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

Sem-V

Scheme of Instruction						Scheme of Evaluation			
Sr. No.	Course Code	Course name	Hr/week			Credits	TA	MST	ESE
			L	T	P				
1.	R4MA3005S	Mathematics V	3	1	0	4	20	20	60
2.	R4EE3001S	Signal &Systems	3	0	0	3	20	20	60
3.	R4EE3002T	Electromagnetic Fields & Waves	3	0	0	3	20	20	60
4.	R4EE3003T	Control System - I	3	0	0	3	20	20	60
5.	R4EE3004T	Microprocessor and Microcontroller	3	0	0	3	20	20	60
6.	R4EE3005A	IEGC & Electricity Act	2	0	0	**P/NP**			
7.	R4EE3002P	Electromagnetic Field Lab	0	0	2	1	60	-	40
8.	R4EE3003P	Control System Lab	0	0	2	1	60	-	40
9.	R4EE3004P	Microprocessor and Microcontroller Lab	0	0	2	1	60	-	40
10.	R4EE3006L	Simulation Software I	1	0	2	2	60	-	40
		Total	**18**	**1**	**8**	**22**			

Sem-VI

Scheme of Instruction						Scheme of Evaluation			
Sr. No.	Course Code	Course name	Hr/week			Credits	TA	MST	ESE
			L	T	P				
1.	R4EE3011T	Electric Drives	3	0	0	3	20	20	60
2.	R4EE3012T	Digital Signal Processing	3	0	0	3	20	20	60
3.	R4EE3013S	Control System – II	3	0	0	3	20	20	60
4.		** Professional Elective - I	3	0	0	3	20	20	60
5.		Open Elective I	3	0	0	3	20	20	60
6.	R4HM3002L	Professional Communication skills	1	0	2	2	60	40	
7	R4EE3011P	Electric Drives Lab	0	0	2	1	60	-	40
8	R4EE3012P	Digital Signal Processing Lab	0	0	2	1	60	-	40
9		** Professional Elective - I Lab	0	0	2	1	60	-	40
10	R4EE3014L	Simulation Software II	0	0	2	1	60		40
		Total	**16**	**0**	**10**	**21**			

Abbreviations: **L**: Lecture, **T**: Tutorial, **P**: Practical, **TA**: Teacher Assessment / Term work Assessment, M**ST**: Mid Semester Tests, **ESE**: End Semester Examination,

** Refer List of Electives

List of Electives

Course Code	Elective I
R4EE3101T	Renewable Energy Sources
R4EE3101P	Renewable Energy Sources Lab
R4EE3102T	Internet of Things
R4EE3102P	Internet of Things Lab
R4EE3103T	Basics of Communications
R4EE3103P	Basics of Communications Lab
R4EE3104T	Biomedical Instrumentation
R4EE3104P	Biomedical Instrumentation Lab

Course Code	Open elective I
R4EE3612S	Electric Vehicles

Semester –V

Programme Name	T.Y. B. Tech. (Electrical Engineering)	Semester –V			
Course Code	R4MA3005S	L	T	P	Credit
Course Title	MATHEMATICS FOR ENGINEERING - V	3	1	-	4

COURSE OUTCOMES

Student should be able to

1. Formulate probability distribution function and cumulative distribution function of various distribution system i.e. binomial distributions, Poisson distribution etc.
2. Apply sampling theory and able to perform tests of significance for small and large sample.
3. Solve curve fitting problem and do analysis s of variance.
4. Apply of reliability engineering

Course Contents

Module I	**Review of Probability**
	Baye's theorem. Discrete and continuous random variables, Probability mass function and density function. Expected value. (Expectation) Moments and moments generating functions. Relation between Raw moments and Central moments.
Module II	**Probability Distribution**
	Binomal, Poisson, Normal, Student's distribution, x^2 (Chisquare), F distribution.
Module III	**Sampling Theory**
	Sampling distribution. Test of hypothesis. Level of significance. Critical region. One- tailed and two-tailed tests. Degree of freedom. Estimation of population parameters. Central limit theorem. Large and Small samples: 1. Test of significance for large samples. i) Test of significance of the difference between sample proportion and population proportion. ii) Test of significance of the difference between the sample proportions. iii) Test of significance of the difference between sample mean and population means. iv) Test of significance of the difference between the means of two samples. 2. Test of significance for small samples : a. Test of significance of the difference between sample mean and population mean.

	b. Test of significance of the difference between means to two small samples drawn from the same normal population c. Paired- t test. 3. F-test of significance of the difference between population variances. 4. Test of the Goodness of fit and independence of attribute. Contingency table. Yate's correction.
Module IV	**Fitting of Curves**
	Least square method, fitting of the straight line and parabolic curve. Bivariate frequency distribution. Co-relation, Co-variance. Karl Pearson's Coefficient and Spearman's Rank Co-relation coefficients, Regression coefficients and lines of regression.
Module V	**Analysis of Variance**
	One way and two way classification.
Module VI	**Statistical Quality Control and Control Charts, Reliability**

Text Books:	1. S G Gupta, V K Kapur, Fundamentals of Mathematical Statistics, S Chand & Co. 2. T Veerrajan, Probability, Statistics and Random Processes, Tata McGraw Hill. 3. R P Hooda, Statistics for Business and Economics, Macmillan. R. Billington, Reliability Evaluation of Power System, PHI.

Programme Name	T.Y. B. Tech. (Electrical Engineering)	Semester -V			
Course Code	R4EE3001S	L	T	P	Credit
Course Title	SIGNAL & SYSTEMS	3	-	-	3

COURSE OUTCOMES

Students should be able to

1. Characterize signals and systems and obtain output of LTI systems in continuous-time and discrete time domains.
2. Obtain Laplace transform and Z-domain and their inverse in CT and DT domains respectively.
3. Analyse CT and DT signals and systems in frequency domain domains using Fourier Series and Transforms.
4. Solve differential and difference equations and to realize CT and DT systems.

COURSE CONTENTS

Module I	**Basis of Signals & Systems (CT and DT domain)**
	Definition of Signal, Signal classification, Signal manipulations, Periodicity in CT (Continuous Time) & DT(Discrete Time) domain, Concept of a system, System representations & classification, Concept of LTI system and Impulse Response, Convolution in CT domain, Linear and Circular Convolution in DT domain, BIBO stability.
Module II	**Fourier Series & Fourier Transform (CTFS, CTFT, DTFS & DTFT)**
	Concept, properties and uses, Transforms and inverse, Amplitude & phase spectra, Energy Spectral Density, Power Spectral Density. Frequency response, Magnitude and Phase response.
Module III	**Laplace Transforms**
	Definition & properties of Two-sided & one-sided Laplace Transform, Region of Convergence (ROC), System transfer function, Relationship with Fourier Transform & mapping.
Module IV	**Z Transform**
	Definition & properties of Two-sided & one-sided Z Transform, Region of Convergence (ROC), Relationship with Fourier and Laplace Transform, & mapping, Inverse Z Transform. Transfer Function.
Module V	**Introduction to CT Systems**
	System Transfer function & Impulse response, Differential Equations, Solutions to Differential Equations. , Zero state & Zero input responses
Module VI	**Introduction to DT Systems**
	System Transfer function & Impulse response, FIR & IIR systems, Difference equation, Solution of a difference equation, zero input & zero state response, System realization: Direct forms, Cascade & parallel forms.

Text Books:	1.” Signals and Systems” S. Haykin, , Wiley Eastern Publication 2. ”Signals and Systems”, H P Hsu and R. Ranjan, Tata McGrew Hill Education Private Ltd.

Reference Books:	1.“Discrete- Signals and Systems”,A V Oppenheim and A S Willsky with S H Nawab, Prentice Hall of India. 2.“Analog and Digital Signal Processing”,Ambardar, Thomson Learning, second edition. 3.”Discrete- Time Signal Processing”, A V Oppenheim and Schafer with Buck, Prentice Hall of India 4.“Digital Signal Processing: Principles, Algorithms and applications”, J G. Proakis, D G. Manolakis, Prentice Hall of India.

Programme Name	T.Y. B. Tech. (Electrical Engineering)	Semester -V			
Course Code	R4EE3002T	L	T	P	Credit
Course Title	ELECTROMAGNETIC FIELDS AND WAVES	3	-	-	3

COURSE OUTCOMES:

Students should be able to

1. Identify and make use of different coordinate systems for representation of vectors and apply Coulomb's law, Gauss' law and Maxwell's equation to physical problems.
2. Describe electric fields in materials and write continuity equation, Poisson's and Laplace equation, and analyze solutions to boundary value problems.
3. Apply Ampere's law and Bio-Savart's law to physical problems, derive forces on magnetic field.
4. Summarize time varying Maxwell's equation and explain electromagnetic wave propagation.

COURSE CONTENTS:

Module I	**Vector calculus, coordinate systems and transformations**
	Cartesian coordinates, Cylindrical coordinates, Spherical coordinates, Differential length, Area and volume, Line surface and volume integral, Del operator and gradient of scalar, Divergence of vector, Curl of vector.
Module II	**Electrostatics**
	Coulomb's law and field intensity, Electric fields due to continuous charge distributions, Electric flux density, Gauss's law - Maxwell's equation, Applications of Gauss's law, Electric potential, Potential gradient, Relation between E and V Maxwell's equation, Electric dipole and flux lines, Equipotential contours Energy density in electrostatic fields.
Module III	**Electric fields in Material's space and Boundary value problems**
	Properties and materials, Convection and conduction current, Current density, Conductors, Polarization in dielectrics, Dielectric constant and strength, Continuity equation and boundary condition, Poisson's and Laplace equation, Uniqueness theorem, Resistance, capacitance and super-conductance, The Earth capacitor : an automatic electrostatic pilot.
Module IV	**Magneto statics**
	Biot - Savart's law, Ampere's circuit law - Maxwell's equation, Applications of Ampere's law, Magnetic flux density - Maxwell's equation, Maxwell's equation for static fields, Magnetic scalar and vector potentials, Derivations of Biot-Savart's law and Ampere's Law.
Module V	**Magnetic forces and materials**
	Forces due to magnetic fields, Magnetic torque and moment, Magnetic dipole, Magnetisation in materials, The solenoid, Classification of magnetic materials, Magnetic boundary conditions, Inductor and inductance, Magnetic energy and

	circuits, Forces on magnetic materials.
Module VI	**Time varying Maxwell's equations**
	Faraday's law, Transformer and motional electromotive forces, Displacement current, Inconsistency of Ampere's law, Maxwell's equation in time varying and harmonic form, Analogies between electric and magnetic field.
Module VII	**Electromagnetic wave propagation**
	Waves in general, Comparison and relation between permittivity & permeability, Propagation in lossy dielectric, Plane wave in lossless dielectrics, Plane waves in free space, Plane waves in good conductors, Power and Pointing vector, Reflection of plane wave at normal incidence.

Text Books:	1. "Principles of Electromagnetics", Matthew N. O. Sadiku and S. V Kulkarni, Sixth edition, 2015, Oxford university press.". 2. Electromagnetic Waves and Radiating Systems", Edward C. Jordan, Keith G. Balmain, "Second edition, Prentice-Hall.

Reference Books:	1. "Engineering Electromagnetics", William Hayt, McGraw Hill, fourth edition, 1987. 2."Schaum's series in Electromagnetics", Edminister, McGraw Hill, third edition, 1986

Programme Name	T.Y. B. Tech. (Electrical Engineering)	Semester -V			
Course Code	R4EE3003T	L	T	P	Credit
Course Title	CONTROL SYSTEMS - I	3	-	-	3

COURSE OUTCOMES:

Students should be able to:

1. Derive mathematical model of systems infrequency & time domain.
2. Perform time domain analysis of systems. (Transient as well as steady state)
3. Sketch root locus of systems & perform stability analysis.
4. Perform stability analysis of systems using Bode &Nyquist plots.

COURSE CONTENTS:

Module I	**Modelling in the Frequency domain**
	Laplace Transform review, The Transfer function, Electric network transfer function, Translational mechanical system transfer function, Rotational mechanical system transfer function, Electro-mechanical system transfer function, Electrical circuit analogs.
Module II	**Modeling in the Time Domain**
	The general state-space representation, Applying the state-space representation, Converting the transfer function to state-space, Converting from state-space to transfer function.
Module III	**Reduction of Multiple Systems**
	Block diagrams, Analysis and design of feedback system, Signal flow graphs, Mason's rule, Signal flow graphs of state equations.
Module IV	**Time Response**
	Poles, Zeros & System response, First Order System, Second Order System: Introduction, the General Second Order System, Under damped Second Order System ,System response with additional poles, System response with zeros, Laplace transform solution of state equations, Time domain solution of state equations.
Module V	**Steady State Error**
	Steady state error for unity feedback systems, Static error constants and system type, Steady state error specification, Steady state error for disturbances, Steady state error for non-unity feedback systems, Sensitivity, Steady state error for systems in state space.
Module VI	**Stability**
	Routh Hurwitz criterion, Routh Hurwitz criterion: special cases, Routh Hurwitz criterion: Additional examples, Stability in state space
Module VII	**Root Locus Techniques**
	Introduction, Root locus plots, Summary of general rules for constructing Root-Loci, Root locus analysis for control systems, Root loci for systems with transport lag

Module VIII	Frequency Response Techniques
	Asymptotic Approximations: Bode plots, Introduction to the Nyquist criterion, Sketching the Nyquist diagram, Stability via the Nyquist diagram, Gain margin and phase margin via the Nyquist diagram, Stability Gain margin and phase margin via the Bode-plots, Relation between closed loop transient and closed loop frequency response, Relation between closed loop and open loop frequency response, Relation between closed loop transient and open loop frequency response, Steady state error characteristic from frequency response.

Text Books:	1. "Control system engineering", Norman S. Nise 3rd edition, John Wiley and Sons, (Asia) Pvt. Ltd.2001. 2. . "Modern Control Engineering" K. Ogata, Fourth Edition, Prentice Hall, 2010.

Reference Books:	1. Modern Control System Theory", M. Gopal, Wiley Eastern Ltd., NewDelhi. 2."Modern Control Systems",R.Bishop&R.Dorf8th edition(LPE),Addison Wesley,1998

Programme Name	T.Y. B. Tech. (Electrical Engineering)	Semester -V			
Course Code	R4EE3004T	L	T	P	Credit
Course Title	MICROPROCESSOR AND MICROCONTROLLER	3	-	-	3

COURSE OUTCOMES:

Student should be able to:

1. Compare various microprocessor / microcontroller architecture.
2. Use turbo debugger and other similar tool for assembly language programming
3. Develop assembly language programmes for 8086 and 8051 microcontroller
4 Design and implement 8051 based small application systems

COURSE CONTENTS:

Module I	**8051 Microcontroller Architecture** Introduction to Microprocessor/microcontroller, 8086 architectural features. 8051 architectural features, Overview of MCS51 family, Memory organisation.
Module II	**8086 Hardware and programming** Block Diagram and functions of each block, Assembly language programming of 8086, Instructions : Data transfer, Arithmetic, Logical, Branching and special instructions, Memory management in 8086 system, Peripheral IC interfacing 8255,8259.
Module III	**8051 Microcontroller assembly language programming** Addressing modes of 8051, Instruction Set: Data transfer, Arithmetic, Logical, Branching , Assembly Language Programming.
Module IV	**8051 Internal Hardware & Programming** I/O port structure and programming, programming Interrupts and programming, Timer/Counter and programming, Serial port and programming.
Module V	**8051 Interfacing & Applications** Display interfacing: 7-segment LED display, 16x2 generic alphanumeric, Keyboard interfacing: 4x4 matrix keyboard, Analog devices interfacing: 8-bit ADC/DAC, temperature sensor (LM35), Motor interfacing: Relay, dc motor, stepper motor and servo motor.

Text Books	1.”Microcomputer systems:the 8086/8088 family”, By Yu cheng Liu, Glenn A. Gibson Eastern Economy edition PHI 2.”Microprocessor & interfacing Programming& Hardware”, Douglas V Hall Tata McGraw hill 3.”The 8051 Microcontroller Architecture,Programming and applications” By Kenneth J Ayala Penram International

Reference Books	“The 8086/8088 Family Design Programming and interfacing” by John Uffenbeck Eastern economy edition PHI

Programme Name	T.Y. B. Tech. (Electrical Engineering)	Semester - VI			
Course Code	R4EE3005A	L	T	P	Credit
Course Title	IEGC & ELECTRICITY ACT	2	-	-	P/NP

COURSE CONTENTS:

Module I	**IEGC & Various organisations**
	Introduction, roles of NLDC, Role of RLDC, Role of RPC, Role of CTU, Role of CEA, Role of SLDC, Role of STU, planning code for interstate transmission, planning criterion, planning data, implementation of transmission plan
Module II	**Connection & Operating Code**
	procedure for connection, connection agreement, important technical requirements for connectivity to the grid, international connections to ISTS, schedule of assets of regional grid Operating philosophy, system security aspects, demand estimation for operational purposes, demand management, periodic reports, operational liaison, outage planning, recovery procedures, event information
Module III	**Scheduling and Dispatch Code**
	Introduction, objective, scope, demarcation of responsibilities, scheduling and dispatch procedure for long term access, medium term and short term open access. Reactive power and voltage control
Module IV	**Evolution of Electricity Act**
	Introduction, Evolution of Electricity Act 1910, Necessity of the Act, Basic definition Electricity Act 1910, National Electricity Policy and Plan, Act related to Power Generation, Act related to Power License, Act related to Power Transmission, Act related to Power Distribution, Tariff Act
Module V	**Various commissions and their Roles**
	Function and Constitution of CEA, Function and Constitution of Regulatory commissions at central level and state level, work and Responsibilities of Licensing Authority. Open access policies and correct laws incorporated in EA2003
Module VI	**Amendments in Electricity act**
	Amendments from 2003 onwards, Electricity Act – 2015 , Electricity Act – 2018, Rules regarding Quality of Supply and Consumer Rights.

Reference Books:	1. Electricity Act 2003 2. Amendments in electrical Act 3. Indian Grid codes

Programme Name	T.Y. B. Tech. (Electrical Engineering)	Semester -V			
Course Code	R4EE3002P	L	T	P	Credit
Course Title	ELECTROMAGNETIC FIELDS AND WAVES LAB	-	-	2	1

COURSE OUTCOMES:

Students should be able to

1. Code in freeware different coordinate systems for representation of vectors and apply Coulomb's law, Gauss' law and Maxwell's equation.
2. Apply proper logic for coding the field problems
3. Observe the field patterns and analyse the field problem

LIST OF EXPERIMENTS

1. Divergence of a vector field
   a. Vector with Zero Divergence
   b. Vector with Positive Divergence
   c. Vector with negative Divergence
2. Curl of a vector field
   a. Rotational field
   b. Irrotational field
3. Force on a single current carrying conductor
   a. Force on an isolated conductor (current into the plane)
   b. Force on an isolated conductor (current coming out of the plane)
   c. Current carrying conductor in a uniform field distribution
4. Force between two current carrying conductors
   a. Currents in opposite Direction
   b. Currents in same direction
5. Coding problems on Laplace and Poissons equations
6. Coding problems on Maxwell's Equations
7. Coding problems on wave propagation
8. Term project (group activity)

Programme Name	T.Y. B. Tech. (Electrical Engineering)	Semester -V			
Course Code	R4EE3003P	L	T	P	Credit
Course Title	CONTROL SYSTEMS – I LAB	-	-	2	1

COURSE OUTCOMES:

Students should be able to:

1. Derive mathematical model of systems infrequency & time domain.
2. Perform time domain analysis of systems. (Transient as well as steady state)
3. Sketch root locus of systems & perform stability analysis.
4. Perform stability analysis of systems using Bode &Nyquist plots.

LIST OF EXPERIMENTS

1. Introduction to SCILAB programs

   Part I : Introduction to Scilab

   Part II : Matrix, Polynomials, Equations solving in Scilab

   Part III : Plotting graphs, Loop conditions in Scilab

2 Time response analysis of second order systems

   Part I: RLC Circuit

   Part II: Mass Spring Damper Circuit

3 Effect of time response characteristics of horizontal, vertical and diagonal movement of poles of the systems.

4 To find the stability of the system.

5 Root locus of given circuit and its specifications

6 Frequency response analysis

Bode plot of given circuit and its specifications

Polar &Nyquist plot of the given circuit and its specifications

7 To model a DC Motor using state space model.

8 To analysis RLC series circuit using state space method.

9 To study and analyze the operation of a Proportional Controller.

10 To study and analyze the operation of Proportional-Integration (PI) Controller.

11 To study and analyze the operation of Proportional-Derivative (PD) Controller

12 To study and analyze the operation of Proportional-Integration-Derivative (PID) Controller.

Programme Name	T.Y. B. Tech. (Electrical Engineering)	Semester -V			
Course Code	R4EE3004P	L	T	P	Credit
Course Title	MICROPROCESSOR AND MICROCONTROLLER LAB	-	-	2	1

COURSE OUTCOMES:

Student should be able to:

1. Compare various microprocessor / microcontroller architecture.
2. Use turbo debugger and other similar tool for assembly language programming
3. Develop assembly language programmes for 8086 and 8051 microcontroller
4. Design and implement 8051 based small application systems

LIST OF EXPERIMENTS:

1 Program involving Data transfer instructions

Program involving Arithmetic and logic operations like addition and subtraction of multi precision numbers

2 Multiplication and Division of signed and unsigned Hexadecimal numbers

16 Bit multiplication for unsigned numbers

8 Bit Division for Unsigned numbers

16 Bit Division for Unsigned numbers

16 Bit Division for Signed numbers

3 Code Conversion

i) ASCII adjustment instructions
ii) Binary to BCD code conversion
iii) BCD to Binary code conversion

4 Arithmetic programs to find square, cube, LCM, GCD and factorial

i) Program to find square and cube of a number
ii) Program to find LCM of a given number
iii) Program to find GCD of two numbers
iv) Program to find factorial of a given number

5 Program involving bit manipulation instruction

i) If given data is positive or negative
ii) If given data is odd or even
iii) Logical ones and zeros in a given data
iv) Bit wise palindrome
v) Nibble wise palindrome

6 Programs involving branch/loop instructions / programs on arrays

i) addition of n numbers
ii) program to subtract n numbers

iii) program to find largest number among the series
iv) program to find the largest number using dos display interrupts
v) program to sort the numbers in ascending/descending order programs on string manipulation like string transfer, string reversing, searching for a character in a string and palindrome
vi) program for string transfer
vii) program to reverse a string
viii) program to search for a character in a string

Programme Name	T.Y. B. Tech. (Electrical Engineering)	Semester -V			
Course Code	**R4EE3006L**	**L**	**T**	**P**	**Credit**
Course Title	**Simulation Softwares 1**	1	**-**	2	2

Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcome: Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.

Module I	**Introduction to MATLAB Simulink.**
	Introduction to basic blocks. Model a simple system using basic blocks.
Module II	**Introduction to Simscape tool box.**
	Simulation to plot the response of series RL, RC and RLC circuits for standard test signals. Simulation of transmission line model. Simulation of DC motor performance characteristics Simulation of single phase bridge rectifier with and without filter.
Module III	**Introduction to Control System tool box.**
	Simulation of differential equation. Study response with PI, PD and PID controller of feedback system.

Semester – VI

Programme Name	T.Y. B. Tech. (Electrical Engineering)	Semester – VI			
Course Code	R4EE3011T	L	T	P	Credit
Course Title	ELECTRIC DRIVES	3	-	-	3

COURSE OUTCOMES:

Students should be able to:

1. Select the appropriate electric motor and drive for an application
2. Employ various techniques for Induction motor control
3. Propose appropriate method of control for a DC machine and Synchronous machine
4. Employ and justify use of special machines for various applications.

COURSE CONTENTS:

Module I	**Dynamics of Electric Drives**
	Fundamental torque equation, Multi-quadrant operation and speed torque conventions, steady state stability, load equalization, classes of duty and selection of motor.
Module II	**Control of DC Motor**
	Starting and Braking methods, Speed control of DC Motors, Ward Leonard Drives, Phase Controlled DC Motor Drive, multi-quadrant operation, Chopper-controlled, DC drives, multi-quadrant operation.
Module III	**Induction Motor Control**
	Modelling of induction machine (Review), Starting and Braking methods, Scalar control of induction motor – Stator Voltage Control, Static Scherbius Drive, Principle of vector control and field orientation, Sensorless control and flux observers, Direct torque and flux control of induction motor.
Module IV	**Control of Synchronous Motor**
	Starting and Braking methods, Modeling of synchronous machine (Review), Control of synchronous reluctance motor.
Module V	**Control of Special Electric Machines**
	Permanent magnet synchronous motor, Brushless dc motor, Switched reluctance motor, Stepper motors and control.

Text Books	1. B. K. Bose, "Modern Power Electronics and AC Drives", Pearson Education. 2. G.K. Dubey, "Fundamentals of Electrical Drives", Narosa Publication, 2001.

Reference Books	1. R. Krishnan, "Electric Motor Drives: Modeling, Analysis and Control", Prentice Hall 2. P.C. Krause, O. Wasynczuk, and S. D. Sudhoff, "Analysis of Electric Machinery", McGraw-Hill Book Company

	3. P. S. Bhimbra, “Generalized Theory of Electric Machines”, Khanna Publication. 4. Rashid M. H, “Power Electronics - Circuits, Devices and Applications”, Pearson Education.

Programme Name	T.Y. B. Tech. (Electrical Engineering)	Semester – VI			
Course Code	R4EE3012T	L	T	P	Credit
Course Title	DIGITAL SIGNAL PROCESSING	3	-	-	3

COURSE OUTCOMES:

Students should be able to:

1. Obtain frequency response and Impulse response. Also find DFT and inverse DFT directly and using FFT
2. Identify the different types Linear phase FIR filters and obtain the locations of zeros and magnitude response.
3. Design Linear phase FIR filters using Windowing and Frequency Sampling Techniques.
4. Design analog Butterworth and Chebyshev filters and convert to digital filters using various techniques.

COURSE CONTENTS:

Module I	**Discrete Fourier Transform**
	Review of Discrete Time Fourier Transform and its properties, Discrete Fourier Transform (DFT) and its properties, Fast Fourier Transform (FFT), Decimation In Time FFT (DIT-FFT) and Decimation In Frequency FFT (DIF-FFT), Radix 8 Flow diagrams.
Module II	**FIR and IIR filters**
	Finite Impulse Response (FIR), Infinite Impulse Response (IIR) Comparison and Differences. Frequency response (Analytically and Graphically). Concept of Magnitude and phase response. Other transforms like Discrete Cosine transforms (DCT), Hilbert Transform, Implementation of Discrete Time Systems. Relationship between spectra of discrete- and continuous- time representations
Module III	**Linear phase FIR Digital filters**
	Concept of linear phase, types, position of zeros, frequency response
Module IV	**Design of FIR Digital filters**
	Basic concept of Design of FIR Filters Designing using Window method, Frequency Sampling Techniques, Park-McClellan's method etc.
Module V	**Design IIR Digital Filters**
	Basic concept of Design of IIR Filters, Design analog filters like Butterworth, Chebyshev and Elliptic Approximations; Various techniques of conversion of analog filter into digital filters like Impulse Invariant, Derivatives, Bilinear transformation, Match Z-transform and its modifications., mapping of s-plane to z-plane, limitations.
Module V	**DSP Processor Fundamentals**
	DSP processor, Fundamentals, Basic architecture.

Text Books:	1. “Digital Signal Processing: Principles, Algorithms and Applications”,John G. Proakis and D.G. Manolakis, Prentice Hall, 1995 2. “Digital Signal Processing”, S. Salivahanan, A. Vallavaraj, Gnanapriya, McGraw Hill (2nd Edition), 2001.

Reference Books:	1. “Discrete Time Signal Processing”, A.V. Oppenheim and Schafer, Prentice Hall, 2009 2. ”Analog and Digital Signal Processing”, AAmbardar, Thomson Learning, second edition 3. “Theory and Application of Digital Signal Processing”, L.R. Rabiner and B. Gold, Prentice Hall, 1975. 4. “Introduction to Digital Signal Processing”, J.R. Johnson, Prentice Hall, 1989. 5. “Discrete Time Signal Processing: principles, algorithms, d applications”, E.C. Ifeachor and B.W. Jervis, Addison Wesley, 1993.

Programme Name	T.Y. B. Tech. (Electrical Engineering)	Semester – VI			
Course Code	R4EE3013S	L	T	P	Credit
Course Title	CONTROL SYSTEM – II	3	-	-	3

COURSE OUTCOMES:

Students should be able to:

1. Design passive as well as active compensators using root locus design techniques.
2. Design Lag, lead & Lag-lead compensators using frequency response techniques.
3. Design Controllers & Observers using State-space design techniques.
4. Analyse Digital Control Systems using z-transform

COURSE CONTENTS:

Module I	**Introduction to Design**
	Analysis & Design Objectives, An Outline of Control System Design
Module II	**Design via Root Locus Techniques**
	Transient Response Design via Gain Adjustment, Improving Steady State Error via Cascade Compensation, Improving Transient Response via Cascade Compensation, Improving Steady Sate and Transient Response. Introduction to various controllers and their steady state errors.
Module III	**Design via Frequency Response**
	Transient Response via Gain Adjustment, Lag Compensation, Lead Compensation, Lag- Lead Compensation.
Module IV	**Design via State Space**
	Controller Design, Controllability, Alternative Approaches to Controller Design, ObserverDesign, Observability, Alternative Approaches to Observer Design, Steady-State Error Design via Integral Control.
Module V	**Digital Control System**
	Introduction, The Z-Transform, Transfer Function, Block Diagram Reduction, Stability, Steady-State Errors. Introduction to Non Linear Control systems.

Text Books:	1. "Control System Engineering", Norman Nise, Fourth Edition. Wiley International Edition. 2. "Modern Control System Theory", M. Gopal, Wiley Eastern Ltd., NewDelhi.

Reference Books:	1. "Control Engineering: An introductory course", J. Wilkie, M. Johnson & R. Katebi, 1st edition,Palgrave

Programme Name	T.Y. B. Tech. (Electrical Engineering)	Semester – VI			
Course Code	**R4HM3002L**	**L**	**T**	**P**	**Credit**
Course Title	**PROFESSIONAL COMMUNICATION SKILLS**	1	-	2-	2

COURSE OBJECTIVE:

- To enable students to become effective communicators through gaining knowledge and skills in professional communication.
- To develop the communicative abilities of students making them industry- ready.

COURSE OUTCOME

Students will be able to:

1. Apply the principles and practices of business communication for communicating in a professional environment.
2. Design a technical document with correctness of language, appropriate vocabulary and style.
3. Display competence in oral and visual communication
4. Demonstrate capabilities for self -assessment and development

COURSE CONTENTS:

Module I	**Basics of Business Communication**
	a. Concept and meaning of communication b. Verbal and non-verbal communication **c.** barriers to the process of communication d. Channels of communication e. Role of communication in the age of information technology
Module II	**Technical Writing**
	a. Technical writing process b. Style and organization in technical writing c. objectivity, clarity, precision as defining features of technical communication d. Language and format of various types of business letters, reports; proposals, e-mails, minutes of meeting, research papers
Module III	**Self Development & Assessment**
	a. Time Management b. Perception & Attitude c. Personal Goal Setting d. Emotional Intelligence e. Team work f. Creativity

Module IV	**Spoken Communication**
	a. Public Speaking b. Group Discussion c. Presentation d. Interviews e. None verbal Communication **f.** Using Visual Aids
Module V	**Business Ethics & Etiquettes**
	a. Business & Corporate Ethics b. Social and Business Etiquettes c. Interview Etiquettes

Text Books:	1. "Business Communication", Hory Shankar Mukharjee,OUP 2. "Effective Technical Communication ", Asharaf Rizvi, The McGraw Hill 3. "Business Communication" , Meenakshi Raman, Prakash Singh,OUP

Reference Books:	**1.** " Basic Managerial Skills for All", E.H. McGrath, PHI Learning Pvt Ltd **2.** "Professional Ethics", R. Subramanian,OUP **3.** *https://learnenglish.britishcouncil.org/en/english-grammar*

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Programme Name	T.Y. B. Tech. (Electrical Engineering)	Semester – VI			
Course Code	R4EE3011P	L	T	P	Credit
Course Title	ELECTRIC DRIVES LAB	0	0	0	1

COURSE OUTCOMES:

Students should be able to:

1. Select the appropriate electric motor and drive for an application
2. Employ various techniques for Induction motor control
3. Propose appropriate method of control for a DC machine and Synchronous machine
4. Employ and justify use of special machines for various applications.

LIST OF EXPERIMENTS

1. To perform rheostatic braking on three phase Induction Motor.
2. To perform rheostatic braking on D.C. Motor.
3. To perform plugging on three phase Induction Motor.
4. To perform plugging on D.C. Motor
5. To perform regenerative braking on three phase Induction Motor.
6. To perform retardation test on D.C. Motor to find out its Moment of inertia.
7. To study the starting and running characteristics of converter fed DC traction motor
8. To study the performance of VSI fed three-phase induction motor using PWM technique.
9. To control the speed of a three phase slip ring Induction motor using rotor impedance control.
10. To study the performance & control of a Stepper motor.
11. To Study the Performance of a permanent magnet Brushless dc motor drive.
12. To study the control & performance Characteristics of switched Reluctance motor.
13. To study vector control of 3 phase induction motor.

Programme Name	T.Y. B. Tech. (Electrical Engineering)	Semester – VI			
Course Code	R4EE3012P	L	T	P	Credit
Course Title	DIGITAL SIGNAL PROCESSING LAB	0	2	0	1

COURSE OUTCOMES:

Students should be able to:

1. Obtain frequency response and Impulse response. Also find DFT and inverse DFT directly and using FFT
2. Identify the different types Linear phase FIR filters and obtain the locations of zeros and magnitude response.
3. Design Linear phase FIR filters using Windowing and Frequency Sampling Techniques.
4. Design analog Butterworth and Chebyshev filters and convert to digital filters using various techniques.

LIST OF EXPERIMENTS

1. Construct signals in digital domain.
2. Perform linear and circular convolution to obtain output.
3. Obtain frequency domain representation of periodic signals using Fourier Series.
4. Obtain frequency domain representation of aperiodic signals using Fourier Transform.
5. Obtain impulse response from Frequency response.
6. Perform DFT/IDFT
7. Perform DIT-FFT and DIF-FFT and Inverse DIT-FFT and DIF-FFT /IDFT
8. Obtain frequency response of different Linear phase FIR filter.
9. Design a linear phase FIR filter using windowing techniques.
10. Design a linear phase FIR filter using frequency sampling techniques.
11. Design an analog IIR filter using Butter worth response and convert it into Digital IIR Filter by any of the techniques like impulse invariant technique, Bilinear transformation
12. Design an analog IIR filter using Chebyshev response and convert it into Digital IIR Filter by any of the techniques like impulse invariant technique, Bilinear transformation

PROGRAM ELECTIVE 1

Programme Name	T.Y. B. Tech. (Electrical Engineering)	Semester - VI			
Course Code	R4EE3101T	L	T	P	Credit
Course Title	RENEWABLE ENERGY SOURCES (ELECTIVE-I)	3	-	-	3

COURSE OUTCOMES

Students should be able to:

1. Analyze solar radiation patterns and the various technologies for harnessing solar energy.
2. Design solar PV panels and associated systems.
3. Calculate generation of biomass, wind and geothermal energy and factors affecting it.
4. Demonstrate awareness of impact of renewable sources in electrical system design and smart grid.

COURSE CONTENTS:

Module I	Solar cell technology
	Solar Spectrum, Extraterrestrial radiation, Radiation on the earth surface, Global, diffuse solar radiation, Solar radiation at a given location, Daily radiation pattern, Annual variation in solar radiation, Optimal tilt for solar equipment, Monthly averaged global radiation at optimal tilt, Flat plate collectors, heat transfer processes, short term and long term collector performance, solar concentrators-design, analysis and performance evaluation. Si Wafer based solar cell technology: Development of commercial Si solar cells, high efficiency Si solar cells and other types of solar cell technologies. Thin Film Solar Cell Technologies: advantages, materials, common features, types of thin film cell technologies.
Module II	**Wind energy**
	Power plant consisting of wind power technology, power conversion, AC power conversion and connectivity to the grid using on line and off line inverters. Understanding of grid codes. Wind flow, Motion of wind, Vertical wind speed variation, Distribution of wind speeds, Power in the wind, Conversion of wind power, Site selection considerations, Wind turbines.
Module III	**System design for solar PV**
	Power plant consisting of solar cell technology, DC power conversion, DC AC power conversion and connectivity to the grid using on line and off line inverters. Understanding of grid codes.
Module IV	**System design of wind energy**
	Various components for typical wind mill, Ratings of components used for wind generation, Environmental survey, Parameter estimation for commissioning of wind power station, Costing for wind power plant.
Module V	**Storage devices**
	Need for energy storage, conventional systems for storage, modern storage devices like fuel cell, ultra capacitors and their ratings, Modern battery

	technologies and their applications
Module VI	**Integration of renewable and financial estimates**
	Impact of renewable energy sources in electrical system design, concept of green building, grid connected and stand alone renewable energy systems, challenges in grid integration of renewable sources of energy, introduction to smart grid, costing and payback period.
Text Books:	1. "Renewable Energy Systems", Kaltschmitt, M.; Themelis, N.J.; Bronicki, L.Y.; Söder, L.; Vega, L.A. (Eds.) 3 volumes, 2013, XXVI, 1898 p. 2. "Introduction to Renewable Energy", Vaughn Nelson, West Texas A&M University, Canyon, USA Published: April 25, 2011 by CRC Press
Reference Books	1."Solar Energy - Principles of Thermal Collection and Storage",S. P. Sukhatme, Second Edition, Tata McGraw-Hil, New Delhi, 1996. 2. "Principles of Solar Engineering", Y. Goswami, F. Kreith and J. F. Kreider, Taylor and Francis, Philadelphia, 2000. 3. "Non conventional energy sources"B H Khan TataMc-Graw Hills Publication

Programme Name	T.Y. B. Tech. (Electrical Engineering)	Semester - VI			
Course Code	R4EE3102T	L	T	P	Credit
Course Title	INTERNET OF THINGS (ELECTIVE – I)	3	0	0	3

COURSE OUTCOMES:

Students will be able to

1. Apply principles of IoT in global context.
2. Use Devices, Gateways and Data Management in IoT.
3. Build state of the art architecture in IoT.
4. Design small applications of IoT in Industrial and Commercial Building Automation

Module I	**Introduction to IoT**
	Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs
Module II	**IoT& M2M**
	Machine to Machine, Difference between IoT and M2M, Software define Network
Module III	**Network & Communication aspects**
	Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination
Module IV	**IoT Applications for Value Creations**
	Introduction, IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Four Aspects in your Business to Master IoT, Value Creation from Big Data and Serialization, IoT for Retailing Industry, IoT For Oil and Gas Industry, Opinions on IoT Application and Value for Industry, Home Management, eHealth.
Module V	**Developing IoTs**
	Introduction to Python, Introduction to different IoT tools, Developing applications through IoT tools, Developing sensor based application through embedded system platform, Implementing IoT concepts with python
Module VI	**Internet of Things Privacy, Security and Governance**
	Design challenges, Development challenges, Security challenges, Other challenges, Introduction, Overview of Governance, Privacy and Security Issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach. Data Aggregation for the IoT in Smart Cities, Security

Text Books	1. “Internet of Things: A Hands-On Approach”, by Vijay Madisetti, Arshdeep Bahga 2. “Rethinking the Internet of Things: A Scalable Approach to Connecting

	Everything", by Francis daCosta, 1 st Edition, Apress Publications, 2013

Reference Books	1."Fundamentals of Wireless Sensor Networks: Theory and Practice", by Waltenegus Dargie, Christian Poellabauer

Programme Name	T.Y. B. Tech. (Electrical Engineering)	Semester -VI			
Course Code	R4EE3103T	L	T	P	Credit
Course Title	BASICS OF COMMUNICATION SYSTEM– (ELECTIVE- I)	3	-	-	3

COURSE OUTCOMES:

Students should be able to

1. Analyse the need of communication Systems.
2. Demonstrate and apply the techniques to reduce noise and interference in communication system
3. Differentiate Analogue and Digital Communication System
4. Describe various modulation techniques used in Analog and Digital communication system.
5. Describe the Modern communication network used in wired and wireless system

COURSE CONTENTS:

Module I	**Basics of Communication System**
	Elements of a communication system, Types of signals, Block diagram, electromagnetic spectrum, modulation and demodulation, noise in communication system, types of noise, Signal-to-Noise ratio, noise factor and noise figure signal bandwidth and power, types of communication channels .
Module II	**Principle of Analog Communication System**
	Amplitude Modulation: Modulation and Demodulation Basic concept, signal representation, Spectrum, waveforms, modulation index, bandwidth, voltage distribution, and power calculation **Amplitude demodulation techniques**: Radio receivers Receiver characteristics, TRF and super heterodyne receivers, AM detectors.Diode detector, practical diode detector, and square law Detector DSBFC: Principles, modulating circuits, low level and high level transmitters DSB suppressed carrier:- Multiplier modulator, nonlinear modulator, and switching Modulator, **Single Side Band (SSB):-**Principle, filter method, phase shift method and third method, independent sideband (ISB) and Vestigial Side Band (VSB) principles and transmitters.
Module III	**Phase angle and frequency modulation**
	Frequency Modulation (FM): Basic concept, mathematical analysis, frequency spectrum of FM wave, sensitivity, phase deviation and modulation index, frequency deviation and

	percent modulated waves, bandwidth requirement of angle modulated waves, deviation ratio, narrow band FM, and wide band FM. Modulator circuits: Varactor diode modulator, FET reactance modulator. Direct FM transmitter, indirect FM Transmitter, noise triangle in FM, pre-emphasis and de-emphasis. Phase Modulation (PM): Principle and working of transistor direct PM modulator, relationship and comparison between FM and PM. FM demodulation: Balance slope detector, Foster-Seely discriminator, ratio detector, comparison between FM demodulators, comparison between AM, FM and PM. Applications of FM and PM
Module IV	**Principle of Digital Communication System**
	Sampling theorem for Low-pass and Band-pass signals, proof with spectrum, Aliasing. Sampling Techniques- Principle, generation, demodulation, spectrum. Quantization, Quantization error, Non-uniform quantizing Encoding. PCM, DPCM- transmission system, band width. ASK, PSK, and QPSK system. **Optical fibre communication**: Type of fibres, optical source, detectors, basic principle of optical communication system.

Text books	1. "Electronic Communications", by Dennis Roddy and John Coolen, PrenticeHall of India, 3rd Ed. 1992. 2. "Electronics Communications System", by Kennedy Davis, Fourth Edition, Mcgraw Hill Publication 3. "Principles of communication systems", by Taub & Schlling, Tata McGraw Hill, Third edition 2007.

Reference Books:	1. "Digital Communication", by John C. Proakis, McGraw Hill International, 1995 2. "Data and computer communication", by William Stallings, Pearson Education, Tenth Edition, 2013. 3. "Communication Systems", by Haykin S John, Wiley & sons, Fifth Ed 2009.

Programme Name	TY ,B.Tech Electrical Engineering	Semester - VI			
Course Code	R4EE3104T	L	T	P	Credit
Course Title	BIOMEDICAL INSTRUMENTATION – (ELECTIVE- I)	3	-	-	3

COURSE OUTCOMES:

Students should be able to

1. Integrate the information about generation of bio potentials
2. Apply electronic engineering principles for data acquisition and measurement of bio potentials
3. Analyze the working and design aspects of the instruments used in medical field.
4. Evaluate the necessity of prosthetic devices and develop block schematic.

COURSE CONTENTS:

Module I	Fundamentals of Medical Instrumentation
	Anatomy and Physiology, Physiological Systems of the Body, Problems in measuring the Physiological variables, Components of Medical Instrument.
Module II	**Bioelectric Signals and Electrodes, Transducers**
	Origin of Bioelectric signals, Resting and Action Potentials, Depolarization and Repolarization, Propagation of Action Potentials. Electrode Theory, Recording Electrodes, Silver-Silver Chloride Electrodes, Microelectrodes. Transducer Principle, Classification of Transducers, various Transducers for the measurement of Physiological Events, Amplifiers and Signal Processing.
Module III	**The Cardiovascular System and Measurements**
	The Heart and Cardiovascular System: Heart Sounds and their measurements with Phonocardiograph, Stethoscope etc., Phonocardiogram. Blood Flow: Characteristics of Blood Flow, Measurement of Blood flow and Cardiac output with Magnetic Blood Flow meter, Ultrasonic Blood Flow Meter & Radio Graphic Method. Blood Pressure: Measurement of Blood Pressure with Indirect and Direct methods, Sphygmomanometry, Programmed Electro sphygmomanometry, Digital Blood Pressure meter, Impedance Plethysmography.
Module IV	**Generation & Recording of Bio Electrical Activities**
	Electrocardiogram: ECG Electrode Placement- "Bipolar Limb Lead Configuration by Einthoven, Unipolar Limb Leads (Wilson leads), Augmented Unipolar Limb Leads, Precordial and Marriott Leads", ECG Recorders. Electromyogram: EMG System, Electrodes used and their placement, Latency, Applications. Electro Encephalogram: EEG Electrodes and their placement-'Anterior-Posterior' and 'Lateral' measurements, Recording Modes of EEG, Applications of EEG. Electro Retinogram:

	Human Eye System, ERG Recording techniques, Standards of ERG, Applications of ERG. Electro Oculogram: EOG basics, Recording methods, patient preparation, Arden Index, Diagnostic Utility of EOG.
Module V	**Measurements in the Respiratory System**
	Introduction, Physiology of the Respiratory System, Lung Volumes/Capacities, Instrumentation for measuring the Mechanics of Breathing- Kymograph, Spiro meter etc.
Module VI	**Prosthesis & Therapeutic Equipment**
	Introduction, Types of Prosthetic Devices, Application and working principle of various prosthetic devices eg. Myoelectric Control System for paralyzed arm, Audiometry and Hearing Aids. Dialysis: Introduction, Function of the Kidneys, Artificial Kidney, Dialyzers, Membranes for Dialysis, Haemodialysis, Peritoneal Dialysis Introduction, High Frequency Heat Therapy, Short-wave Diathermy, Microwave Diathermy, Ultrasonic Therapy Unit., Endoscopy, Gastroscope, Bronchoscope, Sigmoidoscope, Laproscope, Pacemakers and Defibrillators.
Module VII	**Medical Imaging Systems**
	Introduction, X-ray Machines and Digital Radiography, Computed Tomography, CT Scanners, Ultrasonic Imaging Systems, MRI & PET Scan, Thermal Imaging Systems.
Module VIII	**Patient Care& Safety**
	The elements of Intensive-Care Monitoring, Patient-Monitoring Equipment – Different types, The Organization of Hospital for Patient-Care Monitoring. Physiological effects of Electric Current, Shock Hazards and Leakage Currents, precautions to minimize Electric Shock Hazards and Leakage Current, Methods of Accident Prevention, Safety codes for electro medical equipment.

Text Books:	1. "Handbook of Biomedical Instrumentation", R.S. Khandpur, 3rd Edition, Tata McGraw Hill Education Private Limited, 2014. 2. "Biomedical Instrumentation and Measurements", Leslie Cromwell, Fred J. Weibell and A. Erich, Pfeiffer, 2nd Edition , Prentice Hall of India publication, 2011.

Reference Books:	1. "Introduction to Biomedical Equipment Technology", Joseph J. Carr and John M. Brown4th Edition, Pearson Education, 2011. 2. "Biophysical Measurements", P. Strong, 2nd Edition, Measurement Concepts Publication, 1970.

Programme Name	T.Y. B. Tech. (Electrical Engineering)	Semester - VI			
Course Code	R4EE3101P	L	T	P	Credit
Course Title	RENEWABLE ENERGY SOURCES LAB (ELECTIVE – I)	-	-	2	1

COURSE OUTCOMES:

Students should be able to:

1. Analyze the different sources of renewable energy and the energy scenario in India.
2. Analyze solar radiation patterns and the various technologies for harnessing solar energy.
3. Design solar PV panels and associated systems.
4. Calculate generation of biomass, wind and geothermal energy and factors affecting it.
5. Demonstrate awareness of impact of renewable sources in electrical system design and smart grid.

LIST OF EXPERIMENTS:

1 Introduction to MATLAB Simlink.

2 Design the equivalent circuit of a PV cell.

3 Design solar panel using series-parallel connection of solar cell.

4 Design model for VI characteristics of PV cell.

5 Design boost converter used in DC AC conversion.

6 Design inverter for solar power plant.

7 Design Solar PV power plant interconnected to grid.

8 Study wind power plant in MATLAB.

9 Study of Smart grid

Case study on

a Indian Energy Conservation Act 2001.

b Worldwide energy production

c Energy scenario of India and current situation.

Programme Name	T.Y. B. Tech. (Electrical Engineering)	Semester -VI			
Course Code	R4EE3102P	L	T	P	Credit
Course Title	INTERNET OF THINGS LAB (ELECTIVE – I)	0	0	2	1

COURSE OUTCOMES:

Students will be able to

1. Apply principles of IoT in global context.
2. Use of Devices, Gateways and Data Management in IoT.
3. Building state of the art architecture in IoT.
4. Design small applications of IoT in Industrial and Commercial Building Automation

List of Experiments:

1. Introduction and study of Eclipse IoT Project.
2. List and summarize few Eclipse IoT Projects.
3. Sketch the architecture of IoT Toolkit and explain each entity in brief.
4. Demonstrate a smart object API gateway service reference implementation in IoT toolkit.
5. Write and explain working of an HTTP- to-CoAP semantic mapping proxy in IoT toolkit.
6. Use of gateway-as-a-service deployment in IoT toolkit.
7. Study of application framework and embedded software agents for IoT toolkit.
8. Working of Raspberry Pi.

Programme Name	TY B.Tech Electrical Engineering	Semester - VI			
Course Code	**R4EE3104P**	**L**	**T**	**P**	**Credit**
Course Title	**BIOMEDICAL INSTRUMENTATION LAB – (ELECTIVE I)**	**-**	**-**	2	1

COURSE OUTCOMES:

Students should be able to:

1. Integrate the information about generation of bio potentials
2. Apply electronic engineering principles for data acquisition and measurement of bio potentials
3. Analyze the working and design aspects of the instruments used in medical field.
4. Evaluate the necessity of prosthetic devices and develop block schematic.

LIST OF EXPERIMENTS

1. Analyze the salient traits of the following medical instruments and demonstrate the related experimentation :
    a. CG System
    b. BP Monitor
    c. Heart Rate Monitor
    d. Respiration Rate Monitor
    e. EMG System
    f. EEG System
    g. Phonocardiograph System
2. Design and demonstration of ECG amplifier system
3. Design and demonstration of signal conditioning system for biopotentials
4. Develop algorithms for biopotentials processing (using MATLAB/ LabVIEW, etc)

OPEN ELECTIVE

Programme Name	TY ,B.Tech Electrical Engineering	Semester - V			
Course Code	R4EE3612T	L	T	P	Credit
Course Title	ELECTRIC VEHICLES (OPEN ELECTIVE- I)	3	-	-	3

COURSE OUTCOMES:

Students should be able to

1. Distinguish different types of Drive trains used in Electric Vehicle
2. Analyze different types of energy storage devices used in Electric Vehicles
3. Provide the correct sizing of various components in a Drive system
4. Demonstrate energy management strategies required for an electric vehicle

COURSE CONTENTS:

Module I	**Introduction**
	Specifications and ratings of any vehicle. Vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance. Conventional Hybrid and Electric vehicles
Module II	**Vehicle drive System**
	Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drives-trains on energy supplies. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive train topologies, power flow control in hybrid drive-train topologies, Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, Switch Reluctance Motor drives, drive system efficiency.
Module III	**Energy Storage**
	Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery Parameters, Battery Charging, Battery Modelling and Analysis, Fuel Cells – Principle, Types, Analysis of Fuel Cell in EV, Super Capacitor: Principle, Integration of different energy storage devices.
Module IV	**Sizing the drive system**
	Series Hybrid Electric Drive Train - Operation Patterns, Control Strategies, Sizing of major components , Parallel Hybrid Electric Drive Train - Control Strategies, Design of Drive Train Parameters : Engine Power Capacity, Electric Motor Drive Power Capacity, Energy Storage Design
Module V	**Fundamentals of Regenerative Braking**

	Energy Consumption in Braking, Principle of regeneration in vehicles, Brake System of EVs and HEVs, Antilock Brake System (ABS),

Text Books:	1. “Electric Vehicle Technology Explained ”,Larminie and Lowry, Wiley 2.“Modern Electric, Hybrid Electric & Fuel Cell Vehicles”,Mehrdad Ehsani CRC Press, 2005 3. Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Hussein, CRC Press, 2003.

Reference Books:	1. “Power Electronics - Circuits, Devices and Applications”, H. Rashid, Pearson Education. 2. “Generalized Theory of Electric Machines”,P. S. Bhimbra, Khanna publication.