Uttarakhand Technical University, Dehradun

Scheme of Examination as per AICTE Flexible Curricula

Evaluation Scheme & Syllabus for B. Tech Third Year

W.E.F. Academic Session 2020-21

III to VIII SEMESTER

Bachelor of Technology (B. Tech.) [Electrical & Electronics Engineering]

Semester III

S. No.	Subject Code	Category	Subject Name	Maximum Marks Allotted						Contact Hours			
				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	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.	BC	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 IV

S. No.	Subject Code	Category	Subject Name	Maximum Marks Allotted						Contac			
				Theory			Practical						
				End Sem.	Mid Sem	Quiz/ Assignment	End Sem.	Term work 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	3	0	2	4
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	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	17	4	6	24
8.	BCSP 408	MC	Cyber Security	Non-credit course									
			NSS/NCC										

V Semester

S. No.	Subject Code	Category	Subject Name	Maximum Marks Allotted					Total Marks	Contact Hours per Week			
				Theory			Practical						
				End Sem	Mid Sem	Quiz / Assignment	End Sem	Term Work /Lab Work & Sessional		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 / B / C / D)	OE	Open Elective-I	100	30	20	-	-	150	3	0	0	3
5.	BEET-505	DC	Electromagnetic Field theory	100	30	20	-	-	150	3	1	0	4
6	BENP-506	IN	Evaluation of Internship-II completed at II year level	-	-	-	-	100	100	0	0	4	2
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	190	1000	11	5	19	22
NSS/NCC													

Departmental Electives			Open Electives	
BEET 503(A)	CAD of Power Apparatus		BOET-504(A)	Digital Control System
BEET 503(B)	Applied Instrumentation		BOET-504(B)	Communication Engineering
BEET 503(C)	Electrical Engineering Material		BOET-504(C)	Industrial electronics
			BOET-504(D)	Innovation and Entrepreneurship

VI Semester

S. No.	Subject Code	Category	Subject Name	Maximum Marks Allotted					Total Marks	Contact Hours per Week			
				Theory			Practical						
				End Sem	Mid Sem	Quiz / Assignment	End Sem	Team Work / Lab Work & Sessional		L	T	P	
1.	BEET-601 & BEEP-601	DC	Power Electronics	100	30	20	30	20	200	3	1	2	5
2.	BECT-602 & BECP-602	DC	Microprocessor & Embedded systems	100	30	20	30	20	200	3	1	2	5
	BECT-603	DC	Digital Signal Processing	100	30	20	30	20	200	3	1	2	5
3.	BEET-604(A or B or C)	DE	Departmental Elective	100	30	20	-	-	150	3	0	0	3
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	Simulation lab/Virtual Lab	-	-	-	30	20	50	0	0	4	2
6.	BEEP-607	P	Minor Project -I				-	50	50	0	0	4	2
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	14	4	14	25

Departmental Electives			Open Electives	
BEET 604(A)	FACTS		BOET-605(A)	Introduction to smart grids
BEET 604(B)	Energy Management and SCADA		BOET-605(B)	Power Plant Engineering
BEET 604(C)	NCER		BOET-605(C)	Special Electromechanical Systems

VII Semester

S. No.	Subject Code	Category	Subject Name	Maximum Marks Allotted					Total Marks	Contact Hours per Week			
				Theory			Practical						
				End Sem	Mid Sem	Quiz / Assignment	End Sem	Term Work /Lab Work & Sessional		L	T	P	
1.	BEET-701	DC	Switchgear and protection	100	30	20	30	20	200	3	1	2	5
2.	BEET-702	DC	Utilization of Electrical Energy and traction	100	30	20	30	20	200	3	1	2	5
3.	BEET-703(A or B or C)	DE	Departmental Elective	100	30	20	-	-	150	3	0	0	3
4.	BOCT-704(A or B or C)	OE	Open Elective	100	30	20	-	-	150	3	0	0	3
5.	BEEP-705	D Lab	Open Source S/w lab	-	-	-	30	20	50	0	0	2	1
6	BENP-706	DLC-1	Evaluation of Internship-II completed at II year level	-	-	-	-	100	100	0	0	2	1
7	BEEP-707	P	Minor Project-II	-	-	-	100	50	150	0	0	2	1
Total				400	120	80	160	240	1000	12	5	18	19
NSS/NCC													

Departmental Electives		Open Electives	
BEET-703(A)	Soft computing Techniques	BOCT-704(A)	Internet of things
BEET-703(B)	Non Conventional Energy resources	BOCT-704(B)	Advances in Entrepreneurship Development
BEET- 703(C)	High Voltage Engineering	BOCT-704(C)	Probability theory and stochastic process
		BOCT- 704 (D)	Robotics and automation

VIII Semester

S. No.	Subject Code	Category	Subject Name	Maximum Marks Allotted					Total Marks	Contact Hours per Week			
				Theory			Practical						
				End Sem	Mid Sem	Quiz / Assignment	End Sem	Term Work /Lab Work & Sessional		L	T	P	
1.	BEET-801	DC	Advance control systems	100	30	20	30	20	200	3	1	2	5
2.	BEET - 802	DC	Electric Drives and its applications	100	30	20	30	50	200	3	1	2	5
3.	BEET - 803(A or B or C)	DE	Departmental Elective	100	30	20	-	-	150	3	0	0	3
4.	BOCT-804(A or B or C or D)	OE	Open Elective	100	30	20	-	-	150	3	0	0	3
5	BEEP-805	P	Major Project	-	-	-	100	200	300	0	0	8	4
Total				400	120	80	130	270	1000	12	2	10	20
NSS/NCC													

Departmental Electives		Open Electives	
BEET 803 (A)	Digital Image processing	BOCT - 804(A)	Cyber Security
BEET 803 (B)	Bio Medical Instrumentation	BOCT-804 (B)	Machine Learning
BEET 803 (C)	Modelling and analysis of electric machines	BOCT-804 (D)	Cloud Computing

Note: 20% of subjects can be allowed to be taken online through SWAYAM or any other international Institute.

Electrical & Electronics Engineering,
V-Semester BEET-501
Electrical Machine-I
Course Objectives

1. **1.**

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

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 & Electronics 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

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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 & Electronic 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

U n i t - 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

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New Scheme of Examination as per AICTE Flexible Curricula Electrical & Electronic Engineering, V-Semester Departmental Elective BEET- 503 (A) CAD of power system

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

Unit-I

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..

Unit-II

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.

Unit-III

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.

Unit-IV

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

References Books:

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 1980.

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New Scheme of Examination as per AICTE Flexible Curricula Electrical & Electronic 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:

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

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

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New Scheme of Examination as per AICTE Flexible Curricula

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Electrical & Electronics Engineering, V-Semester Open Elective BOCT- 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.

BOET- 504 (B) Communication Engineering

Course objectives	To familiarize students with the fundamentals of analog and digital communication systems, to provide students with tools for communication signal analysis, to familiarize students with various techniques for amplitude modulation and demodulation of analog 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
CO 4	Analyze concept of advanced modulation techniques	L 4
CO 5	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.

New Scheme of Examination as per AICTE Flexible Curricula
Electrical & Electronics 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.

Uttarakhand Technical University, Dehradun

New Scheme of Examination as per AICTE Flexible Curricula

& **Electrical & Electronics Engineering, VI-Semester**

BOCT- 504 (D) Innovation and Entrepreneurship

Innovations in Entrepreneurship Development

Course Objectives	To acquaint with the fundamental concept of Entrepreneurship. It deals with basic theory of startups/businesses. It is important for the student to understand the value of pow Entrepreneurship and its operation.
Code	Course outcome
CO1	To describe Types of Entrepreneurs.
CO2	Describe basic operation and Major Motives of an Entrepreneur
CO3	Analyze Market Survey and Research.
CO4	Formulate a Good Business opportunity.

UNIT-1

Entrepreneur – Types of Entrepreneurs – Difference between Entrepreneur and Intrapreneur Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth.

UNIT-2

Major Motives Influencing an Entrepreneur – Achievement Motivation Training, Self Rating, Business Games, Thematic Apperception Test – Stress Management, Entrepreneurship Development Programs – Need, Objectives.

UNIT-3

Small Enterprises – Definition, Classification – Characteristics, Ownership Structures – Project Formulation – Steps involved in setting up a Business – identifying, selecting a Good Business opportunity.

UNIT -4

Market Survey and Research, Techno Economic Feasibility Assessment – Preparation of Preliminary Project Reports – Project Appraisal – Sources of Information – Classification of Needs and Agencies.

TEXT BOOKS :

- Khanka. S.S., "Entrepreneurial Development" S.Chand & Co. Ltd.,Ram Nagar, New Delhi, 2013.
- Donald F Kuratko, " Entreprenuership – Theory, Process and Practice", 9th Edition, Cengage Learning 2014.

REFERENCES :

- Hisrich R D, Peters M P, "Entrepreneurship" 8th Edition, Tata McGraw-Hill, 2013.
- Mathew J Manimala, "Enterprenuership theory at cross roads: paradigms and praxis" 2nd Edition Dream tech, 2005.
- Rajeev Roy, 'Entrepreneurship' 2nd Edition, Oxford University Press, 2011.
- EDII "Faulty and External Experts – A Hand Book for New Entrepreneurs Publishers: Entrepreneurship Development", Institute of India, Ahmadabad, 1986.

Uttarakhand Technical University, Dehradun

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.

Uttarakhand Technical University, Dehradun

New Scheme of Examination as per AICTE Flexible Curricula

Electrical & Electronics Engineering, VI-Semester BECT -602 Microprocessor and Embedded System

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**
CO1	Examine the evolution of processor and architecture of 8085, 8086, 80286, 80386, 80486, microcontroller, Pentium processors.	**L 4**
CO2	Analyze the architecture of 8086 microprocessor along with the addressing mode and comparison with 8088	**L 4**
CO3	Comply simple programs for 8085/86 in assembly language	**L 5**
CO4	Interpret the interfacing of 8086 microprocessor	**L 6**
CO5	Employ analog to digital converter and set up their interfacing with 8086 microprocessor	**L 5**

Unit-I

Introduction to Microprocessor: Introduction to Microprocessor and its applications, Microprocessor Evolution Tree, Microprocessor Architecture (Harward& Princeton), General Architecture of the Microprocessor and its operations, Component of Microprocessor system: Processor, Buses, Memory, Inputs-outputs (I/Os) and other Interfacing devices.

Unit-II

8-bit Microprocessor: Intel 8085 microprocessor: Pin Diagram, Internal architecture: ALU, Registers, Timing and control unit, interrupt: Instruction Set of 8085: Instruction format, op-codes, mnemonics, no. of bytes computation of the instruction, Machine cycles and Tstates and Execution time computation of an instruction. Classification of instruction with their examples. Writing of assembly Language programs.

Unit-III

Architecture of Intel 8086: Pin Diagram, Bus Interface Unit, Execution unit, Register organization, Memory addressing, Memory Segmentation, Pipelining, Min & Max operating Modes 8086Instruction set: Format, Addressing Modes, Instruction Set Groups: Data transfer, Arithmetic, Logic, String, Branch control transfer and Processor control. Interrupts: Hardware and software interrupts.

Unit-IV

Fundamental of Programming: Program structure for microprocessors, Flowcharts of series, parallel, and controls structures. Assembler Level Programming: Memory space allocation for monitor and user program.Assembly language program using Debug or MASM assembler.

Unit-V

Peripheral Interfacing: Programmed I/O, Memory Mapped I/O, Interrupt Driven I/O, DMA I/O interface, Serial and Parallel communications. Peripheral Devices: DMA controller (Intel 8237), Programmable peripheral interface (Intel 8255), Programmable timer/counter (Intl 8253/8254),Programmable Interrupt Controller (Intel 8259).

Text Books:

1. Gaonkar, Ramesh S, "Microprocessor Architecture, programming and applications with the 8085" Pen ram International Publishing 5th Ed.
2. Avtar Singh& Walter A. Triebel "8088 & 8086 Microprocessor" Pearson Education.
3. Ray, A.K. &Burchandi, K.M., "Advanced Microprocessors and Peripherals: Architecture, Programaming and Interfacing" Tata Mc. Graw Hill.

CO1	Acquire knowledge about the time domain representation and classification of discrete time signals and systems	L 2
CO2	Acquire knowledge about the time domain analysis of linear time invariant discrete time systems and representation of total response in various formats.	L 4
CO3	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

New Scheme of Examination as per AICTE Flexible Curricula

Electrical & Electronics Engineering, VI-Semester Departmental Elective BEET - 604(A) FACTS

Code	Course outcome	Level
CO1	Understand the operations of different FACTS devices	L2
CO2	Select the controllers for different Contingencies.	L3
CO3	Analyze the different FACTS devices in different stability conditions.	L4
CO4	Select an appropriate FACTS device for a particular application	L3

Unit-I: 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).

Unit-II: 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..

Unit-III:

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.

Unit-V: 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 the control of power flow – modelling of SSSC in load flow and transient stability studies.

Text/References:-

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.

3. K.R.Padiyar," FACTS Controllers in Power Transmission and Distribution", New Age International(P) Limited, Publishers, New Delhi, 2008.

Uttarakhand Technical University, Dehradun

New Scheme of Examination as per AICTE Flexible Curricula

Electrical & Electronics Engineering, VI-Semester

Departmental Elective EEE-604(B) Energy Management and SCADA

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

Unit-I

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.

Unit-II

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 processin 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

Unit-III

MAN- Machine Communication

Operator consoles and VDUs, displays, operator dialogues, alarm and event loggers, mimic diagrams, report and printing facilities.

Unit-IV

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

Unit-V

Energy Management Center

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

Text Books:

1. TorstenCergrell, " 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.

New Scheme of Examination as per AICTE Flexible Curricula **Electrical & Electronics Engineering VI-Semester EEE- 603 (C) NCER**

Code	Course outcome	Level
CO1	Create awareness among students about Non-Conventional sources of energy technologies	L3
CO2	Enable students to understand various renewable energy technologies and systems.	L3
CO3	To impart the knowledge of Storage technologies form the autonomous renewable energy sources	L3
CO4	Equip the students with knowledge and understanding of various possible mechanisms about renewable energy projects	L4

Unit 1: Physics of Wind Power:
History of wind power, Indian and Global statistics, Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind speed statistics-probability distributions, Wind speed and power-cumulative distribution functions.

Unit 2: Wind generator topologies:
Review of modern wind turbine technologies, Fixed and Variable speed wind turbines, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent Magnet Synchronous Generators, Power electronics converters. Generator-Converter configurations, Converter Control.

Unit 3: The Solar Resource
Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability.

Unit 4: Solar photovoltaic:
Technologies-Amorphous, mono crystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Power Electronic Converters for Solar Systems, Maximum Power Point Tracking (MPPT) algorithms. Converter Control.

Unit 5: Network Integration Issues and Solar thermal power generation:
Overview of grid code technical requirements. Fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances. Power quality issues. Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems. Technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, elementary analysis.

Text / References:
1. T. Ackermann, “Wind Power in Power Systems”, John Wiley and Sons Ltd., 2005.
2. G. M. Masters, “Renewable and Efficient Electric Power Systems”, John Wiley and Sons, 2004.
3. S. P. Sukhatme, “Solar Energy: Principles of Thermal Collection and Storage”, McGraw Hill, 1984.
4. H. Siegfried and R. Waddington, “Grid integration of wind energy conversion systems” John Wiley and
Sons Ltd., 2006.
5. G. N. Tiwari and M. K. Ghosal, “Renewable Energy Applications”, Narosa Publications, 2004.

Uttarakhand Technical University, Dehradun

New Scheme of Examination as per AICTE Flexible Curricula

Electrical & Electronics Engineering V-Semester open elective BOCT 605(A) Introduction to Smartgrids.

Code	Course outcome	Level
CO 1	Classify the basic terms of a Power System Grid; explain the importance and objectives of the various dispersed generation units	L3
CO 2	Analysis of various energy management policies; distinguish them according to their priorities	L4
CO 3	Describe and classify the modern and innovative application fields of dispersed generation units	L3
CO 4	Describe by drawing a block diagram and explain the operation of the basic part of a smart grid (namely the Micro-grid); quantify its operational, financial and environmental advantages.	L3
CO 5	Acquire the knowledge on power quality of the smart-grid system	L3

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

UNIT II Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading (AMR), Outage Management System (OMS), Plug in Hybrid Electric Vehicles (PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation.

UNIT III Smart Substations, Substation Automation, Feeder Automation, Geographic Information System (GIS), Intelligent Electronic Devices (IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System (WAMS), Phase Measurement Unit (PMU), PMUs application to monitoring & control of power system.

UNIT IV Concept of microgrid, need & application of microgrid, formation of microgrid, Issues of interconnection, protection & control of microgrid, Plastic & Organic solar cells, thin flim solar cells, Variable speed wind generators, fuel cells, microturbines, Captive power plants, Integration of renewable energy sources

UNIT V Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring.

Reference Books:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai, “Integration of Green and Renewable Energy in Electric Power Systems”, Wiley.
2. Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand Response”, CRC Press.
3. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, Wiley.
4. Jean Claude Sabonnadiere, NouredineHadjsaid, “Smart Grids”, Wiley Blackwell 19.
5. Stuart Borlase, “Smart Grids (Power Engineering)”, CRC Press.

New Scheme of Examination as per AICTE Flexible Curricula

Electrical & Electronics Engineering, VI-Semester Open Elective BOCT-605(B)
Power Plant Engineering

Code	Course outcome	Level
CO 1	Able to get the basics of Power Plants.	L3
CO 2	Able to get the idea about the power generation by renewable and non-renewable energy resources	L3
CO 3	Able to know about the different types of cycles and natural resources used in power plants and their applications.	L3
CO 4	Understanding of Power Plant Economics, Energy Storage including compressed air energy and pumped hydro etc.	L3
CO 5	Discussing environmental and safety aspects of power plant operation	L3

Unit-I

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

Unit-II

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

Unit-III

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

Unit-IV

Hydroelectric power plants, classification, typical layout and components, principles of wind, tidal, solar PV and solar thermal, geothermal, biogas and fuel cell power systems.

Unit-V

Energy, economic and environmental issues, power tariffs, load distribution parameters, load curve, capital and operating cost of different power plants, pollution control technologies including waste disposal options for coal and nuclear plants.

Text Books:

1. Nag P.K., Power Plant Engineering, 3rd ed., Tata McGraw Hill, 2008.
2. El Wakil M.M., Power Plant Technology, Tata McGraw Hill, 2010.
3. Elliot T.C., Chen K and Swanekamp R.C., Power Plant Engineering, 2nd ed., McGraw Hill, 1998.

Uttarakhand Technical University, Dehradun

New Scheme of Examination as per AICTE Flexible Curricula

Electrical & Electronics Engineering, VI-Semester -Departmental Elective BOCT-603(C) Special Electromechanical Systems

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

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).

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

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.

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

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

Text/Reference Books:

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

BEEP 501- EMEC- II Lab

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

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

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- Microprocessors and Embedded systems lab

A. Study Experiments (any two):

1. To study 8085 based microprocessor system
2. To study 8086 and 8086A based microprocessor system
3. To study Pentium Processor

B. Programming based Experiments (any four):

4. To develop and run a program for finding out the largest/smallest number from a given set of numbers.
5. To develop and run a program for arranging in ascending/descending order of a set of Numbers
6. To perform multiplication/division of given numbers
7. To perform conversion of temperature from 0F to 0C and vice-versa
8. To perform computation of square root of a given number
9. To perform floating point mathematical operations (addition, subtraction, multiplication and division)

C. Interfacing based Experiments (any four):

10. To obtain interfacing of RAM chip to 8085/8086 based system
11. To obtain interfacing of keyboard controller
12. To obtain interfacing of DMA controller
13. To obtain interfacing of PPI
14. To obtain interfacing of UART/USART
15. To perform microprocessor based stepper motor operation through 8085 kit
16. To perform microprocessor based traffic light control

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

Course Objectives	To understand the operations of various types of circuit breakers and their ratings. To understand the unit **protection** and over voltage **protection** of different apparatus in power system	
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	Different circuit breaking techniques, construction, working operation and ratings.	L4
CO5	Testing of circuit breakers (methods)	L4

BEET- 701- Switchgear and protection

Contents		**Hours**
Unit 1	**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.	9
Unit 2	**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	9
Unit 3	**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	8
Unit 4	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.	9
Unit 5	**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.	8

	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.	

Experiment

1. To determine direct axis reactance (xd) and quadrature axis reactance (xq) of a salient pole alternator.
2. To determine negative and zero sequence reactances of an alternator.
3. To determine sub transient direct axis reactance (xd) and sub transient quadrature axis reactance (xq) 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 and Reactance type Distance relays
8. To determine location of fault in a cable using cable fault locator
9. To study ferranti effect and voltage distribution in H.V. long transmission line using transmission line model.
10. To study operation of oil testing set.

Simulation Based Experiments (using MATLAB or any other software)

11. To determine transmission line performance.
12. To obtain steady state, transient and sub-transient short circuit currents in an alternator
13. To obtain formation of Y-bus and perform load flow analysis
14. To perform symmetrical fault analysis in a power system
15. To perform unsymmetrical fault analysis in a power system

Suggested Readings :

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

BEET-702- 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	Illustrate fundamental concepts of welding; classify welding scheme for domestic and industrial applications.	L4
CO3	Design the interior and exterior lighting systems-illumination levels for various purposes light fittings-factory lighting- flood lighting-street lighting.	L5
CO4	Design and investigate operating characteristics of traction motors with respect to speed, temperature and loading condition.	L5
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.
3. Pandey & Kumar-Biomedical Electronics and Instrumentation. – Kataria

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)

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(C)- 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	10

	polarity. Electrostatic voltmeter; principle and classification. Constructional details of an absolute electrostatic voltmeter. Oscilloscope and their application in high voltage measurements.	
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. \

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 Outcomes	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 Transformations of Continuous Random Variable, Transformation of a Discrete Random Variable.	8

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.

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- 801- Advance control Systems

Course Objectives	To learn the methods for analyzing the behavior of nonlinear control systems and the designing of control systems.	
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

Contents		**Hours**
Unit 1	State Space Analysis of Continuous System: Review of state variable representation of continuous system, conversion of state variable models to transfer function and vice-versa, solution of state equations and state transition matrix, controllability and obsrvability, design of state observer and controller	8
Unit 2	Analysis of Discrete System: Discrete system and discrete time signals, state variable model and transfer function model of discrete system, conversion of state variable model to transfer function model and vice-versa, modeling of samplehold circuit, solution of state difference equations, steady state accuracy, stability on the z-plane and Jury stability criterion, bilinear transformation, Routh-Hurwitz criterion on rth planes	8
Unit 3	Lyapunov's stability theorems for continuous and discrete systems, methods for generating Lyapunov function for continuous and discrete system, Popov's criterion. Non linear System: Types of non linearities, phenomena related to non - linear systems. Analysis of non linear systems-Linearization method, second order non-linear system on the phase plane, types of phase portraits, singular points, system analysis by phase-plane method, describing function and its application to system analysis.	8
Unit 4	Optimal Control: Introduction, formation of optimal control problem, calculus of variations minimization of functions, constrained optimization.Pontryagin's Minimum Maximum Principle, Linear Quadratic Problem-Hamilton Jacobi equation, Riccati equation and its solution.	8
Unit 5	Adaptive Control: Introduction, modal reference adaptive control systems, controller structure, self tuning regulators. Introduction to neural network, fuzzy logic and genetic algorithms	9

Suggested Readings :

1. M.Gopal, "Digital Control and State variable Methods", Tata Mc Graw Hill
2. Ajit K.Madal, "Introduction to Control Engineering: Modelling, Analysis and Design" New Age International.
3. D.Landau, "Adaptive Control", Marcel Dekker Inc.
4. S.Rajasekaran & G.A.Vjayalakshmi Pai, "Neural Networks,Fuzzy Logic and Genetic Alogorithms: Synthesis and Applications" Prentice Hall of India.

Experiments:

1. State space modeling of discrete time systems and study of responses.
2. Pole placement design for regulator and tracking discrete time systems.
3. Observer design for discrete time systems
4. Design of digital kalman filter.
5. Optimal control design of digital systems
6. Analysis of non linear systems using describing function method
7. Phase plane analysis of non linear systems.

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	8 40

	conduction), and Dual converter fed separately excited dc motor drive, Rectifier control of dc series motor. 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

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.

BEET 803 (A)- Digital Image Processing

Course Objectives	1.Describe and explain basic principles of digital image processing. 2. Design and implement algorithms that perform basic image processing (e.g. noise removal and image enhancement). 3. Design and implement algorithms for advanced image analysis (e.g. image compression, image segmentation). 4. Assess the performance of image processing algorithms and systems.	
Code	Course outcome	Level
CO1	Understand the need for image transforms different types of image transforms and their properties.	L3
CO2	Learn different techniques employed for the enhancement of images.	L2
CO3	Learn different causes for image degradation and overview of image restoration techniques.	L2
CO4	Understand the need for image compression and to l earn the spatial and frequency domain techniques of image compression.	L3

Contents		**Hours**
Unit 1	Introduction and Fundamentals Motivation and Perspective, Applications, Components of Image Processing System, Element of Visual Perception, A Simple Image Model, Sampling and Quantization. Image Enhancement in Spatial Domain Introduction; Basic Gray Level Functions – Piecewise-Linear Transformation Functions: Contrast Stretching; Histogram Specification; Histogram Equalization; Local Enhancement; Enhancement using Arithmetic/Logic Operations – Image Subtraction, Image Averaging; Basics of Spatial Filtering; Smoothing - Mean filter, Ordered Statistic Filter; Sharpening – The Laplacian.	8
Unit 2	Image Enhancement in Frequency Domain Fourier Transform and the Frequency Domain, Basis of Filtering in Frequency Domain, Filters – Low-pass, High-pass; Correspondence Between Filtering in Spatial and Frequency Domain; Smoothing Frequency Domain Filters – Gaussian Lowpass Filters; Sharpening Frequency Domain Filters – Gaussian Highpass Filters; Homomorphic Filtering. Image Restoration A Model of Restoration Process, Noise Models, Restoration in the presence of Noise only-Spatial Filtering – Mean Filters: Arithmetic Mean filter, Geometric Mean Filter, Order Statistic Filters – Median Filter, Max and Min filters; Periodic Noise Reduction by Frequency Domain Filtering – Bandpass Filters; Minimum Mean-square Error Restoration.	8
Unit 3	Color Image Processing Color Fundamentals, Color Models, Converting Colors to different models, Color Transformation, Smoothing and Sharpening, Color Segmentation. Morphological Image Processing Introduction, Logic Operations involving Binary Images, Dilation and Erosion, Opening and Closing, Morphological Algorithms – Boundary Extraction, Region	8

	Filtering, Extraction of Connected Components, Convex Hull, Thinning, Thickening	
Unit 4	Registration Introduction, Geometric Transformation – Plane to Plane transformation, Mapping, Stereo Imaging – Algorithms to Establish Correspondence, Algorithms to Recover Depth Segmentation Introduction, Region Extraction, Pixel-Based Approach, Multi-level Thresholding, Local Thresholding, Region-based Approach, Edge and Line Detection: Edge Detection, Edge Operators, Pattern Fitting Approach, Edge Linking and Edge Following, Edge Elements	8
Unit 5	Feature Extraction Representation, Topological Attributes, Geometric Attributes Description Boundary-based Description, Region-based Description, Relationship. Object Recognition Deterministic Methods, Clustering, Statistical Classification, Syntactic Recognition, Tree Search, Graph Matching	10

Suggested Readings :

1. Digital Image Processing 2nd Edition, Rafael C. Gonzalvez and Richard E. Woods. Published by: Pearson Education.
2. Digital Image Processing and Computer Vision, R.J. Schalkoff. Published by: John Wiley and Sons, NY.
3. Fundamentals of Digital Image Processing, A.K. Jain. Published by Prentice Hall, Upper Saddle River, NJ.

BEET 803 (B)- Bio Medical Instrumentation

Course Objectives	To introduce an fundamentals of transducers as applicable to physiology ● To explore the human body parameter measurements setups ● To make the students understand the basic concepts of forensic techniques. ● To give basic ideas about how multimedia evidences are useful in crime investigation.	
Code	Course outcome	Level
CO1	Understand the physiology of biomedical system.	L2
CO2	Measure biomedical and physiological information	L3
CO3	Discuss the application of Electronics in diagnostics and therapeutic area	L2
CO4	Analyze where and how sensors are used in healthcare.	L4
CO5	Study design parameter of ECG, EEG.	L6

Contents		**Hours**
Unit 1	**Basic Physiological system of body** Problem encountering measuring leaving system, bioelectric potential, biomaterial, Basic transducers principle, Active and passive transducers, transducer for biomedical applications, Generation, propagation and distribution of bioelectric potential (ECG, EEG and EMG)	8
Unit 2	**Bio Potential Electrode** Basic type (micro skin surface and needle electrodes), Biochemical transducer (PH, blood gas and specification electrodes), Cardiovascular System & Measurement, Heat and cardiovascular system and circulation block diagram blood pressure and, measurement, characteristics of blood flow and heart sound, Electrocardiography, ECG an lead, configuration, ECG recording and their types	8
Unit 3	**Nervous System** The anatomy of nervous system, neuronal communication, EPSP, IPSP, Organization of brain, Measurement from the nervous system, Systematic skin and body temperature measurement, Temperature measurement, Brief idea about ultrasonic measurements	8
Unit 4	**Patient Care Monitoring** Element of intensive care, Organizational the hospital fore patient-care monitoring, Pace makers-type, systems, mode and generators, Defibrillator-types.Biotelemetry and application of telemeter inpatient care	8
Unit 5	**Automation of Chemical Test** Instrumentation for diagnostic X rays, Interfacing computer with medical instrumentation and other equipments, Bio medical computer application. Shock hazards from electrical equipments, methods of accident prevention.	9

Suggested Readings :

1. Cromwell- Biomedical Instrumentation and Measurements- PHI
2. Webster, J.G. –Bio- Instrumentation, Wiley (2004)
3. Ananthi, S. –A Text Book of Medical Instruments-2005-New Age International
4. Carr & Brown –Introduction to Biomedical Equipment Technology – Pearson
5. Pandey & Kumar-Biomedical Electronics and Instrumentation. – Kataria

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BEET 803 (C)- Modelling and analysis of electric machines

Course Objectives	This course deals with the basics of electromechanical energy conversion and enables them to be acquainted with the mathematical modeling of various types of machines and the dynamics related to speed control of these machines	
Code	Course outcome	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
CO4	Evaluate cost of practical design of such non linear machine for the design of industrial electrical drives	L4
CO5	Design a high performancesensor less drive system with optimal dynamic response	L6

Contents		**Hours**
Unit 1	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	8
Unit 2	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	8
Unit 3	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	8
Unit 4	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 -	8

	simulation of three phase synchronous machine- modeling of PM Synchronous motor.	
Unit 5	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.	10

Suggested Readings :

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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