixed bias, collector to base bias, emitter bias, voltage divider, Stability factors.	14Hrs

UNIT-III	**Power Amplifiers**: Classifications according to mode of operation and driving output, Class A direct coupled with resistive load, operation of class- B power amplifier, Push-Pull Amplifiers, Concept of feedback in amplifiers: Positive and negative feedback, effect of negative feedback. **Oscillators:** Principle of operation of different oscillator circuits-RC Phase shift, Wien Bridge, Hartley Bridge, Colpits and Crystal oscillators Operational amplifiers and its characteristics and applications.	**16Hrs**
UNIT-IV	**Field Effect Transistors**: FET construction and working, P-channel and N-channel JFETs. Comparison with BJT, Characteristics of JFET, JFET parameters-AC drain resistance, trans-conductance, amplification factor, dc drain resistance. Construction, working and characteristics of MOSFET. Comparison of BJT, JFET and MOSFET.	**10 Hrs**

Course Outcomes :

On successful completion of this course, the student will be able

CO1	**BELE -2304.1**	Skills about the basic electronic circuits, their operational characteristics and their applications.
CO2	**BELE -2304.2**	Examine PN junction in semiconductors devices under various conditions.
CO3	**BELE -2304.3**	Describe the behavior of special purpose diodes..
C04	**BELE -2304.4**	Use the techniques, skills, and modern engineering tools necessary for engineering practice.

Recommended Books:

1. Boylstad and Nashelsky, 'Electronic Devices and Circuits', Prentice Hall**.**
2. Millman and Halkias, 'Integrated Electronics', McGraw Hill**.**
3. Malvino, 'Electronic Principles', McGraw Hill**.**
4. V.K. Mehta, 'Principles of Electronics', S. Chand**.**
5. Donald L. Shilling and Charles Below, 'Electronic Circuits', TMH**.**

SUBJECT TITLE: PYTHON PROGRAMMING
SUBJECT CODE: BELE-2305
SEMESTER:
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam:3 Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Course Objectives:

1. To understand why Python is a useful scripting language for developers.
2. To learn how to design and program Python applications.
3. To learn how to use lists, Tuples, and dictionaries in Python programs.
4. To learn how to identify Python object types.
5. To learn how to use indexing and slicing to access data in Python programs.

S.No	Content	Contact Hours
1.	Introduction to Python: Overview, History, importance, characteristics, features and applications. Local Environment Setup, Getting Python, Installation, Environment Variables, IDE. pyCharm, Anaconda, Jupyter etc. Basics of Python: Syntax: Interactive vs Script Programming, Identifiers, Reserved Words, Lines and Indentation, Single line Multiline Statements, Command Line. Variable Types: assignment, Data Types (Numbers, String, List, Tuple, Dictionary). Operators, Decision Making, Loops and Date & Time.	13
2.	Functions & Packages: Define & Call Functions, Pass by reference vs value, Function Arguments (Required, Keyword, Default, Variable length), Anonymous Functions, return statement, Global vs Local vs Dir vs Reload. Import Statement, PYTHONPATH and Packages. Files I/O and Exception Handlings: Input, Opening and Closing, file Object Attributes, Reading and Writing, File Positions, Directories. Standard Exceptions, Exception Handling, Assertion, except Clauses, Argument and Raising with Exceptions, User Defined Exceptions.	12

3.	Object Oriented with Python: Classes, Objects, Class-variable, Function Overloading, Operator Overloading, Instantiation, Inheritance, Garbage Collection, Overriding, Base Overloading and Data Hiding. Regular Expressions, Matching vs Searching, Modifiers, Patterns, Special Characters and Syntax	**13**
4.	Programming with Python Modules: Python Tools & Utilities, Matplotlib, Module Creation, Modules locating, NumPy, Pandas, SciPy, Django and etc. python examples with A.I.	**12**

Course Outcome:

CO1	**BECE-2305.1**	Understand Python syntax and semantics and be fluent in the use of Python flow control and Functions
CO2	**BECE-2305.2**	Develop, run and manipulate Python programs using Core data structures like Lists, Dictionaries, and use of Strings Handling methods
CO3	**BECE-2305.3**	Develop, run and manipulate Python programs using File Operations and searching pattern using regular expressions.
CO4	**BECE-2305.4**	Interpret the concepts of object oriented programming using Python
CO5	**BECE-2305.5**	Determine the need for python modules, libraries to design games, GUI and create efficient web applications using Matplotlib, NumPy, Pandas, Django

Suggested Readings / Books:

1. SheetalTaneja Naveen Kumar," Python Programming: A Modular Approach, by Pearson, 2017.
2. Downey, Allen B. Think Python: How to Think Like a Computer Scientist (Version 1.6.6 Ed.), 2012.
3. Hamilton, Naomi. "The A-Z of Programming Languages: Python", 2008.
4. Lutz, Mark Learning Python (5th ed.). O'Reilly Media, 2013.
5. Pilgrim, Mark Dive into Python 3. Apress, 2009
6. JISU ELSA JACOB, BHARATH VISAM S, “Python Programming”, Katson Books 2022

7. Sushil Bhardwaj, “Introduction to Python Programming”, Kalyani Publishers, 2022.

Subject Title: Programming with Python Lab
Subject Code : BELE-2371
Semester : 3
Contact Hours / Week:

Lecture(L)	Tutorial(T)	Practical(P)	Credit(C)
-	-	2	-

Internal Assessment: 50
End Term Exam: 50

Objective: To learn the concepts of data structure and algorithms and its implementation. The course has the main ingredients required for a computer science graduate and has all the necessary topics for assessment of data structures and algorithms

S.No	List of Experiments
1	Compute the GCD of two numbers
2	Find the square root of a number (Newton's method)
3	Exponentiation (power of a number)
4	Find the maximum of a list of numbers
5	Linear search and Binary search
6	Selection sort, Insertion sort
7	Merge sort
8	First n prime numbers
9	Multiply matrices
10	Programs that take command line arguments (word count)
11	Find the most frequent words in a text read from a file
12	Simulate elliptical orbits in Pygame
13	Simulate bouncing ball using Pygame
14	Program to generate different waves
15	Program to generate different graphs
16	Tower of Hanoi
17	Program To Find Given Number is Armstrong Number or not
18	Bubble Sort Algorithm
19	Program to interface with an Image (open CV)
20	Program to develop web page (Django)

Course Outcome:

CO1	**BELE-2371.1**	Develop, run and manipulate Python programs using Core data structures like Lists, Dictionaries, and use of Strings Handling methods
CO2	**BELE-2371.2**	Develop, run and manipulate Python programs using File Operations and searching pattern using regular expressions.
CO3	**BELE-2371.3**	Interpret the concepts of object oriented programming using Python
CO4	**BELE-2371.4**	Determine the need for python modules, libraries to design games, GUI and create efficient web applications using Matplotlib, NumPy, Pandas, Django

SUBJECT TITLE: PROGRAMMING IN MATLAB
SUBJECT CODE: BELE-2372
SEMESTER: 3rd
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 50
External Assessment: 50

S.N.	Contents	Contact Hours
1	Introduction to Fundamentals of MATLAB Programming.	**2 Hrs**
2	To perform Arithmetic and logic operations in MATLAB.	**2 Hrs**
3	To perform branch and loop operations in MATLAB.	**2 Hrs**
4	To use basic built-in function of Matrices in MATLAB.	**2 Hrs**
5	To develop a user defined function file in MATLAB	**2 Hrs**
6	To plot 2-D & 3-D graphs in MATLAB, such as plots, subplots, logarithmic plots and multiple plots etc.	**2 Hrs**
7	To plot 3-phase AC supply voltage in MATLAB.	**2 Hrs**
8	To develop MATLAB program to calculate ABCD parameters of transmission line.	**2 Hrs**
9	To develop Simulink model to show series resonance phenomenon and to plot voltage & current waveforms and frequency vs impedance graph.	**2 Hrs**
10	To develop Simulink model to show parallel resonance phenomenon and plot voltage & current waveforms and frequency vs admittance graph.	**2 Hrs**
11	To develop a Simulink model of symmetrical three phase power system supplying a three phase balanced load and to display the three phase voltage, current, active and reactive power.	**2 Hrs**
12	To develop a Simulink model of symmetrical three phase power system supplying a three phase balanced load and to display the three phase voltage, current, active and reactive power.	**2 Hrs**
13	To develop Simulink model of three phase transformer and to display the primary and secondary voltages and currents.	**2 Hrs**

Course Outcomes:

On successful completion of this course, the learner will be able to

CO1	**BELE-2372.1**	Know about BASIC built in functions of MATLAB.
CO2	**BELE-2372.2**	Break a complex task into simple and smaller.
CO3	**BELE-2372.3**	They will learn to do various programming operations in MATLAB and develop simulink models in SIMULINK.

CO4	**BELE-2372.4**	They will be able to draw 2-D and 3-D plots in MATLAB.

SUBJECT TITLE: ELECTRICAL& ELECTRONICS MEASUREMENT &INSTRUMENTATIONLABORATORY
SUBJECT CODE: BELE-2373
SEMESTER: 3
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 50
External Assessment: 50

Course Objectives

1. To understand the working principal and construction of the measuring instruments and recorders.
2. To measure various electrical parameters using meters and transducers.
3. To calibrate the measuring devices such as meters and transducers.

S.No.	Contents	Contact Hours
1	Study of principle of operation of various types of electromechanical measuring instruments.	2 Hrs
2	To measure high value of DC current and voltage using shunt and multiplier.	2 Hrs
3	To measure low resistance using wheat stone bridge.	2 Hrs
4	To measure active and reactive power in 3-phase balanced load by one wattmeter method.	2 Hrs
5	To measure the active power in 3-phase balanced and unbalanced load by two wattmeter method and observe the effect of power factor variation on wattmeter readings.	2 Hrs
6	To study and calibrate single phase energy meter.	2 Hrs
7	Measurement of resistance using Kelvin's Bridge.	2 Hrs
8	Measurement of self-inductance using Anderson's Bridge.	2 Hrs
9	Measurement of capacitance using Schering Bridge.	2 Hrs
10	Plotting of Hysteresis loop for a magnetic material using flux meter.	2 Hrs
11	Measurement of frequency using Wein's Bridge.	2 Hrs
12	To study the connections and use of Current and Potential transformers and to find out ratio error.	2 Hr
13	Determination of frequency and phase angle using CRO.	2 Hrs
14	Measurement of unknown voltage using potentiometer.	2 Hrs
15	To find 'Q' of an inductance coil and verify its value using Q-meter.	2 Hrs

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

Course Outcomes:

CO1	**BELE-2373.1**	Measurement of various electrical and non electrical parameters.
CO2	**BELE-2373.2**	Compute the errors present in measuring instruments and calibrate them.
CO3	**BELE-2373.3**	Ability to use the techniques and skills to operate CRO.
CO4	**BELE-2373.4**	Select various transducers for the measurement of physical quantities like temperature, pressure ,distance and displacement.

SUBJECT TITLE: ELECTRICAL MACHINES – I
SUBJECT CODE: BELE-2401
SEMESTER: 4
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks.

Course Objectives

1. To prepare students to perform the analysis of any electromechanical system.
2. To empower students to understand the working of electrical equipment used in everyday life

.

Contents of Syllabus:

Sr. No	Contents
UNIT-I	**Transformers:** Working principle, construction of single phase transformer, EMF equation, phasor diagrams on no-load and on loaded conditions, open circuit and short circuit tests, equivalent circuit parameters estimation, voltage regulation and efficiency, back to back test. Effect of saturation on exciting current and in-rush current phenomenon. Parallel operation of single phase transformers.
UNIT-II	**Auto Transformers:** Principle of operation, equivalent circuit and phasor diagrams, comparison with two winding transformer.
UNIT-III	**Three-Phase Transformers:** Different types of winding connections, Voltage and current ratios, Parallel operation of three phase transformers. Three winding transformer's equivalent circuit, off-load and on-load tap changing transformer, Scott connections. Testing of transformers.
UNIT-IV	**DC Generator:**Working principle, construction of DC Machines, Armature windings, single and double layer winding diagrams, EMF and torque equations, armature reaction,effect ofbrushshift,compensatingwinding,commutation,causesofbadcommutation,methods ofimprovingcommutation,methods of excitation of DC generators and their characteristics
UNIT-V	**DC Motor:** Working principle characteristics, starting of shunt and series motor, starters, speed control methods: field and armature control. Braking: plugging, dynamic and regenerative braking, Testing: Swinburne's test, Hopkinson test, Field test. Estimation of losses and efficiency.

COURSE OUTCOMES

On successful completion of this course, the learner will be able to

CO1	**BELE-2401.1**	Outline the principle of operation, construction and testing of single phase transformer
CO2	**BELE-2401.2**	Demonstrate the working principle of different types of dc machines
CO3	**BELE-2401.3**	Analyze the losses in dc machines to improve the efficiency by conducting various tests.
C04	**BELE-2401.4**	The skill to analyze the response of any electrical machine.

SUBJECT TITLE: DIGITAL ELECTRONICS
SUBJECT CODE: BELE-2402
SEMESTER: 4
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3 Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Course Objectives

1. To provide knowledge about basics of digital electronics.
2. To impart knowledge about designing of digital circuits.
3. Students will use schematics and symbolic algebra to represent digital gates inthe creation of solutions to design problems

Contents of Syllabus:

Sr. No	Contents
UNIT-I	**Number System and Binary Code:** Introduction, Binary, decimal, Octal, hexadecimal, BCD number system, Signed and unsigned numbers, binary operations: Addition, Subtraction. Multiplication and division. Subtractions using 1's and 2's compliment. ASCII code. Excess 3 codes and Gray code. Logic gates: OR, AND, NOT, NOR, NAND, Ex-OR gates, Basic theorems of Boolean algebra, sum of products and product of sums. Minimisation using theorems, minimisation using K-map up to 4 variables.
UNIT-II	**Combinational logic circuits:** Combinational circuit design, multiplexer, demultiplexer, encoders, decoders, adders, subtractors, code converters, parity checkers, BCD display drive, magnitude comparators.
UNIT-III	**Sequential circuits:** Flip Flop fundamentals, different flip flop configurations: SR, JK, D,T. Edge triggered and clocked flip flops, Registers: Types of Registers, series and parallel shift: circuit diagram, timing wave form and operations. Counters: synchronous and asynchronous, Johnson counter.
UNIT-IV	**D/A and A/D Converters:** Introduction, Weighted register D/A converter, binary ladder D/A converter, D/A accuracy and resolution, parallel A/D converter, Counter type A/D converter, Successive approximation A/D converter, Single and dual slope A/D converter, A/D accuracy and resolution.

Course Outcomes: On successful completion of this course, the learner will be able to

CO1	**BELE-2402.1**	Became familiar with the digital signal, positive and negative logic, Boolean algebra, logic gates, logical variables, the truth table, number systems, codes, and their conversion from to others.
CO2	**BELE-2402.2**	Learn the minimization techniques to simply the hardware requirements of digital circuits, implement it, design and apply for real time digital systems.
CO3	**BELE-2402.3**	Understand all types of combinational & sequential digital circuits and their designing.
CO4	**BELE-2402.4**	Know various types of components-ADC and DAC, memory elements and the timing circuits to generate different waveforms, and also the different logic families involved in the digital system.

Recommended Books:

1. R.P. Jain, 'Modern Digital Electronics', Tata McGraw Hill**.**
2. Malvino& Leach, 'Digital Principals & Applications', Tata McGraw Hill**.**
3. Fletcher, 'An Engg. Approach to Digital Design', PHI, Indian Edn.**.**
4. Sanjay Sharma, 'Digital Electronics' Kataria Sons**.**

SUBJECT TITLE: POWER SYSTEM-I (TRANSMISSION AND DISTRIBUTION)
SUBJECT CODE: BELE-2403
SEMESTER: 4
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3 Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Course Objectives:

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

Contents of Syllabus:

Sr. No	Contents
UNIT-I	**Structure of Power System:** Growth of power systems: Indian overview, Interconnectionsand their advantages, Electricity act 2003, Environmental and safety measures. **Distribution Systems:** DC 2-wire and 3-wire systems, AC single phase, three phase and 4-wire systems, and comparison of copper efficiency. Distribution Systems: primary and secondary distribution systems, concentrated and uniformly distributed loads on distributors; one and both ends, ring distribution, sub mains and tampered mains
UNIT-II	**Overhead Transmission Lines:** Materials and types of conductors, line parameters calculation of inductance and capacitance of single and double circuit transmission lines, three phase lines with stranded and bundle conductors, generalized ABCD constants and equivalent circuits of short, medium and long lines. Line performance: regulation and efficiency of short, medium and long lines, series and shunt compensation.
UNIT-III	**Overhead Line Insulators and Mechanical Design of Transmission Lines:** Type, string efficiency, voltage distribution in string of suspended insulators, grading ring, preventive maintenance. Different types of towers, sag-tension calculations, Corona-losses, radio and audio noise, transmission line–communication line interference, Comparison of EHVAC and HVDC

	transmission systems.
UNIT-IV	**Underground Cables:** classification of cables based upon voltage and dielectric material, insulation resistance and capacitance of single core cable, dielectric stress, capacitance of 3 core cables, methods of laying, heating effect, Maximum current carrying capacity, cause of failure, comparison with overhead transmission lines.

Course Outcomes: On successful completion of this course, the learner will be able to

CO1	**BELE-2403.1**	Understand power distribution systems.
CO2	**BELE-2403.2**	Analyse performance of transmission lines and underground cables.
CO3	**BELE-2403.3**	Design and Select overhead line insulators and transmission lines
CO4	**BELE-2403.4**	Implement the appropriate safety equipments for design of electrical power system with enhancing the efficiency of the transmission and distribution system with environment friendly technology.

Recommended Books:

1. D.P. Kothari and I. J. Nagrath, 'Power System Engineering', Tata McGraw Hill.
2. J.B. Gupta, 'Transmission and Distribution of Electrical Power', Katson Books.
3. C.L. Wadhwa, 'Electric Power Systems',New Age International Publishers.
4. J. Grainger John and Jr. W.D. Stevenson, 'Power System Analysis', McGraw Hill.

SUBJECT TITLE: LINEAR CONTROL SYSTEM
SUBJECT CODE: BELE-2404
SEMESTER: 4
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3 Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Course Objectives

1. To obtain transfer functions for electrical circuits, translational/rotational mechanical systems and electromechanical systems.
2. To learn basic goals of control systems in terms of transient/steady state time response behavior.
3. To update the knowledge about control components.

Contents of Syllabus:

Sr. No	Contents
UNIT-I	**Introductory Concepts**: Plant, Systems, Servomechanism, regulating systems, Open loop control system, closed loop control systems, linear and non-linear systems, time variant and invariant, Block diagrams, some illustrative examples
UNIT-II	**Modelling:** Force voltage analogy, force current analogy, Transfer function, Block diagram reduction technique, signal flow graphs and Mason's gain formula, characteristics equation. **Time Domain Analysis**: Transient response of the first and second order systems, Time domain specifications, Steady state error and coefficients, Absolute and relative stability, Routh-Hurwitz Criterion.
UNIT-III	**Stability Analysis**: Root locus technique, sketch of the root locus plot, Frequency domain analysis: Closed loop frequency response, bode plots, relative stability using bode plot. Frequency response specifications, relation between time and frequency response for second order systems, Nyquist criterion for stability.
UNIT-IV	**State Space Analysis:** State space representations, transfer function from state model, state transition matrix, controllability, observability. Control components: Error detectors- potentiometers and synchros, servo motors, A.C. and D.C. techno generators, Magnetic amplifiers.

Course Outcomes : On successful completion of this course, the learner will be able to

CO1	**BELE-2404.1**	Identify a set of algebraic equations to represent and model a complicated system into a more simplified form.
CO2	**BELE -2404.2**	Classify any Laplace domain system to illustrate different specification of the system using transfer function concept.
CO3	**BELE -2404.3**	Various mechanical and physical systems in terms of electrical system to construct equivalent electrical models for analysis .
CO4	**BELE -2404.4**	Analyzed the designed systems stability

Recommended Books

1. Dorf Richard C. and Bishop Robert H., 'Modern Control System', Addison–Wesley,Pearson New Delhi**.**
2. K. Ogata, 'Modern Control Engineering', Prentice Hall**.**
3. B.C. Kuo, 'Automatic Control System', Prentice Hall**.**
4. I.J. Nagrath and M. Gopal, 'Control System Engineering', Wiley Eastern Ltd.**.**
5. B.S. Manke, 'Linear Control Systems'

SUBJECT TITLE: POWER PLANT ENGINEERING
SUBJECT CODE: BELE-2405
SEMESTER: 4
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Course Objectives:

1. To introduce the students to the classification of steam and hydro-electric power plants and make them familiar with the main equipment and machinery used in them.
2. To provide them basic concepts of nuclear, gas and diesel power plants.
3. To impart knowledge about pollution control and combined operation of different plants.

Contents of Syllabus:

Sr. No	Contents
UNIT-I	**Steam Generators, Condensers and Turbines**: Classification of steam generators, Typesof condensers, effect of air in condensers, steam nozzles, types of steam turbine efficiencies. **Steam Power Plant:** Classification, Operation, Description of Rankin cycle, coal handlingsystem, combustion system, Ash handling, Feed pumps, Heat exchangers, Economizers, Super heaters, Reheaters, Air preheaters, Feed water heaters, Evaporators.
UNIT-II	**Hydro-Electric Power Plants:** Hydrological cycle, Hydrograph, Flow duration curve,Classification of hydro plants, Selection of water turbines for hydro power plant. **Nuclear Power Plants:** Nuclear physics, Binding energy, Radioactive decay. Fertile material, Mass defect, Nuclear reactions type and application, Generation of nuclear energy by fission, Nuclear reactors. Safety measures, Future of nuclear power.
UNIT-III	**Gas Turbine:** Elements of gas turbines Open and closed cycles for gas turbines, Performance terms, Plant layout, applications. **Diesel Power Plants:** Classifications of IC Engines and their performance, four stroke and two stroke diesel engines, combustion phenomenon; Essential components, Cetane number, knocking, super charging, operation and layout of diesel power plant.
UNIT-IV	**Combined Operation of Different Power Plants**: Advantages of combined operation of plants, load division between power stations, coordination of

	different types of Power Plants. **Pollution Control**: Pollution from thermal and nuclear plants, Particulate emission and control, electrostatic precipitator, solid waste disposal.

Course Outcomes:

On successful completion of this course, the learner will be able to

CO1	**BELE-2405.1**	Acquire knowledge about various equipment used in thermal, hydro and nuclearpower generation.
CO2	**BELE -2405.2**	Become familiar with equipment used in gas and diesel power plants.
CO3	**BELE -2405.3**	Analyze the working and layout of steam power plants and the different systems comprising the plant and discuss about its economic and safety impacts.
CO4	**BELE -2405.4**	Know about the importance of co-ordinate operation of different power plants and methods of pollution control.

Recommended Books:

1. Chakrabarti, Soni, Gupta and Bhatanagar, 'A Textbook on Power System Engineering', DhanpatRai& Co.
2. M.M. EI-Wakil, 'Power Plant Technology', Tata McGraw Hill Edn..
3. R.K. Rajput, 'Power Plant Engineering', Luxmi Publications.
4. P.C. Sharma, 'Power Plant Engineering', Kataria and Sons.
5. B.G.A. Skrotzki and W.A. Vapot, 'Power Station Engineering and Economy', Tata McGraw Hill Education Pvt.Ltd..
6. P.K. Nag, 'Power Plant Engineering',McGraw Hill Education (India) Pvt. Ltd..
7. P.K. Nag, 'Power Plant Engineering',McGraw Hill Education (India) Pvt. Ltd..

SUBJECT TITLE: ELECTRICAL MACHINE-I LABORATORY
SUBJECT CODE: BELE-2471
SEMESTER: 4
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 50
External Assessment: 50

Course Objectives

1. To understand the basics of D.C Machines.
2. To introduce variety of speed control of dc shunt motor.
3. To Study the universal motor.

LIST OF EXPERIMENTS

Sr. No	Contents
EXP-1	To study various components/cut-section of DC machine
EXP-2	To perform starting techniques of various DC machines.
EXP-3	To obtain torque and speed characteristics of a D.C. Shunt motor
EXP-4	To obtain external characteristics of a D.C. shunt generator
EXP-5	To obtain external characteristics of a D.C. series generator.
EXP-6	To obtain external characteristics of DC compound generator.
EXP-7	Speed control of a dc shunt motor by varying armature circuit and field circuit method
EXP-8	To obtain performance characteristics of universal motor.
EXP-9	To perform Swinburne's Test
EXP-10	To perform Hopkinson's Test
EXP-11	To perform the Brake Load Test
EXP-12	Calculate the power rating of DC machines.
EXP-13	To determine losses and efficiency of DC machines

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

Course Outcomes (CO):

On successful completion of this course, the learner will be able to

CO1	**BELE-2471.1**	Acquire skills to understand all types of dc machines
CO2	**BELE-2471.2**	Ability to analyze the speed control of machine

CO3	**BELE-2471.3**	Determine the performance characteristics of DC shunt motor and DC compound motors.
CO4	**BELE-2471.4**	Determine the performance characteristics of DC machine by conducting direct and indirect tests

SUBJECT TITLE: DIGITAL ELECTRONICS LABORATORY
SUBJECT CODE: BELE-2472
SEMESTER: 4
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 50
External Assessment: 50

Course objectives

1. To give students a practical knowledge about all types of digital circuits.
2. To give students a working knowledge to connect digital circuits and verify their truth tables.
3. To give students acknowledge about integrated circuits of different combinational and sequential circuits.

LIST OF EXPERIMENTS

Sr. No	Contents
EXP-1	To Study Logic Gates: Truth-table verification of OR, AND, NOT, XOR, NAND and NOR gates and realization of OR, AND, NOT and XOR functions using universalgates.
EXP-2	To design Half Adder using Logic gates on breadboard.
EXP-3	To design Full Adder using Logic gates on breadboard.
EXP-4	To design Half Subtractor using Logic gates on breadboard.
EXP-5	To design Full Subtractor using Logic gates on breadboard.
EXP-6	To design 4-Bit Binary-to-Gray Code Converter on breadboard.
EXP-7	To design 4-Bit Gray-to-Binary Code Converter on breadboard.
EXP-8	To study and design 4-Bit magnitude comparator using logic gates on breadboard.
EXP-9	Design and verification of Truth-table ofmultiplexer.
EXP-10	Realization of Half adder and Full adder usingMUX.
EXP-11	Design and verification of Truth-table of Demultiplexer.
EXP-12	Realization of half subtractor and full subtractor usingDEMUX.
EXP-13	To study and verify Truth-table of RS, JK, D, JK Master Slave FlipFlops.
EXP-14	To design MOD-7 Synchronous up-counter using JK/RS/D FlipFlops.
EXP-15	To Study different shift registers: SIPO, SISO, PIPO, andPISO.
EXP-16	To Study digital logicfamilies.

Course Outcomes:

On successful completion of this course, the learner will be able to

CO1	**BELE-2472.1**	Become familiar to logic gates ,digital signals, truth table and conversions
CO2	**BELE-2472.2**	Learn how to minimize the hard ware needs for digital circuit ,put them into practice and use them for real time circuit.
CO3	**BELE-2472.3**	Ability to test and validate the truth table and working condition of combinational and sequential circuits
CO4	**BELE-2472.4**	Working knowledge to study output input wave form on oscilloscope

Note: At least ten experiments should be performed in semester

SUBJECT TITLE: CONTROL SYSTEM LABORATORY
SUBJECT CODE: BELE-2473
SEMESTER: 4
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 50
External Assessment: 50

Course Objectives

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

LIST OF EXPERIMENTS

Sr. No	Contents
EXP-1	Familiarization with MATLAB control system toolbox, MATLAB Simulink toolbox andPSPICE.
EXP-2	Determination of step response for first order and second order system with unity feedback and their display on CRO. Calculation and verification of time constant, peak overshoot, setting time etc. from the response.
EXP-3	Simulation of step response and impulseresponsefortype-0, type-1and type-2 systems with unity feedback using MATLAB andPSPICE.
EXP-4	Determination of Root Locus, Bode-Plot, Nyquist Plot using MATLAB-Control system toolbox for 2^{nd}order system. Determination of different control system performance indices from theplots.
EXP-5	Experimental determination of approximate transfer functions from Bode plot.
EXP-6	Evaluation of steady state error, settling time, percentage peak overshoot, gain margin, phase margin, with addition of lead compensator and by compensator in forward path transfer function for unity feedback control system usingPSPICE.
EXP-7	Design of a second order linear time invariant control system and study of system response with unit step input.
EXP-8	To study the characteristics of potentiometers and to use 2-potentiometers as an error detector in a control system.
EXP-9	To study the synchro Transmitter-Receiver set and to use it as an errordetector.
EXP-10	To study the Speed-Torque characteristics of an AC Servo Motor and to explore its applications.
EXP-11	To study the Speed-Torque characteristics of a DC Servo Motor and explore its applications.
EXP-12	To study various electro-mechanical transducers i.e. resistive, capacitive and inductive transducers.
EXP-13	To study the speed control of an A.C. Servo Motor using a closed loop and an open loop system.
EXP-14	To study the operation of a position sensor and study the conversion of position in to correspondingvoltage

Course Outcomes:

On successful completion of this course, the learner will be able to

CO1	**BELE-2473.1**	Demonstrate the response of first order and second order systems with various standard test signals.
CO2	**BELE-2473.2**	Understand concepts of time domain analysis of series RLC Circuit
CO3	**BELE-2473.3**	Examine the DC motors time response and determine the transfer function
CO4	**BELE-2473.4**	Evaluate the stability of control systems

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

SUBJECT TITLE: ELECTRICAL MACHINES-II
SUBJECT CODE: BELE-3501
SEMESTER: 5th
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	2	0	4

Internal Assessment: 40

End Term Exam: 60

Duration of Exam; 3 Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Course Objectives:

1. To impart knowledge of the constructional features and principle of operation of three-phase and single-phase induction machines.
2. To impart knowledge about methods of starting and speed control of induction motors.
3. To make the students aware about construction, principle of operation and applications of special purpose motors.

Contents of Syllabus:

Sr. No	Contents
UNIT-I	**Three Phase Induction Motors**: Constructional features, Production of rotating field in space distributed three-phase winding, Principle of operation, Concept of slip, rotor frequency, current, torque and power output, Types of induction motors, Analogy between induction motor and transformer, no load and blocked rotor test, Circle diagram, Equivalent circuit parameters, Phasor diagram, Torque-slip characteristics, Effect of rotor circuit resistance, Crawling and Cogging, Cage motors (double cage and deep bar motor).
UNIT-II	**Starting Methods and Speed Control:** Starting methods of squirrel cage and slip ring induction motor, Different speed control methods, effect of voltage injection in rotor circuit of slip ring induction motor. **Induction Generator:** Isolated and Grid mode operation, method of excitation, performance characteristics of three-phase self-excited induction generator, introduction to doubly fed induction generator.
UNIT-III	**Single Phase Motors**: Introduction, Double revolving field theory, types of single phase motors (Split phase, capacitor start, capacitor run, capacitor start and run) and their characteristics, shaded pole motor: working principle and characteristics. Reluctance motor: construction, principle of operation

	and applications.
UNIT-IV	**Special Purpose Motors:** Stepper Motor: construction, principle of operation and applications. Linear Induction Motor: construction, principle of operation and applications. Universal Motor: construction, principle of operation and applications.

Course Outcomes: On successful completion of this course, the learner will be able to

CO1	**BELE-3501.1**	Identify alternator types ,and appreciate their performance.
CO2	**BELE-3501.2**	Skills to analyse the performance of the asynchronous machines using the phasor diagrams and equivalent circuits.
CO3	**BELE-3501.3**	Gain knowledge of speed control and testing of asynchronous machines.
CO4	**BELE-3501.4**	Select appropriate asynchronous machine for any application and appraise its significance

Recommended Books:

1. A.E. Fitzgerald, C. Kingsley and S.D. Umans, 'Electric Machinery',McGrawHill.
2. E.H. Langsdorff, 'Principles of A.C. Machines', McGraw Hill.
3. I.J. Nagrath and D.P. Kothari, 'Electrical Machines',Tata McGraw Hill.
4. P.S. Bimbhra, 'Electrical Machinery', Khanna Publishers.
5. M.G. Say,' Alternating Current Machines', Sir Isaac Pitman and Sons Ltd.

SUBJECT TITLE: POWER ELECTRONICS & DRIVES
SUBJECT CODE: BELE-3502
SEMESTER: 5
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Course Objectives:

1. To make the students aware about the power electronic devices and construction, operation and characteristics of most popular member of thyristor family i.e. SCR.
2. To acquaint them with basic concepts of operation of different types of convertors.
3. To impart knowledge about application of converters to motor drives.

Contents of Syllabus:

Sr. No	Contents
UNIT-I	**Introduction:**Thyristor family and SCR, Constructional features of SCR, its static and dynamic characteristics, turn-on and turn-off methods and firing circuits, Ratings and protection of SCR'S, series and parallel operation, commutation circuits.
UNIT-II	**Phase Controlled Converters:** Principle of phase control, single phase and three phase converter circuits with different types of loads, dual converters and their operation. DC Choppers: Principle of chopper operation, control strategies, types of choppers, step up and step down choppers, voltage, current and load-commutated choppers.
UNIT-III	**Inverters:** Single phase Voltage source bridge inverters, Modified Mc-Murray half bridge inverter, series inverters, three phase bridge inverters with 180^0 and 120^0 modes. Single phase PWM inverters, Current source inverters. **AC Voltage Controllers:** Types of single-phase voltage controllers, single-phase voltage controller with R and RL type of loads. **Cycloconverters:** Principle of operation, single phase to single phase step up and step down Cycloconverters, three phase to single phase cycloconverters.
UNIT-IV	**DC Motor Drives:** DC motor drive–starting, braking, transient analysis, speed control,controlled rectifier converters for DC drives and chopper fed DC drives. AC Motor Drives Induction motor drive–starting, braking, transient analysis, speed control, ac controller fed induction motor, voltage source inverter, current source inverter and cyclo-converter fed induction motor drive.

Course Outcomes: On successful completion of this course, the learner will be able to

CO1	**BELE-3502.1**	The students will learn the operation and characteristics of power electronic devices
CO2	**BELE -3502.2**	The students will be able to analyse operation of different types of converter circuits such as; AC-DC, DC-DC, AC-AC and DC-AC.
CO3	**BELE -3502.3**	Understand the concepts about parallel operation and transient conditions of alternators.
CO4	**BELE -3502.4**	Design single phase and three phase inverters.

Recommended Books

1. G.K. Dubey, S.R. Doradla, A. Joshi, R.N.K. Sinha, 'Thyristorised Power Controllers', New Age International (P) Limited, Publishers, **2004**.
2. M. Rashid, 'Power Electronics', Prentice Hall of India Private Ltd., **2006**.
3. P.S. Bimbhra, 'Power Electronics', Khanna Publishers, **2004**.
4. Bimal Bose, 'Power Electronics and Motor Drives', Academic Press, **2006**.
5. P.C. Sen, 'Power Electronics', Tata McGraw Hill Company Ltd., New Delhi, **1992**.
6. C. Rai Harish, 'Power Electronics and Industrial Applications', 1st Edn., CBS Publishers& Distributors Pvt Ltd., **2018**.

SUBJECT TITLE: GENERATION AND ECONOMICS OF ELECTRIC POWER
SUBJECT CODE: BELE-3503
SEMESTER: 5
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Course Objectives:

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

Contents of Syllabus:

Sr. No	Contents
UNIT-I	**Loads and Load Curves:** Types of load (fixed voltage loads, resistive loads, Inductive motor loads, mechanical load), effect of load on supply voltage, maximum demand, group diversity factor, peak diversity factor, types of load, chronological load curves, load-duration curve, mass curves, load factor, capacity factor, utilization factor, base load and peak load plants, load forecasting.
UNIT-II	**Power Plant Economics:** Capital cost of plants, annual fixed cost, operating costs and effect of load factor on cost of energy, depreciation, tariffs and power factor improvement, objectives of tariff making, different types of tariff (domestic, commercial, agricultural and industrial loads). Need for power factor improvement, power factor improvement using capacitors, determination of economic power factor.
UNIT-III	**Selection of Plant:** Plant location, plant size, number and size of units in plants, economic comparison of alternatives based on annual cost, rate of return, present

	worth and capitalized cost methods. Economic operation of steam plants, methods of loading turbo-generators, input- output curve, heat rate, incremental cost, method of Lagrangian multiplier, effect of transmission losses, co-ordination equations, and iterative procedure to solve co-ordination equations.
UNIT-IV	**Hydro-Thermal Co-ordination:** Advantages of combined working of Run-off River plant and steam plant, reservoir hydro plants and thermal plants, long-term operational aspects, scheduling methods. Cogeneration: Definition and scope, Topping and Bottoming Cycles, Benefits, cogeneration technologies.

Course Outcomes: On successful completion of this course, the learner will be able to

CO1	**BELE-3503.1**	Understand how electricity is generated and how it affects people.
CO2	**BELE-3503.2**	knowledge of different types of loads and related terminology.
CO3	**BELE-3503.3**	Demonstrate the working operation and maintenance of substation
CO4	**BELE-3503.4**	Get knowledge about co-ordinated operation of Hydro and Steam power plants.

Recommended Books

1. M.V. Deshpande, 'Power Plant Engineering', Tata McGraw Hill, **2004**.
2. M.M. EI-Wakit, 'Power Plant Engineering', McGraw Hill, USA, **2010.**
3. D.P. Kothari and I.J. Nagrath, 'Power System Engineering', Tata McGraw Hill, **2008**
4. S.C. Arora and S. Dom Kundwar, 'A Course in Power Plant Engineering', 6th RevisedEdn.,Dhanpat Rai,**2011-12**.
5. P.K. Nag, 'Power Plant Engineering', Tata McGraw Hill, **2014**.
6. B.R. Gupta, 'Generation of Electrical Energy', S. Chand, **2017**.

SUBJECT TITLE: ELECTROMAGNETIC FIELD THEORSUBJECT TITLE: ELECTROMAGNETIC FIELD THEORY
SUBJECT CODE: BELE-3504
SEMESTER: 5
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Course Objectives:

1. To provide the knowledge about the time varying fields and Maxwell's equations.
2. To provide knowledge about the propagation of electromagnetic wave along different mediums.
3. Study of physical concept and all the important fundamental parameters of waveguides.

Contents of Syllabus:

Sr. No	Contents
UNIT-I	**Review of Electrostatic and Magnetostatic Fields:** Review of vector algebra, Review of Cartesian, Cylindrical and spherical coordinate systems, Introduction to del operator, Use of del operator as gradient, divergence, curl. Introduction to coulomb's law, Gaussian law. Laplace's and Poisson's equation in various coordinate systems. Introduction to Ampere's law, Magnetic vector potential.
UNIT-II	**Time Varying Fields and Maxwell's Equations:** Equation of continuity, Inconsistency of Ampere's law for time varying fields, Concept of displacement current, Maxwell's equation in integral and differential form (for static fields, time varying fields, free space, good conductors, harmonically varying fields), Poynting theorem.
UNIT-III	**Uniform Plane Waves:** Introduction, Uniform plane wave propagation, Wave equations: Wave equations for free space, Wave equations for conductors. Transverse nature of uniform plane waves, Reflection of electromagnetic waves

	by perfect conductor and perfect dielectric, wave impedance and propagation constant, depth of penetration, surface impedance.
UNIT-IV	**Wave Guides:** Introduction, simple waveguides between two infinite and parallel conducting plates, Transverse Electric (TE) Waves or H-Waves, Transverse magnetic (TM) Waves or E-Waves, Characteristics of TE and TM waves, Transverse Electromagnetic (TEM) waves and its characteristics

Course Outcomes: On successful completion of this course, the learner will be able to

CO1	**BELE-3504.1**	Understand concepts of electromagnetic field theory and fundamental field equations.
CO2	**BELE-3504.2**	Get knowledge of various application of the boundary conditions for fields.
CO3	**BELE-3504.3**	Have skills to identify, formulates and solves engineering problems related to electromagnetic fields.
CO4	**BELE-3504.4**	Determine and describe the Dynamic and static magnetic and electric fields for important technologically structures:

Recommended Books

1. Jordan and Balmain, 'Electromagnetic Wave', PHI and Radiation System,**2010.**
2. Kraus, 'Electromagnetics', T.M.H.**2003.**
3. W.H. Hayt and J.A. Buck, 'Problem and Solutions in Electromagnetics', Tata McGrawHill, **1999.**
4. W.H. Hayt, 'Engineering Electromagnetic', Tata McGraw Hill,**2012**.

SUBJECT TITLE: MICROPROCESSORS AND INTERFACING
SUBJECT CODE: BELE-3505
SEMESTER: 5
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal Assessment: 40

End Term Exam: 60

Duration of Exam; 3 Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Course Objectives:

1. To understand the basic architecture of 8 and 16-bit microprocessor.
2. To understand interfacing of microprocessor with memory and peripheral chips involving system design.
3. To understand the techniques for faster execution of instructions and improve the performance of microprocessor.
4. To understand the concepts of multi core processor.

Contents of Syllabus:

Sr. No	Contents
UNIT-I	**Introduction:** Introduction to microprocessor, Intel 8085 microprocessor architecture and pindiagram, Data flow to/from memory, from/to microprocessor unit, multiplexing and de-multiplexing of address data bus. Bus timings, T state, machine cycle, timing diagram, Memories- RAM, DDR/SDR, ROM, EROM, EPROM, EEPROM, Flash Memory, Cache Memory.
UNIT-II	**Programming with 8085:** Addressing modes, Detail study of 8085 instruction set. I/O andMemory mapping, Interfacing I/O Devices, Interrupts, stack and subroutines, Counter and Time, Delays, Code conversion, BCD Arithmetic and 16-bit data operations, Programming techniques with additional instructions, Program Debugging.
UNIT-III	**Interfacing with 8085:** Architecture, interfacing and programming of 8155/8156(programmable I/O port timer), 8251(universal synchronous, asynchronous

	receiver transmitter), 8253/ 8254 (programmable interval timer), 8255 (programmable peripheral interface), 8279 (keyboard display controller), and 8257 (direct memory access controller).
UNIT-IV	**Other Microprocessor and interfacing:** 8086 -Block diagram, Architecture, pipelining, flagregister, register bank operation, memory segmentation, addressing modes. Introduction to 80186, 80286, 80386, 80486 and Pentium and their comparison, Comparative study of 8-bit microprocessors: Intel 8085, Motorola 6800, Zilog Z-80.

Course Outcomes: On successful completion of this course, the learner will be able to

CO1	**BELE-3505.1**	Write program to run on 8085 microprocessor based systems.
CO2	**BELE-3505.2**	Design system using memory chips and peripheral chips.
CO3	**BELE-3505.3**	Understand various techniques for faster execution of instructions and improve speed of operations.
CO4	**BELE-3505.4**	Build systems using microcontrollers for real time applications.

Recommended Books:

1. R.S. Gaonkar, 'Microprocessor Architecture Programming and Applications with the 8085' Penram International Pub.
2. D.V. Hall, 'Microprocessor and Interfacing Programming and Hardware', McGraw Hill Co.
3. Barry B. Brey, 'The Intel Microprocessors, Architecture Programming and Interfacing, PHIPublications.
4. B. Ram, Dhanpat Ra, 'Fundamentals of Microprocessor and Microcontrollers'.

SUBJECT TITLE: ELECTRICAL MACHINES-II LAB.
SUBJECT CODE: BTEE-3571
SEMESTER: 5
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 50

End Term Exam: 50

Course Objectives:

1. To plot speed-torque characteristics of three-phase and single-phase induction motors.
2. To obtain equivalent circuit parameters of three-phase and single-phase induction motors.
3. To study speed control of induction motors using different techniques.
4. To plot characteristics of a three-phase alternator and a synchronous motor.
5. To synchronize two 3-phase alternators by different methods

LIST OF EXPERIMENTS

Sr. No	Contents
EXP-1	To perform load-test on three-phase induction motor and to plot speed-torque characteristics
EXP-2	To perform no-load and blocked rotor test on three-phase induction motor to obtain equivalent circuit parameters and to draw circle diagram.
EXP-3	To study the speed control of three-phase induction motor by Kramer's method.
EXP-4	To study the speed control of three-phase induction motor by cascading of two induction motors.
EXP-5	To study star- delta starters and a. To draw electrical connection diagram. b. To start the three-phase induction motor using it. c. To reverse the direction of three-phase induction motor
EXP-6	To start a three-phase slip ring induction motor by inserting different levels of resistance in the rotor circuits and to plot speed- torque characteristics.
EXP-7	To perform no-load and blocked rotor test on single-phase induction motor and to determine the parameters of equivalent circuit.
EXP-8	To perform load test on single-phase induction motor and plot speed-torque characteristics.
EXP-9	To perform no load and short circuit test on three-phase alternator and draw open and short circuit characteristics.
EXP-10	To find voltage regulation of an alternator by zero power factor (ZPF) method.
EXP-11	To study effect of variation of field current upon the stator current and power factor of synchronous motor running at no load and draw V and inverted V curves of motor.
EXP-12	To synchronise two 3-phase alternators using dark lamp method, and two-bright & one dark lamp method
EXP-13	To start a synchronous motor using appropriate method.

Course Outcomes:

On successful completion of this course, the learner will be able to

CO1	**BTEE-3571.1**	Obtain equivalent circuit parameters of single-phase and three- phase Induction motors.
CO2	**BTEE-3572.2**	Control speed of Induction motors by different methods.
CO3	**BTEE-3573.3**	Find voltage regulation of an alternator by using various tests.
CO4	**BTEE-3574.4**	Draw open and short circuit characteristics of three-phase alternator and V and inverted V curves of synchronous motor.

 # Note: At least ten experiments should be performed in semester

SUBJECT TITLE: POWER ELECTRONICS LAB.
SUBJECT CODE: BELE-3572
SEMESTER: 5
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 50
End Term Exam: 50

Course Objectives:

1. To obtain the characteristics of SCR and UJT and to obtain triggering pulses for them.
2. To verify the performance of various converter circuits by measuring the currents and voltages at different points in the circuit and to display their waveforms.
3. To control speed of motors by using thyristors.

LIST OF EXPERIMENTS

Sr. No	Contents
EXP-1	To obtain V-I characteristics of SCR and measure latching and holding currents.
EXP-2	To plot V-I Characteristics of UJT
EXP-3	To obtain triggering wave forms for SCR using R and RC firing circuits.
EXP-4	To obtain output voltage waveforms of single phase half wave controlled rectifier for R-L load.
EXP-5	To obtain output voltage wave forms for single phase full-wave controlled rectifiers with resistive and inductive loads.
EXP-6	To simulate three phase bridge rectifier and draw load voltage and load current waveform for resistive and inductive loads.
EXP-7	To study different types of chopper circuits and obtain waveforms for at least one of them
EXP-8	To simulate single phase inverter using different modulation techniques and obtain load voltage and load current waveform for different types of loads.
EXP-9	To simulate single phase full wave ac voltage controller and draw load voltage and load current waveforms for inductive load.
EXP-10	To study single phase cycloconverter.
EXP-11	To study speed control of induction motor using thyristor
EXP-12	To study speed control of DC motor using thyristor.

Course Outcomes: On successful completion of this course, the learner will be able to

CO1	**BELE-3572.1**	Verify the characteristics of SCR and UJT and triggering pulses for them.
CO2	**BELE-3572.2**	Understand Control of Dc motor using single phase half and full controlled bridge rectifier

CO3	**BELE-3572.3**	Visualize and analyse the performance of various converter circuits.
CO4	**BELE-3572.4**	Control the speed of motors using thyristors.

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

SUBJECT TITLE: POWER SYSTEM-II (SWITCHGEAR AND PROTECTION
SUBJECT CODE: BELE-3601
SEMESTER: 6
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Course Objectives:

1. To provide knowledge about principle and components of protective system.
2. To impart knowledge about basics of Substation, Isolator and Fuses
3. To provide knowledge about operating Principle, types of Relays and Circuit Breakers
4. To provide knowledge about protection of Feeder, Bus bar, Generator and Transformer

Contents of Syllabus:

Sr. No	Contents
UNIT-I	**Introduction to Components of Protection System:** Need for Protective System, Nature and Causes of Faults, Types and Effects of Faults, Zones of Protection, Primary and Backup Protection, Essential Qualities of Protection, Basic Principle of Protective System, Components and Classification of Protective System, Brief Idea of Instrument Transformers, Circuit Breakers, Relays and related Terminologies. **Substation, Isolator and Fuses:** Functions, Types, Classification, Main Equipment, Layout, Bus-bar Arrangement of Substation. Operation, Types and Rating of Isolators. Types, Rating and Characteristics of Fuses.
UNIT-II	**Circuit Breakers:** Circuit Breaker Ratings, Arc Initiation and their Interruption Methods, Arc Quenching Theories, Re-striking voltage, Recovery Voltage, RRRV, Plain Break Oil Circuit Breaker, Minimum Oil Circuit Breaker, Air Circuit Breaker, Air Blast Circuit Breaker, Vacuum Circuit breaker and SF^6 Circuit Breaker. Introduction to D.C. Circuit Breaker. **Protective Relays:** Introduction, Classification, Constructional Features; and

	Characteristics of Electromagnetic, Induction, Thermal, Over-current relays, Directional Over Current Relay, Distance relays (Impedance, Reactance and Mho relay), Differential Relays, Trans-lay, Negative sequence relay, introduction to Static and Numerical Relays.
UNIT-III	**Feeder or Transmission Line Protection**: Over current Protection by Time Graded System,Current Graded and Time- Current Graded System, Protection of Parallel Feeder, Protection of Ring Mains, Over Current Earth Fault Protection, Distance Protection of Transmission lines (Impedance, Reactance and Mho Relay), Comparison between Distance Relays, Differential and Percentage Differential Protection, Pilot Relaying Protection of Feeder. **Bus-Bar Protection:** Differential Protection of Bus Bars
UNIT-IV	**Transformer Protection:** Over current protection, percentage differential protection, incipient faults in transformers, inter-turn fault, protection against over fluxing. **Generator Protection:** Various faults and abnormal operating conditions, protection against unbalanced loading, over speeding, loss of excitation, loss of prime mover.

Course Outcomes: On successful completion of this course, the learner will be able to

CO1	**BELE-3601.1**	Understand about basic components of power system protection system
CO2	**BELE-3601.2**	Know about basics of Substation, Isolator and Fuses
CO3	**BELE-3601.3**	Understand about Principle, Operation and types of Relays and Circuit Breakers
CO4	**BELE-3601.4**	Know about Protection of Feeder, Bus bar, Generator and Transformer

Recommended Books

1. C.L. Wadhwa, 'Electrical Power System', New Age International (P) Ltd.
2. D.N. Badri Ram, D.N. Vishakarma, 'Power System Protection and Switchgear'.
3. Ravindranath and M. Chander, 'Power System Protection and Switchgear'.
4. Dahiya and Attri, 'Substation Engineering', Khanna Publishers
5. B.R. Gupta, 'Power System Analysis and Design', S. Chand & Company (P) Ltd.
6. Nagrath and Kothari, 'Modern Power System Analysis', Tata McGraw Hill.
7. J. Grainger John and Jr. W.D. Stevenson, 'Power System Analysis', McGraw Hill, **1994**.
8. Sunil S. Rao, 'Switchgear Protection and Power Systems', Khanna Publishers.
9. S.L. Uppal, 'Electrical Power', Khanna Publishers.

SUBJECT TITLE: ELECTRICAL POWER UTILIZATION
SUBJECT CODE: BELE-3602
SEMESTER: 6
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Course Objectives:

1. To acquire knowledge about various elements of A.C and D.C electric motor drives and their characteristics.
2. To acquire detailed knowledge about electric traction systems.
3. To know various phenomena related to electrolytic processes and illumination.

Contents of Syllabus:

Sr. No	Contents
UNIT-I	**Electric Drives**: Introduction concept of electric drives, classification of electric drives, nature of load, factors effecting selection of drive, Running characteristics of D.C, Series and shunt motor, 3-phase induction motor, 3-phase synchronous motor and A.C series motors, starting methods of D.C series and shunt motors, starting methods of 3-phaseinduction motors, examples, starting methods of synchronous motors and single-phase induction motor. Speed control of D.C series and shunt motors, examples, Speed control of 3- phase induction motor, examples, Methods of electric braking of D.C motor, examples. Braking of 3-phase induction motor, Mechanical features of electric drive, Load equalization, flywheel calculations, examples. Temperatures rise of electric drives, heating and cooling curves, standard ratings of motors, examples Applications of electric drives and selection of drives for particular service, conservation approach to be considered.
UNIT-II	**Electrical Traction:** Introductions, different traction systems, various systems of electric traction. Locomotives, tramways, trolleys, track electrification, comparison between A.C and D.C systems of railway electrification, Types of speed and speed-time curves, examples. Mechanics of train movement, tractive effort, power, output, examples., Energy output from driving axles, energy output using simplified speed-time curves, examples, Factors affecting energy consumption, dead weight, accelerating weight, adhesion weight, examples., Traction motors and their characteristics, starting and speed control of D.C series and shunt motors, examples, Starting and speed control of A.C series and 3-phase induction motors, Braking of

	traction motors and mechanical considerations, conservation approach to be considered.
UNIT-III	**Electrical Heating and Welding:** Advantages of electric heating, modes of transfer of heat, classification of electric heating methods, Resistances heating methods, requirements of heating elements, design of heating elements, methods of temperature control, problems, Induction heating: principle, types of induction furnaces, direct core type, vertical core type, indirect core type, core less type, advantages and disadvantages, eddy current heating, applications examples., Arc-furnace: principle, types, direct and indirect arc furnaces, power supply and control, condition for maximum output, examples., Dielectric heating: principles, advantages and disadvantages, applications, choice of frequency, examples., Electric welding: different types of resistance welding and electric arc welding, conservation approach to be considered.
UNIT-IV	**Electrolytic Process:** Principle, Faradays laws of electrolysis, current efficiency, energy efficiency etc., Rating of metals, production of chemicals, Electro deposition, electroplating, power supply for electrolytic processes. **Illumination**: Nature of light, definitions, laws of illumination, different types of lamps, tungsten lamp, discharge lamp, sodium vapour lamp, fluorescent lamp, design of lighting scheme, methods of lighting, calculations

Course Outcomes: On successful completion of this course, the learner will be able to

CO1	**BELE-3602.1**	Knowledge about D.C and A.C electric motor drive characteristics and select them for particular traction systems.
CO2	**BELE-3602.2**	Explore and control various electric heating and welding methods and processes
CO3	**BELE-3602.3**	Understand the electrical attraction .
CO4	**BELE-3602.4**	Students will be able to calculate illumination requirements

Recommended Books

1. R.K. Rajput, 'Utilization of Electrical Energy',Luxmi Publications Pvt. Ltd., **2006**.
2. J.B. Gupta, 'Utilization of Electric Power & Electric Traction', S.K. Kataria and Sons,Katson Books,**2013**.
3. C.L. Wadhwa, 'Generation, Distribution and Utilization of Electrical Energy',NewageInternational Pvt. Ltd., Publishers, **2005**.

SUBJECT TITLE: MICROCONTROLLER AND PLC
SUBJECT CODE: BELE-3603
SEMESTER: 6th
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

Objective and outcome of course:

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Learning Outcomes:

1. The course describes Architecture of Microcontrollers, Programming with Application of Microcontroller, Advanced Microcontroller and Interfacing.
2. It explains the Applications & Importance of PLC connection of PLC and a relay panel.
3. It describes the block diagram and operation of a micro PLC, gives an idea of ladder programming.
4. It also explains how to select a PLC for a typical application.

Contents of Syllabus:

Sr. No	Contents
UNIT-I	**Introduction:** Microprocessor, Micro-controllers and their comparison. The 8051 Architecture: Introduction, 8051 micro-controller hardware, input/ output, pins, ports and circuits, external memory, counters and timers, serial data input/ output, interrupts
UNIT-II	**8051 Assembly Language Programming:** The mechanics of programming, assembly language programming process, programming tools and techniques, instruction set (data moving, logical operations, arithmetic operations, jump and call instructions) **8051 Microcontroller Design:** Micro-controller specification, external memory and memory space decoding, reset and clock circuits, expanding input and output (I/O), memory mapped I/O, memory address decoding, memory access times, testing the design, timing subroutines, lookup tables for the 8051, serial data transmission
UNIT-III	**Microcontroller Applications:** Interfacing keyboards, displays, Digital-to-Analog (D/A) and Analog-to-Digital (A/D), multiple interrupts, serial data communications, introduction to the use of assemblers and simulators Embedded Systems: Introduction

	to PLDs and FPGA- architecture, technology and design issues, implementation of 8051 core.
UNIT-IV	**Programmable Logic Controllers (PLC):** Introduction, operation of PLC, difference between PLC and Hardwired system, difference between PLC and Computer, relay logic and ladder logic, ladder commands and examples of PLC ladder diagram realization, PLC timers, PLC counters, PLC classification

Course Outcomes: On successful completion of this course, the learner will be able to

CO1	**BELE-3603.1**	Understand the architecture of microcontroller and understand the counter & timers.
CO2	**BELE-3603.2**	Design the PLC ' architecture
CO3	**BELE-3603.3**	Know various application of the M C 8051
CO4	**BELE-3603.4**	Implement PLC interfacing

RECOMMENDED BOOKS:

1. Kenneth J Ayola, *The 8051 Micro Controller- Architecture, Programming and Application,* Penram International Publication
2. John B Peatman, *Design with Micro Controller,* Tata McGraw Hill
3. Ray A. K. and Bhurchandi K. M., *Advanced Microprocessors and Peripherals; Architecture, Programming and Interfacing*, Tata McGraw Hill
4. Mazidi M. A. and Mazidi J. G., *The 8051 Micro-controller and Embedded System,* Pearson Education.
5. Udayashankara V. and Mallikarjunaswamy M.S., *8051 Microcontroller Hardware, Software and Applications*, TataMcGraw Hill Education Pvt. Ltd., (2010)
6. SurekhaBhanot, *Process Control,* Oxford Higher Education.
7. Otter, Job Dan, *Programmable Logic Controlle*r, P.H. International, Inc, USA
8. Dunning Gary, *Introduction to PLCs*, Tata McGraw Hill
9. Kumar Rajesh, *Module on PLCs and their Applications*, NITTTR

SUBJECT TITLE: ELECTRICAL MACHINES-III
SUBJECT CODE: BELE-3604
SEMESTER: 6
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	2	0	4

Internal Assessment: 40

End Term Exam: 60

Duration of Exam; 3 Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Course Objectives:

1. To make the students aware about the general aspects of synchronous machines.
2. To apprise the students about the construction, operation and characteristics of alternators and synchronous motors.
3. To make them to understand the underlying aspects of parallel operation of alternators.

Contents of Syllabus:

Sr. No	Contents
UNIT-I	**General Aspects:** Construction and working principle of synchronous machines, Excitation systems, Production of sinusoidal electromotive force (EMF) and its equation, flux and magneto motive force (MMF), phasor diagrams, cylindrical and salient pole rotors, pitch factor, distribution factor
UNIT-II	**Alternators:** Construction, Phasor diagram of cylindrical rotor alternator, ratings, armature reaction, determination of synchronous reactance; open-circuit and short- circuit characteristics, short-circuit ratio, short-circuit loss. Determination of voltage regulation: EMF, MMF and zero power factor method. Power flow through inductive impedance, Power-angle characteristics of cylindrical and salient pole synchronous machines, Two-reaction theory of salient pole machines, power factor control.
UNIT-III	**Synchronous Motors:** Operating characteristics, power-angle characteristics, condition for maximum power, V-curves and inverted V-curves, methods of starting, synchronous motor applications, synchronous condenser, Hunting, damper windings, Hysteresis motors.
UNIT-IV	**Parallel Operation of Alternators:** Conditions for synchronization of single phase and three phase alternators, conditions for parallel operation, synchronizing power, current and torque, effect of increasing excitation

	of one of the alternators, effect of change of speed of one of the alternators, effect of unequal voltages, load sharing.

Course Outcomes: On successful completion of this course, the learner will be able to

CO1	**BELE-3604.1**	Understand about the general aspects and winding terminology used in 3-ϕ synchronous machines and 1-ϕ synchronous motors.
CO2	**BELE-3604.2**	Analyse the various methods of voltage regulation and EMF equations of alternators.
CO3	**BELE-3604.3**	Memorize power-angle characteristics of synchronous machines and the working and characteristics of synchronous motors.
CO4	**BELE-3604.4**	Understand the concepts about parallel operation and transient conditions of alternators.

Recommended Books

1. P.S. Bimbhra, 'Electrical Machinery', Khanna Publishers, **2010.**
2. A.E. Fitzgerald, C. Kingsley and S.D. Umans, 'Electric Machinery', 6thEdn.,McGrawHill.
3. I.J. Nagrath and D.P. Kothari, 'Electrical Machines', 4thEdn.,Tata McGraw Hill, **2011**.
4. M.G. Say, 'Alternating Current Machines', 5thEdn., Sir Isaac Pitman and Sons Ltd., **2004**.
5. S. SarmaMulukutla and Mukesh K. Pathak, 'Electric Machines', 3rd Indian Reprint, CENGAGE Learning, **2009**.

SUBJECT TITLE: SIGNALS AND SYSTEMS
SUBJECT CODE: BELE-3611
SEMESTER: 6
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Course Objectives:

1. To understand the classification of signals.
2. To apply Fourier series and Fourier Transformation to periodic and aperiodic signals.
3. To introduce the concepts of probability of occurrence of random events.
4. To understand different types of noise associated with signals.

Contents of Syllabus:

Sr. No	Contents
UNIT-I	**Introduction:** Classification of Signals and Systems, Linear time invariant systems, Convolution, Representation of signals in terms of impulses, Signal Representation using Fourier Series, Complex and Exponential Fourier Series, Fourier Series Representation of Periodic Signals, Properties of Fourier series, Parseval's theorem.
UNIT-II	**Signal Analysis:** Periodic Signal Representation using Fourier Transforms, Fourier Transforms of Periodic Power Signals, Signal Transmission through Linear Networks, Convolution Theorem and its graphical interpretation, Sampling Theorem, Correlation, Autocorrelation.
UNIT-III	**Probability:** Introduction to Probability Theory, Definition of Probability of Random Events, Joint and Conditional Probability, Cumulative Distribution Function (CDF), Probability Density Functions (PDF) and Statistical Averages of random variables, introduction to random processes.
UNIT-IV	**Noise:** Thermal Noise, Shot noise, Partition noise, Flicker noise, Gaussian Noise, Noise in Bipolar Junction Transistors (BJTs), FET noise, Equivalent input noise, Signal to Noise Ratio (SNR), Noise Temperature, Noise equivalent Bandwidth, Noise Figure, Experimental determination of Noise Figure.

Course Outcomes: On successful completion of this course, the learner will be able to

CO1	**BELE-3611.1**	Learn about various types of signals and systems.

CO2	**BELE-3611.2**	Explain state space analysis of LTI systems.
CO3	**BELE-3611.3**	Evaluate various types of Fourier transformer and series for discrete and continuous time signals.
CO4	**BELE-3611.4**	Analyze signal and system properties like stability and causality using Laplace and Z transforms

Recommended Books

1. V. Oppenheim Alan, 'Signals and Systems', Prentice Hall, **1997**.
2. S. Haykins and B.V. Veen, 'Signals and Systems', John Wiley and Sons, **2007.**
3. M.J. Roberts, 'Fundamentals of Signals and Systems', SIE Edn.,McGraw HillEducation, **2007**.
4. B.P. Lathi, 'Linear Systems and Signals', Oxford University Press, **2009**.
5. Sanjay Sharma, 'Signals and Systems', Katson Publishers, **2013**.
6. Rajeswari K. Raja, Rao B. Visvesvara, 'Signals and Systems', PHI Learning Pvt. Ltd., **2014**.
7. M. Nahvi, 'Signals and Systems', McGraw Hill Education, **2015.**

SUBJECT TITLE: FLEXIBLE AC TRANSMISSION SYSTEM DEVICES
SUBJECT CODE: BELE-3612
SEMESTER: 6
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal Assessment: 40

End Term Exam: 60

Duration of Exam; 3 Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Learning Objectives:

1. To acquire knowledge about the various elements of instrumentation systems.
2. To acquire knowledge about working of data acquisition and corresponding signal conditioning.
3. To know about different types of display devices and recorders.

Contents of Syllabus:

Sr. No	Contents
UNIT-I	**Introduction:** Measurement of electrical quantities, Active and reactive power in power plants, Energy meters, Instrument transformers and their transient response.
UNIT-II	**Instrumentation Techniques:** Telemetry, Remote Control, remote signaling and supervisory control and data acquisition (SCADA), signal formation, conversion and transmission
UNIT-III	**Signal Transmission Techniques:** Analog pulse and digital modulation, Amplitude modulation(AM) and Frequency modulation (FM), AM and FM Transmitter and Receiver, Phase Modulation, Pulse modulation, Digital transmission techniques, error detection and correction. **Telemetry:** Telemetry errors, DC, pulse and digital telemetry methods and systems.
UNIT-IV	**Supervisory Control and Data Acquisition:** Function of SCADA system remote terminal unit(RTU) details, Control center details, Communication between control centers, control center and remote terminal unit.
UNIT-V	**Power Plant Instrumentation:** Hydroelectric power plant instrumentation,

	Thermal power plant instrumentation, Nuclear Power plant Instrumentation. Applications of SCADA system to Indian Power Systems

Course Outcomes: On successful completion of this course, the learner will be able to

CO1	**BELE-3612.1**	Know various types of transducers, signal conditioning and data acquisition systems.
CO2	**BELE-3612.2**	Familiar with digital measurement systems, display devices and recorders.
CO3	**BELE-3612.3**	Understand the concept of data transmission and telemetry.
CO4	**BELE-3612.4**	Understand about measurement of different parameters in power plant.

RECOMMENDED BOOKS:

1. Cegrell,T., Power System Control Technology, Prentice-Hall of India Private Limited(2001).`

2. Lindsley, D.M. , Power Plant Control and Instrumentation, IEEE Press (2000).

3. Jarvis, E.W., Modern Power Station Practice: Control and Instrumentation (Vol. F), British Electricity International (1980).

SUBJECT TITLE: INSTRUMENTATION IN POWER SYSTEM
SUBJECT CODE: BELE-3613
SEMESTER: 6
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal assessment:40
End Term exam: 60
Duration of exam : 3 Hrs.

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Course Objectives:

1. To review the power electronics fundamentals.
2. To review power transmission fundamentals and to introduce the FACTS concept.
3. To introduce to the need of shunt and series compensation and UPFC.

Contents of Syllabus:

Sr. No	Contents
UNIT-I	**Power Electronics Fundamentals:** Basic function of power electronics, Powersemiconductor device for high power converters, Static power convertor structures, AC controller based structure, DC link convertor topologies, Convertor output and harmonic control.
UNIT-II	**Power Transmission Control:** Fundamental of ac power transmission, Transmissionproblems and needs, the emergence of FACTS, FACTS control considerations, FACTS controllers
UNIT-III	**Shunt and Series Compensation:** Shunt SVC principles, Configuration and control,STATCOM, Configuration applications. Fundamental of series compensation using GCSC, TCSC and TSSC, Application of TCSC for different problems of power system, TCSC lay out, SSSC principle of operation
UNIT-IV	**Unified Power Flow Controllers:** Basic operating principles and characteristics,independent active and reactive power flow control, control of UPFC, installation, applications, UPFC model for power flow studies, comparison of UPFC with the controlled series compensators and phase shifters.

Course Outcomes: On successful completion of this course, the learner will be able to

CO1	**BELE-3613.1**	Understand the working of various FACTS devices.
CO2	**BELE-3613.2**	Learn to choose the controllers for various scenarios.
CO3	**BELE-3613.3**	Examine various FACT devices under various stability conditions
CO4	**BELE-3613.4**	**S**elect an appropriate FACTS device for a particular application

Recommended Books

1. A. Ghosh and G. Ledwich, 'Power Quality Enhancement Using Custom Power Devices', Kluwer Academic Publishers, **2005**.
2. N.G. Hingorani and L. Gyragyi, 'Understanding FACTS: Concepts and Technology of Flexible AC Transmission System', Standard Publishers and Distributors,**2005**.
3. Y.H. Sang and A.T. John, 'Flexible AC Transmission Systems', IEEE Press,**2006**.
4. R.M. Mathur and R.K. Verma, 'Thyristor Based FACTS Controllers for Electrical Transmission Systems', IEEE Press, **2002**.T.J.E. Miller, 'Reactive Power Control in Electric Systems', John Wiley, **1982**

SUBJECT TITLE: ELECTRICAL POWER SYSTEM
SUBJECT CODE: BELE-3671
SEMESTER: 6
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 50

End Term Exam: 50

LIST OF EXPERIMENTS

Sr. No	Contents
EXP-1	To study the performance of a transmission line. Also compute its ABCD parameters
EXP-2	Study of Characteristics of over current and earth fault protection.
EXP-3	To study the operating characteristics of fuse. (HRC or open type)
EXP-4	To find the earth resistance using three spikes
EXP-5	To study the radial feeder performance when (a) Fed at one end. (b). Fed at both ends
EXP-6	To study the performance of under voltage and over voltage relay.
EXP-7	To study the characteristics of bimetal mini circuit breakers.
EXP-8	To study over current static relay.
EXP-9	To find the breakdown strength of transformer oil.

Course Outcomes: On successful completion of this course, the learner will be able to

CO1	**BELE-3671.1**	Analyze the performance of a transmission line.
CO2	**BELE-3671.2**	Analyze the performance of relays.
CO3	**BELE-3671.3**	Analyze breakdown strength of transformer oil.
CO4	**BELE-3671.4**	Analyze operating characteristics of fuse.

SUBJECT TITLE: MICROCONTROLLER AND PLC LAB
SUBJECT CODE: BELE-3672
SEMESTER: 6
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 50

End Term Exam: 50

LIST OF EXPERIMENTS

Sr. No	Contents
EXP-1	Study of 8051/8031 Micro-controller kits.
EXP-2	Write a program to add two numbers lying at two memory locations and display the result.
EXP-3	Write a program for multiplication of two numbers lying at memory location and display the result. 4. Write a program to check a number for being ODD or EVEN and show the result on display.
EXP-4	Write a program to split a byte in two nibbles and show the two nibbles on display.
EXP-5	Write a program to arrange TEN numbers stored in memory location in ascending and descending order.
EXP-6	Write a program to find a factorial of a given number.
EXP-7	Study of interrupt structure of 8051/8031 micro-controllers.
EXP-8	Write a program to show the use of INT0 and INT1.
EXP-9	Write a program of flashing LED connected to port 1 of the micro-controller.
EXP-10	Write a program to control a stepper motor in direction, speed and number of steps.
EXP-11	Write a program to control the speed of DC motor. 13. Implementation of different gates using PLC.
EXP-12	Implementation of DOL and star delta starter using PLC.

EXP-13	Implement basic logic operations, motor start and stop operation using (i) Timers (ii) Counters
EXP-14	Motor forward and reverse direction control using PLC.
EXP-15	1. Make a PLC based system for separating and fetching work pieces.
	2. Make a PLC based control system for conveyor belt.
EXP-16	Implement a PLC based traffic light control.

Course Outcomes: On successful completion of this course, the learner will be able to

CO1	**BELE-3672.1**	Identifying and defining the automation control requirements, and specifying tasks to be performed.
CO2	**BELE-3672.2**	Choose the proper actuators and control hardware (Microcontroller, PLC, or PAC)
CO3	**BELE-3672.3**	Setting up and testing of actuators and control hardware .
CO4	**BELE-3672.4**	Documenting and presenting an appropriate solution.

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

SUBJECT TITLE: POWER SYSTEM ANALYSIS
SUBJECT CODE: BELE-4701
SEMESTER: 7
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1`	0	4

Internal assessment:40

End Term exam: 60
Duration of exam : 3 Hrs.

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Learning Objectives:

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

Contents of Syllabus:

Sr. No	Contents
UNIT-I	**SYSTEM MODELLING:** System modelling of synchronous machines, transformers, loads etc, per unit system, single line diagram of electrical networks, single phase impedance diagrams. Formulation of impedance and admittance matrices for the electrical networks.
UNIT-II	**LOAD FLOW STUDIES:** Data for the load flow studies, Swing Bus, Formulation

	of simultaneous equations, Iterative solutions by the Gauss-Seidal method and Newton-Raphson Method.
UNIT-III	**FAULT ANALYSIS:** Transients on transmission line, short circuit of synchronous machine, selection of circuit breakers, Algorithm for short circuit studies, Symmetrical Component transformation, and construction of sequence networks of power systems. Symmetrical Analysis of Unsymmetrical Line-to-ground (LG), Line-to line (LL), double line to ground (LLG) faults using symmetrical components
UNIT-IV	**POWER SYSTEM STABILITY**: Steady state stability, Dynamics of a synchronous machine, Power angle equations, Transient stability, equal area criterion, Numerical solution of swing equation, factors effecting transient stability.

Course Outcomes: On successful completion of this course, the learner will be able to

CO1	**BELE-4701.1**	Develop per unit system models of synchronous machines, transformers, transmission lines and static loads for power system studies.
CO2	**BELE-4701.2**	Touse bus admittance matrix to do load flow analysis and to do fault analysis by bus impedance matrix.
CO3	**BELE-4701.3**	Compare features of Gauss-Siedel, Newton-Raphson and Fast decoupled methods of load flow analysis.
CO4	**BELE-4701.4**	Examine the impact of various faults on power system.

BOOKS RECOMMENDED

1. Elgerd O.I., Electric Energy Systems Theory, Tata McGrawHill
2. Nagrath I.J., Kolthari D.P., Modern Power System Analysis, Tata McGrawHill
3. StevensonW.D., Elements of Power System Analysis, McGraw Hill
4. Nagrath I.J. and Kothari D.P., Power System Engineering, Tata McGrawHill

SUBJECT TITLE: NON-LINEAR AND DIGITAL CONTROL SYSTEMS
SUBJECT CODE: BELE-4702
SEMESTER: 7
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal assessment:40
End Term exam: 60
Duration of exam : 3 Hrs.

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Learning Objectives:

1. To make the students aware about digital control system, sampling process and Z-transform.
2. To introduce the students to state variable analysis and design of digital control systems.
3. To make them familiar with nonlinear control systems and to understand their stability criterion

Contents of Syllabus:

Sr. No	Contents
UNIT-I	**STATE VARIABLE TECHNIQUES:** State variable representation of systems by various methods, solution of state variable model. Controllability and observability.

UNIT-II	**PHASE PLANE ANALYSIS:** Singular points, Method of isoclines, delta method, phase portrait of second order nonlinear systems, limit cycle.
UNIT-III	**DESCRIBING FUNCTION ANALYSIS:** Definition, limitations, use of describing function for stability analysis, describing function of ideal relay, relay with hysteresis, dead zone, saturation, coulomb friction and backlash.
UNIT-IV	**LYAPUNOV'S STABILITY METHOD:** Lyapunov's direct method, generation of Lyapunov'sfunction by Krasovskii's and Variable Gradient methods
UNIT-V	**SAMPLED DATA SYSTEMS:** Sampling process, mathematical analysis of sampling process, application of Laplace transform. Reconstruction of sampled signal, zero order, first order hold. Z-transform definition, evaluation of Z-transform, inverse Z-transform, pulse transfer function, limitations of Z-transform, State variable formulation of discrete time systems, solution of discrete time state equations. Stability definition, Jury's test of stability, extension of Routh-Hurwitz criterion to discrete time systems.

Course Outcomes: On successful completion of this course, the learner will be able to

CO1	**BELE-4702.1**	examine discrete time systems
CO2	**BELE-4702.2**	Design and evaluate digital controllers.
CO3	**BELE-4702.3**	Understand Non Linear control systems and analyze their stability
CO4	**BELE-4702.4**	Implement observers and estimators for nonlinear systems.

BOOKS RECOMMENDED:

1. Ogata K., *Modern control engineering*. Prentice Hall (India)
2. Nagrath I.J., Gopal M., *Control system engineering*, New Age Publications
3. Hsu J.C. and Meyer A.U., *Modern control principles and application*
4. Gopal M., *Digital Control and State Variable Methods*, Tata McGraw Hill
5. Kuo B.C. and Golnaraghi F., *Automatic Control System, Wiley* Publications
6. Dorf R.V. and Bishop R.H., *Modern Control Systems*, Adison Wesley

SUBJECT TITLE: NON CONVENTIONAL ENERGY RESOURCES
SUBJECT CODE: BELE-4704
SEMESTER: 7
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal assessment:40
End Term exam: 60
Duration of exam : 3 Hrs.

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Learning Objectives:

1. To obtain knowledge about renewable energy sources and solar energy and their utilization.
2. To introduce to wind energy conversion and bio-mass energy conversion systems.
3. To introduce to geothermal energy and energy from ocean. To make them aware about hydrogen energy sources.

Contents of Syllabus:

Sr. No	Contents
UNIT-I	**INTRODUCTION:** Limitation of conventional energy sources, need and growth

	of alternative energy source, basic scheme and application of direct energy conservation.
UNIT-II	**MHD GENERATORS:** Basic principles, gaseous, conduction and hall effect, generator and motor effect, different types of Magneto-Hydro-Dynamic (MHD) generator, types of MHD material, conversion effectiveness, analysis of constant area MHD generator, practical MHD generator, application and economic aspects.
UNIT-III	**THERMO-ELECTRIC GENERATORS:** Thermoelectric effects, Seeback effect, Peltier effect, Thomson effect, thermoelectric converters, figures of merit, properties of thermoelectric material, brief description of the construction of thermoelectric generators, application and economic aspect.
UNIT-IV	**PHOTOVOLTAIC EFFECT AND SOLAR ENERGY:** Photovoltaic effect, different types of photovoltaic cells, cell fabrication, characteristics of photovoltaic cells, conversion efficiency, solar batteries, application, solar radiation analysis, solar energy in India, solar collectors, solar furnaces and applications.
UNIT-V	**FUEL CELLS:** Principle of action, Gibb's free energy, general description of fuel cells, types, construction, operational characteristics and application.
UNIT-VI	**MISCELLANEOUS SOURCES:** Geothermal system, hydro-electric plants, wind power, tidal energy, Bio-mass energy

Course Outcomes: On successful completion of this course, the learner will be able to

CO1	**BELE-4703.1**	Understand the need of conversion of various energy sources
CO2	**BELE-4703.2**	Examine fuel cell and magneto hydrodynamics technologies..
CO3	**BELE-4703.3**	Understand harnessing of biomass energy and wind energy.
CO4	**BELE-4703.4**	Analyze harnessing of Geothermal and Ocean energies

BOOKS RECOMMENDED:

1. Gupta B. R., Generation of Electrical Energy, S. Chand.
2. Rai, G.D., Non Conventional Energy Sources, Khanna Publishers.

3. Rao, S. and Parulekar, B.B., Energy Technology: Non Conventional, Renewable and Conventional, Khanna Publishers.

4. Wadhwa, C.L., Generation, Distribution and Utilization of Electric Energy, New Age International(P) Limited, Publishers.

SUBJECT TITLE: POWER SYSTEM ANALYSIS LAB
SUBJECT CODE: BELE-4771
SEMESTER: 7
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 60
End Term Exam: 40

LIST OF EXPERIMENT

Sr. No.	Contents
EXP-1	Design of transmission systems for given power and distance.
EXP-2	Short circuit calculations and calculations of circuit breaker ratings for a power system network.
EXP-3	Design of substations
EXP-4	Design of distribution systems
EXP-5	Y-bus formation
EXP-6	Z-bus formulation
EXP-7	Load flow analysis by Gauss-Seidal method
EXP-8	Load flow analysis by Newton-Raphson method
EXP-9	Fault analysis for line-to-line (L-L), Line-to-Ground (L-G)etc
EXP-10	Design of underground cabling system for substation.
EXP-11	To obtain power system stability on High Voltage Alternating current (HVAC) system with the help of Flexible Alternating Current Transmission Systems

	(FACTS)devices.
EXP-12	Optimal Capacitor placement on a system having variable reactive power and low voltage profile.
EXP-13	To obtain relay co-ordination on a power system.
EXP-14	To obtain optimal generator pricing on hydro-thermal and renewable energy systems.
EXP-15	To find synchronous reactance (Transient, sub-transient) during fault analysis.

Course Outcomes: On successful completion of this course, the learner will be able to

CO1	**BELE-4771.1**	Modeling of power system.
CO2	**BELE-4771.2**	Effectively employ different techniques to analyze different power system.
CO3	**BELE-4771.3**	Design of distribution systems, substations.
CO4	**BELE-4771.4**	To obtain relay co-ordination on a power system.

Note: At least TEN experiments are to be performed in a semester. List of experiments is given below:

SUBJECT TITLE: POWER SYSTEM OPERATION AND CONTROL

SUBJECT CODE: BELE -4711

SEMESTER: 7
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	4

Internal assessment:40
End Term exam: 60
Duration of exam : 3 Hrs.

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Learning Objectives:

1. To make students express Economic operation of power system and importance of LFC control.
2. To allow students discuss about thermal and hydro power plants operation in meeting the load demand optimally and expressing importance of reactive power control.
3. Ability to discuss single area load frequency control and two area load frequency control along with express variation of frequency in the power system with varying load.
4. Ability to model and design turbine and Automatic controller.

Contents of Syllabus:

Sr. No	Contents
UNIT-I	**Introduction to Power Generation Units:** Characteristics and its variations, **Economic Operation of Power Systems:** Fuel consumption, Characteristics of thermal unit, Incremental fuel rate and their approximation, minimum and maximum power generation limits.
UNIT-II	**Economic Dispatch:** Economic dispatch problem with and without transmission line losses, Unit Commitment and solution methods. Hydrothermal scheduling: fixed-head and variable head, Short- term and Long-term,
UNIT-III	**Power System Control:** Power system control factors, interconnected operation, tie-line operations, Reactive power requirements, during peak and off peak hours, Elementary ideas of load frequency and voltage, reactive power control; block diagrams of P-f and Q-V controllers, ALFC control, Static and Dynamic performance characteristics of automatic load frequency control (ALFC) and automatic voltage regulator (AVR) controllers, Excitation systems.
UNIT-IV	**Power System Security:** Factors affecting security, Contingency analysis, Network sensitivity, correcting the generation dispatch by using sensitivity method and linear programming.
UNIT-VI	**Power flow analysis in AC/DC systems**: General, modelling of DC links, solution of DC load flow, discussion, per unit system for DC quantities, solution techniques of AC-DC power flow equations

Course Outcomes: On successful completion of this course, the learner will be able to

CO1	**BELE-4711.1**	Understand operation of generators in various power plants
CO2	**BELE-4711.2**	Students will able to design the mathematical model of the speed governing systems, turbines and excitation systems.
CO3	**BELE-4711.3**	Students will able to discuss about load frequency control.
CO4	**BELE-4711.4**	Students will able to understand different types of loads and their characteristics

BOOKS RECOMMENDED:

1. Nagrath,I.J.andKothari,D.P.,PowerSystemEngineering,TataMcGrawHill.
2. Stevenson W.D. and Grainger J.J., Power System Analysis, McGraw Hill.
3. Arrillaga J. and Smith Bruce, AC-DC Power System Analysis, IEEPress
4. Elgerd, O.I., Electric Energy Systems Theory: An Introduction. 2nd Ed., Tata

McGraw Hill.
5. Dhillon J.S., Kothari D.P., Power System Optimisation, 2nd Ed., Prentice Hall India.
6. Kundur P, "Power System Stability and Control", Third Reprint, tat McGraw Hill.
7. Kennedy, B., Power Quality Primer, McGraw Hill.
8. Bollen, M.H.J., Power Quality Problems: Voltage Sag and Interruptions, IEEE Press.
9. Mohan, N., Power Electronics, New Age International (P) Limited, Publishers.

SUBJECT TITLE: HIGH VOLTAGE ENGINEERING
SUBJECT CODE: BELE-4713
SEMESTER:7
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	3	0	3

Internal assessment:40
End Term exam: 60
Duration of exam : 3 Hrs.

Objective and outcome of course:

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Learning Objectives:

1. To know about how power systems are subjected to over voltages and what are protection methods adopted against these over voltages.
2. To understand the basic physical phenomenon related to various breakdown processes in solid, liquid and gaseous insulating materials at high voltages.
3. To know about generation and measurement of D. C., A.C., & Impulse voltages.
4. To know about various tests on H. V. equipment and on insulating materials, as per the standards.

Contents of Syllabus:

Sr. No	Contents

UNIT-I	**Extra High Voltage (EHV) Transmission and Corona Loss:** Need for EHV Transmission. Use of bundled conductors, corona characteristics of smooth bundled conductors with different configurations, Corona loss. Factors affecting the corona loss. Radio interference due to corona. Shunt and series compensation in EHV lines. Tuned power lines. InsulationCo-ordination.
UNIT-II	**High Voltage Direct Current (HVDC) Transmission:** Advantages, disadvantages and economics of HVDC Transmission system.Types of Direct Current (DC) links, converter station equipment, their characteristics.
UNIT-III	**Insulating materials for High Voltage** Applications of insulating materials used in power transformers rotating machines, circuit breakers, cables, power capacitors. Conduction and breakdown in Gases, Liquids and Solid Dielectrics: **Solids-**Intrinsic, electromechanical and thermal breakdown composite dielectrics, solid dielectrics used in practice. **Liquids-**Conduction and breakdown in pure and commercial liquids, suspended particle theory, cavitation and bubble theory, stressed oil volume theory, Liquids used in practice. **Gases-**Ionization process, Townsend's current growth equations, Ist and 2nd ionization coefficients. Townsend's criterion for breakdown. Streamer theory of breakdown, Pashen's law of Gases. Gases used in practice.
UNIT-IV	**Generation of High Voltages:** High Voltage Direct Current (HVDC), High Voltage Alternating Current (HVAC), Power frequency and High frequency: Impulse voltage and impulse current Generation, Tripping and contact of Impulse Generator. Measurement of voltage and current: High voltage direct current, Alternating current and Impulse voltage and currents.

Course Outcomes: On successful completion of this course, the learner will be able to

CO1	**BELE-4713.1**	Various principles of HV generation and its measurements
CO2	**BELE-4713.2**	Examine lightning phenomena and high voltage insulation environment pollution.
CO3	**BELE-4713.3**	Understand the basic physical phenomenon occurring in various breakdown processes in solid, liquid and gaseous insulating materials.
CO4	**BELE-4713.4**	Know about generation and measurement of D. C., A.C., & Impulse voltages.

BOOKS RECOMMENDED:

1. Bagamudre, Rakesh Das Extra High Voltage A.C. Transmission Engineering, New Age International Publishers.

2. Kimbark E.W., High Voltage Direct Current Transmission, Wiley-Interscience
3. Kamaraju V. and Naidu M.S., High Voltage Engineering, Tata McGraw-Hill Education
4. Jha R.S., High Voltage Engineering, DhanpatRai.