CURRICULUM AND SYLLABI FOR B.TECH DEGREE PROGRAMME IN ELECTRICAL AND ELECTRONICS ENGINEERING

DEPARTMENT OF ELECTRICAL ENGINEERING

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NATIONAL INSTITUTE OF TECHNOLOGY CALICUT

Programme Educational Objectives of B. Tech. in Electrical and Electronics Engineering

PEO1	To prepare under graduate students to excel in technical profession/ industry and/or higher education by providing a strong foundation in mathematics, science and engineering.
PEO2	To transform engineering students to expert engineers so that they could comprehend, analyze, design and create novel products and solutions to Electrical and Electronics Engineering problems that are technically sound, economically feasible and socially acceptable.
PEO3	To train students to exhibit professionalism, keep up ethics in their profession and relate engineering issues to address the technical and social challenges.
PEO4	To develop communication skills and team work and to nurture multidisciplinary approach in problem solving.

Programme Outcomes of B. Tech. in Electrical and Electronics Engineering

PO1	Ability to apply the knowledge of mathematics, science and engineering principles for modeling, analyzing and solving electrical and electronics engineering problems.
PO2	Ability to identify, formulate and analyze real-life electrical and electronics engineering problems.
PO3	Ability to design and develop solutions for real-life electrical and electronics engineering problems.
PO4	Ability to design and develop sophisticated equipment and experimental systems for carrying out detailed investigation to multifaceted electrical and electronics engineering problems.
PO5	Ability to develop and utilize modern tools for modeling, analyzing and solving electrical and electronics engineering problems.
PO6	Dedication to work as an electrical or electronics engineer who is capable of identifying solutions to various local and global problems faced by the society.
PO7	Ability to design and develop modern systems for the upkeep of pollution free environment.
PO8	Willingness and ability to upkeep professional ethics and social values.
PO9	Willingness and ability to think independently, take initiative, lead a team of engineers or researchers and inculcate team spirit.
PO10	Ability to express ideas clearly and communicate orally as well as in writing with others.
PO11	Willingness and ability to maintain lifelong learning process by way of participating in various professional activities.
PO12	Willingness and ability to take up administrative responsibilities involving both project and financial management confidently.

CY1001: Chemistry

L	T	P	C
3	0	0	3

Pre-requisites: Nil

Course outcomes:

CO1: To acquire knowledge on the role of chemistry in solving the problems related to electrical and electronics engineering.
CO2: To acquire knowledge about the fundamental principles of bonding in materials.
CO3: To acquire knowledge on the characterization of materials by modern tools.
CO4: To acquire knowledge on the chemistry of bio-molecules.
CO5: To acquire knowledge on the fundamental mechanisms of reactions
CO6: To apply the acquired knowledge in chemistry to solve problems for the benefit of the society.

Module 1: Chemical Bonding (8 hours)

Quantum mechanical methods in chemical bonding: molecular orbital theory, symmetry of molecular orbitals, MOs for homonuclear diatomic molecules, application of MO theory to heteronucleardiatomics, valence bond theory, hybridization, hybridization involving d orbitals, conjugated molecules, Huckel molecular orbital theory of conjugated systems, metallic bonding, band theory .

Module2: Spectroscopy (14 hours)

General features of spectroscopy, interaction of radiation with matter, theory and application of rotational, vibrational, Raman, electronic, mass, NMR, fluorescence and photoelectron spectroscopy.

Module 3: Transition Metal Chemistry (12 hours)

Bonding in transition metal complexes: coordination compounds, crystal field theory, octahedral, tetrahedral and square planar complexes, crystal field stabilization energies, Jahn-Teller theorem, spectral and magnetic properties.

Bio-Inorganic chemistry: Trace elements in biology, heme and non-heme oxygen carriers, haemoglobin and myoglobin-cooperativity; Bohr effect, Hill coefficient, oxy and deoxy haemoglobin, reversible binding of oxygen.

Module 4: Aromaticity (8 hours)

Electron delocalization, resonance and aromaticity; molecular orbital description of aromaticity and anti-aromaticity, annulenes; ring current, NMR as a tool, diamagnetic anisotropy; aromatic electrophilic substitutions, aromatic nucleophilic substitutions, benzyne; reaction mechanisms, reactivity and orientation.

Text Books:

1. J. E. Huheey, E.A. Keiter and R.L. Keiter, *Inorganic Chemistry, Principles of Structure and Reactivity*, Harper Collins, New York 1997.

2. F. A. Cotton and G Wilkinson,*Advanced Inorganic Chemistry*, 5th Edition, Wiley Interscience, New York, 1988.

3. J. D. Lee, *Concise Inorganic Chemistry,* Chapman & Hall, London, 1996.

4. W. L. Jolly, *Modern Inorganic Chemistry*, McGraw-Hill International, 2nd Edition, New York, 1991.

5. R. T. Morrison and R N Boyd, *Organic Chemistry*, 6th Edition, Prentice Hall, New Delhi, 1999.

6. P. Bruice, *Organic Chemistry*, 3rd Edition,Prentice Hall, New Delhi ,2001.

7. F. Carey, *Organic Chemistry*, 5th Edition,McGraw Hill Publishers, Boston, 2003.

8. J. Mc Murray, *Organic Chemistry*, 5th Edition, Brooks/ Cole Publishing Co, Monterey, 2000.

9. C.N. Banwell and E. M. McCash, *Fundamentals of Molecular Spectroscopy*,McGrawHill, International, UK, 1995.

10. William Kemp, *Organic Spectroscopy,* 3rd edition, Palgrave, New York, 2005.
11. R.M. Silverstein, F.X. Webster and D.J. Kiemle,*Spectrometric Identification of Organic* C*ompounds***,** 7th edition**,**John-Wiley and Sons, New York, 2005.

12. D. L. Pavia, GM. Lampman, GS. Kriz and J.R Vyvyan, I, *Spectroscopy*, Cengage Learning India Pvt. Ltd, New Delhi, 2007.

13. B. R.Puri, L. R. Sharma and M. S. Pathania, *Principles of Physical Chemistry*, Vishal Publishing CO. Delhi, 2008.

14. P.W. Atkins, *Physical Chemistry,* 6th Edition, Oxford University Press, Oxford, 1998.

CY1094: Chemistry Laboratory

L	T	P	C
0	0	2	1

Pre-requisites: Nil

Course outcomes:

CO1: To acquire practical knowledge on the basic chemistry principles to apply in electrical and electronics engineering

CO2: To acquire practical knowledge on the techniques for the preparation and characterization of materials

CO3: To acquire knowledge on electrochemical techniques

CO4: To acquire training in accurate and precise data collection

Total Hours: 28

Potentiometric and conductometric titrations, complexometric and iodimetric estimations, polarimetry, determination of pH, single step organic / inorganic preparations, colorimetry, determination of eutectic point.

References:

1. G.H Jeffery, J Bassett, J Mendham, R.C Denny, *Vogel's Text Book of Quantitative Chemical Analysis*, Longmann Scientific and Technical, John Wiley, New York.
2. J.B Yadav,*Advanced Practical Physical Chemistry*, Goel Publishing House, 2001.
3. A.I Vogel, A.R Tatchell, B.S Furnis, A.J Hannaford, P.W.G Smith, *Vogel's Text Book of Practical Organic Chemistry*,Longman and Scientific Technical, New York, 1989.

EE1001 INTRODUCTION TO ELECTRICAL ENGINEERING

Pre-requisites: None

L	**T**	**P**	**C**
2	**0**	**0**	**2**

Course outcomes:

CO1: Become familiar with the curricular structure of Electrical Engineering

CO2: Be exposed to the breadth of electrical engineering

CO3: Awareness of general structure of power systems

CO4: Acquireknowledgeabout battery technology

CO5: Acquireknowledgeabout the single phase and three base electrical circuits

Module 1 : Introduction to Electrical Engineering (7 hrs)

Introduction to Engineering Profession, History of EE and milestones, Professional ethics, Professional organisations in the field of EE, about standards and certification of EE equipment and concerned organisations in the country, codes of practice in EE.

Structure and components of an Electrical Energy System – Generation, Transmission, Distribution and Utilisation overview – DC power versus AC power – DC transmission versus AC transmission – common voltage levels – major components of residential , commercial and industrial loads – guaranteed voltage and frequency values – Tariff structures – study of tariff structure of local Electrical utility (KSEB)

Brief introduction to various renewable energy sources

Module 2 : Batteries and Battery Charging (5 hrs)

Principle of operation of Lead-acid Batteries, AH rating, available capacity at different discharge rates, types of lead-acid batteries, different factors that affect battery life, abnormal conditions during charging and discharging, high discharge versus deep discharge, desirable charging profile, energy efficiency, float voltage, trickle charge current, need to avoid overcharging, constant current – constant voltage charging algorithm.

Different ways to charge a Lead-acid battery : (i) Capacitor + diode system (ii) full-wave or full-bridge rectifier with ac side choke (iii) full-wave or full-bridge rectifier with dc side resistor – qualitative description of more precise battery charging systems.

Areas of application of Lead-acid batteries and application requirements – in UPS, DG Sets cranking, Automobiles, Emergency lamps, Solar Power Systems etc.

Ni-Cd batteries and their charging, Lithium batteries and charging.

Module 3 : Analysis of Circuits with Dependent Sources (8 hrs)

Linear Dependent sources : VCVS, VCCS, CCVS and CCCS - node analysis and mesh analysis of circuits containing resistors, independent sources and linear dependent sources - effect of dependent sources on the symmetry of nodal admittance matrix and mesh impedance matrix - determination of Thevenin's and Norton's equivalent for circuits containing dependent sources

Dependent source equivalent circuits for coupled coils – a.c steady-state analyis of circuits containing coupled coils – the perfectly coupled two-winding transformer and the ideal two-winding transformer

Module 4 :**Study of three-phase balanced and unbalanced circuits (8 hrs)**

Thevenin's Theorem, Norton's Theorem and Maximum Power Transfer Theorem for ac circuits - Polyphase working - 3 phase ac systems - balanced system - phase sequence - Star Delta Transformation Theorem - Balanced 3 phase ac source supplying balanced 3 phase star connected and delta connected loads - Three phase loads with mutual coupling between phases - 3 wire and 4 wire systems - neutral shift - neutral current - active power, reactive power, complex power, apparent power and power factor in balanced and unbalanced three phase systems -Measurement of Power in Balanced and Unbalanced Systems.

Text books:

1. 'Rechargeable Batteries Applications Handbook', Technical Marketing Staff of Gates Energy Products, BPB Publications, 1994
2. 'Electric Circuits & Networks' , Suresh Kumar K.S, Pearson Education, 2009
3. 'Engineering Circuit Analysis', Hayt & Kemmerly, 6th Edition, TMH, 2003

Reference:

1. National Electrical Code, ISI, 1985

MA1001 - MATHEMATICS – I

L	T	P	C
3	1	0	3

Course outcomes:

CO1: Learn to find the solution of constant coefficient differential equations.
CO2: Acquire knowledge about the notion of convergence of numerical sequences and series and learn ways of testing convergence.
CO3: Learn the basic definition and properties of partial differentiation of functions of several variables and to learn to use this to solve problems related to maxima and minima.
CO4: Learn the basic results about the properties of Fourier transform and Fourier series and its convergence.
CO5: Learn the properties of Laplace transforms and to learn to use this to solve differential equations.

Module I: Preliminary Calculus & Infinite Series (9L + 3T)

Preliminary Calculus : Partial differentiation, Total differential and total derivative, Exact differentials, Chain rule, Change of variables, Minima and Maxima of functions of two or more variables.

Infinite Series : Notion of convergence and divergence of infinite series, Ratio test, Comparison test, Raabe's test, Root test, Series of positive and negative terms, Idea of absolute convergence, Taylor's and Maclaurin's series.

Module II: Differential Equations (13L + 4T)

First order ordinary differential equations: Methods of solution, Existence and uniqueness of solution, Orthogonal Trajectories, Applications of first order differential equations.

Linear second order equations: Homogeneous linear equations with constant coefficients, fundamental system of solutions, Existence and uniqueness conditions, Wronskian, Non homogeneous equations, Methods of Solutions, Applications.

Module III: Fourier Analysis (10 L+ 3T)

Periodic functions: Fourier series, Functions of arbitrary period, Even and odd functions, Half Range Expansions, Harmonic analysis, Complex Fourier Series, Fourier Integrals, Fourier Cosine and Sine Transforms, Fourier Transforms.

Module IV: Laplace Transforms (11L + 3T)

Gamma functions and Beta functions, Definition and Properties. Laplace Transforms, Inverse Laplace Transforms, shifting Theorem, Transforms of derivatives and integrals, Solution of differential Equations, Differentiation and Integration of Transforms, Convolution, Unit step function, Second shifting Theorem, Laplace Transform of Periodic functions.

Text Book:

1. Kreyszig E, 'Advanced Engineering Mathematics' 8th Edition, John Wiley &Sons New York, (1999)

Reference :

1. Piskunov, 'Differential and Integral Calculus, MIR Publishers, Moscow (1974).

2. Wylie C. R. & Barret L. C 'Advanced Engineering Mathematics' 6th Edition, Mc Graw Hill, New York, (1995).

3. Thomas G. B. 'Calculus and Analytic Geometry' Addison Wesley, London (1998).

MA1002 - MATHEMATICS II

L	T	P	C
3	1	0	3

Course outcomes:

CO1: Acquire knowledge about the ideas and techniques of linear algebra, and to illustrate some of their applications in engineering.
CO2: Acquire knowledge about the physical interpretation of the gradient, divergence and curl.
CO3: Acquire knowledge of vector calculus and to apply in electromagnetic field.
CO4: Prepare to evaluate multiple integrals in rectangular, polar, spherical and cylindrical coordinates.
CO5: Acquire knowledge about how to use double ,triple and line integrals in applications, including Green's theorem, Stoke's theorem and Divergence theorem.

Module I **(11 L + 3T)**

Linear Algebra I: Systems of Linear Equations, Gauss' elimination, Rank of a matrix, Linear independence, Solutions of linear systems: existence, uniqueness, general form. Vector spaces, Subspaces, Basis and Dimension, Inner product spaces, Gram-Schmidt orthogonalization, Linear Transformations.

Module II **(11 L+ 3T)**

Linear Algebra II: Eigen values and Eigen vectors of a matrix, Some applications of Eigen value problems, Cayley-Hamilton Theorem, Quadratic forms, Complex matrices, Similarity of matrices, Basis of Eigen vectors – Diagonalization.

Module III **(10L+3T)**

Vector Calculus I: Vector and Scalar functions and fields, Derivatives, Curves, Tangents, Arc length, Curvature, Gradient of a Scalar Field, Directional derivative, Divergence of a vector field, Curl of a Vector field.

Module IV **(11 L+4T)**

Vector Calculus II: Line Integrals, Line Integrals independent of path, Double integrals, Surface integrals, Triple Integrals, Verification and simple applications of Green's Theorem, Gauss' Divergence Theorem and Stoke's Theorem.

Text Book:

1. Kreyzig E, Advanced Engineering Mathematics, 8th Edn, John Wiley & Sons, New York (1999).

Reference:

1. Wylie C. R & Barrret L. C, Advanced Engineering Mathematics, 6th Edn, Mc Graw Hill, New York (1995).

2. Hoffman K & Kunze R, Linear Algebra, Prentice Hall of India, New Delhi (1971).

MA2001: MATHEMATICS III

Pre-requisite: MA 1001 Mathematics I

L	T	P	C
3	1	0	3

Course Outcomes

CO1: Acquire knowledge about important probability distributions and their properties.
CO2: Acquire knowledge about statistical parameter estimation.
CO3: Acquire knowledge about statistical hypotheses tests.
CO4: Acquire knowledge about regression and correlation analysis.
CO5: Acquire knowledge about ANOVA principles and methods.

Total Hours: 56 Hrs

Module 1: Probability distributions (15 Hours)

Random variables, Binomial distribution, Hyper- geometric distribution, Mean and variance of a probability distribution, Chebyshev's theorem, Poisson distribution, Geometric distribution, Normal Distribution, Uniform distribution, Gamma distribution, Beta distribution, Weibull distribution. Joint distribution of two random variables.

Module 2: Sampling distributions and Inference concerning means (14 Hours)
Population and samples, The sampling distribution of the mean (σ known and σ unknown), Sampling distribution of the variance, Maximum Likelihood Estimation, Point estimation and interval estimation, point estimation and interval estimation of mean and variance, Tests of hypothesis, Hypothesis concerning one mean, Inference concerning two means.

Module 3: **Inference concerning variances proportions (13Hours)**
Estimation of variances , Hypothesis concerning one variance, Hypothesis concerning two variances , Estimation of proportions , Hypothesis concerning one proportion , Hypothesis concerning several proportions, Analysis of r x c tables, Chi – square test for goodness of fit.

Module 4: Regression Analysis (14 Hours)
Bi-variate Normal distribution- joint, marginal and conditional distributions. Curve fitting, Method of least squares, Estimation of simple regression models and hypothesis concerning regression coefficients, Correlation coefficient- estimation of correlation coefficient, hypothesis concerning correlation coefficient. Estimation of curvilinear regression models,
Analysis of variance:- General principles, Completely randomized designs, Randomized block diagram, Latin square designs, Analysis of covariance.

References:

1. Johnson, R. A., Miller and Freund's Probability and Statistics for Engineers, 6thedition., PHI, 2004.
2. Levin R. I. & Rubin D. S., Statistics for Management, 7th edition, PHI, New Delhi, 2000.
3. S.M. Ross, Introduction to Probability and statistics for Engineers, 3rd edition, Academic Press(Elsevier), Delhi, 2005.

MA2002: MATHEMATICS IV

Pre-requisite: MA 1001 Mathematics I, MA 1002 Mathematics II

L	T	P	C
3	1	0	3

Course Outcomes
CO1: Acquire the knowledge to solve differential equations using power series and Frobenius method.
CO2: Acquire knowledge about the ability to solve problems using partial differential equations.
CO3: To know the properties of analytic and harmonic functions.
CO4: Understanding Cauchy's integral theorem and its consequences.
CO5: Acquire the knowledge to compute residues and integrals using the residue theorem.
Total Hours: 56 Hrs

Module 1: Series Solutions and Special Functions (15 Hours)

Power series solutions of differential equations, Theory of power series method, Legendre Equation, Legendre Polynomials, Frobenius Method, Bessel's Equation, Bessel functions, Bessel functions of the second kind, Sturm- Liouville's Problems, Orthogonal eigenfunction expansions.

Module 2: Partial differential Equations (16 Hours)

Basic Concepts, Cauchy's problem for first order equations, Linear Equations of the first order, Nonlinear Partial Differential Equations of the first order, Charpit's Method, Special Types of first order equations, Classification of second order partial differential equations, Modeling: Vibrating String, Wave equation, Separation of variables, Use of Fourier Series, D'Alembert's Solution of the wave equation, Heat equation: Solution by Fourier series, Heat equation: solution by Fourier Integrals and transforms, Laplace equation, Solution of a Partial Differential Equations by Laplace transforms.

Module 3: Complex Numbers and Functions (13 Hours)

Complex functions, Derivative , Analytic function, Cauchy- Reimann equations, Laplace's equation, Geometry of Analytic functions: Conformal mapping, Linear fractional Transformations, Schwarz - Christoffel transformation, Transformation by other functions.

Module 4: Complex Integration (12 Hours)

Line integral in the Complex plane, Cauchy's Integral Theorem, Cauchy's Integral formula, Derivatives of analytic functions.Power series, Functions given by power series, Taylor series and Maclaurin's series. Laurent's series, Singularities and Zeros, Residue integration method, Evaluation of real Integrals.

References:

1. Kreyszig E, Advanced Engineering Mathematics, 8th Edition, John Wiley & Sons, New York, 1999 .

2. I.N. Sneddon, Elements of Partial Differential Equations, Dover Publications, 2006.

3 . Wylie C. R. & Barret L. C., Advanced Engineering Mathematics, 6th Edition, Mc Graw Hill, New York,1995.

4. Donald W. Trim, Applied Partial Differential Equations, PWS – KENT publishing company, 1994.

MS1001 PROFESSIONAL COMMUNICATION

L	T	P	C
3	**0**	**0**	**3**

Course outcomes

CO1: Effectively communicate technical material in print.
CO2: Present technical material orally with confidence and poise, including audiovisual materials.
CO3: Communicate effectively in ways appropriate to the discipline, audience and purpose.
CO4: Think critically and creatively to generate innovative and optimum solutions.
CO5: Identify, evaluate and synthesise information from a range of sources to optimise process engineering design and development.
CO6: Engage in continuous education, training and research, and take control of their own learning and development.
CO7: Work effectively and efficiently individually and in teams.
CO8: Be 'career ready' for the process engineering profession, demonstrate leadership qualities, and work ethically and professionally.

Module 1 (11 hours)

Verbal Communication: received pronunciation; how to activate passive vocabulary; technical/non-technical and business presentations; questioning and answer skills; soft skills for professionals; role of body postures, movements, gestures, facial expressions, dress in effective communication; Information/ Desk/ Front Office/ Telephone conversation; how to face an interview/press conference; Group discussions, debates, elocution.

Module 2 (9 hours)

Reading Comprehension: skimming and scanning; factual and inferential comprehension; prediction; guessing meaning of words from context; word reference; use and interpretation of visuals and graphics in technical writing.

Module 3 (11 hours)

Written Communication: note making and note taking; summarizing; invitation, advertisement, agenda, notice and memos; official and commercial letters; job application; resume and curriculum vitae; utility, technical, project and enquiry reports; paragraph writing: General – Specific, Problem – Solution, Process – Description, Data – Comment.

Module 4 (11 hours)

Short essays: description and argument; comparison and contrast; illustration; using graphics in writing: tables and charts, diagrams and flow charts, maps and plans, graphs; how to write research paper; skills of editing and revising; skills of referencing; what is a bibliography and how to prepare it.

Text Books

1. Adrian Doff and Christopher Jones: Language in Use – Upper intermediate, selfstudy workbook and classroom book. (Cambridge University Press)[2000]
2. Sarah Freeman: Written Communication (Orient Longman)[1978]
3. Mark Ibbotson: Cambridge English for Engineering (Cambridge University Press) November 2008
4. T Balasubramanian: English Phonetics for Indian Students: A Workbook (Macmillan publishers India) 2000

Reference

1 Chris Mounsey: Essays and Dissertation (Oxford University Press) February 2005.

2 Sidney Greenbaum: The Oxford English Grammar (Oxford University Press) March 2005

3 Krishna Mohan and Meera Banerji: Developing Communication Skills (Mac Millan india Ltd)[2000]

4 Krishna Mohan and Meenakshi Raman: Effective English Communication (Tata McGraw Hill)[2000]

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MS4003 ECONOMICS

Pre-requisite: Nil

L	T	P	C
3	0	0	3

Total Hours: 42 Hrs

Course outcomes

CO1: To evaluate the economics of the management, operation, and growth and profitability of engineering firms and analyze operations of markets under varying competitive conditions.
CO2: The course equips a student to carry out and evaluate benefit/cost, life cycle and breakeven analyses on one or more economic alternatives.
CO3: To analyze cost/revenue data and carry out make economic analyses in the decision making process to justify or reject alternatives/projects on an economic basis.
CO4: Produce a constructive assessment of a social problem by drawing the importance of environmental responsibility and demonstrate knowledge of global factors influencing business and ethical issues.
CO5: Helps to use models to describe economic phenomena; analyze and make predictions about the impact of government intervention and changing market conditions on consumer and producer behavior and well-being.

Module 1 (11 hours)

General Foundations of Economics; Nature of the firm; Forms of organizations-Objectives of firms-Demand analysis and estimation-Individual, Market and Firm demand, Determinants of demand, Elasticity measures and business decision making, Theory of the firm-Production functions in the short and long run

Module 2 (9 hours)

Cost concepts- Short run and long run costs- economies and diseconomies of scale, real and pecuniary economies; Product Markets; Market Structure- Competitive market; Imperfect competition (Monopoly, Monopolistic & Oligopoly) and barriers to entry and exit -Pricing in different

Module 3 (11 hours)

Macro Economic Aggregates-Gross Domestic Product; Economic Indicators; Models of measuring national income; Inflation ; Fiscal and Monetary Policies ; Monetary system; Money Market, Capital market; Indian stock market; Development Banks; Changing role of Reserve Bank of India

Module 4 (11 hours)

International trade - Foreign exchange market- Balance of Payments (BOP) and Trade-Effects of disequilibrium in BOP in business- Trade regulation- Tariff versus quotas- International Trade and development and role of international institutions (World Bank, IMF and WTO) in economic development.

References

1. Bo Soderston,International Economics,
2. Gupta, S.B Monetary Economics,. (1994). S. Chand & Co., New Delhi.
3. Gregory.N.Mankiw,Principles of Micro Economics, Cengage Publications,2007
4. Gregory.N.Mankiw ,Principles of Macro Economics, Cengage Publications,2007
5. *Indian Economy – Its Development Experience*, Misra, S.K. and V.K. Puri (2001)Himalaya Publishing House, Mumbai,2009.
6. *Microeconomics*, R.S. Pindyck, D.L Rubinfield and P.L. Mehta ,Pearson Education, 2005. *Advanced Economic Theory*, Micro Economics H.L. Ahuja,Chand Publications,2004.
7. Economics, Samuelson, P.A.;& W.D. Nordhaus ,Tata McGraw Hill,18 Ed.,2005.
8. Public Finance , B.P.Tyagi,Jai PrakashNath & Co.,1997.

PH1001 PHYSICS

L	T	P	C
3	0	0	3

Course Outcomes:

CO1: Acquire knowledge and understanding of fundamental principles of modern physics relevant to problems of Electrical and Electronics Engineering.

CO2: Acquire knowledge of basic principles of Quantum Physics and Relativity.

CO3: Acquire knowledge of the basic physics of a collection of particles and the emergent macroscopic properties.

CO4: Apply principles of quantum and statistical physics to understand properties of semiconducting and magnetic materials

CO5: Acquire knowledge of new emerging areas of Science and Technology like nanomaterials.

Module 1 – Theory of Relativity (6 hours)

Frames of reference, Galilean Relativity, Michelson-Morley experiment, postulates of Special Theory of Relativity, Lorentz transformations, simultaneity, length contraction, time dilation, velocity addition, Doppler effect for light, relativistic mass and dynamics, mass energy relations, massless particles, Description of General Theory of Relativity.

Module 2 - Quantum Mechanics   (10 hours)

Dual nature of matter, properties of matter waves, wave packets, uncertainty principle, formulation of Schrödinger equation, physical meaning of wave function, expectation values, time-independent Schrödinger equation, quantization of energy – bound states, application of time-independent Schrödinger equation to free particle, infinite well, finite well, barrier potential, tunneling, Simple Harmonic Oscillator, two-dimensional square box, the scanning tunneling microscope.

Module 3 – Statistical Physics   (12 hours)

Temperature, microstates of a system, equal probability hypothesis, Boltzman factor and distribution, ideal gas, equipartition of energy, Maxwell speed distribution, average speed, RMS speed, applications – Lasers and Masers, Quantum distributions – many particle systems, wave functions, indistinguishable particles, Bosons and Fermions, Bose-Einstein and Fermi-Dirac distribution, Bose-Einstein condensation, Specific heat of a solid, free electron gas and other applications.

Module 4 – Applications to Solids   (14 hours)

Band theory of solids, conductors, semi-conductors and insulators, metals – Drude model and conductivity, electron wave functions in crystal lattices, E-k diagrams, band gaps, effective mass, semiconductors, Fermi energy, doping of semiconductor, conductivity and mobility of electrons, Hall effect, Fundamentals of mesoscopic physics and nano technology: size effects, interference effect, quantum confinement and Coulomb blockade. Quantum wells, wires, dots, nanotubes, semiconductor nano materials, Magnetism: dipole moments, paramagnetism, Curie's law, magnetization and hysterisis, Ferromagnetism and Anti-Ferromagnetism.

Text Books

1 Modern Physics for Scientists and Engineers, J. R. Taylor, C.D. Zafiratos and M. A. Dubson, 2nd Ed., Pearson (2007)
2 Concepts of Modern Physics Arthur Beiser, 6th Ed., Tata Mc Graw –Hill Publication (2009)

References

1 Quantum Physics of atoms, Molecules, Solids, Nuclei and Particle, Robert Eisberg and Robert Resnick, 2nd Ed., John Wiley(2006)
2 Solid state Devices, B. G. Streetman, 5th Ed., Pearson (2006)

PH1091 PHYSICS LAB

L	T	P	C
0	0	2	1

Course Outcomes:

CO1: To develop experimentation skills and understand importance of measurement practices in Science & Technology.

CO2: Develop analytical skills for interpreting data and drawing inferences.

CO3: Understand nature of experimental errors and practical means to estimate errors in acquired data.

CO4: Develop skills for team work and technical communication and discussions.

CO5: Apply theoretical principles of modern physics to analysis and measurements performed in the laboratory.

LIST OF EXPERIMENTS

1. Magnetic Hysteresis loss - Using CRO
2. Band gap using four probe method
3. Hall effect- determination of carrier density, Hall coefficient and mobility
4. Solar cell characteristics
5. Double refraction – measurement of principle refractive indices.
6. Measurement of N.A & Attenuation
7. Measurement of e/m of electron – Thomson's experiment
8. Determination of Planck's constant
9. Measurement of electron charge – Milliken oil drop experiment
10. Determination of Magnetic Field along the axis of the coil
11. Newton's rings
12. Laurent's Half shade polarimeter –determination of specific rotatory power
13. Study of P-N junction
14. Study of voltage-current characteristics of a Zener diode.
15. Laser – measurement of angle of divergence & determination of λ using grating
16. Measurement of Magnetic susceptibility- Quincke's Method / Gouy's balance.
17. Mapping of magnetic field

Reference:

1. *Experiments in Engineering physics,* Avadhanulu, Dani and Pokley, S. Chand & Company ltd (2002).

2. *Experiments in Modern Physics*, A.C. Melissinos, J. Napolitano, Academic Press (2003)

3. *Practical physics*, S.L. Gupta and V. Kumar, Pragathi Prakash (2005)

ZZ1001 ENGINEERING MECHANICS

L	T	P	C
3	0	0	3

Course Outcomes

CO1: The student will be able to analyse statically determinate structures including trusses using equations of equilibrium.

CO2: The student will be able to find space-time relationship (kinematics) of particle.

CO3: The student will be able to solve dynamic problems of particle using Newton's law, energy method and impulse-momentum approach.

CO4: The student will be able to solve elementary problems in vibration.

Part A--Statics

Module 1 (12 hours)

Fundamentals of mechanics: idealisations of mechanics, vector and scalar quantities, equality and equivalence of vectors, laws of mechanics.

Important vector quantities: Position vector, moment of a force about a point, moment of a force about an axis, the couple and couple moment, couple moment as a free vector, moment of a couple about a line.

Equivalent force systems: Translation of a force to a parallel position, resultant of a force system, simplest resultant of special force systems, distributed force systems.

Equations of equilibrium: Free body diagram, free bodies involving interior sections, general equations of equilibrium, problems of equilibrium, static indeterminacy.

Module 2 (10 hours)

Applications of Equations Equilibrium: Trusses: solution of simple trusses, method of joints, method of sections; Friction forces: laws of Coulomb friction, simple contact friction problems.

Properties of surfaces: First moment, centroid, second moments and the product of a plane area, transfer theorems, rotation of axes, polar moment of area, principal axes, concept of second order tensor transformation.

Part B—Dynamics

Module 3 (10 hours)

Kinematics of a particle: Introduction, general notions, differentiation of a vector with respect to time, velocity and acceleration calculations, rectangular components, velocity and acceleration in terms of cylindrical coordinates, simple kinematical relations and applications.

Particle dynamics: Introduction, rectangular coordinates, rectilinear translation, Newton's law for rectangular coordinates, rectilinear translation, cylindrical coordinates, Newton's law for cylindrical coordinates.

Module 4 (10 hours)

Energy and momentum methods for a particle: Analysis for a single particle, conservative force field, conservation of mechanical energy, alternative form of work-energy equation, Linear momentum, impulse and momentum relations, moment of momentum.

Vibrations: Single degree of freedom systems, free vibration, undamped and damped, forced vibration, sinusoidal loading, introduction to multi degree of freedom systems, illustration using two degree-of-freedom systems.

Text Book

1 H. Shames, Engineering Mechanics—Statics and Dynamics, 4th Edition, Prentice Hall of India, 1996.

Reference Books

1. F.P. Beer and E.R. Johnston, *Vector Mechanics for Engineers – Statics*, McGraw Hill Book Company, 2000.
2. J.L. Meriam and L.G. Kraige, *Engineering Mechanics – Statics*, John Wiley & Sons, 2002.

ZZ1002 ENGINEERING GRAPHICS

L	T	D	C
2	0	3	3

Course Outcomes

CO1: Students' ability in legible writing letters and numbers will be improved.

CO2: Students' ability to perform basic sketching techniques and instrumental drawing will be improved.

CO3: Students will be able to draw orthographic projections of different objects irrespective of number of dimensions and to develop pictorial views.

CO4: Students' ability to present the scale drawings of the visualized objects will be increased.

CO5: Students' ability to produce engineered drawing of any newly designed object will be improved.

CO6: Students will become familiar with practice and standards in technical drawing.

CO7: Students will develop good communication skills and team work.

Module 1 **(4Lecture+6drawing hours)**

Introduction to Engineering Graphics – Drawing instruments and their use – Different types of lines - Lettering & dimensioning – Familiarization with current Indian Standard Code of Practice for Engineering Drawing.
Scales, Plain scales, Diagonal scales, Vernier scales.
Introduction to orthographic projections- Horizontal, vertical and profile planes – First angle and third angle projections – Projection of points in different coordinates – Projections of lines inclined to one of the reference planes

Module II

Projections of lines inclined to both the planes – True lengths of the lines and their angles of inclination with the reference planes – Traces of lines. **(4Lecture+6 drawing hours)**

Projection of plane lamina of geometric shapes inclined to one of the reference planes – inclined to both the planes, Traces of planes **(2Lecture+3 drawing hours)**

Projections on auxiliary planes **(2lecture +3 drawing hours)**

Module III

Projections of polyhedra and solids of revolution, projection of solids with axis parallel to one of the planes and parallel or perpendicular to the other plane – Projections with the axis inclined to one of the planes. Projections of solids with axis inclined to both the planes – Projections of spheres and combination of solids. **(4Lecture+6 drawing hours)**

Module IV

Sections of solids by planes perpendicular to at least one of the reference planes – True shapes of sections. **(2 lectures, 3 drawing hours)**

Developments, development of the lateral surface of regular solids like, prisms, pyramids, cylinders, cones and spheres, development of truncated solids **(2 lectures +3 drawing hours)**

Isometric projection – Isometric scale – Isometric views – Isometric projection of prisms, pyramids, cylinders, cones, spheres and solids made by combination of the above. **(2 lectures +6 drawing hours)**

Text book

1. Bhatt N. D**,** Elementary Engineering Drawing, Charotar Publishing House, Anand, 2002

References

1. Narayana K L & Kannaiah P, Engineering Graphics, Tata McGraw Hill, New Delhi, 1992

2. Luzadder W J, Fundamentals of Engineering Drawing, Prentice Hall of India, New Delhi, 2001

3. Thomas E French & Charkes J V, Engineering Drawing & Graphing Technology,

   McGraw Hill Book Co, New York, 1993

4. Venugopal K, Engineering Drawing & Graphics, New Age International Pvt. Ltd., NewDelhi,1994

ZZ1003 BASIC ELECTRICAL SCIENCES

Pre-requisites: None

L	***T***	***P***	***C***
3	***0***	***0***	***3***

Course Assessment Methods:

2 Tests : 20 marks each
Assignments : 10 marks
End Exam : 50 marks
Total : 100 marks
Grading : Absolute

Course Outcomes:

CO1: Analysis of Resistive Circuits and Solution of resistive circuits with independent sources

CO2: Two Terminal Element Relationships for inductors and capacitors and analysis of magnetic circuits

CO3: analysis of Single Phase AC Circuits, the representation of alternating quantities and determining the power in these circuits

CO4: to acquire the knowledge about the characteristics and working principles of semiconductor diodes, Bipolar Junction Transistor

CO5: To get an insight about the basic introduction of Digital electronics.

Module – 1 (11 Hours)

Two Terminal Element Relationships

Inductance - Faraday's Law of Electromagnetic Induction-Lenz's Law -Self and Mutual Inductance-Inductances in Series and Parallel-Mutual Flux and Leakage Flux-Coefficient of Coupling-Dot Convention-Cumulative and Differential Connection of Coupled Coils-

Capacitance - Electrostatics-Capacitance-Parallel Plate Capacitor-Capacitors in series and parallel-Energy Stored in Electrostatic Fields-.

v-i relationship for Inductance and Capacitance - v-i relationship for Independent Voltage and Current Sources

Magnetic Circuits

MMF, Magnetic Flux, Reluctance- Energy Stored in a Magnetic Field-Solution of Magnetic Circuits.

Analysis of Resistive Circuits

Solution of resistive circuits with independent sources- Node Analysis and Mesh Analysis-Nodal Conductance Matrix and Mesh Resistance Matrix and symmetry properties of these matrices-Source Transformation-

Circuit Theorems - Superposition Theorem-Thevenin's Theorem and Norton's Theorem-Maximum Power Transfer Theorem

Module – 2 (10 Hours)

Single Phase AC Circuits

Alternating Quantities- Average Value - Effective Value - Form and Peak factors for square, triangle, trapezoidal and sinusoidal waveforms - Phasor representation of sinusoidal quantities - phase difference -Addition and subtraction of sinusoids - Symbolic Representation: Cartesian, Polar and Exponential forms-

Analysis of a.c circuits R, RL, RC, RLC circuits using phasor concept - Concept of impedance, admittance, conductance and susceptance –Power in single phase circuits – instantaneous power – average power – active power – reactive power – apparent power – power factor – complex power – Solution of series, parallel and series-parallel a.c circuits

Module - 3 (14 hrs)

Introductory Analog Electronics-Semiconductor Diode: Principle, Characteristics - Applications: Rectifier Circuits -Zener Diode,LED, Photo diode, IR diode-Bipolar Junction Transistor: Principle, Operation, Characteristics (CB, CE, CC)-

Principle of working of CE, CB and CC amplifiers, quantitative relations for midband operation, input and output resistance levels – qualitative coverage on bandwidth - cascading considerations.

Introductory Digital Electronics.Transistor as a switch – switching delays, inverter operation

Digital Electronics : Number Systems and Conversions- Logic Gates and Truth Tables – Boolean Algebra – Basic canonical realizations of combinatorial circuits.

Standard Combinatorial Circuit SSI and MSI packages (Adder, Code Converters, 7-Segment Drivers, Comparators, Priority Encoders etc).MUX-based and ROM-based implementation of combinatorial circuits.

Module - 4 (7 hours)

Measuring instruments
Basics of electronic/digital voltmeter, ammeter, multimeter, wattmeter and energy meter. Measurement of Voltage, Current and Resistance. Introduction to Cathode Ray Oscilloscope - CRT, Block diagram of CRO

Text Books :

1. Electric Circuits, James W Nilsson and Susan A Riedel, Pearson, 8th Edn, 2002

2. Electronic Devices and Circuit Theory, Robert L Boylestead & L Nashelsky, Pearson, 9th Edition, 2007

3. Digital Design , Morris Mano , PHI, 3rd Edition, 2005

ZZ1004 COMPUTER PROGRAMMING

Pre-requisite: NIL

L	T	P	C

Course outcomes:

CO1: To learn the basics of different types of programming.

CO2: To understand the syntax and building blocks of C-program.

CO3: To learn to solve a problem using the C-Program.

CO4: To compile and debug a C-Program.

CO5: To generate an executable file from program.

Module 1 (7 Hours)

Data Types, Operators and Expressions: Variables and constants - declarations - arithmetic, relational and logical operators – Assignment operator and expressions – conditional expressions – precedence and order of evaluation.

Control Flow**:** Statements and blocks – if-else, switch, while, for and do-while statements – break and continue statements, goto and labels.

Module 2 (7 Hours)

Functions and Program structure: Basics of functions, Parameter passing – scope rules - recursion.

Module 3 (7 Hours)

Pointers and Arrays: Single and multidimensional arrays - Pointers and arrays – address arithmetic - Passing pointers to functions.

Module 4 (7 Hours)

Structures and Unions: Basics of structures, Structures and functions – Arrays of Structures – Pointers to structures – self referential structures – Type definitions – Unions.

Input and Output: Standard input and output – Formatted output – variable length argument list – file access.

Text Book:

1. B. W. Kernighan and D. M. Ritchie, *The C Programming Language* (2/e), Prentice Hall, 1988.

References:

1. B.S. GottFried, *Schaum's Outline of Programming with C*(2/e), McGraw-Hill, 1996.
2. *C. L. Tondo and S. E. Gimpel, The* C Answer Book(2/e), Prentice Hall, 1988.
3. B. W. Kernighan, The Practice of Programming, Addison-Wesley, 1999.

ZZU1091 WORKSHOP PRACTICE I
CIVIL ENGINEERING WORKSHOP

L	T	P	C
0	0	3	2

Course Outcomes

CO1: Acquire knowledge on the basic civil engineering practices of brick and concrete masonry, plumbing and surveying.

CO2: Get hands on training in basic masonry and surveying.

CO3: Understand the quality requirements and quality testing procedures of selected building material, viz., cement, fine aggregate, coarse aggregate, concrete, timber and steel.

CO4: Acquire knowledge about various types of wiring systems, wiring tools, lighting & wiring accessories, wiring estimation & costing, etc.

CO5: Acquire knowledge about household electrical appliances, need of earthing, electric shock, etc.

Introduction to Construction Materials: Cement, sand, coarse aggregate, structural steel, brick, timber, concrete – methods of testing **(3 hours)**
Masonry: English bond – Flemish bond –wall –junction – one brick – one and a half brick - Arch construction. **(6 hours)**

Plumbing: Study of water supply and sanitary fittings—water supply pipe fitting –tap connections - sanitary fittings. **(3 hours)**

Surveying: Introduction to land surveying and linear measurements; Introduction to leveling. **(9 hours)**

ZZ1091 ELECTRICAL WORKSHOP

L	T	P	*C*
0	0	3	2

1

a) Familiarization of wiring tools, lighting and wiring accessories, various types of wiring systems.

b) Wiring of one lamp controlled by one switch

2

a) Study of Electric shock phenomenon, precautions, preventions; Earthing

b) Wiring of one lamp controlled by two SPDT Switch and one 3 pin plug socket independently.

3

a) Familiarization of types of Fuse, MCB, ELCB etc.

b) Wiring of fluorescent lamp controlled by one switch from panel with ELCB & MCB.

4

a) Study of estimation and costing of wiring

b) Domestic appliance – Wiring, Control and maintenance: Mixer machine, Electric Iron, fan motor, pump motor, Battery etc.

Reference:

1. K B Raina & S K Bhattacharya: Electrical Design Estimating and costing, New Age International Publishers, New Delhi,2005.Uppal S. L., Electrical Wiring & Estimating, Khanna Publishers---5th edition, 2003

2. John H. Watt, Terrell Croft :American Electricians' Handbook: A Reference Book for the Practical Electrical Man- McGraw-Hill, 2002

ZZ1092 ELECTRONICS ENGINEERING

L	T	P	*C*
0	0	3	2

1

a) Familiarization of electronic components colour code, multimeters.

b) Bread board assembling - Common emitter amplifier

2

a) Study of soldering components, solders, tools, heat sink.

b) Bread board assembling – phase shift oscillator

3

a) Soldering practice - Common emitter amplifier

b) Soldering practice - Inverting amplifier circuit

4

a) Study of estimation and costing of soldering –PCB: 3 phase connections
b) Domestic appliances – Wiring PCB, control, Identification of fault: Electronic Ballast, fan regulator, inverter, UPS etc.

Reference:

1. G. Randy Slone **-** Tab Electronics Guide to Understanding Electricity and Electronics, Mc- GrawHill, 2000

2 Jerry C Whitaker -The Resource Handbook of Electronics, CRC Press-2001

ZZ1092 WORKSHOP PRACTICE II

(Eight classes of 3 hour duration each)

L	T	P	C
-	**-**	**3**	**2**

Course Outcomes

CO1: To learn the basic manufacturing processes of Casting, Joining, Forming and machining through hands on experience and use of hand tools.

CO2: To get familiarized with the properties of different materials- metals and non metals.

CO3: To learn about the various measuring devices and to know about the importance of sequential plans of action in manufacturing through practice in various sections.

CO4: Acquire knowledge about electronic components, measuring instruments, bread board assembling, etc.

CO5: Acquire knowledge about soldering tools & components, estimation & costing of PCB soldering, household electronic appliances, etc.

The course is intended to expose the student to the manufacturing processes through hands on training in the sections of Central Workshop. After the course, the student acquires the skill in using various tools, measuring devices, and learns the properties of different materials at varying conditions.

1) Carpentry: Study of tools and joints – plaining, chiseling, marking and sawing practice, one typical joint- Tee halving/Mortise and Tenon/ Dovetail

2) Fitting: Study of tools- chipping, filing, cutting, drilling, tapping, about male and female joints, stepped joints- one simple exercise of single V joint for welding exercise.

3) Welding: Study of arc and gas welding, accessories, joint preparation, Exercise of a single V joint

4) Smithy: Study of tools, forging of square or hexagonal prism/ chisel/bolt

5) Foundry: Study of tools, sand preparation, moulding practice.

6) Sheet Metal work: Study of tools, selection of different gauge sheets, types of joints, fabrication of a tray or a funnel

7) Plumbing Practice: Study of tools, study of pipe fittings, pipe joints, cutting, and threading 8)

Lathe Exercise: Study of the basic lathe operations, a simple step turning exercise.

References

1) Chapman W.A.J., Workshop Technology. Parts 1 & 2, 4th Edition, Viva Books P. Ltd., New Delhi, 2002

2) Hajra Choudhury.Workshop Technology Vol 1 & 2, Media Promoters & Publishers P.Ltd, Bombay, 2004

3) Welding Handbook. Miami, American Welding Society, 2000

4) Metals Handbook. Vol 6, Welding, Brazing & Soldering. Metals Park, Ohio, American Society of Metals, 1998

5) Serope Kalpakjian. Manufacturing Engineering & Technology. Pearson Steven R. Schmid Education (Asia) Inc., Delhi, 2002.

6) Anderson J., Shop Theory. Tata McGraw Hill, New Delhi, 2002

7) Olson D.W., Wood and Wood working. Prentice Hall India. 1992

8) Douglass J.H., Wood Working with Machines. McKnight &McKnight Pub. Co. Illinois, 1995

9) Tuplin W.A., Modern Engineering Workshop Practice Odhams Press, 1996

10) P.L. Jain. Principles of Foundry Technology. 4th Edition, Tata McGraw Hill, 2008.

11) R.K.Singal, Mridul Singal, Rishi Sringal. Basic Mechanical Engineering. 2007

ZZ1093 PHYSICAL EDUCATION SYLLABUS FOR O T & 1- CREDIT COURSE

Course Outcomes

CO1: Every student is made aware of the relevance of physical education.

CO2: Every student is inculcated with desired health related physical fitness awareness.

CO3: Every student is Inculcated with Olympic Values that go to make a good citizen.

CO4: Every student is made aware of the scientific bases of physical education.

CO5: Each student is made capable of selecting a game/ activity of his/ her choice and thereby develop good health and fitness which he/she would carry over to post-campus life for maintaining health, fitness and wellness.

CO6: Each student is made to take a role to play in participation, organisation and administration of sporting programmes.

UNIT – I

- Introduction, definitions, aims & objectives of Physical Education.
- Importance and scope of Physical Education.
- Health, Physical fitness and wellness.
- Importance and relevance of Physical Education in NITC curriculum.

UNIT – II

- Components of physical fitness.
- Types of physical fitness.
- Benefits of exercise – physical and physiological.
- Fitness balance.

UNIT – III

- Physical exercise.
- Principals of Physical exercise.
- Activities for developing physical fitness components – walking, jogging, running, weight training, stretching, yogasanas.
- Athletic injuries and their management.
- Nutritional balance.
- Postural deformities and their corrections.

UNIT – IV

- Motivation and its importance in sports.
- Psychological factors affecting sports performance – stress, anxiety, tension, aggression.
- Personality, self confidence and performance.
- Team cohesion and leadership in sports.

UNIT – V

- Lifestyle diseases and its management
    - ¾ Diabetes
    - ¾ Hypertension
    - ¾ Obesity
    - ¾ Osteoporosis
    - ¾ Coronary heart diseases
    - ¾ Cholesterol
    - ¾ Backpain

UNIT – VI

- Olympic Values Education.
- Event management.

<u>ONE-CREDIT (ZZ1093) COURSE IN PHYSICAL EDUCATION</u>

<u>Scheme</u>

(Approved by the NITC Senate.)

1.Nature of the course	Core programme for all B.Tech/ B.Arch students.
2.Aim & Objective	a) Orientation to physical education activities and infrastructure. b) Relevance of physical education in professional curriculum. c) Inculcation of health related physical fitness awareness. d) **Inculcation of Olympic Values, symbols and ceremonies.**
3.Course Content	a) Brief introduction to physical education ,its scientific bases and modern day relevance in Technical Education curriculum. b) Need and importance of Health related physical fitness ,its components and Modus operandi (inculcation & maintenance) c) First Aid and Care of common sports injuries. **d) Olympic Values Education Programme.** e) Campus infrastructure and activities offered. f) Identification of any one mandatory activity of choice. **g) Group project/assignment on Olympic symbols and ceremonies.** **h) Introduction to organization of tournaments & mock-olympics** **(Annual Athletic meet of NITC)**
4.Course duration	A minimum of one compulsory class room session of one hour every week for the first year student during July to April every academic year. A minimum of two compulsory follow-up hours per week for every student to be insisted on the playground ,Gymnasium, Swimming pool and indoor games under the guidance of teachers and coaches to learn and practice the choice-activity.
5. Credit system and attendance.	@ one class room session per week followed by playground activity. Attendance of at least 90% : O T Credit (first years only) **Compulsory activity & Olympic group project (Annual Sports)** Attendance of 90% mandatory : 1 Credit.

6.Evaluation	The recording of attendence , **evaluation of Olympic group project** and grading of Excellence in sports & games will be vested with the Course Co-ordinator.

ZZ1094 Value Education

Course Objective:
CO1: Build an overall awareness, about one's surroundings its needs, its dynamics and sensitivity to its welfare and betterment.
CO2: Bring about a qualitative change in overall health of society.

Unit – I

Human Values-Values in Social interactions-Social norms and sanctions-Need for value education-Technology development and its impact on society-sustainability of modern technology-Concept of holistic development-Need for inner transformations-living in tune with nature-Professional ethics-Holistic approach in engineering design-Role and social responsibility of an engineer.

Introductory lecture on Value Education

Project

A mini project in indentified areas/topics in groups of not more than five. The work has to be completed and a report to be submitted at the end. The work can be done under the guidance of any faculty member in CSED, NITC and the attendance and progress report to be obtained from concerned faculty member.

ZZ1095 NSS

Course Objectives

CO1: The students will be able to work more cohesively in a group

CO2: The student will have a broader vision on life with social dimensions

CO3: The student will be more empathetic in their attitude towards fellow beings

CO4: The student will be capable of demonstrating service mentality where it is required

CO5: The student will be more patriotic in their approach

i. Understand the community in which one works
ii. Understand oneself in relation to his/her community
iii. Identify the needs and problems of the community and involve in problem solving process
iv. Develop among oneself a sense of social and civic responsibility
v. Utilize ones knowledge in finding practical solution to individual and community problems
vi. Develop competence required for group living and sharing of responsibilities
vii. Gain skills in mobilizing community participation
viii. Acquire leadership qualities and democratic attitude
ix. Develop capacity to meet emergencies and natural disasters and
x. Practice national integration and social harmony

EE2001 SIGNALS & SYSTEMS

REQUIRED COURSE

Pre-requisites: None

L	T	P	C
3	0	0	3

Course outcomes:

CO1: Acquire knowledge about the interconnection of elements in a system, classification of signals and basic operations on signals.

CO2: Acquire knowledge about the time domain analysis of first order systems and representation of total response in various formats.

CO3: Acquire knowledge about the standard time domain specifications of second order systems and the time domain analysis of higher order systems.

CO4: Acquire knowledge about the application of Fourier series , Fourier transform and Laplace transform in signal representation and analysis of linear time invariant systems.

CO5: Acquire knowledgeabout the block diagram representation and structures for system realisation

Total Hours: 42 Hours

Module 1: First Order LTI Systems in Time-domain (11 hours)

Signals and Systems-

System as interconnection of elements – electrical system elements, thermal system elements, translational and rotational mechanical system elements.

Signal definition – Size of a signal - Classification of signals – Basic signal operations – Commonly used signal models (impulse, step, ramp, complex exponential etc), even and odd components of a signal
Linearity of system elements – element relation – superposition principle – Time-invariance - Bilateral versus unilateral elements

Formulation of System Differential Equation –
Formulation of differential equation for Series and Parallel RC circuits, Series and Parallel RL circuits, massdamper system, single body heating and cooling system – need for initial condition specification - equivalence between impulse excitation and initial conditions

First-Order Dynamics –
Source-free response of RC circuit – time constant – Source-free response of RL circuit – time constant – Sourcefree response of first order mechanical system and thermal system – mechanical time constant, thermal time constant – DC switching problem in RC and RL Circuits with and without initial energy storage– Natural response and forced response – transient response – Rise time and fall time in first order systems – Difference between DC switching and applying step input - Complete Solution for step/impulse/sinusoid inputs – First order mechanical system impulse and step response - First order thermal system impulse and step response, generalisations for all first order systems – zero-input response and zero-state response state frequency response function of first order systems – periodic steady-state in first order systems.

Module 2:Higher Order LTI Systems in Time-domain – Impulse Response Description (11 hours)

Time-domain analysis of second-order systems –The mass-spring-damper system (for example, an ammeter or voltmeter) - series and parallel RLC –initial conditions – zero-state and zero-input response components - impulse response – step response – undamped and damped natural frequencies – damping factor – quality factor – undamped spring-mass system and LC system – weakly damped spring-mass system and LC system – Q factor versus rate of decay in stored energy in a weakly damped system - time-domain specifications for a second order system.

Time-domain analysis of higher order systems –Formulation of differential equation for multi-mesh circuits – determination of initial conditions - solution of n^{th} order Linear ODE using material learnt from Maths-I - natural frequencies – natural frequencies versus stability – frequency response function in terms of coefficients of differential equation

Convolution Integral –Impulse decomposition of an arbitrary input– convolution integral for zero-state response of a LTI system.Properties of systems – linearity, time-invariance, causality and stability in terms of impulse response – cascading LTI systems with and without inter-stage interaction –
Zero-state output of an LTI System for complex exponential input – condition of ‘dominance’ - eigen function – eigen value versus system function – system function $H(s)$ of a n^{th} order LTI system

Module 3: LTI Systems in Frequency-domain - with Periodic Inputs (9 hours)

Signal Expansion in terms of e^{st}kind of signals – Fourier Series
Expansion of an arbitrary input function into a sum of complex exponential inputs of e^{st} type with different values of s - Special case : periodic waveforms – Fourier series - symmetry properties – Fourier series coefficients and time-domain differentiation and integration– rate of decay of harmonic coefficients – *Frequency Response Function of a LTI System*
Frequency response function by substituting $s = jw$ in System Function – first order and second order system examples - one-sided frequency response plots versus two-sided frequency response plots – interpreting negative values of ω - symmetry properties of frequency response of LTI systems – use of frequency response and Fourier series to solve for periodic steady-state output in RC, RL and RLC Circuits

Module 4: LTI Systems in Frequency-domain - with Arbitrary Inputs (11 hours)

Signal Expansion in terms of e^{st}kind of signals – Fourier Transforms (FT)
Aperiodic inputs – Fourier Transform from Fourier Series – interpretation of Fourier transform – revise what was learnt in Maths-I (properties and theorems)– frequency response function and its role in LTI system solution for aperiodic inputs – band-limiting versus time-limiting of signals – continuity of

Fourier transform – convolution theorem – modulation theorem – sampling of CT signals and reconstruction – Nyquist's Theorem on sampling – ideal interpolation versus practical interpolation.
Signal Expansion in terms of e^{st} kind of signals – Laplace Transforms (LT)
Laplace transform from Fourier transform – LT as signal expansion in terms of complex exponential functions – ROC – revise what was learnt in Maths-I – Unilateral Laplace Transform – Shifting theorem - use of LT for solving complete response of LTI system

Text/Reference Books :

1. Lathi,, B.P., *Signal Processing and Linear Systems*, Oxford University Press, New Delhi, 2006
2. Lathi,, B.P., *Signals, Systems and Communication*, BS Publications, Hyderabad, 2008
3. Shearer, Murphy and Richardson, *Introduction to System Dynamics*, Addison-Wesley Publishing Company, 1967
4. Eronini Umez-Eronini, '*System Dynamics & Control*, Thomson Asia Pvt. Ltd.,Singapore, 1998

EE2002 LOGIC DESIGN

REQUIRED COURSE

Pre-requisites: None

L	T	P	C
3	0	0	3

Course outcomes:

CO1: Develop competence in Combinational Logic Problem formulation and Logic Optimization.

CO2: Develop design capability in the field of combinational logic using gates and state-of-the art MUX, ROM, PLA and PAL units

CO3: Develop competence in analysis of synchronous and asynchronous sequential circuits.

CO4: Develop design capability in synchronous and asynchronous sequential circuits

Total Hours: 42 Hours

Module 1: **(12 Hours)**

Basic digital circuits:

Review of number systems and Boolean algebra - Simplification of functions using Karnaugh map and Quine McCluskey methods - Boolean function Minimization and combinational design. Examples of useful digital circuits: Arithmetic Circuits, Comparators and parity generators, multiplexers and demultiplexers, decoders and encoders.
Ordered Binary Decision diagram (OBDD) and Reduced Order Binary decision diagram (ROBDD), unate covering, prime, essential and irredundant properties of implicants, Two level optimization

Module 2: **(11 Hours)**

Combinational logic design:

Combinational circuit design using Multiplexer, ROM, PAL, PLA.

Introduction to Sequential circuits:

Latches and flip-flops (RS, JK, D, T and Master Slave) - Design of a clocked flip-flop – Flip-flop conversion Practical clocking aspects concerning flip-flops.

Module 3: **(12 Hours)**

Design and analysis of sequential circuits:

General model of sequential networks - State diagrams – Analysis and design of
Synchronous sequential Finite Sate Machine – Exact State reduction – State reduction with don't cares Minimization and design of the next state decoder.

Counters: Design of single mode counters and multimode counters – Ripple Counters – Ring Counters – Shift registers counter design.

Module 4: (7 Hours)

Practical design aspects:

Timing and triggering considerations in the design of synchronous circuits – Set up time - Hold time – Clock skew - Static timing analysis - Dynamic analysis.

Asynchronous sequential logic: Analysis and Design – Race conditions and Cycles – Hazards in combinational circuits – Hazard free realization.

Text/Reference Books:

1. M. Mano, "Digital Design", 3rd Ed., Prentice Hall, India.
2. Roth C.H., Fundamentals of Logic Design, Jaico Publishers. IV Ed.
3. W. I. Fletcher, An Engineering Approach to Digital Design, Prentice-Hall, Inc., Englewood Cliffs, NJ, 1980
4. Tocci, R. J. and Widner, N. S., Digital Systems - Principles and Applications, Prentice Hall, 7th Ed.
5. Wakerly J F, Digital Design: Principles and Practices, Prentice-Hall, 2nd Ed. 6.D.D. Givone, "Digital Principles and Design", Tata McGraw Hill
7. Katz R, Contemporary Logic Design, Addison Wesley, 1993.
8. Lewin D. & Protheroe D., Design of Logic Systems, Chapman & Hall, University and Professional Division, 1992, II Ed.
9. T. L. Floyd, Digital Fundamentals, Prentice Hall, June 2005.

EE2003 ELECTRICAL MEASUREMENTS

REQUIRED COURSE

Pre-requisites: None

L	T	P	C
3	0	0	3

Course Outcomes:

CO1: to impart them the knowledge required for them, in understanding the working of various instruments and equipments used for the measurement of various electrical engineering parameters like voltage, current, power, phase etc in industry as well as in power generation, transmission and distribution sectors.

CO2: to make students capable of analyzing and solving the varieties of problems and issues coming up in the vast field of electrical measurements

CO3: To enable the students to think in terms of innovative ideas to improve the existing technology in the field of measurements in terms of accuracy, cost, durability and user friendliness

Total Hours: 42 Hours

Module 1: (11 Hours)

General Principles of measurements, units, dimensions, standards and calibration of meters.

Characteristics of Instruments - qualities and errors of Measurements and its analysis.

Cathode ray oscilloscope - Theory and working –measurements using CRO - Types of CRO – Time base generator circuit – Applications.

principle, construction, operation, torque equation ,calibration and application of D'Arsonval Galvanometer. Direct Deflecting Instruments - Moving Coil - Moving Iron, Dynamo Meter, Induction, Thermal, Electrostatic and Rectifier Type meters- Shunts and Multipliers- Various Types of Galvanometers. (principle, construction, operation, torque equation and comparison)

Module 2: (12 Hours)

Measurement of Current, Voltage and resistance –

Wheatstone bridge - Kelvin Double Bridge - Carey Foster Slide Wire Bridge - Bridge Current Limitations Insulation Resistance, Earth Resistance, Earth Tester Localization of Cable Fault by Murray and Varley Loop Tests.

Measuremet of Power and energy :Dynamometer Type Wattmeter - Error and Compensation - Ampere Hour Meter - Single and Three Phase Energy Meters (Induction Type) – Calibration- phantom loading.

Current transformer and potential transformer : Construction, theory operation, phasor diagram, characteristics – error elimination and its application. Trivector Meter - Frequency Meters - Power Factor Meters.

Module 3: (9 Hours)

DC Potentiometer –Crompton Potentiometer- Vernier Potentiometer- Diesselhorst Potentiometer-Method of Use-

Use of potentiometer for Measurement of Resistance, current and Voltage and power. Applications of DC Potentiometers

A.C. Potentiometers – Applications of AC Potentiometers.

Various A.C. Bridges and Measurement of Inductance & Capacitance and frequency.

Module 4: (10 Hours)

Magnetic Measurements: Classification – Magnetometer measurement, Ballistic Galvanometer Flux MeterMagnetic potentiometer- Hall effect devices- B.H. Curve and Permeability Measurement Hysteresis Measurement– Hibbert's Magnetic Standard - Core Loss Measurement.

Illumination: Laws of Illumination – standards of luminous intensity- Measurement of luminous intensityDistribution of Luminous intensity- MSI- Rousseau's construction – Integrating sphere- Illumination Photometers.

Reference/Text Books:

1. Golding E.W *Electrical Measurements & Measuring Instruments,* 5e, Reem Publications,2009.
2. Cooper W.D, *Modern Electronics Instrumentation*, Prentice Hall of India, 1996.
3. Stout M.B, *Basic Electrical Measurements,* Prentice Hall, 1986.
4. Oliver & Cage, *Electronic Measurements & Instrumentation*, McGraw Hill, 1979.
5. Sawhney A. K., Electrical and Electronic Measurements and Instrumentation, Dhanpath Rai & Co.,2007

EE2004 BASIC ELECTRONIC CIRCUITS

REQUIRED COURSE

L	T	P	C
3	0	0	3

Course outcomes:

CO1: Acquire basic knowledge on the working of various semi-conductor devices

CO2: Develop analysis capability in BJT and FET Amplifier Circuits

CO3: Develop competence in frequency response analysis of discrete amplifiers

CO4: Develop design competence in signal and power amplifiers using BJT and FET

CO5: Acquire knowledge on basic digital electronic gates

CO6: Develop knowledge on design trade-offs in various digital electronic families with a view towards reduced power consumption

Total Hours: 42 Hours

Module 1: **(11 Hours)**

Semiconductors Devices and Small Signal Models

Revision of principles of operation of diodes and bipolar junction transistors - transition capacitance of a diode minority carrier storage-diffusion capacitance-breakdown diodes -schottky diode – forward and reverse recovery processes in a diode -Transistor capacitances – Transistor ratings – Biasing a BJT – Thermal stability of bias. Concept of small signal operation of semiconductor devices – small equivalent circuit for diodes including capacitances – h-parameter equivalent circuit for a BJT – hybrid-π equivalent for a BJT – determination of small signal parameters from static characteristics- Construction and characteristics of JFETs – capacitances of a JFET – biasing a JFET - small signal model for a JFET- Construction and characteristics of depletion type and enhancement type MOSFETs – MOSFET capacitances – biasing a MOSFET – small signal model of a MOSFET

Module 2: **(10 Hours)**

BJT, JFET and MOSFET Amplifier Circuits – Midband Analysis.

Amplification in a CE amplifier - CE , CB and Emitter Follower Analysis and Comparison using h parameters as well as hybrid-π parameters - considerations in cascading transistor amplifiers -CS and CD Amplifiers using JFETs and MOSFETs – comparison of BJT, FET and MOSFET amplifiers - Class B and Class AB Power Amplifiers using BJT.

Module 3: **(11 Hours)**

Digital Electronic Circuits

Transistor as an inverter – switching delays – various components of switch-off and switch-on delays – calculation of switching time components – comparison between high frequency transistor and switching transistor- Charging and discharging a capacitive load by a BJT and MOSFET – rise time and fall time calculations for capacitive load switching- Analysis of basic DTL gate, propagation delay, rise and fall times, fan-in and fan out – power supply current versus frequency of operation -Analysis of basic TTL gate, propagation delay, rise and fall times, fan-in and fan out, ratings, power supply current versus frequency of operation -Different variants of TTL gates-Analysis of basic ECL gate, propagation delay, rise and fall times, fan-in and fan out -Analysis of basic CMOS gate, propagation delay, rise and fall times, fan-in and fan out – power dissipation in the gate and effect of (i) supply voltage (ii) frequency of operation and (iii) load capacitance on gate dissipation -Comparison of various digital logic families.

Module 4: **(10 Hours)**

Frequency Response of BJT/FET/MOSFET Amplifiers (phasor equivalent circuit approach is envisaged) Distortion in amplifiers – Non-linear distortion – linear distortion due to frequency response – conditions for distortionless amplification- Low Frequency response of BJT and FET Amplifiers-Dominant Time ConstantSelection of Coupling and Bypass Capacitors -High Frequency Response of CE current gain- α-cut off and β cut off frequencies - Gain-Bandwidth product-Miller Effect-Emitter Follower at high frequencies- FET and MOSFET amplifiers at high frequencies -Cascode Amplifier – BJT discrete version, BJT IC version, MOSFET IC version

Text/Reference Books

1. A.S Sedra and K.C Smith, .'*Microelectronic Circuits*', Oxford University Press, 5thEdn,2009
2. Taub & Scilling, '*Digital Integrated Elecronics*', McGraw-Hill, Singapore, 1997
3. Millman J, '*Microelectronic'*, 2nd edition, McGraw-Hill, New Delhi,2005.
4. Schilling & Belove, '*Electronic Circuits – Discrete and Integrated*', 3rd edition , McGraw-Hill, New Delhi,2006
5. Boylested & Nashesky , Electronic Devices and Circuit Theory, 10th Edn, Pearson Education, New Delhi, 2009

EE2090 BASIC ELECTRICAL ENGINEERING LABORATORY

REQUIRED COURSE

L	T	P	C
0	0	3	2

Course Outcomes:

CO1: Study different meters and instruments for measurement of electrical quantities

CO2: Study the linear and nonlinear characteristics of different types of loads experimentally

CO3: Design and experiment potential divider circuits

CO4: Experimentally verify the basic circuit theorems

CO5: Measure power and power factor in ac circuits

CO6: Understand 3 phase balanced and unbalanced, star and delta connected supply and load and to measure power in 3 phase circuits

CO7: Measure inductance in coupled circuits

CO8: Measure earth resistance and insulation resistance

CO9: Learn the characteristics of fuse experimentally

Total Hours: 42 Hours

1. a) Study of Analog/Digital meters/Multimeters/CROs. Interfacing a C.R.O with a PC.
   b) Verification of Kirchhoff's laws in D.C circuits.
2. Study of Linear and Non- linear characteristics of loads – Determination of voltage – current characteristics of linear resistor and linear inductor, incandescent and CFL lambs, iron cored solenoid
3. a) Potential divider connection and study of the dependence of output voltage upon the value of the loading resistance.
   b) Methods of measurement for low- medium-high resistance using voltmeter and ammeter.
4. Verification of Superposition Theorem and Maximum Power Transfer theorem.
5. Verification of Thevenin's Theorem and Generalized Reciprocity theorem.
6. a) study of Fuse, MCB, ELCB – Selection of Fuse rating for circuits.
   b) Determination of fuse characteristics and fusing factor of different specimens (open, enclosed, HRCfuses and MCB).
7. a) Single phase power measurement (fan load) – study of variation of speed, input power and power factor with supply voltage.
   b) Determination of thermal efficiency of an electric kettle.
8. Measurement of power and power factor in R-L-C series and parallel circuits and design of P.F compensator.
9. Three phase power measurement of balanced and unbalanced loads.
10. Experiments and Analysis of Resonance in the RLC circuits and design of an RF circuits to receive an RF signal and verifying it experimentally.
11. Measurement of Self-inductance, Mutual inductance and Coupling coefficient of windings.
12. Measurement of Earth Resistance and Insulation Resistance.

Note: Normally the practical classes are administered in two cycles. Depending on the availability of equipments and time, class coordinators may choose the experiments for each cycle.

Reference/Text Books:

1. H-cotton, Advanced Electrical Technology, Wheeler Publications.
2. Suresh Kumar K.S, Electrcial Circuit and Networks, Pearson Education, New Delhi, 2009
3. EW. Golding Electrical Measurements and Measuring Instruments, 5th edition, reem publications.
4. Huges, Electrical Technology, ed 6

EE2091 ELECTRONICS LAB – I

REQUIRED COURSE

L	T	P	C
0	0	3	2

Course outcomes:

CO1: Study different meters and instruments for measurement of electronic quantities

CO2: Study the characteristics of different semiconductor devices like diode, BJT, FET, UJT etc experimentally

CO3: Design and experiment with various application circuits using diodes

CO4: Design and experiment with various signal and power amplifier circuits using BJTs and FETs
CO5: Design and experiment with various voltage regulation circuits

Total Hours: 42 Hours

List of Experiments:

1. Use of CRO: a) Measurement of current, voltage, frequency and phase shift.
2. Semiconductor diodes: V-I and transfer characteristics of Si, Ge and zener diodes.
3. Characteristics of clipping and clamping circuits using diodes and zener diodes.
4. Rectifiers and filters with and without shunt capacitors- Characteristics of half-wave, full wave and bridge rectifiers- Ripple factor, Rectification efficiency, and % regulation.
5. Transistor characteristics in CB and CE configurations - Identification of cut off, active and saturation regions.
6. JFET characteristics in the common source configuration- determination of equivalent circuit parameters.
7. Characteristics of voltage regulators- Design and testing of:
   a) Simple zener voltage regulator
   b) Zener regulator with emitter follower output.
8. UJT Characteristics and UJT relaxation oscillator- Design for a particular frequency.
9. RC coupled amplifier using BJT in CE configuration- measurement of gain, input and output impedance and frequency response
10. BJT emitter follower- Measurement of voltage gain, current gain, input impedance, output impedance and load characteristics
11. FET amplifier- Measurement of voltage gain, current gain, input and output impedance.
12. Power amplifiers- Class AB (complementary symmetry).

Text/Reference Books:

1. Boylested &Nashesky , Electronic Devices and Circuit Theory, 10th Edn, Pearson Education, New Delhi, 2009

EE2005 CIRCUITS& NETWORKS

REQUIRED COURSE

Pre-requisites: ZZ1001 Basic Electrical Sciences
EE1001 Introduction to Electrical Engineering

L	T	P	C
3	**0**	**0**	**3**

Course Outcomes:

CO1: Do the time-domain and S- domain analysis of circuits

CO2: Obtain transfer functions of circuits and analysis of stability using poles of the transfer function

CO3: Analyze the frequency response of circuits and to obtain the correlation between time-domain and frequency domain response specifications

CO4: Learn about 3 phase supply and to perform symmetrical transformation

CO5: Obtain steady state solutions for non-sinusoidal inputs using fourier series and to analyze the effect of harmonics in circuits

CO6: Understand the features of two port networks and to obtain their equivalent circuits

CO7: Design low pass, high pass, band pass and band elimination filter networks

Total Hours: 42 Hours

Module 1: – Circuit Analysis in Time-domain and *s*-domain (10 hours)

Time Domain Analysis of Circuits **-**

Solution of multi-mesh and multi-node circuits by differential equation method - Determination of initial conditions – Obtaining step response and ramp response of circuits from impulse response – Generalization of time-domain analysis technique for higher order circuits-

s-domain Analysis of Circuits **-** Transformed equivalent of inductance, capacitance and mutual inductance Impedance and admittance in the transform domain – concept of the transformed circuit in *s*-domain –

Node Analysis and Mesh Analysis of the transformed circuit - Nodal Admittance Matrix and Mesh Impedance Matrix in the s-domain

Solution of transformed circuits with mutual inductance – step response of an ideal trnsformer – step response of a non-ideal transformer – flux expulsion by short circuited winding –instantaneous change in current in coupled coil systems.Generalization of Circuit theorems

Module 2: - Sinusoidal Steady-State Frequency Response (12 hours)

Concept of sinusoidal steady-state and frequency response function – frequency response function as a complex function of *w* as evaluated from phasor equivalent circuit - frequency response function from *s*-domain transfer and immittance functions - explanation for substituting $s = jw$ in *s*-domain transfer function to get frequency response function – frequency response of first order circuits – concept of cut-off frequencies and bandwidth – Series and parallel RC circuits as an averaging filter, low-pass filter, highpass filter, integrator, differentiator, signal coupling circuit, signal bypassing circuit etc. –

Graphical evaluation of frequency response function from pole-zero plots, introduction to filtering and illustration of graphical evaluation of frequency response function from pole-zero plots in the case of standard second order filter functions using Series RLC and Parallel RLC Circuits – frequency response specifications for second order functions – correlation between time-domain specs and freq-domain specs in the case of first order and second order circuits.

Bode plot approximation - Transfer function from frequency response data –Frequency response of an ideal and non-ideal two-winding transformer, tank circuits.

Steady-state analysis of three-phase balanced loads excited by three-phase unbalanced sources – symmetrical transformation – sequence components – sequence impedances – sequence decoupling – power in sequence components.

Module 3: - Fourier Analysis of Circuits (10 hours)

Fourier Series representation of non-sinusoidal periodic waveforms

Steady State Solution of Circuits with non-sinusoidal periodic inputs by Fourier Series and frequency response function, power and rms value of non-sinusoidal waveforms, Discrete Power Spectrum, THD measure for waveforms. – Application of tuned series LC and parallel LC structures in Power Systems – Application of parallel RLC circuit in Communication circuits – Application of LC circuits in power supply filtering – Application of RLC circuit in power supply decoupling.

Fourier Transforms

Energy spectral density of finite energy waveforms – Parseval's theorem - energy spectral density of output waveform of a circuit – Relation between impulse response and frequency response of a circuit - Frequency response of Ideal filter functions – why ideal filters cannot be realised – time-limited waveforms and continuous nature of their Fourier transforms – band limited Fourier transforms and corresponding time-domain signals bandwidth measures for Fourier transforms – uncertainty principle in Fourier transforms –

Linear distortion in signal transmission context – amplitude and phase distortion – conditions for distortion-free transmission – why such conditions cannot be met in practice – Practical distortion criterion for pulse transmission in terms of energy content of output.

Module 4: Two-port Networks and Passive Filters (10 hours)

Two Port Networks **-** Two port networks-characterization in terms of impedance, admittance, hybrid and transmission parameters - inter relationships among parameter sets - Reciprocity Theorem-Interconnection of Two port networks: Series, Parallel and Cascade - Input impedance, output impedance and gain of terminated two-ports in terms of two-port parameters and termination impedance – Application of *y, z, g* and *h* parameters in the analysis of negative feedback systems – Application of *ABCD* parameters in the power frequency analysis of transmission lines – T and Π models for a line.

Symmetrical Two Port Networks **-** T and Π Equivalent of a two port network – T and Π equivalents for Ladder networks, transmission lines, amplifiers etc., iterative impedance and image transfer constant, image impedance – determination of image parameters from open circuit and short circuit impedance measurements characteristic impedance and propagation constant of a symmetrical two port network - properties of a symmetrical two port network.

Symmetrical Two Port Reactive Networks as Filters **-** Filter fundamentals-pass and stop bands-behaviour of iterative impedance-Constant-k low pass filter-Constant-k high pass filter- m-derived T and Π sections and their applications for infinite attenuation and filter terminations-constant-k band pass and band elimination filters.

Text/Reference Books :

1. K.S. Suresh Kumar, '*Electric Circuits and Networks*' , Pearson Education, New Delhi, 2009
2. M.E. Van Valkenburg, '*Network Analysis'*, Prentice-Hall India, 3rd Edn, 2010

EE2006 APPLIED ELECTROMAGNETICS

Pre-requisites : Nil

L	T	P	C
3	0	0	3

Course Outcomes:

CO1: Knowledge of the calculation of electric and magnetic field due to various charge and current distributions.

CO2: Acquire concepts to design various devices which are working based on the forces generated by electric and magnetic fields.

CO3: Knowledge of the fundamental Maxwell's equations and the design of various electrical machines based on this.

CO4: Knowledge of propagation of electromagnetic energy through transmission lines and the design of propagation medium based on the requirements.

CO5: Knowledge of the parameters in propagation of electromagnetic energy through space.

Total Hours : 42 Hours

Module 1: (12 Hrs)

The Co-ordinate Systems; Rectangular, Cylindrical, and Spherical Co-ordinate System.Co-ordinate transformation.Gradient of a Scalar field, Divergence of a Vector field and Curl of a Vector field.Their Physical interpretation.The Laplacian. Divergence Theorem, Stokes' Theorem. Useful Vector identifies Electrostatics : The experimental law of Coulomb, Electric field intensity. Field due to a line charge, Sheet Charge and Continuous Volume Charge distribution.Electric Flux and Flux Density; Gauss's law. Application of Gauss's law.Energy and Potential .The Potential Gradient.The Electric dipole. The Equipotential surfaces. Energy stored in an electrostatic field. Boundary Conditions.Capacitors and Capacitances.Poisson's and Laplace's equations. Solutions of Simple Boundary value problems. Method of Images.

Module 2: (10 Hrs)

Steady Electric Currents: Current densities , Resistance of a Conductor; The Equation of Continuity . Joules law.Boundary Conditions for Current densities.The EMF.Magnetostatics : The Biot-Savart law. Amperes' Force Law . Torque exerted on a current carrying loop by a magnetic field. Gauss's law for magnetic fields.Magnetic Vector Potential .Magnetic Field Intensity and Ampere's Circuital law.Boundary conditions.Magnetic Materials .Energy in magnetic field .Magnetic circuits.Application to cathode Ray Oscilloscope.

Module 3: (10 Hrs)

Faraday's Law of Induction; Self and Mutual inductance .Maxwell's Equations from Ampere's and Gauss's Laws.Maxwell's Equations in Differential and Integral forms; Equation of Continuity.Concept of Displacement Current, Electromagnetic Boundary Conditions.Poynting's Theorem , Time – Harmonic EM Fields . Application to Transformer. Plane wave Propagation : Helmholtz wave Equation. Plane wave solution. Plane wave propagation in lossless and lossy dielectric medium and conducting medium . Plane wave in good conductor, surface resistance , depth of penetration. Polarization of EM wave - Linear, Circular and Elliptical polarization. Normal and Oblique incidence of linearly Polarized wave at the plane boundary of a perfect conductor, Dielectric – Dielectric Interface . Reflection and Transmission Coefficient for parallel and perpendicular polarizations , Brewstr angle.

Module 4: **(10Hrs)**

The TEM wave and the transmission line limit - Transmission Lines: The high-frequency circuit. Time domain reflectometry.LCR ladder model for transmission lines.The transmission line equation.Analogy with wave equation.Solution for lossless lines. Wave velocity and wave impedence. Reflection and Transmission coeffcients at junctions.VSWR. Introduction to electromagnetic interference and compatibility

Text/Reference Books:

1. Nannapaneni Narayana Rao, "Elements of Engineering Electromagnetics", Prentice Hall of India.
2. Elements of Electromagnetic by Mathew N. O. Sadiku, Publisher Oxford University Press.
3. Fields and Wave Electromagnetics, By David K. Cheng, 2nd Edition,Publisher: Pearson Education.
4. Electromagnetics By John D Kraus , (Mcgraw-Hill)

EE2007 ELECTRICAL MACHINES I

REQUIRED COURSE

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Course Outcomes:

CO1: Acquire knowledge about the fundamental principles and classification of electromagnetic machines.

CO2: Acquire knowledge about the constructional details and principle of operation of dc machines.

CO3: Acquire knowledge about the working of dc machines as generators and motors.

CO4: Acquire knowledge about testing and applications of dc machines.

CO5: Acquire knowledgeabout the constructional details, principle of operation, testing and applications of transformers.

Total Hours : 42 Hours

Module 1: Electromagnetic Machines **(8 hours)**

Fundamental principles - classification - generators, motors and transformers - elements of electromagnetic machines - armature windings - commutator winding - lap winding and wave winding - phase winding - single phase winding and three phase winding - single layer winding and double layer winding - MMF of a winding space harmonics - torque developed in a winding - EMF developed in a winding - distribution factor - chording factor.

Module 2: DC Machines **(7 hours)**

Construction - principle of operation - magnetic circuit - flux distribution curve in the air-gap - EMF equation armature reaction - demagnetizing and cross magnetizing ampere turns - commutation - methods of excitation generators and motors.

Module 3: DC Generators and Motors **(12 hours)** DC Generators: Power flow diagram -circuit model - magnetization characteristics - process of voltage build up terminal characteristics - control of terminal voltage - parallel operation - applications.

DC Motors: Power flow diagram - circuit model - back EMF - torque and speed equations performance characteristics - applications - starting methods - design of starters - methods of speed control - testing Swinburne's test - Hopkinton's test - separation of losses - retardation test - permanent magnet DC motor.

Module 4: Transformers **(15 hours)**

Types and construction - principle of operation - magnetizing current - harmonics - ideal and real transformer dot convention - current and voltage ratio - equivalent circuit - phasor diagram - per unit impedance - losses efficiency and regulation - all day efficiency - OC and SC tests - Sumpner's test - parallel operation - tap changing - switching transients - auto transformers - voltage and current relationships - saving of copper different connections of three phase transformers - notations - Scott connection - cooling methods.

Text/Reference Books:

1. Clayton & Hancock, Performance & Design Of DC Machines, CBS, 3rd edition, 2001
2. Langsdorf A.S., Principles of DC Machines, McGraw Hill.6th edition, 1959.
3. Say M. G, Performance & Design of AC Machines, Pitman, ELBS.3rd edition, 1983.
4. Langsdorf A.S., Theory of AC Machinery, McGraw Hill., 2nd edition, 2002.
5. Toro V.D, Electrical Machines & Power Systems, Prentice Hall, 2nd edition, 2003.
6. Chapman S.J, Electric Machinery Fundamentals, McGraw Hill, 2nd edition, 1991.
7. Nagarath I.J. & Kothari D.P, Electric Machines, Tata McGraw Hill, 3rd edition, 2004.

EE2008 ANALOG ELECTRONIC CIRCUITS & SYSTEMS

REQUIRED COURSE

Pre-requisites: EE2004 Basic Electronic Circuits

L	T	P	C
3	0	0	3

Course outcomes:

CO1: Develop analytical capability to analyze feedback in amplifiers

CO2: Develop design competence in the area of discrete feedback amplifiers

CO3: Acquire knowledge on the fundamentals of analog integrated circuits

CO4: Develop competence in linear and non-linear Opamp circuit analysis

CO5: Acquire knowledge on commonly used linear and non-linear applications of Opamps and Comparators

CO6: Develop design competence in linear and non-linear Opamp Circuits

CO7: Develop analysis and design competence on signal filtering and signal conversion

Total Hours : 42 Hours

Module 1: **(11 Hours)**

Feedback Amplifiers ,Stability and Oscillators (s-domain approach is envisaged)

Concept of Feedback-Negative and Positive Feedback-Loop Gain-Closed Loop Gain-Voltage Series Feedback on a single time constant voltage to voltage amplifier-Advantages of negative feedback in a single time constant voltage to voltage amplifier-gain, input and output resistances, rise time, bandwidth, nonlinearity etc- stability and positive feedback in the above amplifier-Voltage Shunt,Current series and Current Shunt topologies and properties.

Voltage Series feedback on a second order amplifier-Closed Loop poles and loop gain-Transient Response of Closed Loop Amplifier vs Loop Gain-Voltage Series Amplifier with third order open loop amplifier-pole migration to right half of s-plane – Bode Plots of Loop Gain-Barkhausen's criterion for stability of feedback amplifiers-Gain Margin and Phase Margin-Introduction to amplifier compensation-dominant pole compensationOscillators- Transistor Phase Shift Oscillator-Wein's Bridge Oscillator

Module 2: **(11 Hours)**

Linear Opamp Circuits

BJT and MOSFET Differential Amplifiers-Common Mode and Differential Mode gains-CMRR-Current Source Biasing-Offset behaviour.Current Sources for biasing inside an IC.Operational Amplifier-ideal opamp properties-properties of practical opamps (LM741,LM324,LM358,LF351and OP07)-different stages in an opamp-internally compensated and externally compensated opamps-slew rate offsets.

CMOS Operational Amplifiers – basic two-stage CMOS Opamp – Folded Cascode Opamp

Analysis of opamp circuits using ideal opamp model-concept of virtual short and its relation to negative feedback-offset model of a practical opamp-Non inverting Amplifier-Gain bandwidth product-Voltage Follower-Inverting Amplifier-Summing AmplifierOffset analysis of Non inverting and inverting amplifiers-Subtracting Circuit-Instrumentation Amplifier-Voltage to Current Converter for floating and grounded loads-Opamp Integrator-Opamp Differentiator. Series Voltage Regulators-Monolithic Regulators-Three terminal regulators.

Module 3: **(10 Hours)**

Nonlinear IC Applications

Regenerative Comparator Circuits using Opamps-Comparator IC LM311 and its applications-Square, Triangle and Ramp Generator Circuits using Opamps and Comparator ICs-Effect of Slew Rate on waveform generationStudy of Function Generator IC ICL8038- Principles of VCO circuits-

Opamp based Astable and Monostable Circuits, Sweep circuits, Staircase waveform generation, Timer ICs – 555 Applications

Precision half wave and full wave rectification using opampsLog and antilog amps and applications.

Phase Locked Loops-Principles-Lock and Capture Ranges-Capture Process-Loop Filter-PLL dynamics under locked condition-study of NE564 and CD 4046-Applications of PLL in signal reconstruction, noise rejection, frequency multiplication, frequency synthesis, FSK demodulation, FM demodulation, line synchronization etc.

Module 4: **(10 Hours)**

Signal Conditioning and Signal Conversion

Active Filtering-Butterworth Low Pass Filter Functions-Low Pass Filter Specifications-order and cut off frequency of Butterworth Function from Low Pass Specifications-Sallen and Key Second Order LP SectionGain Adjustment in Butterworth LP filters-Butterworth High Pass Filters-Second Order Wide Band and Narrow Band Bandpass Filters. Multiple Feedback Single OPAMP LPF,HPF& BPF.
Analog Switches-Sample and Hold Amplifier-Data Conversion Fundamentals-D/A Conversion-Weighted Resistor DAC- R/2R Ladder DAC-Current Switching DAC-Multiplying DAC-Bipolar DACs-A/D conversionQuantiser Characteristics-Single Slope and Dual Slope ADCs-Counter Ramp ADC-Tracking ADC - Successive Approximation ADC-Simultaneous ADC.

Text/Reference Books:

1. A.S Sedra and K.C Smith, .'*Microelectronic Circuits*', Oxford University Press, 5th Edn,2009
2. Millman J, '*Microelectronic'*, 2nd edition, McGraw-Hill, New Delhi,2005.
3. Schilling & Belove, '*Electronic Circuits – Discrete and Integrated*', 3rd edition , McGraw-Hill, New Delhi,2006
4. D.H. Sheingold, .Nonlinear Circuits Handbook., Analog Devices Inc. 1976
5. Sergio Franco, '*Design with Operational Amplifiers and Analog Integrated Circuits*', Tata McGraw-Hill, New Delhi, 2005
6. M.E Van Valkenburg, '*Analog Filter Design'*, Oxford University Press 2001
7. National Semiconductor, '*Linear Applications Handbook*', 1994
8. Anvekar D.K. & Sonde B.S, '*Electronic Data Converters'*, Tata McGraw Hill,1994

EE2092: ELECTRICAL MEASUREMENTS LABORATORY

REQUIRED COURSE

Pre-requisites: EE2003 Electrical Measurements

L	T	P	C
0	0	3	2

Course Outcomes:

CO1: Acquire hand on experience about different measurement devices and its working principles.

CO2: Acquire knowledge of dealing with magnetic circuit and measurement of its parameters like determination of B-H curve μr - H curve and μr - B curve using standard solenoid, search coil and Hibbert's magnetic standard.

CO3: Acquire knowledge of principle of calibration of a measuring instrument and plotting of calibration curves.

CO4: Acquire hand on experience and knowledge on working of ammeter, voltmeter, wattmeter, Kelvin's double bridge and wheat stone's bridge, AC bridges, slide wire potentiometer. CT/PT, single – phase energy meter, concept of direct loading and phantom loading, 3-phase energy meter using standard wattmeter, AC potentiometer.

CO5: Acquire hand-on experience on measurement of parameters and verification of laws of illumination

Total Hours : 42 Hours

LIST OF EXPERIMENTS:

1. Determination of B-H curve μ_r -H curve and μ_r - B curve of an iron ring specimen.
2. Calibration of magnetic flux meter using standard solenoid, search coil and Hibbert's magnetic standard.
3. a) Measurement of low/medium resistance using Kelvin's double bridge and wheat stone's bridge.

   b) Measurement of various cable resistance as per ISI specifications.
4. a) Measurement of Capacitance and Inductance using AC bridges.

   b) Measurement of Inductive and capacitive reactance at HF, VHF and UHF ranges.
5. Calibration of dynamometer type wattmeter using slide wire potentiometer.
6. Extension of range of ammeter/voltmeter using shunt/series resistance and calibration of the extended meter using standard ammeter/voltmeter.
7. Extension of range of a dynamometer type wattmeter using CT/PT and calibration of the extended meter using a standard wattmeter.
8. Calibration of single – phase energy meter by direct loading and phantom loading at various power factors.
9. Calibration of 3-phase energy meter using standard wattmeter.
10. Determination of hysteresis loop of an iron ring specimen using 6- point method and CRO.
11. Measurement of branch and node voltage of a given R-L-C circuit using AC potentiometer.
12. a)Measurement of candle power of given light sources. Determine the illumination levels at different working planes and verify laws of illumination.

. b) Determination of MSCP of an Incandescent lamp/CFL.

c) Determination of the polar curve of candle power distribution and hence find MHCP/MSCP of light sources.

Text/Reference Books

1. Golding E.W, Electrical Measurements & Measuring Instruments, 5e reem publications, 2009.
2. Cotton.H,. Advanced Electrical Technology,
3. Suresh Kumar K.S Electric Circuit and Networks, Pearson education.
4. Cooper W.D, Modern Electronics Instrumentation , Prentice Hall of India, 1986

EE2093 ELECTRONICS LAB II

REQUIRED COURSE

Pre-requisites : None

L	T	P	C
0	0	3	2

Course outcomes:

CO1: Design and test various basic linear application circuits using Opamps

CO2: Design and test various signal comparison operation circuits using Opamps and Comparators

CO3: Design and test various waveform generation circuits using Opamps, Comparators and IC packages

CO4: Design and test various Opamp based Active Filter Circuits

CO5: Design and test PLL application circuits including FM Demodulation

CO6: Design and test various combinational logic circuits and systems

CO7: Design and test various sequential logic circuits and systems

Total Hours : 42 Hours

List of experiments

1. OPAMP circuits - design and set up of inverter - scale changer - adder - non-inverting amplifier integrator and differentiator
2. OPAMP comparator - design and set up of Schmitt trigger - window comparator
3. Phase shift and Wein's bridge oscillator with amplitude stabilization using OPAMPs
4. Waveform generation - square, triangular and saw tooth wave form generation using OPAMPs
5. Precision rectification - absolute value and averaging circuit using OPAMPs
6. Second order LP and BP filters using single OPAMP
7. Using CD 4046 (PLL), study the dynamics of set up (a) Frequency multiplier (b) FSK MOD/DEMOD using PLL
8. Set up analog to digital converter (a) successive approximation method (b) dual slope method
9. Using UP DOWN COUNTER and a DAC Ics, generate triangular waveform

a) Using Cd 40447 IC, design and set up gated/ungated astable and monostable multivibrators

b) Using Cd 4093 Schmitt NAND IC, design and set up astable and monostable multivibraors 10.Design of Half adder and half subtractor circuits with NAND gates using mode control

a) Design and realization of ripple counter using JK flip-flop

b) Cascading of ripple counters

11. Design and realization of Johnson & Ring counter using (a) JK flip flop (b) shift register
12. Synchronous UP/DOWN counter design and realization
13. IC 555 applications

Text/Reference Books:

1. A.S Sedra and K.C Smith, .'*Microelectronic Circuits*', Oxford University Press, 5th Edn,2009

ME2007 MECHANICAL ENGINEERING

REQUIRED COURSE

Pre-requisite: nil

L	T	P	C
3	0	0	3

Course Outcomes

CO1: Acquire knowledge about various thermodynamics concepts and enable students to approach real life engineering problems like engines compressor etc.

CO2: Acquire knowledge about fluid mechanics concepts and its applications to various real life engineering problems like notches, flow-measuring devices etc.

CO3: Acquire knowledge about the various fluid machineries such as pumps turbines etc.

CO4: Acquire knowledge about working of various power plants.

Number of Hours: 42

Module 1 **(10 hours)**

Thermodynamics: Thermodynamic systems, Properties, Processes, Heat and work, Zeroth law of thermodynamics, First law of thermodynamics -- concept of internal energy and enthalpy -- steady flow energy equation -- applications, Second law of thermodynamics -- concept of entropy -- absolute zero -- heat engine -- refrigerator -- heat pump.

Module 2 **(10 hours)**

Engineering applications of thermodynamics: Carnot cycle, Otto cycle, Diesel cycle – applications, Principle of operation of two stroke and four stroke engines, Spark ignition and compression ignition engines – applications, Rankine cycle, Brayton cycle -- their applications.

Refrigeration -- methods of producing cold, Refrigeration cycle -- vapour compression system – vapour absorption system – applications, Psychrometric properties, Psychrometric processes.

Module 3 **(12 hours)**

Fluid mechanics and fluid machinery: Fluid properties – viscosity -- surface tension -- fluid pressure - measurement of viscosity and pressure, Centre of pressure, Buoyancy, Classifications of flow, Continuity equation, Bernoulli’s equation, Momentum equation – applications, Friction in flow passages, Flow measuring instruments.

Fluid machinery: Air compressors -- working principles – loads -- characteristics and electric power requirement.

Hydraulic turbines – classifications -- performance characteristics – governing -- cavitation,

Hydraulic pumps – classification -- performance characteristics – cavitation -- electric power requirements.

Module 4 **(10 hours)**

Power plant Engineering: Conversion technology of conventional and non-conventional energy sources.

Steam power plant: Layout -- steam generators -- types of boilers for power station.

Hydel power plants: Layout -- classifications and study of various components -- operation

Gas turbine power plant and Internal Combustion engine power plants. Layout -- schemes -- study of various components – operation.

Text/Reference books:

1. Cengel, Y.A., and Boles, M.A, *Thermodynamics- An Engineering approach*, 6th edition, McGraw Hill, 2008.
2. Cengel, Y.A., and Cimbala, J.M., *Fluid mechanics*, 2nd ed., McGraw Hill, 2010.
3. Zemansky, M.W., Basic *Engineering Thermodynamics*, 2nd ed., McGraw hill, 2002.
4. Spalding, D.B., and Cole, B.H., *Thermodynamics*, 3rd ed., Arnold, 1987.
5. Gill, P.W., and Smith J.H., *Internal combustion engines*, 4th ed., United States Naval Institute, 2010. 6.Joseph Heitner, *Automotive systems*, 2nd ed., D. Van Nostrand company Inc, 1984
6. Streeter, V.L., *Fluid Mechanics*, 8th ed., McGraw Hill 1985.
7. Krivchenko, G.I., *Hydraulic Machinery*, 2nd ed., Lewis Publishers, 1994.
8. Skrotsky, B., Vopat, H., *Power Plant Engineering*, 2nd ed., McGraw hill, 1985.
9. Gredrick, T. Morse, *Power Plant Engineering*, 3rd ed., Van Nostrand Company,1994 11.El-Wakil, M.M., *Power Plant Engineering*, 1st ed., McGraw Hill, New York, 1985.
10. Stoecker, W.F. and Jones, *Refrigeration & Air conditioning*,2nd edition, McGraw Hill, New York,1987
11. Nag, P.K., *Engineering thermodynamics*, 4th ed., McGraw Hill, 2008.
12. Jagdish Lal *,Hydraulics and fluid mechanics*, 9th ed., Metropolitan, 1987.

EE3001 MICROPROCESSORS AND MICROCONTROLLERS

REQUIRED COURSE

Pre-Requisites: None

L	T	P	C
3	0	0	3

Course outcomes:

CO1: To learn the basics of Digital Systems.

CO2: To understand the working of a microprocessor/controller.

CO3: To learn to program a processor using assembly language .

CO4: To learn configuring and using different peripherals in a digital system.

CO5: To compile and debug a Program.

CO6: To generate an executable file and use it.

Total Hours : 42 Hours

Module 1: **(8 hours)**

Basics of computer– Number systems – Computer languages of different levels – compilers – cross compilers - History of Microprocessors – Computer architecture (Block diagram) – Memory types, Addressing concept.

Module2: (13hours)

Microcontrollers

Microchip PIC 18F 452 Microcontroller- Introduction - Architecture – Memory organization - Assembly

Language programming – simulation using MPLAB IDE - Programming of I/O ports – Addressing modes Bank switching – Table processing – Timers and its programming – Interrupt programming.

Module 3: (10hours)

Intel 8086 processor- Architecture –– addressing modes – Instruction set – assembly Language programming – Interrupts Pin configuration of 8086 – Timing diagrams – Minimum and maximum mode –address decoding .

Module 4: (11 hours)

Interfacing chips – Programmable peripheral interface (8255) - Programmable timer (8253)- -serial communication interface (8251) –DMA controller (8257) - Programmable Interrupt Controller (8259).

Text/Reference Books

1. Muhammad Ali Mazidi, - Rolin D.Mckinlay, Danny Causey. PIC microcontroller and Embedded Systems. 2008 1stEdition , Pearson Education.
2. Lyla B Das - The x86 Microprocessors – 1st Edition – Pearson Education, 2010
3. T R Padmanabhan - Introduction to Microcontrollers and their applications – 1st Edition 2007 – Narosa Publishing House Pvt Ltd..
4. Hall D V , Microprocessors & Interfacing , Second Edition ,1991 McGraw Hill.
5. Brey B B , The Intel Microprocessors, Architecture , Implementation & Programming, 2005,7th edition, McGraw Hill
6. Peter Norton - Peter Norton's Intro to Computers, 6th Edition, 2006, McGraw Hill.
7. Dr Badri Ram - Fundamentals of Microprocessors and Microcomputers . 3rd Edition, 1989, Dhanpat Rai & Sons.

EE3002 CONTROL SYSTEMS - 1

REQUIRED COURSE

Pre-requisites : None

L	T	P	C
3	0	0	3

Course Outcomes:

CO1: Obtain models of dynamic systems in transfer function and state space forms

CO2: Understand the common control schemes

CO3: Analyze the system response and stability in both time-domain and frequency domain

CO4: Learn the features of different types of compensators and to design compensators using time-domain and frequency domain specifications

CO5: Analyze the system response and stability of systems represented in state space form and to design compensators for systems modeled in state space form

CO6: Model and to analyze the response of discretized systems

Total Hours: 42

Module 1: (11 hrs)

General scheme of control systems – open loop and closed loop – SISO and MIMO systems- effect of feedback in SISO systems- regulator and tracking systems- feedback control strategies – ON-OFF, P, PI ,Pd and PID control – Modelling of dynamic systems- Transfer function – DC Motor-AC Motor- Thermal and pneumatic systems- Control actuators – power amplifiers – amplidyne-magnetic amplifier- pneumatic and hydraulic actuators- sensors and control valves- tachometer- shaft encoders- synchro and flow sensors..

Transfer function and impulse response (review)- derivation for typical closed loop systems- block diagrams reduction and signal flow graphs – Mason's gain formula.

State space modeling- concept of state – state equations general formulation – matrix-vector formulation for linear systems- state model for typical systems- state space model from differential equations and transfer function – canonical models - non-uniqueness of state models -transfer function from state model

Module 2: (11 hrs)

Time domain analysis of SISO control systems- standard test inputs- impulse, step, ramp and sinusoidal inputsunder damped and over damped responses – first order systems – time constant – second order systems- damping factor natural frequency –and other transient response specifications- higher order systems – steady state error and error constants – error for polynomial type inputs –Solution of linear time invariant state equation – zero input (free) and zero state(forced) responses – state transition matrix-definition and properties- complete response – output response – bounded input bounded output – eigen values and nature of responses.

Module 3: (10 hrs)

Stability of linear systems – BIBO stability – characteristic equation roots and stability – Routh Hurwitz criterion for stability – stability from eigen values of system matrix.

Frequency domain methods – root locus techniques – frequency response plots – Polar plots and Bode plots – stability from open loop gain functions – Nyquist criterion – relative stability – gain margin, phase margin etc from polar plot and Bode plot – stability from Bode plot. Frequency domain specifications – band width- cut of frequency etc - Closed loop frequency domain specifications-peak resonance and resonant frequency- correlation with time domain parameters.

Module 4: (10 hrs)

Introduction to Sampled data and discrete time systems-Sampling Process- uniform rate sampling - ideal sampler- Definition of Z Transform and Inverse Z Transform-Z-Transform & Inverse Z Transform pairsTheorems of Z transform-Sample & Hold- Zero order Hold-Finite pulse width sampling-Examples for finding zTransform and Inverse z-Transforms. Pulse transfer functions - State model for discrete time systems- time response from z transform and state models.

Text/Reference Books:

1. Modern Control Engineering, Katsuhiko Ogata, Pearson Prentice Hall , 2006
2. Control Systems, M Gopal, Tata McGraw Hill, 3rd Edition, 2006
3. Modern Control Engineering, K P Mohandas, Revised Edition, Sanguine Pearson, 2010.
4. Digital Control Systems, Benjamin C Kuo, Oxford University Press, 1992.

EE3003 ELECTRICAL MACHINES II

REQUIRED COURSE

Prerequisite: None

L	T	P	C
3	0	0	3

Course outcomes:

CO1: Acquire knowledge about the constructional details and principle of operation of alternators.
CO2: Acquire knowledge about the working of synchronous machines as generators and motors.

CO3: Acquire knowledge about testing and applications of synchronous machines.

CO4: Acquire knowledge about the constructional details and principle of operation of three phase and single phase induction motors.

CO5: Acquire knowledge about the starting and speed control of induction motors.

CO6: Acquire knowledge about testing and applications of induction motors.

Total Hours: 42 Hours

Module 1: Alternators **(12 hours)**
Construction - principle of operation - type and selection - armature reaction - voltage regulation predetermination of voltage regulation - EMF method - synchronous reactance and short circuit ratio - MMF method - Potier method - phasor diagrams - two reaction theory - modified phasor diagram - analysis by two reaction theory - sudden short circuit - current waveforms - transient and sub transient reactance - slip test - DC excitation - static excitation - brush less excitation and self excitation - measurement of losses.

Module 2: Synchronous Machines **(12 hours)**
Power angle characteristics of cylindrical rotor and salient pole machines - reactance power - active and reactive power control - load sharing upon parallel operation - effect of armature reactance - automatic synchronizing effect of change in fuel supply and excitation - alternator connected to infinite bus - governor characteristics synchronizing power and torque - phasor diagram for two identical generators in parallel - locus of generated voltage for constant real power and variable excitation - automatic voltage regulators - synchronous motor principle of operation - equivalent circuit - effect of load changes on synchronous motor - mechanical load diagram - armature current as function of power developed and excitation - V curves - inverted V curves - O curves - transition of a machine from generator mode to motor mode - phasor diagram - torque and power relations - minimum excitation forgiven power - hunting - periodicity of hunting - suppression - different starting methods.

Module 3: Induction Machines **(12 hours)**
Three phase induction motors - construction - principle of operation - rotor MMF and production of torque - slip and frequency of rotor current - phasor diagram - equivalent circuit - mechanical power developed - maximum torque - torque slip characteristics - losses and power flow - single phasing - no-load and blocked rotor tests circle diagram - effect of deep bar and double cage rotors - effects of air gap flux harmonics - cogging and crawling - line excited and self excited induction generators - single phase induction motors - double revolving field theory - equivalent circuit - applications of all types of induction motors.

Module 4: Starting & Speed Control of Induction Motors **(6 hours)**

Starting methods of three phase induction motors - direct on line starting - auto transformer starting - star delta starting - rotor resistance starting - starters and contactors - basic methods for speed control of three phase induction motors - voltage control - frequency control - rotor resistance control - pole changing - static frequency conversion and slip power recovery scheme - starting methods of single phase induction motors.

Text/Reference Books:

1. Say M. G, Performance & Design of AC Machines, Pitman, ELBS.3rd edition, 1983.
2. Langsdorf A.S., Theory of AC Machinery, McGraw Hill., 2nd edition, 2002.
3. Fitzgerald A.E. & Kingsley: Electrical Machinery, Tata McGraw Hill.,6th edition, 2003.
4. Chapman S.J, Electric Machinery Fundamentals, McGraw Hill., 2nd edition, 1991.
5. Toro V.D, Electrical Machines & Power Systems, Prentice Hall, 2nd edition, 2003.
6. Puchestein, Lloyd & Cenrad,Alternating Current Machines, Asia Publishing House.,1962.
7. Nagarath I.J. & Kothari D.P, Electric Machines, Tata McGraw Hill, 3rd edition, 2004.
8. P.S. Bimbra, Generalized Theory of Electrical Machines, Khanna Publishers,2001

EE3004 POWER SYSTEMS – I

REQUIRED COURSE

Pre-requisites : None

L	T	P	C
3	0	0	3

Course Outcomes:

CO1: Awareness of general structure of power systems

CO2: Impart the knowledge of generation of electricity based on conventional and non-conventional energy sources

CO3: Awareness of the concept of micro grid and distributed generation

CO4: To make students capable of analysis of mechanical and electrical design aspects of transmission system

CO5: Enable the students to do analysis of different types of distribution systems and its design

CO6: Impart the knowledge of protective relays and circuit breakers.

Total Hours: 42 Hours

Module 1: **(10 hours)**

Conventional sources of electrical energy - thermal, hydroelectric, diesel and nuclear power plants - renewable energy sources - power plant economics - operating costs - load factor - demand factor - diversity factor - plant factor - tariffs-distributed generation-microgrid-smartgrid.

Module 2: **(10 hours)**

Overhead transmission systems - arrangement of conductors - sag and tension - transmission line supports choice of transmission voltage - line insulators - failure of insulation - corona - underground cables - different types - capacitance of single core and three core cables - grading of cables.

Module 3: **(10 hours)**

Distribution systems - classification and arrangement of distribution systems - distribution substation layout and arrangement - economic loading of distribution transformers - Kelvin's law - considerations in primary and secondary distribution system design - current distribution and voltage drop calculation- design of feeders and distributors - improvement of existing distribution systems - LT capacitor installation – System and equipment earthing-Energy Conservation Measures- Power quality issues and mitigation techniques-distribution system planning and automation-traction-heating-welding-lighting.

Module 4: **(12 hours)**

Switch gear and protection .Circuit breaker-Types-rating .Selection -Neutral earthing .Lightning and protection Protective Relays-Functions-Types of Relays-protection schemes- NEC and importance of relevant IS/IEC

Specifications

Text/Reference Books:

1. Soni, Gupta, Bhatnagar, "A course in Electric Power", Dhanpat Rai & Sons, NewDelhi, 9 ed.,1996.
2. A.T. Starr, "Generation, Transmission & Utilization of Electric Power", Sir Issac Pitman and Sons, 4 ed., 1973
3. Turan, Goren, "Electric Power Transmission System Engineering", John Wiley, 1988
4. S.L. Uppal, "Electric Power", Khanna Publishers, 1992.
5. A.S. Pabla, "Electric Power Distribution System", Tata McGraw Hill, 1992.
6. M N Bandyopadhyay, "Electrical Power Systems- Theory and Practice", Prentice Hall of India, 2006.
7. Weedy B M, Cory B J, "Electric Power Systems", John Wiley Publication, 4 ed., 1998.
8. Sunil S Rao, "Switch Gear Protections", Khanna Publications, Delhi 1999
9. T S Madhav Rao, "Power system protection static relays with microprocessor Applications", Tata McGraw hill Publication,1998.
10. Badri Ram, D N Vishwakarma, " Power System Protection and Switchgear', Tata Mc Graw Hill, 2005.

EE3021 ELECTRICAL ENGINEERING MATERIALS

ELECTIVE COURSE

Pre-requisites: None

L	T	P	C
3	0	0	3

Course outcomes:

CO1: to provide students with a thorough understanding of the electrical properties and characteristics of various materials, used in the electrical appliances , devices , instruments and in the applications associated with generation, transmission and distribution of electric power.

CO2: to provide students with a moderate level understanding of the physics behind the electrical engineering materials
CO3: An understanding of the electrical engineering material science essential for them to work in different industries and also motivate them to do innovative research while going for higher studies and also to work in R & D with scientific enthusiasm

Total Hours: 42 Hours

Module 1: (12 hours)
Conducting materials: Review of metallic conduction on the basis of free electron theory-electrical and thermal conductivity-Wiedemann-Franz law-drawback of classical theory-quantum free electron theory-Fermi-Dirac distribution - variation of conductivity with temperature and composition, Materials for electric resistancesgeneral electric properties: brushes of electrical machines, lamp filaments ,fuses and solder.
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 - hysterisis curve-magnetostriction - hard and soft magnetic materials- magnetic materials used in electrical machines instruments and relays.

Module 2: (12 hours)
Dielectrics: Dielectric polarization under static fields - electronic, ionic and dipolar polarizations - behavior of dielectrics in alternating fields - mechanism of breakdown in gases, liquids and solids- factors influencing dielectric strength- capacitor materials-Ferro and piezo electricity
Insulating materials-complex dielectric constant - dipolar relaxation .dielectric loss insulator materials used inorganic materials (mica, glass, porcelain, asbestos) - organic materials (paper, rubber, cotton silk fiber, wood, plastics, bakelite) - resins and varnishes - liquid insulators(transformer oil) - gaseous insulators (air, SF_6, and hydrogen) – ageing of insulators.

Module 3: (10 hours)
Special purpose materials and processes: Thermo couple materials-soldering materials- fuse materials-contact materials-structural materials-fluorescent and phosphorescent materials- galvanizing and impregnation process –
Super conductors – effect of magnetic field- Meissner effect-type I and type II superconductors –London equations –Josephson effect –applications of superconductors

Module 4: (8 hours)
Materials for electronic components – resistors –insulated moulded resistors-Cracked carbon resistors-alloy resistors-metallic oxide thin film resistors-High value resistors-wire wound resistors-non linear resistors – varistors –capacitors-mica- dielectric capacitors-glass-dielectric capacitors-plastic-dielectric capacitors etc – inductors –air cored coils –cored coils-ferrite core-relays-

Text/Reference Books:

1. Indulkar C.S.& Thiruvengadam S, An Introduction to ElectricalEngineering Materials, S. Chand Co,1998.
2. P.K. Palanisamy ,Solid State Physics, SCITECH Publications,Hyderabad, 2004
3. A.J. Dekker,"Electrical Engineering Materials" Prentice Hall of India

4. Yu Koritsky, Electrical Engineering Materials., MIR,1970
5. Arumugam M., Materials Science., Anuradha Publishers, 1990
6. Kapoor P.L., Electrical Engineering Materials., Khanna Publications,
7. Hutchison T.S. & Baird D.C, The Physics of Engineering Solids., John Wiley Publications
8. S.O.Kasap,Principles of Electrical engineering Materials and Devices, Tata Mc Graw Hill.
9. R.K. Rajput," Electrical Engg. Materials," Laxmi Publications 10. T. K. Basak, "Electrical Engineering Materials" New age International.
11. Solymar, "Electrical Properties of Materials" Oxford University Press.
12. Ian P. Hones," Material Science for Electrical and Electronic Engineering," Oxford University Press.
13. Meinal A.B.& Meinal M.P, Applied Solar Energy -An Introduction., Addison Wesley Publications,1977.
14. TTTI Madras, Electrical Engineering materials, Tata Mc Graw Hill, 1999.

EE3022 NETWORK ANALYSIS & SYNTHESIS

ELECTIVE COURSE

Pre-requisite: EE2005 Circuits & Networks

L	T	P	C
3	0	0	3

Course Outcomes:

CO1: Obtain circuit matrices of linear graphs and analyze networks using graph theory

CO2: Obtain network functions and poles and zeros of network functions

CO3: Learn conditions for stability and realizability of network functions

CO4: Synthesize driving point functions of RL, RC and RLC networks

CO5: Synthesize two port network functions

Total Hours : 42 Hours

Module 1: – Network Analysis using Linear Graph Theory **(12 Hrs)**

Network Topology:

Linear Oriented Graphs - incidence matrix – Kirchoff's Laws in incidence matrix form – nodal analysis (with independent and dependant sources) – Circuit matrix of linear oriented graph – Kirchoff's laws in fundamental circuit matrix form - Loop analysis of networks (with independent and dependant sources) – Planar graphs – Mesh analysis- Duality – Cut set matrix - Fundamental cut set matrix – Relation between circuit, cut set and incidence matrices – Kirchoff's laws in fundamental cut set form – Node pair analysis – Analysis using generalized branch model (node, loop and node pair analysis) – Tellegen's theorem for lumped parameter network in topological form.

Module 2: - Network Functions and Elements of Realizability (10 Hrs)

Review of Network Functions:

Network functions for one port and two port networks – Poles and Zeros of network functions – Restrictions on pole and zero locations for driving–point functions – Restrictions on pole and zero locations for transfer functions – Concept of stability Elements of Realizability:

Hurwitz polynomials – properties - Brune's positive real functions – Properties of positive real functions Necessary and sufficient conditions for positive real functions – Sturm's test for positive real functions

Module 3: - Synthesis of reactive one - port networks (12 Hrs)

Elementary synthesis operations:

Removal of pole at infinity – Removal of pole at zero – Removal of conjugate imaginary poles- Synthesis procedure

Driving point synthesis:

Frequency response of reactive one ports – Synthesis of reactive one-ports by Foster's and Cauer's methods Synthesis of LC driving-point functions – Properties of driving point immitances – Pole Zero interpretation First and Second Foster forms of LC networks – First and Second Cauer forms of LC networks - Synthesis of RC and RL driving–point functions – Properties of RC network functions – First and Second Foster forms of RC networks – First and Second Cauer forms of RC networks – Properties of RL network functions – First and Second Foster forms of RL networks –First and Second Cauer forms of RL networks - RLC one terminal-pair network synthesis – Minimum positive real functions – Brune's method of RLC synthesis – Series Parallel realization – Chop- chop method - The method of Bott and Duffin – Actual realization difficulties

Module 4: - Synthesis of reactive two - port networks (8 Hrs)

Two terminal–pair synthesis – Some properties of y_{12} and z_{12} – The coefficient conditions – Transfer immittances with positive coefficients – Constant resistance symmetric lattice - Zeros of transmission – The LC ladder development – Common ground impedance and admittance synthesis - Zero shifting by partial pole removal – Zero producing by complete pole removal – The RC ladder development – Gullimen's transfer admittance synthesis

Text/Reference Books

1. Van Valkenburg M.E: Introduction to Modern Network Synthesis, John Wiley & Sons, 1962.
2. K. S. Suresh Kumar, Electric Circuits and Networks, 1st Ed, Pearson Education, 2009
3. Umesh Sinha, Network Analysis& Synthesis, 5th Ed, Satyaprakashan, 2001.
4. Van Valkenburg M.E: Network Analysis, Prentice Hall India, 1989
5. Dov Hazony, Elements of Network Synthesis, East West Publishers, 1971.

6.Franklin F Kuo, Network Analysis and Synthesis, John Wiley, 2001

EE3023OPTIMIZATION TECHNIQUES AND ALGORITHMS

ELECTIVE COURSE

Pre-Requisites : None

L	T	P	C
3	0	0	3

Course Outcomes:

CO1: State the optimization problem

CO2: Solve optimization problems using linear programming and apply for solving engineering optimization problems

CO3: Solve optimization problems using nonlinear programming (Hessian and gradient) and apply for solving engineering optimization problems

CO4: Solve optimization problems using descent methods (Newton, Kuhn-ticker, Quasi Newton, Convex programming, Frank and Wolfe methods) and apply for solving engineering optimization problems

CO5: Solve constrained optimization problems using direct and indirect methods and apply for solving engineering optimization problems

CO6: Solve optimization problems using dynamic programming and genetic algorithm and apply for solving engineering optimization problems

CO7: Familiarize Optimization programming, tools and Software: MATLAB- SIMULINK, FSQP, SOLVER, LINDO etc.

Total Hours: 42 Hours

Module 1: (11 Hrs)

Concepts of optimization: Engineering applications-Statement of optimization problem-Classification - type and size of the problem.

Classical Optimization Techniques: Single and multi variable problems-Types of Constraints Semi definite casesaddle point.

Linear programming: Standard form-Geometry of LP problems-Theorem of LP-Relation to convexity formulation of LP problems - simplex method and algorithm -Matrix form- two phase method.

Duality- dual simplex method- LU Decomposition.Sensitivity analysis.Artificial variables and complementary solutions-QP.

Engineering Applications: Minimum cost flow problem, Network problems-transportation, assignment & allocation, scheduling .Karmarkar method-unbalanced and routing problems.

Module 2: (11 Hrs)

Nonlinear programming: Non linearity concepts-convex and concave functions- non-linear programming gradient and Hessian.

Unconstrained optimization: First & Second order necessary conditions-Minimization & Maximization-Local & Global convergence-Speed of convergence.

Basic decent methods: Fibonacci & Golden section search - Gradient methods - Newton Method- Lagrange multiplier method - Kuhn-tucker conditions .Quasi-Newton method- separable convex programming - Frank and Wolfe method, Engineering Applications.

Module 3: (10 Hrs)

Nonlinear programming- Constrained optimization: Characteristics of constraints-Direct methods- SLP,SQPIndirect methods-Transformation techniques-penalty function-Lagrange multiplier methods- checking convergence- Engineering applications

Module 4: (10 Hrs)

Dynamic programming: Multistage decision process- Concept of sub optimization and principle of optimalityComputational procedure- Engineering applications.

Genetic algorithms- Simulated Annealing Methods

Optimization programming, tools and Software: MATLAB- SIMULINK, FSQP, SOLVER, LINDO etc.

Text/Reference Books:

1 David G Luenberger, “Linear and Non Linear Programming”, 2nd Ed, Addison-Wesley Pub.Co., Massachusetts, 1973

2 W.L.Winston, “Operation Research-Applications & Algorithms”, Thomson publications, 2003.

3 S.S.Rao, “Engineering Optimization”, 3rd Ed., New Age International (P) Ltd, New Delhi,2004

4W.F.Stoecker, “Design of Thermal Systems”, 3rd Ed., McGraw Hill, 1989.

5 G.B.Dantzig, “Linear Programming and Extensions”, Princeton University Press, 1963.

6 L.C.W.Dixton, “Non Linear Optimization: theory and algorithms”, Birkhauser, Boston, 1980

7 Bazarra M.S, Sherali H.D. & Shetty C.M., “Nonlinear Programming Theory and Algorithms”, John Wiley, New York,1979.

8 Kalyanmoy Deb, “Optimization for Engineering Design-Algorithms and Examples”, Prentice Hall India-
1998

EE3024 SPECIAL MACHINES AND LINEAR MACHINES

ELECTIVE COURSE

Prerequisite: EE2007 Electrical Machines I

L	T	P	C
3	0	0	3

Course Assessment Methods:

Test 1 : 20 marks
Test 2 : 15 marks
Assignment/Class tests : 15 marks

End Exam : 50 marks
Total : 100 marks
Grading : Relative

Course Outcomes:

CO1: To gainknowledgeabout the basic principles and classification of servo motors.

CO2: To understand and apply the fundamentals of systematical components for the analysis of AC servo motor leading the design of its equivalent circuit and evaluation of its performance.

CO3: To learn about construction features and method of operation stepper motor and acquire the knowledge of design procedure of drive amplifier and transistor logic for stepper motor.

CO4: To learn about characteristics and application of stepper motor.

CO5: Acquire the knowledge of fundamentals, construction details and classification of universal motors and synchronous motor like reluctance motors, hysteresis motors.

CO6: Acquire the knowledge of fundamentals, construction details and classification of linear machines.

Total Hours: 42 Hours

Module 1: Servo Motors (12 Hrs)

Servo motors -Requirement of a good servomotor, Types of servomotors: D. C. servomotor: Basic working principle and its classification, Field controlled and Armature controlled DC servomotor, Application: servostabilizer and position control system. AC servo motor: construction, operating principle and Application. Symmetrical components applied to two - phase servo motors -equivalent circuit and performance based on symmetrical components - servo motor torque - speed curves.

Module 2: Stepper Motors (8 Hrs)

Stepper motors - construction features - method of operation - drive - amplifiers and transistor logic - Drive Circuits - half stepping and the required switching sequence - the reluctance type stepper motor – ratings. Characteristics of Stepper Motor- Stepper motor application.

Module 3: (11 Hrs)

Reluctance motors - General types of synchronous motors - Reluctance motors - definitions - construction polyphase and split phase reluctance motors - capacitor type reluctance motors

Hysteresis motors- Construction - polyphase - capacitor type and shaded pole hysteresis motors – Methods of reversing direction of rotation in shaded pole motor. Advantage over reluctance motors, Torque develop and slip

Universal motors – Applications - torque characteristics - essential parts of universal motors - EMF due to main filed and cross field - Transformer and rotational emf - circuit model and Phasor Diagram.

Module 4: Linear Machines (11 Hrs)

Linear machines - basic difference between LEMS and rotating - machine – classification of LEMS, linear motors and levitation machines - linear induction motors - linear synchronous motors - DC linear motors - linear levitation machines, Edge Effect, MMF wave and its velocity, air gap flux density

Text/Reference Books

1. Toro.V.D, “Electric machines and power systems”, Prentice Hall of India, 1985.
2. Veinott, “Fractional horse power electric motors”, Mc Graw Hill, 1948
3. Nasar.S.A,Boldeal, “Linear Motion Electric machine”, John Wiley,1976

4. V.U.Bakshi U.A.Bakshi, “Electrical Circuits And Machines”, Technical Publication, Pune,2008.
5. V V Athani, “Stepper Motors: Fundamentals Applications and Design” , New Age International 2007.
6. Fitzgerald, Charles Kingsley, Stephen D. Umans, “Electric machinery”, Tata McGraw-Hill 2002.

EE3025 ELECTRIC POWER UTILIZATION

ELECTIVE COURSE

Prerequisite: EE3004 Power Systems I

L	T	P	C
3	0	0	3

Course outcomes:

CO1: To impart the knowledge of Electric Traction, Electric heating, Electric welding and Illumination
CO2: To make students capable of analyzing and solving the varieties of problems and issues in electric power utilization
CO3: Enable the students to design of interior and exterior lighting systems- illumination levels for various purposes light fittings- factory lighting- flood lighting-street lighting
CO4: Create awareness of energy conservation.
CO5: To impart the knowledge of air conditioning and refrigeration

CO6: Awareness of technology of electric and hybrid electric vehicles

Total Hours: 42 Hours

Module 1: Electric Traction (11 Hrs)

Electric Traction: Features of an ideal traction system-systems of electric traction- mechanism of train movement- speed-time curve, Power and Power Measurement, traction supply system- transmission line to substation- feeding and distributing system on an ac traction- system of current collection-traction motorstractive effort and horse power- Speed control Schemes-Electric braking.

Module 2: Electric Heating (11 Hrs)

Electric heating: classification- heating element-losses in oven and efficiency- resistance furnace- radiant heating- induction heating- high frequency eddy current heating- dielectric heating- arc furnace- heating of buildings-Electric welding:- methods and equipments- Electrolysis and Electroplating applications, Heating of Bare Conductors.

Module 3: Illumination (10 Hrs)

Illumination: radiant energy-terms and definitions- laws of illumination- polar curves- photometry-MSCPintegrating sphere- luminous efficacy- electrical lamps- Color values of illuminates and color effects: colorimeter, artificial daylight, design of interior and exterior lighting systems- illumination levels for various purposes- light fittings- factory lighting- flood lighting-street lighting-energy conservation in lighting.

Module4: Air-Conditioning and Refrigeration (10 Hrs)

Air conditioning and refrigeration: Control of temperature - protection of motors - simple heat load and motor calculations. Air-conditioning - function of complete air conditioning system - type of compressor motor. Cool storage - estimation of tonnage capacity and motor power. Technology of electric and hybrid electric vehicles.

Text/Reference Books:

1. Taylor E Openshaw, "Utilisation of Electric Energy", Orient Longman,1986.
2. J B Gupta, "Utilization of electric power and electric traction", S K Kataria & Sons, 2002.
3. Wadhwa. C.L., "Generation, Distribution and utilization of electrical energy", Wiley Eastern Limited,1993.
4. Soni, Gupta, Bhatnagar, "A course in electric power", Dhanapat Rai & sons, 2001.
5. S.L.Uppal, "Electrical Power", Khanna pulishers,1988.
6. Partab H., "Art and Science of Utilisation of Electrical Energy", Dhanpat Rai and Sons, New Delhi. Second edition
7. Tripathy S.C., "Electric Energy Utilization And Conservation", Tata McGraw Hill,1993 .
8. Web sites: bee-india.org, eia.doe.gov, www.irfca.org.
9. IEEE bronze book-IEEE press
10. William Edward Barrows, "Light, Photometry and Illumination", BiblioBazaar, LLC, 2009

EE3026 DYNAMIC ANALYSIS OF ELECTRICAL MACHINES

ELECTIVE COURSE

Pre-requisites: EE2007 Electrical Machines I & EE3003 Electrical Machines II

L	T	P	C
3	0	0	3

Course outcomes:

CO1: Formulation of electrodynamic equations of all electric machines and analyse the performance characteristics.
CO2: Knowledge of transformations for the dynamic analysis of machines.
CO3: Knowledge of the determination of stability of the machines under small signal and transient conditions.

Total Hours: 42 Hours

Module 1: (12 Hrs)

Electro dynamical Equations and their Solution .A Spring and Plunger System- Rotational Motion System .Mutually Coupled Coils . Solution of Electrodynamical Equations by Euler's method and Runge-Kutta method . Linearisation of the Dynamic Equations and Small Signal Stability .Differential Equations of a smooth air-gap two winding machine .Conditions for Conversion of Average Power in such a Machine .A two phase machine with current excitation - Interpretation of the Average Power Conversion Conditions in terms of air-gap Magnetic Fields. The Primitive 4 Winding Commutaor Machine- The Brush Axis and its Significance . Self and Mutually induced voltages in the stationary and commutator windings . Speed e.m.f induced in Commutator Winding . Rotational Inductance Coefficients . Sign of Speed e.m.f terms in the Voltage Equation . The Complete Voltage Equation of Primitive 4 Winding Commutator Machine .The Torque Equation .Analysis of Simple DC Machines using the Primitive Machine Equations.

Module 2: **(11 Hrs)**

The Three Phase Induction Motor . Equivalent Two Phase Machine by m.m.f equivalence .equivalent two phase machine currents from three phase machine currents . Power Invariant Phase Transformation . Voltage Transformation . Voltage and Torque Equations of the Equivalent Two Phase Machine . Commutator Transformation and its interpretation . Transformed Equations . Different Reference Frames for Induction Motor Analysis . Nonlinearities in Machine Equations . Equations under Steady State - Solution of Large Signal Transients in an Induction Machine . Linearised Equations of Induction Machine . Small Signal Stability . Eigen Values . Transfer Function Formulation.

Module 3: **(10 Hrs)**

The Three Phase Salient Pole Synchronous Machine .Three Phase to Two Phase Transformation . Voltage and Torque Equations in stator, rotor and air-gap field reference frames . Commutator Transformation and Transformed Equations . Parks Transformation . Suitability of Reference Frame Vs kind of Analysis to be Carried out . Steady State Analysis . Large Signal Transient Analysis . Linearisation and Eigen Value Analysis .

General Equations for Small Oscillations . Small Oscillation Equations in State Variable form .Damping and Synchronizing Torques in Small Oscillation Stability Analysis .Application of Small Oscillation Models in Power System Dynamics.

Module 4: **(9 Hrs)**

Dynamical Analysis of Interconnected Machines .Machine Interconnection Matrices . Transformation of Voltage and Torque Equations using Interconnection Matrix . Large Signal Transient Analysis using Transformed Equations . Small Signal Model using Transformed Equations . The DC Generator/DC Motor System . The Alternator /Synchronous Motor System . The Ward-Leonard System . Hunting Analysis of Interconnected Machines Selection of proper reference frames for individual machines in an Interconnected System.

Text/Reference Books:

1. Sengupta D P & J.B. Lynn, “Electrical Machine Dynamics”, The Macmillan Press Ltd.

2. Jones C V, “The Unified Theory of Electrical Machines”, Butterworth, London.
3. Woodson & Melcher, “Electromechanical Dynamics”, John Wiley & Sons.
4. P.C. Kraus, “Analysis of Electrical Machines”, McGraw Hill Book Company

EEU 3027 LINEAR SYSTEM THEORY

ELECTIVE COURSE

L	T	P	C
3	0	0	3

Pre-requisites: None

Course Outcomes:

CO1: Obtain models of dynamic systems

CO2: Linearize nonlinear system models
CO3: Analyze the system stability
CO4: Analyze the system response in both time-domain and frequency domain
CO5: Perform computer simulations of standard dynamical systems

Total Hours: 42 Hours

Module 1: **(11 Hrs)**
Introduction to the concepts of dynamic systems modelling and analysis design and development-Definition of system –System Dynamics--Feedback-Classification of systems- static, dynamic, linear, non-linear, time varying, time invariant, distributed, lumped, continuous time, discrete time, discrete event, systems etc.Modelling of electrical systems- passive networks- d c and a c motors linear models – Concept of transfer function – transfer functions for simple electrical and electromechanical systems. Impulse response and transfer function- convolution –block diagrams and signal flow graphs- Mason's gain formula

Module 2: **(10 Hrs)**
Modelling of non-electrical systems- Examples of simple pneumatic, hydraulic and thermal and liquid level systems-control valves - Translational and rotational systems- D'Alembert's principle-Modelling of electromechanical systems, force-voltage and force-current analogy- Comparison of RLC Circuits and MassSpring-Damper system- Development of linearised models- Superposition principle-Linearized model for Inverted Pendulum. Introduction to Time delay systems.

Module 3: **(11 Hrs)**
Fourier representation of aperiodic signals- Fourier transform and inverse Fourier transform pairs- Properties of Fourier transforms. Continuous amplitude and phase spectra-Relation between Laplace transforms and Fourier transforms. Concepts of attenuation, amplification and filtering of signals.
Stability of linear systems – open loop and closed loop stability – bounded input bounded output stability -Routh Hurwitz criterion – limitations

Module 4: **(10 Hrs)**
Time domain and Frequency domain analysis of single input-single output linear time invariant systemsDetermination ofImpulse response-Analysis ofresponse to other standard inputs- step, ramp ,acceleration and sinusoidal inputs- Time domain performance measures for first order and second order systems- under-damped and over-damped systems- Significance of damping factor. Definition of order and type of dynamical systemssteady state and dynamic error-Determination of error constants from transfer functions- Analysis of response of higher order systems- Effect of poles and zeros. Frequency response – Bode plots – performance criteria in frequency domain – band width – cut off frequency – gain margin –phase margin. Computer simulation of systems.

Text/Reference Books:

1. David K Cheng: Analysis of Linear Systems, Narosa Publishers,1998.
2. Gene F Franklin, J David Powell, Abbas Emami Naeini, Feedback Control of Dynamic Systems, 4th Ed, Pearson Education Asia, 2002
3. M. Gopal Control Systems Engineering, Tata McGrah Hill , 2008.
4. John J D'Azzo, Constantine H Houpis, Stuart N. Sheldon, Linear Control System Analysis & Design with MATLAB, 5th Ed, Marcel Dekker, 2003
5. Burton T.D., Introduction to Dynamic Systems, McGrawHill, 1994
6. John Dorsey, Continuous & Discrete Control Systems, McGrawHill, 2002.

7. Wayne H Chen, The Analysis of Linear Systems, McGrawHill, 1963.
8. Benjamin Kuo, Automatic Control Systems, 7th Ed, Prentice Hall India,1995.
9. Norman S. Nise, Control Systems Engineering, 4th Ed., John Wiley, 2004
10. Chi-Tong Chen, Linear System Theory and Design, Oxford University Press, 1999

EE 3028 HIGH VOLTAGE ENGINEERING

ELECTIVE COURSE

Pre-requisites : None

L	T	P	C
3	0	0	3

Course outcomes:

CO1: Acquire the knowledge of the necessity and methods of testing various apparatus in power system.

CO2: Knowledge of various circuits for generating high voltages for testing various apparatus and their measurement method.

CO3: Knowledge of the various reasons of overvoltage in powersystem and protection methods against them.

CO4: Knowledge of insulation coordination and design of insulation levels of various parts of power system.

Total Hours: 42 Hours

Module 1: (10 Hrs)

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

Module 2: (11 Hrs)

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-rogowski coils-hall effect generators

Module 3: (10 Hrs)

High voltage testing of materials and apparatus-preventive and diagnostic tests-dielectric loss measurementsschering bridge-inductively coupled ratio arm bridge-partial discharge and radio interference measurementtesting of circuit breakers and surge diverters

Module 4: (11 Hrs)

Introduction to Insulation materials: Different types of insulating materials, Insulating materials used in various equipments. Breakdown in gas and gas mixtures-breakdown in uniform and non uniform fields-Paschens lawTownsends criterion-streamer mechanism-corona discharge-breakdown in electro negative gases- Breakdown in liquid dielectrics-Breakdown in solid dielectrics.

Natural causes of over voltages- lightning phenomena - over voltages due to switching surges - system faults and other abnormal conditions for different voltage levels- principles of insulation co-ordination

Text/Reference Books:

1. Kuffel and Zaengal , "High Voltage Engineering Fundamentals", Newness, 2 ed.2002

2. M. S. Naidu, V. Kamaraju, "High Voltage Engineering", McGraw-Hill, 3 ed.,1995.
3. M. Khalifa, "High Voltage Engineering: Theory and Practice", Dekker, 1990.
4. H. M. Ryan, "High Voltage Engineering and Testing", IEE 2001.
5. Kuffel and Abdullah.M, “High Voltage Engineering”, Pergamon press,1978
6. Wadhwa C L, “High Voltage Engineering”, New Age International, NewDelhi,1994
7. Relevant IS standards and IEC standards
8. Haddad A , Warne D F, “Advances in High Voltage Engineering”, IEE publication,2004
9. Standard techniques for high voltage testing, IEEE Publication 1978.

EE3029 NON-CONVENTIONAL ENERGY SYSTEMS AND APPLICATIONS

ELECTIVE COURSE

Pre-requisites : None

L	T	P	C
3	0	0	3

Course outcomes:

CO1: Create awareness among students about Non-Conventional sources of energy technologies

CO2: Enable students to understand various renewable energy technologies and systems.
CO3: To impart the knowledge of Storage technologies form the autonomous renewable energy sources
CO4: Equip the students with knowledge and understanding of various possible mechanisms about renewable energy projects

Total Hours: 42 Hours

Module 1: (12 Hrs)

Introduction to renewable energy various aspects of energy conversion-Principle of renewable energy systemsenvironment and social implications
Solar energy: Solar radiation components- measurements-estimation-solar collectors-solar water heatersCalculation-Types-analysis-economics-Applications Solar thermal power generation
Solar Photovoltaics- energy conversion principle-classifications-equivalent circuit-characteristics-Cell efficiency- Limitations-PV modules-MPPT algorithms

Module 2: (9 Hrs)

Wind energy: Basics of wind-wind turbines-power and energy from wind turbine-characteristics- - types of electric generators for wind power generation. Dynamics matching- performance of wind generators applications- economics of wind power

Module 3: (10 Hrs)

Storage Devices: Super capacitor-SMES- Battery storage-flywheel storage- compressed air storage- Fuel cells–types and applications; MHD generators – backup -System design-industrial and domestic applications.

Module 4: **(11 Hrs)**

Bioenergy: Bio fuels-classification-biomass conversion technologies-applications; Ocean Energy: Tidal energy-wave energy-ocean thermal energy conversion systems-applications; - mini, micro and pico hydel power

Text/Reference Books:

1. Godfrey Boyle, "Renewable Energy: Power for a sustainable future", Oxford University press, Second edition.
2. Rai G D, "Solar Energy Utilization", Khanna Publishers, 1997.
3. B H Khan, "Non-Conventional Energy Resources", The McGraw-Hill Companies, Second Edition. 4.Sukhatme, S.P, "Solar Energy -Principles of Thermal Collection and Storage", Tata
5. McGraw-Hill, 2 ed., 1997.
6. Sammes, Nige, "Fuel Cell Technologies-State and Perspectives", Springer publication, 2005
7. Kreith, F., and Kreider, J.F., "Principles of Solar Engineering", Mc-Graw-Hill Book Co, 1978.
8. S.L.Soo , "Direct Energy Conversion" , Prentice Hall Publication, 1968
9. James Larminie, Andrew Dicks, **"**Fuel Cell Systems", Wiley & Sons Ltd, 2ed, 2003.
10. E.J. Womack , "MHD power generation engineering aspects" , Chapman, Hall Publication, 1969.

EE 3030 APPLICATIONS OF ANALOG INTEGRATED CIRCUITS

ELECTIVE COURSE

Pre-requisite: EE 2004 Basic Electronic Circuits & EE 2008 Analog Electronic Circuits

L	T	P	C
3	0	0	3

Course outcomes:

CO1: Acquire in-depth knowledge on internal circuits of BJT and CMOS Opamps

CO2: Develop analytical capability in analyzing signal generation, signal amplification, signal conditioning and signal processing applications of analog integrated circuit packages

CO3: Develop design capability in signal generation, amplification, conditioning using analog integrated circuit packages

CO4: Develop analysis and design competence on Opamp RC filters, OTA-C filters and Switched Capacitor filters

CO5: Acquire knowledge on advanced analog signal processing systems such as log/antilog amplifiers, multipliers anddividers, PLLs, DDS, etc

Total Hours: 42 Hours

Module 1: **(10 Hrs)**

Various Stages of an Operational Amplifier, Active Load, Current Mirror –

Simplified Schematic Circuit of a typical BJT Opamp, Bias and Small Signal Analysis of a typical BJT

Opamp, Bias and Small Signal Analysis of a typical two-stage CMOS Opamp, Bias and Small Signal Analysis of a typical folded cascode CMOS Opamp
Ideal and practical characteristics of Opamps, Compensating an Opamp, Offset model of opamp and offset analysis of simple application circuits, special design opamps, auto-zero amplifiers, single supply opamps and applications. Noise Dynamics and Properties. Sources of Noise and Low-Noise Op Amps

Module 2: (10 Hrs)

Applications : Amplifiers for Signal Conditioning, Schmitt Triggers, analog switches, comparator ICs, precision rectifiers, precision clipping circuits,Sine, Triangular, Sawtooth, and Monolithic Wave Generators, Multivibrators , V-F and F-V Converters, VCO Circuits, Timers.Voltage References and Regulators.
Switching, linear, and monolithic switching regulators. Switching Regulator Control ICs , Battery Charging Control ICs.Operational Transconductance Amplifiers . Applications

Module 3: (12 Hrs)

Active Filters:Categories of Filters, LP,HP,BP,BE and All Pass Filters, Second Order s-domain equations in each case and their pole-zero plots. The Filter approximation problem - Butterworth Approximation, Chebyshev and Inverse Chebyshev Approximations, frequency transformations.Biquad Topologies, Analysis and Design of Single OPAMP Biquads with finite gain. Analysis and design of LP,HP and BP Filter with second order response KHN (Universal Active Filter) Filter, Tom-Thomas Biquad, Analysis and Design for various categories of filters- OTA .C Tunable Filters.

SC Filters, SC Resistor, First and second Order SC Filters, Structure for LP, HP, BP and BE SC Filters

Module 4: (10 Hrs)

Applications and Design Techniques:Log/Antilog Amplifiers and Applications, Analog Multipliers . Log / Antilog , Transconductance Type and TDM Type .Applications of Multipliers - True RMS to DC Converters -

Phase-Locked Loops, Monolithic PLLs, PLL Applications- Direct Digital Synthesis of Waveforms. Hardware Design Techniques.Grounding and Shielding, Power Supply Filtering and Noise reduction, Grounding in Mixed Signal Systems, EMI/RFI considerations.

Text/Reference Books:

1. A.S Sedra and K.C Smith, .Microelectronic Circuits., Holt Saunders International Edition-3,1989
2. D.H. Sheingold, .Nonlinear Circuits Handbook., Analog Devices Inc. 1976
3. Clayton , .Operational Amplifiers., Butterworth Publications,1979
4. Sergio Franco, Design with Operational Amplifiers and Analog Integrated Circuits., Mc Graw Hill, 1988
5. M.E Van Valkenburg, Analog Filter Design., Oxford University Press 2001
6. National Semiconductor, Linear Applications Handbook., 1994
7. Analog Devices Inc, Practical Design Techniques for Thermal and Power Management., 2004
8. Analog Devices Inc , RMS to DC Conversion Application Guide.
9. Analog Devices Inc., A Designers. Guide to Instrumentation Amplifiers.

10. Analog Devices Inc., Practical Design Techniques for Sensor Signal Conditioning.

EE3091 ELECTRICAL MACHINES LAB I

REQUIRED COURSE

Pre-requisite: EE2007 Electrical Machines I

L	T	P	C
0	0	3	2

Course outcomes:

CO1: Acquire hands on experience of conducting various tests on dc machines and obtaining their performance indices using standard analytical as well as graphical methods.

CO2: Acquire hands on experience of conducting various tests on transformers and obtaining their performance indices using standard analytical as well as graphical methods.

Total Hours: 42 Hours

List of Experiments

1. Determination of open circuit characteristic of a dc shunt generator and its analysis.
2. Load test on a dc shunt generator, determination of internal/ external characteristics and analysis.
3. Break test on dc shunt and series motors, determination of performance characteristics and analysis.
4. Swinburne's test on a dc shunts motor and predetermination of efficiency of the machine.
5. Hopkinton's test on a pair of dc shunts machines and predetermination of their efficiencies.
6. Retardation test on a dc shunt machine and separation of losses.
7. No load test on a dc shunt machine and separation of losses.
8. OC and SC tests on a single-phase transformer and predetermination of efficiency/ regulation.
9. Separation of losses in a single-phase transformer.
10. Sumpner's test on a pair of single-phase transformers and predetermination of efficiency/ regulation.
11. Scott connection of two single-phase transformers and performance evaluation.
12. Polarity test on single phase transformers and three phase connections of the same.

Text/Reference Books:

1. Clayton & Hancock, Performance & Design Of DC Machines, CBS, 3rd edition, 2001
2. Langsdorf A.S., Principles of DC Machines, McGraw Hill.6th edition, 1959.

3. Say M. G, Performance & Design of AC Machines, Pitman, ELBS.3rd edition, 1983.
4. Langsdorf A.S., Theory of AC Machinery, McGraw Hill., 2nd edition, 2002.

ME3094 MECHANICAL ENGINEERING LABORATORY

REQUIRED COURSE

Pre-requisite: ME2007 Mechanical Engineering

L	T	P	C
0	0	3	2

Course Outcomes

CO1: Acquire knowledge about various flow measuring devices and its calibration.

CO2: Acquire knowledge about testing procedures of fluid machineries such as pumps turbines etc.

CO3: Familiarize various types of IC engines and its performance characteristics through laboratory testing.

CO4: Familiarize the various mechanical engineering devices such as compressor through laboratory demonstration and testing.

Number of Hours: 42

Fluid mechanics lab:
Flow measurement -- venturi meter -- nozzle meter -- orifice meter – notches, Friction factor for various types of flows through pipes, Metacentric height for floating bodies.

Hydraulic machinery lab:
Characteristics of turbines – Pelton turbine -- Francis turbine, Characteristics of pumps – centrifugal pump -reciprocating pump -- gear pump.

Heat engines lab:
Properties of oils – viscosity -- flash and fire points, Constant speed characteristics of internal combustion engines – spark ignition engines and compression ignition engines, Characteristics air compressors

EE3005 DIGITAL SIGNAL PROCESSING
REQUIRED COURSE

Pre-requisites: EE2001 Signals & Systems

L	T	P	C
3	0	0	3

Course Outcomes:

CO1: Acquireknowledgeabout the time domain representation and classification of discrete time signals and systems

CO2: Acquireknowledgeabout the time domain analysis of linear time invariant discrete time systems and representation of total response in various formats.

CO3: Acquireknowledgeabout the application of discrete time Fourier transform, Discrete Fourier series and z-transform for discrete time signal representation and analysis of linear time invariant systems discrete time systems.

CO4: Acquireknowledgeabout the application of discrete Fourier transform in signal representation and system analysis and DFT computation using FFT algorithms.

CO5: Acquireknowledgeabout the design methods for IIR and FIR filters and their realisation structures.

CO6: Acquireknowledgeabout the finite wordlength effects in the implementation of digital filters

Total Hrs : 42 Hrs

Module 1: (10 Hrs)

Discrete-time signals and systems: Discrete-time signals - sequences - Discrete-time systems- linear shift invariant systems - stability and causality - difference equations - frequency domain representations – Review of Fourier transform and its properties - sampling of continuous - time signals – Spectral characteristics - z transform - inverse z transforms .

Module 2: (10 Hrs)

Transform Analysis of LTI Systems and Structures for DTS: Frequency response for rational system functions- Geometric construction for computation of the frequency response function from pole-zero plots- All pass systems-minimum phase systems-Linear systems with generalized linear phase characteristics- basic structures for IIR and FIR systems- Direct forms- cascade forms- parallel forms.

Module 3: (12 Hrs)

Digital filter design techniques and finite wordlength effects: Design of IIR filters from analog filters - analog Butterworth function for various frequency selective filters- analog to digital transformation - backward difference and forward - difference approximations - impulse invariant transformation - bilinear transformation prewarping - design examples - properties of FIR filters - design of FIR filters using windows - comparison of IIR and FIR filters - finite word length effect in DSP- zero-input limit cycles in fixed point realizations of IIR digital filters-Limit cycles due to overflow.

Module 4: (10 Hrs)

The Discrete Fourier Transform : Representation of periodic sequences - properties of discrete Fourier series discrete Fourier transforms - properties of DFT - linear convolution using DFT - overlap - add method - overlap save method - FFT - Radix2 DIT FFT algorithm - Radix2 DIF FFT algorithm - butterfly structure - bit reversed order - in - place computations-Fourier analysis of signals using the DFT .

Text/Reference Books:

1. Alan V . Oppenheim, Ronald W. Schafer, .Discrete-Time Signal Processing., Prentice-Hall of India Pvt. Ltd., New Delhi, 1997
2. Sanjit K Mitra, .Digital Signal Processing: A computer-based approach. ,Tata McGrow-Hill edition .1998
3. John G. Proakis, and Dimitris G. Manolakis, .Digital Signal Processing.(Fourth Edition), Pearson Prentice Hall of India Pvt. Ltd, New Delhi, 2007
4. Emmanuel C. Ifeachor, Barrie W. Jervis , .Digital Signal Processing-A practical Approach., Addison Wesley Publishers Ltd.,1993
5. Abraham Peled and Bede Liu, Digital Signal Processing ,Theory, Design and Implementation, John Wiley and Sons,Inc., 1976
6. Haykin and Van Veen, Signals and Systems, (second edition), John Wiley and sons, Inc.,2003.

EE3006 POWER SYSTEMS – II

REQUIRED COURSE

Pre-requisites: None

L	T	P	C
3	0	0	3

Course Outcomes:

CO1: Exposure to the modeling of individual power system components like transmission lines and generators

CO2: Enable the students to do load flow and short circuit calculations

CO3: Enable the students to do analysis of economic dispatch of thermal generators , load sharing and governor control

CO4: To impart the knowledge of automatic generation control and voltage regulation

CO5: To make students capable of analysis of power system stability, security and reliability

CO6: Awareness of deregulated power system

Total Hrs: 42 Hrs

Module 1: (12 Hrs)

Performance of transmission lines - calculation of transmission line inductance and capacitance - GMD and GMR - bundled conductors - transposition - ABCD constants - effect of capacitance - nominal T and π methods of calculations -power flow through a transmission line. Methods of voltage control

Representation of power systems - per unit quantities - Y-bus and Z-bus matrices - load flow studies:- GaussSeidal- Newton Raphson and fast decoupled methods - line loss computation – HVDC Transmission and AC-DC load flow

Module 2: (10 Hrs)

Short circuit studies - faults on power systems - short circuit capacity of a bus and circuit breaker ratings-current limiting reactor- sequence impedances and sequence network - symmetrical component methods of analysis of unsymmetrical faults at the terminals of an unloaded generator – Z bus building algorithm-fault analysis using Zbus

Module 3: **(10 Hrs)**

Economic dispatch of thermal plants.B-coefficient - optimal load flow solution –unit commitment-speed governing of turbo generator - load sharing and governor characteristics-load frequency control of single and multi area systems - implementation of Economic Dispatch and Automatic Generation Control - automatic voltage regulation - EMS.SCADA, hydro thermal scheduling.

Module 4: **(10 Hrs)**

Power system stability studies - electrical stiffness - swing equation - inertia constant - equal area criterion multi machine stability analysis - factors affecting stability-Voltage stability problem: causes and improvement methods-introduction to power system security and reliability-deregulated power systems.

Text/Reference Books:

1. Stevenson J V, William D, "Elements of Power System Analysis", McGraw Hill, 1988.
2. D.P. Kothari & 1.J. Nagrath, "Modern Power System Analysis", Tata McGraw Hill, 2007.
3. A.K. Mahalanabis, "Computer Aided Power System Analysis & Control", Tata McGraw Hill, 1991 4.Arthur R Bergen, Vijay Vittal, "Power system Analysis", Pearson Education (Singapore) Pte, Ltd., 2004
5. Hadi Saadat, "Power System Analysis", Tata Mc Graw Hill, 2003.
6. J Arrilaga, C P Arnold, B J Harker, "Computer Modelling of Electric Power Systems"
7. Elgerd olleI, "Electric Energy Sytems Theory- An Introduction", Tata Mc Graw Hill, 2ed. 1995.
8. Wadhwa C L, "Electrical Power Systems", New Age Publication, 3ed., 2002
9. LOI LEI LAI, "Power system restructuring and deregulation", John Wiley & sons, 2002.
10. Antonio Gomez-Exposito, Antonio j.conejo & Claudio canizares, "Electric Energy systems analysis and operation", CRP press, 2009.

EE3007 POWER ELECTRONICS

REQUIRED COURSE

Prerequisite: Nil

L	T	P	C
3	0	0	3

Course outcomes:

CO1: To understand the basics of Power Electronics.

CO2:To learn the basics of power semiconductor switches (Construction, Characteristics and operation).
CO3: To understand the working of various types of converters.
CO4: To learn how to analyse the converters and design the components of them, under various load types.
CO5: To learn about the control of various converters.

Total Hrs: 42 Hrs

Module 1: Power Semiconductor Switches **(12 Hrs)**

Power diodes - Basic structure and V-I characteristics - various types - DIACs – Basic structure and V-I characteristics – TRIACs - Basic structure and V-I characteristics -Thyristors - basic structure - static and dynamic characteristics - device specifications and ratings - methods of turning on - gate triggering circuit

using UJT - methods of turning off - commutation circuits. IGBTs - Basic structure and V-I characteristics.
MOSFETs - Basic structure and V-I characteristics

Module 2: Rectifiers **(11 Hrs)**

Line frequency phase controlled rectifiers using SCR
Single Phase – Half wave rectifier with R and RL loads – Full wave half controlled and fully controlled converters with continuous and constant currents - Input side harmonics and power factor - Effect of source inductance.Three Phase - Half wave rectifier with R and RL loads - Full wave fully controlled converters with continuous and constant currents

Module 3: Inverters & Cycloconverters **(10 Hrs)**

Inverters – Single phase inverters – series, parallel and bridge inverters.Single Phase Pulse Width Modulated (PWM) inverters – Basic circuit and operation.
AC regulators - single phase ac regulator with R and RL loads - sequence control of ac regulators - single phase to single phase cycloconverters - basic principle of operation.

Module 4: DC – DC Converters **(9 Hrs)**

Choppers - principle of operation - step-up and step-down choppers.Switching regulators - Buck regulators - Boost regulators - Buck-boost regulators - Switched mode power supply - principle of operation and analysis

Text/Reference Books:

1. Ned Mohan, Power Electronics., John Wiley and Sons, 2nd edition, 1995.
2. Rashid, Power Electronics, Circuits Devices and Applications, Pearson Education, 3rd edition, 2004.
3. G.K.Dubey, Thyristorised Power Controllers, Wiley Eastern Ltd, 1993.
4. Dewan & Straughen, Power Semiconductor Circuits, John Wiley & Sons, 1975.
5. Cyril W Lander, Power Electronics, Mc Graw Hill, 3rd edition, 1993.

EE3008 ENVIRONMENTAL STUDIES FOR ELECTRICAL ENGINEERS

REQUIRED COURSE

Pre-requisites: None

L	T	P	C
3	0	0	3

Course outcomes:

CO1: To instil the spirit of environmental enthusiasm and environmentalism
CO2: To make them aware of the environmental problems faced by the modern man in terms of pollution, deforestation and in general the environmental degradation
CO3: To enable them to think in terms of sustainable envelopment based on the knowledge they have in different subjects of science and engineering
CO4: To make them think in terms of scientific and technological advancement in the spirit of a sustainable earth

CO5: To make them understand the relationships between natural resources, consumption, population, economics of consumerism, etc in an environmental context.

Total Hrs: 42 Hrs

Unit 1 : Multidisciplinary nature of environmental studies (2 hrs)
Definition, scope and importance, Need for public awareness.

Unit 2 : Natural Resources : (7 hrs)
Renewable and non-renewable resources :
Natural resources and associated problems. a) Forest resources : Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources : Use and over-utilization of surface and ground water,floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources : Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d) Food resources : World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. e) Energy resources : Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Case studies. f) Land resources : Land as a resource, land degradation, man induced landslides, soil erosion and desertification.
Role of an individual in conservation of natural resources-Equitable use of resources for sustainable lifestyles.

Unit 3 : Ecosystems (5 hrs)
Concept of an ecosystem. - Structure and function of an ecosystem - Producers, consumers and decomposers Energy flow in the ecosystem - Ecological succession - Food chains, food webs and ecological pyramidIntroduction, types, characteristic features, structure and function of the following ecosystem :- (a) Forest ecosystem (b) Grassland ecosystem (c) Desert ecosystem (d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit 4 : Biodiversity and its conservation (6 hrs)
Introduction – Definition : genetic, species and ecosystem diversity. - Biogeographical classification of India Value of biodiversity : consumptive use, productive use, social, ethical, aesthetic and option values Biodiversity at global, National and local levels - India as a mega-diversity nation - Hot-spots of biodiversity. Threats to biodiversity : habitat loss, poaching of wildlife, man-wildlife conflicts. - Endangered and endemic species of India - Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity.

Unit 5 : Environmental Pollution (6 hrs)
Definition - Cause, effects and control measures of :- (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards - Solid waste Management : Causes, effects and control measures of urban and industrial wastes - Role of an individual in prevention of pollution - Pollution case studies. - Disasters management : floods, earthquake, cyclone and landslides.

Unit 6 : Social Issues and the Environment (6 hrs)
From Unsustainable to Sustainable development - Urban problems related to energy - Water conservation, rain water harvesting, watershed management - Resettlement and rahabilitation of people; its problems and concerns. Case Studies - Environmental ethics : Issues and possible solutions - Climate change, global warming, acid rain, ozone layer depletion, nuclear
accidents and holocaust. Case Studies - Wasteland reclamation -Consumerism and waste products - Environment Protection Act -Air (Prevention and Control of Pollution) Act - Water (Prevention and

control of Pollution) Act - Wildlife Protection Act - Forest Conservation Act - Issues involved in enforcement of environmental legislation - Public awareness.

Unit 7 : Human Population and the Environment (5 hrs)

Population growth, variation among nations - Population explosion – Family Welfare Programme - Environment and human health - Human Rights - Value Education - HIV/AIDS - Women and Child Welfare - Role of Information Technology in Environment and human health - Case Studies.

Unit 8 : Field work (5 hrs)

Visit to a local area to document environmental assets- river/forest/grassland/hill/mountain - Visit to a local polluted site-Urban/Rural/Industrial/Agricultural - Study of common plants, insects, birds -Study of simple ecosystems-pond, river, hill slopes, etc.

Text/Reference Books:

1. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
2. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India, Email:mapin@icenet.net (R)
3. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p
4. Clark R.S., Marine Pollution, Clanderson Press Oxford (TB)
5. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumbai, 1196p
6. De A.K., Environmental Chemistry, Wiley Eastern Ltd.

EE3093 MINI PROJECT

L	T	P	C
0	3	0	2

CO1: Enable theStudents to undertake short research projects under the direction of members of the faculty

CO2: To impart skills in preparing detailed report describing the project and results.

CO3: To enable theStudents to undertake fabrication work of new experimental set up/devices or develop software packages

CO4: To effectively communicate by making an oral presentation before an evaluation committee

The mini project can be analytical / simulation/design or and fabrication in any of the areas in Electrical Engineering. Project can be done by individual student or by a group of students under any faculty of the Electrical Engineering Department as the guide. Maximum number of students in a project group shall be three. A faculty coordinator will coordinate project work of all students. The mini project is usually allotted by the Dept at the beginning of 6th semester and preferably shall be completed before the end of 6th semester.

The project work is evaluated by a committee consisting of the concerned guide and two/three faculty members in the concerned area of the project nominated by the HOD. The faculty coordinator of the project will be a member of the evaluation committee all the projects. The mode of presentation, submission of the report, method of evaluation, award of grades etc will be decided by the evaluation committee. Students shall submit both soft and hard copies (required number of copies) of project report in the prescribed form to the department and library after incorporating all the corrections and changes suggested by the evaluation committee.

EE 3031 DYNAMIC SYSTEM SIMULATION

ELECTIVE COURSE

Prerequisite: EE2001 Signals & Systems

L	T	P	C
3	0	0	3

Course Outcomes:

CO1: Simulate system models using computers

CO2: Simulate continuous – time systems using transfer function model

CO3: Simulate discrete-time and digital control sytems

CO4: Simulate power electronic circuits, machines and drives

CO5: Simulate time-series models, statistical models, Markovian models and discrete event systems

Total Hrs: 42 Hrs

Module 1: (11 Hrs)

Simulation of systems using Computers: Study of popular Simulation Tools- Text based programming

Integrated Programming Environments-Case studies for typical systems Computer simulation of continuous time dynamic systems usingtransfer function models- electromechanical hydraulic and pneumatic systemsSimulation of discrete time and digital control systems-State Space Models-State feedback Control.

Module 2: **(11 Hrs)**
Blockset based simulation techniques- Case studies for typical systems- Computer simulation of continuous time dynamic systems usingtransfer function models**-** electromechanical hydraulic and pneumatic systems Simulation of discrete time and digital control systems.

Module 3: **(10 Hrs)**
Simulation of Power Electronic Circuits, Machines and Drives- Circuit Simulation and Systems Simulation approaches-Development of generalized machine models for induction motor. Simulation of Ward Leonard system of speed control.Simulation of induction motor driven from inverters.

Module 4: **(10 Hrs)**
Introduction to Random Processes and Stochastic Systems Theory : Time Series Methods- Simulation of AR, MA, ARMA processes- Outliers- Statistical models in simulation. discrete and continuous distributions- Poisson processes- empirical distributions- queuing models- characteristics of queuing systems- performance measuresMarkovian models- steady state behaviour of infinite population Markov models-single server queues with Poisson arrivals- Steady state behavior of finite population models-Developing Random Sequences with different distributions like Gaussian, Cauchy, Laplace etc from Uniform random numbers-Discrete Even Systems.

Text/Reference Books:

1. Narsingh Deo, . System Simulation with Digital Computer, Prentice Hall India, 1989
2. Graham C Goodwin, Stefan F Graebe, Mario E Salgado, Control System Design, Prentice Hall India, 2003 3.Richard C. Dorf and Robert H Bishop, Modern Control Systems, 8th Ed., Addison Wesley, 1998.
4. Karl J. Aström, Björn Wittenmark, Computer Controlled Systems: Theory and Design, 3rd Ed. Prentice Hall, 1997.
5. Douglas M. Considine, Process/Industrial Instruments & Control Handbook, 4th Ed., McGrawHill, 1993.
6. Jai P. Agarwal, Power Electronic Systems: Theory & Design, Pearson Education Asia, 2001.

7. P.C. Sen, Principles of Electrical Machines & Power Electronics, John Wiley, 2003.
8. Louis G Birta and Gilber Arbez, Modelling and Simulation(Exploring Dynamic System behavior) Springer Verlag, 2007

EE3032 DIGITAL CONTROL SYSTEMS

ELECTIVE COURSE

Pre-requisite: EE3002 Control Systems I

L	T	P	C
3	0	0	3

Course Outcomes:

CO1: To understand the basic principles and modeling of digital control system in transfer function and state-space domain.

CO2: To understand application of Laplace and Z-transforms and its correlation for digital control system.

CO3: To learn to analysis different aspect of time response like steady state analysis, transient response analysis with system pole location, disturbance rejection, robustness and sensitivity analysis

CO4: To understand the analysis techniques like Root locus, Bode and Nyquist plots, Jury stability criteria, Routh stability criteria, Bilinear transformation

CO5: To learn the design procedure for controller for digital control system using root locus method, Bilinear transformation.

CO6: Acquire the knowledge of fundamentals and design procedures of deadbeat controllers for digital control system.

Total Hrs: 42 Hrs

Module 1: (**11 Hrs**)

Basic digital control system- Examples - mathematical model-ZOH and FOH- choice of sampling rateprinciples of discretisation-Mapping between s-domain and z-domain-Pulse transfer function-Different configurations for the design- Modified z-transform- Multi-rate discrete data systems.

Module 2: **(11 Hrs)**

Time responses of discrete data systems- Correlation between time response and root locations in the z-planeSteady state performance- Disturbance Rejection- Robustness and Sensitivity -Jury's stability test – Routh stability criterion on the r-plane -Root locus- Polar plots-Nyquist stability criterion- Bode plot-Bilinear transformation method .

Module 3: **(10 Hrs)**

Cascade compensators using Root Locus- Design of PID controllers by using bilinear transformation-Digital controller design using bilinear transformation- Dead-beat response design- Deadbeat controller without and with prescribed manipulated variable-Choice of sample time for deadbeat controller-Realization of digital controllers- Computer based simulation.

Module 4: **(10 Hrs)**

State variable model of discrete data systems with S/H devices- State transition equations- state diagramsTransfer function- Transformation to Jordan canonical form and phase variable form-Computation of state transition matrix using Cayley-Hamilton theorem and z-transform method-Response between sampling instantsControllability, Observability, stabilizability and reachability- Loss of controllability and observability due to sampling- Pole placement design using state feedback for SISO systems- Computer based simulation.

Text/Reference Books:

1. M.Gopal,Digital control and State Variable methods, Tata McGraw –Hill , 1997
2. B.C.Kuo, Digital Control Systems, 2nd Ed., Oxford University Press,1992.
3. Constantine H. Houpis and Gary B. Lamont, Digital control systems Theory, hardware software, Mc-Graw Hill Book Company, 1985.
4. R.Isermann, Digital control systems, Volume 1, Fundamentals , Deterministic control,(2nd revised edition),Springer Verlag, 1989.
5. R.G.Jacquot, Modern digital control systems, (second edition),Marcel Dekker, Inc., 1995.
6. Philips and Nagle, Digital control system analysis and design, Prentice Hall, 1984.

7. G.F.Franklin, J.David Powell and M.Workman,Digital Control of Dynamic Systems, 3rd Ed.,,Addison Wesley, 2000.

EE 3033 FUZZY LOGIC SYSTEMS

ELECTIVE COURSE

Pre-requisite: None

L	T	P	C
3	0	0	3

Course outcomes:

CO1: Provide the student with the basic understanding of fuzzy logic fundamentals.
CO2: Enable students with Program of Fuzzy logic control in MATLAB
CO3: Understand various possible applications of fuzzy systems to electrical engineering field
CO4: Cater the knowledge of Fuzzy Logic Control and use of these for controlling real time systems

Total Hrs: 42 Hrs

Module 1: (12 Hrs)

Theory of Fuzzy Sets and fuzzy relations: Fuzzy Reasoning-Fuzzy Rules-Fuzziness compared to randomnessIntroduction - Classical sets and fuzzy sets-operations on both- properties of fuzzy sets-classical relations and fuzzy relations- cardinality of fuzzy relations-Fuzzy Cartesian product and composition–fuzzy tolerance and equivalence relations- value assignments - cosine amplitude-max-min method.

Module 2: (12 Hrs)

Fuzzification and De-fuzzification : Formation of Fuzzy Rule Base-Membership functions - features - standard forms –fuzzification - membership value assignments - intuition – inference-rank ordering - angular fuzzy sets inductive reasoning -fuzzy to crisp conversion – lambda/alpha cuts for fuzzy sets and fuzzy relations defuzzification methods.

Module 3: (11 Hrs)

Fuzzy Logic : Classical logic and fuzzy logic –fuzzy rule based systems - approximate reasoning - canonical rule forms - decomposition of compound rules - likelihood and truth classification - aggregation of fuzzy rules – fuzzy inference systems- Mamdani and Takagi-Sugeno fuzzy models- fuzzy control models-P-1-D like fuzzy control rules – implementation. Computer based simulation-Language based programming in C/C++-Use of Simulation Tools.

Module 4: (7 Hrs)

Fuzzy nonlinear simulation- fuzzy classification - clustering – fuzzy pattern recognition - fuzzy control systems- fuzzy optimization - case studies – Fuzzy Logic combined with Neural Networks and Genetic Algorithms-Soft Computing Techniques- Fuzzy measures (brief introduction only).

Text/Reference Books:

1.Timothy J Ross, *Fuzzy Logic with Engineering Applications*, McGraw Hill, 2007.

2. Guanrong Chen & Trung Tat Pham Introduction to Fuzzy Systems, Chapman & hall /CRC, 2006

3. Driankov D., Hellendoorn H., Reinfrank M, *An Introduction to Fuzzy Control*., Narosa Publications ,1993.

4. Robert Babuska, *Fuzzy Modeling for Control*, International Series in Intelligent Technologies, Kluwer Academic Publications, 1998
5. Ronald R Yager and Dimitar P Filev, *Essentials of Fuzzy Modelling &Control*., John Wiley & Sons, Inc, 2002.
6. J.-S.R.Jang, C.-T.Sun,E.Mizutani, *Neuro-Fuzzy and Soft Computing*, Prentice Hall, 1997.
7. B.Kosko, *Fuzzy Engineering*, Prentice Hall, 1997

EE3034 ELECTRICAL MACHINE DESIGN

ELECTIVE COURSE

Prerequisite: EE2007 Electrical Machines I & EE3003 Electrical Machines II

L	T	P	C
3	0	0	3

Course outcomes:

CO1: Acquire knowledge to carry out a detailed design of a dc machine and provide the information required for the fabrication of the same along with an estimate of various performance indices of it.
CO2: Acquire knowledge to carry out a detailed design of a transformer and provide the information required for the fabrication of the same along with an estimate of various performance indices of it.
CO3: Acquire knowledge to carry out a detailed design of an alternator and provide the information required for the fabrication of the same along with an estimate of various performance indices of it.
CO4: Acquire knowledge to carry out a detailed design of an induction machine and provide the information required for the fabrication of the same along with an estimate of various performance indices of it.

Total Hrs: 42 Hrs

Module 1: DC machines **(11 Hrs)**
Output equation - main dimensions - choice of specific electric and magnetic loadings - choice of speed and number of poles - design of armature conductors, slots and winding - design of air-gap, field system, commutator, interpoles, compensating winding and brushes - Carter's coefficient - real and apparent flux density - design examples.

Module 2: Transformers **(10 Hrs)**
Output equation of single phase and three phase power transformers - main dimensions - choice of specific electric and magnetic loadings - design of core, LV winding, HV winding, tank and cooling tubes - prediction of no load current, forces on winding during short circuit, leakage reactance and equivalent circuit based on design data - design examples.

Module 3: Alternators **(10 Hrs)**
Output equation of salient pole and turbo alternators - main dimensions - choice of specific electric and magnetic loadings - choice of speed and number of poles - design of armature conductors, slots and winding - design of air-gap, field system and damper winding - prediction of open circuit characteristics and regulation of the alternator based on design data - design examples.

Module 4: Induction machines **(11 Hrs)**

Output equation - main dimensions - choice of specific electric and magnetic loadings - design of stator and rotor windings, stator and rotor slots and air-gap of slip ring and squirrel cage motors - calculation of rotor bar and end ring currents in cage rotor - calculation of equivalent circuit parameters and prediction of magnetising current based on design data - design examples

Text/Reference Books:

1. Clayton & Hancock, Performance & Design Of DC Machines, CBS, 3rd edition, 2001
2. Sawhney, Electrical Machine Design, Educational Publishers and Distributors, 1998.
3. Say M. G, Performance & Design of AC Machines, Pitman, ELBS.3rd edition, 1983.

EE 3035 BIOMEDICAL INSTRUMENTATION

ELECTIVE COURSE

Pre-requisites : None

L	T	P	C
3	0	0	3

Course outcomes:

CO1: Provide students with an understanding of the basic physiology associated with the generation of various bioelectric signals like ECG,EEG etc.

CO2: Provide students with basics concepts in transduction of these signals and understand their characteristic features.

CO3: provide students with knowledge necessary to understand the working of most common biomedical equipments like ECG ,EEG machines etc.

CO4: Provide students With the ideas of application of the principles of engineering, mathematics and physics to medicine and biology by which man kind is benefited.

Total Hrs : 42 Hrs

Module 1: **(11 Hrs)**

Introduction to electrophysiology – action potential – transducers for biomedical applications - electrodes – mono polar and bipolar recording - heart and cardiovascular system –blood pressure measurement – characteristics of blood flow-electromagnetic and ultrasonic blood flow meters- indicator dilution technique plethysmography - sounds of the heart – blood pumps – heart lung machine - ECG – Eindhoven ‘s law - 12 lead system – cardiac pace maker –defibrillator -EMG – introduction to nervous system and brain -EEG –

Module 2: **(11 Hrs)**

Introduction to intensive care monitoring –patient monitoring instruments –organization of hospital for patient care monitoring – respiratory physiology – measurements in respiratory system –respiratory therapy equipments – instrumentation for sensory measurement and behavioral studies – ultrasonics in medicine

Module 3: **(10 Hrs)**
Lasers in medicine - X- ray and radio isotopes – radio therapy equipment -safety and dosage

Module 4: **(10 Hrs)**
Renal physiology – membranes for haemodialysis – haemodialysis machines- lithotripters – Measurement of p^H , $p^{CO}{}_2$ and $p^O{}_2$

Text/Reference Books:

1. Hand book of Biomedical instrumentation By RS Khandpur, Tata McGrawHill , 2007
2. Biomedical instrumentation and measurements By Leslie Cromwell, Fred J Weibell Erich A Pfeiffer , Pearson 2008
3. Principles of Applied biomedical instrumentation , Geddes & Baker , 3rd edition John Wiley & Sons

EE3036 ILLUMINATION ENGINEERING

ELECTIVE COURSE

Pre-requisites : None

L	T	P	C
3	0	0	3

Course Outcomes:

CO1: Understand the need for good illumination and hence understand the Laws of Illumination.

CO2: Knowledge of the various Electric light sources and their operating characteristics

CO3: Knowledge of the Entities in the illumination systems and their units, measurement of illumination- determination of total luminous flux emitted by different sources

CO4: Knowledge of the Design of lighting systems. Maintenance of lighting system and Lighting Calculations considering day light. Design of Energy efficient lighting systems

Total Hrs: 42 Hrs

Module1: **(9 Hrs)**
Introduction : State the need for Illumination, Define good Illumination, Radiation - Eye and Vision - The purkinje effect- Laws of Illumination –Candela- Frechner's law - Inverse Square Law - Lambert's Cosine Law of Incidence Photometry and spectrophotometry .

Module 2: **(10 Hrs)**

Electric light sources and their operating characteristics: Incandescent lamps: ratings, operating characteristicsvapor lamps- mercury vapor lamps- sodium vapor lamps-Fluorescent lamps: fundamentals, ratings, cathode types- starters- ballasts- operating characteristics- CFL- Bulb Temperature Vs Light output - Lumen Maintenance Curve

Module 3: **(11 Hrs)**

Entities in the illumination systems and their units: Illumination, intensity, brightness, soild angle relationships, luminous flux-luminosity-measurement of illumination- determination of total luminous flux emitted by a plane source, circular disc source, rectangular source, strip source.

Module 4: **(12 Hrs)**

Design of lighting systems- Interior Lighting -Sports Lighting -Road Lighting -Street lighting-Factory outdoor lighting- Flood lighting -Maintenance of lighting system and Lighting Calculations considering day light.Design of Energy efficient lighting systems.

Text/Reference Books:

1. Prathab H, “Art and Science of Utilization of Electrical Energy”, Dhanapat Rai & Sons, Delhi
2. Steffy G, “Architectural Lighting Design”, 3rd Edition, John Wiley & Sons, 2008
3. Boast W.B, Illumination Engineering, Mc Graw Hill Book Company, 1953.
4. Cotton H, Principles of Illumination, John Wiley and Sons, 1960.

EE3037 ANALOG FILTERS

ELECTIVE COURSE

Pre-requisites: EE2001 Signals & Systems, EE2004 Basic Electronic Circuits,

EE2005 Circuits & Networks, EE2008 Analog Electronic Circuits & Systems

L	T	P	C
3	0	0	3

Course outcomes:

CO1: Acquire knowledge on the Filter approximation problem and its various solutions in analog domain

CO2: Develop design capability on analog filters – from word description of filtering problem to the final filter transfer function

CO3: Develop design capability in passive filters

CO4: Develop analysis capability on single Opamp biquad filter sections, multiple-opamp biquad sections and cascade of such sections

CO5: Develop capability to apply Opamp biquad cascades to practical filtering problems

CO6: Acquire knowledge on gyrator based filters

Total Hrs : 42 Hrs

Module 1: **(12 Hrs)**

Review of continuous time LTI systems – frequency domain representation of continuous time signals. Laplace transform- inverse Laplace transform- properties.

Categories of Filters- LP, HP, BP, BE and All Pass Filters- Second Order s-domain equations in each case and their pole-zero plots.

The Filter approximation problem: - Butterworth Approximation- Chebyshev and Inverse Chebyshev Approximations- Elliptic Approximation- Bessel approximation- Phase and Group delay characteristics of approximation functions-delay equalizer functions

Module 2: **(10 Hrs)**

Passive filters Realization of first order First Order LP, HP, BP, All Pass Filters- frequency transformation.

Higher order filters- network functions-synthesis of higher order passive filters. Singly and doubly terminated LC ladders. Limitations of Passive filters

Module 3: **(11 Hrs)**

Active Filters Single OPAMP Biquads :First Order LP,HP,BP, All Pass Filters- Biquad Topologies, Analysis and Design of Single OPAMP Biquads with finite gain . Analysis and design of LP, HP and BP Filter with second order response. Sensitivity Analysis of Single OPAMP Filters. Analysis and design of various multiple OPAMP filters - Compensation

Module 4: **(9 Hrs)**

Inductor Simulation, Antoniou Gyrators, LP,HP,BP and BE Filters using Antoniou Gyrators**.**
Structure for LP, HP, BP and BE SC Filters, Basic ideas of method of realization of higher order filters.
Synthesis of LC ladder Networks using gyrators

Text /Reference books:

1. G. Daryanani, Digital and Analog Communication Systems, John Wiley and Sons, 1976
2. M.E Van Valkenberg, Analog Filter Design, Prentice Hall of India, 2004.
3. M.E Van Valkenberg , Design of Analog Filters, Oxford University Press,2001
4. L.P Huelsman, Introduction to the Theory and Design of Active Filters, McGraw Hill, 1980
5. Roubik Gregorian and Gabor C, Analog MOS Integrated Circuits for Signal Processing, John Wiley and Sons, 1986
6. Kendall L. Su, Analog Filters, Kluwer academic publishers, 1996
7. Wai-Kai Chen, Passive and active filters, John Wiley & Sons, 1986

EE3038: POWER SEMICONDUCTOR DEVICES

ELECTIVE COURSE

Pre-requisite: None

L	T	P	C
3	0	0	3

Course outcomes:

CO1: To learn the basics of power semiconductor switches.

CO2: To understand the working of various types of converters and application of them.

CO3: To understand and design the drive circuits for various Power Semiconductor Switches.

CO4: To learn to model the converters and semiconductor switches.

CO5: To learn about the control of various power semiconductor switches.

Total Hrs: 42 Hrs

Module 1: **(11 Hrs)**

Power Diode: Basic Structure and 1-V Characteristics . Breakdown Voltages and Control . On State Losses . Switching Characteristics . Turn on Transient . Turn off Transient . Reverse Recovery Transient .Schottky Diodes .Snubber Requirements for Diodes and Diode Snubbers.

Thyristor: Basic Structure . V-1 Characteristics . Turn on Process . On State operation . Turn off process. Switching Characteristics .Turn on Transient and di/dt limitations . Turn off Transient . Turn off time and reapplied dv/dt limitations .Ratings of Thyristors .Snubber Requirements and Snubber Design.

Module 2: **(9 Hrs)**

DIAC: Basic Structure and operation . V-1 Characteristics . Ratings

TRIAC: Basic Structure and operation .V-1 Characteristics .Ratings .Snubber Requirements.

Gate Turnoff Thyristor (GTO): Basic Structure and Operation . GTO Switching Characteristics . GTO Turn on Transient . GTO Turn off Transient . Minimum ON and OFF State times .Maximum Controllable Anode
Current . Overcurrent protection of GTOs

Module 3: **(12 Hrs)**

Power BJT: Basic Structure and 1-V Characteristics . Breakdown Voltages and Control . Second Breakdown and its Control- FBSOA and RBSOA Curves - On State Losses . Switching Characteristics . Resistive Switching Specifications . Clamped Inductive Switching Specifications . Turn on Transient . Turn off Transient . Storage Time .Base Drive Requirements . Switching Losses . Device Protection-Snubber Requirements for BJTs and Snubber Design - Switching Aids.

Power MOSFET: Basic Structure . V-1 Characteristics . Turn on Process . On State operation . Turn off process . Switching Characteristics . Resistive Switching Specifications . Clamped Inductive Switching Specifications Turn on Transient and di/dt limitations . Turn off Transient . Turn off time . Switching Losses .Effect of Reverse Recovery Transients on Switching Stresses and Losses - dv/dt limitations .Gating Requirements .Gate Charge Ratings of MOSFETs. FBSOA and RBSOA Curves . Device Protection -Snubber Requirements .

Module 4: **(10 Hrs)**

Insulated Gate Bipolar Transistor (IGBT): Basic Structure and Operation .Latch up IGBT Switching Characteristics . Resistive Switching Specifications . Clamped Inductive Switching Specifications - IGBT Turn on Transient . IGBT Turn off Transient- Current Tailing - Ratings of MOSFETs. FBSOA and RBSOA Curves . Switching Losses - Minimum ON and OFF State times - Switching Frequency Capability - Overcurrent protection of IGBTs .Short Circuit Protection .Snubber Requirements and Snubber Design. New power semiconductor devices.

Text/Reference Books:

1. Ned Mohan et.al ,"Power Electronics",John Wiley and Sons,2006
2. G. Massobrio, P. Antognet," Semiconductor Device Modeling with Spice", McGraw-Hill, Inc.,1988.
3. B. J. Baliga," Power Semiconductor Devices",Thomson, 2004.

4. V. Benda, J. Gowar, D. A. Grant,” Power Semiconductor Devices. Theory and Applications”, John Wiley & Sons1994.99

EE3039 ADVANCED PROCESSOR ARCHITECTURE & SYSTEM ORGANISATION

ELECTIVE COURSE

L	T	P	C
3	0	0	3

Pre-requisites: EE3001 Microprocessors & Microcontrollers

Course outcomes:

CO1: To learn the history of development of the processors.
CO2: To understand the working of a modern processor.
CO3: To learn how to program a processor in assembly language and develop a processor based system.
CO4: To learn about the architecture of a modern processor and latest trends in processor industry.

Total Hrs : 42 Hrs

Module 1: (11 Hrs)

Basic Concepts of Microprocessors, Different Architectures of Microprocessors. 8051 Microcontroller Hardware, 1/O Pins, Ports and Circuits, External Memory, Counters and Timers, Serial Data Input/ Output, Interrupts, Assembly Language Programming of 8051.

Module 2: (11 Hrs)

8086 Hardware Details, Memory Organization and Addressing Modes, System Bus Structure – Minimum Mode and Maximum Mode, Interrupt Priority Management, System Bus Timing, Multiprocessor Configuration

Module 3: (10 Hrs)

Design of 8086 based system, Architecture of 80286, 80386, Development of Personal Computers.

Module 4: (10 Hrs)

Processor Types and Instruction Sets , Microcode , Protection and Processor Modes, Physical Memory , Virtual Memory, Caches, Bus Architecture , Parallelism and Pipelining , Performance Assessing of processors,

Text/Reference Books:

1. Brey B.B., The Intel Microprocessors - Architecture, Programming & Interfacing, Prentice Hall, 6th edition, 2004.
2. Liu Y.C. & Gibsen G.A., Microcomputer System: The 8086/8088 Family, Architecture Programming and Design , Prentice Hall of India, 2nd edition,2004 .
3. Ayala K.J., The 8051 Micro controller, Architecture, Programming and Applications, Penram International Publishing (India),2nd edition,1996.
4. Ayala K.J., The 8086 Microprocessor: Programming and Interfacing The PC, Penram International Publishing (India),1995.
5. Trebel, Walter A Singh, Avtar, 8088 and 8086 microprocessors, Programming Interfacing, Software, Hardware and Aplications , Pearson Education , 4th edition, 2004.
6. Douglas E Comer, Essentials of Computer Architecture , Pearson Education,2005.
7. Pattersen D.A. & Hennesy J.L., Computer Organization and Design: The Hardware/ Software Interface, Harcourt Asia Pvt Ltd (Morgan Kaufman), 2nd edition, 2002.
8. Heuring V.P. & Jordan H.F., Computer System Design and Architecture, Addison Wesle Hamacher, Vranesic & Zaky, Computer Organisation, McGraw Hill,2002

EE3040 LT & HT DISTRIBUTION SYSTEMS

ELECTIVE COURSE

Pre-requisites: None

L	P	T	C
3	0	0	3

Course outcomes:

CO1:To impart the knowledge of Power system-general concepts, Load and Energy forecasting
CO2: To make students capable of Power system analysis, Optimization of distribution system-network cost modeling
CO3: To enable the students to analyze economic loading of distribution transformers, Distribution system reliability
CO4:Awareness of Consumer services, Tariffs-costing and pricing, Overhead and underground lines-optimum design considerations
CO5:To impart the knowledge of Power capacitors - HT and LT capacitor installation
CO6: Create awareness of Electrical Safety and Earthing Practices, Lightning protection
CO7: An understanding of Distribution Automation System –SCADA systems and Automation

Total Hrs: 42 Hrs

Module 1: (11 Hrs)

Power system-general concepts-distribution of power, load and energy forecasting-factors in power system loading, Power system analysis-load flow-fault studies-voltage control, Optimization of distribution systemnetwork cost modeling-economic loading of distribution transformers. Distribution system reliability-reliability assessment techniques

Module 2: (10 Hrs)

Consumer services-maximum demand, diversity and load factor-consumer load control for power shortages, Tariffs-costing and pricing –economically efficient tariff structure.

Overhead and underground lines-optimum design considerations, Power capacitors-size of capacitor for power factor improvement- HT and LT capacitor installation requirements.

Module 3: (10 Hrs)

Distribution System Design- Electrical Design Aspects of Industrial, Commercials Buildings-

Design, estimation and costing of outdoor and indoor Substations, Electrical Safety and Earthing Practices at various voltage levels- Lightning protection.-Regulations and standards.

Module 4: (11 Hrs)

Distribution Automation System : Necessity, System Control Hierarchy- Basic Architecture and implementation Strategies for SCADA and DAC systems -Basic Distribution Management System Functions.

Communication Systems for Control and Automation- Wireless and wired Communications- SCADA and DAC communication Protocols, Architectures and user interface

Text/References:

1. Turan Gonen, "Electric Power Distribution system Engineering" Mc Graw-hill ,Inc,1987
2. A.S. Pabla, " Electric Power Distribution systems" Tata Mc Graw-hill Publishing company limited, 4th edition, 1997.
3. Alexander Eigeles Emanuel, "Power Definitions and the Physical Mechanism of Power Flow", John Wiley & Sons, October 2009.
4. "Handbook of International Electrical Safety Practices", John Wiley & Sons, PERI June 2009.
5. Ali A. Chowdhury, Don O. Koval, "Power distribution system reliability-Practical methods and applications" John Wiley & sons Inc., *IEEE Press* 2009
6. Richard E.Brown, "Electric power distribution reliability" Taylor & Francis Group,LLC,2009.
7. James Northcote-Green, Robert Wilson, "Control and automation of electrical power distribution system", Taylor & Francis Group, LLC,2007.
8. S.Sivanagaraju, V.Sankar, Dhanpat Rai & Co, "Electrical Power Distribution and Automation",2006.
9. Pansini,Anthony J, "Guide to electrical power distribution system",Fairmont press, inc., 6th edition,2006.
10. Stuart A. Boyer, "SCADA-Supervisory Control and Data Acquisition" Instrument Society of America Publication,2004
11. Leveque, Francois , "Transport Pricing of Electricity Networks" Springer 2003
12. Lakervi & E J Holmes, "Electricity distribution network design", Peter Peregrimus Ltd. 2nd Edition,2003
13. William H. Kersting, "Distribution system modeling and analysis" CRC press LLC, 2002.
14. Michael Wiebe, "A Guide to Utility Automation: Amr, Scada, and It Systems for Electric Power" PennWell,1999.
15. IEEE Press: IEEE Recommended practice for Electric Power Distribution for Industrial Plants, published by IEEE, Inc., 1993

EE3041 DC DRIVES

ELECTIVE COURSE

Prerequisite: EE3007 Power Electronics

L	T	P	C
3	0	0	3

Course outcomes:

CO1: Develop capability to choose a suitable DC Motor and Power Electronic Converter package from a description of drive requirement – involving load estimation, load cycle considerations, thermal aspects and motor-converter matching

CO2: Acquire detailed knowledge of DC Shunt and Series motor operation using Generalised machine theory

CO3: Develop capability to arrive at different analytical models –large signal and small signal models – for a motor-drive combination and to develop capability to use the models to arrive at time-domain and frequency-domain responses

CO4: Acquire detailed knowledge on AC-DC Converters and DC-DC Converters and their modeling for steady-sate and transient

CO5: Develop design knowledge on how to design the speed control and current control loops of a DC Motor drive

CO6: Acquire knowledge on how DC Drives may pollute the power supply and how to mitigate such pollution

Total Hrs: 42 Hrs

Module 1: Introduction (8 Hrs)

Introduction to Drives– characteristic matching of the load and the motor - Criteria for selection of subsystems of the Drive - Thermal consideration – considerations in the match between the Power Electronics converter and the motor - Characteristics of mechanical systems - stability criteria

Module 2: Modelling of DC Machine (8 Hrs)

Theory of operation – Induced EMF – Equivalent circuit and electromagnetic torque – Elecrtomechanical modeling – state space modeling – Block diagram.

Module 3: Phase controlled DC motor Drives (14 Hrs)

Field Control – Armature Control – Four quadrant operation – Single phase controlled convertors - Three phase controlled convertors – half controlled convertor – Converters with freewheeling – Converter configuration for a four quadrant DC motor drive – Steady state analysis of Three phase converter controlled DC motor drive – Two quadrant, Three phase converter controlled DC motor drive. Two quadrant, DC motor drive with field weakening. Harmonics and Associated problems – Effect of field weakening.

Module 4: Chopper Controlled DC motor Drive (12 Hrs)

Principle of operation of chopper – Four quadrant chopper circuit and its operation in all quadrants - Model of chopper – Steady state analysis of chopper controlled DC motor drive- Torque pulsations.

Text/Reference Books:

1. Electrical Motor Drives : Modeling, Analysis and control : R Krishnan - 1st edition – 2007 : Pearson Eduction.
2. Electric Drives Concepts and applications – Vedam Subrahmanyam – 1st Edition 1994 : Tata McGrawHill Education Pve Ltd.
3. André Veltman, Duco W.J. Pulle and Rik W. De Doncker : Fundamentals of Electrical Drives – 1st edition 2007 Springer
4. G.K.Dubey &C.R.Kasaravada ,"Power Electronics & Drives", Tata McGraw Hill,1993.
5. Dubey ,Power Electronics Drives ,Wiley Eastern,1993
6. Chilikin ,M ,Electric drives , Mir publications, 2nd edition,1976
7. Ned Mohan ,"Power Electronics", et. al ,Wiley 2006

EE3042 ELECTRICAL SYSTEM DESIGN FOR BUILDINGS

ELECTIVE COURSE

Pre-requisites: None

L	T	P	C
3	0	0	3

Course Outcomes:

CO1: Acquire knowledge of fundamentals of electrical Installations like requirements, design considerations, testing, estimating and costing.

CO2: Acquire knowledge of national electrical Code, design and estimation methods of service connections and its safety aspects.

CO3: Acquire the knowledge of various scheme of illumination, the energy conversation method used in it and design methods of illumination system for a given purpose.

CO4: Acquire the knowledge of design procedure, estimation and costing method, safety aspect of electrical installation in a commercial building, hospital, industries.

CO5: To learn the design procedure, estimation and costing methods of outdoor and indoor substations.

CO6: Knowing of designing aspect of earthing system and lightning protection scheme.

Total Hrs: 42 Hrs

Module 1: (10 Hrs)

Electrical Installations: general requirements, design considerations, testing, estimating and costing - symbols, standards – National Electrical Code – design of panel boards – design and estimation of service connections – design and safety aspects of residential buildings

Module 2: (10 Hrs)

Illumination schemes – types of light sources and lighting arrangements – energy efficiency in lamps and illumination – design of lighting for various purposes.

Module 3: (12 Hrs)

Electrical system design, estimation and costing of commercial buildings, hospitals, recreational and assembly buildings, cinema theatres, small industries, Design of electrical installations of high rise buildings: electrical aspects of lifts, escalators services, stand by generators.

Module 4: (10 Hrs)

Design, estimation and costing of outdoor and indoor Substations –Design of earthing system, earth mat, plate and pipe earthing – Safety of electrical installations – Lightning protection.

Text/Reference Books:

1. K.B. Raina, S.K. Bhatacharya, “Electrical Design, Estimating and Costing,” New Age International (p) Ltd. Publishers, New Delhi, 2002.
2. Surjit Singh. “Electrical Estimating and Costing”, Dhanpat Rai & Co., Delhi, 2005.
3. ISI, National Electrical Code, Bureau of Indian Standard Publications.
4. G. Ramamurthy, “Hand book of Electrical Power Distribution”, Universities Press (India) Private Ltd., New Delhi, 2004.

EE3092 ELECTRICAL MACHINES LAB II

REQUIRED COURSE

Prerequisite: EE3003 Electrical Machines II

L	T	P	C
0	**0**	**3**	**2**

Course outcomes:

CO1: Acquire hands on experience of conducting various tests on alternators and obtaining their performance indices using standard analytical as well as graphical methods.

CO2: Acquire hands on experience of conducting various tests on induction machines and obtaining their performance indices using standard analytical as well as graphical methods.

Total Hrs : 42 Hrs

List of Experiments

1. No load and blocked rotor tests on a 3-phase squirrel cage induction motor, determination of its equivalent circuit and performance analysis by drawing the circle diagram.
2. No load and blocked rotor tests on a 3-phase slip ring induction motor, determination of its equivalent circuit and performance analysis by drawing the circle diagram.
3. No load and blocked rotor tests on a single phase induction motor, determination of its equivalent circuit and performance analysis.
4. Load tests on a 3-phase squirrel cage induction motor and its performance analysis.
5. Load tests on a 3-phase slip ring induction motor and its performance analysis.
6. Operation of a dc machine coupled induction machine as an induction generator and its performance analysis.
7. Speed control of an Induction motor by pole changing method.
8. Speed control of an Induction motor by variable frequency method.
9. Predetermination of voltage regulation of a 3-phase alternator by EMF/ MMF methods.
10. Predetermination of voltage regulation of a 3-phase alternator by ZPF method.
11. Slip test on a salient pole alternator and predetermination of voltage regulation.
12. Synchronization of a 3-phase alternator to the supply mains and plotting of V-curves/ inverted V-curves.

Text/Reference Books:

1. Say M. G, Performance & Design of AC Machines, Pitman, ELBS.3rd edition, 1983.
2. Langsdorf A.S., Theory of AC Machinery, McGraw Hill., 2nd edition, 2002.

EE4001 CONTROLSYSTEMS - II

REQUIRED COURSE

Pre-requisites : None

L	T	P	C
3	0	0	3

Course Outcomes:

CO1: Learn the characteristics of nonlinear systems and common types of nonlinearities

CO2: Analyze the behavior of nonlinear systems using both phase plane and describing function methods

CO3: Test the stability of nonlinear systems

CO4: Design full order and reduced order observers

CO5: Design state feedback controllers

CO6: Learn microprocessor/microcontroller/DSP based control/ programmable logic controllers

Total Hours: 42 Hours

Module 1: **(11 Hrs)**

Non-linear Systems - Characteristics- different types of nonlinearities and their occurrences Phase plane analysis .linearization and equilibrium points - stability of equilibrium points-Lyapunov's First method-Isocline and Delta method- limit cycles of phase plane- stability of limit cycles . Bendixson's criteria-Computer based analysis and simulation. Concepts of Inverse Control-Feedback linearization-Principles of model predictive control

Module 2: **(10 Hrs)**

Describing functions- Filter hypothesis- describing function for single valued and double valued non-linear elements - Limit cycles amplitude and frequency -Stability of non-linear systems . Lyapunov.s method for nonlinear systems . Popov.s criterion- Circle criterion

Module 3: **(11 Hrs)**

Controllability Observability -state variable design, state feedback, pole placement - Ackerman's formula – design of full order and reduced order observers. : Optimal control problem – different performance measures and constraints - Optimal control using quadratic performance measures -State feedback regulator problem-

Module 4: **(10 Hrs)**

Compute Computer Control of Industrial Processes-Control hierarchies for plant level automationMicroprocessor/microcontroller/DSP based control-Programmable Logic controllers-Introduction to PLC Programming-PC based control-Distributed Control Systems-Control Networks-Protocols-Ethernet-Field BusMan-Machine Interface.

Text/Reference Books:

1. Benjamin C Kuo, *Digital Control Systems*, Oxford University Press, 1992
2. Hassan K Khalil, *Nonlinear Systems*., Prentice Hall International (UK),1996
3. Mohandas K P : Modern Control Engineering,(Revised edition) Sanguine Pearson 2010
4. Alberto Isidori, .*Nonlinear Control Systems*., Springer Verlag, 1995.
5. S. Wiggins, .*Introduction to Applied Nonlinear Dynamical Systems and Chaos*, Springer Verlag, 1990
6. M. Gopal, *Digital Control & State Variable Methods*, Tata McGrawHill, 1992.

EE4021: ARTIFICIAL NEURAL NETWORKS& GENETIC ALGORITHMMETHODS

ELECTIVE COURSE

L	T	P	C
3	0	0	3

Prerequisite: NIL

Course outcomes:

CO1: Understanding of various neural network and the applications of these models to solve engineering

CO2: Enable students with Program of ANN in MATLAB

CO3: Understanding of optimization using Genetic algorithm

CO4: Understand various possible applications of Genetic algorithm to electrical engineering field

Total Hours: 42 Hours

Module 1: (11 Hrs)

Introduction to Artificial Neural Networks - Biological neurons .Computational models of neuron-McCulloch Pitts model - types of activation function .Introduction to network architectures - knowledge representation Learning process .Learning algorithms- - error-correction learning .Boltzmann learning-Hebbian learning, competitive learning- Learning paradigms- supervised learning - unsupervised learning - method of steepest descent - least mean square algorithms - Adaline/medaline units . perceptrons-derivation of the backpropagation algorithm-Adavnces in Learning strategies-Computer based simulation of simple Network Structures.

Module 2: (11 Hrs)

Neural Network Architectures-MLFFN-Recurrent NN- RBF Network structure - separability of patterns - RBF learning strategies - comparison of RBF, RNN and MLP networks- Hopfield networks- associative memoryenergy function - spurious states - error performance - simulated annealing - applications of neural networks . Forecasting-the XOR problem - traveling salesman problem - image compression using MLPs - character retrieval using Hopfield networks-Advances in ANN Theory- Computer based simulation.

Module 3: (11 Hrs)

Genetic Algorithm-Introduction to Genetic Algorithms . The GA computation process-natural evolution-parent selection-crossover-mutation-properties - classification – Advances in the theory GA- Application to Engineering problems

Module 4: (9 Hrs)

Hybrid systems and Soft Computing- Limitations of ANN and GA- Concept of neuro-fuzzy and neuro-genetic systems- GA as an optimization tool for ANN-Application of ANN in forecasting-Signal characterization-Fault diagnosis-Neuro-Fuzzy-Genetic Systems- Case Studies in solving Engineering problems of control, signal/image processing etc.

Text/Reference Books:

1. Simon Haykin, *Neural Network – A Comprehensive Foundation*, 2nd Ed, Pearson Education, 2002.
2. Zurada J.M., *Introduction to Artificial Neural Systems*, Jaico Publishers,2003.
3. Bart Kosko, *Neural Network and Fuzzy Systems*, Prentice Hall of India, 2002
4. Goldberg D.E., .*Genetic Algorithms in Search Optimization and Machine Learning*, Addison Wesley,1989
5. Suran Goonatilake & Sukhdev Khebbal (Eds.), *Intelligent Hybrid Systems*., John Wiley,1995.
6. Hassoun Mohammed H, *Fundamentals of Artificial Neural Networks*, Prentice Hall of India, 2002.

EE4022 AC DRIVES

ELECTIVE COURSE

Prerequisite: EE3007 Power Electronics

L	T	P	C
3	0	0	3

Course outcomes:

CO1: To learn about various AC machines used in drives.

CO2: To understand the working of various phase controlled converters used in AC Drives.

CO3: To learn the working principle and design details of frequency controlled converters used in induction motor drives.

CO4: To learn about the operation, working, modeling and controlling CSI based drives.

Total Hours : 42 Hours

Module 1: AC Machines for Drives (8 Hrs)

Induction machine – Synchronous machine – Permanent Magnet machines – Synchronous reluctance and variable reluctance machine – Principle of operation, Equivalent circuit, Modeling and characteristics of all these machines.

Module 2: Phase Controlled Induction Motor Drives (13 Hrs)

Cycloconverters - Phase Controlled Cycloconverters – Circuits and operation principle – Circulating and noncirculating current mode – load and line harmonics – Line Displacement power factor. Stator Voltage control – Slip energy recovery scheme.

Module 3: Frequency Controlled Induction Motor Drives (10 Hrs)

Voltage Source Inverter (VSI) – VSI fed Induction motor - constant V/F control – Constant Flux control – Constant Slip-speed control – Torque pulsation – effect of Harmonics and its control - PWM control – Flux weakening operation.

Module 4: Current Source Inverter fed Induction Motor Drives (11 Hrs)

Current Source Inverter (CSI) fed Induction motor Drives - CSI – Operation – Modeling - Steady state performance of CSI motor drive. Vector controlled Induction motor Drives – principle and operation. Permanent Magnet Motor drives.

Text/Reference Books:

1. Electrical Motor Drives : modeling, Analysis and control : R Krishnan - 1st edition – 2007 : Pearson Eduction.
2. Electric Drives Concepts and applications – Vedam Subrahmanyam – 1st Edition 1994 : Tata McGrawHill Education Pve Ltd.

3. André Veltman, Duco W.J. Pulle and Rik W. De Doncker : Fundamentals of Electrical Drives – 1st edition 2007 Springer
4. G.K.Dubey &C.R.Kasaravada ,"Power Electronics & Drives", Tata McGraw Hill,1993.
5. Dubey ,Power Electronics Drives ,Wiley Eastern,1993
6. Chilikin ,M ,Electric drives , Mir publications, 2nd edition,1976
7. Ned Mohan ,"Power Electronics", et. al ,Wiley 2006

EE4023 COMPUTER CONTROL OF INDUSTRIAL PROCESSES

ELECTIVE COURSE

Pre-requisite: Nil

L	T	P	C
3	0	0	3

Course Outcomes:

CO1: Learn the basics of MIMO systems and calculation of system norms

CO2: Study the concept of robustness and robust stability using $\mathcal{H}_2$ and $\mathcal{H}_\infty$theory

CO3: Understand the hardware and programming of programmable logic controllers

CO4: Learn large scale control systems like SCADA

CO5: Familiarize real time systems and inter task communication

CO6: Build knowledge on supervisory control,distributed control and PC based automation

Total Hrs: 42 Hrs

Module 1: Multivariable Control **(12 Hrs)**

Multivariable control- Basic expressions for MIMO systems- Singular values- Stability norms- Calculation of2 2 system norms- Robustness- Robust stability- H / H Theory- Solution for design using H / H - Case studies. Interaction and decoupling- Relative gain analysis- Effects of interaction- Response to disturbancesDecoupling- Introduction to batch process control.

Module 2: Programmable Logic Controllers **(10 Hrs)**

Programmable logic controllers- Organisation- Hardware details- I/O- Power supply- CPU- Standards Programming aspects- Ladder programming- Sequential function charts- Man- machine interface- Detailed study of one model- Case studies.

Module 3: Large Scale Control System **(12 Hrs)**

SCADA: Introduction, SCADA Architecture, Different Commnication Protocols, Common System Components, Supervision and Control, HMI, RTU and Supervisory Stations, Trends in SCADA, Security Issues DCS: Introduction, DCS Architecture, Local Control (LCU) architecture, LCU languages, LCU - Process interfacing issues, communication facilities, configuration of DCS, displays, redundancy concept - case studies in DCS.

Module 4: Real Time Systems **(8 Hrs)**

Real time systems- Real time specifications and design techniques- Real time kernels- Inter task communication and synchronization- Real time memory management- Supervisory control- direct digital control- Distributed control- PC based automation.

Text/Reference Books:

1. Shinskey F.G., Process control systems: application , Design and Tuning, McGraw Hill International Edition , Singapore,1988.
2. Be.langer P.R. , Control Engineering: A Modern Approach, Saunders College Publishing , USA, 1995.
3. Dorf, R.C. and Bishop R. T. , Modern Control Systems , Addison Wesley Longman Inc., 1999
4. Laplante P.A., Real Time Systems: An Engineer.s Handbook, Prentice Hall of India Pvt. Ltd., New Delhi, 2002.
5. Constantin H. Houpis and Gary B. Lamont, Digital Control systems, McGraw Hill Book Company, Singapore, 1985.
6. Stuart A. Boyer: SCADA-Supervisory Control and Data Acquisition, Instrument Society of America Publications,USA,1999
7. Gordon Clarke, Deon Reynders:Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems, Newnes Publications, Oxford, UK,2004
8. Efim Rosenwasser, Bernhard P. Lampe, Multivariable computer-controlled systems: a transfer function approach, Springer, 2006

EE4024 POWER SYSTEM OPERATION AND CONTROL

REQUIRED COURSE

Pre-requisites: None

L	T	P	C
3	0	0	3

Course outcomes:

CO1: An understanding of operational constraints (equipment and stability), control objectives and their implementation, under normal and abnormal states of a power system

CO2: To enable the students to analyze Economic dispatch of thermal units and methods of solution, Unit commitment- Solution methods

CO3: To impart the knowledge of automatic generation control and automatic voltage regulation

CO4: An understanding of interchange of power and energy- Economy interchange between interconnected utilities

CO5: Create awareness of Power system security -factors affecting power system security - contingency analysis

Total Hours: 42 Hours

Module 1:(11 Hrs)

Economic dispatch of thermal units and methods of solution- Formulation of AC power flow- Transmission losses- B matrix loss formula- Take-or-pay fuel supply contract- Composite generation production cost function solution by gradient search techniques.

Module 2: (11 Hrs)

Unit commitment- Solution methods- Hydrothermal coordination- Scheduling problems- Short term hydrothermal scheduling problem - Short term hydro scheduling-load model - prime mover model - governor model - tie-line model - generation control.

Module3: **(10 Hrs)**

AGC-Single and multi-area system-Speed governing -TG response-ALFC loop-tie line bias control - AVR-Exciter types-Modeling - AVR loop

Module 4: **(10 Hrs)**

Interchange of power and energy- Economy interchange between interconnected utilities- inter - utility economy energy evaluation- capacity interchange - diversity interchange - energy banking- emergency power interchange - power pools.

Power system security -factors affecting power system security - contingency analysis- linear sensitivity factors optional power flow - linear sensitivity analysis -state estimation

Text/Reference Books:

1. A.J. Wood and B.F. Wollenberg, "Power Generation Operation and Control", John Wiley & Sons, ICN., 2nd Edition.
2. A.K.Mahalanabis, "Computer Aided Power system analysis and control", Tata McGraw Hill 1991
3. O.I. Elgerd: "Electric Energy Systems Theory", McGraw Hill, 2nd Edition, 1982,Dec.
4. Antonio Gomez-Exposito, Antonio j.conejo & Claudio canizares, "Electric Energy systems analysis and operation", CRP press, 2009.

EE4025 ANALOG MOS CIRCUITS

ELECTIVE COURSE

L	T	P	C
3	0	0	3

Pre-requisites: EE 2004 Basic Electronic Circuits

EE 2008 Analog Electronic Circuits

Course outcomes:

CO1: Acquire detailed knowledge on MOS transistor with special emphasis on short channel effects

CO2: Acquire detailed knowledge on modeling a MOS Device and Spice models.

CO3: Develop analysis and design capability on basic analog CMOS building block circuits

CO4: Acquire knowledge on analysis and design of CMOS differential amplifiers and CMOS Opamps

CO5: Acquire knowledge on used CMOS Analog systems and mixed-signal systems

Total Hours: 42 Hours

Module 1: **(10 Hrs)**

Basic MOS Device:

Analog MOS models – Device construction, Principle of operation, static characteristics, Body effect on static characteristics and DC biasing, VVR explanation and use, channel length modulation – Early Voltage, low frequency model – MOS in saturation –high frequency model – MOS resistors and resistor circuits

Module 2: **(9 Hrs)**

Single-Stage Amplifiers–– common source –common gate – common drain amplifiers, cascode and folded cascode structures

Current sources and sinks – regulated cascode current source/sink, Wilder current source

Passive and Active current mirrors – Basic Current mirrors-cascode current mirror – Wilson current mirror – Active Current mirror

Module 3: **(11 Hrs)**

Differential amplifiers – Basic differential pair, common mode response.

Frequency response of amplifiers- General considerations of Miller effect, common source, common gate, common drain amplifiers, cascade and differential pair.

CMOS Operational amplifiers – Basic one and two stage CMOS OAs, folded cascade type.

Module 4: **(12 Hrs)**

Mixed signal circuits – CMOS comparator design – analog multiplier – dynamic analog circuits – charge injection and capacitive feed through in

Introduction to switched capacitor circuits- MOSFET as switch – sample and hold circuits– switched capacitor filters

Ring Oscillator, LC oscillator, VCO - PLL, Charge pump PLL, delay locked loops and applications.

Text/Reference Books:

1. Adel S. Sedra and K. C. Smith, 'Microelectronic circuits' 4th edition, Oxford University Press, 2003
2. Jacob Baker R., Li H.W.& Boyce D.E., `CMOS - Circuit Design, Layout & Simulation', PHI,2005.
3. Behzad Razavi, 'Design of Analog CMOS Integrated Circuit' Tata-Mc GrawHill, 2002.
4. Roubik Gregorian & Gabor C Temes, Analog MOS Integrated Circuits for Signal Processing, John Wiley, 1986.

EE4026 SWITCHED MODE POWER SUPPLIES

ELECTIVE COURSE

Prerequisite: EE3007 Power Electronics

L	T	P	C
3	0	0	3

Course Outcomes:

CO1: Acquire knowledge on operation of non-isolated and isolated DC-DC Converters

CO2: Develop analytical competence required for modelling and simulation of these converters

CO3: Develop competence in design of power circuit (including magnetics) and closed-loop control systems for DC-DC Converters

CO4: Develop design competence in analysis, modelling and design of Off-line Switched Mode Power Supplies

CO5: Acquire detailed analysis-level and design-level knowledge on active power factor corrected front-end for SMPS Units

Total Hours: 42 Hours

Module 1: Introduction **(8 Hrs)**
Linear regulator Vs. Switching regulator – Topologies of SMPS – isolated and non isolated topologies – Buck – Boost – Buck boost – Cuk – Polarity inverting topologies – Push pull and forward converters half bridge and full bridge – Fly back converters Voltage fed and current fed topologies. EMI issues.

Module 2: Design Concepts **(10 Hrs)**
Magnetic Circuits and design – Transformer design - core selection – winding wire selection – temperature rise calculations - Inductor design. Core loss – copper loss – skin effect - proximity effect. Power semiconductor selection and its drive circuit design – snubber circuits. Closing the feedback loop – Control design – stability considerations

Module 3: Control Modes **(12 Hrs)**
Voltage Mode Control of SMPS.. Transfer Function and Frequency response of Error Amp. Transconductance Error Amps . PWM Control ICs (SG 3525,TL 494,MC34060 etc.)
Current Mode Control and its advantages.Current Mode Vs Voltage Mode. Current Mode PWM Control IC(eg. UC3842).

Module 4: **(12 Hrs)**
Applications of SMPS - Active front end – power factor correction – High frequency power source for fluorescent lamps - power supplies for portable electronic gadgets.

Resonant converters
Principle of operation – modes of operation – quasi resonant operation- advantages.

Text/Reference Books:

1. Abraham I Pressman - Switching power supply design – 2nd edition 1998 Mc-Graw hill Publishing Company.
2. Keith H Billings - Switch mode power supply handbook – 1st edition 1989 Mc-Graw hill Publishing Company.
3. Sanjaya Maniktala - Switching power supplies A to Z. – 1st edition 2006, Elsevier Inc.
4. Daniel M Mitchell : DC-DC Switching Regulator Analysis. McGraw Hill Publishing Company
5. Ned Mohan et.al : Power Electronics. John Wiley and Sons.
6. Otmar Kilgenstein : Switched Mode Power Supplies in Practice. John Wiley and Sons.
7. Mark J Nave : Power Line Filter Design for Switched-Mode Power Supplies. Van Nostrand Reinhold, New York.

EE4027 BIO SIGNAL PROCESSING

ELECTIVE COURSE

Pre-requisites: None

L	T	P	C
3	0	0	3

Course Outcomes:
CO1: Acquire knowledge about the time domain and frequency domain representation and analysis of discrete time signals and systems.

CO2: Acquire knowledge about functioning of brain, its potentials and the electrophysiological origin of brain waves.

CO3: Acquire knowledge about characteristics and analysis of EEG signals.

CO4: Acquire knowledge about linear prediction theory and its application in signal modelling.

CO5: Acquire knowledge about ECG signal processing, ECG data compression and clinical applications.

Total Hours: 42 Hours

Module 1: (12 Hrs)

Discrete time signals and systems –classification and representation of discrete –time signals Classifications of sequences –basic operation of sequences – discrete time systems – Discrete Time Fourier Transform - Discrete Fourier Transform – computation of DFT –Mathematical derivation of unilateral zTransform – properties of z- Transform –the inverse z – Transform – bilateral z –Transform - power series – region of convergence

Module 2: (12 Hrs)

The brain and it's potentials – electrophysiological origin of brain waves –EEG signal and it's characteristics – EEG analysis – linear prediction theory – recursive estimation of AR parameters Spectral error measure – transient detection and elimination (the case of epileptic patents)-review of Wiener Filtering Problem – principle of adaptive filter –the Steepest -Descent Algorithm -50Hz interference and it's cancellation –cancellation of ECG signal from the electrical activity of the chest muscles –

Module 3:(10 Hrs)

Basic electrocardiography- ECG data a acquisition-ECG lead systems – steps in ECG analysis -ECG parameters and their estimation – QRS detection algorithm -arrhythmia analysis and monitoring - long term ECG recording

Module 4: (8 Hrs)

Direct ECG data compression techniques – Transformation compression Techniques –other data compression techniques – Prony's method – clinical applications

Text/Reference Books:

1. Biomedical signal processing by DC Reddy , TMH 2005 edition
2. A Biomedical signal processing by Willis J Tompkins, PHI, 2009
3. Biomedical signal analysis by Rangaraj M. Rangayyan ,IEEE Press, 2002
4. Bioelectrical signal processing in cardiac and neurological applications : Leif Sornmo and Pablo
5. Laguna , Elsevier Academic Press, 2005
6. Advances in Cardiac Signal Processing , U.R. Acharya J.S. Suri JAE Spaan, S.M.Krishnan(Editotrs)

EE4028 POWER SYSTEM RELIABILITY AND DEREGULATION

ELECTIVE COURSE

L	T	P	C
3	0	0	3

Pre-requisites: None

Course Outcomes:

CO1: Understand basic reliability concepts and reliability measures.

CO2: Develop analytical models for power system reliability analysis.

CO3: Implement and use algorithms for power system reliability analysis

CO4: Conduct reliability studies of typical system using simulation tools

CO5: Acquire knowledge on deregulation and its social impacts

Total Hours : 42 Hours

Module 1: (10 Hrs)
Generator System Models- State Load Model- Probability Methods- Unit Unavailability- Outage Probability Generating Capacity Limits- Recursive Techniques- Capacity Expansion Analysis -Scheduled Outages Reliability Indices- Frequency Duration Method. Power quality issues.

Module 2: (11 Hrs)
Interconnected Systems - Two Systems with Tie- Probability Array Methods- Reliability Indices-Variable Reserve And Maximum Peak Load Reserve- Multi Connected Systems.
Distribution System- Interruption Indices- System Performance- risk prediction- Radial Systems- Effect Of Load Transfer- Line Failures- Parallel And Mesh Networks- Industrial Systems.

Module 3: (10 Hrs)
Deregulated Systems: Need and conditions for deregulation-Introduction of Market structure-Market Architecture-Spot market-forward markets and settlements. Review of Concepts- marginal cost of generationleast-cost operation-incremental cost of generation.

Module 4: (11 Hrs)
Reconfiguring Power systems- Unbundling of Electric Utilities- Competition and Direct access. Transmission network and market power - Power wheeling transactions and marginal costing -transmission costing. Framework and methods for the analysis of Bilateral and pool markets.

Text/Reference Books:

1. Dong**,** Z**.,** Zhang**,** P**.** Ma**,** J**.,** Zhao, J.,Ali**,** Meng**,** K**.,** Yin, "Emerging Techniques in Power System Analysis" Springer, 1st edition 2010.
2. S.C. Savulescu, "Real-Time Stability assessment in modern power system control centres", John Wiley & Sons, January 2009
3. Eric Monmasson, "Static Converters", John Wiley & Sons, September 2009.
4. Bo Bergman, Jacques de Mare, Thomas Svensson, Sara Loren, "Robust Design methodology for reliability", John Wiley & Sons, October 2009
5. Ali A. Chowdhury, Don O. Koval, "Power distribution system reliability-Practical methods and applications" John Wiley & sons Inc., *IEEE Press* 2009
6. Richard E.Brown, "Elactric power distribution reliability" Taylor & Francis Group,LLC,2009.
7. Elmakias, David (Ed.) "New Computational Methods in Power System Reliability" Studies in Computational Intelligence, Springer 2008
8. Leveque, Francois , "Transport Pricing of Electricity Networks" Springer 2003
9. Steven Stoft , " Power System Economics-Designing markets for electricity" *IEEE Pres*,2002
10. M. Shahidehpour, H. Yamin and Zuyi Li, "Market operations in electric power systems-Forecasting, scheduling and risk management" John Wiley & sons Inc., 2002
11. Kankar Bhattacharya, Math H.J. Bollen, and Jaap E. Daalder, "Operation of restructured power systems", Kluwer international series,2001
12. Loe lei lai, "Power system restructuring and deregulation- trading, performance and information technology", John Wiley and sons,ltd,2001
13. Wilson K. Kazibwe and Musoke H Semdaula. "Electric Power Quality Control Techniques". Van Nostarand Reinhold New York.2001

14. Yong-Hua Song "Modern Optimisation Techniques in Power Systems" Intelligent Systems, Control and Automation: Science and Engineering, Vol. 20, Springer 1999
15. Roy Billinton, Ronald N. Allan, "Reliability Assessment of Large Electric Power Systems", *IEEE Press* 1995
16. R.Ramakumar, "Reliability Engineering: Fundamentals and Applications", Prentice Hall, 1993
17. Roy Billinton, "Power System Reliability Evaluation", Plenum Press, New York,1991
18. 7.J. Endrenyi, "Reliability Modeling in Electrical Power Systems", *Wiley* New York, 1978

EE4029 CONTROL & GUIDANCE ENGINEERING

ELECTIVE COURSE

Pre-requisites: EE3002 Control Systems I

L	T	P	C
3	0	0	3

Course Outcomes:

CO1: Learn the basics of satellite based navigation systems, GPS and GNSS

CO2: Learn the guidance system components: gyros and accelerometers

CO3: Model the dynamics of space vehicles and missiles

CO4: Design guidance and control schemes for space vehicles and missiles

Total Hours: 42 Hours

Module 1: **(12 Hrs)**

Navigation Systems:

General principles of early conventional navigation systems-Geometric Concepts of navigation-Reference frames-Direction cosine matrix-Euler angles-Transformation of angular velocities-Quaternion representation in co-ordinate transformations-Comparison of transformation methods. Inertial platforms-Stabilized platformsGimbaled and Strap down INS and their mechanization-Gyrpcompassing for initial alignment, Externally aided inertial navigation systems, TACAN, TERCOM, LORAN, OMEGA, DECCA, VOR, DME, JTIDS, FLIRBasics of satellite based navigation systems: Global Positioning Systems (GPS) and Global Navigation of Satellite Systems (GNSS)

Module 2: **(10 Hrs)**

Guidance Systems:

Guidance information requirements-Energy Conservation Methods-Time Conservation Methods-Collision Warning and Avoidance-Rendezvous - Satellite Orbit maintenance-Inertial navigation-block diagram representation of essential components-Inertial sensors, Gyros: Principle of operation-TDF and SDF gyrosprecession-Nutation-gimbal lock-gimbal flip-gyro transfer function-rate gyro-integrating gyro-Constructional details and operation of floated rate integrating gyro-Dynamically tuned gyro-Ring laser gyro-Fiber optic gyrogyro performance parameters-Accelerometers-transfer function-Pendulous gyro integrating accelerometerVibrating String accelerometer-Accelerometer performance parameters-Navigation equations-Schuler principle and mechanization

Module 3: **(10 Hrs)**

Space vehicle dynamics and control:

Powered flight-unpowered flight-Orbital mechanics, Orbital parameters, circular, elliptical, parabolic, hyperbolic and rectilinear orbits, energy of the orbit, orbital transfer and rendezvous, LEO, SSPO,GSO,GTO orbits, impulse transfer between circular orbits, Hoffmann transfer, other co-planar and non-coplanar transfers, N-body problem, two-body problem- Re-entry of space vehicle, re-entry dynamics, ballistic re-entry, skip re-entry, double-dip re-entry, aerobraking, lifting body re-entry, entry corridor, equilibrium glide, thermal and structural constraints, commanded drag guidance.

Module 4: **(10 Hrs)**

Missile guidance and Control:

Guided missile - surface to surface, surface to air, air to surface and air to air missiles.Tactical and strategic missile, Subsystems of a missile – airframe, flight control and guidance, warhead, data link, fuze, propulsion, telemetry. Control – Canad, wing and tail control. Steering policy – skid to turn (STT), preferred orientation control (POC), bank to turn (BTT) and hybrid. Aerodynamic and Ballistic missiles.Auto pilots.Types of fuze, warhead and propulsion systems. Guidance sequence, different schemes of guidance during launch, midcourse and terminal phases. Collision avoidance

Text/Reference Books:

1. Marshall H Kaplan, Modern Spacecrafts dynamics and control' John Wiley & Sons, 1976.
2. Hanspeter Schaub, John L. Junkins,Analytical Mechanics of Space Systems, AIAA, USA, 2003.
3. Edward V B Stearns, Navigation and Guidance in Space, Prentice Hall, 1983.
4. Manuel Fernadez, George R Macomber, Inertial Guidance Engineering, Prentice Hall, 1962.
5. Ching-Fang –Lin, Modern Navigation, Guidance, and Control Processing, Prentice-Hall, 1991.
6. M.J. Zucrow, Aircraft & Missile Propulsion**,** John Wiley & Sons, 1958.
7. David B. Newman, Space Vehicle Electronics, D. Van Nostrand Co, 1964.
8. A C Kermode, Mechanics of flight, Pearson Education, 2004
9. Paul Zarchan, Tactical and Strategic Missile Guidance, AIAA, 2007.

EE4030 SWITCHGEAR AND PROTECTION

ELECTIVE COURSE

Pre-requisites: None

L	T	P	C
3	0	0	3

Course outcomes:

CO1: Acquire the knowledge of various abnormal conditions that could occur in power system.

CO2: Ability to design various protective devices in power system for protecting equipment and personnel.

CO3: Knowledge of various types of existing circuit breakers, their design and constructional details.

CO4: Knowledge of various conventional relays, their design and latest developments.

CO5: **K**nowledge of standards and specifications related to switchgear and protection.

Total Hours: 42 Hours

Module 1: **(10 Hrs)**

Circuit breakers-principles of operation–RRRV-Current chopping.Constructional features and Selection of LT breakers (MCB/MCCB/ELCB) and HT Breakers (ABCB - OCB – SF_6CB– VCB); Circuit breaker ratings-Testing of circuit breakers.

Module 2: **(10 Hrs)**

Overvoltages – Surges and travelling waves – Wave propagation on transmission lines - reflection and attenuation- Lightning strokes- protection against lightning - earth wires- lightning diverters - surge absorbers arcing ground - neutral earthing - basic concepts of insulation levels and their selection - BIL – Co-ordination of insulation.

Module 3: **(12hours)**

Protective relays - protective zones - requirement of protective relaying- definitions-Codes-Standards - Types – Over current Relays - Earth fault relays- Directional relays- Differential relays- Distance relays- Under voltage/ Frequency relays. Static, digital and numerical relays-PC based relays-Construction-Characteristic FunctionsConverter Elements-Comparators-Relay Schematics, Analysis.

Module 4: **(10 Hrs)**

Protection Scheme for Generators-Power Station & DG sets, Power & Distribution Transformers, Transmission lines and Busbars, Motors.

NEC and importance of relevant IS/IEC specifications related to switchgear and protection.

Text/Reference Books:

1. Sunil S Rao, "Switch Gear Protections", Khanna Publications, Delhi 1999
2. Allen Greenwood, " Electrical Transients in Power Systems", 1991.
3. Van. C. Warrington A.R., "Protective Relays"Vol. 1 & 2, Chapman & Hall, 1998.
4. T S Madhav Rao, "Power system protection static relays with microprocessor Applications", Tata McGraw hill Publication,1998.
5. Badri Ram, D N Vishwakarma, " Power System Protection and Switchgear', Tata Mc Graw Hill, 2005.
6. Anderson P M, " Power System Protection", IEEE publication, 1999.
7. Walter -Marcel Dekker, "Protective relaying theory and applications", 2ed, Elmore, 2004.

EE4090 ELECTRICAL ENGINEERING DRAWING

REQUIRED COURSE

Pre-requisites: EE2007 Electrical Machines I & EE3003 Electrical Machines II

L	T	P	C
1	0	3	3

Course Outcomes:

CO1: Acquire experience to design and draw different types of AC and DC armature windings

CO2: Acquire experience to design, visualize and draw the sectional plan and elevation of different aspect of transformer structure and to know the relative position of its components.

CO3: Acquire experience to design, visualize and draw the sectional plan and elevation of different type of DC machines, alternator and induction motor.

CO4: To acquire knowledge of layout of schematic representation of outdoor and indoor substations.

Total Hours: 56 Hours

Module 1: Armature Windings **(16 Hrs)**

1. Simplex lap/ wave dc armature windings with equalizer rings/ dummy coils.

2. Simplex lap/ wave, integral/ fractional slot, double layer three phase ac armature windings with full pitched/ short chorded coils.
3. Mush type/ concentric, 2-tier/ 3-tier, bifurcated/ unbifurcated single layer three phase ac armature windings.

Module 2: Transformers (12 Hrs)

1. Sectional plan and elevation of a transformer limb with windings.
2. Sectional plan and elevation of the core assembly of a power transformer.
3. Sectional plan and elevation of a distribution transformer tank with its accessories.
4. Sketches of capacitor and oil filled type transformer bushings.

Module 3: Rotating Machines (24 Hrs) DC Machines

1. Sectional front and side elevation of armature with commutator.
2. Sectional front and side elevation of yoke and pole assembly with field winding.
3. Sectional front and side elevation of assembled Machine.

Alternators

1. Sketches of the methods of pole fixing and slot details of turbo & water wheel alternators.
2. Sectional front and side elevation of water wheel rotor assembly with winding.
3. Sectional front and side elevation of salient pole alternator.
4. Sectional front and side elevation of turbo alternator.

Induction Motors

1. Sectional front and side elevation of slip ring induction motor.
2. Sectional front and side elevation of squirrel cage induction motor.

Module 4: Substations (4 Hrs)

1. Layouts and single line diagrams of outdoor and indoor substations.
2. Layout of a 220KV substation.
3. Layout of a captive power substation.
4. Single line diagram of a distribution center.

Text/Reference Books:

1. Clayton & Hancock, Performance and Design of DC Machines, ELBS, 1992.
2. Say M.G, Performance and Design of AC machines, Pitman, ELBS, 1991.
3. A.K. Sawhney, Electrical Machine Design, Dhanpath Rai, New Delhi, 1991.
4. Narang K.L., A Text Book of Electrical Engineering Drawing, Tech India Publications.
5. Bhattacharya S.K, Electrical Engineering Drawing, Wiley Eastern, Edition 2.

EE4091 POWER ENGINEERING LAB

REQUIRED COURSE

Pre-requisite: EE3004 Power Systems I & EE3007 Power Electronics

L	T	P	C
0	0	3	2

Course outcomes:

CO1: Acquire experience to design and assemble circuits with different types of power electronic devices for various types of power conversion.

CO2: Testing of various relays for different characteristics and comparison with the performance characteristics provided by manufacturers.
CO3: Acquire knowledge of performance characteristics of renewable energy sources.
Total Hours : 42 Hours

List of Experiments

IDMT Over current relay: plot the IDMT characteristics of the inverse over current relay, identify PSM and settings required for a 3 phase 5 hp induction motor with 120% overload limit, Determine the tripping time for 50*I.

1. Under voltage and Over voltage relay: Plot the inverse characteristics of the relay in under and over voltage operation zone. Determine the tripping time for 150*V and 50*V.
2. Design and setup a single-phase full-converter and study its performance for R and RL loads.
3. Solar PV Module: Plot I-V characteristics of a P-V Module. Determine the maximum power point and power transferred for a lamp load.
4. Design and setup a single-phase semi-converter and study its performance for R and RL loads.
5. Design and set up a Single Phase half wave rectifier and study its performance for R and RL loads.
6. Design and set up a Single Phase AC voltage controller using Triac.
7. Design and set up a Single Phase square wave inverter and study the effect of variation is DC Bus voltage and duty cycle.
8. Study of V-I characteristics of Thyristor.
9. Study of V-I characteristics of IGBT.
10. Study of V-I characteristics MOSFET.
11. Study of switching characteristics of IGBT.
12. Study of switching characteristics of MOSFET.
13. Cable Testing: Determine the IR value, conductor resistance and calculate the leakage current. Conduct HV test on 415V grade cable.

Text/Reference Books:

1. Ned Mohan et.al ,"Power Electronics",John Wiley and Sons,2006
2. Rashid, Power Electronics, Circuits Devices and Applications, Pearson Education, 3rd edition, 2004.
3. G.K.Dubey, Thyristorised Power Controllers, Wiley Eastern Ltd, 1993.
4. Dewan & Straughen, Power Semiconductor Circuits, John Wiley & Sons, 1975.
5. Cyril W Lander, Power Electronics, Mc Graw Hill, 3rd edition, 1993.

EE4002: INSTRUMENTATION SYSTEMS

REQUIRED COURSE

Prerequisites: EE2001 Signals and Systems,
EE2008 Analog Electronic Circuit and systems

L	T	P	C
3	0	0	3

Course Outcomes:

CO1: Learn the different types of errors in measurement, calibration process and standards

CO2: Understand the different methods for measurement of various electrical quantities

CO3: Familiarize the dynamics of instrument systems

CO4: Learn various methods for measurement of non-electrical quantities like temperature, Pressure, Force, Torque, Density, Liquid level, Viscosity, Flow, Displacement etc.

CO5: Familiarize various passive and active transducers

CO6**:** Recognize various signal processing circuits.

Total Hours: 42 Hours

Module 1: **(10 Hrs)**

Measurement, Instrumentation and Calibration - Introduction to Instrumentation systems - Classification of transducers – performance characteristics, static and dynamic characteristics – Errors in measurement - gross Errors, systematic Errors – statistical Analysis of Random Errors – Calibration and Standards - Process of calibration, classification of standards, standards for calibration. Signals and their representation.

Module 2: **(10 Hrs)**

Electrical Measuring systems –Measurement of Current, Voltage, Resistance, Impedance. Electronic Amplifiers- difference or Balanced Amplifiers, Electrometer Amplifier, operational Amplifiers, feed back amplifiers, Isolation Amplifiers, charge Amplifiers, power Amplifiers. Measurement of phase Angle- Frequency Measurement – Time – Interval measurement **-** Dynamics of Instrument systems – generalized performance of systems – electrical Networks – Mechanical systems - Electromechanical systems – Thermal systems – Fluidic systems – Filtering and Dynamic Compensation.

Module 3: **(12 Hrs)**

Basics of Temperature, pressure, Force, Torque, Density, Liquid level, Viscosity, Flow, Displacement, measurement. Passive Electrical Transducers – resistive, Inductive and capacitive Transducers and ,measurement of various physical variables, Active Electrical Transducers – Thermoelectric , piezoelectric , magnetostrictive, Hall – Effect, Electromechanical, Electro Chemical Photoelectric and Ionization Transducers, Digital Transducer, Feed back Transducers Systems –

Module 4: **(10 Hrs)**

Signal processing Circuits – Data Display and recording systems – Data Transmission and Telemetry –

Developments in sensor Technology –

Text/Reference Books:

1. D.V.S Murty, Transducers & Instrumentation, prentia Hall of India (pvt ltd), Edition 2, 2008
2. 2. Ernest O. Deobine, Measurement System Application & design, Mcgraw Hill International, Edition 5, 2004.
3. K.B Kalasen, Electronic Measurement & Instrumentation, Cambridge University Press, 1996.
4. Cooper W.D, Modern Electronics Instrumentation, Prentia Hall of India,1996.

EE4031 ADVANCED DIGITAL SIGNAL PROCESSING

ELECTIVE COURSE

Pre-requisite: **EE3005 Digital Signal Processing**

L	T	P	C
3	0	0	3

Course Outcomes:

CO1: Acquire knowledge about the optimization methods for IIR and FIR filter design in time domain and frequency domain and algorithms for filter implementation.

CO2: Acquire knowledge about modelling and analysis of speech signals and speech signal processing

CO3: Acquire knowledge about two dimensional signal processing and its application in image processing .

CO4: Acquire knowledgeabout digital signal processors and their architecture.

Total Hours : 42 Hours

Module 1: (10 Hrs)

Optimisation Methods for IIR and FIR filter Design:

Deczky's method for IIR filter design in the frequency domain, Pade approximation method , Least-squares design method in time domain; Frequency sampling method for FIR filters, Parksand McClellan Algorithm for design, Remez exchange algorithm for implementation.

Module 2: (12 Hrs)

Speech signal processing:

Digital models for speech signal, Mechanism of speech production, Acoustic theory, Lossless tube models , Formulation of LPC equation, Solution of LPC equation, Levinson Durbin algorithm, Schur algorithm, Spectral analysis of speech, Short time fourier analysis, Speech coding, subband coding, Transform coding, Channel vocoder,Formant vocoder, Cepstral vocoder, Vector quantisation coder.

Module 3: (12 Hrs)

Two dimensional signal processing(Image Processing)

Digital image representation; 2-D DFT . properties; DCT; Image enhancement ,Spatial and frequency domain filtering methods; colour image processing; Image restoration- Degradation model, Inverse filtering; Fundamentals of image compression.

Module 4: (8 Hrs)

Digital signal processors

Introduction to DSP processors- common features, fixed point versus floating point; Memory architectureHarvard architectures, multiple access memories, multi processor support, addressing modes; instruction set; An example DSP architecture- Analog Devices/Motorola/Texas Instruments

Text/Reference Books:

1. Alan V . Oppenheim, Ronald W. Schafer, .Discrete-Time Signal Processing., Prentice-Hall of India Pvt. Ltd., New Delhi, 1997
2. John G. Proakis, and Dimitris G. Manolakis, Digital Signal Processing. (third edition), Prentice-Hall of India Pvt. Ltd, New Delhi, 1997

3. L.R. Rabiner and R.W Schafer, Digital processing of speech signals, Prentice Hall, New Jersey , 1978.
4. R. C. Gonzalez and R.E. Woods , Digital Image processing, Addison Wesley, 1992
5. Jae S. Lim, Two Dimensional signal and image processing, Prentice Hall Inc., Englewood Cliffs, New Jersey,1990.
6. Lapsley P, Jeff Bier, Amit Shoham and Lee E. A., DSP Processor Fundamentals ,Architectures and features, IEEE Press.

EE4032 STATIC VAR COMPENSATION AND HARMONIC FILTERING

ELECTIVE COURSE

Pre-requisites: None

L	T	P	C
3	0	0	3

Course Outcomes:

CO1: Acquire knowledge on shunt compensation of Power Systems

CO2: Acquire knowledge on Power Quality issues

CO3: Acquire detailed knowledge on Static VAr Compensators and STATCOMS

CO4: Develop design capability in control systems for SVC and STATCOM

CO5: Acquire detailed analysis-level and design-level knowledge on various power electronic converters used static reactive power compensation units

CO6: Acquire detailed analysis-level and design-level knowledge on single-phase and three-phase shunt/series active harmonic filters and their control systems

Total Hours: 42 Hours

Module 1:
(10 Hrs)
Fundamentals of Load Compensation , Steady-State Reactive Power Control in Electric Transmission Systems , Reactive Power Compensation and Dynamic Performance of Transmission Systems .
Power Qulity Issues . Sags, Sweels, Unbalance, Flicker , Distortion , Current Harmonics - Sources of Harmonics in DistributionSystems and Ill Effects .

Module 2:
(10 Hrs)
Static Reactive Power Compensators and their control . Shunt Compensators, SVCs of Thyristor Switched and Thyristor Controlled types and their control, STATCOMs and their control, Series Compensators of Thyristor Switched and Controlled Type and their Control, SSSC and its Control, Sub-Synchronous Resonance and damping, Use of STATCOMs and SSSCs for Transient and Dynamic Stability Improvement in Power Systems

Module 3:
(11 Hrs)
Converters for Static Compensation . Single Phase and Three Phase Converters and Standard Modulation Strategies (Programmed Harmonic Elimination and SPWM) . GTO Inverters . Multi-Pulse Converters and Interface Magnetics . Multi-Level Inverters of Diode Clamped Type and Flying Capacitor Type and suitable modulation strategies (includes SVM) . Multi-level inverters of Cascade Type and their modulation .Current Control of Inverters.

Module 4:
(11 Hrs)
Passive Harmonic Filtering . Single Phase Shunt Current Injection Type Filter and its Control, Three Phase Three-wire Shunt Active Filtering and their control using p-q theory and d-q modelling . Three-phase four-wire shunt active filters . Hybrid Filtering using Shunt Active Filters . Series Active Filtering in Harmonic Cancellation Mode . Series Active Filtering in Harmonic Isolation Mode . Dynamic Voltage Restorer and its control . Power Quality Conditioner

Text/Reference Books:

1. T.J.E Miller, "Reactive Power Control in Electric Systems", John Wiley & Sons,1982.
2. N.G. Hingorani & L. Gyugyi, "Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems", IEEE Press, 2000.
3. Ned Mohan et.al, "Power Electronics", John Wiley and Sons 2006
4. R. Sastry Vedam & Mulukutla S. Sarma, "Power quality VAR compensation in power systems", CRC press, 2009.
5. Hirofumi akagi, Edson hirokazu watanabe, Mauricio aredes, "Instantaneous power theory and applications to power conditioning" Wiley Inter Science,2007.
6. K.R. Padiyar, "FACTS controllers in power transmission and distribution", New age international publications, 2008.

EE4033 OPTIMAL AND ADAPTIVE CONTROL

ELECTIVE COURSE

L	T	P	C
3	0	0	3

Course Outcomes:

CO1: Formulate performance index and to define various optimal control problems

CO2: Solve discrete linear regulator problem using dynamic programming

CO3: Learn the conditions for optimality and to solve continuous time linear regulator problem

CO4: Solve minimum time and minimum control effort problems

CO5: Understand adaptive control problem and to learn the mathematical description of model reference adaptive systems

CO6:Design model reference adaptive systems

Module 1: **(10 Hrs)**

Optimal control problem – formulation of performance measure - performance measure for linear regulator problem - dynamic programming - principle of optimality - application to multi stage decision making – application to optimal control problem – need for interpolation - recurrence relation of dynamic programming curse of dimensionality - discrete linear regulator problem - Hamilton-Jacobi-Bellman equation - continuous linear regulator problem.

Module 2: **(10 Hrs)**

Fundamental concepts and theorems of calculus of variations - Euler - Legrange equation and solution -

extremal of functionals of a single function - extremal of functionals of several independent functions - various boundary conditions - extremal of functionals with dependent functions - differential equation constraints – isoperimetric constraints.

Module 3: (12 Hrs)

Open loop and closed loop form of optimal control - the variational approach to solving optimal control problems - necessary conditions and boundary conditions for optimal control using *Hamiltonian* – closed loop control for linear regulator problem - linear tracking problem – Pontryagin's minimum principle - state inequality constraints - minimum time problems - minimum control effort problems.

Module 4: (10 Hrs)

Model following control – Model Reference Adaptive systems (MRAS) - an over view of adaptive control systems - mathematical description of MRAS - design hypothesis - equivalent representation of MRAS introduction to design method based on the use of Liapunov function

Text / Reference Books:

1. Donald E. Kirk - Optimal Control Theory, An introduction, Prentice Hall Inc.
2. A.P. Sage - Optimum Systems Control, Prentice Hall.
3. Kwakernaak -Linear optimal control systems . Wiley.
4. HSU and Meyer - Modern Control . Principles and Applications, McGraw Hill.
5. Yoan D. Landu - Adaptive Control - Model Reference Approach, Marcel Dekker.

EE4034 POWER SYSTEM STABILITY AND CONTROL

ELECTIVE COURSE

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Course outcomes:

CO1: Introduces a student to power stability problems and the basic concepts of modeling and analysis of dynamical systems.

CO2: To impart the knowledge of modeling of power system components - generators, transmission lines, excitation and prime mover controllers - is covered in detail.

CO3: To enable the students to analyze stability of single machine and multi-machine systems using digital simulation and small-signal analysis techniques.

CO4: Create awareness of impact of stability problems on power system planning, and operation is also brought out.

CO5: An understanding of Sub Synchronous Resonance and Countermeasures

CO6**:** To impart the knowledge of voltage Stability Assessment Using PVCurves

Total Hours: 42 Hours

Module 1: (11 Hrs)

Generation Control Loops. AVR Loop. Performance And Response. Automatic Generation Control Of Single Area And Multi Area Systems. Static And Dynamic Response Of AGC Loops . Economic Dispatch And AGC.

Module 2: (11 Hrs) Transient Stability Problem. Modeling Of Synchronous Machine, Loads, Network, Excitation And Systems, Turbine And Governing Systems. Trapezoidal Rule Of Numerical Integration Technique For Transient Stability Analysis. Data For Transient Stability Studies. Transient Stability Enhancement Methods.

Module 3: **(11 Hrs)** Low Frequency Oscillations. Power System Model For Low Frequency Oscillation Studies. Improvement Of System Damping With Supplementary Excitation Control. Introduction To Sub Synchronous Resonance And Countermeasures.

Module 4: **(9 Hrs)** Voltage Stability Problem. Real And Reactive Power Flow In Long Transmission Lines . Effect Of ULTC And Load Characteristics On Voltage Stability .Voltage Stability Limit .Voltage Stability Assessment Using PV Curves .Voltage Collapse Proximity Indices.Voltage Stability Improvement Methods.

Text/Reference Books:

1. O.I. Elgard, .Electric Energy System Theory: An Introduction., II Edition, McGraw Hill, New York, 1982.
2. A.J. Wood, B.F. Wollenberg, .Power Generation, Operation And Control., John Wiley And Sons, New York, 1984, 2nd Edition: 1996.
3. J. Arrilaga, C.P. Arnold, B.J. Harker, .Computer Modeling Of Electrical Power Systems., Wiley, New York, 1983.
4. I.J. Nagrath, O.P. Kothari, .Power System Engineering., Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1994.
5. Yao-Nan-Yu, .Electric Power System Dynamics..
6. P. Kundur, .Power System Stability And Control., McGraw Hill, New York, 1994.
7. K.R. Padiyar, .Power System Dynamics . Stability And Control., Interline Publishing (P) Ltd., Bangalore, 1999.
8. C. Van Custem, T. Vournas, .Voltage Stability Of Electric Power Systems., Rlever Academic Press (U.K.), 1999.
9. .B.R. Gupta, .Power System Analysis And Design., III Edition, A.H. Wheeler & Co. Ltd., New Delhi, 1998.
10. T.J.E. Miller, .Reactive Power Control In Electric Power Systems., John Wiley and Sons, New York, 1982.

EE4035 FLEXIBLE AC TRANSMISSION SYSTEMS

ELECTIVE COURSE

L	T	P	C
3	0	0	3

Course Outcomes:

CO1: Acquire the knowledge of FACTS Concept and general system considerations.

CO2: Knowledge of the static series compensation and the static shunt compensation and the different types of compensators in each category.

CO3: Knowledge of the Unified Power Flow Controller including its circuit arrangement, operation and control.

CO4**:** Knowledgeof the special purpose FACTS controllers and custom power.

Module 1: **(11 Hrs)**

FACTS concepts and general system considerations: Power flow in AC systems - Definition of FACTS - Power flow control -Constraints of maximum transmission line loading - Benefits of FACTS

Transmission line compensation- Uncompensated line -shunt compensation - Series compensation -Phase angle control.

Module 2: (11 Hrs)

Static shunt compensators: SVC and STATCOM - Operation and control of TSC, TCR and STATCOM Compensator control - Comparison between SVC and STATCOM.

Static series compensation: TSSC, SSSC -Static voltage and phase angle regulators - TCVR and TCPAROperation and Control –Applications- Modeling and Simulation

Module 3: (10Hrs) Unified Power Flow Controller: Circuit Arrangement, Operation and control of UPFC- Basic Principle of P and Q control- independent real and reactive power flow control- Applications - Introduction to interline power flow controller.

Module 4: (10 Hrs) Special purpose FACTS controllers - Thyristor controlled voltage limiter - Thyristor controlled voltage regulator - Thyristor controlled braking resistor - Thyristor controlled current limiter-
Custom Power - Compensation Devices - STS - SSC - SVR -Backup energy supply devices, UPQC.

Text/Reference Books:

1. N.G. Hingorani & L. Gyugyi,"Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems", IEEE Press, 2000..
2. 2.T.J.E Miller, "Reactive Power Control in Electric Systems ",John Wiley & Sons
3. 3.Ned Mohan et.al "Power Electronics", John Wiley and Sons.
4. K. R. Padiyar, "FACTS controllers in power transmission and distribution", New Age International (P) Ltd, 2008.

EE4036 NONLINEAR CONTROL THEORY

ELECTIVE COURSE

Pre-requisites: EE3002 Control Systems I , EE4001 Control Systems II

L	T	P	C
3	0	0	3

Course Outcomes:

CO1: Learn the characteristics of nonlinear systems and common type of nonlinearities

CO2: Classify equilibrium points and analyze limit cycle

CO3: Analyze the nonlinear systems using phase plane method

CO4: Analyze the stability of nonlinear systems using Lyapunov methods, invariance theorems, center manifold theorem and L stability

CO5: Analyze the frequency response of nonlinear systems using describing function, circle criterion and Popov criterion

CO6: Linearize nonlinear systems using feedback linearization and design state feedback controller

Total Hours: 42 Hours

Module 1: (11 Hrs)

Introduction and classical techniques- Characteristics of nonlinear systems – Types of nonilearities and their occurrences- classification of equilibrium points - limit cycles - analysis of systems with piecewise constant inputs using phase plane analysis . perturbation techniques- periodic orbits - stability of periodic solutions singular perturbation model - slow and fast manifolds.

Module 2: **(10 Hrs)** Stability of Nonlinear Systems - Lyapunov stability - local stability - local linearization and stability in the smallDirect method of Lyapunov - generation of Lyapunov function for linear and nonlinear systems - variable gradient method - Centre manifold theorem - region of attraction - Invariance theorems - Input output stability L stability - L stability of state models - L2 stability- Robust stabilization.

Module 3: **(10 Hrs)** Harmonic Linearisation and Describing Function Method-Harmonic linearization - filter hypothesis - Sine Input describing function of standard nonlinearities- study of limit cycles (amplitude and frequency) using SIDF- Dual Input Describing function - study of sub-harmonic oscillations. Jump response.

Module 4: **(11 Hrs)**
Feedback Control and Feedback Stabilisation- Analysis of feedback systems- Circle Criterion - Popov Criterion– Concepts of Inverse control-Feedback linearization-Model predictive control-Simultaneous Feedback controlDesign via linearization- stabilization - regulation via intgral control- gain scheduling - Exact Feedback
Linearization - Input state linearization - input output linearization - state feedback control - stabilization tracking - integral control.

Text/Reference Books:

1. Hassan K Khalil, *Nonlinear Systems*, Prentice - Hall International (UK), 1996
2. JJE Slotine & W.LI .Applied Nonlinear Control. Prentice Hall, Englewood Clifs, New Jersey 1991Alberto Isidori, *Nonlinear Control Systems*, Springer Verlag, 1995

EE4037 ENERGY AUDITING, CONSERVATION & MANAGEMENT

ELECTIVE COURSE

L	T	P	C
3	0	0	3

Course Outcomes:

CO1:Acquire the knowledge of fundamentals of economic operation of an Electrical system.

CO2: Acquire the knowledge of basic principles of energy auditing types and objectives, instruments used

CO3: To learn energy efficient control methods and schemes for improvement of starting efficiency in Electrical Motors.

CO4: Understand efficient control strategies, optimal selection, sizing, operation of variable speed drives like pumps and fans.

CO5: Acquire the knowledge of analysis of Transformer loading and Feeder loss evaluation methods, Scheme for reactive power management, Energy efficient illumination system.

CO6: Acquire the knowledge of different types and schemes of cogeneration.

CO7: To learn the Energy conservation measures and optimal operation methods for electric load like air conditioning, refrigeration, gysers-solar water heaters, compressors, electrolytic process.

Module 1: **(9Hrs)** Electrical Systems: Supply & Demand Side, Economic operation, Input-Output curves, Load profiling,Electricity tariff types; Energy auditing: Types and objectives-audit instruments- ECO assessment and Economic methodsspecific energy analysis

Module 2: **(11Hrs)**

Electric motors-Energy efficient controls and starting efficiency-Motor Efficiency and Load Analysis-Energy efficient /high efficient Motors-Case study; Load Matching and selection of motors.

Variable speed drives; Pumps and Fans-Efficient Control strategies- Optimal selection and sizing - Optimal operation and Storage; Case study

Module 3: **(11 Hrs)**

Transformer Loading/Efficiency analysis, Feeder/cable loss evaluation, case study.

Reactive Power management-Capacitor Sizing-Degree of Compensation, Peak Demand controlsMethodologies-Types of Industrial loads-Optimal Load scheduling-case study;

Lighting- Energy efficient light sources-Energy conservation in Lighting Schemes- Electronic ballast-Power quality issues-Luminaries, case study;

Module 4: **(11 Hrs)**

Cogeneration-Types and Schemes;

Electric loads of Air conditioning & Refrigeration-Energy conservation measures- Cool storage .Types-Optimal operation-case study; Electric water heating-Gysers-Solar Water Heaters- Power Consumption in Compressors, Energy conservation measures; Electrolytic Process; Computer Controls- softwares-EMS

Text/Reference Books:

1. Rik DeGunther, “Alternative energy for dummies”, John Wiley & Sons, May 2010.
2. Paul A. Lynn, “Electricity from sunlight”, John Wiley & Sons, July 2010
3. Leon K. Kirchmayer, “Economic Operation of power system”, Wiley India Pvt Ltd, July 2010.
4. Jean-Claude SabonnadiAre, “Low emission power generation technologies and energy management”, John Wiley & Sons, August 2010
5. Ursula Eicker, “Low energy cooling for sustainable buildings”, John Wiley & Sons, August 2010
6. Allen J. Wood, “ Power generation Operation and Control”, Wiley 2^{nd} edition, August 2010.
7. Timothy J. E. Miller, “Reactive power control in electric systems”, Wiley edition, August 2010
8. Paul C. Crause, Oleg Wasynczuk, Scott D.sudhoff, “Analysis of electric machinery and drive system” , Wiley 2^{nd} Edition, August 2010.
9. Marion Pagliaro, Giovanni Palmisano Rosaria Ciriminna, “Flexible Solar Cells”, John Wiley & Sons, November 2009.

10. Alexander Mitsos, Paul I.Barton, “Microfabricated Power Generation Devices”, John Wiley & Sons, March 2009.
11. Albert Thumann, P.W,Plant Engineers and Managers Guide to Energy Conservation” TWI PressInc, Terre Haute, 9th edition,2008
12. Roland Wengenmayr, “Renewable Energy”, John Wiley & Sons, April 2004
13. Francois, Leveque, “Transport pricing of electricity networks”, Springer 2003.
14. Parasiliti F., P. Bertoldi, “Energy Efficiency in motor driven systems”, Springer, 2003.
15. Turner, Wayne C., “Energy Management Handbook”, Lilburn, The Fairmont Press, 2001
16. Donald R. W., “Energy Efficiency Manual”,Energy Institute Press,2000
17. Giovanni Petrecca, “.Industrial Energy Management:
Principles and Applications”,The Kluwer international series -207,1999
Springer 2000.
18. Anthony J. Pansini, Kenneth D. Smalling, “Guide to Electric Load Management”,Pennwell Pub,1998
19. Albert Thumann, “Handbook of Energy Audits”, Fairmont Pr; 5th edition,1998
20. Howard E. Jordan, “Energy-Efficient Electric Motors and Their Applications”, Plenum Pub Corp; 2ndedition 1994
21. Petrecca, Giovanni, “Industrial Energy Management”, Springer 1993
22. IEEE Bronze Book- “Recommended Practice for Energy Conservation and cost effective planning in Industrial facilities”, IEEE Inc, USA.,1985
23. Partab H., “Art and Science of Utilisation of Electrical Energy”, Dhanpat Rai and Sons, New Delhi, 2nd edition,
24. Tripathy S.C, “Electric Energy Utilization And Conservation”, Tata McGraw Hill.
NESCAP-Guide Book on Promotion of Sustainable Energy Consumption

EE4038 DATA ACQUISITION & SIGNAL CONDITIONING

ELECTIVE COURSE

Pre-requisite: None

L	T	P	C
3	0	0	3

Course Outcomes:

CO1: Learn the fundamentals of data acquisition systems

CO2: Familiarize various transducers and signal conditioning circuits

CO3: Learn different first order and second order filter circuits and sample and hold devices

CO4: Understand different signal conversion (analog to digital and digital to analog converters)

CO5: Familiarize various analog and digital data transmission systems

CO6: Studymodulation and telemetry systems

Total Hours: 42 Hours

Module 1: Transducers & Signal Conditioning **(10 Hrs)**

Data Acquisition Systems(DAS)- Introduction – Fundamentals of signals acquisition, conditioning and processing. -Objectives of DAS . Block Diagram Description of DAS- General configurations - Single and multichannel DAS-Transducers for the measurement of motion, force, pressure, flow, level, dc and ac voltages and currents (CTs, PTs for supply frequency as well as high frequency, Hall Effect Current Sensors, High Voltage Sensors) – Signal Conditioning: Requirements - Instrumentation amplifiers: Basic characteristics . Chopped and Modulated DC Amplifiers-Isolation amplifiers - Opto couplers - Buffer amplifiers .Noise Reduction Techniques in Signal Conditioning- Transmitters .Optical Fiber Based Signal Transmission Piezoelectric Couplers- Intelligent transmitters.

Module 2: Filtering and Sampling **(12 Hrs)**

Review of Nyquist.s Sampling Theorem-Aliasing . Need for Prefiltering-First and second order filters classification and types of filters - Low -pass, High-pass, Band-pass and Band-rejection and All Pass: Butterworth, Bessel, Chebyshev and Elliptic filters . Opamp RC Circuits for Second Order Sections-Design of Higher Order Filters using second order sections using Butterworth Approximation-Narrow Bandpass and Notch Filters and their application in DAS. Sample and Hold Amplifiers

Module 3: Signal Conversion **(12 Hrs)**

Analog-to-Digital Converters(ADC)-Multiplexers and demultiplexers - Digital multiplexer . A/D Conversion . Conversion Processes , Speed, Quantization Errors . Successive Approximation ADC . Dual Slope ADC . Flash ADC . Digital-to-Analog Conversion(DAC) . Techniques, Speed, Conversion Errors, Post Filtering- Weighted Resistor, R-2R, Weighted Current type of DACs- Multiplying Type DAC-Bipolar DACs

Module 4: Data Transmission **(8 Hrs)**

Data transmission systems- Analog transmission system, Digital transmission system,Analog encoding of analog information, Analog encoding of digital Information, Digital encoding of analog information, Digital encoding of digital information, Schmitt Trigger-Pulse code formats- Modulation techniques and systems-Telemetry systems.

Text/Reference Books:

1. Ernest O Doeblin., Measurement Systems: Application and Design, McGraw Hill (Int. edition) 1990
2. George C.Barney, Intelligent Instrumentation, Prentice Hall of India Pvt Ltd., New Delhi, 1988.
3. Ibrahim, K.E., Instruments and Automatic Test Equipment, Longman Scientific & Technical Group Ltd., UK, 1988.
4. G.B. Clayton, .Operational Amplifiers, Butterworth &Co, 1992
5. Oliver Cage, .Electronic Measurements and Instrumentation., McGraw-Hill, (Int. edition) 1975

EE4039 ADVANCED DC-AC POWER CONVERSION

ELECTIVE COURSE

Pre-requisite: EE3007 Power Electronics

L	T	P	C
3	0	0	3

Course outcomes:

CO1: To learn the details of modulation techniques of two-Level Voltage Source Inverters.
CO2: To understand the working of Cascaded H-Bridge Multilevel Inverters, various modulation techniques used and analysis of them.
CO3: To learn and analyze the control strategies, algorithms, and operation of Diode-Clamped Multilevel Inverters.
CO4: To learn in details about the PWM Current Source Inverters.

Total Hours: 42 Hours

Module 1: Two-Level Voltage Source Inverter (10 Hrs)

Introduction - Sinusoidal PWM - Modulation Scheme - Harmonic Content – Over-modulation - Third Harmonic Injection PWM - Space Vector Modulation - Switching States - Space Vectors - Dwell Time

Calculation - Modulation Index - Switching Sequence - Spectrum Analysis - Even-Order Harmonic Elimination - Discontinuous Space Vector Modulation

Module 2: Cascaded H-Bridge (CHB) Multilevel Inverters (9 Hrs)

Introduction - H-Bridge Inverter - Bipolar Pulse-Width Modulation - Unipolar Pulse-Width Modulation – Multilevel Inverter Topologies - CHB Inverter with Equal dc Voltage - H-Bridges with Unequal dc Voltages. Carrier Based PWM Schemes - Phase-Shifted Multicarrier Modulation - Level-Shifted Multicarrier Modulation - Comparison Between Phase- and Level-Shifted PWM Schemes - Staircase Modulation.

Module 3: Diode-Clamped Multilevel Inverters (13 Hrs)

Introduction -Three-Level Inverter - Converter Configuration - Switching State - Commutation - Space Vector Modulation - Stationary Space Vectors - Dwell Time Calculation - Relationship Between V_{ref}Location and Dwell Times - Switching Sequence Design -Inverter Output Waveforms and Harmonic Content - Even-Order Harmonic Elimination - Neutral-Point Voltage Control - Causes of Neutral-Point Voltage Deviation - Effect of Motoring and Regenerative Operation - Feedback Control of Neutral-Point Voltage - Other Space Vector Modulation Algorithms - Discontinuous Space Vector Modulation - SVM Based on Two-level Algorithm High-Level Diode-Clamped Inverters - Four- and Five-Level Diode-Clamped Inverters - Carrier-Based PWM – Other Multilevel Voltage Source Inverters – Introduction - NPC/H-Bridge Inverter - Inverter Topology Modulation Scheme - Waveforms and Harmonic Content - Multilevel Flying-Capacitor Inverters - Inverter Configuration - Modulation Schemes

Module 4: PWM Current Source Inverters (10 Hrs)

Introduction - PWM Current Source Inverter - Trapezoidal Modulation - Selective Harmonic Elimination Space Vector Modulation - Switching States - Space Vectors - Dwell Time Calculation - Switching Sequence Harmonic Content - SVM Versus TPWM and SHE - Parallel Current Source Inverters - Inverter Topology Space Vector Modulation for Parallel Inverters - Effect of Medium Vectors on dc Currents - dc Current Balance Control - Load-Commutated Inverter (LCI)

Text/Reference Books:

1. B. Woo, “High Power Converters and AC Drives”, John Wiley & Sons, 2006
2. Ned Mohan et.al , “Power Electronics” ,John Wiley and Sons,2006
3. Rashid, “Power Electronics, Circuits Devices and Applications”, Pearson Education, 3rd edition, 2004.
4. G.K.Dubey, Thyristorised Power Controllers, Wiley Eastern Ltd, 1993.
5. Dewan & Straughen, Power Semiconductor Circuits, John Wiley & Sons, 1975.

6. Cyril W Lander, Power Electronics, Mc Graw Hill, 3rd edition, 1993.

EE4040 SYSTEM IDENTIFICATION AND PARAMETER ESTIMATION

ELECTIVE COURSE

Pre-requisites: None

L	T	P	C
3	0	0	3

Course Outcomes:

CO1: Estimate structure and parameters of transfer function from time and frequency responses and validate the model
CO2: Estimate disturbance spectra
CO3: Estimate parameters using statistical framework
CO4: identify multivariable and closed loop systems
CO5: Design experiments to identify systems

Total Hours: 42 Hours

Module 1: (14 Hrs)
Principles of Modelling and Identification of transfer function
System Identification and Stochastic Modeling- Structure and parameter estimation .properties of estimates validation of models-impulse Response. Step Response . Frequency response- transfer function from these.disturbances and transfer function .State Space Models- Distributed parameter models- model structures .identifiability of model structures. signal spectra . single realization and ergodicity . multivariable systems.Transfer function from frequency response. Fourier Analysis and Spectral analysis- Estimating Disturbance Spectrum . Correlation Identification . Practical Implementation . Pseudo random binary signals .maximum length sequences .generation using hardware .random number generation on digital computer

Module 2: (10 Hrs)
Parameter Estimation Methods
Guiding principles behind parameter estimation methods .minimizing prediction errors .linear regression and least squares methods .statistical framework for parameter estimation . maximum likelihood estimation . correlating prediction errors with past data . Instrumental variable method .consistency and identifiabilityRecursive methods . RLS Algorithm, Recursive IV Method- Recursive Prediction Error Method . Recursive pseudo-linear regressions .choice of updating step

Module 3: (10 Hrs)
Identification of Multivariable Systems and Closed Loop Systems-Transfer function matrix representation of MVS- state space method input output difference equation method - canonical models for MVS . comparison of different models . identification of continuus MV systems from input output data.Identification of closed loop systems . reduction of higher order systems . aggregation method . aggregation with partial realization . singular perturbation method . optimum approximation . comparison of different methods of model reduction.

Module 4: **(8 Hours)**

Experiment Design and Choice of Identification Criterion

Optimal Input design . Persistently exciting condition .optimal input design for higher order black box models .choice of sampling interval and presampling filters .Choices of Identification criterion .choice of norm . variance: optimal instruments

Text/Reference Books:

1. System Identification Theory for The User : Lennart Ljung , Prentice Hall Information Systems Science Series (1987)

2. Sinha N K , Kuztsa : System Identification And Modeling of Systems(1983)
3. Harold W Sorensen : Parameter Estimation : Marcel Dekker Inc, New York. 1980, Advances in Control Systems series
4. Daniel Graupe :Identification of Systems : Van Nostrand

EE4041 POWER QUALITY

ELECTIVE COURSE

Pre-requisites: None

L	T	P	C
3	0	0	3

Course outcomes:

CO1: To introduce to students the term and definition of power quality disturbances, and their causes, detrimental effects and solutions.

CO2: Understand the causes of power quality problems and relate them to equipment.

CO3: To introduce the harmonic sources, passive filters, active filters and standards.

CO4: To prepare students to know the power quality monitoring method, equipments and develop the ability to analyze the measured data.

Total Hours: 42 Hours

Module 1: **(9 Hrs)**

Power Quality –overview of power quality phenomena -Basic terminologies –Power Quality Issues – Causes for reduction in Power Quality — Power Quality Standards and indices.

Module 2: **(11 Hrs)**

Voltage sags-Causes of voltage sags – magnitude & duration of voltage sags – effect on drives and peripherals– monitoring & mitigation of voltage sags.

Interruptions -Origin of Long & Short interruptions – influence on various equipments – monitoring & mitigation of interruptions.

Harmonics-important harmonic introducing devices-SMPS-Three phase power converters-arcing devicessaturable devices-harmonic distortion of fluorescent lamps-effect of power system harmonics on power system equipment and loads.

Module 3: **(11Hrs)**

Power factor improvement- Passive Compensation- Passive Filtering- Harmonic Resonance - Impedance Scan Analysis- Active Power Factor Corrected Single Phase Front End-Control Methods for Single Phase APFCThree Phase APFC and Control Techniques- PFC Based on Bilateral Single Phase and Three Phase Converter-Static var compensators-SVC and STATCOM

Module 4: **(11Hrs)** Active Harmonic Filtering-Shunt Injection Filter for single phase , three-phase three-wire and three-phase four wire systems-d-q domain control of three phase shunt active filters -UPS-constant voltage transformers- series active power filtering techniques for harmonic cancellation and isolation . Dynamic Voltage Restorers for sag , swell and flicker problems.

Grounding and wiring-introduction-NEC grounding requirements-reasons for grounding-typical grounding and wiring problems-solutions to grounding and wiring problems.

Text/Reference Books:

1. G.T.Heydt, "Electric Power Quality", Stars in a Circle Publications, 1991
2. Math H. Bollen , "Understanding Power Quality Problems", IEEE Press, 1st Edition,2001
3. J. Arrillaga, "Power System Quality Assessment", John Wiley, 2000
4. J. Arrillaga, B.C. Smith, N.R. Watson & A. R.Wood, Power system Harmonic Analysis, Wiley, 1997
5. Wilson E Kazibwe, Musoke H Sendaula, "Electic Power quality control techniques", Van Nostrand Reinhold , NewYork,1993
6. J. Schlabbach,D. Blume,T. Stephanblome , "Voltage quality in Electrical Power Systems",IEE, 2001.
7. Roger c. Dugan/ Mrak F. McGranaghan, Surya santoso & H. Wayne Beaty, "Electrical power systems quality", Tata Mc Graw-Hill,2010.
8. George J. Walkilesh, "Power Systems Harmonics", springer,2007.
9. R. Sastry Vedam & Mulukutla S. Sarma, "Power quality VAR compensation in power systems", CRC press, 2009.
10. Angelo Baggini, " Handbook of power quality", Wiley,2008.

EE4042 DIGITAL PROTECTIVE RELAYING

ELECTIVE COURSE

Pre-requisites : None

L	T	P	C
3	0	0	3

Course Outcomes:

CO1: Acquire the knowledge of the Protective Relaying, their Standards and Classification of relays and to understand the zones and degree of protection..

CO2: The knowledge of the various types of faults, the basic relay units, thefault sensing data processing units and the relay schematics and analysis.

CO3: Knowledge of the protection of power system equipment and the system grounding and analyze the various ground faults and their protection

CO4: Knowledge of the various numerical relays and their characteristics.

CO5: **K**nowledge of the Integrated and multifunction protection schemes

Total Hours: 42 Hours

Module 1: **(8Hrs)**

Protective Relaying - Qualities of relaying - Definitions - Codes- Standards; Characteristic Functions; Classification –analog-digital- numerical; schemes and design-factors affecting performance –zones and degree of protection; faults-types and evaluation; Instrument transformers for protection.

Module 2: **(12Hrs)**

Basic relay units-sequence networks-fault sensing data processing units- FFT and Wavelet based algorithms Phase& Amplitude Comparators-. Duality - Zero Crossing/Level Detectors; Relay Schematics and AnalysisOver Current Relay- Instantaneous/Inverse Time –IDMT Characteristics; Directional Relays; Differential Relays- Restraining Characteristics; Distance Relays: Types- Characteristics;

Module 3: **(12 Hrs)**

Protection of Power System Equipment - Generator, Transformer, Generator- Transformer Units, Transmission Systems, Busbars, Motors; Pilotwire and Carrier Current Schemes;
System grounding –ground faults and protection; Load shedding and frequency relaying; Out of step relaying ; Re-closing and synchronizing

Module 4: **(10Hrs)**

Numerical relays - Characteristics -Functional Diagrams-architecture - algorithms -Microprocessor & DSP based relays- sampling –aliasing –filter principles;
Integrated and multifunction protection schemes -SCADA based protection systems- FTA; Testing of Relays.

Text/Reference Books:

1. C.R. Mason, The art and science of protective relaying, John Wiley &sons.
2. A.R.Warrington, Protective Relays, Vol .1&2, Chapman and Hall.
3. T.S.Madhav Rao, Power system protection static relays with microprocessor applications, Tata McGraw Hill Publication.
4. Power System Protection Vol. I, II , III&IV, The Institution Of Electrical Engineers, Electricity Association Services Ltd., 1995
5. Helmut Ungrad , Wilibald Winkler, Andrzej Wiszniewski, Protection techniques in electrical energy systems, Marcel Dekker, Inc.
6. Badri Ram , D.N. Vishwakarma, Power system protection and switch gear, Tata McGraw Hill.
7. Blackburn, J. Lewis ,Protective Relaying, Principles and Applications, Marcel Dekker, Inc., 1986.
8. Anderson, P.M, Power System Protection,. McGraw-Hill, 1999
9. Singh L.P ,Digital Protection, Protective Relaying from Electromechanical to Microprocessor, John Wiley & Sons, 1994
10. Wright, A. and Christopoulos, C, Electrical Power System Protection,. Chapman & Hall, 1993,
11. Walter A. Elmore, J. L. Blackburn, Protective Relaying Theory and Applications, ABB T&D Co. Marcel Dekker, Inc.
12. Arun G. Phadke, James S. Thorp, Computer Relaying for Power Systems, Marcel Dekker, Inc.

EE4093 SEMINAR

Course outcomes:

CO1: To study research papers for understanding of a new field, in the absence of a textbook , to summarize and review them.

CO2: To identify promising new directions of various cutting edge technologies

CO3: To impart skills in preparing detailed report describing the project and results

CO4: To effectively communicate by making an oral presentation before an evaluation committee

Individual students will be asked to choose a topic in any field of Civil Engineering, preferably from outside the B.Tech syllabus and give seminar on the topic for a bout thirty minutes. A committee consisting of at least three faculty members specialized on different fields of engineering will assess the presentation of the seminars and award the marks to the students. Each student will be asked to submit two copies of a write up of the seminar talk – one copy will be returned to the student after duly certifying by the Chairman of the assessing committee and the other copy will be kept in the departmental library.

EE4092 PROJECT

L	T	P	C
0	3	0	2

Course Outcomes

CO1: Provides an opportunity to pursue their interest in Electrical Engg., through design, research, theoretical and experimental approach.

CO2: To enable the students to identify a topic of interest and complete the preliminary work of undertaking case studies, data collection and feasibility studies.

CO3:Students get guidance to formulate and develop a design proposal and to effectively communicate the same

The project work will be a design project – experimental project – or in the areas of electrical engineering The assessment of the project will be done at the end of the semester by a committee consisting of three or four faculty members specialized in various fields of Electrical Engineering. The students will present their project work before the committee. The complete project report is not expected at the end this semester. However a six to ten page typed report based on the work done will have to be submitted by the students to the assessing committee. The project guides will award the grades to the individual students depending on the group average awarded by the committee.

EE4095 PROJECT

L	T	P	C
0	6	0	4

Course Outcomes

CO1: To enable thestudents to develop comprehensive solution to issues identified in previous semester work and to meet the requirements as stated in project brief.

CO2:To inculcate the ability to synthesize the results of the detailed analytical studies conducted, lay down validity and design criteria, interpret the result for application to the problem, develop the concept and detailed design solution and to effectively communicate the thesis rationale.

The period of the major project is for two continuous semesters from the seventh to eighth semester. The type of the project can be analytical / simulation/design or and fabrication in any of the areas in Electrical Engineering. Project can be done by individual student or by a group of students. Maximum number of students in a project group shall be three. A faculty coordinator will coordinate project work of all students.

The project work is evaluated in two stages. The first stage assessment of the project will be done at the end of seventh semester and the final stage assessment at the end of eighth semester. Evaluation will be done by a committee consisting of the concerned guide and two/three faculty members in the concerned area of the project nominated by the HOD. The faculty coordinator of the project will be a member of the evaluation committee all the projects. The mode of presentation, submission of the report, method of evaluation, award of grades etc will be decided by the evaluation committee. Students shall submit both soft and hard copies (required number of copies) of project report in the prescribed form to the department and library after incorporating all the corrections and changes suggested by the evaluation committee.

EE4094 CONTROL SYSTEMS LABORATORY

REQUIRED COURSE

Prerequisite: None

L	T	P	C
0	0	3	2

Course Outcomes:

CO1: Obtain the moment of inertia experimentally and develop the transfer function of the given DC Motor for (a) Armature controlled and (b) Field controlled cases

CO2: Obtain the transfer function and the load characteristics under different levels of compensation of the given amplidyne experimentally

CO3: Study the DC Modular Servo System and obtain the characteristics of the constituent components. Also to set up a closed loop position control system and study the system performance

CO4: To design a Lead, lag and Lag-Lead compensator sand to obtain the characteristics by experiment and simulation using MATLAB®

CO5: Set up a system for closed loop voltage regulation for a dc separately excited generator using amplidyne and obtain its characteristics

CO6: Obtain the model of the Inverted pendulum and study the closed loop performance using experiments

CO7: Obtain the characteristics of the synchro systems and set up a synchro link position control system

CO8:Conduct experiments on the Level Process Control Station and to study the working of a level control loop

Total Hours: 42 Hours

List of experiments:

1. To obtain the moment of inertia and develop the transfer function of the given DC Motor for (a) Armature controlled and (b) Field controlled cases. Draw the relevant block diagrams.
2. To conduct experiments on the given amplidyne for (a) To obtain the transfer function (b)To obtain the load characteristics under different levels of compensation (c) To obtain the characteristics of a metadyne.
3. To Study the FEEDBACK® MS150 DC Modular Servo System and to obtain the characteristics of the constituent components. Also to set up a closed loop position control system and study the system performance.
4. To design a Lead compensator and to obtain the characteristics by experiment and simulation using MATLAB®.
5. To design a Lag compensator and to obtain the characteristics by experiment and simulation using MATLAB®.
6. To design a Lag-Lead compensator and to obtain the characteristics by experiment and simulation using MATLAB®.
7. To set up a system for closed loop voltage regulation for a dc separately excited generator using amplidyne and to obtain its characteristics.
8. To obtain the model of the Inverted pendulum and study the closed loop performance using experiments on Bytronic® Inverted Pendulum
9. To obtain the characteristics of the synchro systems and to set up a synchro link position control system using FEEDBACK® MS150 AC Modular Servo.
10. To set up a closed loop feedback control system using the FEEDBACK® MS150 DC Modular Servo System-with velocity (rate) feed back.
11. To conduct experiments on the Level Process Control Station and to study the working of a level control loop.
12. To set up a closed loop feedback control system using the FEEDBACK® MS150 AC Modular Servo System-with velocity (rate) feed back.

Text/Reference Books:

1. Gene F Franklin, J David Powell, Abbas Emami Naeini, *Feedback Control of Dynamic Systems,* 4^{th} Ed, Pearson Education Asia, 2002
2. Graham C Goodwin, Stefan F Graebe, Mario E Salgado, *Control System Design*, Prentice Hall India, 2003.
3. John J D'Azzo, Constantine H Houpis, Stuart N. Sheldon, *Linear Control System Analysis & Design with MATLAB,* 5^{th} Ed, Marcel Dekker, 2003
4. P.C. Sen, *Principles of Electrical Machines & Power Electronics*, John Wiley, 2003.
5. John E Gibson, Franz B. Tuteur, Control System Components, McGrawHill, 1958.
6. Ramesh S Gaonkar, Microprocessor architecture Programming and application with 8085/8080A 2E, New Age Publications, 1995.
7. Users' Manual for FEEDBACK® MS150 DC Modular Servo System
8. Users' Manual for FEEDBACK® MS150 AC Modular Servo System
9. Users' Manual for 8085n Microprocessor kit, ©Vi MicroSystems.
10. www.mathworks.com
11. Users' Manual for Bytronic Inverted Pendulum.
12. Users' Manual for Level Process Station, ©Vi McroSystems

ME4104 PRINCIPLES OF MANAGEMENT

REQUIRED COURSE

Prerequisite: Nil

L	T	P	C
3	0	0	3

Course Outcomes

CO1: To learn the fundamentals of management and the various theories of management.
CO2: To learn the functions of management and practice in real world.
CO3: To understand the functional areas of management-Marketing, Finance, HRM and Operations Management.
CO4: To prepare students to solve decision making problems and project management problems.

Total Hours: 42 hours

Module 1 (9 Hours)

Introduction to management theory, Characteristics of management, Management as an art – profession, Systems approach to management, Task and responsibilities of a professional manager, Levels of managers and skill required. Management process – planning – mission – objectives – goals – strategy – policies – programmes – procedures.

Module 2 (9 Hours)

Organizing – principles of organizing – organization structures, Directing – delegation – span of control – leadership – motivation – communication, Controlling.

Module 3 (12 Hours)

Decision making process – decision making under certainty – risk – uncertainty – models of decision making, Project management – critical path method – programme evaluation and review technique – crashing.

Module 4 (12 Hours)

Introduction to functional areas of management, Operations management, Human resources management, Marketing management, Financial management.

References

1. Koontz, H., and Weihrich, H., *Essentials of Management: An International Perspective*, 8th ed., McGraw Hill, 2009.
2. Hicks, *Management: Concepts and Applications*, Cengage Learning, 2007.
3. Mahadevan, B., *Operations Management, Theory and Practice*, Pearson Education Asia, 2009.
4. Kotler, P., Keller, K.L, Koshy, A., and Jha, M., *Marketing Management*, 13th ed., 2009.
5. Khan, M.Y., and Jain, P.K., *Financial Management*, Tata-Mcgraw Hill, 2008