RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
B.E. (Electrical Engineering)
SCHEME OF EXAMINATION

SEVENTH SEMESTER

S.N.	Sub Code	Subject	Board	Teaching Scheme				Credits	Examination Scheme			Min. Passing Marks	Paper Duration
				L	T	P	Total		College Assessment	Univ. Assessment	Total Marks		
1	BEELE701T	CONTROL SYSTEM-II	EE	4	1	0	5	5	20	80	100	40	3 Hours
2	BEELE702T	ELECTRICAL POWER SYSTEM –II	EE	4	1	0	5	5	20	80	100	40	3 Hours
3	BEELE703T	ELECTIVE –I	EE	3	1	0	4	4	20	80	100	40	3 Hours
4	BEELE704T	HIGH VOLTAGE ENGINEERING	EE	4	1	0	5	5	20	80	100	40	3 Hours
5	BEELE704P	HIGH VOLTAGE ENGINEERING	EE	0	0	2	2	1	25	25	50	25	
6	BEELE705T	ELECTRICAL INSTALLATION DESIGN	EE	4	1	0	5	5	20	80	100	40	3 Hours
7	BEELE705P	ELECTRICAL INSTALLATION DESIGN	EE	0	0	2	2	2	25	25	50	25	
8	BEELE706P	PROJECT SEMINAR	EE	0	0	3	3	3	50	0	50	25	
		Total		19	5	7	31	30			650		

RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
B.E. (Electrical Engineering)
SCHEME OF EXAMINATION

EIGHTH SEMESTER

S.N.	Sub Code	Subject	Board	Teaching Scheme				Credits	Examination Scheme			Min. Passing Marks	Paper Duration
				L	T	P	Total		College Assessment	Univ. Assessment	Total Marks		
1	BEELE801T	ELECTIVE- II	EE	3	1	0	4	4	20	80	100	40	3 Hours
2	BEELE802T	ELECTIVE- III	EE	3	1	0	4	4	20	80	100	40	3 Hours
3	BEELE803T	SWITCHGEAR & PROTECTION	EE	4	1	0	5	5	20	80	100	40	3 Hours
	BEELE803P	SWITCHGEAR & PROTECTION	EE	0	0	2	2	1	25	25	50	25	
4	BEELE804T	COMPUTER APPLICATIONS IN POWER SYSTEM	EE	4	1	0	5	5	20	80	100	40	3 Hours
	BEELE804P	COMPUTER APPLICATIONS IN POWER SYSTEM	EE	0	0	2	2	1	25	25	50	25	
5	BEELE805P	PROJECT	EE	0	0	6	6	6	75	75	150	75	
		Total		14	4	10	28	26			650		

S. No.	Elective-I	Elective-II	Elective - III
1	IT and Its Applications in Power System Control	Entrepreneurship Development	Bio-medical Engineering
2	Fuzzy Logic and Neural Networks	Digital Signal Processing	Advanced Microprocessor Peripherals
3	Flexible AC Transmission Systems	Power Quality	Power Semiconductor Based Electric Drives
4	Energy Management and Audit	EHV AC and HVDC Transmission	Electrical Distribution System

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

Absorption Scheme for the students of B. E. Electrical Engg. (Electronics & Power)

from <u>OLD semester</u> pattern to <u>NEW semester</u> pattern

VII Semester B. E. Electrical Engineering

Subject Code	Name of subject in Old semester pattern	Subject Code	Name of subject in New semester pattern
7S-EE-01	CONTROL SYSTEM-II (Th.)	BEELE701T	CONTROL SYSTEM-II
7S-EE-02	ELECTRICAL POWER –II (Th.)	BEELE702T	ELECTRICAL POWER SYST –II
7S-EE-03	ELECTIVE –I i) IT and Its Applications in Power System Control ii) Fuzzy Logic and Neural Networks iii) Flex A.C. Transmission Systems iv) Non conventional energy sources	BEELE703T	ELECTIVE –I i) IT and Its Applications in Power System Control ii) Fuzzy Logic and Neural Networks iii) Flex A.C. Transmission Systems iv) Energy Management and Audit
7S-EE-04	HIGH VOLTAGE ENGG. (Th.)	BEELE704T	HIGH VOLTAGE ENGG.
7S-EE-04	HIGH VOLTAGE ENGG (Pract.)	BEELE704P	HIGH VOLTAGE ENGG.
7S-EE-05	POWER ELECTRONICS (Th.)		----
	Power Electronics (Pract.)		----
7S-EE-06	PROJECT SEMINAR	BEELE706P	PROJECT SEMINAR
7S-EE-03	Electrical Installation Design (Elective-I) (Th.)	BEELE705T	ELECTRICAL INSTALLATION DESIGN*
		BEELE705P	ELECTRICAL INSTALLATION DESIGN *

***** The students who fail to clear any subject(s) of the VII semester (old pattern) by the last chance prescribed, shall be required to clear the respective equivalent subject of VII semester (new pattern) along with an additional subject marked with (*****).

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

Absorption Scheme for the students of B. E. Electrical Engg. (Electronics & Power)

from <u>OLD semester</u> pattern to <u>NEW semester</u> pattern

VIII Semester B. E. Electrical Engineering

Subject Code	Name of subject in Old semester pattern	Subject Code	Name of subject in New semester pattern
8S-EE-01	POWER SEMICONDUCTOR BASED DRIVES	BEELE802T	ELECTIVE- III i) Bio-medical Engineering ii) Advanced Microprocessor Peripherals iii) Power Semiconductor based Drives iv) Electrical Distribution System
8S-EE-02	ELECTIVE- II (Th.) i) EHV AC and HVDC Transmission ii) Entrepreneurship Development iii) Advanced Microprocessor Peripherals iv) Bio-medical Engineering v) Digital Signal Processing vi) Optimization Technique	BEELE801T	ELECTIVE – II i) Entrepreneurship Development ii) Digital Signal Processing iii) Power Quality iv) EHV AC and HVDC Transmission
8S-EE-03	SWITCHGEAR & PROTECTION (Th.)	BEELE803T	SWITCHGEAR & PROTECTION
8S-EE-03	SWITCHGEAR & PROTECTION (Pract.)	BEELE803P	SWITCHGEAR & PROTECTION
8S-EE-04	COMP.APPL.IN ELECTRICAL ENGG. (Th.)	BEELE804T	COMP.APPL.IN POWER SYSTEM
8S-EE-04	COMP.APPL.IN ELECTRICAL ENGG. (Pract.)	BEELE804P	COMP.APPL.IN POWER SYSTEM
8S-EE-05	PROJECT	BEELE805P	PROJECT

The students who fail to clear any subject(s) of the VIII semester (old pattern) by the last chance prescribed, shall be required to clear the respective equivalent subject of VIII semester (new pattern).

VII – SEM. ELECTRICAL ENGG.

BEELE701T - CONTROL SYSTEMS -II

Learning Objectives	Learning Outcomes
To impart knowledge of classical controller/compensator design for linear systems. To understand the theory and analyze non-linear system. To have idea about optimal and discrete time control system.	Students will be able to • Analyze the practical system for the desired specifications through classical and state variable approach. • Design the optimal control with and without constraints • Analyze non-linear and work with digital system and their further research.

UNIT - I

COMPENSATION: Need for compensation. Performance Analysis of Lead, Lag and Lag-lead Compensators in time & frequency domain, Bode Plots of Lead, Lag and Lag-lead Compensators. (Design of Compensator is not required).

UNIT-II

Solution of state equation: Review of state variable representations , diagonalization of state model ,eigen values and eigen vectors , generalized eigen vector, properties of state transition matrix (STM) , Computation of STM by Laplace transform, Cayley Hamilton theorem and Canonical transformation method. Solution of state equation.

UNIT-III

Design by state variable feedback: Controllability & observability. Kalman's test and Gilbert's test, duality, Design of State variable feedback. Effect of state feedback on controllability and observability.

UNIT-IV

Optimal Control System: Performance Index. Desirability of single P.I. Integral Square Error (ISE), Parseval's Theorem, parameter Optimization with & without constraints. Optimal control problem with T.F. approach for continuous time system only.

UNIT - V

Non Linear Control Systems: Types of non - linearities. jump resonance. Describing function analysis and its assumptions. Describing function of some common non- linearities. Singular points. Stability from nature of singular points. Limit cycles. Isocline method, Delta method.
(Construction of phase trajectories is not expected)

UN1T-VI

Sampled Data Control Systems: Representation SDCS. Sampler & Hold circuit. Shanon's Sampling theorem, Z-Transform. Inverse Z- Transform & solution of Differencial Equations. 'Z' & 'S' domain relationship. Stability by Bi-linear transformation & Jury's test. Controllability &. observability of Discrete time systems.

BOOKS :

Text Books		
Title of Book	**Name of Author/s**	**Edition & Publisher**
Control System Analysis	Nagrath & Gopal	New Age International
Linear Control System Analysis and Design	Constantine H. Houpis, Stuart N. Sheldon, John J. D'Azzo, Constantine H. Houpis, Stuart N. Sheldon	CRC Press
Digital Control and state variable methods	M. Gopal	The McGraw-Hill
Reference Books		
Modern Control Engineering	k. Ogata	Prentice Hall
Modern control system	M.Gopal	New Age International
Modern Control Engineering	D.Roy Choudhury	PHI Learning Private Limited, New Delhi

BEELE702T - ELECTRICAL POWER SYSTEM - II

Learning Objectives	Learning Outcomes
Students will understand the various aspects of electrical power systems such as stability, analysis of symmetrical components, various faults, economic scheduling and different methods of earthling.	A student will be able to • Understand the basics of power system. • Analyze and solve problems on symmetrical & unsymmetrical fault, stability. • Understand economy of operation and get familiar with types of grounding.

Unit 1: Symmetrical Component transformation: Three phase power in unbalanced circuit in terms of symmetrical component. Sequence impedances of Generator. Transformer Transmission line & Passive loads. Phase shift in Y/ delta three phase transformer (Yd1, Yd11 connection.).

Unit 2: **Symmetrical fault analysis:** Without & with pre fault load current . Selection of Circuit Breakers ratings, current limiting reactors.

Unit 3: **Unsymmetrical fault Analysis:** L-G, L-L-G, L-L, open conductors faults analysis using symmetrical components.

Unit 4: Stability of Power System- Steady state, Dynamic and Transient stability definition. Dynamics of synchronous machine, swmg equation, swing equation for machines swinging coherently and Non Coherently. Power angle equation. Steady state stability studies.

Transient stability studies: -

Swing curve. Equal Area criterion for transient stability. Application of equal area criterion for different disturbances. Solution of swing equation by point by point method. Methods of improving transient stability..

Unit 5: Economic operation of power system: Introduction, Distribution of load between units Within the plant Optimum generation scheduling considering transmission losses. Representation of transmission loss using loss formula coefficient. Derivation of loss formula co-efficient, simulation of co-ordination equation on digital computer.

Unit 6: i) Grounding of Neutral in power system.

ii) Shunt & series compensation-

Generalized equation, shunt reactor compensation of very long line with intermediate switching station, series capacitor compensation at line centre, shunt reactors at both ends and series capacitor in middle of line. Elementary idea of sub synchronous resonance problem arid counter measures.

Text Books		
Title of Book	**Name of Author/s**	**Edition & Publisher**
Elements of P.S. Analysis	William D. Stevenson	The McGraw-Hill Company
Modem power System analysis	Nagrath & Kothari	The McGraw-Hill Company
Power System Analysis	Wadhwa C.L	Tata McGraw-Hill Education
Reference Books		
Extra High Voltage AC. - Transmission Engineering	R D. Begamudre	New Age International

Note: - Unit 6 (ii) - Scope will be limited to the treatment given in recommended Book (4).

Elective- I BEELE703T (1)- I.T. & ITS APPLICATIONS IN POWER SYSTEM CONTROL

Learning Objectives	Learning Outcomes
Students will understand the various aspects of real time issues and communication required for automation. Student will also learn energy management and auditing.	A student will be able to • Understand the communication used for automation. • Understand the various aspects of energy auditing in industry • Do the networking of communication in industry with instrumentation and microprocessors.

UNIT# 1

Real-time issues on signal transmission and control; Communication systems for industrial automation; Data acquisition and Supervisory" control; Control of discrete manufacturing processes, Intelligent systems for monitoring, supervision and control; Case studies of industrial control systems.

UNIT # 2

Energy Auditing-Introduction, importance of Energy Audit basic terms of energy audit, Procedure for carrying energy audit, instruments used for energy audit such as power analyzer multipoint heat flow meter, lux meter, portable infrared radiation thermometer, thermocouple based temperature indicator.

Energy Conservation & Management-Need & importance of Energy Conservation & Management, payback period, return on investment (ROI),life cycle costs ,specific energy consumption. Calculation of Energy costs of specified products & simple systems. Analysis of selected energy intensive units like iron-steel, cement, petroleum refining etc.

UNIT # 3

Principles of multi-objective Energy management - with emphasis on conservation, User friendly software development on Windows 9x. UNIX Platforms for Energy Conservation &. Management Studies.

UNTT # 4

Serial data communication using RS232 and RS485 based system, distributed measurement system. IEEE488 protocol.

UNIT # 5

Local area networks - Common topologies. Medium access control-round-robin, reservation and contention based strategies. ALOHA protocol and its variants. CSMA and CSMA/CD protocols. Token-ring protocol. IEEE 802 standards for local area networks. High speed LANs - Fast and Gigabit Ethernet, FDDI. Wireless LANs. Internet Working- Repeaters, bridge routers *a*nd gateway S. TCP/IP protocol suite. TCP/IP sockets, client server computing. Name Service. Application protocols over TCP/IP. Network-Security.

UNIT # 6

Design of microprocessor based Instrumentation systems, design. interfacing circuits and data acquisition systems.

Text Books		
Title of Book	**Name of Author/s**	**Edition & Publisher**
Microprocessor & Interfacing	D.V Hall	Tata McGraw-Hill Education
LAN	Keiser	McGraw Hill
Reference Books		
Energy management	William T. Synder & Fredric W. symonds	
Energy management Handbook	W C Turker	

Elective- I BEELE703T (2)- FUZZY LOGIC & NEURAL NETWORK

Learning Objectives	Learning Outcomes
Students will understand the various aspects of fuzzy logic and neural network.	A student will be able to • Understand the fundamentals of fuzzy logic and ANN. • Learn different neural networks • Learn concepts of Associative memories and self organizing network.

UNIT –I: Introduction:

1. Fuzzy sets, Approximate reasoning Representing set of rules.
2. Fuzzy knowledge based.(FKBC)parameters. Introduction rule and data base inference engine, choice of fuzzyfication and & defuzzyfication processes.

UNIT -II: Nonlinear Fuzzy Control

Introduction, Control problem, FKBC as nonlinear transfer element, types of' FKBC.

UNIT - Ill: Adaptive Fuzzy control

Introduction, design, and performance evaluation, main approach to design.

UNIT-IV:

I. Fundamental concept of ANN.

2. Model of artificial neural network (ANN), Learning & adaptation learning rules.

Feed forward network:

Classification Model, feature & decision regions; Minimum distance, Classification, perceptron, delta learning rules for multi-perceptron layer, Generalized learning rules, back propagation Algorithm, back propagation training, learning factors.

UNIT - V: Recurrent Networks

Mathematical foundation of discrete time & gradient type hope field networks, transient response & relaxation modeling.

UNIT-VI: Associative memories &, self organizing networks.

Basic concept & performance analysis of recurrent associative memory',' 'Bidirectional associative memory, Hamming net & MAXNET Unsupervised larning of clusters, counter propagation network, feature mapping self organizing feature maps, cluster discovery network (ART 1)

Text Books		
Title of Book	**Name of Author/s**	**Edition & Publisher**
Introduction of Artificial Neural Networks	Jacek M. Zurada	PWS Publishing Company
Neural Network & Fuzzy system	Bart Kosko	Prentice Hall,India
Neural Networks: Comprehensive Foundation	Simon Hayking	Macmillan , Canada Inc
Reference Books		
An Introduction to Fuzzy Control	Dimiter Driankov, Hans Hellendoorn, Michael Reinfrank	Springer,
Fuzzy sets: ncertainty & information	Klir & Folger	Prentice Hall,India
Digital Image Processing	Gonzalez	AWFC

Elective- I BEELE703T (3) FLEXIBLE AC TRANSMISSION SYSTEMS

Learning Objectives	Learning Outcomes
To understand the problems and constraints related with stability of large interconnected systems and to study their solutions using different FACTS controllers, shunt (SVC, STATCOM), series (TCSC, GCSC, SSSC), series-shunt (UPFC), series-series (IPFC) .	A student who successfully completes the course will be able to demonstrate the • Ability to understand and identify the problems and constraints with stability of large interconnected system. • Ability to understand different types of converters, regulators and compensators

Unit-I: FACTS CONCEPT AND GENERAL SYSTEM CONSIDERATION:
Transmission Interconnection, Flow of Power in an AC System, factors affecting the Loading Capability, Power Flow and Dynamic Stability Consideration of Transmission interconnection, relative importance of controllable. Parameters, FACTS Controller.

Unit-II: VOLTAGE-SOURCED AND CURRENT. SOURCED CONVERTERS:
Single phase three phase full wave bridge converters transformer connections for 12 pulse 24 and 48 pulse operation. Three level voltage source converter, Generalized Technique of Harmonic Elimination and Voltage Control, Basic pulse width modulation converter, basic concept of current source Converters, and comparison of current source converters with voltage Source converters.

Unit-3: **STATIC SHUNTS COMPENSATORS: SVC AND STATCOM:**
Objectives of shunt Compensation, midpoint voltage regulation voltage instability prevention, improvement of transient stability, Power oscillation damping, Methods of Controllable VAR Generation, Static Var Compensators SVC and STATCOM, Comparison Between STATCOM and SVC, Static Var System.

Unit-4: STATIC SERIES COMPENSATORS: GCS, TSSC, TCSC AND SSSC:
Objectives of series Compensation, improvement of transient stability, power oscillation damping, Variable Impedance Type Series Compensators, Switching Converter Type Series Compensators (only SSSC), External (System) Control for Series *Reactive* Compensators. Applications of SSSC in load flow and transient stability studies.

Unit-5: STATIC VOLTAGE AND PHASE ANGLE REGULATORS; TCVR AND TCPAR:
Objectives of Voltage and Phase Angle regulators, Approaches to Thyristor Controlled Voltage and Phase Angle Regulators (TCVR and TCPARs), Switching Converter-Based Voltage and Phase Angle regulator, Hybrid Phase Angle Regulators.

Unit-6: COMBINED COMPENSATORS (UPFC, IPFC) AND SPECIAL PURPOSE FACTS CONTROLLERS:
The Unified Power Flow Controller (UPFC}, operating principal v-I Characteristics UPFC_–_Principal of Operation-modes of operation-application**.** Interline Power Flow Controllers Generalized and Multifunctional FACTS Controllers, Sub synchronous Resonance, NGH-SSR Damping Scheme, Thyristor-Controlled Braking Resistor (TCBR).

BOOKS :

Text Books		
Title of Book	**Name of Author/s**	**Edition & Publisher**
Understanding FACTS	Narayan G. Hingorani and Laszlo Gyigyi	Standard Publishers
FACTS : Controllers in Power Transmission & Distribution	K. R. Padiyar	1st , New Age International
Flexible AC Transmission System (FACTS)	Edited by Yang Hua Song and Johns	IEEE Publishers
Reference Books		
HVDC and FACTS controllers – Applications of Static Converters in Power System	V.K.Sood	New Age International(P) Limited, Publishers, New Delhi,
Thyristor Based FACTS Controllers for Electrical Transmission System	R. Mohan Mathur, Rajiv K Verma	Wiley

Elective- I BEELE703T (4) ENERGY MANAGEMENT AND AUDIT

Learning Objectives	Learning Outcomes
To understand the need of energy audit and the mechanism through which it should be carry out and also to manage the electric and thermal energy.	A student will able to • Know Present energy scenario with need of energy audit and energy conservation. • Understand various aspects of energy audit such as planning, monitoring and implementation • Manage electric and thermal energy in the industry.

Unit 1: Basics of Energy Management and Conservation (10 Hrs)

Global and Indian energy scenario. Global environmental concerns, Climate Change, Concept of energy management, energy demand and supply, economic analysis; Carbon Trading & Carbon foot prints.

Energy Conservation: Basic concepts, Energy conservation in household, transportation, agricultural, service and industrial sectors; Lighting & HVAC systems in buildings.

Unit 2: Energy Audit (8 Hrs)

Definition, need, and types of energy audit; Energy management (audit) approach: Understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements; Fuel & energy substitution; Energy audit instruments; Energy Conservation Act; Duties and responsibilities of energy managers and auditors.

Unit 3: Material & Energy balance and Waste Heat Recovery (8 Hrs)

Facility as an energy system; Methods for preparing process flow; material and energy balance diagrams.
Cogeneration and waste heat recovery;

Unit 4: Energy Action Planning, Monitoring and Targeting: (8 Hrs)

Energy Action Planning : Key elements; Force field analysis; Energy policy purpose, perspective, contents, formulation, ratification; Organizing the management: location of energy management, top management support, managerial function, roles and responsibilities of energy manager, accountability; Motivation of employees: Information system-designing barriers, strategies; Marketing and communicating: Training and planning.

Monitoring and Targeting : Defining monitoring & targeting; Elements of monitoring & targeting; Data and information analysis; Techniques: energy consumption, production, cumulative sum of differences (CUSUM); Energy Service Companies; Energy management information systems; SCADA systems.

Unit 5: Electrical Energy Management: (8 Hrs)

Supply side: Methods to minimize supply-demand gap, renovation and modernization of power plants, reactive power management, Demand side management: conservation in motors, pumps and fan systems; energy efficient motors.

Unit 6: Thermal energy Management: (8 Hrs)

Energy conservation in boilers, steam turbines and Furnaces; Application of FBC, Heat exchangers and heat pumps.

Text Books		
Title of Book	**Name of Author/s**	**Edition & Publisher**
Handbook on Energy Audits and Management	Amit Kumar Tyagi	TERI
Energy Management Handbook	Wayne C. Turner	Wiley Inter Science Publication
Reference Books		
Principles of Energy Conservation	Archie, W Culp	McGraw Hill, 1991
Energy Management	P. O'Callaghan	McGraw - Hill Book Company, 1993
Handbook of Energy Engineering	Thuman A and Mehta D Paul	The Fairmount Press
Bureau of Energy Efficiency Study material for Energy Managers and Auditors Examination: Paper I to IV.		
Handbook of Energy Audit and Environment Management	Y.P. Abbi, Shashank Jain	TERI

BEELE 704 T- HIGH VOLTAGE ENGINEERING

Learning Objectives	Learning Outcomes
Student will learn the various concepts of high voltage engineering such as breakdown mechanism, lightning and switching overvoltage, travelling waves etc. Student will also learn measurement and calculation of high voltage and current using different tests.	Students has understood breakdown mechanism in solid liquid and gaseous medium lightening and switching over-voltages and insulation coordination different methods of generation and measurement of high voltage and currents in laboratory different methods of non destructive and High Voltage testing of apparatus.

Unit 1 : Breakdown mechanism in Di-electric : Ionization process; Townsend's criterion for B.D. Break down in electro-negative gases, Time-lag for B.D.; Streamer theory for B.D in gases, Paschen's law; B.D in non-uniform field. Corona discharges and introduction of corona post B.D. phenomenon and applications, Practical considerations in using gases for insulation purpose; vacuum insulation, Liquid as insulators, conduction and B.D. in pure and commercial liquids. Intrinsic, electromechanical &.thermal B.D., B.D. of solid di-electrics in practice; B.D. in composite dielectrics.

Unit 2: Lighting and switching over voltages; Mechanism of lightening, types of strokes, parameter and characteristics of lightening strokes, characteristics of switching surges; power frequency over voltages. control of O.V. due to switching. Protection of lines by ground wires, protection by lightning Arrester, gap type and sapless L.A.., selection of L.A. ratings, surge-absorbers.

Unit 3: Traveling waves and Insulation coordination; Traveling waves' on transmission lines, Classification of lines attenuation and distortion of traveling waves, reflection and transmission of waves, behavior of rectangular waves at transition points. Introduction to insulation coordination, associated terms, impulse waveform. Introduction to BIL Reduced BIL and SIL.

Unit 4: Generation of high voltage and. Currents: Generation of High D.C voltages by rectifiers, voltage doubler and multiplier, circuits (Derivations and expression 'not required), electrostatic machines, Generation of high AC voltages by Cascade transformers, Resonant transformers, generation high frequency AC high voltage. Generation of impulse voltages: Standard impulse wave shapes, analyses of model and commercial impulse generation circuits, wave shape contro1 Marx circuit, tripping and control of impulse generation, generation of switching surges generation of impulse current.

Unit 5: -Measurement of high voltage and current: Measurement of high AC and DC voltage by micro ammeter, generating voltmeter resistance and capacitance potential divider, series impedance voltmeter CVT, Magnetic type potential transformers, electrostatic voltmeter. Peak reading AC voltmeter. Sphere gap arrangement. Measurement of impulse voltage by' potential dividers and peak reading voltmeters. Measurement of High AC DC current; measurement of high frequency and impulse current by resistive shunt (Bifilar strip shunt only,)

Unit 6: Non destructive and high voltage testing of electrical apparatus; Non destructive testing Measurement of DC Resistivity, measurement of Dielectric constant and loss-factor *(low* and power frequency only), Schering bridge for high charging circuits, for high dissipation factor for three terminal measurement, transformer ratio arm bridges, partial discharge measurements by straight detectors & by balance detectors , calibration of detectors, discharge detection *in* power cables. High voltage testing. Testing of insulators, bushings, Isolators, circuit. breakers, cables, transformer, lightning arresters and power capacitors.

Text Books		
Title of Book	**Name of Author/s**	**Edition & Publisher**
High Voltage Engineering	M.S. Naidu and V Kamaraju	TMG
High Voltage Engineering	C.L.Wadhwa	New Age International
EHV AC Transmission	Begamudre	New Age international Publisher
Reference Books		
Advances In high Voltage Engineering	A.Haddat and D. Warne	IET

BEELE 705 T - ELECTRICAL INSTALLATION DESIGN

Learning Objectives	Learning Outcomes
The course will prepare students 1. The course will prepare students to understand methodology of load forecasting and assessment of electrical loads, types of electric loads and selection of apparatus for controlling electrical power. 2. The course will prepare students to design the distribution system for residential, commercial, industrial applications and utility distribution networks and illumination design 3. The course will prepare students to understand methods of installation, testing and commissioning of electrical apparatus and conductors. 4. The course will prepare the students to understand statutory requirements related to electrical design, safety and protection.	Upon the completion of this course, a. The students will understand concept of load forecasting, solve problems based on regression analysis. b. The students will be able to draw single line diagrams with specifications for electrical distribution networks for residential and commercial installations. c. The students will be able to draw single line diagrams with specifications for distribution networks, motor and power control centers for industrial installations and design reactive power compensation. d. The students will be able to understand construction, types and selection of PVC/ XLPE cables and overhead conductors e. Students shall be able to design 11kV and 33 kV substations for utility and industrial installations and specify the ratings and specifications of apparatus used f. Students shall be able to understand procedure for receipt, storage, testing and commissioning of transformers along with its accessories viz OTI, WTI, Silica Gel Breather, MOG, Buchholz relay etc g. Students will be able to determine fault level at various locations in radial networks and be able to find rating and location of series reactors h. Students will understand the relevant provisions of IE rules for low medium and high voltage installations i. Students will be able to understand provisions for system and equipment earthings as per IS 3043

Unit 1:

Electrical load assessment: **(4H)**

Concept of electrical load, categories of load, types of loads, connected load, demand factor, Maximum demand, diversity factor, load factor, power factor, TOD Tariff, Industrial Electric Bills.

Cables, conductors & bus-bars: **(4H)**

Construction, selection, installation, testing of LT/ HT cables, overload & short circuit ratings, rating factors; Overhead line conductors, copper and aluminium busbars.

Unit 2:

Switching & protection devices: **(5H)**

Types, specifications; selections of isolators, switches, switch fuse units, MCB, ELCB, MCCB,ACB, VCB, SF6 breakers, dropout/ horn gap fuses, AB switches, contactors for voltages upto 33 kV. Various types of protective releases for above circuit breakers.

Symmetrical Short Circuit Calculations: **(4H)**

Determining symmetrical short circuit currents at various locations for selecting proper circuit breaker rating & determining value of series reactors for limiting short circuit current. Overcurrent protection with two phase fault & one ground fault relays.

Unit 3:

Electric supply to Induction Motors in industries: **(5H)**

Types of motors, SLD and working of DOL/ Star-Delta/ Autotransformer starters; types, specifications, selection of power contactors, Overload relays, short circuit protective devices.

Reactive power management in industries: **(4H)**

Reactive power compensation in industries using static capacitors, use of Power Triangle, Calculating payback period for capacitor investment due to reduced system currents.

Unit 4:

Transformers: **(4H)**
Specifications, ratings, selection, installation, testing & commissioning.
Substations: **(4H)**
11kV & 33 kV, indoor/ outdoor substations, plan/ elevations, Earthing Arrangement

Unit 5:
Design of Industrial Electrical Installations: **(8H)**
Preparing load list, assessing various factors associated with loads, selection of transformer, design of PCC & MCC, selection of all the associated electrical apparatus, busbars, cables, switchgear, protective devices, earthing system, testing, commissioning.
Unit 6:
Earthing (IS 3043): **(4H)**
Necessity of earthing, concept of system & equipment earthing, definitions of various terms, types of earthing, earth tester and measurement of earth resistance.
IE Rules: **(4H)**
Important IE Rules applicable to residential, commercial & industrial installations.

Text Books		
Title of Book	**Name of Author/s**	**Edition & Publisher**
Electric Power Distribution system	A.S.Pabla,	Tata McGraw-Hill
Course in Electrical Power	P. V. Gupta, M. L. Soni, U. S. Bhatnagar	Dhampat Rai and Sons., 1987
Electrical Substation Engineering & Practice	S. Rao	Kanna Tech. Publ., 1992
Reference Books		
Design of Electrical Installations	V. K. Jain, Er. V.K. Jain & Er. Amitabh Bajaj	Laxmi Publications Pvt Limited, 01-Jan-1993
Electrical Engineering Handbook	C. L. Wadhwa	
Indian Electricity Regulation 1956		

BEECE 705 P – ELECTRICAL INSTALLATION DESIGN (PRACTICAL)

A. Visit for Comprehensive study of existing electrical installation:
Student should visit a residential/ commercial or industrial facility, preferably with its own transformer substation and:

1. Understand the processes in which the electricity is used and characterize the processes viz lighting, heating, cooling, air-conditioning, ventilation, pumping and other industry specific applications like mixing, pulverizing, machining, welding etc.
2. Prepare a list of all the loads demanding electric supply and assess "connected load"
3. Get the copies of at least six previous electric bills and determine the "demand factor", "load factor""power factor" etc.
4. Study the tariff structure and note various costs, taxes and duties. Understand TOD tariff. Note the sanctioned load, contract demand etc.
5. Note how the establishment receives electric supply (overhead/ underground), its voltage level (HT/LT, single phase two wire/ three phase three wire, three-phase four wire etc. Note the specifications of incoming conductor/ cable.
6. Note the type of energy meter used by electricity board (analogue/ digital, single/ three phase, directly connected/ CT operated, HT metering cubical)
7. Draw the power flow diagram of the electrical installation including transformers, stand- by DG supply
8. Convert the power flow diagram into single line diagram (SLD). Identify different components of Power Control Center (PCC) and Motor Control Center (MCC). Specify the current rating and specifications of various HT/LT switchgear and control- gear.

9. Identify various protections against earth leakage, overloads and short circuits.
10. Note in details the Earthing System, types, material used and quantity of earth electrodes etc.
11. Note reactive power management system, types and rating of capacitors, manual/ automatic control of PF improvement capacitors, Location of capacitors in system.
12. Submit the report for assessment.

B) Understanding the operating principle, construction and internal parts of electrical apparatus/ equipments:

Power and Control contactors: power contacts, control contacts, fixed/ moving contacts, magnetic circuit, copper shading band in AC contactors, operating coil, arc chutes; dismantling & assembly of contactors.Capacitor Duty Contactors.Rating & Specifications.

Switchgear: Re-wirable/ HRC main switches (Switch fuse, fuse switch units), MCB/ MCCB (Thermal/ magnetic release), Overload relays. Identifying difference between switch and circuit breakers. Single vs double break arrangement of contacts.

Transformer accessories: Buchholz Relay, Oil temperature Indicator (OTI), Winding Temperature Indicator (WTI), magnetic Oil Level Gauge, Silica Gel Breather.

C) Performing Routine Tests:

1. OC/ SC test on 5 kVA, Three –phase, delta- star transformer.Megger Test.
2. Turns ratio, magnetic Balance Test; Megger Test on three phase transformer.
3. Megger and Continuity test for HT/ LT cables.

C) Assembling and testing of DOL and Automatic Star Delta Starters.

D) Simulation for 3-phase short circuit current in distribution system using software like e-tap.

E) Common HT equipments: construction, operation, specifications, ratings of 11 kV AB Switch, Drop Out/ Horn Gap fuse, Distribution/ station class lightening arrestors.

F) Earthing system: Study of various types of Earth electrodes (rod/pipe/plate), maintenance free earth electrodes, Measurement of Earth electrode resistance and measurement of soil resistivity.

G) Some practicals based on illumination.

H)Preparing a list of reputed national/ global manufacturers in Electrical systems, their product range.

VIII – SEM. ELECTRICAL ENGG.

Elective II BEELE 801 T (1) - ENTREPRENEURSHIP DEVELOPMENT

Learning Objectives	Learning Outcomes
Student will learn how to become an entrepreneur. Various role an entrepreneur has to play such as market surveyour, project manager, planner, Operational incharge etc.	Students has understood • How to carry out market survey, demand forecasting etc. • How to calculate economic feasibility, preparation of project report, project planning, implementation schedule etc. • How to do performance analysis, environmental and societal impact.

UNIT - I

Need analysis, market survey, characteristics of market, sample survey, demand forecasting secondary data, accuracy, and confidence level, uncertainty.

UNIT- II

Technical feasibility: Process selection, level of automation, plant capacity, acquiring technology, appropriate technology plant location, Equipment selection & procurement, Govt. policies.

UNIT - III

Economic feasibility: Cost of project working capital analysis, fixed cost, means of finance, estimation of sales and production price analysis, breakeven point, projected cash flow statements, projected balance sheet, projected profit and loss statement, projected cash projected cash flow, rate of return, discounted payback period, cost benefit analysis , return after taxes.

UNIT - IV

Project Planning & Control: CPM, PERT. Optimum project duration, resource allocation, updating.

UNIT V:

Project report: Preparation of project report, risk analysis, sensitivity analysis, methods of raising capital.

UNIT VI:

Project review:

Initial review, performance analysis, ratio analysis, sickness, project revival, environmental & social aspects.

Text Books		
Title of Book	**Name of Author/s**	**Edition & Publisher**
Engineering Economy	H.G. Thuesen. W.J. Fabricky, G.J. Thuersen	Prentice Hall of India Pvt. Ltd
CPM & PERT	Shrinath	East West publisher
Reference Books		
Projects	P.K Joy	Mc Millan
Projects	Prasanna Chandra	Tata Mc Graw Hill Publishing Company Ltd

ELECTIVE-II BEELE 801 T (2) -DIGITAL SIGNAL PROCESSING

Learning Objectives	Learning Outcomes
Student will learn discrete time signals and systems with representation in different ways. They will also learn how to do the analysis using Fourier and Z-transform.	Students has understood • Discrete time signals and system. • Use of Fourier and z-transform in analysis of discrete signals. • Various filter design techniques use for discrete variables and discrete Fourier transform

UNIT–1: Discrete time signals & systems; Discrete time signals, Discrete time systems, Classification of discrete time systems: Linearity, causality, stability, static dynamic, Time Invariance Time variance. Linear convolution, circular convolution, cross correlation, Autocorrelation. Sampling theorem & sampling process, Reconstruction of sampled data.

UNIT- II: Frequency domain representation of discrete time signals and systems, Fourier transform (DTFT) of discrete time signals, properties of discrete time Fourier transform,

UNIT - III: The Z - transform: Definition. Properties of the region of convergence for the Z- transformer, Z - transform properties, Inverse Z - transform using contour integration, partial fraction expansion, power series methods, Parseval's theorem, unilateral Z – transform.

UNIT – IV: Transform analysis of LTI system & structures for discrete - time system: Frequency response of LTI system, relationship between magnitude & phase, all pass system, minimum phase system, linear system with generalized linear phase.

Block diagram representation & signal flow graph representation of linear constant Coefficient difference equations, basic structures for IIR systems, transposed forms, basic network structures for FIR systems, lattice structures.

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UNIT - V: Filter design techniques: Design of discrete time IIR filters from continuous time filters.
Frequency transformations of low pass IIR filters, Design of FIR filters by windowing, FIR filter design by Kaiser Window method. Frequency sampling method.

UNIT-VI: Discrete Fourier Transform: Discrete Fourier series, properties of discrete Fourier series, discrete Fourier transform, properties of DFT, circular convolution using discrete Fourier transform. Decimation in time FFT algorithm, decimation in frequency FFT, FFT of long sequences using overlap add & overlap save method.

Text Books		
Title of Book	**Name of Author/s**	**Edition & Publisher**
Discrete time signal processing	Alan V. Oppenheim, Ronald W. Schafer & Buch	2nd, Pearson
Digital Signal Processing - A Computer based approach	Sanjit K. Mitra	McGraw-Hill Education, 2011
Reference Books		
Digital signal processing Theory & application	Prows end Manolakis	3rd, PHI Ltd.
Digital signal processing, principles, algorithm and applications	John G. Prokis	PHI Ltd.

Elective- II **BEELE 801T (3) POWER QUALITY**

Learning Objectives	Learning Outcomes
Students will know the various power quality issues such as voltage sag, swell, flickers etc. with a waveform distortion. They will also learn how to monitor, assess and mitigate these issues.	Students will be able to understand • Power quality standards for voltage sag, swell, distortions, flickers etc. • Approach for power quality monitoring, assessment and mitigation. • State variable model and harmonic estimation.

Unit I: Introduction: Importance of power quality, terms and definitions of power quality as per IEEE std. 1159. such as transients, short and long duration voltage variations, interruptions, short and long voltage fluctuations, imbalance, flickers and transients. Symptoms of poor power quality. Definitions and terminology of grounding. Purpose of groundings. Good grounding practices and problems due to poor grounding. **(8 Hrs)**

Unit II: Flickers & transient voltages: RMS voltage variations in power system and voltage regulation per unit system, complex power. Principles of voltage regulation. Basic power flow and voltage drop. Various devices used for voltage regulation and impact of reactive power management. Various causes of voltage flicker and their effects. Short term and long term flickers. Various means to reduce flickers. Transient over voltages, sources, impulsive transients, switching transients, Effect of surge impedance and line termination, control of transient voltages. **(10 Hrs)**

Unit III: Voltage sag, swells and interruptions: Definitions of voltage sag and interruptions. Voltage sags versus interruptions. Economic impact of voltage sag. Major causes and consequences of voltage sags. Voltage sag characteristics. Voltage sag assessment. Influence of fault location and fault level on voltage sag. Areas of vulnerability. Assessment of equipment sensitivity to voltage sags. Voltage sag *limits for computer equipment, CBEMA, ITIC, SEMI F 42 curves. Representation of the results of voltage sags analysis. Voltage sag indices. Mitigation measures for voltage sags, such as UPS, DVR, SMEs, CVT etc., utility solutions and end user solutions. **(8Hrs)**

Unit IV: Waveform Distortion: Definition of harmonics, inter-harmonics, sub-harmonics. Causes and effect of harmonics. Voltage versus current distortion. Overview of Fourier analysis. Harmonic indices. A.C. quantities under non-sinusoidal conditions. Triplen harmonics, characteristics and non characteristics harmonics. Harmonics series and parallel resonances. Consequences of harmonic resonance. Principles for controlling harmonics. Reducing harmonic currents in loads. K-rated transformer. Harmonic study procedure. Computer tools for harmonic analysis. Locating sources of harmonics. Harmonic filtering, passive and active filters. Modifying the system frequency response. IEEE Harmonic standard519-1992. **(10Hrs)**

Unit V: Power quality monitoring Need of power quality monitoring and approaches followed in power quality monitoring. Power quality monitoring objectives and requirements. Initial site survey. Power quality Instrumentation. Selection of power quality monitors, selection of monitoring location and period. System wide and discrete power quality monitoring. Setting thresholds on monitors, data collection and analysis. Selection of transducers. Harmonic monitoring, Transient monitoring, event recording and flicker monitoring. **(6Hrs)**

UNIT VI: Power Quality Assessment & Mitigation Power Quality assessment, Power quality indices and standards for assessment disturbances, waveform distortion, voltage and current unbalances. Power assessment under waveform distortion conditions. Power quality state estimation, State variable model, observability analysis, capabilities of harmonic state estimation. Test systems. Mitigation techniques at different environments. (**8 Hrs**)

Text Books		
Title of Book	**Name of Author/s**	**Edition & Publisher**
Understanding power quality problems, voltage sag and interruptions	M. H. J. Bollen	IEEE press, 2000, series on power engineering
Electrical power system quality	R.C. Dugan, M.F. McGranghan, S. Santoso, H. Wayne Beaty	2nd, McGraw Hill Pub.
Reference Books		
Power system quality assessment	J. Arrillaga, M.R. Watson, S. Chan	John Wiley and sons
Electric power quality	G. J. Heydt	
Power system harmonics: Computer modeling and analysis	Enriques Acha, Manuel Madrigal	John wiley and sons ltd
Power System Harmonics	J. Arrillaga & N. Watson	
IEEE std 519-1992/ IEEE std 1159 IEEE recommended practices and requirements for harmonics control in electrical power system		

ELECTIVE-II BEELE 801T (4) - EHV AC & HVDC TRANSMISSION

Learning Objectives	Learning Outcomes
Students will understand various aspects of Transmission systems, power flow controls for EHVAC and HVDC transmission lines,design parameters of filters and Layout of HVDC power plant	On Successful Completion of the course the Student will be able to demonstrate the knowledge of : • Power handling capacity of different Transmission systems • Electrostatic and electromagnetic fields and corona in EHVAC lines • Voltage control and current control systems for power flow controls in HVDC system. • The knowledge of design parameters of AC filters as well as DC filters and Reactive power compensation • Overall knowledge about the HVDC system such as MTDC, protection and substation layout of HVDC power plant.

Unit 1: (i) Power Handling capacities of EHV AC transmission lines. (ii) Voltage, gradients; Electric field of point charge sphere gap, line-charge, single and three phase line bundled conductors. Maxwell's potential coefficients, Mangoldt formula.

Unit 2: (i) Electrostatic and electromagnetic fields of EHV line electric shock and Threshold current capacitance of long object; calculation of electrostatic field of AC. Lines (3-phase single and double circuit lines only) Effect of high electrostatic field, measurement *of* electrostatic field, induced voltages in insulated ground wires, electromagnetic interference (ii) Corona types, critical disruptive voltages; factor affecting corona, methods for reducing corona power loss, corona current wave form charge voltage diagram audible noise and radio interference.

Unit 3: (i) Comparison of EHVAC and HVDC systems. (ii) Conversion from AC to DC. Rectifiers, converter conversion from DC to AC, Invertors. (iii) Kinds of DC link. (iv) Earth electrode and earth returns; Introduction & objectives, location and configuration, resistance of electrodes, means of reducing earth electrode resistance, trouble caused by earth current and remedies. (v) Multi terminal HVDC system: Introduction, 2 pole transmission, MTDC system with series and paral1el connected converters, advantages OF parallel connected converters, and applications, configurations and types.

Unit 4:- (1) Power flow control in HVDC system: Constant current. Constant voltage, constant ignition and excitation angle control, control characteristics. (ii) Parallel operation of AC and DC links (Synchronous and Asynchronous links)

Unit 5:-(i) Harmonic Filters: Introduction, Filters, Surge capacitor and damping circuit, shunt filters, senes filters, AC filters, design of AC. filters and turned filters, double frequency and damped filters cost consideration. Rating AND harmonics on D.C. Side of converter, D.C. Harmonic filters. (ii) Reactive power compensation: Reactive power requirements of HVDC convertors, substations, effect of Delay angle and extinction angle on reactive power.

Unit 6: (1) HVDC circuit breakers Introduction, construction, principle, switching energy interruption of DC current application of MRTB. Types of HVDC C.B. capability and characteristics of HVDC circuit breakers (ii) HVDC substation protection against short circuit: Introduction, fault Clearing, protective zones, protection symbols, HVDC line pole protections (fault clearing and re-energizing), (iii) HVDC sub-station protection against over voltage, difference between Insulation coordination of AC and DC systems, fundamentals of switching over voltages, Over Voltages on A.C sides, and on D.C side surge- Arrestors protection scheme. Insulation coordination and protection margin.

Text Books		
Title of Book	**Name of Author/s**	**Edition & Publisher**
EHV AC and HVDC Transmission Engineering and practice	Sunil S. Rao	Khanna, publications
Electrical Power Systems	C.L. Wadhwa	2nd Edition New Age International
Reference Books		
EHV AC Transmission	Rakosh Das Begamudre	New Age International

ELECTIVE-III BEELE 802 T (1) - BIOMEDICAL ENGINEERING

Learning Objectives	Learning Outcomes
Students will understand the human body physiology with subsystem. Different methods of monitoring system of human body parameters and different control methods used.	On Successful Completion of the course the Student will be able to understand : • Physiology of human body with subsystem. • Different parameter measurement and monitoring using different devices • Control of body functioning using electronic devices.

UNIT - 1: Introduction: Human body physiology and subsystems, Biochemistry, Measurement of Electrical activities of human body.

UNIT - 2: Electrocardiography, Electro-encephalography, electromyography, Electroretinography, Principles specifications and interpretation of records.

UNIT -3: Measurement of no electrical quantity in human body, Measurement of blood flow respiration rate and depth heart rate.

UNIT- 4: ESR blood pressure, temperature PH impedance of various parts GSR mobility of internal organs.

UN1T-5: Control of body functioning: Stimulator for muscle and nervous system cardiac pacemaker.

UNIT- 6: Blood pump respiration controller myo electric control of paralyzed muscles.

Text Books		
Title of Book	**Name of Author/s**	**Edition & Publisher**
Biomedical Instrument	Cromwell.	Prentice Hall of India, New Delhi
Biomedical Engineering System		McGraw Hill
Biomedical Instrumentation & Measurement	Carr & Brown	Pearson
Medical Instrumentation	John. G. Webster	John Wiley
Reference Books		
Bioelectric Phenomena	Robert Blensev	McGraw Hill
Introduction to Biomedical electronics	Edwand J. Bukstein	Sane and Co. Inc

ELECTIVE-III
BEELE 802 T (2) - ADVANCED MICROPROCESSORS AND PERIPHERALS

Learning Objectives	Learning Outcomes
Students will understand various aspects of microprocessor and its peripherals	On Successful Completion of the course the Student will be able to understand : • Microprocessor and microcontrollers with its architecture. • Interfacing of microprocessor and microcontroller with its peripherals • Concept of virtual memory and DoS structure

Unit 1: Introduction to 16 bit microprocessors. 8086/8088 CPU architecture, Memory organization and interfacing.

Addressing modes, Instruction Set, examples Pseudo op-codes with ASM.86. ..

Unit 2: Interfacing of peripherals 8255 and 8253 with 8086. Architecture, operation and interfacing of 8251, 8257 with 8085 and. 8086/8088.

Unit 3: Architecture, operation and interfacing of 8259; with 8279 with 8085 and 8086/8088.

Unit 4: Multiprocessor system bus, 8087 coprocessor with architecture and instruction set, organization of PCXT / AT mother board.

Unit 5: Introduction to 80286, 386, 486 architecture. Concepts of Cache, associated/virtual memory. DOS structure.

Unit 6: Architecture of 8097 microcontrol1er, its important features, interface with parallel and serial I/O (Instruction set not included.)

Text Books		
Title of Book	**Name of Author/s**	**Edition & Publisher**
Programming and interfacing of 8086/808,8	D. V.Ha11	McGraw Hill
Programming and Interfacing 8086	Leu and Gibson	PHI
Reference Books		
Intel Reference Manuals for i) Microprocessor and ii) microcontrollers		
80286/80386 Assembly Language	Murary	Tata McGraw Hill
80386 Assembly Language	Femamdez	T.M.H.

ELECTIVE-III
BEELE 802 T (3) -POWER SEMICONDUCTOR BASED DRIVES

Learning Objectives	Learning Outcomes
• To study the converter and Chopper control of DC drives. • To study the semiconductor based control of Induction and Synchronous motors. • To learn the basics of Switched reluctance motor and Brushless DC motor. • To Study the non conventional and renewable energy based drives.	The student will be able to :- • work with confidence on the various drives used in the Industry. • The students can carry research on the newer Switched Reluctance motor and Brushless DC motor. • Understands the traction drives with ac and dc motors.

Unit 1: Dynamics of electric drives and control of electric drives,

Unit 2: D.C. motor drives: Controlled rectifier fed d.c. drives, single phase and three phase rectifier control of d.c. separately excited motor. Dual converter control of D.C separately excited motor. Power factor, supply harmonics and ripple in motor current. Chopper controlled dc drives of separately excited dc motor, chopper control of series motor, source current harmonics.

Unit 3: Induction motor drives: Stator voltage control, variable frequency control using
voltage source invertors, and current sources invertors. Concept of scalar control of 3-ph Induction Motor, Basic philosophy of vector control of 3-ph I.M. their advantages and list of applications.

Basic idea of energy conservation in fan and pump type loads using scalar controlled induction motor drives.(Numericals excluded)

Unit 4: Synchronous Motor Drive ; Starting Braking of synchronous motor, variable frequency control self controlled synchronous motor drive employing load commutated thyristor inverter or cycloconverter, starting of large synchronous motors.

Unit 5: Brushless de motor, stepper motor, switched reluctance motor drives and eddy current drives. introduction to solar and battery powered drives. Energy conservation in electric drives.

Unit 6: Traction drives: Conventional dc and ac traction drives, semiconductors converter controlled Drives, 25KV AC traction using semiconductor converter controlled dc motor. DC traction using semiconductor, chopper controlled dc motors, polyphase AC motors for traction drives.

BOOKS:

Text Books		
Title of Book	**Name of Author/s**	**Edition & Publisher**
Fundamentals of Electric drives	G. K. Dubey	CRC Press
Modern Electric Traction	H. Partab	Pritam Surat, 1973
Power Electronics and drives	B. K. Bose	Pearson
Reference Books		
Electric drives concepts and applications	Vedam Subrahmanyam	McGraw-Hill, 1996

ELECTIVE-III BEELE 802 T (4) ELECTRICAL DISTRIBUTION SYSTEM

Learning Objectives	Learning Outcomes
Student will able to learn various aspects of distribution system including distribution automation.	The student will be able to :- • Calculate different distribution factors, • Understand classification of load, types of load curves. • Control of voltage and reactive power in distribution system • Understand distribution automation • Understand distribution substation layout with associated equipments.

UNIT-1: Introduction to Distribution systems, Explanation of basic terms like demand factor, utilization factor, load factor, plant factor, diversity factor, coincidence factor, contribution factor and loss factor-Relationship between the load factor and loss factor - Classification of loads , Changes in load curve due to loads.

UNIT-2: Feeders: Radial and loop types, engineering considerations for voltage levels and loading, causes of unbalance and unequal drops.

UNIT-3 : System analysis : Voltage drop and power loss calculations, manual methods of solution of radial networks, three-phase & non-three-phase primary lines load flow and symmetrical component applications.

UNIT-4: Voltage control : Equipment for voltage control, effect of series capacitors, effect of AVB/AVR, line drop calculations and compensations, Reactive power requirements, economic consideration & best location.

UNIT-5 : Introduction to Distribution Automation, Data acquisition system and decentralized control, data acquisition and protection considerations of control panel(Specific reference to MCCB, HRC), earthing.

UNIT-6: Substation :- Equipment, layouts, theoretical consideration for fault calculations.

Text Books		
Title of Book	**Name of Author/s**	**Edition & Publisher**
Electrical Power Distribution System	Kamaraju	Tata-McGraw Hill Publications
Electric Power Distribution	A. S. Pabla	Tata Mc Graw-Hill Publishing Company
Reference Books		
Electric Power Distribution Automation	M. K. Khedkar & G. M. Dhole	University Science Press

BEELE 803 T -SWITCH GEAR AND PROTECTION

Learning Objectives	Learning Outcomes
Students will understand • The theory and applications of the main components used in power system protection. • The protection systems used for electric machines, transformers, bus bars, transmission lines. • The theory, construction, and applications of main types of circuit breakers. • to design the feasible protection systems needed for each main part of a power system	Students has understood • Theory & application of main components used in power system protection. • Protection systems used for electric machines, transformers, bus bars, transmission lines. • Theory, construction, and applications of main types of circuit breakers. • Design the protection systems needed for each main part of a power system.

Unit 1:- General philosophy of Protective Relaying: Protective zones, primary protection, Back up protection Remote and Local Back up selectivity.

Unit 2:- Medium voltage Line Protection: Over current relaying, directional- over current relay.

Unit 3: High Voltage Line Protection: Distance relays, carrier distance Schemes. Unit carrier schemes.

Unit 4: Equipment Protection: Principles of differential relaying, protection of generator, transformers and bus Bars by differential relaying and other relays. Protection of Induction Motors against overloads, short circuits. thermal relays, miniature circuit breakers.

Unit 5: - Introduction static relays *:* Comparison of static and electro mechanical relays, two input amplitude and phase comparator and their duality. Generation of various distance relay characteristics using above comparators.

Unit 6: Switchgear: Circuit breakers. Arc interruption theory, recovery and Restricting voltages, RRRV, breaking of inductive and capacitive currents, C.B, ratings, different media of arc interruption, overview of oll circuit breakers, construction and operation of Air blast, SF6 and vacuum breakers.

Books:

Text Books		
Title of Book	**Name of Author/s**	**Edition & Publisher**
Switchgear and Protection	Sunil S Rao	Khanna Publishers, 1992
Power System *Protection* and *Switchgear*	B. Ravindranath, M. Chander	New Age International
Power System Protection and switchgear	B.Ram	Tata McGraw Hill
Reference Books		
The art and science of protective relaying	C. Russell Mason	Wiley, 1956
Protective Relaying, Vol. I & II	Warrington	Springer

BEELE 804 T - COMPUTER APPLICATIONS IN POWER SYSTEM.

Learning Objectives	Learning Outcomes
This subject exposes students to the mathematical foundational concepts that are necessary in the field of electrical engineering such as a) Load flow. b) Short Circuit studies. c) Transient Stability Studies.	On successful completion of this course, students will be able to • Determine Bus Impedance & Admittance matrix (required for Load flow & Short circuit Studies) by graphically, Inspection & building algorithm. • Load flow study of a power system by Newton-Raphson & Gauss-Seidal Iterative Method. • Short circuit studies. • Transient stability by using Eulers, Modified Eulers & RK-4th order differential method.

Unit 1: Incidence & Network Matrices: Graph incidence Matrices, Primitive network, formation of network matrices by Singular transformations.

Unit 2: Algorithm for formation of Bus Impedance and Bus Admittance matrix' for system without mutual coupling.

Unit 3: Three phase Networks: Three phase balance network elements with balanced and unbalanced excitation, incidence and network matrices *for* three phase element. Algorithm for formation of three phase bus impedance matrices without mutual coupling. .

Unit 4: Load Flow Studies: Power system load flow equations, solution Technique; Gauss Seidel Newton Raphson and fast decoupled technique with and without voltage control buses. Representation of tap changing and phase shifting transformers, Elementary load flow programs.

Unit 5: Short circuit studies: Three phase network short circuit calculations using bus impendence matrix for balance and unbalanced faults. Computer programme for short circuit studies on simple system.

Unit 6: Transient Stability studies: Modelling of synchronous machine. power system network for transient stability studies, Numerical, solution of swing equation by modified Euler and Runge Kutta 4th order method. Elementary computer programme for the transient stability study.

BOOKS:

Text Books		
Title of Book	**Name of Author/s**	**Edition & Publisher**
Computer method in power system analysis	Stagg and E1e Abid	McGraw Hill
Elements of power system analysis	William D. Stevenson	Mcgraw-Hill Book Comp., 1982
Computer Analysis of Power system	R N Dhar	
Reference Books		
Electric Energy System Theory and introduction	Ole Elegard	Tata McGraw-Hill, 1983