BIJU PATNAIK UNIVERSITY OF TECHNOLOGY, ODISHA
ROURKELA

Tentative Curriculum and Syllabus

of

B.Tech (*ECE / ETC)* from the Batch 2018-19

Semester (4th)

Fourth Semester							
Theory							
Sl No	**Category**	**Course Code**	**Course Title**	**L-T-P**	**Credit**	**University Marks**	**Internal Evaluation**
1	PC	REC4C001	Electromagnetic Theory	3-0-0	3	100	50
2	PC	REC4C002	Digital Systems Design	3-0-0	3	100	50
3	HS	REN4E001 / ROB4E002	Engineering Economics / Organisational Behaviour	3-0-0	3	100	50
4	PC	REC4C003	Network Theory	3-0-0	3	100	50
5	PE	REC4D001	Semiconductor Devices	3-0-0	3	100	50
		REC4D002	Power Electronics				
		REC4D003	Sensors and Transducers				
6	OE	REC4G001	Probability Theory And Stochastic Process	3-0-0	3	100	50
		REC4G002	Data Structure				
		REC4G003	Brain Control Interface				
6	MC*	RCN4F001	Constitution of India	3-0-0	0	__	100 (Pass mark is 37)
Total Credit (Theory)					**18**		
Total Marks						**600**	**300**
Practical							
1	PC	REC4C201	Electronic Device Laboratory	0-0-3	2		100
2	PC	REC4C202	Digital System Design Laboratory	0-0-3	2		100
3	PC	REC4C203	Network Theory Laboratory	0-0-3	2		100
Total Credit (Practical)					**6**		
Total Semester Credit					**24**		
Total Marks							**300**

***Mandatory Non-Credit Courses (MC) result will be reflected with Pass (P) / Fail (F) grade. Thus the grade obtained will not be affecting the grade point average. However it shall appear on the grade sheet as per AICTE rule.**

4th Semester	**REC4C001**	**Electromagnetic Theory**	**L-T-P 3-0-0**	**3 CREDITS**

Module-I (10 Hours)

1. Cartesian, Cylindrical and Spherical Coordinate Systems; Scalar and Vector Fields; Line, Surface and Volume Integrals.
2. Coulomb's Law; The Electric Field Intensity; Electric Flux Density and Electric Flux; Gauss's Law; Divergence of Electric Flux Density: Point Form of Gauss's Law; The Divergence Theorem; The Potential Gradient; Energy Density; Poisson's and Laplace's Equations.
3. Ampere's Magnetic Circuital Law and its Applications; Curl of H; Stokes' Theorem; Divergence of B; Energy Stored in the Magnetic Field.

Module-II (9 Hours)

1. The Continuity Equation; Faraday's Law of Electromagnetic Induction; Conduction Current: Point Form of Ohm's Law, Convection Current; The Displacement Current;
2. Maxwell's Equations in Differential Form; Maxwell's Equations in Integral Form; Maxwell's Equations for Sinusoidal Variation of Fields with Time; Boundary Conditions; The Retarded Potential; The Poynting Vector; Poynting Vector for Fields Varying Sinusoid ally with Time.

Module-III (10 Hours)

1. Solution of the One-Dimensional Wave Equation; Solution of Wave Equation for Sinusoid ally Time-Varying Fields; Polarization of Uniform Plane Waves; Fields on the Surface of a Perfect Conductor; Reflection of a Uniform Plane Wave Incident Normally on a Perfect Conductor and at the Interface of Two Dielectric Regions; The Standing Wave Ratio; Oblique Incidence of a Plane Wave at the Boundary between Two Regions; Oblique Incidence of a Plane Wave on a Flat Perfect Conductor and at the Boundary between Two Perfect Dielectric Regions.

Module-IV (8 Hours)

1. Types of Two-Conductor Transmission Lines; Circuit Model of a Uniform Two-Conductor Transmission Line; The Uniform Ideal Transmission Line; Wave Reflection at a Discontinuity in an Ideal Transmission Line; Matching of Transmission Lines with Load.

Module-V (8 Hours)

1. Formulation of Field Equations; Wave Types; the Parallel-Plate Waveguide; the Rectangular Waveguide. TE and TM modes of propagation in a Rectangular waveguide
2. Radiation Properties of a Current Element; Radiation Properties of a Half-Wave Dipole; Yagi–Uda Antenna; the Parabolic Reflector Antenna.

Books:

- Principles of Electromagnetic, S.C. Mahapatra, S. Mahapatra, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 2nd Edition, 2015.
- Principles of Electromagnetics**,**Mathew N.O. Sadiku & S.V. Kulkarni., Oxford University Press, 6th edition,2009.
- Electromagnetic Waves and Radiating Systems, E.C. Jordan and K.G. Balmain, Pearson Education, New Delhi, 2nd Edition,2009.
- Engineering Electromagnetic Essentials, B. N. Basu, University Press.
- Engineering Electromagnetic Essentials, Nathan Ida, Springer
- Engineering Electromagnetic, William H. Hayt & J. Buck, Tata McGraw Hill Publishing
- Company Ltd., New Delhi, 7th Edition,2006
- Electromagnetic, Joseph A. Edminister, adapted by Vishnu Priye, Tata McGraw Hill
- Publishing Company Ltd., New Delhi, 2nd Edition.
- Fundamentals of Electromagnetic for Engineering, First Impression, N. N. Rao, Pearson Education, New Delhi, 2009.
- Fields and Waves in Communication Electronics, Simon Ramo, Wiley Publication, 3ed, 2007.
- Electromagnetic Field Theory, Bhag Singh Guru, Cambridge Publication,3rd Edition, 2011.

4th Semester	**REC4C201**	**Electronic Device Laboratory**	**L-T-P 0-0-3**	**2 CREDITS**

Laboratory Experiments: (Minimum 8 experiments)

1. *Wave-propagation in conductors and dielectrics using HFSS/CST/MATLAB.*
2. *Current and charge flow of electromagnetic wave in a rectangular waveguide using HFSS/CST/MATLAB.*
3. *Uniform Plane Wave Propagation in an Arbitrary Direction*
4. *Transverse Electric Waves in a Parallel-Plate Waveguide*
5. *To calculate Dispersion and Group Velocity*
6. *To design Rectangular Waveguide*
7. *To design cavity Resonator*
8. *To show the modes of a rectangular waveguide using HFSS.*
9. *To show azimuth and elevation patterns*
10. *To show the input and output impedence*
11. *SWR measurements of rectangular waveguide*
12. *Reflection of plane waves*

*HFSS – High Frequency Structure Simulator
*CST- Computer Simulation Tool

4th Semester	**REC4C002**	**Digital Systems Design**	**L-T-P 3-0-0**	**3 CREDITS**

MODULE – I (10 Hours)

Revision of Number System: Introduction to various number systems and their Conversion. Arithmetic Operation using 1's and 2`s Compliments, Signed Binary and Floating Point Number Representation Introduction to Binary codes and their applications.

Revision Boolean Algebra and Logic Gates: Boolean algebra and identities, Complete Logic set, logic gates and truth tables. Universal logic gates, Algebraic Reductionand realization using logic gates

MODULE – II (11 Hours)

Combinational Logic Design: Specifying the Problem, Canonical Logic Forms, Extracting Canonical Forms, EX-OR Equivalence Operations, Logic Array, K-Maps: Two, Three and Four variable K-maps, NAND and NOR Logic Implementations.

Logic Components: Concept of Digital Components, Binary Adders, Subtraction and Multiplication, An Equality Detector and comparator, Line Decoder, encoders, Multiplexers and De-multiplexers.

MODULE – III (8 Hours)

Synchronous Sequential logic Design: sequential circuits, storage elements: Latches (SR, D), Storage elements: Flip-Flops inclusion of Master-Slave, characteristics equation and state diagram of each FFs and Conversion of Flip-Flops. Analysis of Clocked Sequential circuits and Mealy and Moore Models of Finite State Machines**.**

MODULE – IV (9 Hours)

Binary Counters : Introduction, Principle and design of synchronous and asynchronous counters, Design of MOD-N counters, Ring counters. Decade counters, State Diagram of binary counters.
Shift resistors: Principle of 4-bit shift resistors. Shifting principle, Timing Diagram, SISO, SIPO, PISO and PIPO resistors.

Memory and Programmable Logic: Types of Memories, Memory Decoding, error detection and correction), RAM and ROMs. Programmable Logic Array, Programmable Array Logic, Sequential Programmable Devices.

MODULE – V (7 Hours)

IC Logic Families: Properties DTL, RTL, TTL, I^2L and CMOS and its gate level implementation. A/D converters and D/A converters**.**

College Level (20%)
Basic hardware description language: Introduction to Verilog/VHDL programming language, Verilog/VHDL program of logic gates, adders, Substractors, Multiplexers, Comparators, Decoders flip-flops, counters, Shift resistors.

Books:

- Digital Design, 3rd Edition, Moris M. Mano, Pearson Education.
- Fundamentals of digital circuits, 8th edition, A. Anand Kumar, PHI
- Digital Fundamentals, 5th Edition, T.L. Floyd and R.P. Jain, Pearson Education, New Delhi.
- Digital Electronics, G. K. Kharate, Oxford University Press.
- Digital Systems – Principles and Applications, 10th Edition, Ronald J. Tocci, Neal S. Widemer and Gregory L. Moss, Pearson Education.
- A First Course in Digital System Design: An Integrated Approach, India Edition, John P. Uyemura, PWS Publishing Company, a division of Thomson Learning Inc.
- Digital Systems – Principles and Applications, 10th Edition, Ronald J. Tocci, Neal S. Widemer and Gregory L. Moss, Pearson Education.

4th Semester	**REC4C202**	**Digital System Design Laboratory**	**L-T-P 0-0-3**	**2 CREDITS**

List of Experiments

(At least 10 experiments should be done, Experiment No. 1 and 2 are compulsory and out of the balance 8 experiments at least 3 experiments has to be implemented through both Verilog /VHDL and hardware implementation as per choice of the student totaling to 6 and the rest 2 can be either through Verilog /VHDL or hardware implementation.)

1. Digital Logic Gates: Investigate logic behavior of AND, OR, NAND, NOR, EX-OR, EX-NOR, Invert and Buffer gates, use of Universal NANDGate.
2. Gate-level minimization: Two level and multi level implementation of Booleanfunctions.
3. Combinational Circuits: design, assemble and test: adders and subtractors, code converters, gray code to binary and 7 segmentdisplay.
4. Design, implement and test a given design example with (i) NAND Gates only (ii) NOR Gates only and (iii) using minimum number ofGates.
5. Design with multiplexers andde-multiplexers.
6. Flip-Flop: assemble, test and investigate operation of SR, D & J-Kflip-flops.
7. Shift Registers: Design and investigate the operation of all types of shift registers with parallelload.
8. Counters: Design, assemble and test various ripple and synchronous counters - decimal counter, Binary counter with parallelload.
9. Memory Unit: Investigate the behaviour of RAM unit and its storage capacity – 16 X 4 RAM: testing, simulating and memoryexpansion.
10. Clock-pulse generator: design, implement andtest.
11. Parallel adder and accumulator: design, implement andtest.
12. Binary Multiplier: design and implement a circuit that multiplies 4-bit unsigned numbers to produce a 8-bitproduct.
13. Verilog/VHDL simulation and implementation of Experiments listed at Sl. No. 3 to 12

4th Semester	REN4E001	ENGINEERING ECONOMICS	L-T-P 3-0-0	3 CREDITS

Module - I (08 hours)

Engineering Economics- Nature, Scope, Basic problems of an economy, Micro Economics and Macro Economics.
Demand - Meaning of demand, Demand function, Law of Demand and its exceptions, Determinants of demand, Elasticity of demand & its measurement (Simple numerical problems to be solved), Demand Forecasting – Meaning
Supply-Meaning of supply, Law of supply and its exception, Determinants of supply, Elasticity of supply, Determination of market equilibrium (Simple numerical problems to be solved).

Module - II (08 hours)

Production - Production function, Laws of returns: Law of variable proportion, Law of returns to scale
Cost and Revenue Concepts - Total Costs, Fixed cost, Variable cost, Total revenue, Average revenue and Marginal revenue, Cost-Output Relationships in the Short Run, and Cost-Output Relationships in the Long Run, Analysis of cost minimization.

Module III (08 hours)

Market - Basic understanding of different market structures, Determination of equilibrium price under perfect competition (Simple numerical problems to be solved), Break Even Analysis-linear approach (Simple numerical problems to be solved).

Module - IV (12 hours)

Time Value of Money- Interest - Simple and compound, nominal and effective rate of interest, Cash flow diagrams, Principles of economic equivalence.
Evaluation of Engineering Projects-Present worth method, Future worth method, Annual worth method, Internal rate of return method, Cost benefit analysis for public projects.
Depreciation- Depreciation of capital assert, Causes of depreciation, Methods of calculating depreciation - Straight line method, Declining balance method, SOYD method, After tax comparison of project.

Module –V (06 Hours)

Inflation-Meaning of inflation, types, causes, measures to control inflation.
National Income-Definition, Concepts of national income, Method of measuring national income.
Banking -Commercial bank, Functions of commercial bank, Central bank, Functions of Central Bank.

Books:

1. Principles of Economics by Deviga Vengedasalam and Karaunagaran Madhavan, Oxford
2. Riggs, Bedworth and Randhwa, “Engineering Economics”, McGraw Hill Education India
3. C. S. Park, Contemporary Engineering Economics, 6th Edition, Pearson Education, 2015.
4. Engineering Economy by William G.Sullivan, Elin M.Wicks, C. Patric Koelling, Pearson
5. R.Paneer Seelvan, “ Engineering Economics”, PHI
6. Ahuja,H.L., “Principles of Micro Economics” , S.Chand & Company Ltd
7. Jhingan,M.L., “Macro Economic Theory”

8. Macro Economics by S.P.Gupta, TMH

Course Outcomes of Engineering Economics

At the end of the course the engineering graduates will be able to

1. **Remembering** : Define the basic concept of micro and macro economics, engineering economics and their application in engineering economy.
2. **Understanding** : Evaluate numerically the effects of changes in demand and supply on price determination of products and services.
3. **Analyze :** the macroeconomic environment and financial systems of the country and its impact on business, society and enterprise.
4. **Develop :** the ability to account for time value of money using engineering economy factors and formulas.
5. **Apply:** knowledge of mathematics, economics and engineering principles to solve engineering problems and to analyze decision alternatives in engineering projects considering upon depreciation, taxes and inflation.

4th Semester	ROB4E002	ORGANISATIONAL BEHAVIOUR	L-T-P 3-0-0	3 CREDITS

Objectives:

1. To develop an understanding of the behavior of individuals and groups inside organizations
2. To enhance skills in understanding and appreciating individuals, interpersonal, and group process for increased effectiveness both within and outside of organizations.
3. To develop theoretical and practical insights and problem-solving capabilities for effectively managing the organizational processes.

Module-I: **(06 Hrs.)**

Fundamentals of OB: Definition, scope and importance of OB, Relationship between OB and the individual, Evolution of OB, Theoretical framework (cognitive), behavioristic and social cognitive), Limitations of OB.

Module-II: **(12 Hrs.)**

Attitude: Importance of attitude in an organization, Right Attitude, Components of attitude, Relationship between behavior and attitude, Developing Emotional intelligence at the workplace, Job attitude, Barriers to changing attitudes.
Personality and values: Definition and importance of Personality for performance, The Myers-Briggs Type Indicator and The Big Five personality model, Significant personality traits suitable to the workplace (personality and job – fit theory), Personality Tests and their practical applications.
Perception: Meaning and concept of perception, Factors influencing perception, Selective perception, Attribution theory, Perceptual process, Social perception (stereotyping and halo effect).
Motivation: Definition & Concept of Motive & Motivation, The Content Theories of Motivation (Maslow's Need Hierarchy & Herzberg's Two Factor model Theory), The Process Theories (Vroom's expectancy Theory & Porter Lawler model), Contemporary Theories – Equity Theory of Work Motivation.

Module-III: **(10 Hrs.)**

Foundations of Group Behavior: The Meaning of Group & Group behavior & Group Dynamics, Types of Groups, The Five – Stage Model of Group Development.
Managing Teams: Why Work Teams, Work Teams in Organization, Developing Work Teams, Team Effectiveness & Team Building.
Leadership: Concept of Leadership, Styles of Leadership, Trait Approach Contingency Leadership Approach, Contemporary leadership, Meaning and significance of contemporary leadership, Concept of transformations leadership, Contemporary theories of leadership, Success stories of today's Global and Indian leaders.

Module-IV: **(08 Hrs.)**

Organizational Culture : Meaning & Definition of Organizational Culture, creating & Sustaining Organizational Culture, Types of Culture (Strong vs. Weak Culture, Soft Vs. Hard Culture & Formal vs. Informal Culture), Creating Positive Organizational Culture, Concept of Workplace Spirituality.

Module-V: **(09 Hrs.)**

Organizational Change: Meaning, Definition & Nature of Organizational Change, Types of Organizational Change, Forces that acts as stimulants to change.
Implementing Organizational Change : How to overcome the Resistance to Change, Approaches to managing Organizational Change, Kurt Lewin's-Three step model, Seven Stage model of Change & Kotter's Eight-Step plan for Implementing Change, Leading the Change Process, Facilitating Change, Dealing with Individual & Group Resistance, Intervention Strategies for Facilitating Organizational Change, Methods of Implementing Organizational Change, Developing a Learning Organization.

Books:

1. Understanding Organizational Behaviour, Parek, Oxford
2. Organizational Behaviour, Robbins, Judge, Sanghi, Pearson.
3. Organizational Behaviour, K. Awathappa,HPH.
4. Organizational Behaviour, VSP Rao, Excel
5. Introduction to Organizational Behaviour, Moorhead, Griffin, Cengage.
6. Organizational Behaviour, Hitt, Miller, Colella, Wiley

4th Semester	REC4C003	Network Theory	L-T-P 3-0-0	3 CREDITS

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- Apply network theorems for the analysis of electrical circuits.
- Obtain the transient and steady-state response of electrical circuits.
- Analyse circuits in the sinusoidal steady-state (single-phase and three-phase).
- Analyse two port circuit behavior.

Module-I: **(10 Hrs.)**

Network Theorems:Superposition theorem, Thevenin theorem, Norton theorem, Maximum power transfer theorem, Reciprocity theorem, Compensation theorem. Analysis with dependent current and voltage sources. Node and Mesh Analysis. Concept of duality and dual networks.

MODULE – II (09 Hrs.)

Solution of First and Second order networks: Solution of first and second order differential equations for Series and parallel R-L, R-C, R-L-C circuits, initial and final conditions in network elements, forced and free response, time constants, steady state and transient state response.

MODULE – III (09 Hrs.)

Sinusoidal steady state analysis: Representation of sine function as rotating phasor, phasor diagrams, impedances and admittances, AC circuit analysis, effective or RMS values, average power and complex power. Three-phase circuits. Mutual coupled circuits, Dot Convention in coupled circuits, Ideal Transformer.

MODULE – IV (08 Hrs.)

Electrical Circuit Analysis Using Laplace Transforms: Review of Laplace Transform, Analysis of electrical circuits using Laplace Transform for standard inputs, convolution integral, inverse Laplace transform, transformed network with initial conditions. Transfer function representation. Poles and Zeros. Frequency response (magnitude and phase plots), series and parallel resonances

MODULE – V (09 Hrs.)

Two Port Network and Network Functions: Two Port Networks, terminal pairs, relationship of two port variables, impedance parameters, admittance parameters, transmission parameters and hybrid parameters, interconnections of two port networks.

Books:

- M. E. Van Valkenburg, "Network Analysis", Prentice Hall, 2006.
- D. Roy Choudhury, "Networks and Systems", New Age International Publications, 1998.
- W. H. Hayt and J. E. Kemmerly, "Engineering Circuit Analysis", McGraw Hill Education, 2013.
- C. K. Alexander and M. N. O. Sadiku, "Electric Circuits", McGraw Hill Education, 2004.
- K. V. V. Murthy and M. S. Kamath, "Basic Circuit Analysis", Jaico Publishers, 1999.

- Network Synthesis – M E Van Valkenburg – Pearson Education.

- Network Analysis and Synthesis – Franklin F. Kuo – Wiley Student Edition.
- Linear Circuits Analysis and Synthesis – A Ramakalyan – Oxford University Press.
- Problems & Solutions in Electric Circuit Analysis – Sivananda & Deepa – Jaico Book.
- Theory and problem of electrical circuits, Schaum's Outline Series, TMH – Joseph A. Edminister, MahmoodMaqvi.
- Electric Circuits – David A.Bell – Oxford, 7th Edition, 2015.

4th Semester	**REC4C203**	**Network Theory Laboratory**	**L-T-P 0-0-3**	**2 CREDITS**

List of Experiments:
(At least 08 out of 10 experiments should be done)

1. Verification of Network Theorems using AC circuits. (Superposition, Thevenin, Norton, Maximum Power Transfer).
2. Study of DC and AC Transients for R-L, R-C & R-L-C circuits using storage oscilloscope.
3. Determination of circuit parameters: Open Circuit and Short Circuit parameters.
4. Determination of circuit parameters: Hybrid and Transmission parameters.
5. Frequency response of Low pass and High Pass Filters.
6. Frequency response of Band pass and Band Elimination Filters.
7. Determination of self inductance, mutual inductance and coupling coefficient of a single phase two winding transformer representing a coupled circuit.
8. Study of resonance in R-L-C series circuit using oscilloscope.
9. Study of resonance in R-L-C parallel circuit using oscilloscope.
10. Spectral analysis of a non-sinusoidal waveform.

4th Semester	REC4D001	Semiconductor Devices	L-T-P 3-0-0	3 CREDITS

MODULE-I (08 Hours)

Introduction to the quantum theory of solids: Formation of energy bands; the k-space diagram (two and three dimensional representation), conductors, semiconductors and insulators.

Electrons and Holes in semiconductors: Silicon crystal structure; Donors and acceptors in the band model; electron effective mass; Density of states; Thermal equilibrium; and Fermi-Dirac distribution function for electrons and holes; Fermi energy. Equilibrium distribution of electrons & holes: derivation of *n* and *p* from D(E) and f(E), Fermi level and carrier concentrations.

MODULE-I (09 Hours)

The *np* product and the intrinsic carrier concentration. General theory of *n* and *p;* Carrier concentrations at extremely high and low temperatures: complete ionization, partial ionization and freeze-out; Energy-band diagram and Fermi-level, Variation of E_F with doping concentration and temperature.

Motion and Recombination of Electrons and Holes: Carrier drift: Electron and hole mobilities; Mechanism of carrier scattering; Drift current and conductivity.

MODULE-III (10 Hours)

Motion and Recombination of Electrons and Holes (continued): Carrier diffusion: diffusion current, Total current density; relation between the energy diagram and potential, electric field; Einstein relationship between diffusion coefficient and mobility; Electron-hole recombination; Thermal generation.

PN Junction: Building blocks of the pn junction theory: Energy band diagram and depletion layer of a pn junction, Built-in potential; Depletion layer model: Field and potential in the depletion layer, depletion-layer width; Reverse-biased PN junction; Capacitance-voltage characteristics; Junction breakdown: peak electric field. Tunneling breakdown and avalanche breakdown; Carrier injection under forward bias-Quasi-equilibrium boundary condition; current continuity equation; Excess carriers in forward-biased pn junction; PN diode I-V characteristic, Charge storage.

MODULE-IV (08 Hours)

The Bipolar Transistor: Introduction, Modes of operation; Minority Carrier distribution, Collector current, Base current, current gain, Base width Modulation by collector current, Breakdown mechanism, Equivalent Circuit Models – Ebers -Moll Model.

MODULE-V (10 Hours)

Metal-Semiconductor Junction: Schottky Diodes: Built-in potential, Energy-band diagram, I-V characteristics, Comparison of the Schottky barrier diode and the pn-junction diode; Ohmic contacts: tunneling barrier, specific contact resistance**.**

MOS Capacitor: The MOS structure, Energy band diagrams, Flat-band condition and flat-band voltage, Surface accumulation, surface depletion, Threshold condition and threshold voltage, MOS C-V characteristics, Q_{inv} in MOSFET.

Books:

- Semiconductor Physics and Devices-Donald A. Neamen, Tata McGraw Hill Publishing Company Limited, New Delhi, 3rd Edition.
- Solid State Electronics Devices-Ben. G. Streetman and Sanjay Banarjee, Pearson Education, New Delhi, 6th Edition.
- Modern Semiconductor Devices for Integrated Circuits-Chenming Calvin Hu, Pearson Education/Prentice Hall, 2009.
- Physics of Semiconductor Devices-S.M. Sze and Kwok K. Ng, Wiley India Pvt. Limited, New Delhi, 3rd Edition.
- Physics of Semiconductor Devices-Dillip K. Roy, University Press (India) Pvt. Ltd., Hyderabad, 2nd Edition
- Semiconductor Physics and Devices- Fowler, Oxford University Press.
- Solid State Electronics Devices-D.K. Bhattacharya and Rajnish Sharma, Oxford University Press, New Delhi, 2nd Edition
- Fundamentals of Semiconductor Devices-M.K. Achuthan and K.N. Bhatt, Tata McGraw Hill Publishing Company Limited, New Delhi.

4th Semester	**REC4D002**	**Power Electronics**	**L-T-P 3-0-0**	**3 CREDITS**

Course Outcomes:

At the end of this course students will demonstrate the ability to

- Understand the differences between signal level and power level devices.
- Ability to analyze various single phase and three phase power converter circuits and understand their applications.
- Ability to analyze the operation of DC-DC choppers and their applications.
- Ability to analyze the operation of voltage source inverters and their applications.

Module-I: Power switching devices (8 Hours)

Diode, Thyristor, MOSFET, IGBT: I-V Characteristics; Firing circuit for thyristor; Voltage and current commutation of a thyristor; Gate drive circuits for MOSFET and IGBT.

Module-II: Thyristor rectifiers (9 Hours)

Single-phase half-wave and full-wave rectifiers, Single-phase full-bridge thyristor rectifier with R- load and highly inductive load; Three-phase full-bridge thyristor rectifier with R-load and highly inductive load; Input current wave shape and power factor.

Module-III: DC-DC buck converter (8 Hours)

Elementary chopper with an active switch and diode, concepts of duty ratio and average voltage, power circuit of a buck converter, analysis and waveforms at steady state, duty ratio control of output voltage.

Module-IV: DC-DC boost converter (8 Hours)

Power circuit of a boost converter, analysis and waveforms at steady state, relation between duty ratio and average output voltage.

Module-V: Single-phase voltage source inverter (12 Hours)

Power circuit of single-phase voltage source inverter, switch states and instantaneous output voltage, square wave operation of the inverter, concept of average voltage over a switching cycle, bipolar sinusoidal modulation and unipolar sinusoidal modulation, modulation index and output voltage

Power circuit of a three-phase voltage source inverter, switch states, instantaneous output voltages, average output voltages over a sub-cycle, three-phase sinusoidal modulation

Books:

- M. H. Rashid, "*Power electronics: circuits, devices, and applications*", Pearson Education India, 2009.
- N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.
- R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science & Business Media, 2007.
- L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.

4th Semester	REC4D003	Sensors and Transducers	L-T-P 3-0-0	3 CREDITS

MODULE–I (12 Hours)

Elements of a general measurement system; Static Characteristics: systematic characteristics, statistical characteristics, calibration; Dynamic characteristics of measurement systems: transfer functions of typical sensing elements, step and frequency response of first and second order elements, and dynamic error in measurement systems.

MODULE–II (10 Hours)

Sensing elements: Resistive sensing elements: potentiometers, Resistance Temperature Detector (RTD), thermistors, strain gages. Capacitive sensing elements: variable separation, area and dielectric; Inductive sensing elements: variable reluctance and LVDT displacement sensors.

MODULE–III (10 Hours)

Signal Conditioning Elements: Deflection bridges: design of resistive and reactivebridges, push-pull configuration for improvement of linearity and sensitivity Amplifiers: Operational amplifiers-ideal and non-ideal performances, inverting, non-inverting and differential amplifiers, instrumentation amplifier, filters. A.C. carrier systems, phase sensitive demodulators and its applications in instrumentation.

MODULE–IV (8 Hours)

Thermoelectric sensing elements: laws, thermocouple characteristics, installation problems, cold junction compensation. IC temperature sensor Elastic sensing elements: Bourdon tube, bellows, and diaphragms for pressure sensing, force and torque measurement.

MODULE–V (5 Hours)

Electromagnetic sensing elements: velocity sensors

Books:

- Principles of Measurement Systems, J.P. Bentley, Pearson Education, New Delhi, 3rd Edition 2007.
- Introduction to Measurement and Instrumentation, A.K. Ghosh , PHI Learning, 3rd Edition,2009.
- Transducers and Instrumentation, D.V.S. Murthy, PHI Learning, New Delhi, 2009.
- Measurement Systems Application and Design, E.O. Doeblin, McGraw-Hill, 4th Edition.
- Instrumentation for Engineering Measurements, J.W. Dally, W.F. Riley and K.G. McConnel , John Wiley, NY,2nd edition 2003.
- Industrial Instrumentation, T.R. Padmanabhan, Springer, London, 2000.

4th Semester	REC4G001	Probability Theory And Stochastic Process	L-T-P 3-0-0	3 CREDITS

MODULE – I (12 Hours)

Sets and set operations; Probability space; Conditional probability and Bayes theorem;Combinatorial probability and sampling models.

MODULE – II (12 Hours)

Discrete random variables, probability mass function, probability distribution function,example random variables and distributions; Continuous random variables, probability density function, probability distribution function, example distributions;

MODULE – III (8 hours)

Joint distributions, functions of one and two random variables, moments of randomvariables; Conditional distribution, densities and moments; Characteristic functions of a random variable; Markov, Chebyshev and Chernoff bounds.

MODULE – IV (7 hours)

Random sequences and modes of convergence (everywhere, almost everywhere,probability, distribution and mean square); Limit theorems; Strong and weak laws of large numbers, central limit theorem.

MODULE – V (6 hours)

Random process. Stationary processes. Mean and covariance functions. Ergodicity.Transmission of random process through LTI. Power spectral density.

Books:

- H. Stark and J. Woods, ``Probability and Random Processes with Applications to Signal Processing," Third Edition, Pearson Education
- A.Papoulis and S. Unnikrishnan Pillai, ``Probability, Random Variables and Stochastic Processes," Fourth Edition, McGraw Hill.
- K. L. Chung, Introduction to Probability Theory with Stochastic Processes, Springer International
- P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability, UBS Publishers,
- P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Stochastic Processes, UBS Publishers
- S. Ross, Introduction to Stochastic Models, Harcourt Asia, Academic Press.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand representation of random signals
2. Investigate characteristics of random processes
3. Make use of theorems related to random signals
4. To understand propagation of random signals in LTI systems.

4th Semester	REC4G002	Data Structure	L-T-P 3-0-0	3 CREDITS

Module - I (12 Hrs.)

Introduction: Basic Terminologies: Elementary Data Organizations, Data Structure Operations: insertion, deletion, traversal etc.; Analysis of an Algorithm, Asymptotic Notations, Time-Space trade off.
Searching: Linear Search and Binary Search Techniques and their complexity analysis.

Module – II (08 Hrs.)

Stacks and Queues: ADT Stack and its operations: Algorithms and their complexity analysis, Applications of Stacks: Expression Conversion and evaluation – corresponding algorithms and complexity analysis. ADT queue, Types of Queue: Simple Queue, Circular Queue, Priority Queue; Operations on each types of Queues: Algorithms and their analysis.

Module - III (08 Hrs.)

Linked Lists: Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list; Linked representation of Stack and Queue, Header nodes, Doubly linked list: operations on it and algorithmic analysis; Circular Linked Lists: all operations their algorithms and the complexity analysis.

Module - IV (10 Hrs.)

Sorting and Hashing: Objective and properties of different sorting algorithms: Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort; Performance and Comparison among all the methods, Hashing.

Module - V (07 Hrs.)

Trees: Basic Tree Terminologies, Different types of Trees: Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree; Tree operations on each of the trees and their algorithms with complexity analysis. Applications of Binary Trees. B Tree, B+ Tree: definitions, algorithms and analysis.

Graph: Basic Terminologies and Representations, Graph search and traversal algorithms and complexity analysis.

Books:

- "Fundamentals of Data Structures", Illustrated Edition by Ellis Horowitz, Sartaj Sahni, Computer Science Press.
- Algorithms, Data Structures, and Problem Solving with C++", Illustrated Edition by Mark Allen Weiss, Addison-Wesley Publishing Company
- "How to Solve it by Computer", 2nd Impression by R.G. Dromey, Pearson Education.

4th Semester	REC4G003	Brain Control Interface	L-T-P 3-0-0	3 CREDITS

Module - I (10 Hrs.)

Introduction to Brain Control Interface
Fundamentals of BCI – Structure of BCI system – Classification of BCI: Invasive, Non-invasive and Partially invasive BCI-Brain signal acquisition, Signal Preprocessing, Artifacts removal.

Module – II (10 Hrs.)

Electrophysiological Sources
Sensorimotor activity –Neuronal activity in motor cortex and related areas- Electric and magnetic fields produced by the brain- signals reflecting brain metabolic activity- Mu rhythm, Movement Related Potentials – Slow Cortical Potentials - P300 Event related potential - Visual Evoked Potential - Activity of
Neural Cells - Multiple Neuromechanisms

Module - III (10 Hrs.)

Feature Extraction Methods
Time/Space Methods – Fourier Transform, Wavelets, AR, MA, ARMA models, Bandpass filtering, Template matching, Kalman filter, PCA, Laplacian filter – Linear and Non-Linear Features.

Module - IV (07 Hrs.)

Feature Translation Methods
Linear Discriminant Analysis –Nearest neighbours, Support Vector Machines - Regression – Learning Vector Quantization – Gaussian Mixture Modeling – Hidden Markov Modeling –
Neural Networks.

Module - V (08 Hrs.)

Applications of BCI
Study of BCI Competition III – Dataset I, II, III, IV and V, Functional restoration using Neuroprosthesis - Functional Electrical Stimulation, Visual Feedback and control - External
device controllers, Case study: Brain actuated control of mobile Robot. Ethical issues in BCI research

Books:

- Jonathan Wolpaw,Elizabeth Winter Wolpaw,'Brain Computer Interfaces: Principles and practice", Edition 1, Oxford University Press, USA, January 2012
- Special Issue on Brain Control Interfaces, IEEE Transactions on Neural Systems and Rehabilitation Engineering, Vol 14, June 2006.
- R. Spehlmann, "EEG Primer", Elsevier Biomedical Press, 1981.
- Bernhard Graimann, Brendan Allison, Gert Pfurtscheller, "Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction", Springer, 2010
- Ali Bashashati, Mehrdad Fatourechi, Rabab K Ward, Gary E Birch," A survey of signal Processing algorithms in brain–computer interfaces based on electrical

brain signals" JOURNAL OF NEURAL ENGINEERING, VOL.4, 2007, PP.32-57

- Arnon Kohen, "Biomedical Signal Processing", Vol I and II, CRC Press Inc, Boca Rato, Florida.
- Bishop C.M., "Neural networks for Pattern Recognition", Oxford, Clarendon Press, 1995.
- Andrew Webb, "Statistical Pattern Recognition", Wiley International, Second Edition, 2002.
- Torsten Felzer, "On the possibility of Developing a Brain Computer Interface", Technical Report, Technical University of Darmstadt, Germany,2001.
- Wolpaw J.R, N.Birbaumer et al, "Brain control interface for Communication and control", Clinical Neurophysiology, 113, 2002.
- Jose del R.Millan et al, "Non-invasive brain actuated control of a mobile robot by human
- EEG", IEEE Transactions on biomedical Engineering, Vol 51, No.6, 2004 June.
- S.Coyle, T.Ward et al, "On the suitability of near infra red systems for next generation Brain Computer interfaces", Physiological Measurement, 25, 2004.
- Carlo Tomasi, "Estimating Gaussian Mixture Densities with EM – A Tutorial", Duke University, 2000.
- R.Dugad, U.B Desai, "A Tutorial on Hidden Markov Modeling", Signal Processing and Artificial Neural Networks Laboratory, IIT Bombay, 1996.
- http:://ida.first.fhg.de/projects/bci/competition_iii

Course Outcomes:

Capable of acquiring the brain signal in the format required for the specific application

1. Well prepared for preprocessing the signal for signal enhancement
2. Ability to extract the dominant and required features and classify the signal for applications

4th Semester	RCN4F001	Constitution of India	L-T-P 3-0-0	0 CREDIT

Basic features and fundamental principles

The Constitution of India is the supreme law of India. Parliament of India can not make any law which violates the Fundamental Rights enumerated under the Part III of the Constitution. The Parliament of India has been empowered to amend the Constitution under Article 368, however, it cannot use this power to change the "basic structure" of the constitution, which has been ruled and explained by the Supreme Court of India in its historical judgments. The Constitution of India reflects the idea of "Constitutionalism" – a modern and progressive concept historically developed by the thinkers of "liberalism" – an ideology which has been recognized as one of the most popular political ideology and result of historical struggles against arbitrary use of sovereign power by state. The historic revolutions in France, England, America and particularly European Renaissance and Reformation movement have resulted into progressive legal reforms in the form of "constitutionalism" in many countries. The Constitution of India was made by borrowing models and principles from many countries including United Kingdom and America.

The Constitution of India is not only a legal document but it also reflects social, political and economic perspectives of the Indian Society. It reflects India's legacy of "diversity". It has been said that Indian constitution reflects ideals of its freedom movement, however, few critics have argued that it does not truly incorporate our own ancient legal heritage and cultural values. No law can be "static" and therefore the Constitution of India has also been amended more than one hundred times. These amendments reflect political, social and economic developments since the year 1950. The Indian judiciary and particularly the Supreme Court of India has played an historic role as the guardian of people. It has been protecting not only basic ideals of the Constitution but also strengthened the same through progressive interpretations of the text of the Constitution. The judicial activism of the Supreme Court of India and its historic contributions has been recognized throughout the world and it gradually made it "as one of the strongest court in the world".

Course content

1. Meaning of the constitution law and constitutionalism
2. Historical perspective of the Constitution of India
3. Salient features and characteristics of the Constitution of India
4. Scheme of the fundamental rights
5. The scheme of the Fundamental Duties and its legal status
6. The Directive Principles of State Policy – Its importance and implementation
7. Federal structure and distribution of legislative and financial powers between the Union and the States
8. Parliamentary Form of Government in India – The constitution powers and status of the President of India
9. Amendment of the Constitutional Powers and Procedure
10. The historical perspectives of the constitutional amendments in India

11. Emergency Provisions : National Emergency, President Rule, Financial Emergency
12. Local Self Government – Constitutional Scheme in India
13. Scheme of the Fundamental Right to Equality
14. Scheme of the Fundamental Right to certain Freedom under Article 19
15. Scope of the Right to Life and Personal Liberty under Article 21.