VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE
(VJTI)
MATUNGA, MUMBAI 400 019

(Autonomous Institute affiliated to University of Mumbai)

Curriculum
(Scheme of Instruction & Evaluation and Course contents)

For
Undergraduate Programme Leading to
Bachelor of Technology (B. Tech.) Degree
in
Electrical Engineering

Implemented from the batch admitted in Academic Year 2018-19

Proposed Revised Scheme for Electrical Engineering (Sem III to VIII)
Academic Year 2019-20 onwards

Sem-III

Scheme of Instruction						Scheme of Evaluation				
Sr. No.	Course Code	Course name	Hr/week			Credits	TA	MST	ESE	ESE Hrs
			L	T	P					
1.	R4MA2003S	Mathematics - III	3	0	0	3	20	20	60	3
2.	R4EE2001S	Electrical Networks - I	3	0	0	3	20	20	60	3
3.	R4EE2002S	Introduction to Power System	3	0	0	3	20	20	60	3
4.	R4EE2003T	Electrical Machines - I	3	0	0	3	20	20	60	3
	R4EE2003P	Electrical Machines Lab	0	0	3	1.5	60	-	40	3
5.	R4EE2004T	Electronic Devices and Circuits	3	0	0	3	20	20	60	3
	R4EE2004P	Electronic Devices and Circuits lab	0	0	3	1.5	60	-	40	2
6	R4CH2001A	Environmental Studies	1	0	1	MNC	60	-	40	2
		Total	**16**	**0**	**7**	**18**				

Sem-IV

Scheme of Instruction						Scheme of Evaluation				
Sr. No.	Course Code	Course name	Hr/week			Credits	TA	MST	ESE	ESE Hrs
			L	T	P					
1.	R4MA2004S	Mathematics - IV	3	1	0	4	20	20	60	3
2.	R4EE2006S	Electrical Networks - II	3	0	0	3	20	20	60	3
3.	R4EE2007T	Power Electronics	3	0	0	3	20	20	60	3
	R4EE2007P	Power Electronics Lab	0	0	3	1.5	60	-	40	2
4.	R4EE2008T	Electrical Machines - II	3	0	0	3	20	20	60	3
	R4EE2008P	Electrical Machines Lab	0	0	3	1.5	60	-	40	3
5.	R4EE2009T	Analog and Digital Circuits	3	0	0	3	20	20	60	3
	R4EE2009P	Analog and Digital Circuits Lab	0	0	2	1	60	-	40	2
6	R4EE2010S	Principles of Measurements and Instrumentation	3	0	0	3	20	20	60	3
		Total	**18**	**1**	**8**	**23**				

Abbreviations: **L**: Lecture, **T**: Tutorial, **P**: Practical, **TA**: Teacher Assessment / Term work Assessment, M**ST**: Mid Semester Tests, **ESE**: End Semester Written Examination, **CIE**: Continuous In-semester Evaluation

Semester –III

Programme Name	S.Y. B. Tech. (Electrical Engineering)	Semester -III			
Course Code	R4MA2003S	L	T	P	Credit
Course Title	MATHEMATICS –III (Complex Variables)	3	-	-	3

COURSEOUTCOMES

Students should be able to:

1. Demonstrate the ability of using Laplace Transform and Fourier series in solving the Ordinary Differential Equations and Partial Differential Equations.
2. Able to use basic knowledge of Laplace Transform. Fourier Series, Bessel Functions, Vector Algebra and Complex Variable in solving real problems.
3. An ability to apply knowledge of mathematics, including Laplace Transform, Fourier Integral, Complex variable, discrete mathematics, probability, statistics, science, computer science and engineering, electronic engineering and electrical engineering as it applies to computer hardware and software.
4. An ability to design hardware and software systems, components, or processes to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.
5. To know the condition for a Complex variable function to be analytical and / Or harmonic

COURSE CONTENTS

Module I	**Complex Variables I**
	Function of Complex variable. Analytic function, Necessary and sufficient conditions for f(Z) to be analytic. Cauchy-Riemann equations in polar coordinates. Milne-Thomson method to determine analytic function f(Z) when its real or imaginary part or its combination is given. Harmonic function, orthogonal trajectories. Transformations. Conformal mapping and standard transformations such as Rotation, Magnification and inversion. Bilinear Transformation and Mapping under bilinear Transformation with geometrical interpretation. Cross ratio and fixed points.
Module II	**Complex Variables II**
	Line integral of a function of Complex variable, Properties of line integral Cauchy's theorem for analytic function. Cauchy's Goursat theorem (without proof), Cauchy's integral formula and deductions. Series of Complex Term: Taylor's and Laurent's Series (without proof), Singularities and poles, Residues, Residue Theorem and its evaluation. Application of Residue to evaluate real Function.
Module III	**Laplace Transforms I**
	Functions of bounded variation, Linear property of Laplace transforms.Laplace transforms of standard functions such as; $1, t^n, e^{at}, sinat, cosat, sinhat, \text{erf}(t).$ Change of scale property ,First shifting theorem, Second shifting theorem $L\{t^n f(t)\}, L\{f'(t)\}, L\left\{\frac{f(t)}{t}\right\}, L\left\{\int_0^t f(u)du\right\}, L\left\{\frac{d^n}{dt^n}f(t)\right\}$
Module IV	**Laplace Transform II**
	Inverse Laplace transform using linear property, theorems, partial fractions and convolution theorem.Unit step functions, Heaviside, Dirac delta functions, Periodic functions and their Laplace transforms. Application to solve ordinary

	differential equations with one dependent variable.
Module V	**Fourier Series**
	Orthogonal, Orthonormal sets, Expressions of a Function in Series of Orthogonal Functions. Dirchlet's conditions. Fourier series of periodic function with period 2π, $2l$. Dirchlet's theorem, even and odd functions. Half range expansions, Parseval's relations. Complex form of Fourier series. Fourier integral and Fourier transform.

Text Books:	1. Advanced Engineering Mathematics, H K Dass, S Chand & Co. Ltd, 3rd Edition, 2006 2. Higher Engineering Mathematics, Dr B S Grewal, Khanna Publications, 39th Edition,2005 3. A Text Book of Engineering Mathematics, N.P. Bali & Dr. Manish Goyal, Eight Edition, Laxmi Pubilcation. 4. Complex Variables & Applications: Churchil, Mc Graw Hill, 2003, 7th Edition

Reference Books:	1. Theory of functions of complex variables, Shanti Narayan, S Chand & Co, 2006. 2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Ltd 3. Engineering Mathematics for semester III, T Veerrajan, Tata McGraw Hill. Matrices , A R Vasishtha , 2005 4. Advanced Engineering Mathematics, Jain & Iyengar, II Edition, Narosa Publication 5, Engineering Mathematics, Srimanta Pal & Subodh C.Bhunia, OXFORD University Press, First Published in 2015.

Programme Name	S.Y. B. Tech. (Electrical Engineering)	Semester -III			
Course Code	R4EE2001S	L	T	P	Credit
Course Title	ELECTRICAL NETWORK- I	3	-	-	3

COURSEOUTCOMES

Students should be able to:

1. Students shall be familiar with the transient and steady state behaviour of circuits.
2. Student shall be able to demonstrate skills to use modern engineering tools, software and equipment to analyse problems.
3. Student shall be able to apply the knowledge for analysis in the other courses in the following semesters.

COURSE CONTENTS

Module I	**Network Theorems**
	Introduction to Network Theorems, Solution of network using dependent sources, mesh analysis, super mesh analysis, nodal analysis, super node analysis, source transformation and source shifting, superposition theorem, Thevenin's theorems and Norton's theorem, maximum power transfer theorem. Solution of network with A.C. sources, magnetic coupling, mesh analysis, nodal analysis, superposition theorem, Thevenin's theorems, Norton's theorem, maximum power transfer theorem, Tellegen's theorem, Millman's theorem, reciprocity theorem. Three Phase systems. Star and delta connections, phasor diagram for balanced and unbalanced load. Measurement and Calculation of power in three phase systems, different connections, calculation of neutral shift and problems based on it.
Module II	**Graph Theory and Network Topology**
	Introduction, graph of network, tree, co-tree, incidence matrix, cut set matrix, tie set matrix and loop current, number of possible tree of a graph, analysis of network equilibrium equation, duality.
Module III	**First Order and Second Order Differential Equations**
	Initial condition of networks, General and partial solutions, time constant, integrating factor, geometrical interpretation of derivative. Transient response of R-L ,R-C and R-L-C networks in time domain.
Module IV	**Laplace Transform**
	The Laplace transform and its application to network analysis, transient and steady state response to step, ramp, impulse and sinusoidal input function, transform of other signal waveform, shifted step, ramp and impulse function, waveform synthesis. Solution of networks by using Laplace transforms.
Module V	**Network Functions**
	Network functions for one port and two port networks, Driving point and transfer functions, ladder network, General network, poles and zeros of network functions, restrictions on Pole and zero locations for driving point functions and Transfer functions, time domain behaviour from pole - zero plot.

Text Books:	1. “Engineering Circuit Analysis”, by W H Hayt, S M Durbin, J E Kemmerly, , 7th Edition Tata McGraw-Hill Education. 2. “Network Analysis”, by M. E. Van Valkenburg, , 3rd Edition, PHI Learning. 3. “Networks and Systems”, by D. Roy Choudhury, 2nd Edition, New Age International. 4. “Linear Circuits”, by M. E. Van Valkenburg, Prentice Hall.

Reference Books:	1. “Network Analysis and synthesis”,by F. F. Kuo, John Wiley and sons. 2.”Linear Network Theory: Analysis”, by Properties,Design and Synthesis’ N Balabanian and T.A. Bickart, Matrix Publishers, Inc. 4.“Network Analysis and synthesis”, by C. L.Wadhwa, , New Age international. 5.“Network Analysis and Synthesis”, by B. Somanathan Nair, Elsevier Publications

Programme Name	S.Y. B. Tech. (Electrical Engineering)	Semester -III			
Course Code	R4EE2002S	L	T	P	Credit
Course Title	INTRODUCTION TO POWER SYSTEMS	3	-	-	3

COURSE OUTCOMES:

Students should be able to:

1. Calculate transmission line parameters, viz. resistance, inductance and capacitance.
2. Analyse performance of overhead transmission lines and underground cables.
3. Analyse faults in transmission lines.
4. Demonstrate Insulation coordination.

COURSE CONTENTS

Module I	**Basics of Power System**
	Conventional and non-conventional sources, Type of Generation, variable load on Power Stations, Load curve and Load Duration Curve and other curves and factors related to operation of power systems.
Module II	**Components of Electrical Power Transmission**
	Mechanical concepts of transmission line: Components of overhead lines, insulators - different types, string efficiency, cross arms, conductor configuration, spacing and clearance span lengths, sag and tension (Numerical compulsory), Underground cable, their types and construction.
Module III	**Transmission line parameters**
	Calculations of resistance, inductance and capacitance, inductance and capacitance and their existence in transmission lines at various points. Bundled and unbundled conductors, single and double circuit transmission lines.
Module IV	**Performance of Transmission Line**
	Representation of power system components: Single phase representation of balanced three phase networks. One line diagram, impedance and reactance diagram. Per unit (p.u.) system, per unit impedance diagram, representation of loads **Transmission line model:** Short, medium, and long line model. Equivalent circuit of a long line. Ferranti effect Surge Impedance loading, power flow through transmission lines.
Module V	**Fault Analysis**
	Types of Faults, Symmetrical Fault Calculations, sequence components – zero sequence (for transformers), positive sequence, negative sequence, Unsymmetrical Faults. Introduction to Insulation coordination, SIL, BIL.

Text Books:	1. "A Course in Power system", by J.B. Gupta, S. K. Kataria& Sons 2. "A Text Book on Power System Engineering", by M.L.Soni, P.V.Gupta, U.S.Bhatnagar, DhanpatRai Publishing Company (P) Limited

Reference Books:	1. "Electrical Power",by S.L.UPPAL,Khanna Publishers 2. "Power Systems Analysis", by HadiSaddat, Tata McGraw Hill 3. "Power System Analysis", by John Grainger, William Stevenson Jr.,McGraw-Hill 4. "Power System: Analysis & Design", by Thomas Overbye, J. Duncan Glover, Mulkutla .S. Sarma, Cengage Learning

Programme Name	S.Y.B. Tech. (Electrical Engineering)	Semester -III			
Course Code	R4EE2003T	L	T	P	Credit
Course Title	ELECTRICAL MACHINES – I	3	-	-	3

COURSE OUTCOMES:

Students should be able to:

1. Calculate efficiency &regulation of transformers.
2. Analyse and interpret parameters of electrical equivalent circuit of transformer
3. Demonstrate electro mechanical energy conversion principles.
4. Analyse different methods of speed control of DC machines.
5. Calculate efficiency and other performance parameters of DC machines.

COURSE CONTENTS

Module I	Basics of Magnetism and Electromechanical Energy Conversion
	Magnetic field, Magnetic circuit, Numerical from series parallel magnetic circuit, Flux linkage, Inductance and energy, Hysteresis and eddy current losses. Principle of electromechanical energy conversion, Energy stored in magnetic field, Torque in singly excited magnetic field, Reluctance motor, Doubly excited magnetic field, Torque from energy and Co- energy. Dynamic equations
Module II	**DC Machines**
	Construction of machine, Basic design concept of lap and wave winding, Principle of operation, Significance of commutator and brushes, EMF and torque equation, concept of back EMF, Armature reaction, Methods to minimize the effect of Armature reaction, Process of commutation, Methods to improve commutation. Characteristics of DC Motors, speed-torque characteristic equations, Electrical braking (Rheostatic, regenerative and plugging), Necessity of starter, Types of Starter, Speed control of DC shunt and series motor, losses and efficiency, Applications of DC motor, Retardation, Brake load, Swinburne, Hopkinson's and field test.
Module III	**Transformer**
	Transformer principle of operation, EMF equation, Equivalent Circuit, Phasor diagram, voltage regulation, Losses and Efficiency, All day Efficiency, Polarity Test, OC and SC Test, Sumpner Test, Impluse Test, Autotransformer, High Frequency Transformer, Isolation Transformer, Three phase transformer connections and phasor groups. Parallel operation of single and three phase transformer, Excitation Phenomenon in transformers, Harmonics in three phase transformers, Suppression of harmonics, oscillating neutral phenomenon, Switching in transient phenomenon.
Module IV	**Introduction to Special Machines**
	Basic principle and operation of Brushless dc motor, stepper motor, permanent magnet synchronous motor

Text Books:	1. "Electrical Machinery Performance and Applications", by Bimbhra P.S., KhannaPublisher, Fifth Edition, 1995 2. "Electric Machines", by D. P. Kothari and I. J. Nagrath , Tata McGraw Hills 3. "Electrical Technology", Volume II, by B.L.Theraja, S.Chand Publishers

Reference Books:	1. "Electrical Machines", by A. E. Fitzgerald & C. Kingsley, 3rd Edition, TMH Publication 2. "Performance and Design of A.C. Machines", by M.G. Say, CBS Publishers, 2005.

Programme Name	S.Y. B. Tech. (Electrical Engineering)	Semester -III			
Course Code	R4EE2003P	L	T	P	Credit
Course Title	ELECTRICAL MACHINES LAB– I	-	-	3	1.5

COURSE OUTCOMES:

Students should be able to:

1. Calculate efficiency, regulation of transformers.
2. Analyse and interpret parameters of electrical equivalent circuit of transformer
3. Demonstrate electro mechanical energy conversion principles.
4. Analyse different methods of speed control of DC machines.
5. Calculate efficiency and other performance parameters of DC machines.

LIST OF EXPERIMENTS:

1. Introduction to electrical machines, laboratory equipment, measuring system, power supplies, protective devices, etc.
2. No load and short-circuit test on single phase Transformer
3. Polarity Test on single phase single phase Transformer
4. Parallel Operation single phase Transformer.
5. Load Test on single phase Transformer
6. Sumpner Test on single phase Transformer
7. No Load Test on DC machines
8. Speed control on DC machines
9. Swinburne Test on DC machines
10. Load test on DC motor.

Programme Name	S.Y. B. Tech. (Electrical Engineering)	Semester -III			
Course Code	R4EE2004T	L	T	P	Credit
Course Title	ELECTRONIC DEVICES AND CIRCUITS	3	-	-	3

COURSE OUTCOMES

Students should be able to:

1. Justify the use of diode for different applications.
2. Analyse and calculate performance parameters for various rectifier circuits and filters.
3. Design biasing circuits for transistors and perform their small signal analysis, deriving characteristics like gain and impedance.
4. Design power & feedback amplifiers.
5. Implement oscillators using lump components.

COURSE CONTENTS

Module I	**Diodes**
	Half and full wave rectifier circuits, filter analysis C, LC, CLC & RC filter. Ripple factor and voltage regulation. Clipping and clamping circuits, ratings of the devices used in rectifiers and filters.
Module II	**Bipolar Junction Transistors**
	Operation, input and output characteristics, Configurations, Biasing Circuits: Types, dc analysis, load line, thermal runway, stability factor. Modelling: Small signal analysis of CE, CB, CC configurations with different biasing network using h-parameter model and high frequency models. Amplification.
Module III	**Field Effect Transistors: JFET and MOSFET**
	Types, construction and their characteristics, Biasing circuits for FET amplifiers, FET small signal analysis, and derivation of expressions for voltage gain and output impedance of CS amplifiers.
Module IV	**Feedback Amplifier**
	Introduction to positive and negative feedback, negative feedback -current, voltage, Series and Shunt type. Effect on input impedance, output impedance, voltage gain, current gain and bandwidth. **Cascade amplifiers:** Types of coupling, effect of coupling on performance of BJT and JFET amplifiers, cascade connection, Darlington-pair.
Module V	**Power Amplifiers**
	Introduction, operation of various types: Class A, B, C and D amplifiers, angle of conduction, push pull, efficiency of conversion for different types.
Module VI	**Oscillators**
	Positive feedback, oscillators, frequency of oscillation and condition for sustained oscillations of a) RC phase shift, b) Wien bridge, c) Hartley / Colpitts with derivations.

Text Books:	1. "Electronic Devices and Circuits", by Robert Boylestad and Louis Nashelsky, Prentice-Hall of India. 2. "Electronic Devices and Circuits", by Millman and Halkias, Tata McGrawHill.
Reference Books:	1. "Electronic Devices and Circuits", by David Bell, Oxford University Press 2. "Electronic Devices", by Thomas Floyd, Prentice-Hall of India 3. "Electronic Circuit Analysis and Design", by D. A Neamen, McGraw Hill International.

Programme Name	S.Y. B. Tech. (Electrical Engineering)	Semester -III			
Course Code	R4EE2004P	L	T	P	Credit
Course Title	ELECTRONICS DEVICES AND CIRCUITS LAB	-	-	3	1.5

COURSE OUTCOMES:

Students should be able to:

1. Justify the use of diode for different applications.
2. Analyse and calculate performance parameters for various rectifier circuits and filters.
3. Design biasing circuits for transistors and perform their small signal analysis, deriving characteristics like gain and impedance.
4. Design power & feedback amplifiers.
5. Implement oscillators using lump components.

LIST OF EXPERIMENTS:

1. To study forward and reverse characteristics of PN junction diode.
2. To study forward and reverse characteristics of Zener diode & study Zener diode as voltage regulator.
3. To study static and dynamic characteristics of BJT
4. Design, assemble and test of BJT common-emitter circuit – D.C and A.C performance: Voltage gain, input impedance and output impedance with bypassed and un-bypassed emitter resistor.
5. Design, assemble and test of BJT emitter-follower – D.C and A.C performance: A.C. voltage gain, input impedance and output impedance.
6. Frequency response and performance parameters of single stage and at least two stage BJT/MOSFET amplifiers.
7. Voltage and current series and shunt feedback using BJT/ FET. It‘s effect on frequency response.
8. Experiments on amplifiers tending towards oscillators because of feedback.
9. Experiments on Various oscillator configurations.

Programme Name	S.Y. B. Tech. (Electrical Engineering)	Semester -III			
Course Code	R4CH2001A	L	T	P	Credit
Course Title	ENVIRONMENTAL STUDIES	3	-	-	MNC

COURSE OUTCOMES

Students should be able to:

1. Imply the basic knowledge of environmental protection, sustainable development and improvement.
2. Categorize and scrutinize impact of human development on natural resources. Provide the student with an understanding of radioactive waste.
3. Interpret the impact of environmental problems on socio economic growth and human health.
4. Imply various strategies, technological improvement, and methods for sustainable management of environmental systems and for the remediation of degraded environment.
5. Apply different Science and Technology (S&T) based sustainability solutions and limitations as well as to identify impact of human population on the natural environment and human health.

COURSE CONTENTS

Module I	**Significance of Environment Science**
	Definition, basic principles and scope of environment science. Earth Man and Environment inter-relationship. Need for awareness Industrialization & Urbanization; Modern Human Life, Basic Ecological Concepts Ecosystems, nature of environmental threats Current environmental problems, Importance of clean air.
Module II	**Ecosystems and Its conservation**
	Introduction, definition: genetic, species and ecosystem diversity. **Concept of an ecosystem**: Structure and function of an ecosystem, Producers, consumers and decomposers. **Conservation of ecosystem**: Natural Resources, Renewable and Non-renewable Resources, Natural resources and associated problems. Forest resources, Water resources, Mineral resources, Food resources, Energy resources, Land resources. Role of an individual in conservation of natural resources. Biodiversity and its significance, and conservation. Global, National and effects of biodiversity.
Module III	**Fundamentals of Environmental Chemistry**
	Definition, Causes, 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 (h) Radioactive Waste (I) E-waste. Importance of Environmental Chemistry to access and manage environmental pollution.
Module IV	**Pollution Monitoring and Control Methods**
	Methods of controlling air pollution: Pollution controlling methods, Principle, construction, working and application of Equipment for gaseous pollutants control: Method to control water pollution: Principle, construction, working. Concept of Sustainability and Green Chemistry as a tool for sustainable development.
Module V	**Environmental Assessment, Management and Legislation**

	Aims And Objectives Of Environmental Impact Assessment (EIA). Environmental Impact Statement (EIS) And Environmental Management Plan (EMP) Environmental Ethics: Issues And Possible Solutions: Environment Audit :Principle, Procedure And Benefits Case study can be submit by the students. ***Projects and activities by students on Current Environmental Issues in India*** *Global Environmental Issues:* Biodiversity loss ,Climate change, Ozone layer depletion, Sea level rise Global Warming ***International efforts for environmental protection and contribution of India for same, National Action Plan on Climate Change***

Text Books:	1. De., Environmental Chemistry, 6th Edition, New Age International. 2. P.K.Goel, Water Pollution, Causes, Effects and Control, New Age International 3. Erach Bharucha, Text Book of Environmental Studies for Undergraduate Courses, Universities Press, Second Edition 4. Dr. JagdishKrishnaswamy and Dr. R. J. Ranjit Daniels, Environmental Studies, Wiley India Private Limited, New Delhi, First Edition, 2009.

Reference Books:	1. "BharuchaErach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad, 2. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T., Environmental Encyclopedia, Jaico Publ. House, Mumbai, 200 3. Jadhav, H &Bhosale, V.M., Environmental Protection and Laws. Himalaya Pub. House, Delhi, 1995 4. Wanger K.D., Environmental Management. W.B. Saunders Co. Philadelphia, USA, 1998

Semester IV

Programme Name	S.Y. B. Tech. (Electrical Engineering)	Semester -IV			
Course Code	R4MA2004S	L	T	P	Credit
Course Title	MATHEMATICS -IV	3	1	-	4

COURSE OUTCOMES

Students should be able to:

1. Demonstrate knowledge of Matrix calculation as an elegant and powerful mathematical language in connection with rank of a matrix, linear system of equations, linear dependence and independence.
2. Students will understand the concept of linear algebra, Infinite series, Complex numbers and elementary functions of complex variable.
3. Identify and solve Legendre and Bessel equations using Legendre polynomials and Bessel functions respectively.
4. To demonstrate the ability to use orthogonal functions (Legendre, Hermit, others) in approximating D.E, or expanding functions.
5. This course covers the techniques of modern digital signal processing that are fundamental to a wide variety of application areas. Special emphasis is placed on the architectures and design techniques for digital filters.
6. Ability to identify, formulate, and solve engineering problems.
7. Use the z-transform to evaluate the transfer function of linear time-invariant systems and to identify the corresponding zeros and poles.

COURSE CONTENTS

Module I	**Matrices**
	Eigen values Eigen vectors of square matrix. Cayley Hamilton's theorem and function of square matrix, Similarity Matrices, Modal Matrix, Function of Square a Matrix, Minimal Polynomial and Minimal Equation of a Matrix, Derogatory and Non-Derogatory Matrices, Quadratic forms : Linear Transformation , Linear Transformation of Quadratic forms , Congruence of a square Matrix, Reduction to Canonical form under Congruent and Orthogonal Transformation of Quadratic form, rank, index, signature and class value of Quadratic form.
Module II	**Vector Calculus and Analysis**
	Scalar and vector point functions, Directional derivative, Curl and Divergence, Conservative, Irrotational and Solenoid field, Line integral, Green's theorem for plane regions and Properties of Line integral, Stoke's theorem, Gauss's divergence theorem (without proof) related identities and deductions.
Module III	**Bessel Functions**
	Bessel's Equation**, Solution's of Bessel's function,** Bessel's Function of $J_n(x)$, Recurrence formula $J_n(x)$, Equation Reducible to Bessel's equation , Orthogonality of Bessel's functions, A Generating function for $J_n(x)$, Trigonometric Expansion involving Bessel's functions, Bessel's Integral, Legendre's Equation, Legendre's Polynomial, General solution of Legendre's Equation, Rodrigue's Formula, A Generating function of Legendre polynomial, Orthogonality of Legendre polynomial, Recurrence formula for $p_n(x)$.
Module IV	**Z Transform**
	Z-Transform, Properties of z-transform, Theorem, change of Scale, Shifting property. Inverse Z-Transform solution of Difference Equation, Multiplication

	by k, Division by k, Initial value, Final value, Partial sum. Convolution, Convolution property of Casual Sequence, Transform Important Sequence. Inverse of Z-transform by Division, By Binomial Expansion and partial fraction, Partial fraction. Inversion by residue method, Solution of Difference Equation.

Text Books:	1. Advanced Engineering Mathematics. H. K. Dass S. Chand & Co. Ltd- 3rd Edition 2. Advanced Engineering Mathematics. Erwin Kreyszig, 9th edition 3. A Text Book of Engineering Mathematics. N.P. Bali & Dr. Manish Goyal, Laxmi Publication, Eight Edition

Reference Books:	1. Higher Engineering Mathematics, B. V. Ramana, McGraw Hill Education Publication, Delhi 2. Engineering Mathematics- T. Veerarrajan Tata McGraw-Hill- IInd Edition 3. Engineering Mathematics, Babu Ram, Pearson , 1st Edition. 4. Engineering Mathematics, Srimanta Pal & Subodh C.Bhunia, OXFORD University Press.

Programme Name	S.Y. B. Tech. (Electrical Engineering)	Semester -IV			
Course Code	R4EE2006S	L	T	P	Credit
Course Title	ELECTRICAL NETWORKS -II	3	-	-	3

COURSE OUTCOMES

Students should be able to:

1. Familiar with the various techniques to synthesize electrical circuits.
2. Understand effect of frequency on behaviour of electrical circuits.
3. Use the fundamentals for electrical systems design.

COURSE CONTENTS

Module I	**Introduction and Concept of Frequency Response**
	Mutual inductance, Energy considerations, the linear transformer, the ideal transformer, Complex frequency, Damped sinusoidal forcing function, Z(s) and Y(s), Frequency response as a function of sigma, The complex frequency plane, Natural response and the s-plane, A technique for synthesizing the voltage ratio, Parallel resonance and Series resonance.
Module II	**Two Port Networks Parameters**
	One port networks, Two port networks, Admittance parameters, Impedance parameters, Hybrid parameters, Transmission parameters.
Module III	**Fourier Transforms and State Variable Techniques**
	Definition of Fourier transform, Properties of Fourier transform, Unit impulse function, Fourier transform of general periodic time function, Formulation and circuit response in time domain, System function and response in frequency domain, Physical significance of system function State variables and normal form equations, Writing a set of normal form equations, The use of matrix notation, Solution of first-order equation, Solution of matrix equation.
Module IV	**Fundamentals of Synthesis and Filter Design**
	Concept of stability, Hurwitz polynomials, Properties and testing of positive real functions, Driving point synthesis of LC, RC, RL network. Circuit synthesis using Foster and Cauer forms for RL, RC, RLC and LC circuits. Introduction to filters, first and second order filters, Butterworth and Chebyshev Approximations and introduction to filter design.

Text Books:	1. "Engineering Circuit Analysis", by W H Hayt, S M Durbin, J E Kemmerly, 7th Edition Tata McGraw-Hill Education. 2. "Network Analysis", by M. E. Van Valkenburg, , 3rd Edition, PHI Learning. 3. "Networks and Systems", by D. Roy Choudhury, 2nd Edition, New Age International. 4. "Linear Circuits", by M. E. Van Valkenburg, , Prentice Hall.

Reference Books:	1. "Network Analysis and synthesis", by F. F. Kuo,', John Wiley and sons 2. "Linear Network Theory: Analysis, Properties, Design and Synthesis", by N.Balabanian and T.A. Bickart, Matrix Publishers, Inc. 3. "Network Analysis and synthesis", by C. L.Wadhwa, ', New Age International. 4. "Network Analysis and Synthesis", by B. Somanathan Nair, , Elsevier Publications

Programme Name	S.Y. B. Tech. (Electrical Engineering)	Semester -IV			
Course Code	R4EE2007T	L	T	P	Credit
Course Title	POWER ELECTRONICS	3	-	-	3

COURSE OUTCOMES:

Students should be able to:

1. Describe operation and interpret characteristics of various power electronic devices.
2. Analyse the operation of various controlled converters.
3. Compare the performance of various phase controllers under different load conditions.
4. Describe the operation of various inverters, choppers, cycloconverters and power supplies (DC and AC).

COURSE CONTENTS

Module I	Power Electronics Devices
	Construction, characteristics, ratings of Diode, SCR, IGBT, Power MOSFET. Application of these switches in controlling power AC /DC.
Module II	**IGBT based Controlled Rectifier**
	Principle of Phase-Controlled Converter Operation, Single Phase Full Converters, with RL load, Single Phase Dual Converters, Principle of Three-Phase Half-Wave Converters, Three Phase Full Converters, Three Phase Full Converters with RL load, Three Phase Dual Converter, Power Factor Improvements, Extinction Angle Control, Symmetric Angle Control, PWM control, Single-Phase Sinusoidal PWM, Three Phase PWM Rectifier, Single Phase Semi-Converters with RL load, Three Phase Semi-Converters with RL load **.**
Module III	**AC Voltage Controllers**
	Introduction, Principle of On-Off Control, Principle of Phase Control, Single Phase Bidirectional Controllers with Resistive Loads, Single Phase Controllers with Inductive Loads, AC voltage Controller with PWM Control
Module IV	**IGBT based Inverters**
	Principle of Operation, Performance parameters, Typical Inverters: series Inverters. Bridge Inverters, Three Phase Inverters, Voltage source Inverter, Current Source Inverters, Static Frequency Conversion, Voltage Control of Inverters, grid connected inverters, PWM Inverters, Simple Application of Inverters with Motor load.
Module V	**Chopper**
	Principle of Chopper operation, Step-up Chopper, Step-down Chopper, Step-up/ Step-down Chopper, Switch mode regulators-Buck, Boost, Buck-Boost & Cuck Regulator.
Module VI	**Power Supplies**
	DC Power Supplies, Switched-Mode DC Power Supplies, Flyback Converter, Forward Converter, Push-Pull Converter, Half Bridge Converter, Full Bridge Converter, Principle of Resonant DC Power Supplies.

Text Books	
	1 "Power Electronics-Circuits, Devices and Application", by Rashid . M. H.PHI Publication, second edition, 2009
	2 "Power Electronics- Converter Application and Design", by Mohan N.Wiley Publication, third edition, 2002
	3 "Power Electronics", by P. S. Bimbra, Khanna Publisher

Reference Books	1 “Modern Power Electronics and AC drives” ,by Bose B.K. ,Pearson Education Asia 2 “Power Electronics “, by P.C. Sen, Tata McGraw-Hill Education

Programme Name	S.Y. B. Tech. (Electrical Engineering)	Semester -IV			
Course Code	R4EE2007P	L	T	P	Credit
Course Title	POWER ELECTRONICS LAB	-	-	3	1.5

COURSE OUTCOMES:

Students should be able to:

1 Describe operation and interpret characteristics of various power electronic devices.
2 Analyse the operation of various controlled converters.
3 Compare the performance of various phase controllers under different load conditions.
4 Describe the operation of various inverters, choppers, cycloconverters and power supplies (DC and AC).

List of Experiments:

1 Single-Phase Diode-Bridge Rectifiers.
2 V-I Characteristics of SCR.
3 V-I Characteristics of TRIAC.
4 V-I Characteristics of IGBT.
5 V-I Characteristics of MOSFET.
6 Three-Phase Diode-Bridge Rectifiers.
7 Step-Down (Buck) DC-DC Converters.
8 Step-Up (Boost) DC-DC Converter.
9 Full-Bridge DC-DC Converters.
10 Simulation of single phase Inverter with PWM control.
11 Parallel Inverter.
12 Three Phase PWM Inverters.
13 Step down Cycloconverters.

Programme Name	S.Y. B. Tech. (Electrical Engineering)	Semester -IV			
Course Code	R4EE2008T	L	T	P	Credit
Course Title	ELECTRICAL MACHINES- II	3	-	-	3

COURSE OUTCOMES:

Students should be able to

1 Describe in detail the operation and characteristics of three-phase and single-phase induction motor.

2 Describe in detail the operation and characteristics of synchronous motor and generator.

3 Analyse different speed control methods of Synchronous and Induction machines.

4 Model Synchronous and Induction machines.

COURSE CONTENTS

Module I	**Three Phase and Single Phase Induction Motor**
	Three phase Induction Motors & its types, Flux and MMF Phasors in Induction Motors, Rotor Frequency, Rotor emf, current and power, Phasor diagram, Losses & Efficiency, Equivalent Circuit, Torque- slip characteristics, Circle Diagram, Power Factor Control, Starting and speed control of three phase Induction Motors, Induction Generator, Applications of Induction Machines. Single phase induction motor, Double revolving field theory. Different types, starting methods, characteristics and applications.
Module II	**Synchronous Machines**
	Polyphase Synchronous Machines, Excitation Systems, Flux and MMF Phasors, Synchronous Machines, Cylindrical rotor, Salient-pole machines. **Synchronous generator** Phasor Diagram of synchronous machines, the open circuit, short circuit, ZPF characteristics and Potier triangle. Voltage Regulation Of An Alternator: The EMF method or synchronous impedance method, The MMF method, ZPF method, Operating Characteristics of Alternators and their Ratings, External load characteristics, Alternator compounding characteristics. Power Flow through an Inductive Impedance, Maximum power conditions, Reactive power, Circle Diagrams of Synchronous Machines, Power Factor Control of Synchronous Machines. Synchronizing, Parallel operations of two alternators, Synchronous Machine on Infinite Bus
Module III	**Introduction to synchronous motor**
	V and Inverted V Curves, Starting methods, Applications.
Module IV	**Mathematical Modelling of Machines**
	Electrical equivalent circuit of induction motor and synchronous motor, dq Transformations – Induction Motor & Synchronous Machine.

Text Books:	1 "Electrical Machinery, Performance and Applications", by Bimbhra P. S., Khanna Publisher Fifth Edition 2 "Electrical Machines", by D. P. Kothari and I. J. Nagrath, Tata McGraw Hills.

Reference Books :	1 "Electrical Machines", by A. E. Fitzgerald & C. Kingsley, 3rd Edition, TMH Publication 2 "The performance and design of A.C. Machines", by M. G. Say., C B S Publications, 2005. 3 "Electric motor drives", by R. Krishnan, Pearson Edu.

Programme Name	S.Y. B. Tech. (Electrical Engineering)	Semester -IV			
Course Code	R4EE2008P	L	T	P	Credit
Course Title	ELECTRICAL MACHINES LAB- II	-	-	3	1.5

COURSE OUTCOMES

Students should be able to

1 Describe in detail the operation and characteristics of three-phase and single-phase induction motor.

2 Describe in detail the operation and characteristics of synchronous motor and generator.

3 Analyse different speed control methods of Synchronous and Induction machines.

4 Model Synchronous and Induction machines.

LIST OF EXPERIMENTS

1 Speed control of 3-ph induction motor.

2 No load & blocked rotor test on 1- phase Induction Motor.

3 No load & blocked rotor test on 3-ph induction motor.

4 Load test on 3-ph induction motor.

5 'V' curves of synchronous induction motor.

6 O.C.C. / S.C.C. / Z.P.F.C. on synchronous machine.

7 Synchronization of alternator with infinite bus & 'V' curves of synchronous motor.

8 Slip test on synchronous machine.

9 Load test on synchronous Machine.

10 Parallel operation of two alternators.

Programme Name	S.Y. B. Tech. (Electrical Engineering)	Semester -IV			
Course Code	R4EE2009T	L	T	P	Credit
Course Title	ANALOG AND DIGITAL CIRCUIITS	3	-	-	3

COURSE OUTCOMES

Students should be able to:

1 Compute with different number systems
2 Reduce in SOP and POS form using Boolean algebra.
3 Design basic combinational and sequential digital circuits.
4 Analyse different feedback circuits using opamps.
5 Analyse different opamp and timer circuits

COURSE CONTENTS

Module I	**Number Systems and Binary Arithmetic**
	Decimal, Binary, Octal and Hexadecimal number system and conversion, binary weighted codes, 1's and 2's complement addition and subtraction in 1's and 2's complement system, binary multiplication and division
Module II	**Boolean Algebra and Logic Gates**
	Basic theorems and properties of Boolean Algebra, Various logic Gates (NOT, AND, OR, NAND, NOR, XOR, XNOR) and their truth tables, SOP and POS forms of Boolean functions, Minimization of Boolean function using Karnaugh Map, design of logic circuit for given truth table, Adder and Subtractor
Module III	**Combinational Logic**
	Code converters, Multiplexer, Multiplexers as function generators, De-multiplexer, Decoder, Encoder.
Module IV	**Sequential Logic**
	Basic flip flops – SR, D, JK and T; flip flop applications – synchronous counters, shift registers
Module V	**Operational Amplifier Basics**
	Differential amplifier; Ideal Op-Amp: characteristics, equivalent circuit, virtual ground concept. Voltage transfer curve; open loop op-amp configurations; different types of negative feedback in op-amp – properties.
Module VI	**OP-Amp Based Circuits**
	Linear Applications: Inverting and non-inverting amplifier, voltage follower, summing amplifier, substractor, instrumentation amplifier, voltage to current and current to voltage converter, integrator, differentiator Oscillators: Phase shift and Wein Bridge Oscillator. Non-linear applications: Comparator, Schmitt trigger
Module VII	**Timing Circuits**
	IC555 timer internal block diagram, operation, IC555 based astable, monostable and bistable multivibrator.

Text books	1. "Op-Amps and Linear Integrated Circuits", by Ramakant A. Gayakwad, Fourthedition, PHI, 2013 2. "Digital Logic and Computer design", by M. Morris Mano, PHI, 2006 3. "Modern Digital Electronics", by R. P. Jain, TATA Mcgraw Hill
Reference Books:	1. "Digital Principles and Applications", by Malvino, Leach, Saha, TATA Mcgraw Hill 2. "Integrated Circuits", by Botkar, Vikas Book House

Programme Name	S.Y. B. Tech. (Electrical Engineering)	Semester -IV			
Course Code	R4EE2009P	L	T	P	Credit
Course Title	ANALOG AND DIGITAL CIRCUIITS LAB	-	-	2	1

COURSE OUTCOMES

Students should be able to:

1 Compute with different number systems
2 Reduce in SOP and POS form using Boolean algebra.
3 Design basic combinational and sequential digital circuits.
4 Analyse different feedback circuits using opamps.
5 Analyse different opamp and timer circuits

LIST OF EXPERIMENTS:

Digital Electronics

1 To design – a) half adder, b) full adder, c) half subtractor d) full subtractor using fundamental and universal logic gates.
2 To implement a 4:1 multiplexer using fundamental gates.
3 To implement a Boolean function using multiplexer IC 74151.
4 To design and implement a code converter (e.g. excess 3 to BCD).
5 To verify the truth table of - a) D flip flop using IC7474 b) JK flip flop using IC7473
6 To design a 3 bit binary synchronous counter for a given sequence.
7 To study shift registers (SISO, SIPO, PIPO, PISO) using universal shift register IC74194.

Analog Electronics

1 To study inverting and non-inverting configuration of OP-AMP using IC741.
2 To implement - a) summing amplifier and b) subtractor using IC741.
3 To implement - a) integrator and b) differentiator using IC741.
4 To design and implement different types of oscillators using op-amp.
5 To implement - a) astable multivibrator, b) monostable multivibrator and c) bi-stable multivibrator using IC555.

Programme Name	S.Y. B. Tech. (Electrical Engineering)	Semester –IV			
Course Code	R4EE2010S	L	T	P	Credit
Course Title	PRINCIPLES OF MEASUREMENTS AND INSTRUMENTATION	3	-	-	3

COURSE OUTCOMES

Students should be able to:

1. Handle and measure different instruments.
2. Use correct measurement techniques for electrical and magnetic parameters
3. Analyze different errors in measurement and their sources.
4. Apply different measuring principles AC as well as DC quantities.

COURSE CONTENTS

Module I	**Measurement Errors**
	Accuracy and Precision, Types of Error, Statistical Analysis, Probability of Errors, Limiting Errors.
Module II	**Transducers and Measurement of Current and Voltage**
	Classification of transducers: resistive, capacitive and inductive – piezoelectric transducer — LVDT – thermoelectric – piezoelectric Transducers for measurement of displacement – temperature – pressure – velocity. CT and PT construction working Ratio and phase angle errors, accuracy class, selection of sensor. Transducer signal conditioning and digital interfacing with computing device.
Module III	**Principles of Analog and Digital Instruments:**
	Difference between Indicating and Integrating Instruments. Moving coil and Moving iron Instruments, Ammeters Shunts & Voltmeter Multiplier. Extension of ranges. Advantages of digital meters over analogue meters. Resolution & sensitivity of digital meters. Working principles of digital Voltmeter, Ammeter, Frequency meter, Phase Meter, Energy meter, Tachometer and Multi-meter. Digital measurement sampling, ADC & Data processing signal conditioning.
Module IV	**Oscilloscopes and Waveform Generators**
	CRO – General purpose and advanced type – Sampling and storage scopes – Signal and function generators – Noise generators – Pulse and square wave generator –Sweep generator– Pattern generator. Specification and their interpretation for DSO and Waveform generator.
Module V	**Recording devices and Wave Analyzers**
	Digital recording and data loggers – Basic wave analyzer – spectrum analyzer – Fundamental type harmonic distortion analyzers – Distortion factor meter – Q meter – Distortion analyzers.

Text Books:	1.“A Course in Electrical and Electronics Measurements and Instrumentation”, by Sawhney A.K, 18th Edition, Dhanpat Rai & Company Private Limited, 2007. 2. “Electrical Measurements and Measuring Instruments”,by Golding. E. W, and Widdis F.C,5th Edition, A. H. Wheeler & Company, 2003.

Reference Books:	1. "Electronic Instrumentation", by Kalsi. H. S, 2nd Edition, Tata McGraw Hill, 2004. 2. "Modern Electronic Instrumentation and Measurement Technique",by Copper. W. D and Hlefrick A. D, 5th Edition, Prentice Hall of India, 2002.