Uttarakhand Technical University, Dehradun

Scheme of Examination as per AICTE Flexible Curricula

Evaluation Scheme & Syllabus for B. Tech

W.E.F. Academic Session 2020-21

III to VIII SEMESTER

Bachelor of Technology (B. Tech.)

[Electrical Engineering]

Semester III

S. No.	Subject Code	Category	Subject Name	Maximum Marks Allotted						Contact Hours			Total Credits
				Theory			Practical						
				End Sem.	Mid Sem.	Quiz/ Assignment	End Sem.	Term work Lab Work & Sessional		L	T	P	
1.	BCET 301	ES	Energy & Environmental Engineering	100	30	20	-	-	150	3	-	-	3
2.	BEST 301	BSC	Mathematics-III	100	30	20			150	3	1	-	4
3.	BEET 301 BEEP 301	DC	Electrical Measurements & Instrumentation	100	30	20	30	20	200	3	1	2	5
4.	BECT 304 BECP 304	DC	Electronic Devices	100	30	20	30	20	200	3	0	2	4
5	BEET 305 BEEP 305	DC	Networks Analysis and Synthesis	100	30	20	30	20	200	3	1	2	5
6.	BEEP 306	DC	Programming Practices	-	-	-	30	20	50	-	-	2	1
7	BASP 307		Evaluation of Internship-I Completed at I year level/Seminar Presentation for Lateral Entry					50	50			2	1
8.	BASP 307	DLC	90 hrs Internship based on using various software's –Internship – II/Seminar for Lateral Entry students	To be completed anytime during fourth semester. Its evaluation/credit to be added in fifth semester.									
Total				500	150	100	90	160	1000	15	3	8	23
9.	BCSP 308	MC	Cyber Security	Non-credit course									
		NSS/NCC											

*The Mini Project or internship (3-4 weeks) conducted during summer break after II semester and will be assessed during III semester.

Semester IV

S. No.	Subject Code	Category	Subject Name	Maximum Marks Allotted					Total Marks	Contact Hours per week			Total Credits
				Theory			Practical						
				End Sem.	Mid Sem	Quiz/ Assignment	End Sem.	Term Lab Work & Sessional		L	T	P	
1.	BECT 402	DC	Signals and Systems	100	30	20	-	-	150	3	1	-	4
2.	BEET 402 BEEP 402	DC	Electrical Machine-I	100	30	20	30	20	200	3	1	2	5
3.	BECT 401 BECP 401	DC	Digital Electronics	50	30	20	30	20	200	2	0	2	3
4.	BEET 404 BEEP 404	DC	Power System-I	100	30	20	30	20	200	3	1	2	5
5.	BEET 405 BEEP 405	DC	Control System	100	30	20	-	-	150	3	1	0	4
6.	BHUT 401	DLC	Universal Human Values-2	50	30	20			100	2	0	0	2
7.	BENP 407	DLC	90 hrs Internship based on using various software's –Internship –II	To be completed anytime during fourth semester. Its evaluation/credit to be added in fifth semester.									
		Total		500	180	120	90	110	1000	16	4	6	23
8.	BCSP 408	MC	Cyber Security	Non-credit course									
		NSS/NCC											

V Semester

S. No.	Subject		Subject Name	Maximum Marks Allotted						Contact Hours per			Tota l
				Theory			Practical						
				End Sem	Mid Sem	Quiz / Assign	End Sem	Term Work /Lab		L	T	P	
1.	BEET- 501 BEEP-501	DC	Electrical Machine-II	100	30	20	30	20	200	3	1	2	5
2.	BEET -502 BEEP 501	DC	Power System II	100	30	20	30	20	200	3	1	2	5
3.	BEET-503 (A or B or C)	DE	Departmental Elective-I	100	30	20	-	-	150	3	0	0	3
4.	BOET-504((A or B or C)	OE	Open Elective-I	100	30	20	-	-	150	3	0	0	3
5.	BEET-505	D Lab	Eletromagnetic field theory	100	30	20	-	-	150	3	1	0	4
6	BENP-506	IN	Evaluation of Internship-II completed at II year level	-	-	-	-	10 0	100			2	1
7	BENP-507		Open Source Lab					50	50				
8	BASP-507/607	IN	Internship -III	To be completed any time during Fifth/ Sixth semester. Its evaluation/credit to be added in Seventh semester.									
Total				500	150	100	60	19	100	15	3	6	21
NSS/NCC													

Departmental Electives		**Open Electives**	
BEET 503(D)	Electrical Power Generation and Economy	BOET-504(A)	Digital Control System
BEET 503(B)	Applied Instrumentation	BOET-504(E)	Modelling and analysis of electric machines
BEET 503(C)	Electrical Engineering Material	BOET-504(C)	Industrial electronics
		BOET-504(D)	Innovation and Entrepreneurship

VI Semester

S. No.			Subject Name	Maximum Marks Allotted						Contact Hours per Week			Total Credits
				Theory			Practical						
				End Sem	Mid Sem	Quiz / Assignment	End Sem	Team Work / Lab Work & Sessional		L	T	P	
1.	BEET-602 BEEP-602	DC	Power System Protection	100	30	20	30	20	200	3	1	2	5
2.	BEET-601 BEEP-601	DC	Power Electronics	100	30	20	30	20	200	3	1	2	5
	BEET-603	DC	Advance Control Systems	100	30	20	-	-	150	3	1	0	4
3.	BEET-604 (D or E or F)	DE	Departmental Elective	100	30	20		-	150	3	1	0	4
4.	BOET-605 (A or B or C)	OE	Open Elective	100	30	20	-	-	150	3	0	0	3
5.	BEEP-606	O/E Lab	Open Source Software Lab	-	-	-	30	20	50	0	0	4	2
6.	BEEP-607	P	Minor Project -I					50	50	0	0	2	1
7.	BASP-507/607	IN	Internship - III	To be completed anytime during Fifth/Sixth semester. Its evaluation/credit to be added in Seventh Semester.									
Total				500	150	100	90	160	1000	15	4	10	24

Note: Meaning of Last Character of Subject Code (T – Theory; P – Practical)

Departmental Electives			**Open Electives**	
BEET 604(D)	Electrical Machine Design		BOET-605(A)/ BECT-602	Microprocessor and Interfacing
BEET 604(E)	Power system stablity		BOET-605(B)/ BECT-603	Digital Signal Processing
BEET 604(F)	Energy Conservation and Management		BOET-605(C)	Analog and Digital Communication

VII Semester

S. No.			Subject Name	Maximum Marks Allotted					Total Marks	Contact Hours per Week			Total Credits
				Theory			Practical						
				End Sem	Mid Sem	Quiz / Assignment	End Sem	Term Work /Lab Work & Sessional		L	T	P	
1.	BEET 704 BEEP 704	DC	Power System stability	100	30	20	30	20	200	3	1	2	5
2.	BEET-703(B)	DC	Non Conventional Energy resources	100	30	20	-	-	150	3	1	0	4
3.	BEET-703(A or D or E)	DE	Departmental Elective	100	30	20	-	-	150	3	0	0	3
4.	BOCT-704(A or C or D)	OE	Open Elective	100	30	20	-	-	150	3	0	0	3
6	BENP-706	DLC-1	Evaluation of Internship-II completed at III year level	-	-	-	-	100	100			2	1
7	BEEP- 707	P	Minor Project-2	-	-	-	100	50	150	0	0	4	2
8	BEEP-706	P	Virtual Lab	-	-	-	-	50		0	0	2	1
Total				400	120	80	130	240	900	12	2	10	19
NSS/NCC													

Departmental Electives		**Open Electives**	
BEET-703(A)	Soft Computing	BOET-704(A)	Internet of things
BEET-703(D)	Special Electromechanical systems	BOET-704(C)	Probability theory and stochastic process
BEET- 703(E)	Energy Management & SCADA	BOET-704(D)	Robotics and automation

VIII Semester

S. No.			Subject Name	Maximum Marks Allotted					Total Marks	Contact Hours per Week			Total Credits
				Theory			Practical						
				End Sem	Mid Sem	Quiz / Assignment	End Sem	Term Work /Lab Work & Sessional		L	T	P	
1.	BEET- 805	DC	Operation and control of power system	100	30	20	30	20	200	3	1	2	5
2.	BEET-802	DC	Electric Drives and its applications	100	30	20	30	20	200	3	1	2	5
3.	BEET -803 (A or B or C)	DE	Departmental Elective	100	30	20	-	-	150	3	1	0	4
4.	BOCT-804 (A or B or C)	OE	Open Elective	100	30	20	-	-	150	3	1	0	4
5	BEEP-805	P	Major Project	-	-	-	100	100	200	0	0	8	4
Total				400	120	80	160	140	900	12	4	12	22
NSS/NCC													

Departmental Electives		**Open Electives**	
BEET 803 (D)	High voltage Engineering	BOCT -804(A)	Cyber Security
BEET 803 (E)	Computer aided power system analysis	BOCT-804 (B)	Machine Learning
BEET 803 (F)	Utilization of Electrical energy and traction	BOCT-804 (D)	Cloud computing
BEET 803 (G)	Flexible AC transmission System		

Note : 20% of subjects can be allowed to be completed online through SWAYAM /international Institute/Online teaching by college.

Electrical Engineering,
V-Semester BEET-501

Course Objectives	**Principles of magnetic circuits, transformators, machines and generators, synchronous machines and generators, induction machines, special machines, renewable energy production.** **To give information about conversion of electrical energy into mechanical energy and vice versa using electromagnetic fields, to explain different machines and generators, working principles, to build basis for more advanced studies in electrical machines and to introduce renewable energy resources.**	
Code	**Course outcome**	**Level**
CO1	Analyse theoretically, the performance characteristics for different electrical machines and obtain simple equivalent circuit for the synchronous machine.	L4
CO2	Examine the testing of different electrical machines so as to identify their applicability in different practical situations and the process of 'synchronisation' of a generator to the live bus bar and method of starting a synchronous motor.	L4
CO3	Illustrate the constructional details and principle of operation of three phase and single phase induction motors.	L3
CO4	Apply the knowledge about starting and speed control of induction motors, testing and applications of induction motors.	L3
CO5	Illustrate the construction, operation and characteristics of commonly used special purpose machines.	L3

Electrical Machine-II

Unit-I

D.C. Machine-I : Basic construction of DC machines; types of DC machines and method of excitation; lap and wave windings; Emf equation; armature reaction and methods of limiting armature reaction; Commutation process and methods for improving commutation; Basic performance of DC generators and their performance characteristics; Metadyne and Amplidyne; permanent magnet DC motors; Brush less dc motors.

Unit-II

D.C. Machine-II : Basic operation of DC motors; Torque equation; Operating characteristics of DC motors, Starting of DC motors- 2point, 3 point and 4 point starters; speed control of DC motors; losses and efficiency of DC machines; testing of DC machines, direct testing, Swinburne's test and Hopkinson's test. Application of DC machines.

Unit-III

Synchronous Machine-I: Construction; types of prime movers; excitation system including brushless excitation; polyphase distributive winding, integral slot and fractional slot windings; emf equation, generation of harmonics and their elimination; armature reaction; synchronous reactance and impedance, equivalent circuit of alternator, relation between generated voltage and terminal voltage, voltage regulation of alternators using synchronous impedance, mmf, zpf and new A.S.A method.

Unit-IV

Synchronous Machine-II: Salient pole machines; two reaction theory equivalent circuit model and phasor diagram; determination of XdandXqby slip test; SCR and its significance; regulation of salient pole alternator, power angle equation and characteristics; synchronizing of alternator with infinite busbar,; parallel operation and load sharing; synchronizing current, synchronizing power and synchronising torque coefficient; synchro scopes and phase sequence indicator; effect of varying excitation and mechanical torque.

Unit-V

Synchronous machine-III

Synchronous motor operation, starting and stopping of synchronous motor, pull in torque, motor under load power and torque, reluctance torque, effect of excitation, effect of armature reaction, power factor adjustment, V curves, inverted V curves, synchronous motors as power factor correcting device, super synchronous and sub synchronous motors, hunting and damper winding efficiency and losses. Analysis of short circuit oscillogram, determination of various transient, sub transient and steady reactances and time constants, expression of transient and sub transient reactances in terms of self and mutual inductances of various winding, short circuit current, equivalent circuit. Single phase synchronous motors- hysteresis motor, reluctance motor. Repulsion motor, stepper motor, switched reluctance

REFERENCE BOOKS

1. M.G. Say, Performance & design of AC machines, CBS publishers & distributors, Delhi, 3rd edition
2. I.J. Nagrath& D.P. Kothari, Electric Machines, Tata McGraw Hill , New Delhi,
3. P.S. Bhimbra, Electrical Machinery, Khanna Pub.
4. P.S. Bhimbra, Generalized theory of Electrical Machines, Khanna publishers, Delhi,
5. Ashfaq Husain, Electric Machines, Dhanpat Rai, New Delhi
6. Syed A. Nasar, Electric Machines & Power Systems, Volume I , Tata McGraw Hill, New Delhi
7. A.E. Fitzerald, C. Kingsley & S.D. Umans , Electric Machinery Tata McGraw Hill

New Scheme of Examination as per AICTE Flexible Curricula
Electrical Engineering,
BEET- 502 Power System- II

Course objectives	To model various power system components and carry out load flow, short circuit and stability studies.	
Code	Course outcome	Level
CO1	Create computational models for analysis power systems and able to understand per unit system	L5
CO2	Analyse a power system network under Symmetrical Conditions to discriminate Positive Sequence, Negative & zero sequence system.	L4
CO3	Evaluate load flow computations for an interconnected power system.	L5
CO4	Illustrate power system operation and transient control.	L5
CO5	Test the stability control of a power system	L4

UNIT-I

Representation of power system components:
Synchronous machines, Transformers, Transmission lines, One line diagram, Impedance and reactance diagram, per unit system.
Symmetrical Components:
Symmetrical components of unbalanced phasors, power in terms of symmetrical components, sequence impedances and sequence networks.
Symmetrical fault analysis:
Transient in R-L series circuit, calculation of 3-phase short circuit current and reactance of synchronous **machines, internal voltage of loaded machines under transient conditions**

UNIT-II
Analysis of single line to ground fault, line to line fault and double line to ground fault on an unloaded generator and power system network with and without fault impedance.
Formation of Zbus using singular transformation and algorithm, computer method for short circuit **calculations.**

UNIT-III
Load flows:
Introduction, bus classifications, nodal admittance matrix (YBUS), development of load flow equations, load flow solution using Gauss Siedel and Newton-Raphon method, approximation to N-R method, line flow equation and fast decoupled method.

UNIT-IV

Stability and stability limit, steady state stability study, derivation of Swing equation, transient stability studies by equal area criterion and step by step method. Factors affecting steady sate and transient stability and methods of improvement.

UNIT-V

Wave equation for uniform transmission lines, velocity propagation, surge impedance, reflection and transmission of traveling waves under different line loadings, Bewlay's Lattice diagram, protection of equipments and line against traveling waves.

REFERENCE BOOKS

1. L.P. Singh, "Advanced Power System Analysis & Dynamics", New Age International
2. Hadi Sadat, "Power System Analysis", Tata Mc Graw Hill.
3. A.R. Bergen and V. Vittal, "Power System Analysis", Pearson Publication

Electrical Engineering, V-Semester, Departmental Elective
BEET- 505 Electromagnetic Field theory

Course Objectives	To introduce the basic mathematical concepts related to electromagnetic vector fields. To impart knowledge on the concepts of electrostatics, electric potential, energy density and their applications. To impart knowledge on the concepts of magnetostatics, magnetic flux density, scalar and vector potential and its applications. To impart knowledge on the concepts of Faraday‘s law, induced emf and Maxwell‘s equations	
Code	Course outcome	Level
CO 1	Students can analyze a coordinate of point in Cartesian, Cylindrical and spherical co-ordinate systems. Also interpret the physical interpretation of gradient, divergence and curl.	L4
CO 2	Evaluate the physical quantities of electrostatic fields (Field intensity, Flux density etc.) in dielectric media and free space using the fundamental laws (Coulomb and Gauss law).	L6
CO 3	To compute the magnetic field intensity and magnetic flux density due to finite and infinite length of conductor by using Bioat-Savart and Ampere Circuit law.	L3
CO 4	Apply the phenomena of wave propagation in lossy di-electric, loss-less dielectric and perfect conducting medium.	L3
CO 5	Analyze the nature of electromagnetic wave propagation in guided medium by using of transmission line parameters.	L4

Unit-I

Coordinate systems and transformation: Cartesian coordinates, circular cylindrical coordinates, spherical coordinates Vector calculus: Differential length, area and volume, line surface and volume integrals, del operator, gradient ofascalar,divergenceofavectoranddivergencetheorem,curlofavectorand Stoke’s theorem, Laplacian of a scalar

Unit-II

Electrostatics: Electrostatic fields, Coulombs law and field intensity, Electric field due to charge distribution, Electric flux density, Gausses’sLaw – Maxwell’s equation, Electric dipole and flux lines, energy density in electrostatic fields.

Electric field in material space: Properties of materials, convection and conduction currents, conductors, polarization in dielectrics, dielectric constants, continuity equation and relaxation time, boundary condition.

Electrostatic boundary value problems: Poission’s and Laplace’s equations, general procedures for soling Poission’s or Laplace’s equations, resistance and capacitance, method of images.

Unit-III

Magnetostatics: Magneto-static fields, Biot-Savart’sLaw, Ampere’s circuit law, Maxwell’s equation, application of ampere’s law, magnetic flux density, Maxwell’s equation, Maxwell’s equation for static fields, magnetic scalar and vector potential. Magnetic forces, materials and devices: Forces due to magnetic field, magnetic torque and moment, a magnetic dipole, magnetization in materials, magnetic boundary conditions, inductors and inductances, magnetic energy.

Unit-IV

Waves and applications: Maxwell's equation, Faraday's Law, transformer and motional electromotive forces, Displacement current, Maxwell'sequation in final form.

Electromagnetic wave propagation: Wave propagation in lossy dielectrics, plane waves in lossless dielectrics, plane wave in free space, plain waves in good conductors, power and the pointing vector, reflection of a plain wave in a normal incidence**.**

Unit-V

Transmission lines: Transmission line parameters, Transmission line equations, input impedance, standing wave ratio and power, The Smith chart, Some applications of transmission lines.

REFERENCE BOOKS

1. Hayt, W.H. and Buck, J.A., "Engineering Electromagnetic" Tata McGraw Hill Publishing
2. Mathew Sadiku, "Electromagnetic Field Theory", Oxford University Press.
3. Kaduskar, Principles of Electromagnetics, WileyIndia
4. IDA, Engineering Electromagnetics,Springer
5. Kodali, Engineering Electromagnetic Compatability, John Wiley &sons

New Scheme of Examination as per AICTE Flexible Curricula Electrical Engineering, V-Semester Departmental Elective BEET-503 (D)- Electric power generation and Economy

Course Objective	To introduce the concepts and phenomenon of different sources of Power Generation. To give an idea about the fundamental concepts of electrical power distribution, both AC & DC. To familiarize the students with the Tariff methods for electrical energy consumption in the prospect of optimum utilization of electrical energy.	
Code	Course outcome	Level
CO1	Describe the working of hydroelectric, steam, nuclear power plants and state functions of major equipment of the power plants.	L2
CO2	Classify various substations and explain the functions of major equipments in substations.	L5
CO3	Explain the types of grounding and its importance.	L4
CO4	Infer the economic aspects of power system operation and its effects.	L4
CO5	Explain the importance of power factor improvement.	

Unit-I

Hydrology, run off and stream flow, hydrograph, flow duration curve, Mass curve, reservoir capacity, dam storage. Hydrological cycle, merits and demerits of hydroelectric power plants, Selection of site. General arrangement of hydel plant, elements of the plant, Classification of the plants based on water flow regulation, water head and type of load the plant has to supply. Water turbines – Pelton wheel, Francis, Kaplan and propeller turbines. Characteristic of water turbines Governing of turbines, selection of water turbines. Underground, small hydro and pumped storage plants. Choice of size and number of units, plant layout and auxiliaries.

Unit-II

Steam Power Plants: Introduction, Efficiency of steam plants, Merits and demerits of plants, selection of site. Working of steam plant, Power plant equipment and layout, Steam turbines, Fuels and fuel handling, Fuel combustion and combustion equipment, Coal burners, Fluidized bed combustion, Combustion control, Ash handling, Dust collection, Draught systems, Feed water, Steam power plant controls, plant auxiliaries.Diesel Power Plant: Introduction, Merits and demerits, selection site, elements of diesel power plant, applications. Gas Turbine Power Plant: Introduction Merits and demerits, selection site, Fuels for gas turbines, Elements of simple gas turbine power plant, Methods of improving thermal efficiency of a simple steam power plant, Closed cycle gas turbine power plants. Comparison of gas power plant with steam

Unit III

Introduction, Economics of nuclear plants, Merits and demerits, selection of site, Nuclear reaction, Nuclear fission process, Nuclear chain reaction, Nuclear energy, Nuclear fuels, Nuclear plant and layout, Nuclear reactor and its control, Classification of reactors, power reactors in use, Effects of nuclear plants, Disposal of nuclear waste and effluent, shielding.

Unit IV:

Introduction to Substation equipment; Transformers, High Voltage Fuses, High Voltage Circuit Breakers and Protective Relaying, High Voltage Disconnect Switches, Lightning Arresters, High Voltage Insulators and Conductors, Voltage Regulators, Storage Batteries, Reactors, Capacitors, Measuring Instruments, and power line carrier communication equipment. Classification of substations – indoor and outdoor, Selection of site for substation,

Bus-bar arrangement schemes and single line diagrams of substations.
Grounding:Introduction, Difference between grounded and ungrounded system. System grounding – ungrounded, solid grounding, resistance grounding, reactance grounding, resonant grounding. Earthing transformer. Neutral grounding and neutral grounding transformer.

UNIT V

Introduction, Effect of variable load on power system, classification of costs, Cost analysis. Interest and Depreciation, Methods of determination of depreciation, Economics of Power generation, different terms considered for power plants and their significance, load sharing. Choice of size and number of generating plants. Tariffs, objective, factors affecting the tariff, types. Types of consumers and their tariff. Power factor, disadvantages, causes, methods of improving power factor, Advantages of improved power factor, economics of power factor improvement and comparison of methods of improving the power factor. Choice of equipment.

References Books:

1. Power Plant Engineering P.K. Nag McGrawHill 4th Edition, 2014
2. Generation of Electrical Energy B.R.Gupta S. Chand 2015
3. Electrical power Generation, Transmission and Distribution S.N. Singh PHI 2nd Edition, 2009

New Scheme of Examination as per AICTE Flexible Curricula
Electrical Engineering, V-Semester Departmental Elective
EEE- 503 (B) Applied Instrumentation

Course Objectives	To make students understand the Identification, classification, The students will be able to Learn the measurement systems, errors of measurement, construction, working principle and application of various transducers used for Displacement measurement, Temperature measurement, Level measurement, and Miscellaneous measurement.	
Code	Course outcome	Level
CO 1	Acquire the knowledge basic sensor characteristics.	L3
CO 2	Classify the different types of sensors and actuators	L4
CO 3	Apply and solve appropriate mathematical equations of temperature sensors	L3
CO 4	Apply and solve appropriate mathematical equations of pressure sensors	L3
CO 5	Apply and solve appropriate mathematical equations of level sensors and display devices	L3

Unit-I

Introduction to measurement: Definition, application and types of measurement System Introduction to CRO, Different parts of CRO, Its Block diagram, Electrostatic focusing, Electrostatic deflection, post deflection acceleration, Screen for CRTs, Graticule, Vertical & Horizontal deflection system, Time base circuit, Oscilloscope probes and transducers, Attenuators, Application of CROs, Lissajous patterns, Special purpose CROsMulti input, Dual trace, Dual beam, Sampling, Storage (Analog & Digital) Oscilloscopes.

Unit-II

R, L, C Measurement: Bridges: Measurement of resistance using Measurement of inductance and capacitance by A.C. bridges: Maxwell's bridge, Anderson bridge, Schering bridge, Hay'sbridge, Wein's bridge, Shielding and grounding, Q meter.

Unit-III

NonElectrical Quantities (Transducer): Classification of Transducers, Strain gauge, Displacement Transducer Linear Variable Differential Transformer (LVDT) and Rotary Variable Differential Transformer (RVDT), Temperature Transducer Resistance Temperature Detector (RTD), Thermistor, Thermocouple, Piezoelectric transducer, Photo emissive, Photo conductive, Photo voltaic, Photodiode, Photo Transistor, Nuclear Radiation Detector.

Unit-IV

Digital instruments: Advantages of digital instruments, Over analog instruments, DA, AD conversion, Digital voltmeter, Ramp type DVM, Integrating DVM, successive approximation DVM,frequency meter. Display devices: Digital display system and indicators like CRT, LED, LCD, Nixies, Electro luminescent, Incandescent, Electrophoretic image display, Liquid vapour display dotmatrix display, Analog recorders, XY recorders. Instruments used in computer controlled instrumentation RS 232C and IEEE 488, GPIB electric interface.

Unit-V

Signal generator: Function generator, sweep frequency generator, Pulse and square wave generator, Wave Analysers, Harmonic Distortion Analyser, Spectrum Analyser, frequency counter.

References Books:

1. John P. Bentley : Principles of measurement systems, Longman 1983
2. Johnson C.D: Process control instrumentation technology, 4/e, PHI, 1995
3. D.Patranabis : Principles of Industrial Instrumentation, Tata McGraw Hill Publishing Ltd. New Delhi, 1999
4. Sheingold D. H.: Transducer interfacing hand book – a guide to analog signal conditioning, analog devices Inc masschusetts, 1980.
5. Anderson N A : Instrumentation for process measurement and control :Chilton book company 1980.
6. H. S. Kalsi: Electronics Instrumentation, TMH.
7. K. Sawhney: Instrumentation and Measurements, Dhanpat Rai and Co.
8. Helfric and Cooper: Modern Electronic Instrumentation and Measurement Techniques; Pearso

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BEET 503(C)- Electrical Engineering Materials

Course Objectives	Understand the quantum mechanics of electron in crystals. Understand the basic electrical and magnetic properties of crystalline solids and amorphous materials. Understand the difference between electronic structures and physical properties of semiconductors, metals, and dielectrics.	
Code	Course outcome	Level
CO1	Illustrate students with a moderate level understanding of the physics behind the crystal structure of material	L3
CO2	Employ the students with the understanding of the physics behind the dielectric materials	L3
CO3	Analyse the students with a thorough understanding of the electrical properties and characteristics of various materials, used in electrical appliance	L4
CO4	Analyse the students with a thorough understanding of the magnetic properties and characteristics of various materials, used in electrical appliance	L4

UNIT-I

Conducting Material: Classification and main properties, High resistivity alloy: Constant Mangann, Nichrome, Electrochemical, properties of copper, Aluminum, steel tungsten, Molybdenum,Platinum, Tantalum, Niobium, Mercurry, Nickel, Titanum, Carbon, Lead, thermal, Bitmetals,thermocouple,materials, specific resistance, conductance, variation of resistance with temperature, super conductors.

Unit-II

Semi-Conductor Materials: General conception, variation of electrical conductivity, Elements having semiconductor properties, general application, hall effect, energy levels, conduction insemiconductors, Intrinsic conduction, impurity conduction, P and N type impurities, electrical change,Neutrality, Drift, Mobility current flow in semiconductors P-N junction formation by alloying, Elasing(forward and reverse) of P-n junction, Reverse separation current, Zener effect, Junction,capacitance, hall defects and hall coefficient.

Unit-III

Magnetic Materials: Details of magnetic materials, reduction between B.H. and, soft and hard magnetic materials. Di-magnetic, Para magnetic and Ferromagnetic materials, electrical sheet steel, cast iron. Permanent magnetic materials. Dynamic and static hysteresis loop. Hysteresis loss, eddycurrent loss, Magnetisation, magnetic susceptibility, coercive force, core temperature, rectangularhysteresis loop, Magnet rest square loop core materials, iron silicon, Iron alloys **Unit-IV**

Insulating Materials: General electrical mechanical and chemical properties of insulating material, Electrical characteristics volume and surface resistivity complex permitivity loss, anddielectric loss, equivalent circuits of an imperfect dielectric polarization and polarizability classification of dielectric.

Unit-V

Mechanical Properties: Classification insulating materials on the basis of temperature rise. General properties of transformer oil, commonly used varnishes, solidifying insulating materials, resins,bituminous waxes, drying oils, Fibrous insulating materials, wood, paper and cardboard, insulatingtextiles, varnished adhesive tapes, inorganic fibrous material and other insulating materials, such asmica, ceramic, bakelite, ebonite, glass, PVC, rubber, other plastic molded materials.

REFERENCE BOOKS

1. TTTI Madras; Electrical Engineering Materials; TMH.
2. Electrical Engineering Material s & Devices; John Allison ;TMH
3. Materials for Electrical Engineering: B.M. Tareev
4. Anderson; Di-Electrics :
5. Kortisky; Electrical Engineering Materials:
6. Indulkar and S. Thruvengadem; Electrical Engineering Materials; S. Chand
7. Dekkor AK; Electrical Engineering Materials; PHI

Uttarakhand Technical University, Dehradun

New Scheme of Examination as per AICTE Flexible Curricula

New Scheme of Examination as per AICTE Flexible Curricula

Electrical Engineering, V-Semester Open Elective

BOET- 504 (A) Digital Control System

Course Objectives	To study the stability analysis of digital control system. To study the canonical forms of digital control systems. To determine steady state performance of Digital control systems.	
Codes	Course Outcomes	Level
CO1	Demonstrate non-linear system behavior by phase plane and describing function methods	L4
CO2	Perform the stability analysis nonlinear systems by Lyapunov method develop design skills in optimal control problems	L3
CO3	Derive discrete-time mathematical models in both time domain (difference equations, state equations) and zdomain (transfer function using z-transform)	L4
CO4	Predict and analyze transient and steady-state responses and stability and sensitivity of both open-loop and closed-loop linear, time-invariant, discrete-time control systems	L5
CO5	Acquire knowledge of state space and state feedback in modern control systems, pole placement, design of state observers and output feedback controllers	L3

UNIT I

Introduction to Discrete Time Control System Basic building blocks of Discrete time Control system, Sampling Theorem, Z transform and Inverse Z transform for applications for solving differential equations, Mapping between the S-plane and the Z plane, Impulse sampling and Data Hold.

UNIT II

Pulse Transfer Function and Digital PID Controllers The pulse transfer function, pulse transfer function of Closed Loop systems, Pulse transfer function of Digital PID controller, Velocity & Position forms of Digital PID Controller, Realization of Digital Controllers, Deadbeat response and ringing of poles

UNIT III

Design of Discrete Time Control System by conventional methods Stability analysis in Zplane, Jury stability criterion, bilinear transformations, Design based on the root locus method, Digital Controller Design using Analytical Design Method.

UNIT IV

State Space Analysis of Discrete Time Control System State space representation of discrete time systems, Solution of discrete time state space equations, Pulse transfer function matrix, Eigen Values, Eigen Vectors and Matrix Diagonalization, Discretization of continuous time state space equations, Similarity transformations.

UNIT V

Pole Placement and Observer Design Concept of Controllability and Observability, Useful transformations in state space analysis and design, Stability improvement by state feedback, Design via pole placement, State observers. Optimal Control Quadratic Optimal Control and Quadratic performance index, Optimal state regulator through the matrix riccati equations, Steady State Quadratic Optimal Control.

Reference Books:

1. Discrete Time Control systems by K. Ogata, Prentice Hall, Second Edition.
2. Digital Control and State Variable Methods by M. Gopal, Tata McGraw Hill.
3. B. C. Kuo, Digital Control Systems, Oxford University Press, 2/e, Indian Edition
4. Digital control of Dynamic Systems by G.F.Franklin, J.David Powell, Michael Workman 3rd Edition, Addison Wesley .
5. Digital Control Engineering by M. Gopal, Wiley Eastern Ltd.

6. Digital Control by Kannan Moudgalya, John Wiley and Sons.
7. Digital Control Systems by Contantine H. Houpis and Gary B. Lamont, Second Edition, McGraw-Hill International.

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New Scheme of Examination as per AICTE Flexible Curricula

Electrical Engineering, V-Semester Open Elective

BOCT- 504 (E) Modelling and analysis of Electric machines

Course Codes	To familiarize the various fundamentals, machine design, machine modelling of various types of electrical machines. This will help you to gain knowledge and to do research in the area of electrical machine modelling	
Codes	Course Outcomes	Level
CO1	Understand principle of energy conversion,, two-pole machines and Kron's primitive machine	L2
CO2	Mathematical modelling for analysis of machine in stationary and rotating reference frame	L4
CO3	Examine the transient behaviour of the machine when subjected to sudden load change or during fault	L4
CO 4	Evaluate cost of practical design of such non linear machine for the design of industrial electrical drives	L4
CO 5	Design a high performancesensor less drive system with optimal dynamic response	L6

Unit I:

BASIC CONCEPTS OF MODELING 9 Basic Two - pole Machine representation of Commutator machines, 3 phase synchronous machine with and without damper bars and 3 - phase induction machine, Kron's primitive Machine - voltage, current and Torque equations. DC Machine modeling: Mathematical model of separately excited D.C motor –Steady State analysis - Transient State analysis - Sudden application of Inertia Load - Transfer function of Separately excited D.C Motor - Mathematical model of D.C Series motor, Shunt motor - Linearization Techniques for small perturbations

Unit II:

REFERENCE FRAME THEORY 9 Reference frame theory Real time model of a two phase induction machine-Transformation to obtain constant matrices - three phase to two phase transformation - Power equivalence. Dynamic modeling of three phase Induction Machine Generalized model in arbitrary reference frame - Electromagnetic torque - Derivation of commonly used Induction machine models - Stator reference frame model - Rotor reference frame model Synchronously rotating reference frame model -Equations in flux linkages - per unit model

Unit III:

SMALL SIGNAL MODELING 9 Small Signal Modeling of Three Phase Induction Machine Small signal equations of Induction machine – derivation - DQ flux linkage model derivation - control principle of Induction machine. Symmetrical and Unsymmetrical 2 phase Induction Machine Analysis of symmetrical 2 phase induction machine - voltage and torque equations for unsymmetrical 2 phase induction machine - voltage and torque equations in stationary reference frame variables for unsymmetrical 2 phase induction machine - analysis of steady state operation of unsymmetrical 2 phase induction machine - single phase induction motor - Cross field theory of single - phase induction machine

Unit IV:

MODELING OF SYNCHRONOUS MACHINE 9 Synchronous machine inductances – voltage equations in the rotor's dq0 reference frame - electromagnetic torque - current in terms of flux linkages - simulation of three phase synchronous machine- modeling of PM Synchronous motor.

Unit V:

DYNAMIC ANALYSIS OF SYNCHRONOUS MACHINE 9 Dynamic performance of synchronous machine, three -phase fault, comparison of actual and approximate transient torque characteristics, Equal area criteria.

Reference Books:

1. R. Krishnan, "Electric Motor Drives - Modeling, Analysis& control", Pearson Publications, First edition, 2002..
2. P.C.Krause, Oleg Wasynczuk, Scott D.Sudhoff, "Analysis of Electrical Machinery and Drive systems", IEEE Press, Second Edition.

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New Scheme of Examination as per AICTE Flexible Curricula

Electrical Engineering, V-Semester Open Elective

BOCT- 504 (C) Industrial Electronics

Course Objectives	To build on the knowledge gained by studying power electronic modules and systems as well as support electronics for control and automation and their application in various domains.	
Codes	Course Outcomes	Level
CO1	Acquire basic knowledge on the working of various semi-conductor converters	L 2
CO2	Develop analysis capability in SCR and Circuits	L 4
CO3	Develop design competence in signal and power using SCR family elements	L 2
CO 4	Acquire knowledge on basic power OPAMPS	L 3
CO 5	Acquire knowledge on basic PLC and its working	L 3

Unit-I

Power supply, rectifiers (half wave, full wave), performance parameters of power supplies, filters (capacitor,inductor, inductor-capacitor, pi filter), bleeder resistor, voltage multipliers .Regulated power supplies (series and shunt voltage regulators, fixed and adjustable voltage regulators, current regulator), switched regulator (SMPS), comparison of linear and switched power supply, switch mode converter (flyback, buck, boost, buk-boost, cuk converters).

Unit-II

Silicon controlled rectifies (SCR), constructional features, principle of operation, SCR terminology, turn-onmethods, turn-off methods, triggering methods of SCR circuits, types of commutation, comparison ofthyristors and transistors, thermal characteristics of SCR, causes of damage to SCR, SCR overvoltageprotection circuit, Line commutated converters (half wave rectifier withinductive and resistive load, single phase and three phase full wave rectifiers).

Unit-III

Other members of SCR family Triacs, Diacs, Quadracs, recovery characteristics, fast recovery diodes, power diodes, power transistor, power MOSFET, Insulated gate bipolar transistor (IGBT), loss of power in semiconductor devices, comparison between power MOSFET, power transistor and power IGBT.

Unit-IV

Applications of OP-AMP Basics of OP-AMP, relaxation oscillator, window comparator, Opcomp as rectangular to triangular pulse converter and vice- versa, Wien bridge oscillator, function generator, frequency response of OP-AMP, simplified circuit diagram of OP-AMP, power supplies using OP-AMP, filters (low-pass, high pass) using OP-AMP

Unit-V

Programmable Logic Controller (PLC)Functions, applications, advantages and disadvantages of PLC over conventional relay controllers, comparison of PLC with process control computer system, factors to be considered in selecting PLC, functional block diagram of PLC, microprocessor in PLC, memory, input and output modules (interface cards), sequence of operations in a PLC, status of PLC, event driven device, ladder logic language, simple process control applications of PLC, Programming examples..

REFERENCE BOOKS

1. Bishwanath Paul: Industrial Electronics and control, PHI Learning.

2. Rashid: Power Electronics- Circuits, devices and applications, Pearson Education.
3. Singh and Khanchandani: Power Electronics, TMH
4. Bhimbra: Power Electronics, Khanna Publishers.
5. Moorthi: Power Electronics, Oxford University Press.
6. Webb: Programmable Logic Controllers- Principles and Applications, PHI Learning.

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New Scheme of Examination as per AICTE Flexible Curricula

Electrical Engineering, V-Semester Open Elective

BOCT- 504 (D) Innovation and Entrepreneurship

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New Scheme of Examination as per AICTE Flexible Curricula
Electrical Engineering, VI-Semester

BEET 601 Power Electronics

Course Objectives	To acquaint with the fundamental concept of power electronics. It deals with basic theory of different power electronics switches. It is important for the student to understand the application of power and their operation.	
Code	Course outcome	Level
CO1	Relate basic semiconductor physics to properties of power devices, and combine circuit mathematics and characteristics of linear and non-linear devices	L4
CO2	Describe basic operation and compare performance of various power semiconductor devices, passive components and switching circuits	L3
CO3	Design and Analyze power converter circuits and learn to select suitable power electronic devices by assessing the requirements of application fields..	L6
CO4	Formulate and analyze a power electronic design at the system level and assess the performance.	L5
CO5	Identify the critical areas in application levels and derive typical alternative solutions, select suitable power converters to control Electrical Motors and other industry grade apparatus.	L5

Unit-I

Power semiconductor devices: Power semiconductor devices their symbols and static characteristic, characteristics and specifications of switches, type of power electronic circuits, Thyristor operation, V-I characteristic, two transistor model, methods of turn-on operation of GTO, MCT and TRIAC

Unit-II

Power semiconductor devices (contd): protection of devices, series and parallel operation of thyristors, commutation techniques of thyristor.

DC-DC convertors: Principles of step-down chopper, step down chopper with R-L load, principle of step up chopper, and operation with R-L load, classification of choppers.

Unit-III

Phase controlled converters: Single phase half wave controlled rectifier with resistive and inductive loads, effect of freewheeling diode, single phase fully controlled and half controlled bridge converters. Performance parameters, three phase half wave converters, three phase fully controlled and half controlled bridge converters, Effect of source inductance, single phase and three phase dual converters.

Unit-IV

AC Voltage controllers: Principle of on-off and phase controls, single phase ac voltage controller with resistive and inductive loads, three phase ac voltage controllers (various configuration and comparison).

Cyclo converters: Basic principle of operation, single phase to single phase, three phase to single phase and three phase to three phase cyclo converters, output voltage equation.

Unit-V

Inverters: Single phase series resonant inverter, single phase bridge inverters , three phase bridge inverters, introduction to 1200 & 1800 mode of operation, voltage control of inverters, harmonics reduction techniques, single phase and three phase current source inverters

TEXT BOOKS:

1. M.S. Jamil Asghar, “Power Electronics” Prentice Hall of India Ltd., 2004
2. A. Chakrabarti, Rai & Co. “ Fundamental of Power Electronics & Drives” Ghanpat Rai & Co.
3. K. Hari Babu, “Power Electroncis” Switch Publications.

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New Scheme of Examination as per AICTE Flexible Curricula

Electrical Engineering, VI-Semester BEET -602 Power System protection

Course Objectives	To teach students theory and applications of the main components used in power system protection for electric machines, transformers, bus bars, overhead and underground feeders. To teach students the theory, construction, applications of main types Circuit breakers, Relays for protection of generators, transformers and protection of feeders from over-voltages and other hazards. It emphasis on neutral grounding for overall protection To develop an ability and skill to design the feasible protection systems needed for each main part of a power system in students.	
Code	**Course outcome**	**Level**
CO1	Acquire the knowledge of abnormal conditions to detect faults occurring in a power system.	L4
CO2	Design electromagnetic, static and microprocessor relays in power system for protecting equipment and personnel	L6
CO3	Construct the unit protection and over voltage protection scheme in a power system	L5
CO4	Differentiate circuit breakers on the basis of construction, working operation and ratings.	L4
CO5	Testing of circuit breakers (methods)	L4

Unit-I

Introduction to power system:

Introduction to protective system and its elements, function of protective relaying, protective zones, primary and backup protection, desirable qualities of protective relaying, basic terminology.

Relays:

Electromagnetic, attraction and induction type relays, thermal relay, gas actuated relay, design considerations of electromagnetic relays.

Unit-II

Relay Applications and characteristics:

Amplitude and phase comparators, over current relays, directional relays, distance relays, differential relays.

Static relays:

Comparison with electromagnetic relays, classification and their description, over current relays, directional relays, distance relays, differential relays

Unit-III

Protection of transmission line:

Time graded protection, differential and distance protection of feeders, choice between impedance, reactance and MHO relays, Elementary idea about carrier current protection of lines, protection of bus, auto reclosing, pilot wire protection

Unit-IV

Arc phenomenon, properties of arc, arc extinction theories, recovery voltage and restriking voltage, current chopping, resistance switching, capacitance current interruption, circuit breaker ratings.

Testing of circuit breakers:

Classification, testing station & equipments, testing procedure, direct and indirect testing.

Unit-V

Apparatus protection:
Types of faults on alternator, stator and rotor protection, negative sequence protection, loss of excitation and
overload protection. Types of fault on transformers, percentage differential protection, Ungraounded neutral system, grounded neutral system and selection of neutral grounding.
Circuit breakers:
Need of circuit breakers, types of circuit breakers, operating modes, principles of construction, details of Air
Apparatus protection:
Types of faults on alternator, stator and rotor protection, negative sequence protection, loss of excitation and
overload protection. Types of fault on transformers, percentage differential protection, Ungraounded neutral system, grounded neutral system and selection of neutral grounding.
Circuit breakers:
Need of circuit breakers, types of circuit breakers, operating modes, principles of construction, details of Air Blast, Bulk Oil, Minimum Oil, SF6, Vacuum Circuit Breakers, DC circuit breakers.

Text books

1. Power system protection & switchgear, Badriram & D.V. Vishwakarma, TMH
2. Switchgear & Protection, M.V. Deshpande, TM

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BEET-603: Advance control systems

Course Objectives	To make students understand the concept of non linear control, Internal Model Control and Optimal Control. To Study the stability of Non Linear and Linear systems	
Codes	Course outcomes	Level
CO1	Apply vector and matrix algebra to find the solution of state equations for linear continuous – time and discrete – time systems.	L 2
CO2	Design pole assignment and state observer using state feedback.	L 4
CO3	Develop the describing function for the nonlinearity present to assess the stability of the system.	L 2
CO 4	Develop Lyapunov function for the stability analysis of nonlinear systems.	L 4
CO 5	Discuss state variable approach for linear time invariant systems in both the continuous and discrete time systems.	L 3

Unit 1:

Nonlinear Control Systems: Introduction to Nonlinear systems and their properties, Common Non-linearities, Describing functions, Phase plane method, Lyapounov's method for stability study, concept of Limit Cycle

Unit 2:

Optimal Control Theory: Introduction, Optimal control problems, Mathematical procedures for optimal control design: Calculus of variations, Pontryagin's optimum policy, Bang-Bang Control, Hamilton-Jacobi Principle.

Unit 3:

z-Plane Analysis of Discrete-Time Control Systems: Introduction, Impulse sampling and data hold, Reconstructing original signal from sampled signals, concept of pulse transfer function, Realization of digital controllers.

Unit 4:

Design of Discrete-time Control Systems: Introduction, Stability analysis of closed-loop systems in the z-plane, Transient and steady state response analysis, Design based on the rootlocus method, Design based on the frequency-response method.

Unit 5:

State-Space Analysis: Introduction, State-space representations of discrete-time systems, Solving discrete-time state-space equations, Pulse transfer function matrix, Discretization of continuous time state space equations, Lyapunov stability analysis, Controllability and Observability, Design via pole placement, State observer design.

Text / References:

1. Control Systems Engineering (For the Modules 1 and 2) I.J. Nagarath and M.Gopal New Age 5 th Edition, 2007
2. Digital Control and State Variable Methods: Conventional and Intelligent Control Systems (For the Modules 3,4 and 5) M.Gopal McGraw Hill 3 rdEdition, 2008

New Scheme of Examination as per AICTE Flexible Curricula

Electrical Engineering, VI-Semester Departmental Elective

BEET -604(D) Electric Machine design

Course Objectives	To impart knowledge on principles of design of static and rotating electrical machines, To give a basic idea about computer aided design (CAD) and finite element method.	
Code	Course outcome	Level
CO1	Classify & select proper material for the design of an electrical machine	L4
CO2	Estimate the performance characteristics of Transformer with the constaints specified.	L4
CO3	Design Stator core & stator winding of an Induction motor	L6
CO4	Design rotor core & rotor winding of an induction motor & calcuate load current & other performance characrteristics	L6
CO5	Design overall dimensions of synchronous machine & cooling of synchronous genrator	L6

Unit-I:

Factors and limitations in design. Output coefficients, classification of magnetic materials and allowable flux densities. Calculation of magnetic circuits, magnetizing current, coils for given temperatures...

Unit-II:

Real and apparent flux densities. Tapered teeth. Carter's coefficient, leakage fluxes reactances. Classifications of insulation materials and the temperature ranges

Unit-III:

Armature Winding: General features of armature windings, single layer, double layer and commutator windings, integral and fractional slot windings, winding factors. Harmonics, eddy current losses in conductors

Unit-IV:

Heating, Cooling and Ventilation: Heat dissipation, heat flow, Heating cooling curves. Heating cooling cycles, estimation of maximum temperature rise, cooling media. Quantity of cooling media, Types of enclosures. Ratings, heat dissipation. Methods of ventilation.

Unit-V:

Design of Machines: Application of above design principles for the design of Power Transformers and Synchronous Machines..

Text/References:-

1. A.K. Sawhney: A Course in Electrical Machine Design, Dhanpat Rai & Co.
2. R.K. Agarwal: Principles of Electrical Machine Design, S.K. Kataria & Sons.
3. M. G. Say: Design and Performance of A.C. Machines, CPS Publishers.

New Scheme of Examination as per AICTE Flexible Curricula

Electrical Engineering, VI-Semester

Departmental Elective EEE-604(E) Sensors and Actuators

Course Objectives	Understanding basic laws and phenomena on which operation of sensors and actuators-transformation of energy is based The students will have an exposure to sensors and its importance in the real world. The students will also able to understand how to fabricate

	some of those sensors. Students will have an exposure towards how to fabricate the sensors and its application in real world. The students will provide an understanding on modern day microsensors and micro actuators.	
Code	Course outcome	Level
CO 1	Acquire the knowledge basic sensor characteristics.	L3
CO 2	Classify the different types of sensors and actuators	L4
CO 3	Apply and solve appropriate mathematical equations of temperature sensors	L3
CO 4	Apply and solve appropriate mathematical equations of pressure sensors	L3
CO 5	Apply and solve appropriate mathematical equations of level sensors and display devices	L3

Contents		**Hours**
Unit 1	Functional elements of an instrument; active & passive transducers; analog & digital modes of operation ; null & deflection methods; I/O configuration of measuring instruments & instrument system – methods of correction for interfering & modifying inputs. Static characteristics; Meaning of static calibration, accuracy, precision & bias. Combination of component errors in overall system-accuracy calculation. Addition, subtraction, division & multiplication.	8
Unit 2	Principle of measurement of displacement. Resistive potentiometers, variable inductance & variable reluctance pickups, LVDT, capacitance pickup. Principle of measurement of Force, Torque, Shaft power standards & calibration; basic methods of force measurement; characteristics of elastic force transducer-Bonded strain gauge, differential transformer, piezo electric transducer, variable reluctance/FM-oscillator, digital systems. Loading effects; Torque measurement on rotating shafts, shaft power measurement (dynamometers)	8
Unit 3	Standards & calibration; thermal expansion methods- bimetallic thermometers, liquid-in-glass thermometers, pressure thermometers; thermoelectric sensor (thermocouple) – common thermocouple, reference junction considerations, special materials, configuration & techniques; electrical resistance sensors – conductive sensor (resistance thermometers), bulk semiconductor sensors (thermistors), bulk semiconductor sensors (thermistors); junction semiconductor sensors; digital thermometers. Radiation Methods – radiation fundamentals, radiation detectors, unchopped (dc) broadband radiation thermometers.	8
Unit 4	Standards & calibration; basic methods of pressure measurement; dead weight gauges & manometer, manometer dynamics; elastic transducers; high pressure measurement; low pressure (vaccum) measurement – Mcleod	8

	gage, Knudsen gage, momentum-transfer (viscosity) gages, thermal conductivity gages, ionization gages, dual gage technique	
Unit 5	LEVEL MEASUREMENT: Capacitance probe; conductivity probes; diaphragm level detector, deferential pressure level detector, radiation level sensors, RADAR level gauges, level transmitter, ultrasonic level detector, DISPLAY DEVICES & SYSTEMS: Classification of displays- Storage CRTs, Flat CRTs, LEDs, LCD display, Gas discharge plasma displays, Incandescent display, Electrophoretic image displays(EPID), Liquid Vapor Display (LVD)	10

Suggested Readings

1. Measurement systems application and design, ERNEST DOEBELIN, IV Edn. (Chapter 1, 2, 3, 4, 5).
2. Instrument Engineers Hand Book (process measurement), LIPTAK (Chapter 6).
3. Electronic Instrumentation – by H S Kalsi TMH 2nd Ed 2004

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Electrical Engineering VI-Semester EEE- 603 (F) Energy conservation and management

Course Objectives	Understand the fundamentals of energy management functions, Understand the economic analysis and system energy management for electrical system and equipment. Expose to the concept of supervisory control and data acquisition.	

Code	Course outcome	Level
CO1	Conceptual knowledge of the technology, economics and regulation related issues associated with energy conservation and energy auditing	L3
CO2	Ability to analyse the viability of energy conservation projects	L3
CO3	Capability to integrate various options and assess the business and policy environment regarding energy conservation and energy auditing	L3
CO4	Advocacy of strategic and policy recommendations on energy conservation and energy auditing	L4

Unit 1 Energy conservation
Principles of energy conservation, Energy Conservation Act 2001 and its features, Electricity Act-2003 & its features, Energy consumption pattern, Resource availability, Energy pricing, Energy Security, Estimation of energy use in a building. Heat gain and thermal performance of building envelope -Steady and non-steady heat transfer through the glazed window and the wall -Standards for thermal performance of building envelope, Evaluation of the overall thermal transfer

Unit 2: Energy efficiency in thermal & electrical utilities
Energy efficiency in boilers, furnaces, steam systems, cogeneration utilities, waste heat recovery, compressed air systems, HVAC&R systems, fans and blowers, pumps, cooling tower Energy efficiency for electric motors, lighting systems, Characteristics of Light, Types of Lighting, Incandescent Lighting, Fluorescent Lighting, Vapor Lighting, Street Lighting, LED Lighting, Lighting Design, Light Dimming, Tips for Energy Conservation, Products for Energy Conservation in lighting system

Unit 3: Energy Audit
Definition, objective and principles of Energy Management, Need of Energy Audit and Management, types of energy audit, audit process, Guidelines for writing energy audit report, data presentation in report, findings recommendations, impact of renewable energy on energy audit recommendations and energy audit report, energy audit of building system, lighting system, HVAC system, Water heating system, heat recovery opportunities during energy audit, Industrial audit opportunities, Instruments for Audit and Monitoring Energy and Energy Savings

Unit 4: Energy Audit
Definition, objective and principles of Energy Management, Need of Energy Audit and Management, types of energy audit, audit process, Guidelines for writing energy audit report, data presentation in report, findings recommendations, impact of renewable energy on energy audit recommendations and energy audit report, energy audit of building system, lighting system, HVAC system, Water heating system, heat recovery opportunities during energy audit, Industrial audit opportunities, Instruments for Audit and Monitoring Energy and Energy Savings

Unit 5: Energy Economics
Simple Payback Period, Time Value of Money, Internal Rate of Return, Net Present Value, Life Cycle Costing, Equivalent uniform annual cost (EUAC), Life cycle cost, Discounting factor, Capital recovery, Depreciation, taxes and tax credit, Impact of fuel inflation on life cycle cost, Cost of saved energy, cost of energy generated, Energy performance contracts and role of Energy Service Companies (ESCOs).

Kyoto protocol, Clean development mechanism (CDM), Geopolitics of GHG control; Carbon Market

Text / References:

1. Capehart B.L., Turner W.C., Kennedy W.J. (2011). Guide to Energy Management (7th Edition). Fairmont Press. ISBN: 1439883483.
2. Patrick D.R., Fardo S.W., Richardson R.E., Fardo B.W. (2014). Energy Conservation Guidebook (3rd Edition). Fairmont Press. ISBN: 1482255693.

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New Scheme of Examination as per AICTE Flexible Curricula

Electrical Engineering V-Semester open elective BOCT 605(A) /Microprocessor and interfacing

Course Objectives	To develop background knowledge and core expertise of microprocessors, To know the importance of different peripheral devices and their interfacing to microprocessors. To write assembly language programs of microprocessors for various applications	
Code	Course outcome	Level
CO 1	List and specify the various features of microprocessor, memory and I/O devices including concepts of system bus.	L3
CO 2	Identify the various elements of 8085 microprocessor architecture, its bus organization including control signals.	L4
CO 3	Describe the 8085 processor addressing modes, instruction classification and function of each instruction and write the assembly language programs using 8085 instructions.	L3
CO 4	Explain the concepts of memory and I/O interfacing with 8085 processor with Programmable devices. - List and	L3
CO 5	List and describe the features of advance microprocessors.	L3

UNIT I Introduction to Microprocessor, Components of a Microprocessor: Registers, ALU and control & timing, System bus (data, address and control bus), Microprocessor systems with bus organization Microprocessor Architecture and Operations, Memory, I/O devices, Memory and I/O operations

UNIT II 8085 Microprocessor Architecture, Address, Data And Control Buses, 8085 Pin Functions, Demultiplexing of Buses, Generation Of Control Signals, Instruction Cycle, Machine Cycles, T-States, Memory Interfacing
Assembly Language Programming Basics, Classification of Instructions, Addressing Modes, 8085 Instruction Set, Instruction And Data Formats, Writing, Assembling & Executing A Program, Debugging The Programs
UNIT III Writing 8085 assembly language programs with decision, making and looping using data transfer, arithmetic, logical and branch instructions
Stack & Subroutines, Developing Counters and Time Delay Routines, Code Conversion, BCD Arithmetic and 16-Bit Data operations
UNIT IV Interfacing Concepts, Ports, Interfacing Of I/O Devices, Interrupts In 8085, Programmable Interrupt Controller 8259A, Programmable Peripheral Interface 8255A Advanced Microprocessors : 8086 logical block diagram and segments, 80286: Architecture, Registers 8 20% (Real/Protected mode), Privilege levels, descriptor cache, Memory access in GDT and LDT, multitasking, addressing modes, flag register 80386: Architecture, Register organization, Memory access in protected mode, Paging 80486 : Only the technical features Pentium : Architecture and its versions

UNIT V SUN SPARC Microprocessor: Architecture, Register file, data types and instruction format ARM Processor: Architecture features, Logical block diagram of ARM7 architecture

Reference Books:

1. Microprocessor Architecture, Programming, and Applications with the 8085, Ramesh S. Gaonkar Pub: Penram International.
2. Microprocessors and Interfacing, N. Senthil Kumar, M. Saravanan, S. Jeevanathan, S. K. Shah, Oxford
3. Advanced Microprocessors, Daniel Tabak, McGrawHill
4. Microprocessor & Interfacing - Douglas Hall, TMH
5. 8086 Programming and Advance Processor Architecture, Savaliya M. T., WileyIndia

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Electrical Engineering, VI-Semester

New Scheme of Examination as per AICTE Flexible Curricula

Electrical Engineering, VI-Semester Open Elective
BOET-605(B)/ BECT-603 Digital signal processing

Course Objective	To give an introduction to basic concepts of system transforms, fundamental principles and applications of signals and filters. This subject provides understanding and working knowledge of design, implementation, analysis and comparison of digital filters for processing of discrete time signals.	
Code	Course outcome	Level
CO 1	Acquire knowledge about the time domain representation and classification of discrete time signals and systems	L 2
CO 2	Acquire knowledge about the time domain analysis of linear time invariant discrete time systems and representation of total response in various formats.	L 4
CO 3	Acquire knowledge about the application of discrete time Fourier transform, Discrete Fourier series and z-transform for discrete time signal representation and analysis of linear time invariant systems discrete time systems	L 2
CO 4	Acquire knowledge about the design methods for IIR and FIR filters and their realisation structures.	L 4
CO 5	Acquire knowledge about the finite wordlength effects in the implementation of digital filters	L 3

Unit 1:

DISCRETE FOURIER TRANSFORM: Frequency Domain Sampling: The Discrete Fourier Transform Frequency Domain Sampling and Reconstruction of Discrete-Time Signals. The Discrete Fourier Transform (DFT). The DFT as a linear Transformation. Relationship of the DFT to Other Transforms. Properties of the DFT: Periodicity, Linearity, and Symmetry Properties. Multiplication of two DFTs and Circular Convolution. Additional DFT Properties. Frequency analysis of signals using the DFT.

Unit 2:

EFFICIENT COMPUTATION OF DFT: Efficient Computation of the DFT: FFT Algorithms, Direct Computation of the DFT. Radix-2 FFT algorithms. Efficient computation of the DFT of two real sequences, computations, Efficient computation of the DFT of a 2N-Point real sequences, , Chirp Ztransform algorithm.

Unit 3:

DESIGN OF DIGITAL IIR FILTERS: Impulse invariant and bilinear transformation techniques for Butterworth and chebyshev filters; Direct form (I & II), cascade and parallel.

Unit 4:

DESIGN OF FIR FILTERS:- windowing, optimum approximation of FIR filters, multistage approach to sampling rate concession. Design of Hilbert transforms.

Unit 5:

ADAPTIVE WIENER FILTER AND LMS ALGORITHM: Application of adaptive filtering to echo cancellation and equalization.

APPLICATION OF DSP AND CODING: Implementation of LIT using DFI, Goertzel algorithm, FFT algorithms. Audio and Video coding, MPEG coding standardization, FFT spectral analysis, DCT.

Text / References:

1. Proakis, J.G. & Manolakis, D.G., "Digital Signal Processing: Principles Algorithms and Applications", Prentice Hall (India).
2. Sanjit K. Mitra, "Digital Signal Processing", Third Edition, TMH, 2005
3. Oppenheim A.V. & Schafer, Ronald W., "Digital Signal Processing", Pearson Education.
4. DeFatta, D.J., Lucas, J.G. & Hodgkiss, W.S., "Digital Signal Processing", John Wiley & Sons

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New Scheme of Examination as per AICTE Flexible Curricula

Electrical Engineering, VI-Semester –Open Elective BOET-605(C)) Analog and Digital Communication

Course Objectives	To familiarize students with the fundamentals of analog and digital communication systems, communication signal analysis, to familiarize students with various techniques for amplitude mod signals	
Codes	Course outcomes	Level
CO1	The fundamentals of basic communication system, types of noise affecting communication system and noise parameters	L 2
CO2	Need of modulation, modulation processes and different amplitude modulation schemes	L 4
CO3	Different angle modulation schemes with different generation and detection methods.	L 2
CO4	Analyze concept of advanced modulation techniques	L 4
CO5	Apply the knowledge of digital communication and describe the error control codes like block code, cyclic code	L 3

Unit I:
Introduction: Overview of Communication system, Communication channels, Need for modulation, Baseband and Passband signals, Amplitude Modulation: Double sideband with Carrier (DSB-C), Double side band without Carrier DSB-SC, Single Side Band Modulation SSB, Modulators and Demodulators, Vestigial Side Band (VSB), Quadrature Amplitude Modulator, Radio Transmitter and Receiver..

Unit II:
Angle Modulation, Tone Modulated FM Signal, Arbitrary Modulated FM Signal, Bandwidth of FM Signals using Bessel's Function, FM Modulators and Demodulators, Approximately Compatible SSB Systems, Stereophonic FM Broadcasting

Unit III:
Pulse Modulation, Digital Transmission of Analog Signals: Sampling Theorem and its applications, Pulse Amplitude Modulation (PAM), Pulse Width Modulation, Pulse Position Modulation, Their generation and Demodulation, Digital Representation of Analog Signals Pulse Code Modulation (PCM), PCM System Issues in digital transmission: Frequency Division Multiplexing Time Division Multiplexing, T1 Digital System, TDM Hierarchy.

Unit IV:
Differential Pulse Code Modulation, Delta Modulation. Adaptive Delta Modulation, Voice Coders, Sources of Noises, Frequency domain representation of Noise, Super position of Noises, Linear filtering of Noises, Mathematical Representation of Noise.

Unit V:
Noise in Amplitude Modulation: Analysis, Signal to Noise Ratio, Figure of Merit. Noise in Frequency Modulation: Pre-emphasis, De-Emphasis and SNR Improvement, Phase Locked Loops Analog and Digital.

Reference Books:

1. B.P.Lathi,“ModernDigitalandAnalogcommunicationSystems”,3rd Edition, Oxford University Press.
2. Simon Haykin, “Communication Systems”, 4th Edition, Wiley India.
3. H.P.Hsu& D. Mitra “Analog and Digital Communications”, 2nd Edition, Tata McGraw-Hill.

BEEP 501- EMEC- II Lab

Lab Outcomes

In the lab students study, learn & perform the experiments on different types of electrical machines such as - transformers, Synchronous motors, alternators, dc motors & generators, three phase and single phase induction motors, relays and controlled rectifiers to verify the different characteristics of the electrical machines.

Experiments

1. To perform no load and blocked rotor tests on a three phase squirrel cage induction motor and determine equivalent circuit.
2. To perform load test on a three phase induction motor and draw Torque -speed characteristics
3. To perform no load and blocked rotor tests on a single phase induction motor and determine equivalent circuit.
4. To study speed control of three phase induction motor by varying supply voltage and by keeping V/f ratio constant.
5. To perform open circuit and short circuit tests on a three phase alternator and determine voltage regulation at full load and at unity, 0.8 lagging and leading power factors by (i) EMF method (ii) MMF method.
6. To determine V-curves and inverted V-curves of a three phase synchronous motor.
7. To determine Xd and Xq of a three phase salient pole synchronous machine using the slip test and to draw the power-angle curve.
8. To study synchronization of an alternator with the infinite bus by using: (i) dark lamp method (ii) two bright and one dark lamp method.
9. To determine speed-torque characteristics of three phase slip ring induction motor and study the effect of including resistance, or capacitance in the rotor circuit.
10. To determine speed-torque characteristics of single phase induction motor and study the effect of voltage variation.
11. To determine speed-torque characteristics of a three phase induction motor by (i) keeping v/f ratio constant (ii) increasing frequency at the rated voltage.
12. To draw O.C. and S.C. characteristics of a three phase alternator from the experimental data and determine voltage regulation at full load, and unity, 0.8 lagging and leading power factors.
13. To determine steady state performance of a three phase induction motor using equivalent circuit.

BEEP 502 – Power system- II Lab

Lab outcomes

Calculate the steady-state power flow in a power system and analyze different types of short-circuit faults which occur in power systems

List of Experiments

1. Computation of Parameters and Modeling of Transmission Lines
2. Formation of Bus Admittance and Impedance Matrices and Solution of Networks
3. Load Flow Analysis - I : Solution of Load Flow And Related Problems Using Gauss-Seidel Method
4. Load Flow Analysis - II: Solution of Load Flow and Related Problems Using Newton-Raphson and Fast-Decoupled Methods

5. Transient Stability Analysis of Multi machine Power Systems
6. Load – Frequency Dynamics of Single- Area and Two-Area Power Systems
7. Economic Dispatch in Power Systems.
8. Transient and Small Signal Stability Analysis: Single-Machine Infinite Bus System

BEEP- 601 Power Electronics lab

Lab outcomes

To expose students to operation and characteristics of power semiconductor devices and passive components, their practical application in power electronics. • To provide a practical exposure to operating principles, design and synthesis of different power electronic converters. • To introduce students to industrial control of power electronic circuits as well as safe electrical connection and measurement practices.

List of Experiments

1. To study triggering of (i) IGBT (ii) MOSFET (iii) power transistor
2. To study V-I characteristics of SCR and measure latching and holding currents.
3. To compare the R, RC &UJT trigger circuit for SCR.
4. To study the commutation circuit for SCR.
5. To study single phase fully controlled bridge rectifiers with resistiveand inductive loads.
6. To study single phase fully controlled bridge rectifiers with DC motor load.
7. To study three-phase fully controlled bridge rectifier with resistive and inductive loads.
8. To study single-phase ac voltage regulator with resistive and inductive loads.
9. To study single phase cyclo-converter
10. To study the four quadrant operation of chopper circuit
11. To study MOSFET/IGBT based single-phase bridge inverter.

BEEP 602- Power system protection lab

Lab Outcomes: Analyze the performance of transmission lines and relays, Calculate the steady-state power flow in a power system

1.To determine direct axis reactance (x_d) and quadrature axis reactance (x_q) of a salient pole alternator.
2. To determine negative and zero sequence reactances of an alternator.
3. To determine sub transient direct axis reactance (x_d) and sub transient quadrature axis reactance (x_q) of an alternator
4. To determine fault current for L-G, L-L, L-L-G and L-L-L faults at the terminals of an alternator at very low excitation
5. To study the IDMT over current relay and determine the time current characteristics
6. To study percentage differential relay

7. To study Impedance, MHO and Reactance type distance relays
8. To determine location of fault in a cable using cable fault locator
9. To study ferranty effect and voltage distribution in H.V. long transmission line using transmission line model.
10. To study operation of oil testing set.

Electrical Engineering, VI-Semester BEEP -607/ 707
Minor Project-I/II

The object of Project Work II & Dissertation is to enable the student to extend further the investigative study taken up under Project-I, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide a good training for the student(s) in R&D work and technical leadership. The assignment to normally include:

1. In depth study of the topic assigned in the light of the Report prepared under Project-I;
2. Review and finalization of the Approach to the Problem relating to the assigned topic;
3. Preparing an Action Plan for conducting the investigation, including team work;
4. Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed;
5. Final development of product/process, testing, results, conclusions and future directions;
6. Preparing a paper for Conference presentation/Publication in Journals, if possible;
7. Preparing a Dissertation in the standard format for being evaluated by the Department.
8. Final Seminar Presentation before a Departmental Committee

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BEET 704 - Power System stability

Course Objective:

- To understand the fundamental concepts of stability of power systems and its classification.
- To expose the students to dynamic behaviour of the power system for small and large disturbances.
- To understand and enhance the stability of power systems.

Course Outcome:

- Learners will attain knowledge about the stability of power system
- Learners will have knowledge on small-signal stability, transient stability and voltage stability.
- Learners will be able to understand the dynamic behaviour of synchronous generator for different disturbances.
- Learners will be able to understand the various methods to enhance the stability of a power system.

Unit I

Unit II

Small-Signal Stability
Basic concepts and definitions – State space representation, Physical Interpretation of small-signal stability, Eigen properties of the state matrix: Eigenvalues and eigenvectors, modal matrices, eigenvalue and stability, mode shape and participation factor. Smallsignal stability analysis of a Single-Machine Infinite Bus (SMIB) Configuration with numerical example.

Unit III

Transient Stability
Review of numerical integration methods: modified Euler and Fourth Order Runge-Kutta methods, Numerical stability,. Interfacing of Synchronous machine (classical machine) model to the transient stability algorithm (TSA) with partitioned – explicit approaches- Application of TSA to SMIB system.

Unit IV

Enhancement of Small-Signal Stability and Transient Stability
Power System Stabilizer -. Principle behind transient stability enhancement methods: high-speed fault clearing, regulated shunt compensation, dynamic braking, reactor switching, independent pole-operation of circuit-breakers, single-pole switching, fastvalving, high-speed excitation systems.

Text books

1. Power system stability and control ,P. Kundur ; edited by Neal J. Balu, Mark G. Lauby, McGraw-Hill, 1994.
2. R.Ramnujam, Power System Dynamics Analysis and Simulation, PHI Learning Private Limited, New Delhi, 2009
3. T.V. Cutsem and C.Vournas, Voltage Stability of Electric Power Systems, Kluwer publishers, 1998.

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BEET-703(B) Non-conventional energy resources

Course Objectives

1. To understand the working principle of MHD

2. To recognize the methods of hydrogen production and storage.

3. To understand the fundamentals of fuel cell and to recognize the future scope of fuel cell in various application.

4. To comprehend the theories of Tidal, Wave and OTEC systems.

Course Outcomes

On completion of this subject the student is expected to:

CO1 Have a basic knowledge of the principles of Fuel Cells and its components, types of Fuel Cells, performance characteristics, and applications of Fuel Cells.

CO2 Have a basic knowledge of Hydrogen Energy, Properties of Hydrogen, Production methods and purification, Storage methods, Environmental benefits and its Applications in the Hydrogen Economy.

CO3 Have a basic knowledge of Ocean energy resources and technologies including Tidal energy, Wave power devices, OTEC, Bio Photolysis, Ocean currents and Salinity gradient devices.

CO4 Have a basic knowledge of the principles of Magneto Hydro Dynamic power generation system, and it applications & technologies.

Unit I:

MHD generators basicsPrinciple of MHD generation system, MHD open and closed systems. Advantages and Disadvantages of MHD

Unit II:

Hydrogen Energy: Hydrogen as a fuel, Properties of Hydrogen and Sources of Hydrogen. Hydrogen Production Methods, Storage Methods, Environmental Benefits, Purification of Hydrogen. Hydrogen Production Units in India. Hydrogen Management, Transportation and Limitations.

Unit III:

Fuel Cells: Fuel Cell history, difference between batteries and fuel cell, Components of fuel cells.Working principle of Fuel Cell, Performance Characteristics of Fuel Cell.Fuel Cell power plant: Fuel processor, power conditioner, Advantages and Disadvantages of fuel cell power plantTypes of Fuel Cells, Geometries of Solid Oxide Fuel CellsProblems with Fuel CellsOverview on research activities on fuel cells in world, R&D related to fuel cell development in India

Unit IV:

Tidal Energy: Origin of Tides, Power Generation SchemesWave Energy: Basic Theory, Wave power devicesIntroduction: Open and Closed OTEC cycles, Bio Photolysis, Ocean Currents and Salinity Gradients.

Reference books:

1. John Twidell and Tony Weir, “Renewable Energy Resources”, 2nd Edition, Taylor and Francis London, 2010 ISBN: 9780419253204

2. Rakosh Das Begamudre, “Energy Conversion Systems”, New Age International Publishers, 2000 ISBN: 9788122412666

BEET-703(A) Soft computing Techniques

Course Objectives	Introduce students to **soft computing** concepts and **techniques** and foster their abilities in designing and implementing **soft computing** based solutions for real-world and engineering problems. Introduce students to fuzzy systems, fuzzy logic and its applications.	
Code	Course outcome	Level
CO1	Apply the concepts of neural networks to demonstrate artificial neural network.	L3
CO2	Analyze the types of architecture and perceptron model	L4
CO3	Interpret the concept of Fuzzification to design fuzzy logic control system using MATLAB	L6
CO4	To compute the genetic algorithm method and rules based controller	L4
CO5	Design real time systems using the application of artificial neural network and fuzzy logic control	L6

Contents		**Hours**
Unit 1	Introduction to Soft Computing, ARTIFICIAL NEURAL NETWORKS Basic concepts - Single layer perception - Multilayer Perception - Supervised and Unsupervised learning – Back propagation networks - Kohnen's self-organizing networks - Hopfield network	8
Unit 2	FUZZY SYSTEMS Fuzzy sets, Fuzzy Relations and Fuzzy reasoning, Fuzzy functions - Decomposition - Fuzzy automata and languages - Fuzzy control methods - Fuzzy decision making.	8
Unit 3	NEURO - FUZZY MODELING Adaptive networks based Fuzzy interface systems - Classification and Regression Trees - Data clustering algorithms - Rule based structure identification - Neuro-Fuzzy controls - Simulated annealing – Evolutionary computation	8
Unit 4	GENETIC ALGORITHMS Survival of the Fittest - Fitness Computations - Cross over - Mutation - Reproduction - Rank method - Rank space method.	8
Unit 5	APPLICATION OF SOFT COMPUTING Optimiation of traveling salesman problem using Genetic Algorithm, Genetic algorithm based Internet Search Techniques, Soft computing based hybrid fuzzy controller, Introduction to MATLAB Environment for Soft computing Techniques.	10

Suggested Readings :

1.An Introduction to Genetic Algorithm Melanic Mitchell (MIT Press)
2.Evolutionary Algorithm for Solving Multi-objective, Optimization Problems (2nd Edition), Collelo, Lament, Veldhnizer (Springer)
3.Fuzzy Logic with Engineering Applications Timothy J. Ross (Wiley) 4.Neural Networks and Learning Machines Simon Haykin (PHI)

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BEET-703(D)- Special Electromechanical Systems

Course Objectives	Capable of and actively involved in the specification, procurement, or integration of electromechanical systems Capable of and actively involved in the operation, testing, or maintenance of electromechanical systems	
Code	Course outcome	Level
CO1	The ability to formulate and then analyse the working of any electrical machine under loaded and unloaded conditions	L5
CO2	The skill to analyse the response of any electrical machine	L4
CO3	The ability to troubleshoot the operation of an electrical machine	L3
CO4	Compare accepted standards and guidelines to select appropriate electrical machines to meet specified performance requirements.	L4
CO5	Demonstrate an understanding of the fundamental control practices associated with rotating machines (starting, reversing, braking, speed control etc.).	L4

Contents		**Hours**
Unit 1	Poly-phase AC Machines: Construction and performance of double cage and deep bar three phase induction motors; e.m.f. injection in rotor circuit of slip ring induction motor, concept of constant torque and constant power controls, static slip power recovery control schemes (constant torque and constant power)	8
Unit 2	Single phase Induction Motors: Construction, starting characteristics and applications of split phase, capacitor start, capacitor run, capacitor-start capacitor-run and shaded pole motors. Two Phase AC Servomotors: Construction, torque-speed characteristics, performance and applications.	8
Unit 3	Stepper Motors: Principle of operation, variable reluctance, permanent magnet and hybrid stepper motors, characteristics, drive circuits and applications. Switched Reluctance Motors: Construction; principle of operation; torque production, modes of operation, drive circuits.	8
Unit 4	Permanent Magnet Machines: Types of permanent magnets and their magnetization characteristics, demagnetizing effect, permanent magnet dc motors, sinusoidal PM ac motors, brushless dc motors and their important features and applications, PCB motors. Single phase synchronous motor; construction, operating principle and characteristics of reluctance and hysteresis motors; introduction to permanent magnet generators and applications	8
Unit 5	Single Phase Commutator Motors: Construction, principle of operation, characteristics of universal and repulsion motors ; Linear Induction Motors. Construction, principle of operation, Linear force, and applications..	10

Suggested Readings :

1. P.S. Bimbhra “Generalized Theory of Electrical Machines” Khanna Publishers.
2. P.C. Sen “Principles of Electrical Machines and Power Electronics” Johnwilley&Sons, 2001.

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New Scheme of Examination as per AICTE Flexible Curricula

BEET- 703(E)- Energy Management and SCADA

Course Objectives	Objectives: The course provides an introduction to the role of Computers and Communication in Electrical Power Engineering. Energy Management Systems (EMS) and Supervisory Control and Data Acquisition (SCADA) are strongly linked and associated with each other. EMS deals with the computer operation, optimization and control of power systems. Power System operation, optimization ad control, which are the studies carried in an EMS are presented in detail.	
Code	Course outcome	Level
CO1	Employ the fundamentals of PLC, DCS, and SCADA for automation used in industry.	L3
CO2	Differentiate the hardware and software requirements of PLC and SCADA.	L4
CO3	Categorise the basics of man-machine communication based on the communication system	L4
CO4	Construct the safety instrumented systems on the basis of the requirements of safety.	L6
CO5	Apply the concept of SCADA in different applications	L5

Contents		**Hours**
Unit 1	**SCADA** Purpose and necessity, general structure, data acquisition, transmission & monitoring. general power system hierarchical Structure. Overview of the methods of data acquisition systems, commonly acquired data, transducers, RTUs, data concentrators, various communication channels- cables, telephone lines, power line carrier, microwaves, fiber optical channels and satellites.	8
Unit 2	**Supervisory and Control Functions** Data acquisitions, status indications, majored values, energy values, monitoring alarm and event application processing. Control Function: ON/ OFF control of lines, transformers, capacitors and applications in process in industry - valve, opening, closing etc. Regulatory functions: Set points and feed back loops, time tagged data, disturbance data collection and analysis. Calculation and report preparation..	8
Unit 3	**MAN- Machine Communication** Operator consoles and VDUs, displays, operator dialogues, alarm and event loggers, mimic diagrams, report and printing facilities.	8
Unit 4	**Data basis** SCADA, EMS and network data basis. SCADA system structure - local system, communication system and central system. Configuration- NON-redundant- single processor, redundant dual processor. Multicontrol centers, system configuration. Performance considerations: real time operation system requirements, modularization of software programming languages.	8
Unit 5	**Energy Management Center**	10

	Functions performed at a centralized management center, production control and load management economic dispatch, distributed centers and power pool management.	

Suggested Readings :

1. Torsten Cergrell, " Power System Control Technology", Prentice Hall International.
2. George L Kusic "Computer Aided Power System Analysis",, Prentice Hall of India,
3. A. J. Wood and B. Woolenberg, "Power Generation Operation and Control", John Wiley & Sons.
4. Sunil S Rao, "Switchgear Protection & Control System" Khanna Publishers 11th Edition.

BOET-704(A)- Internet of things

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BOET-704(C)- Probability theory and stochastic process

Course objectives	To provide the students with knowledge about the **random** variable, **random process** and how to model the **random processes** in the communication system such as receiver performance, interference, thermal noise, and multipath phenomenon	
Code	Course outcome	Level
CO 1	Understand the axiomatic formulation of modern Probability Theory and think of random variables as an intrinsic need for the analysis of random phenomena	L2
CO 2	Characterize probability models and function of random variables based on single & multiples random variables.	L3
CO 3	Evaluate and apply moments & characteristic functions and understand the concept of inequalities and probabilistic limits.	L4
CO 4	Understand the concept of random processes and determine covariance and spectral density of stationary random processes	L2
CO 5	Demonstrate the specific applications to Poisson and Gaussian processes and representation of low pass and band pass noise models.	L3

Contents		**Hours**
Unit 1	**Probability and Random Variable** **Probability:** Probability introduced through Sets and Relative Frequency, Experiments and Sample Spaces, Discrete and Continuous Sample Spaces, Events, Probability Definitions and Axioms, Mathematical Model of Experiments, Probability as a Relative Frequency, Joint Probability, Conditional Probability, Total Probability, Bayes' Theorem, Independent Events. **Random Variable:** Definition of a Random Variable, Conditions for a Function to be a Random Variable, Discrete, Continuous and Mixed Random Variable.	8
Unit 2	**Distribution & Density Functions and Operation on One Random Variable – Expectations** **Distribution & Density Functions:** Distribution and Density functions and their Properties - Binomial, Poisson, Uniform, Gaussian, Exponential, Rayleigh and Conditional Distribution, Methods of defining Conditional Event, Conditional Density, Properties. **Operation on One Random Variable – Expectations:** Introduction, Expected Value of a Random Variable, Function of a Random Variable, Moments about the Origin, Central Moments, Variance and Skew, Chebychev's Inequality, Characteristic Function, Moment Generating Function, Transformations of a Random Variable: Monotonic Transformations for a Continuous Random Variable, Non-monotonic	8

	Transformations of Continuous Random Variable, Transformation of a Discrete Random Variable.	
Unit 3	**Multiple Random Variables:** Vector Random Variables, Joint Distribution Function, Properties of Joint Distribution, Marginal Distribution Functions, Conditional Distribution and Density – Point Conditioning, Conditional Distribution and Density – Interval conditioning, Statistical Independence, Sum of Two Random Variables, Sum of Several Random Variables, Central Limit Theorem (Proof not expected), Unequal Distribution, Equal Distributions. **Operations on Multiple Random Variables:** Expected Value of a Function of Random Variables: Joint Moments about the Origin, Joint Central Moments, Joint Characteristic Functions, Jointly Gaussian Random Variables: Two Random Variables case, N Random Variable case, Properties, Transformations of Multiple Random Variables, Linear Transformations of Gaussian Random Variables.	8
Unit 4	**Stochastic Processes – Temporal Characteristics:** The Stochastic Process Concept, Classification of Processes, Deterministic and Nondeterministic Processes, Distribution and Density Functions, Concept of Stationarity and Statistical Independence, First-Order Stationary Processes, Second-Order and Wide-Sense Stationarity, Nth Order and Strict-Sense Stationarity, Time Averages and Ergodicity, Mean-Ergodic Processes, Correlation-Ergodic Processes, Autocorrelation Function and its Properties, Cross-Correlation Function and its Properties, Covariance and its Properties, Linear System Response of Mean and Mean-squared Value, Autocorrelation Function, Cross-Correlation Functions, Gaussian Random Processes, Poisson Random Process.	8
Unit 5	**Stochastic Processes – Spectral Characteristics:** Power Spectrum: Properties, Relationship between Power Spectrum and Autocorrelation Function, Cross-Power Density Spectrum, Properties, Relationship between Cross-Power Spectrum and Cross-Correlation Function, Spectral Characteristics of System Response: Power Density Spectrum of Response, Cross-Power Spectral Density of Input and Output of a Linear System.	10

Suggested Readings :

1. Probability, Random Variables & Random Signal Principles - Peyton Z. Peebles, 4Ed., 2001, TMH.
2. Probability and Random Processes – Scott Miller, Donald Childers, 2 Ed, Elsevier, 2012.

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BOET-704(D)- Robotics and automation

Course Objective	Introduction to mechanics and control of robotic manipulators. Topics include spatial transformations, kinematics, dynamics, trajectory generation, actuators and control, and relations to product design and flexible automation.	
Code	Course outcome	Level
CO1	Demonstrate an ability to apply spatial transformation to obtain forward kinematics equation of robot manipulators	L4
CO2	Demonstrate an ability to obtain the Jacobian matrix and many more to use it to identify singularities	L4
CO3	To study various types of of transducers: electrical , mechanical, electro mechanical and optical etc	L3
CO4	To learn the concepts of special purpose DAC and different types of automation system	L3
CO5	Demonstrate knowledge of robot controllers	L4

Contents		**Hours**
Unit 1	Introduction to Robotics, Types and components of a robot, Classification of robots, Kinematics systems; Definition of mechanisms and manipulators, Degrees of Freedom	8
Unit 2	Robot Kinematics and Dynamics, Kinematic Modelling: Translation and Rotation Representation, Coordinate transformation, DH parameters, Forward and inverse kinematics, Jacobian, Singularity, and Statics, Dynamic Modelling: Forward and inverse dynamics, Equations of motion using Euler-Lagrange formulation, Newton Euler formulation	8
Unit 3	Sensors : Sensor: Contact and Proximity, Position, Velocity, Force, Tactile etc, Introduction to Cameras, Camera calibration, Geometry of Image formation, Euclidean/Similarity/Affine/Projective transformations, Vision applications in robotics.	8
Unit 4	Robot Actuation Systems: Actuators: Electric, Hydraulic and Pneumatic; Transmission: Gears, Timing Belts and Bearings, Parameters for selection of actuators.	8
Unit 5	RobotControl: Basics of control: open loop- closed loop, Transfer functions, Control laws: P, PD, PID , Linear and Non-linear controls, Control Hardware and Interfacing	10

Suggested Readings :

1. Introduction to Robotics : J. Craig , Pearson
2. Robot Dynamics and Control, Spong & Vidyasagar, Mc Graw Hill
3. Robotics Engineering : R. Klafter, PHI
4. Robotics : Subir K Saha , Mc GrawHill
5. Industrial Robotics : M. P. Groover, Ashish Dutta , McGraw Hill

BEET(805) - Operation and control of power system

Course Objectives	To familiarize the load dispatch engineers to sector set up, system control, market operations, logistics and new technologies. To develop the system operators for secure operation of power system in India in the scenario of continuous load growth, system expansion and multiplying number of organizations.	
CO1	Able to compute optimal scheduling of Generators	L2
CO2	Able to understand hydrothermal scheduling	L2
CO3	Able to understand importance of the frequency.	L2
CO4	Able to Understand importance of PID controllers in single area and two area systems.	L2
CO5	Able to understand reactive power control and line power compensation.	L2

Contents		**Hours**
Unit 1	Introduction: Structure of power systems, Power system control center and real time computer control, SCADA system Level decomposition in power system Power system security Various operational stages of power system Power system voltage stability	8
Unit 2	Economic Operation: Concept and problems of unit commitment Input-output characteristics of thermal and hydro-plants System constraints Optimal operation of thermal units without and with transmission losses, Penalty factor, incremental transmission loss, transmission loss formula (without derivation) Hydrothermal scheduling long and short terms Concept of optimal power flow	8
Unit 3	Load Frequency Control: Concept of load frequency control, Load frequency control of single area system: Turbine speed governing system and modeling, block diagram representation of single area system, steady state analysis, dynamic response, control area concept, P-I control, load frequency control and economic dispatch control. Load frequency control of two area system: Tie line power modeling, block diagram representation of two area system, static and dynamic response.	8
Unit 4	Automatic Voltage Control: Schematic diagram and block diagram representation, different types of Excitation systems & their controllers. Voltage and Reactive Power control: Concept of voltage control, methods of voltage controlcontrol by tap changing transformer. Shunt Compensation, series compensation, phase angle compensation	8
Unit 5	State Estimation:Detection and identification, Linear and non-linear models. Flexible AC Transmission Systems: Concept and objectives FACTs controllers: Structures & Characteristics of following FACTs Controllers. TCR,FC-TCR, TSC, SVC, STATCOM, TSSC, TCSC, SSSC, TC-PAR, UPFC	9

Suggested Readings :

1. D.P. Kothari & I.J. Nagrath, “Modern Power System Analysis” Tata Mc Graw Hill, 3rd Edition. 2. P.S.R. Murty, “Operation and control in Power Systems” B.S. Publications.
3. N. G. Hingorani & L. Gyugyi, “ Understanding FACTs” Concepts and Technology of Flexible AC Transmission Systems”

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BEET 802- Electric Drives and applications

Course Objectives	To provide fundamental knowledge in dynamics and control of **Electric Drives**. To justify the selection of **Drives** for various **applications**. To familiarize the various semiconductor controlled **drives** employing various **motors**.	
Code	Course outcome	Level
CO1	Differentiate electric drives systems based on nature of loads, control objectives, performance and reliability.	L4
CO2	Illustrate the concept of braking to distinguish types of motors in electric drives.	L4
CO3	Develop capability to choose a suitable DC Motor and Power Electronic Converter involving load estimation and load cycle consideration.	L6
CO4	Design the frequency controlled converters used in induction motor drives utilising phase controlled converters.	L6
CO5	Analyze the output waveforms of the converters with different types of loads	L4

Contents		**Hours**
Unit 1	**Fundamentals of Electric Drive:** Electric Drives and its parts, advantages of electric drives, Classification of electric drives, Speed-torque conventions and multi-quadrant operations, Constant torque and constant power operation, Types of load, Load torque: components, nature and classification	10
Unit 2	Dynamics of motor-load combination; Steady state stability of Electric Drive; Transient stability of electric Drive **Selection of Motor Power rating:** Thermal model of motor for heating and cooling, classes of motor duty, determination of motor power rating for continuous duty, short time duty and intermittent duty. Load equalization	8
Unit 3	Purpose and types of electric braking, braking of dc, three phase induction and synchronous motors. Dynamics During Starting and Braking: Calculation of acceleration time and energy loss during starting of dc shunt and three phase induction motors, methods of reducing energy loss during starting. Energy relations during braking, dynamics during braking	8
Unit 4	**Power Electronic Control of DC Drives** Single phase and three phase controlled converter fed separately excited dc motor drives (continuous conduction only); dual converter fed separately excited dc motor drive, rectifier control of dc series motor.	8

	Chopper control of separately excited dc motor and dc series motor.	
Unit 5	**Power Electronic Control of AC Drives** Three Phase induction Motor Drive, Static Voltage control scheme, static frequency control scheme (VSI, CSI, and cyclo- converter based) static rotor resistance and slip power recovery control schemes. Special Drives Switched Reluctance motor, Brushless dc motor.	8

Suggested Readings :

1. M.Chilkin, “Electric Drives”, Mir Publishers, Moscow.
2. Mohammed A. El-Sharkawi, “Fundamentals of Electric Drives”, Thomson Asia, Pvt. Ltd. Singapore.
3. N.K. De and Prashant K.Sen, “Electric Drives”, Prentice Hall of India Ltd

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BEET 803 (D)- High Voltage Engineering

Course Objectives	To understand the principles of theory of **high voltage** generation and measurements. 2- To understand the operation of **high voltage** power supplies for ac, dc, and impulse **voltages** 3- To get familiar with various applications where **high voltage** field is used.	
CO1	Understand the principles behind generating high DC – AC and impulse voltages	L 2
CO2	Develop equivalent circuit models of the different high voltage generators	L 4
CO3	Perform a dynamic response analysis of high voltage measurement systems	L 3
CO 4	Compute the breakdown strength of gas, liquids and solids insulation systems	L 4
CO 5	Understands the transient voltages and their propagation characteristics	L 2

Contents	**Hours**

Unit 1	Breakdown in Gases: Mechanism of breakdown in gases; various related ionization processes, Townsends and Streamer theories, Paschen's Law. Breakdown in non-uniform fields. Effect of waveshape of impressed voltage on the breakdown strength. Breakdown of sphere gap and rod gap.	8
Unit 2	Breakdown in Liquid and Solids: Mechanism of breakdown in liquids; suspended particles, suspended water, cavitation and bubble and electronic breakdown theories. Mechanisms of breakdown of solids; intrinsic, electro-mechanical, erosion, surface, thermal and streamer. Relation between electric strength of solids and log time, intrinsic breakdown strength.	8
Unit 3	Impulse Generator: Specifications of an impulse voltage wave, standard impulse. Impulse generator (Mars circuit) circuit, working, earthing and tripping. Technique to observe wavefront on CRO. Generation of High Voltage: Method of generation of power frequency high voltages-cascade transformers and resonance methods. Generation of high voltage-D.C. voltage multiplier circuit, Electrostatic generators, voltage stabilization. Tesla coil.	10
Unit 4	Measurement of High Voltage: Potential dividers; resistive, capacitive and mixed dividers for high voltage. Sphere gap; construction, mounting, effect of nearby earthed objects, effect of humidity and atmospheric conditions, effect of irradiation and of polarity. Electrostatic voltmeter; principle and classification. Constructional details of an absolute electrostatic voltmeter. Oscilloscope and their application in high voltage measurements.	10
Unit 5	High Voltage Testing: Measurement of insulation resistance of cables. Wet and dry flashover tests of insu1ators. Testing of insulators in simulated pollution conditions. Testing of transformers. Measurement of breakdown strength of oil. Basic techniques of non-destructive testing of insulators; measurement of loss angle and partial discharge measurement techniques.	10

Suggested Readings :

1. C.L. Wadhwa, 'High Voltage Engineering' New Age International Publishers, 1994.
2. M.S. Naidu, V. Kamaraju, 'High Voltage Engineering' Tata McGraw Hill, 1995.
3. D.V Razevig, 'High Voltage Engineering' Khanna Publishers, 19904. AK Gautam, "Advanced Microprocessors", Khanna Publishers.

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BEET 803 (E)- Computer aided power system analysis

Course objectives	To introduce computer applications in the analysis of power systems To understand the solution methods and techniques used in power system studies	
Code	Course outcome	Level
CO1	Recent techniques and computer application for modeling of practical and large interconnected power system networks using programming languages	L2
CO2	Recent methodologies for simulation and analysis of power system networks like real and reactive power flows and optimal scheduling.	L5
CO3	Effect of outage of any important component of power system on the operation and reliability of power systems	L4
CO4	Algorithm required to find out parameters for monitoring and control of power system in real time from actual measurement data.	L4

Contents	Hours

Unit 1	NETWORK MATRICES: Evaluation of Bus Admittandce matrix (YBUS), Bus Impedance matrix (ZBUS), Branch Impedance matrix (ZBT) and Loop Admittance matrix (ZLOOP) by singular and nonsinugular transformation.	10
Unit 2	SHORT CIRCUIT STUDIES: Formulation of ZBUS for single phase and three phase networks, transformation of network matrices using symmetrical components; short circuit studies using computer.	10
Unit 3	LOAD FLOW STUDIES: Representation of off load and on load tap changing and phase shifting transformer and dc link, decoupled and fast decoupled methods, sparsity technique, introduction to load flow of integrated ac/dc/ system.	10
Unit 4	STSBILITY STUDIES: Network formulation for stability studies for different types of loads (constant impedance, constant current and constant power loads), digital computer solution of swing equation for single and multimachine cases using Runge-Kutta and predictor corrector method, effect of exciter and governor on transient stability	10

Suggested Readings :

1. G.W. Stagg and A. H. El-Abiad, “Computer methods in power system analysis”, McGraw Hill, 1971.
2. G. L. Kusic, “Computer aided power system analysis”, PHI, 1986.
3. L.P.Singh, “ Advanced power system analysis and dynamics”, Wiley Eastern

BEET 803 (F)- Utilization of Electrical energy and traction

Course Objectives	1.Able to maintain **electric** drives used in an industries 2. Able to identify a heating/ welding scheme for a given application 3. Able to maintain/ Trouble shoot various lamps and fittings in **use** 4. Able to figure-out the different schemes of **traction** schemes and its main components

Code	Course outcome	Level
CO1	Illustrate fundamental concepts of heating, Identify a heating scheme for domestic and industrial applications.	L4
CO2	[illegible] for domestic and industrial applications.	[illegible]
CO3	Design the interior and exterior lighting systems- illumination levels for various purposes light fittings- factory lighting- flood lighting-street lighting	L5
CO4	[illegible] respect to speed, temperature and loading condition.	[illegible]
CO5	Assess the traction system (locomotives) for braking, acceleration and other related parameters, including demand side management.	L6

Contents		**Hours**
Unit 1	**Electric Heating** Advantage & methods of electric heating, Resistance heating, Electric arc heating, Induction heating, Dielectric heating,	8
Unit 2	**Electric Welding** Electric arc welding, electric resistance welding, Electric Welding control, Electrolyte Process: Principal of Electro deposition, laws of Electrolysis, application Electrolysis.	8
Unit 3	**Illumination** Various definition, laws of Illumination, requirement of good lighting, Design of indoor lighting & outdoor lighting system. Refrigeration and Air Conditioning Refrigeration system, domestic Refrigerator, water cooler, Types of Air conditioning, Window air Conditioner	8

Unit 4	**Electric Traction – I** Types of electric traction, system of track electrification, Traction mechanics-types of services, speed time curve and its simplification, average and schedule speeds, Tractive effort specific energy consumption, mechanics of train movement, coefficient of adhesion and its influence	8
Unit 5	**Electric Traction – II** Salient features of traction drives, Series-parallel control of dc traction drives (bridge traction) and energy saving, Power Electronic control of dc & ac traction drives, Diesel electric traction.	9

Suggested Readings :

1. H.Pratab.”Modern electric traction” Dhanpat Rai & Sons.
2. C.L. Wadhwa,”Generation, Distribution and Utilization of Electrical Energy “New Age International Publishers.5. Pandey & Kumar-Biomedical Electronics and Instrumentation. – Kataria

BEET 803 (G)- Flexible AC transmission System

Course Objectives	To impart the students with various **FACTS devices** which are used for proper operation of existing AC system more flexible in normal and abnormal conditions	
Code	Course outcome	Level
CO1	Acquire knowledge on shunt compensation of Power Systems	L2
CO2	Acquire detailed knowledge on Static VAr Compensators and STATCOMS	L2
CO3	Develop design capability in control systems for SVC and STATCOM	L4
CO4	Acquire detailed analysis-level and design level knowledge on various power electronic converters used static reactive power compensation units	L6

Contents		**Hours**
Unit 1	Introduction: Reactive power control in electrical power transmission lines - Uncompensated transmission line – series compensation – Basic concepts of Static Var Compensator (SVC) – Thyristor Controlled Series capacitor (TCSC) – Unified power flow controller (UPFC).	10
Unit 2	Static Var Compensator (SVC) And Applications Voltage control by SVC – Advantages of slope in dynamic characteristics – Influence of SVC on system voltage – Design of SVC voltage regulator –Modelling of SVC for power flow and fast transient stability – Applications: Enhancement of transient stability – Steady state power transfer Enhancement of power system damping..	10
Unit 3	Thyristor Controlled Series Capacitor (TCSC) And Applications Operation of the TCSC – Different modes of operation – Modelling of TCSC – Variable reactance model – Modelling for Power Flow and stability studies. Applications: Improvement of the system stability limit – Enhancement of system damping.	10
Unit 4	Voltage Source Converter Based Facts Controllers Static Synchronous Compensator (STATCOM) – Principle of operation – V-I Characteristics. Applications: Steady state power transfer-enhancement of transient stability – prevention of voltage instability. SSSC-operation of SSSC and	10

	the control of power flow – modelling of SSSC in load flow and transient stability studies.	

Suggested Readings :

1. R.Mohan Mathur, Rajiv K.Varma, "Thyristor – Based Facts Controllers for Electrical Transmission Systems", IEEE press and John Wiley & Sons, Inc, 2002.
2. Narain G. Hingorani, "Understanding FACTS -Concepts and Technology of Flexible AC Transmission Systems", Standard Publishers Distributors, Delhi- 110 006, 2011.

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BEEP 704- Power system stability lab

1. Transient and Small Signal Stability Analysis: Single-Machine Infinite Bus System
2. Transient Stability Analysis of Multi machine Power Systems
3. Electromagnetic Transients in Power Systems
4. Load – Frequency Dynamics of Single- Area and Two-Area Power Systems
5. Economic Dispatch in Power Systems.
6. Load Flow Analysis - I : Solution of Load Flow And Related Problems Using Gauss-Seidel Method
7. Load Flow Analysis - II: Solution of Load Flow and Related Problems Using Newton-Raphson and Fast-Decoupled Method
8. Fault Analysis

BEEP 805- Operation and control of power system

1. Simulation of thermal scheduling with and without losses
2. Unit commitment by dynamic programming
3. Simulation of hydro-thermal scheduling by gradient method
4. Stability analysis of single area frequency control
5. Bias control of two area system and AVR

BEEP 802- Electric drives and applications

1. To study speed control of single phase induction motor using micro controller.
2. Speed control of three phase slipring motor using static rotor resistance control through rectifier & chopper mosfet.
3. To perform speed control of separately excited dc motor using chopper.
4. Speed control of dc motor using closed loop and open loop.
5. To perform Micro controller based speed control of 3 phase induction motor by stator voltage control.