NATIONAL INSTITUTE OF TECHNOLOGY MIZORAM

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

B. TECH COURSE STRUCTURE

SEMESTER WISE CREDIT DISTRIBUTION:

SEMESTER	1ST SEM	2ND SEM	3RD SEM	4TH SEM	5TH SEM	6TH SEM	7TH SEM	8TH SEM
CREDIT	20.5	21.5	19	19	22	20	17	17
TOTAL CREDIT=156								

Prof. S. Chatterjee Dr. P. K. Biswas Mrs. K. De Mr. S. Majumder Mr. R. Kumar Mr. A. Bhattacharya Mr.S.Debnath Mrs.U.Das

BRANCH : **Electrical & Electronics Engineering**

SEMESTER : **I (Common to all Branches)**

Sl No.	Course No.	Subject	Periods			Total Contact Hours	Credits
Theory			**L (Lecture)**	**T (Tutorial)**	**P (Laboratory)**		
1.	MAL 1101	Engineering Mathematics – I	3	1	0	4	4
2.	CHL 1101	Engineering Chemistry	3	0	0	3	3
3.	HUL 1101	Communicative English	2	0	0	2	2
4.	MEL 1101	Engineering Mechanics	3	0	0	3	3
5.	EEL 1101	Basic Electrical Engineering	3	0	0	3	3
6.	OBE 1101	Outcome Base Education	1	0	0	1	0(Audit)
Laboratory							
7.	CHP 1101	Engineering Chemistry Laboratory	0	0	2	2	1.5
8.	HUP 1101	Language Laboratory	0	0	2	2	1
9.	MEP 1101	Engineering Mechanics Laboratory	0	0	2	2	1.5
10.	EEP 1101	Basic Electrical Engineering Laboratory	0	0	2	2	1.5
		TOTAL:	**15**	1	**8**		**20.5**

BRANCH : **Electrical & Electronics Engineering**
SEMESTER : **II (Common to all Branches)**

Sl No.	Course No.	Subject	Periods			Total Contact Hours	Credits
Theory			**L (Lecture)**	**T (Tutorial)**	**P (Laboratory)**		
1.	MAL 1202	Engineering Mathematics – II	3	1	0	4	4

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2.	PHL 1201	Engineering Physics	3	0	0	3	3
3.	HUL 1202	Social Science	2	0	0	2	2
4.	CSL 1201	Introduction to Computer Programming	3	0	0	3	3
5.	ECL 1201	Basic Electronics Engineering	3	0	0	3	3
Laboratory							
6.	PHP 1201	Engineering Physics Laboratory	0	0	2	2	1.5
7.	CSP 1201	Introduction to Computer Programming Laboratory	0	0	3	3	1.5
8.	MEP 1202	Engineering Drawing	0	0	4	4	2
9.	MEP 1203	Workshop	0	0	3	3	1.5
10	ECA 1201	Extracurricular Activity	-	-	-	-	-
		TOTAL:	**14**	**1**	**12**		**21.5**

BRANCH : Electrical & Electronics Engineering
SEMESTER : III

Sl No.	Course No.	Subject	Periods			Total Contact Hours	Credits
Theory			**L (Lecture)**	**T (Tutorial)**	**P (Laboratory)**		
1.	EEL 1307	Circuit Theory	3	1	0	4	4
2.	MAL1304	Mathematics-III (Probability & Statistics)	3	0	0	3	3
3.	EEL 1308	Electrical and Electronics Measurements	3	0	0	3	3
4.	EEL 1303	Numerical Methods	3	0	0	3	3
5.	ECL 1302	Digital Logic Design	3	0	0	3	3

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Laboratory							
6.	EEP 1307	Circuit Theory Laboratory	0	0	2	2	1
7.	ECP 1302	Digital Logic Design Laboratory	0	0	2	2	1
8.	EEP 1308	Electrical and Electronics Measurement Laboratory	0	0	2	2	1
		TOTAL:	**15**	**1**	**6**		**19**

BRANCH : Electrical & Electronics Engineering
SEMESTER : IV

Sl No.	Course No.	Subject	Periods			Total Contact Hours	Credits
Theory			**L (Lecture)**	**T (Tutorial)**	**P (Laboratory)**		
1.	EEL1405	Electrical Machines-I	3	1	0	4	4
2.	EEL1406	Signals and Systems	3	0	0	3	3
3.	EEL1407	Electromagnetic Field Theory	3	0	0	3	3
4.	ECL1401	Analog Circuits	3	0	0	3	3
5.	ECL1402	Analog Communication	3	0	0	3	3
Laboratory							
6.	EEP1405	Electronic System Design	0	0	2	2	1
7.	ECP1401	Analog Circuits Laboratory	0	0	2	2	1
8.	ECP1402	Analog Communication Laboratory	0	0	2	2	1
		TOTAL :	**15**	**1**	**6**		**19**

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BRANCH : Electrical & Electronics Engineering
SEMESTER : V

Sl No.	Course No.	Subject	Periods			Total Contact Hours	Credits
Theory			**L (Lecture)**	**T (Tutorial)**	**P (Laboratory)**		
1.	EEL1505	Electrical Machines-II	3	0	0	3	3
2.	EEL1506	Power Systems-I	3	0	0	3	3
3.	EEL1507	Control Systems-I	3	0	0	3	3
4.	ECL1501	Digital Signal Processing	3	0	0	3	3
5.	ECL1502	Microprocessors & Microcontrollers	3	0	0	3	3
6.	EEL/ ECL/CSL 1508	Elective-I	3	0	0	3	3
Laboratory							
7.	EEP1505	Electrical Machines Laboratory	0	0	2	2	1
8.	EEP1506	Electrical Machine Design	0	0	2	2	1
9.	ECP1502	Microcontroller Laboratory	0	0	2	2	1
10	ECP1501	Digital Signal Processing	0	0	2	2	1
		TOTAL:	**18**	**0**	**8**		**22**

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BRANCH : Electrical & Electronics Engineering
SEMESTER : VI

Sl No.	Course No.	Subject	Periods			Total Contact Hours	Credits
Theory			L (Lecture)	T (Tutorial)	P (Laboratory)		
1.	EEL1605	Power System-II	3	0	0	3	3
2.	EEL1606	Control Systems-II	3	0	0	3	3
3.	EEL1607	Power Electronics & Drives	3	0	0	3	3
4.	ECL1601	Digital Signal Processing	3	0	0	3	3
5.	ECL/ EEL 1608	Elective-II	3	0	0	3	3
Laboratory							
6.	EEP1605	Power system Laboratory	0	0	2	2	1
7.	EEP1606	Control Systems Laboratory	0	0	2	2	1
8.	EEP1607	Power Electronics & Drives Laboratory	0	0	2	2	1
9.	ECP1601	Digital signal processing laboratory	0	0	2	2	1
10.	EET1604	Industrial Training Viva	0	0	2	2	1
		TOTAL:	**15**	**0**	**10**		**20**

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BRANCH : Electrical & Electronics Engineering
SEMESTER : VII

Sl No.	Course No.	Subject	Periods			Total Contact Hours	Credits
Theory			**L (Lecture)**	**T (Tutorial)**	**P (Laboratory)**		
1.	HUL1701	Humanities/Managerial Economics	3	0	0	3	3
2.	ECL1701	Digital Communication	3	0	0	3	3
3.	EEL/ ECL 1705	Elective- III	3	0	0	3	3
4.	EEL/ ECL 1706	Elective-IV	3	0	0	3	3
Laboratory							
5.	ECP1701	Digital Communication Laboratory	0	0	2	2	1
6.	EED1704	Project Phase-1	0	0	8	8	4
7.	EEG1705	Grand Viva	0	0	2	2	1
		TOTAL :	**12**	**0**	**12**		**18**

BRANCH : Electrical & Electronics Engineering
SEMESTER : VIII

Sl No.	Course No.	Subject	Periods			Total Contact Hours	Credits
Theory			**L (Lecture)**	**T (Tutorial)**	**P (Laboratory)**		
1.	CHL1802	Environmental Science and Engineering	2	0	0	2	2(Audit)

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2.	EEL/ ECL 1805	Elective-V	3	0	0	3	3
3.	EEL 1806	Open Elective	3	0	0	3	3
Laboratory							
4.	EEV1802	Seminar	0	0	2	2	1
5.	EED1804	Final Project	0	0	20	10	10
		TOTAL :	**8**	**0**	**22**		**17**

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EEL1101: BASIC ELECTRICAL ENGINEERING

3-0-0-3

Course Outcome:

- Describe KCL, KVL equation, nodal, mesh analysis, voltage method and explaining different network theorems for solving of different problems.
- Analyse AC circuits and Magnetic circuits.
- Describe three Phase balanced Supply & Power Measurement.
- Introduce different types of machine and some measuring instruments.

1. **Introduction:** Introduction to electrical equipments, circuit components, Electrical Elements and their classification, KCL, KVL equation, nodal, mesh analysis, voltage method, D.C. circuits steady state analysis with independent and dependent sources, Series and parallel circuits, star delta conversion, Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer Theorem.

   LECTURES:10

2. **A.C. circuits:** Common signals and their waveform, RMS and Average value, form factor and peak factor of sinusoidal wave, Impedance of series and parallel circuits, Phasor diagram, Power, Power factor, Power Triangle, coupled circuits, Resonance and Q-factor. LECTURES:7
3. **Magnetic circuits:** Introduction, Series & Parallel magnetic circuits, Analysis of Linear and non-linear magnetic circuits, Energy storage, A.C. excitation, Eddy current and hysteresis losses. LECTURES:5

4. **Three Phase Balanced Supply & Power Measurement:** Star-delta connection, Power measurement. LECTURES:2
5. **Introduction of Electrical Machines:** Transformer, DC machines, Induction Machines. LECTURES:7
6. **Introduction of Electrical Measurement**: MI & MC types meter, Energy meter, Wattmeter. LECTURES:5

Text Book:

1. R.J. Smith and R.C. Dorf: Circuits, Devices and Systems; John Wiley & Sons, 1992.
2. V. Del Toro: Electrical Engineering Fundamentals; PHI, 1994.
3. Van Valkenburg Network Analysis, Prentice Hall, India

Reference Books :

1. Fundamentals of Electrical Engg. By Leonard S. Bobrow, Oxford

2. Fundamentals of Electrical Engineering by R. Prasad, PHI Publication
3. J. Nagrath and D. P. Kothari, 'Electric Machines', Tata McGraw Hill, 1985,

EEP1101:BASIC ELECTRICAL ENGINEERING LAB **0-0-2-1**

Course Outcoes:

- Realization of KCL, KVL equations, and different network theorems.
- Determination of different parameters and phasor diagram of AC circuits.
- Energy Measurement using energymeter..
- Study of characteristics of Fluorescent lamp connection and carbon tungsten lamp

List of Experiments

1. Study of Network Theorems (KCL & KVL, Thevenin's, Norton's, Maximum Power transfer Theorem).
2. Familiarization of Voltmeter, Ammeter & Wattmeter
3. Study of RL & RLC circuit.
4. Study of calibration of Energy Meter.
5. Study of characteristic Fluorescent lamp connection.
6. Study of characteristic of carbon tungsten lamp.
7. Study of RL, RC and RLC series and parallel circuit.

Text Book:

1. R.J. Smith and R.C. Dorf: Circuits, Devices and Systems; John Wiley & Sons, 1992.
2. V. Del Toro: Electrical Engineering Fundamentals; PHI, 1994.

3rd SEMESTER

EEL 1307: CIRCUIT THEORY **3-1-0-4**

Course Outcome:

- Describe different types of circuits and networks and explaining different network theorems for solving of different problems by applying the knowledge of mathematics, science and engineering.
- Transient analysis and resonance for various circuits.
- Analyze electrical circuits by utilizing Laplace Transform and Fourier Transform.
- Analyze the two port networks for calculating different circuit parameters.
- Design the various types of filter circuits.

1. **Network Theorems:** Nodal and Mesh analysis, Superposition theorem, maximum power transfer theorem, Reciprocity theorem, Millman's theorem, substitution theorem, compensation theorem, Tellegen's theorem, all theorems using examples of AC networks. LECTURES:8

2. **Transient Analysis and Resonance:** Introduction of transient phenomena, initial conditions and analysis of RL, RC and RLC circuits; series resonance, parallel resonance and comparison of series and parallel resonant circuits

LECTURES: 4

3. **Two Port Network:** One port and two port network, Sign convention, Admittance Parameter, Parallel connection of two port network, Impedance parameter, Series connection of two-port network. Hybrid parameters, Inverse Hybrid parameters, Transmission parameters, Inverse Transmission parameters, Concept of driving point impedance and admittance, Symmetrical two ports and bisection, Image impedance.

LECTURES:7

4. **Graph Theory :** Graph of a network, Trees, Co-trees, Loops, Incidence matrix, cut-set matrix, Ties matrix and loop currents, Number of possible trees of a Graph, Analysis of Net works, Network Equilibrium Equation, Duality, General network transformation.

LECTURES:4

5. **Application of Laplace Transform:** Brief review of Laplace transform technique, Initial and final value Theorem, Solution of circuit transient using Laplace transform. Use of Laplace's transform in electrical circuit analysis. LECTURES:5

6. **Fourier Analysis:** Trigonometric Fourier Series, Evaluation of Fourier Coefficients, Waveform Symmetry, Exponential form, Fourier transform techniques applied in networks. LECTURES:4

7. **Filter Circuits:** Classification of filters, equation of an ideal filter, Theory of pie section, Constant K-type filters, low pass filters, design of low pass filter, high pass filters, band pass filters, band rejection filters and all pass filters. M derived filters, theory of M-derived filters, M-derives low pass and high pass filters. Approximation theory of filters (Butter worth and Chebyshev). LECTURES: 4

Readings:

Prescribed Text Books

1. Hayt & Kemmerly, Engineering Circuit Analysis, Mc Graw Hill, 9 th Edition, 2019.
2. Roy Choudhury, Network and Systems, New Age, Second edition, 2013.
3. Abhijit Chakrabarti., Circuit Theory Analysis and Synthesis, Dhanpat Rai & Co., 2008..

Additional Readings

1. Rajeswaran, Electric circuit Theory, Pearson publications 2004

2. Wadhwa, Network analysis and synthesis, New Age Publication,2007
3. Soni and Gupta, A Course in Electrical Circuit Analysis, Dhanpat Rai & Sons,2016
4.Van Valkenburg, Network Analysis & Synthesis, PHI publications, 2019

EEL1308 ELECTRICAL AND ELECTRONIC MEASUREMENTS 3-0-0-3

Course Outcome:

- Develop an understanding of construction and working of different measuring instruments.
- Develop an understanding of different type of interferences, its causes and methods for its reduction.
- Develop an understanding of construction and working of different AC and DC bridges and its applications.
- Develop an ability to use measuring instruments and AC and DC bridges for measurement.
- Develop an understanding of construction and working of Cathode ray oscilloscope and signal analyzer.
- Develop an understanding of construction and working of non-electrical quantities.

1. Introduction: Introduction of signals, measurement and instruments, static and dynamic characteristics of instruments; different types of instruments; operating forces required for working of indicating instruments; different types of damping and control systems; construction and working principles of PMMC, MI, induction type and electrodynamometer type instruments, Galvanometer: dynamics, sensitivity, D'Arsonval galvanometer, Vibration Galvanometer, Potentiometers and their applications advantages and disadvantages. LECTURES: 8

2. Bridges For Measurements: Measurement of medium resistance using Wheatstone bridge, Measurement of low resistance using Kelvin Double bridge, measurement of insulation resistance by loss of charge method; Maxwell's inductance bridge, Maxwell's inductance-capacitance bridge, Owen's bridge, Schering bridge, Anderson's bridge, Hay's Bridge, Campbell's Mutual Inductance Bridge. LECTURES:7

3. Measurement of Power, Power Factor and Energy: Measurement of power and energy, use of current transformer and potential transformer, electrodynamometer type of wattmeter, induction type energy meter, indicating type frequency meter, electrodynamometer type p.f. meter. LECTURES:4

4. Electronic Instruments: Introduction, electronic voltmeters-advantages, types. differential amplifier; DC voltmeter. Electronic voltmeters using rectifiers. Electronic multimeters, electronic ohmmeter. Consideration in selecting an analog voltmeter; differential voltmeter.AC voltage measurement, AC and DC current measurement using electronic instrument. LECTURES:6

5. Cathode Ray Oscilloscope and Signal Analyzer: Advantages & disadvantages of digital instruments over analog instruments; digital multimeter and description and field of application, C.R.O.—block diagram representation and operation, applications; use of dual trace oscilloscope; function generator—working principle with block diagram; frequency counter-working principle with block diagram. LECTURES:6

6. Measurement of Non-electrical Quantities: Concept of measurement using transducers as input element, active, passive transducers—differences. study of transducers: RTD, Thermistor, thermocouple. Strain gauge. LECTURES:5

Prescribed Text Books

1. A.K.Sawhney, A course in Electrical and Electronic Measurments and Instrumentation, Dhanpat Rai Publications,2015.
2. E.W. Golding. And F.C.Widdis A Text Book of Electrical Measurement and Measuring Instruments, Wheeler Publications, 1968.
3. D. Cooper and A.D. Heifrick, Modern electronic instrumentation and measuring techniques, PHI, 2015.

Additional Readings

1. R. A. Witte, Electronic Test Instruments, Pearson Education, 2002.
2. B. E. Jones, Instrumentation, Measurement and Feedback, Tata McGraw-Hill, 2000.
3. R. P. Areny and T. G. Webster, Sensors and Signal Conditioning, Wiley-Interscience, 2000.
4. C. F. Coombs, Electronic Instruments Handbook, McGraw-Hill, 2000.

ECL 1302	**Digital Logic Design**
As per the syllabus prescribed by Department of Electronics and Communication Engineering	

MAL 1303	**Mathematics-III (Probability & Statistics)**
As per the syllabus prescribed by Department of Mathematics	

MAL 1304	**Numerical Methods**
As per the syllabus prescribed by Department of Mathematics	

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EEP 1307: CIRCUIT THEORY LABORATORY 0-0-2-1

Course Outcome:

- Verify various Laws and Theorems and determine two port network parameters.
- Determine the resonant Frequency, quality factor & bandwidth of the RLC circuits.
- Analyze DC and AC circuits using MATLAB compare these results to those experimentally measured.

1. Transient response in R-L and R-C Network: Simulation/hardware
2. Transient response in R-L-C Series & Parallel circuits Network: Simulation/hardware.
3. Determination of Impedance (Z) and Admittance(Y) parameters of two port network
4. Frequency response of LP and HP filters
5. Frequency response of BP and BR filters
6. Generation of Periodic, Exponential, Sinusoidal, Damped sinusoidal, Step, Impulse, Ramp signals using MATLAB in both discrete and analog form.
7. Evaluation of convolution integral, Discrete Fourier transform for periodic & non-periodic signals and simulation of difference equations using MATLAB.
8. Representation of poles and zeros in z-plane, determination of partial fraction expansion in z-domain and cascade connection of second order system using MATLAB.
9. Determination of Laplace transform and inverse Laplace transformation using MATLAB.
10. Spectrum analysis of different signals.

Text/References:

1. Hayt & Kemmerly, Engineering Circuit Analysis, Mc Graw Hill.
2. Roy Choudhury, Network and Systems, New Age

EEP1308: ELECTRICAL AND ELECTRONIC MEASUREMENTS LAB 0-0-2-1

Course outcomes:

- Determine the resistance, inductance using AC and DC bridges.
- Energy measurement using single phase energy meter.

- Understand the Power measurement for single and three phase using ammeter voltmeter method and wattmeter method.
- Understand the measurement of different AC quantity using AC bridges.
- Understand the use of CRO and different digital meters.

List of Experiments:

1. Measurement of medium resistance using portable Wheatstone bridge.
2. Measurement of inductance using hay's bridge.
3. Measurement of inductance using Maxwell Inductance Bridge.
4. Measurement of low resistance using Kelvin double bridge.
5. Study and calibration of single phase energy
6. Using lissajous figures to measure phase and frequency.
7. Measurement of power using ammeter voltmeter .
8. Study of the range extension of an ammeter.
9. Measurement of capacitance using Schering Bridge.
10. Measurements of three phase power using two wattmeter method.
11. Calibration of voltmeter using potentiometer
12. Measurement power factor, frequency by using electronic method.
13. Study of Digital Multimeter, LC R meter, DSO.

Text/References:

1. A.K.Sawhney, A course in Electrical and Electronic Measurments and Instrumentation, Dhanpat Rai Publications,2012.
2. E.W. Golding. And F.C.Widdis A Text Book of Electrical Measurement and Measuring Instruments, Wheeler Publications, 1968.

ECP 1302	**Digital Logic Design Laboratory**
As per the syllabus prescribed by Department of Electronics and Communication Engineering	

4TH SEMESTER

EEL1405 ELECTRICAL MACHINES-I **3-1-0-4**

Course Outcome:

- Acquire knowledge about the fundamental principles and classification of electromagnetic machines.
- Acquire knowledge about the constructional details and principle of operation of DC machines.
- Acquire knowledge about the working of DC machines as generators and motors.
- Acquire knowledge about testing and applications of dc machines.
- Acquire knowledge about the constructional details, principle of operation, testing and applications of transformers.

- Acquire knowledge about the constructional details and principle of operation of three phase induction motors.
- Acquire knowledge about the starting and speed control of induction motors.
- Acquire knowledge about testing and applications of induction motors.

1. Electromagnetism: Electromagnetism, effect of magnetic field on current carrying conductor, magnetic circuit, magnetising curve, characteristics of magnetic material, electromagnetic induction, excitation to magnetic circuit, hysteresis and eddy current losses, energy stored in magnetic circuit, mmf, mutual inductance and transformer.

LECTURES:6

2. Transformer: Emf equation, relation between voltage per turn and KVA output, phasor diagram based on approx. and exact equivalent circuit, per unit equivalent resistance reactance, open circuit and short circuit tests, back to back test, regulation, losses and efficiency, max. efficiency, all day efficiency, wall cooling; two winding and three winding transformers, auto transformer, phase transformation and connections, parallel operation.

LECTURES:9

3. DC Generators: Classification on methods of excitation, armature reaction, interpoles and compensating winding, commutation, load characteristics of DC generators, regulation, parallel operation.

LECTURES:6

4. DC Motors: Torque equation, characteristic curves of shunt, series and compound motors, starting starter and grading of starting resistance, speed control – armature voltage control and field control methods; Ward Leonard method, choice of motors for different duties, losses and efficiency, testing- Swinburn's test, back to back test, retardation test and brake test. LECTURES:6

5. Polyphase Induction Motor: Operation of polyphase induction motors, effect of slots on performance of the motor, equivalent circuit and phasor diagram, locus diagrams, torque and power, speed – torque curve – effect of rotor resistance, deep barand double cage rotors, performance calculation from circle diagram, methods of speed control, testing, losses and efficiency, slip power recovery schemes application, induction generators and induction regulator.

LECTURES:9

Readings:

Text Books:

1. Electric Machinery Fundamental, Stephen J. Chapman, 5th edition, 2012.
2. Electric Machinery, P.S. Bhimbra, Khanna Publishers, 5th, 2011.
3. Electric Machines, D. P. kothari, I. J. Nagrath, McGrawHill, 2011.

Reference books:

1. Electrical Machines, S.K. Bhattacharya, McGrawHill, 4th,2014.
2. Electrical Machinery, S.K. Sen, Khanna Publishers, 5th, 2015.

EEL 1406: SIGNALS AND SYSTEMS 3-0-0-3

Course Outcome:

- Study the concepts of continuous time and discrete time systems.
- Analyse systems in complex frequency domain.
- Understand sampling theorem and its implications.

1. **Introduction to Signals and Systems**

Signals and systems as seen in everyday life, and in various branches of engineering and science. Signal properties: periodicity, absolute integrability, determinism and stochastic character. Some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential, some special time-limited signals; continuous and discrete time signals, continuous and discrete amplitude signals. System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, realizability. Examples. LECTURES: 8

2. **Behaviour of continuous and discrete-time LTI systems**

Impulse response and step response, convolution, input-output behaviour with a periodic convergent inputs, cascade interconnections. Characterization of causality and stability of LTI systems. System representation through differential equations and difference equations. State-space Representation of systems. State-Space Analysis, Multi-input, multi-output representation. State Transition Matrix and its Role. Periodic inputs to an LTI system, the notion of a frequency response and its relation to the impulse response.

LECTURES:10

3. **Fourier, Laplace and z- Transforms**

Fourier series representation of periodic signals, Waveform Symmetries, Calculation of Fourier Coefficients. Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's Theorem. Review of the Laplace Transform for continuous time signals and systems, system functions, poles and zeros of system functions and signals, Laplace domain analysis, solution to differential equations and system behaviour. The z-Transform for discrete time signals and systems, system functions, poles and zeros of systems and sequences, z-domain analysis. LECTURES:10

4. **Sampling and Reconstruction**

The Sampling Theorem and its implications. Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold. Aliasing and its effects. Relation between continuous and discrete time systems. Introduction to the applications of signal and system theory: modulation for communication, filtering, feedback control systems.

LECTURES:8

Text books:

1. A V Oppenheim, Signals & Systems, Pearson Education, 2nd edition, 2015.
2. A Anand Kumar, Signals and Systems, PHI, 3rd edition, 2013.
3. M Roberts, Fundamentals of Signals and Systems, McGraw Hill, 2nd edition, 2017.

Reference books:

1. H P Hsu, Signal and Systems, McGraw Hill, 2013.

2. J G Proakis, Digital Signal Processing, Pearson Education, 4th edition, 2014.
3. Oppenheim, Discrete-Time Signal Processing, Pearson Education, 3rd edition, 2014.
B. P. Lathi, "Linear Systems and Signals", Oxford University Press, 2009.

EEL1407: ELECTROMAGNETIC FIELD THEORY 3-0-0-3

Course Outcome:

- Finding DEL operator, Gradient of a scalar, Divergence of a vector using Divergence theorem, Curl of a vector using Strokes theorem, Laplacian of a scalar, and classify vector fields.
- Solve problems in Cartesian coordinates, Circular cylindrical coordinates, Spherical coordinates transform vectors from one coordinate system to other.
- Use Coulomb's law, Gauss's law, Poisson's and Laplace's equation to find field intensity, Electric potential and Potential gradient, deduce the Relation between E and V.

- Use Biot- Savart law, Ampere's circuit law to find Magnetic flux density, Magnetic static and Vector potential, Forces due to magnetic field, Magnetic torque and moments, Magnetisation in material, Magnetic boundary condition, Inductor and Inductances, Magnetic energy and Force on magnetic material.
- Use Faraday's law and Maxwell's equations to solve problems related to Transformer and motional emf, Displacement current, Time varying Potential, Time harmonic fields and deduce Wave equation and Transmission line equation, Wave propagation in lossy dielectric, Plane waves in loss less dielectric, free space, good conductor, Skin effect, Power & Poynting vector, Reflection of a plane wave at normal incidence, reflection of a plane wave at oblique incidence, polarisation.

1. Introduction to Vector Calculus: DEL operator, Gradient of a scalar, Divergence of a vector & Divergence theorem, Curl of a vector & Strokes theorem, Laplacian of a scalar, Classification of vector fields. LECTURES:4

2. Co-ordinate Systems: Cartesian coordinates, Circular cylindrical coordinates, Spherical coordinates & their transformation. Differential length, area and volume in different coordinate systems. Solution of problems. LECTURES:3

3. Electrostatic Field: Coulomb's law, field intensity, Gauss's law, Electric potential and Potential gradient, Relation between E and V, an Electric dipole and flux lines. Energy density in electrostatic field. Boundary conditions: Dielectric-dielectric, Conductor –dielectric, Conductor-free space. Poisson's and Laplace's equation, General procedure for solving Poisson's and Laplace's equation. LECTURES:8

4. Magneto Static Field: Biot- Savart law, Ampere's circuit law, Magnetic flux density, Magnetic static and Vector potential, Forces due to magnetic field, Magnetic torque and moments, Magnetisation in material, Magnetic boundary condition, Inductor and Inductances, Magnetic energy, Force on magnetic material. LECTURES:8

5. Electromagnetic Fields: Faraday's law, Transformer and motional emf, Displacement current, Maxwell's equations, Time varying Potential, Time harmonic fields. LECTURES:4

6. Electromagnetic Wave Propagation: Wave equation, Wave propagation in lossy dielectric, Plane waves in loss less dielectric, Plane wave in free space, Plane wave in good conductor, Skin effect, Skin depth, Power & Poynting vector, Reflection of a plane wave at normal incidence, reflection of a plane wave at oblique incidence, Polarisation. Transmission line equation & solutions, Physical significance of solutions, Propagation constants, Characteristic impedance, Wavelength, Velocity of propagation.

LECTURES:9

Readings:

Prescribed Text Books

1. M. N. O. Sadiku, Elements of Electromagnetics, Oxford University Press, 2012.
2. D. K. Cheng, Field and Wave Electromagnetics, Pearson, 2013.

Additional Readings

1. R. K. Shevgaonkar, Electromagnetic Waves; McGraw Hill, 2017.
2. R. F. Harrington, Time-Harmonic Electromagnetic Fields, Wiley-IEEE, 2001.
3. N. Ida, Engineering Electromagnetics, Springer, 2015.

ECL 1401	**Analog Circuits**
As per the syllabus prescribed by Department of Electronics and Communication Engineering	

ECL 1402	**Analog Communication**
As per the syllabus prescribed by Department of Electronics and Communication Engineering	

EEP 1405: Electronic System Design Laboratory **0-0-2-1**

Course Outcome:

- Understand the practical issues related to practical implementation of applications using electronic circuits.

- Choose appropriate components, software and hardware platforms.
- Design a Printed Circuit Board, get it made and populate/solder it with components.
- Work as a team with other students to implement an application.

List of Experiments

1. Design the buck-boost converter for the given input voltage variation, load current and output voltage. Plot the regulation characteristics.
2. Design the fly back converter using ferrite core transformer for the given input voltage variation load current and output voltage. Plot the regulation characteristics.
3. Design a phase controlled voltage regulator using full wave rectifier and SCR, vary the conduction angle and plot the output voltage.
4. Design a sequential timer to switch on & off at least 3 relays in a particular sequence using timer IC.
5. Design AM signal using multiplier IC for the given carrier frequency and modulation index and demodulate the AM signal using envelope detector.
6. Design FM signal using VCO IC NE566 for the given carrier frequency and demodulate the same using PLL NE 565.
7. PCB layout design using CAD. Drawing the schematic of simple electronic circuit and design of PCB layout using CAD.
8. Design a DSP based system for simple applications like echo generation, etc. using TMS 320 DSP kit.

Text/Reference Books

1. A. S. Sedra and K. C. Smith, "Microelectronic circuits", Oxford University Press, 2007.
2. P. Horowitz and W. Hill, "The Art of Electronics", Cambridge University Press, 1997.
3. H.W.Ott, "Noise Reduction Techniques in Electronic Systems", Wiley, 1989.
4. W.C. Bosshart, "Printed Circuit Boards: Design and Technology", Tata McGraw Hill, 1983.
5. G.L. Ginsberg, "Printed Circuit Design", McGraw Hill, 1991.

ECP 1401	**Analog Circuits Laboratory**
As per the syllabus prescribed by Department of Electronics and Communication Engineering	

ECP 1402	**Analog Communication Laboratory**
As per the syllabus prescribed by Department of Electronics and Communication Engineering	

5TH Semester

EEL1505:ELECTRICAL MACHINES-II 3-0-0-3

Course Outcome:

- Acquire knowledge about the constructional details and principle of operation of alternators.
- Acquire knowledge about the working of synchronous machines as generators and motors.
- Acquire knowledge about testing and applications of synchronous machines.
- Acquire knowledge about the constructional details and principle of operation single phase induction motors.
- Acquire knowledge about the starting and speed control of induction motors.
- Acquire knowledge about testing and applications of induction motors.
- Acquire knowledge about the constructional details and principle of operation single phase linear induction motors.
- Acquire knowledge about the constructional details and principle of operation single phase stepper motors.

1. Synchronous Generator (SG): Principle of operation, construction, excitation systems, cooling, emf equation, flux and mmf diagram, synchronous impedance, voltage regulation, short circuit ratio, external characteristics, power angle characteristics of cylindrical rotor alternator, parallel operation, synchronous generator connected with infinite bus, salient pole generators, two reaction theory and phasor diagrams, determination of $X_d$and X_q, power angle characteristics of salient pole machine, synchronizing power and synchronizing torque, hunting and damper winding, Losses and efficiency.
LECTURES:15

2. Synchronous Motors: Principle of operation, equivalent circuit and phasor diagram, starting, power and torque developed in a cylindrical rotor and salient pole rotor synchronous motor, effect in change of load and excitation, V-curves, hunting and its mitigation, application.
LECTURES:5

3. Single Phase Commutator Motors: Series, repulsion and universal motors – construction, principle of operation, commutation, starting methods; speed control; power factor and methods of compensation. LECTURES:6

4. Single Phase Induction Motors: Construction, analysis of starting and running characteristics; starting methods. LECTURES:4

5. Linear Induction Motors: Introduction, operating principles and application areas.
LECTURES:3

6. Stepper Motor: Construction, torque-stepping rate characteristics, application areas.

LECTURES:2

Readings:

Prof. S. Chatterjee Dr. P. K. Biswas Mrs. K. De Mr. S. Majumder Mr. R. Kumar Mr. A. Bhattacharya Mr.S.Debnath Mrs.U.Das

Prescribed Text Books

1. S. Chapman, Electric Machinery Fundamentals, 4/e, McGraw-Hill, 2003.
2. R. K. Rajput, Electrical Machines, 3/e, Laxmi Publications (P) Ltd., 2003.
3. A. chakrabarti and S. Debnath, Electrical Machines, McGraw-Hill Education, 2015

Additional Readings

1. S.K. Sen, Electrical Machinery, Khanna Publishers, 2002
2. P.S. Bimbhra, Generalized Theory of Electrical Machines, Khanna Publishers, 2002
3. D. P. Kothari, I. J. Nagrath, Electrical Machines, TMH, 2004
4. A.S. Leinsdorf, Theory of A.C. Machines, MH, 2001

EEL1506 : POWER SYSTEMS-I **3-0-0-3**

Course Outcome:

- Know the different sources of power generation and its methodologies.
- Understand the economic aspects and tariff of electrical energy and power.
- Calculations and analysis of line parameters of transmission lines.
- Understand and realize per unit representation of power system.
- Explain different terminologies and mechanical designing of power system network components.
- Explain insulation and types of underground cables.

1. Introduction of Generation: Fundamentals of thermal, hydro, nuclear and captive power generation, non-conventional sources of energy, distributed generations.

LECTURES:3

2. Economics of Power Systems: Definitions of load, connected load, demand, peak load, demand intervals, demand factor, average load, load factor, diversity factors, utilization factor, capacity factor, load curves, base load, and peak load; calculations based on the above factors; economics of power factor improvement; tariffs: structures, calculation on tariff and economics of power factor improvement. LECTURES:3

3. Line Constants: Introduction to overhead line (OHL) constants; Inductance: inductance of solid cylindrical conductor, composite conductors, two conductor single phase line, three phase single circuit and double circuit lines with symmetrical and unsymmetrical spacing, transposed and untransposed line, skin and proximity effects Capacitance: potential difference between two points due
to charge, capacitance of two wire line, three phase symmetrical and unsymmetrical line, charging current, effect of earth on capacitance of transmission line. LECTURES:8

4. Steady State Performance of Transmission lines: Classification of transmission lines; performance of short and medium transmission lines, nominal T and nominal π methods; performance of long transmission lines, economic choice of conductor size, Kelvin's law, Basic concepts of EHV AC and DC transmission systems. LECTURES:6

5. Per-Unit Representation of Power Systems:The one line diagram, impedance and reactance diagrams, per unit quantities, changing the base of per unit quantities, advantages of per unit system. LECTURES:4

6. Mechanical Design of Overhead Line: Transmission towers and there classifications, components in transmission towers and lines, calculation of sag, ice and wind loading; stringing chart, sag template. LECTURES: 4

7. Over Head Line Insulators: Types of insulators, voltage distribution of suspension insulators, string efficiency, methods of improving string efficiency, corona: disruptive critical and visual critical voltages, factors effecting corona, corona power loss; advantages and disadvantages of corona, radio interference. LECTURES:3

8. Underground Cables: Insulator materials; construction of single core and three core cables; classification of cables and their construction; laying of cables; jointing of cables; stress and capacitance of single core and three core cables; most economical size of conductor; grading of cables; types of grading; breakdown voltages and mechanism of breakdown, thermal characteristics of cables; comparison of overhead and underground supply system. LECTURES:5

Readings:

Prescribed Text Books

1. A. Chakrabarti, S. Halder, Power System Analysis Operation and Control, PHI, 2016
2. D. P. Kothari and I. J. Nagrath, Power System Engineering, McGraw-Hill, 2012
3. C.L. Wadhwa, Electrical Power systems, New Age International, 2007
4. A. Hussain, Electrical Power System, CBS Publishers,2007
5. B.R.Gupta, Generation of Electrical Energy, S. Chand & Co. 2009

Additional Readings

1. M.LSoni, P.V Gupta, U.S Bhatnagar, Electric Power, DhanpatRai& Sons, 1984
2. J.B.Gupta, A course in Power Systems, S. K. Kataria& Sons, 2002
3. O.I.Elgerd Electric Energy system Theory - An Introduction Tata McgrawHilll, 2002

EEL 1507: Control System-I **3-0-0-3**

Course Outcome:

- Developing the mathematical model of the physical systems.
- Understanding the concepts of time domain analysis.
- Analyze the response of the closed and open loop systems.
- Analyze the stability of the closed and open loop systems.
- Design the various kinds of compensator.

1. Introduction: The control problem and its solution, feedback, regulation and tracking problems. LECTURES:3

2. Physical Systems and Models: Transfer function, examples with mechanical, electrical, hydraulic, pneumatic systems and systems with dead zone; control system components: error detectors, gears, gyroscope, dc motors, servomotors, techogenerators, servo amplifiers; block diagrams and reduction techniques, signal flow graphs, Mason's gain formula. LECTURES:8

3. Time Domain Analysis: Time domain analysis of 1st and 2nd order systems; transient and steady state responses; transient and steady state responses with unity feedback system; sensitivity and error analysis. LECTURES:5

4. Root Locus Analysis: Root locus; effects of pole/zero on root locus; stability and relative stability using root locus. LECTURES:5

5. Frequency Domain Analysis: Routh array analysis; Bode, polar and Nyquist plots; stability and relative stability using these plots; M and N circles; Nichols plot. LECTURES:10

6. Controller/ Compensator Design: Design of lag, lead and lag – lead compensators; P, PD, PI and PID error control strategies. LECTURES:5

Readings:

Prescribed Text Books

1. K. Ogata, Modern Control Engineering, Pearson Education, 2009
2. M. Gopal, Control Systems Principles and Design, Tata McGraw Hill, 2012

Additional Readings

1. D' Azzo and Houpis, Linear Control Systems Analysis and Design McGrow Hill, 1995
2. N S Nise, Control Systems Engineering John Wiley & sons, 201
3. R. C. Dorf and R. H. Bishop, Modern Control Systems, Addison Wesley, 1999

ECL 1501	Digital Signal Processing
As per the syllabus prescribed by Department of Electronics and Communication Engineering	

ECL 1502	Microprocessors & Microcontrollers

As per the syllabus prescribed by Department of Electronics and Communication Engineering

EEL/ECL 15XX	Elective-I
As per the syllabus from list of Program Elective course.	

EEP1505:Electrical Machine Laboratory **0-0-2-1**

Course Outcome:

- Acquire hands on experience of conducting various tests on dc machines and obtaining their performance indices using standard analytical as well as graphical methods.
- Acquire hands on experience of conducting various tests on transformers and obtaining their performance indices using standard analytical as well as graphical methods.
- Acquire hands on experience of conducting various tests on alternators and obtaining their performance indices using standard analytical as well as graphical methods.
- Acquire hands on experience of conducting various tests on induction machines and obtaining their performance indices using standard analytical as well as graphical methods.

Experiments:

1. Obtain the equivalent circuit parameters from OC and SC tests, and to estimate efficiency & regulation at various loads.
2. Study of no-load and load test on DC series motor.
3. Speed control of DC series motor by armature control and field control methods.
4. Study of no-load and load test on DC shunt motor.
5. Speed control of DC shunt motor by armature control and field control motor.
6. Study of no-load and load test on DC shunt generator.
7. Study of no-load and load test on a Three phase Induction Motor.
8. Study of block rotor test on a Three phase Induction Motor.
9. Study of no-load and load test on a single-phase Induction Motor.
10. Study of Block Rotor test on a single-phase Induction Motor.
11. To study the Open & Short circuit characteristics of Three Phase Synchronous Generator.
12. Study of V- curve of Three Phase Synchronous motor.

13. Study of Synchronising and parallel operation of Synchronous Generator.
14. Study of Slip test of synchronous machines.

Text/References:

1. S. Chapman, Electric Machinery Fundamentals, 4/e, McGraw-Hill, 2003.
2. R. K. Rajput, Electrical Machines, 3/e, Laxmi Publications (P) Ltd., 2003.

EEP 1506:ELECTRICAL MACHINE DESIGN **0-0-2-1**

Course Outcomes:

- Determine different parameters and design of DC Machine.
- Understand the principles of electrical machine design and carry out a basic design of an ac machine.
- Use software tools to do design calculations.

List of Experiments

1. Analytical design of DC series motor.

2. Design of DC shunt motor (self and separately excited).

3. Design of 3-phase Transformer.

4. Design of 3-phase of squirrel cage Induction motor.

Text / References:

1. A. K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai and Sons, 1970.
2. M.G. Say, "Theory & Performance & Design of A.C. Machines", ELBS London.
3. S. K. Sen, "Principles of Electrical Machine Design with computer programmes", Oxford and IBH Publishing, 2006.

ECP 1501	**Digital Signal Processing Laboratory**
As per the syllabus prescribed by Department of Electronics and Communication Engineering	

ECP 1502	**Microprocessors & Microcontrollers Laboratory**
As per the syllabus prescribed by Department of Electronics and Communication Engineering	

6TH SEMESTER

EEL1605: POWER SYSTEMS-II **3-0-0-3**

Course Outcome:

- Study and analysis of types of faults, symmetrical and unsymmetrical components.
- Analysis of swing equation and stability studies of power system.
- Perform load flow analysis of power system networks using Gauss-Seidel, Newton-Raphson and Fast-Decoupled iterative methods.
- Analysis of economic operation of energy generation systems and operation of automatic generation control.
- Understand protective relays, circuit breakers and neutral grounding.

1. Fault Analysis: Causes of faults, types of faults, importance of fault analysis in electrical power systems, identification of system fault, fault analysis for generators, transmission lines, concepts of generator reactance's; transient, sub-transients etc, current limiting reactors, types, functions. LECTURES:6

2. Symmetrical Components and Unsymmetrical Fault Analysis: Concepts of symmetrical components, Fortescue's theorem, power in terms of symmetrical components, sequence impedances and sequence networks for generators, transformers, transmission lines etc, unsymmetrical fault (L-G, L-L, LL-G) analysis.
LECTURES:6

3. Power System Stability: Operation of synchronous machine on infinite bus; stability-classification, power limit of transmission lines, steady state stability, Clarke's diagram, transient stability- the swing equations, equal area criterion, critical clearing angles; power angle curves for fault and post fault conditions for various types of faults; solution of swing equation, dynamic stability; factors affecting stability. LECTURES:4

4. Load Flow Analysis: Static load flow equation, system, bus classification, Formation of admittance matrix. Gauss Seidel, Newton-Raphson and fast-decoupled load flow methods and comparison of methods. LECTURES:6

5. Economic Operation of Energy Generation Systems: Generation Cost Curves; Economic Operation of Thermal System; Plant Scheduling; Transmission Loss and Penalty Factor; Hydro-Thermal Scheduling. LECTURES:4

6. Protective Relays&Circuit Breakers: Relay Operating principles, classification, electromagnetic type relays, protective zones, over current relay-characteristics, directional relay, feeder protection- time grading and current grading, distance relays and their characteristics, differential protections, protection of transmission lines, generator and transformers, transley relay, negative sequence relay; CB operating principle, types, circuit breaking transients, restriking and recovery voltages, CB ratings, testing of CBs; introduction to solid state CBs. LECTURES:7

7. Lightning Arrester& Neutral Grounding: Principals of operation, ungrounded system-arcing ground, types of grounding- solid, resistance, reactance and resonant grounding, generator neutral breaker, grounding practices. LECTURES:3

Readings:

Prescribed Text Books

1. J.H. Grainger and W.D. Stevenson Jr., Power System analysis, McGraw-Hill, 1994
2.D.P Kothari and I J Nagrath, Modern *Power System*, Tata McGraw-Hill, 2008
3. A. Chakrabarti and S. Halder, Power system operation analysis and control, PHI, 2016
4. C.L. Wadhwa, Electrical Power systems, New Age International, 2007
5. Ashfaq Husain, Electrical Power System, CBS Publishers, 2007

Additional Readings:

1. M.L. Soni, P.V. Gupta, U.S. Bhatnagar Electric Power, DhanpatRai& Sons, 1984
2. P.Kundur, Power system stability and control, McGraw-Hill, 1994
3. P.Venkatesh, Electrical Power Systems, PHI Learning , 2012.

EEL1606 :CONTROL SYSTEM-II **3-0-0-3**

Course Outcome:

- Developing and analyzing state space models.
- Linearize the non linear physical systems.
- Study the non linear system behavior by phase plane and describing function methods.
- Study the stability of linear and nonlinear systems by Lyapunov method.
- Understand mathematical models of linear discrete-time control systems using transfer functions and state-space models.

1. Introduction to Discrete Time Systems: mathematical preliminaries- difference equations, Z Transform and properties; sampling quantization and reconstruction process,discrete time systems, system response, transfer function stability and the jury stability criterion, implementation of digital controllers and digital controllers for deadbeat performance. LECTURES:12

2. State Space Representation of Continuous Time and Discrete Time Systems: state space models, state space representation of simple electrical and mechanical
systems, canonical forms, solution of state equation, state transition matrix, relation between transfer function and state variable representations; controllability and observability, pole-placement using state variable feedback; design of full order and reduced order observer, observer based state feedback controller. LECTURES:12

3. Introduction to Nonlinear Feedback Control Systems: characteristics of nonlinear systems; linearization techniques; phase plane analysis, singular points, limit cycle vs closed

trajectory; stability analysis using phase plane analysis- describing function (DF) of common nonlinearities, stability analysis using DF; stability in the sense of Lyapunov, Lyapunov's stability theorems for linear and nonlinear systems; effect of non-linearity in root locus and Nyquist plot. LECTURES:12

Readings:

Prescribed Text Books

1. K. Ogata, Modern Control Engineering, Pearson Education, 2009
2. M. Gopal, Digital Control and State Variable Methods, Tata McGraw Hill, 2003

Additional Readings

1. R. C. Dorf and R. H. Bishop, Modern Control Systems, Prentice Hall, 2010
2. B C. Kuo, Digital Control Systems, Oxford University Press, 1995
3. M. Gopal, Modern Control System Theory, New Age International, 1993

EEL1607 :POWER ELECTRONICS AND DRIVES **3-0-0-3**

Course Outcome:

- To understand the basics of Power Electronics
- To learn the details of power semiconductor switches (Construction, Characteristics and operation).
- To understand the working of various types of converters.
- To learn how to analyse the converters and design the components of them, under various load types.
- To learn about the control of various converters.

1. Introduction to power semiconductor Devices: Power diodes, power transistors, SCRs, TRIACs, GTOs, power MOSFETs and IGBTs- principles of operation and V-I characteristics, device specifications, ratings, protection and cooling; methods for turning on SCRs, gate triggering circuit, methods for turning-off SCRs. LECTURES:6

2. AC to DC Converter: Single and three phase diode rectifiers for various loads, single and three phase Controlled rectifiers for various loads, effect of source impedance; symmetrical and unsymmetrical semi converter and dual converter- effect on power factor and total harmonic distortion (THD). LECTURES:6

3. DC to DC Converters: Limitations of linear power supplies, switched mode power supplies (buck, boost, buck-boost, cuk, fly-back and forward converters).

LECTURES:4

4. DC to AC Converters: principle of operation of inverters, half bridge, full bridge, three phase- six step operations, voltage control- pulse width modulation (PWM) techniques.

LECTURES:4

5. AC Controllers: Principle of on-off and phase control, single phase and three phase controllers with R and R-L loads. Principle of operation of cycloconverters, circulating and non-

circulating mode of operation, single phase to single phase step up and step down cycloconverters, three phases to single phase Cycloconverters, three phases to three phase Cycloconveter. LECTURES:4

6. Electric Drives: Modelling of DC motors, State space modeling, block diagram & Transfer function, Starting and braking of DC motor, Single phase, three phases fully controlled and half controlled DC drives. Dual converter control of DC drives,chopper controlled DC motor drives, closed loop control of DC motor. Performance of induction Motor, Starting and braking of induction motor, Stator voltage variation by three phase controllers, Speed control using chopper resistance in the rotor circuit, slip power recovery scheme,current source inverter fed induction motor drive. Volts/Hertz Control, Vector or Field oriented control. Performance of synchronous motor drive, Starting and braking of synchronous motor drive, Variable frequency control, Self Control, Voltage source inverter fed synchronous motor drive
LECTURES:12

Readings:

Prescribed Text Books

1. N. Mohan,T.Undeland, W. Robbins, Power Electronics Converter ,Applicationsand Design, John Wiley & Sons, 2003.
2. M. Rashid, Power Electronics, Prentice Hall India Ltd, 2004
3. G.K. Dubey, Fundamentals of Electrical Drives, Narosa Publishing House,2003

Additional Readings

1. S. B. Dewan &A. Straughen, Power Semiconductor Circuits, John Wiley & Sons,2012
2. B.K Bose, Modern Power Electronics and AC Drives, Pearson Education, 2003
3.

ECL 1601	**Digital Communication**
As per the syllabus prescribed by Department of Electronics and Communication Engineering	

EEL/ECL 16XX	**Elective-II**
As per the syllabus from list of Program Elective course.	

EEP1605: POWER SYSTEM LABORATORY **0-0-2-1**

Course Outcome:

- Understand the line parameters.

- Knowledge of different types of electrical faults.
- Understand relays operation and characteristics.
- Understand the load flow analysis.
- Know Economic load dispatch problems.

List of Experiments

1. Determination of transmission line parameters.
2. Determination of ABCD parameters.
3. Formation of Bus Admittance and Impedance Matrices.
4. Simulation of Symmetrical fault.
5. Simulation of Unsymmetrical fault.
6. Study operating characteristics of directional over current relay.
7. Studyoperating characteristics of differential relay.
8. Study of distance protection using distance relay
9. Study of Distribution transformer protection for differential & over current faults.
10. Newtons'-Raphson Load flow analysis of multi-bus power system network.
11. Economic load dispatch in power systems.

Text/References:

1. C.L. Wadhwa, Electrical Power systems, New Age International, 2007
2. A. Hussain, Electrical Power System,CBS Publishers,2007

EEP1606: CONTROL SYSTEMS LABORATORY **0-0-2-1**

Course Outcomes:

- Determination the response of common nonlinearity and response in Z- domain.
- Determination of pole-zero configuration, step response, stability analysis using Bode and Nyquist plots
- Understand the modeling of linear-time-invariant systems using transfer function and state-space representations.
- Understand the concept of stability and its assessment for linear-time invariant systems.
- Design simple feedback controllers.

List of Experiments

1. Design of load compensation and by compensation using MATLAB
2. Familiarization and use of MATLAB command associated with state variable analysis and Digital Control System.
3. Determination of phase plane trajectory and possibility of limit cycle common non-linearities.
4. Familiarisation with digital controller and determination of response due to variation of controller parameters.
5. Determination of response with common nonlinearity as introduced into the forward path of a 2nd order unity feedback control system using MATLAB.

6. Determination of response in Z- domain using MATLAB SIMULINK Toolbox or
7. Study of pole-zero configuration, step response, stability analysis using Bode and Nyquist plots, study of gain and phase margins.
8. Design of compensators, controllers.
9. Study of open loop and closed loop frequency response and effect of addition of poles and zeros.
10. Study of relay control system.
11. Study of P, PI and PID controller of type 0 and type 1 system with time delay
12. Study of closed loop behaviour of first, second and third order systems.
13. Study of Lead lags controller design.

Text Books

1. K. Ogata, Modern Control Engineering, Pearson Education, 2009
2. M. Gopal, Digital Control and State Variable Methods, Tata McGraw Hill, 2003

EEP1607:POWER ELECTRONICS & DRIVES LABORATORY **0-0-2-1**

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

List of Experiments:

1. Study of the characteristics of an SCR, MOSFET and IGBT.
2. Study of different triggering circuits of an SCR.
3. Study of the operation of a single phase full controlled bridge converter with R and R-L load.
4. Study of performance of step down chopper with R and R-L load.
5. Study of performance of single phase half controlled symmetrical and asymmetrical bridge converter (Simulation).
6. Study of performance of three phase controlled converter with R & R-L load.
7. Simulation of Thysistor controlled DC Drive using PSIM/MATLAB.
8. Simulation of Chopper fed DC Drive using PSIM/MATLAB.
9. PWM Inverter fed 3 phase Induction Motor control using PSPICE / MATLAB / PSIM Software.
10. VSI / CSI fed Induction motor Drive analysis using MATLAB/DSPICE/PSIM Software.
11. Study of V/f control operation of 3Φ induction motor drive.

Text/References:

1. N. Mohan,T. Undeland, W. Robbins, Power Electronics Converter Application and Design, John Wiley & Sons, 2003
2. G.K. Dubey, Fundamentals of Electrical Drives, Narosa Publishing House,2003

ECP 1601	Digital Communication Laboratory
As per the syllabus prescribed by Department of Electronics and Communication Engineering	

EET 1604	Industrial Training Viva

7TH SEMESTER

EEL1701:INSTRUMENTATION ENGINEERING **3-0-0-3**

Course Outcome:

- To understand the functional description of instrumentation system.
- To learn the working of different types Transducers and sensors.
- To study the various pressure, flow, temperature and liquid level.
- To study the advance topics in instrumentation like: Digital data acquisition systems, Smart sensors, Intelligent Instrumentation, Instrumentation for remote control system, Internet based tele-metering.

1. **Introduction:** Functional description of instrumentation. Overview of transducers, signal conditioners, filters, amplifiers, OP-AMP, display devices; instrumentation amplifiers and circuits. LECTURES-2

2. Transducers and sensors for analytical instrumentation:
Measurement of displacement using linear variable differential transducers (LVDTs). Null reduction techniques. Phase compensation circuits. Phase sensitive demodulation.
Rotary variable differential transformers (RVDTs). Capacitive transducers: variable air gap, variable plate overlap, variable dielectric. Level gauge. Thickness gauge. Humidity sensor. Capacitive microphone. Piezoelectric transducers. Fundamental concepts, materials, charge sensitivity, voltage sensitivity. Force/displacement transducers. Charge amplifiers. Accelerometers. Optical pyrometers. Measurement of pressure using elastic transducers: bourdon tubes, diaphragms, bellows. Hall Effect transducers and their applications. Measurement of flow: electromagnetic flowmeters, ultrasonic flowmeters, hot wire anemometers. LECTURES-16

3. Signal Conditioning: Instrumentation amplifiers, A.C. amplifiers. Chopper type D.C. amplifiers. Operation amplifier circuits in instrumentation systems. Amplitude modulation and demodulation. Transformer ratio bridges. Electrical filters: low-pass, high-pass, band-pass and band-stop filters. ADCs and DACs. General considerations of analog to digital and digital to

analog conversions. DACs: Binary-weighted resistance, R-2R ladder. DAC characteristics and specifications. DAC errors. ADCs: Successive-approximation type, Dual-slope type.

LECTURES-12

4. Electronic instruments: AC voltmeters using rectifiers, True-RMS voltmeters, electronic multimeters, digital voltmeters, Q meters. LECTURE-4

5. Fibre optic sensors and instrumentation: basic principles; optical fibre cable- dispersion and losses; connectors and splices, sources and detectors. Examples of typical fibre optic sensing systems. LECTURES-2

Readings:

Prescribed Text Books

1. E.O. Doebelin, Measurement Systems, McGraw Hill,2004
2. A. D. Helfrick and W. D. Cooper, Modern Electronic Instrumentation and Measurement Techniques, Pearson Education, 2007.
3. A. K. Sawhney, A Course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai and Sons.
4. D. Patranabis, Principles of Electronic Instrumentation, Prentice Hall of India, 2008.
5. S.K.Singh, Industrial Instrumentation and Control

Additional Readings

1. C.S Rangan, G.R. Sarma & VSV Mani, Instrumentation, Devices & system, Tata McGraw Hill, 2002
2. D.V.S Murthy, Transducers & Instrumentation, PHI, 2004

HUL 1701	**Humanities/Managerial Economics**
As per the syllabus prescribed by Department of Humanities and Management.	

EEL/ECL 17XX	**Elective-III**
As per the syllabus from list of Program Elective course.	

EEL/ECL 17XX	Elective-IV
As per the syllabus from list of Program Elective course.	

EED 1704	Project Phase-1
EEG 1705.	Grand Viva

8TH SEMESTER

CHL 1802	Environmental Science and Engineering
As per the syllabus prescribed by Department of Chemistry.	

EEL/ECL 18XX	Elective-V
As per the syllabus from list of Program Elective course.	

EEL 18XX	Open Elective
As per the syllabus from list of Open Elective course.	

EEV 1802	Seminar
EED 1804	Final Project

PROFESSIONAL ELECTIVE COURSE SYLLABUS

ECL XX11	Introduction to VLSI
As per the syllabus prescribed by Department of Electronics and Communication Engineering	

2. EEL XX12 :HIGH VOLTAGE AND INSULATION ENGINEERING 3-0-0-3

- **Elucidate** the concepts used for the generation and measurement of high voltages and currents and design corresponding circuits.
- **Understand** breakdown phenomena in gases and to **elucidate** the concepts used for the generation of high voltages and currents.
- **Understand** high voltage testing techniques of Power apparatus and causes of over voltage in Power systems.
- **Understand** the generation of transients and the concept of insulation coordination.

1. Overview of High Voltage Engineering and Electrostatic Field distribution: Overview of High Voltage Engineering and numerical methods applied in calculating electrostatic field in complex insulating configurations. LECTURES:2

2. Generation of high voltages and currents, AC voltages: Cascade transformers-series resonance circuits DC voltages: voltage doubler-cascade circuits-electrostatic machines Impulse voltages: single stage and multistage circuits wave shaping-tripping and control of impulse generators Generation of switching surge voltage and impulse currents.

LECTURES:8

3. Measurement of high voltages and currents: DC, AC and impulse voltages and currents-DSO-electrostatic and peak voltmeters-sphere gaps-factors affecting measurements-potential dividers (capacitive and resistive)-series impedance ammeters-rogowskicoils-hall effectgenerators. LECTURES:6

4.Breakdown mechanisms in Solid, Liquid and Gaseous Dielectrics: Solid Dielectrics Breakdown through Intrinsic, Thermal, Eletrochemical, Treeing, Tracking, partial discharges,

Liquid Dielectrics Breakdown through Electronic, in Pure and Commercial Dielectric, Breakdown in uniform and non uniform fields-Paschens law-Townsends criterion-streamer mechanism-corona discharge-breakdown in electro negative gases.
LECTURES:8

5. Lightning and Switching Transients, Insulation Coordination: Transients and its causes and Effects, Use of Bewley Lattice Diagram in calculation of Transients, Nominal and Maximum System Voltage, Factor of Earthing, Insulation Level, Earth Wire, Conventional and Statistical methods of Insulation Coordination

LECTURES:6

6. High voltage testing of materials and apparatus: Preventive and diagnostic tests-dielectric loss measurements-schering bridge-inductively coupled ratio arm bridge-partial discharge and radio interference measurement-testing of circuit breakers and surge diverter.

LECTURES:6

Readings:

Prescribed Text Books

1. Kuffel, Zaengl, Kuffel, High Voltage Engineering Fundamentals, Newnes Publications, 2000
2. C.L. Wadhwa , High Voltage Engineering, New Age publication, 2007

Additional Readings

1. D. Kind and K. Feser, High Voltage Test Technique, SBA Publication, 1999
2. M.S. Naidu & V. Kamaraju, High Voltage Engineering, McGraw Hill, 1995

CSL XX13	**Datastructure**
As per the syllabus prescribed by Department of Computer Science Engineering	

4.EEL XX14:EXTRA HIGH VOLTAGE AC AND DC TRANSMISSION **3-0-0-3**

Course outcomes:

- Understand the advantages of dc and ac transmission and Principal application of AC and DC Transmission.
- Understand the operation of Line Commutated Converters and Voltage Source Converters.
- Understand the control strategies used in HVAC and DC transmission system.
- Understand the improvement of power system stability using an HVDC system.

1. Constitution of EHV AC and DC Links, Kind of DC Links, Limitations and advantages of AC and DC Transmission, Principal application of AC and DC Transmission, trends EHV AC and DC Transmission, Power-handling capacity, Converter analysis Garentz circuit, Firing control, overlapping.

LECTURES:7

2. Extra long distance lines, Voltage profile of loaded and unloaded line along the line, Compensation of lines, series and shunt compensation, Shunt reactors, Tuned power lines, Problems of extra long compensated lines, FACT concept and application.

LECTURES:7

3. Travelling waves on transmission systems, Their shape, attenuation and distortion, effect of junction and termination on propagation of traveling waves, Over voltages in transmission system, Lightning, switching and temporary over voltage, Control of lighting and switching over voltages

LECTURES:7

4. Components of EHV dc system, converter circuits, rectifier and inverter valves, Reactive power requirements, harmonics generation, adverse effects, Classification, Remedial measures to suppress, filters, Ground return, Converter faults & protection harmonics mis operation,

Commutation failure, Multi-terminal D.C.

LECTURES:8

5. Control of EHV dc system desired features of control, control characteristics, constants current control, Constant extinction angle control, Ignition angle control, parallel operation of HVAC & DC system, Problems and advantages. LECTURES:7

Readings:

Prescribed Text Books

1. K. R. Padiyar, HVDC Power Transmission Systems, Wiley Eastern Ltd, 1990.
2. Begmudre, EHV AC Transmission.

Additional Readings

1. J. Arrillag, High Voltage Direct Transmission, Peter Peregrinus, 1983.
2. E. W. Kimbark, Direct Current Transmission, Vol.I, Wiley Interscience, 1971.
3. S.Rao, EHV AC & DC Transmission.

ECL XX15	**Nano Electronics**
As per the syllabus prescribed by Department of Electronics and Communication Engineering	

6. EEL XX16:UTILIZATION OF ELECTRICAL POWER **3-0-0-3**

Course Outcome:

- To study the Electric Traction: D.C. and A.C traction, speed control and braking etc.
- To learn the methods of electric heating, resistance, dielectric, induction and arc heating, high frequency heating, comparison of electric heating methods, Applications.
- To learn the methods of welding, resistance, electric arc, ultrasonic and laser weldings; welding-transformer, power sources and control circuits, control of current flow.
- To study the Illumination, nature of radiation, definitions, polar curves, laws of illumination, luminous efficiency, sources of light, incandescent, vapour, compact florescent lamp, LED and florescent lighting; factory lighting, flood lighting, street lighting and residential lighting.
- To know the necessity of energy audit, types of energy audit.

1. Electric Traction: D.C. and A.C traction, electric traction motors- starting, speed control and braking; system of power supply in traction. LECTURES:5

2. Electric Heating: Classification, methods of electric heating, resistance, dielectric, induction and arc heating, high frequency heating, comparison of electric heating methods, Applications. LECTURES:4

3. Electric Welding: Classification, methods of welding, resistance, electric arc, ultrasonic and laser weldings; welding-transformer, power sources and control circuits, control of current flow. LECTURES:6

4. Illumination: introduction, nature of radiation, definitions, polar curves, laws of illumination, luminous efficiency, sources of light, incandescent, vapour, compact florescent lamp, LED and florescent lighting; factory lighting, flood lighting, street lighting and residential lighting. LECTURES:10

5. Energy Audit: necessity of energy audit,types of energy audit- preliminary and detailed energy audit, energy management (audit) approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, energy audit methods of saving electricity in drives, lighting, and distributions systems metering, case study of energy auditing and potential energy saving.

LECTURES:1

Readings:

Prescribed Text Books

1. Albert, Plant Engineers & Managers Guide to Energy Conservation, the Fairmont Press, 2011
2. C. Wayne, Turner Energy management handbook, John Wiley and Sons, 1982
3. H. Partab, Art and Science of Electrical Energy, Dhanpat Rai and Co. Pvt. Ltd, 1994

4. H. Partab, Modern Electric Traction, Dhanpat Rai and Co. Pvt. Ltd, 1998

Additional Readings

1. NPC energy audit manual and reports
2. Barney L. Capehart, Wayne C. Turner, William J. Kennedy Guide to Energy Management, 2008

7.EEL XX17:POWER QUALITY AND FACTS **3-0-0-3**

Course outcomes:

- Assess the severity of power quality problems in distribution system.
- Analyze current and voltage related power quality issues.
- Suggest the methodology to improve the power quality for sensitive loads by various mitigating custom power devices.
- Understand the importance of FACTS devices.

- Identify configuration of FACTS controller required for a given application.

1. Power Quality Problems in Distribution Systems: Power Quality problems in distribution systems: Transient and Steady state variations in voltage and frequency.
Unbalance, Sags, Swells, Interruptions, Wave-form Distortions: harmonics, noise, notching, dc-offsets, fluctuations. Flicker and its measurement. Tolerance of Equipment: CBEMA curve. LECTURES-6

2. Dynamic Voltage Restorer and Unified Power Quality Conditioner: Voltage sag/Swell mitigation: Dynamic Voltage Restorer – Working Principle and Control Strategies. Series Active Filtering. Unified Power Quality Conditioner (UPQC): Working Principle. Capabilities and Control Strategies. LECTURES-5

3. Introduction of Flexible AC Transmission Systems (FACTS): Steady state and dynamic problems in AC systems, power flow. Basic realities & roles, types of FACTS controller, principles of series and shunt compensation. LECTURES-5

4. FACTS Devices: Description of Static Var Compensators (SVC), thyristor controlled series compensators (TCSC), static phase shifters (SPS), static condenser (STATCON), static synchronous series compensator (SSSC) and unified power flow controller (UPFC). LECTURES-12

4. **Harmonics:** Harmonic sources from commercial and industrial loads, locating harmonic sources. Power system response characteristics - Harmonics Vs transients. Effect of harmonics - harmonic distortion - voltage and current distortion - harmonic indices - inter harmonics – resonance. Harmonic distortion evaluation - devices for controlling harmonic distortion - passive and active filters design. IEEE and IEC standards. LECTURES-8

Readings:

Prescribed Text Books

1. N.G. Hingorani, Understanding of FACTs, Wiley-IEEE press, 1999
2. G.T. Heydt, Power Quality, Stars in Circle Publications, 1991.
3. T.J.E. Miller, Static Reactive Power Compensation, John Wiley & Sons, 1982.
4. R. C. Dugan, "Electrical Power Systems Quality", McGraw Hill Education, 2012.
5. G. T. Heydt, "Electric Power Quality", Stars in a Circle Publications, 1991.
6. R. Mohan Mathur, Rajiv K. Verma, "Thyristor-Based FACTS Controllers for Electrical Transmission Systems", Wiley, 2015.

Additional Readings

1. Yong Hua Song, Flexible AC transmission system (FACTS), 1999

2. Recent publications on IEEE Journals.

8. EEL XX18:ADVANCE CONTROL SYSTEM **3-0-0-3**

Course outcomes

- Developing and analyzing state space models.
- Study the non linear system behavior by phase plane and describing function methods.
- Study the stability of linear and nonlinear systems by Lyapunov method.
- Understand mathematical models of linear discrete-time control systems using transfer functions and state-space models.

1. State Variable Analysis and Design:
State space models, state space representation of simple electrical and mechanical systems, canonical forms, solution of state equation, state transition matrix, relation between transfer function and state variable representations; controllability and observability, pole- placement using state variable feedback; design of full order and reduced order observer, observer based and state feedback controller, optimal control concept, solution of linear quadratic regulator.
LECTURES:12

2. Sample Data Control System:
Mathematical preliminaries- difference equations, Z Transform and properties; sampling quantization and reconstruction process, discrete time systems, system response, transfer function stability, bilinear transformation and the jury stability criterion, implementation of digital controllers and digital controllers for deadbeat performance. Root loci - Frequency domain analysis - Bode plots - Gain margin and phase margin - Design of Digital Control Systems based on Root Locus Technique, state space analysis of discrete system.
LECTURES:12

3. **Nonlinear Control Systems:**
Characteristics of nonlinear systems; linearization techniques; phase plane analysis, singular points, limit cycle vs closed trajectory; stability analysis using phase plane analysis- describing function (DF) of common nonlinearities, stability analysis using DF;
stability in the sense of Lyapunov, Lyapunov's stability theorems for linear and nonlinear systems; effect of non-linearity in root locus and Nyquistplot. Introduction to Modern Nonlinear control system. Introduction to modern nonlinear control system.

LECTURES:12

Readings:

Prescribed Text Books

1. K. Ogata, Modern Control Engineering, Pearson Education, 2009
2. M. Gopal, Digital Control and State Variable Methods, Tata McGraw Hill, 2003
3. H.K.khalil, Non linear Systems, prentice, 3rd Edition.

Additional Readings

1. R. C. Dorf and R. H. Bishop, Modern Control Systems, Prentice Hall, 2010
2. B C. Kuo, Digital Control Systems, Oxford University Press, 1995.
3. M. Gopal, Modern Control System Theory, New Age International, 1993

ECL XX19	Introduction to MEMS
As per the syllabus prescribed by Department of Electronics and Communication Engineering	

10. EEL XX20:SMART GRID **3-0-0-3**

Course Outcome:

- Understand conventional power grid system.
- Knowledge of smart grid and it definition.
- Know the power system market.
- Understand the smart grid communication system.
- Operation and understanding of demand side management.
- Know the wide area measurement and security issues.

1. Overview of Conventional Grid Power system: Basic components of power system, power generation scenarios, Conventional and restructured power system function of energy control centers, short comings of exciting power grids-emissions, blackouts, emergence of the concepts of smart grid. LECTURES-6

2. Renewable Generation : Renewable Resources: Wind and Solar, Micro-grid Architecture, Distributed Storage and Reserves, Dealing with short term variations, stochastic models based on price forecasting. LECTURES-6

3. Smart Grid: Definition, Various components, Application and standards, Impacts of Smart Grid on reliability, Impacts of Smart Grid on air pollutant emissions reduction. LECTURES-6

4. Smart Grid Communications: Two-way Digital Communications Paradigm, Network Architectures, IP-based Systems Power Line Communications, Advanced Metering Infrastructure. LECTURES-5

5. Demand Side Management: Definition, Applications, Load characteristics, load curve and load duration curve, Energy Consumption Scheduling, Controllable Load Models, Dynamics, and Challenges, Plug-in-hybrid Vehicles and smart appliances. LECTURES-5

6. Wide Area Measurement: Sensor Networks, Phasor Measurement Units, Communications Infrastructure, Fault Detection and Self-Healing Systems, Applications and Challenges. LECTURES-4

7. Security and Privacy: Cyber Security Challenges in Smart Grid, Load Altering Attacks, False Data Injection Attacks, Defense Mechanisms, Privacy Challenges.

LECTURES-4

Reference Books:

1. D.S. Kirshen, Fundamentals of Power System Economics, John Wiley & Sons.
2. A. J. Wood, B. F. Wollenberg, Power Generation Operation and Control, John Wiley & Sons.
3. G. M. Masters, Renewable and Efficient Electric Power Systems, John Wiley & Sons.
4. S. Stoft, Power System Economics: Designing Markets for Electricity, Wiley-Interscience.

11. EEL XX21:SWITCHGEAR AND PROTECTION 3-0-0-3

Course Outcome:

- Understand different types of circuit breaker, protective relays and fuses.
- Knowledge of substation layout and different equipments..
- Understand the function of neutral grounding and lightning arrester

1. Circuit Breakers (CBs): Function, arc phenomenon and arc interruption theories, CB types (min. oil, vacuum and SF_6), circuit breaking transients, restriking and recovery voltages, CB ratings, testing of CBs; introduction to solid state CBs

LECTURES:5

2. Protective Relays: Operating principles, classification, electromagnetic type relays theories for torque generation, protective zones, over current relay-characteristics, directional relay-torque generation, feeder protection- time grading and current grading, distance relays and

their characteristics, differential protections, protection of transmission lines, generator and transformers, transley relay, negative sequence relay.
Principal, operation, types and application

LECTURES:18

3. Substation Layouts For Protection: Single line diagram with different busbar arrangement, reactors, isolators, bus-tie breakers, substation grounding, surge protection. LECTURES:5

4. Neutral Grounding: Principals of neutral grounding, ungrounded system-arcing ground, types of grounding- solid, resistance, reactance and resonant grounding, generator neutral breaker, grounding practices.

LECTURES:5

5. Lightning Arrester: Function, types, working principles and surge absorbers.

LECTURES:2

Readings:

Prescribed Text Books

1. S. S Rao, Switchgear and Protection, Khanna Publisher, 1999
2. D.N Vishwakarma, Badri Ram, Power System Protection and Switchgear, Tata

McGraw - Hill Education 2011

Additional Readings

1. J B Gupta, Switchgear and Protection, S.K. Kataria & Sons, 2002
2. A. Wright and C. Christopoulos, Electrical Power system protection, Chapman & Hall, 1993.

ECL XX22	Digital Image Processing
As per the syllabus prescribed by Department of Electronics and Communication Engineering	

ECL XX23	Wireless Communication Systems
As per the syllabus prescribed by Department of Electronics and Communication Engineering	

14.EEL XX24 POWER SYSTEM OPERATION (DYNAMICS) AND CONTROL 3-0-0-3

Course Outcome:

- Aware of thepower system stability problems.
- Understand the small and large disturbance stabilities.
- Know the modelling if synchronous machines and power system components.
- Understand the different power system stability analysis.
- Measures taken to improve power system stability.

1. Introduction to Power System Operations: Introduction to power system stability. Power System Operations and Control.Stabilityproblems in Power System.Impact on Power System Operations and control. LECTURES-3

2. Analysis of Linear Dynamical System and Numerical Methods: Analysis of dynamical System, Concept of Equilibrium, Small and Large DisturbanceStability. Modal Analysis of Linear System.Analysisusing Numerical IntegrationTechniques. Issues in Modeling: Slow and Fast Transients, Stiff System. LECTURES-5

3.Modelling of Synchronous Machines and Associated Controllers: Modelling of synchronous machine: Physical Characteristics. Rotor position dependent model. D-Q Transformation. Model with Standard Parameters. Steady State Analysis of Synchronous Machine. Short Circuit Transient Analysis of a Synchronous Machine. Synchronization of

Synchronous Machine to an Infinite Bus. Modeling of Excitation and Prime Mover Systems. Physical Characteristics and Models. Excitation System Control. Automatic Voltage Regulator. Prime Mover Control Systems. Speed Governors. LECTURES-8

4. Modelling of other Power System Components: Modelling of Transmission Lines and Loads. Transmission Line Physical Characteristics. Transmission Line Modelling.
Load Models - induction machine model. Frequency and Voltage Dependence of Loads. Other Subsystems – HVDC and FACTS controllers, Wind Energy Systems.

LECTURES-8

5. Stability Analysis: Angular stability analysis in Single Machine Infinite Bus System. Angular Stability in multimachine systems – Intra-plant, Local and Inter-area modes. Frequency Stability: Centre of Inertia Motion. Load Sharing: Governordroop. Single Machine Load Bus System: Voltage Stability. Introduction to Torsional Oscillations and the SSR phenomenon. Stability Analysis Tools:Transient Stability Programs, Small Signal Analysis Programs.

LECTURES-8

6. Enhancing System Stability: Planning Measures. Stabilizing Controllers (Power System Stabilizers).Operational Measures-Preventive Control. Emergency Control. LECTURES-4

Text Books:

1. K.R. Padiyar, "Power System Dynamics, Stability and Control", B. S. Publications, 2002.

2. P. Kundur, "Power System Stability and Control", McGraw Hill, 1995.
3. P. Sauer and M. A. Pai, "Power System Dynamics and Stability", Prentice Hall, 1997.

15. EEL XX25:ADVANCED ELECTRIC DRIVES 3-0-0-3

Course out comes:

- Study different types Power Converters for DC and AC drives.
- Study different methods for Speed controlled of DC and AC drives.
- Study and analysis of special machine drives(PMSM,BLDC,SRM,Stepper motor)

1. Power Converters for DC and AC drives: PWM control of inverter, selected harmonic elimination, space vector modulation, current control of VSI, three level inverter, Different topologies, SVM for 3 level inverter, Diode rectifier with boost chopper, PWM converter as line side rectifier, current fed inverters with self-commutated devices. Control of CSI, H bridge as a 4-Q drive. LECTURES:10

2. Induction motor drives: Different transformations and reference frame theory, modelling of induction machines, voltage fed inverter control-v/f control, vector control, direct torque and flux control (DTC). LECTURES:8

3. Synchronous motor drives: Modelling of synchronous machines, open loop v/f control, vector control, direct torque control, CSI fed synchronous motor drives.

LECTURES:6

4. Permanent magnet motor drives: Introduction to various PM motors, BLDC and PMSM drive configuration, comparison, block diagrams, Speed and torque control in BLDC and PMSM.

LECTURES:6

5. Switched reluctance motor drives: Evolution of switched reluctance motors, various topologies for SRM drives, comparison, Closed loop speed and torque control of SRM.

LECTURES:3

6. DSP based motion control: Use of DSPs in motion control, various DSPs available, realization of some basic blocks in DSP for implementation of DSP based motion control.

LECTURES:3

Text Books:

1. B. K. Bose, "Modern Power Electronics and AC Drives", Pearson Education, Asia, 2003.
2. R. Krishnan, "Permanent Magnet Synchronous and Brushless DC motor Drives", CRC Press, 2009.

References Books:

1. P. C. Krause, O. Wasynczuk and S. D. Sudhoff, "Analysis of Electric Machinery and Drive Systems", John Wiley & Sons, 2013.

2. H. A. Taliyat and S. G. Campbell, "DSP based Electromechanical Motion Control", CRC press, 2003

OPEN ELECTIVES

EELXX41:RENEWABLE ENERGY **3-0-0-3**

Course Outcome:

- Understand the various forms of Non-conventional energy resource.
- Describe the use of solar energy and the various components used in the energy production with respect to applications like - heating, cooling, desalination, power generation, drying, cooking etc.
- Appreciate the need of Wind Energy and the various components used in energy generation and know the classifications.
- Understand the concept of Biomass energy resources and their classification, types of biogas Plants- applications.
- Compare Solar, Wind and bio energy systems, their prospects, Advantages and limitations.
- Acquire the knowledge of fuel cells, wave power, tidal power and geothermal principles and applications.

1. **Non-conventional Sources of Electrical Energy**- Solar, wind, geo-thermal, ocean, tidal, wave, magneto hydrodynamic (MHD) and biomass; their scope and potentialities for energy conversion. LECTURES:6

2. **Solar Energy**- Introduction, physical principles of conversion of solar radiation into heat, solar energy collectors, solar energy storage, solar-electrical power generation and other miscellaneous applications of solar energy. LECTURES:8

3. **Wind Energy** – Introduction, basic principle of wind energy conversion, wind data and energy estimation, site selection, basic component of wind energy conversion system, wind turbines and their analysis, wind-electrical generation; stand-alone and grid connected wind-electrical power system, various applications of wind energy.
LECTURES:10

4. Modelling and control of wind and solar energy systems. LECTURES:6

5. **Optimisation Technique**-Wind / solar photovoltaic integrated systems design, grid synchronized inverter system. LECTURES:8

Readings:

Prescribed Text Books

1. S. Rao and B.B. Parulekar, Energy Technology, Khanna Publishers, 2002.
2. G.D Rai, Non-conventional Energy Sources, Khanna Publishers, 2002.

3. S.P. Sukhatme, Solar Energy, Tata McGrawhill Publishing Co. Ltd., 2003

Additional Readings

1. Thomas Ackermann, Wind Power in Power System, John Willey &Sons, 2005.
2. Rai G.D., Non - Conventional Energy Sources, Khanna Publishers, 1993.
3. Rai G.D., Solar Energy Utilisation, Khanna Publishers, 1993.

EEL XX42 ELECTRICAL ENGINEERING MATERIALS **3-0-0-3**

Course Outcomes:

- Learn the basics of materials used in electrical engineering. Realize the dielectric properties of insulators in static and alternating fields.
- Explain the importance of magnetic properties and superconductivity.
- Explain the behavior of conductivity of metals and classifications of semiconductor materials.

1. **Conducting Materials**: Review of metallic conduction on the basis of free electron theory. Fermi-Dirac distribution – variation of conductivity with temperature and composition,

materials for electric resistors- general electric properties; material for brushes of electrical machines, lamp filaments, fuses and solder. LECTURES:6

2. **Semiconductors**: Mechanism of conduction in semiconductors, density of carriers in intrinsic semiconductors, the energy gap, types of semiconductors. Hall effect, compound semiconductors, basic ideas of amorphous and organic semiconductors. Magnetic materials: Classification of magnetic materials- origin of permanent magnetic dipoles, ferromagnetism, hard and soft magnetic materials, magneto materials used in electrical machines, instruments and relays. LECTURES:8

3. **Dielectrics:** Dielectric, polarization under static fields- electronic ionic and dipolar polarizations, behavior of dielectrics in alternating fields, Factors influencing dielectric strength and capacitor materials. Insulating materials, complex dielectric constant, dipolar relaxation and dielectric loss. LECTURES:6

4. **Insulating materials**: Inorganic materials (mica, glass, porcelain, asbestos), organic materials (paper, rubber, cotton silk fiber, wood, plastics and bakelite), resins and varnishes, liquid insulators(transformer oil) gaseous insulators (air, SF6 and nitrogen) and ageing of insulators. LECTURES:4

5. **Introduction Properties and Application of Piezoelectric materials:** Introduction Properties and Application of Piezoelectric materials, Eletrostrictive materials, Ferromagnetic materials, Magnetostrictive materials, Shape memory alloys, Electro archeological fluids, Magneto archeological fluids, Smart hydrogels.

LECTURES:6

6. **Ceramics:** properties, application to conductors, insulator & capacitors Plastics: Thermoplastics, rubber, thermostats, properties. LECTURES:6

Text book

1. Electrical Engineering Materials Adrianus J Dekker, Phi Learning Publishers.
2. Electrical Properties of Materials, 8th Edition by Solymar, L, Oxford University PressNew Delhi.
3. Introduction to Electrical EngineeringMaterials 4th Edn. 2004 Edition by Indulkar C, S.
4. Chand & Company Ltd-New Delhi. Electrical and Electronic Engineering Materials by SK Bhattacharya, Khanna Publishers, New Delhi.

EEL XX43: CONTROL SYSTEM DESIGN **3-0-0-3**

Course Outcomes

- Understand various design specifications.
- Design controllers to satisfy the desired design specifications using simple controller structures (P, PI, PID, compensators).

- Design controllers using the state-space approach.

1. Design Specifications: Introduction to design problem and philosophy. Introduction to time domain and frequency domain design specification and its physical relevance. Effect of gain on transient and steady state response. Effect of addition of pole on system performance. Effect of addition of zero on system response.

LECTURES:6

2. Design of Classical Control System in the time domain: Introduction to compensator. Design of Lag, lead lag-lead compensator in time domain. Feedback and Feed forward compensator design. Feedback compensation. Realization of compensators.

LECTURES:8

3.Design of Classical Control System in frequency domain: Compensator design in frequency domain to improve steady state and transient response. Feedback and Feed forward compensator design using bode diagram.

LECTURES:8

4. Design of PID controllers: Design of P, PI, PD and PID controllers in time domain and frequency domain for first, second and third order systems. Control loop with auxiliary feedback – Feed forward control.

LECTURES:6

5.Control System Design in state space: Review of state space representation. Concept of controllability & observability, effect of pole zero cancellation on the controllability & observability of the system, pole placement design through state feedback. Ackerman's Formula for feedback gain design. Design of Observer. Reduced order observer. Separation Principle.

LECTURES:8

6. Nonlinearities and its effect on system performance: Various types of non-linearities. Effect of various non-linearities on system performance. Singular points. Phase plot analysis.

LECTURES:3

Text and Reference Books :

1. N. Nise, "Control system Engineering", John Wiley, 2000.
2. I. J. Nagrath and M. Gopal, "Control system engineering", Wiley, 2000.
3. M. Gopal, "Digital Control Engineering", Wiley Eastern, 1988.
4. K. Ogata, "Modern Control Engineering", Prentice Hall, 2010.
5. B. C. Kuo, "Automatic Control system", Prentice Hall, 1995.

EEL XX44: SOFT COMPUTING **3-0-0-3**

Course Outcomes

- hard computing and soft computing
- various ANN and the supervised learning
- various activities of fuzzy inference system and apply Fuzzy logic to various problems
- GA, PSO and DE in various problems.
- the integration of ANN, FL and EA in various problems

Introduction to Soft Computing:
Introduction, importance, main components, Fuzzy Logic, ANN, Evolutionary Algorithms, Hybrid Intelligent Systems. LECTURES-4

Artificial Neural Network and Supervised Learning:
Introduction, Comparison of Neural Techniques and AI, Artificial Neuron Structure, Adaline, ANN Learning, Back Propagation Learning, Properties & Limitations. LECTURES-5

Development of Generalized Neuron and Its Validation:
Existing Neuron Model, Development, Advantages, Learning Algorithm of a Summation Type Generalized Neuron, Benchmark Testing of Generalized Neuron Model, Generalization of GN model, Discussion. LECTURES-5

Introduction to Fuzzy Set Theoretic Approach:
Introduction, Uncertainty and Information., Types of Uncertainty, Fuzzy Logic- Introduction, development, Precision and Significance, set, Operations, Union Intersection, Complement, Combination, Concentration, Dilation, Intensification, α-Cuts. Quantifier/Modifier/Hedges,

Characteristics, Normality, Convexity, Cross Over Point, Singletone, Height, Cardinality, Properties of Fuzzy Sets, Fuzzy Cartesian Product, shape & defining Membership Functions, Defuzzification, Rule Based System. LECTURES-8

Applications of Fuzzy Rule Based System:
Introduction, Modeling and Simulation, approach, selection, Steady State D.C. Machine Model, Control Applications Adaptive Control, PID Control System, Transient Model of D.C. Machine, Fuzzy Control System, Power System Stabilizer Using Fuzzy Logic. LECTURES-4

Evolutionary & Metaheuristic search and optimization Algorithms:
GA-Selection, cross over & mutation, simple GA algorithm, elitism.
PSO- Particle swarm, velocity, mutation, selection, algorithm.
DE- Selection, cross over & mutation, algorithm, elitism. LECTURES-6

Integration of Neural Networks, Evolution Algorithms and Fuzzy Systems:
Adaptive Neuro-Fuzzy Inference Systems, Neuro-Fuzzy Approach of Modeling.ANN – GA-Fuzzy Synergism and Its Applications Training of ANN, ANN Learning Using GA, Validation and Verification of ANN-GA Model LECTURES-4.

Readings:
Prescribed Text Books
S N Sivanandam, S.N. Deepa, Principles of Soft Computing, Wiley.
Goldenberg, soft computing, Allied publisher.

Prof. S. Chatterjee Dr. P. K. Biswas Mrs. K. De Mr. S. Majumder Mr. R. Kumar Mr. A. Bhattacharya Mr.S.Debnath Mrs.U.Das

Additional Readings

1. D K Chaturvedi, Soft Computing - Techniques and its Applications in Electrical Engineering, Springer