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
Third Year Undergraduate Programme Leading to
Bachelor of Technology (B. Tech.) Degree
in
Electronics Engineering

Implemented from the batch admitted in Academic Year 2018-19

(Autonomous Institute affiliated to University of Mumbai)

Curriculum

(Scheme of Instruction & Evaluation and Course contents)

For

Third Year Undergraduate Programme Leading to
Bachelor of Technology (B. Tech.)
In

106 Electronics Engineering

Institute Vision

To establish global leadership in the field of Technology and develop competent human resources for providing service to society

Institute Mision

- **To provide students with comprehensive knowledge of principles of engineering with a multi-disciplinary approach that is challenging**
- **To create an intellectually stimulating environment for research, scholarship, creativity, innovation and professional activity.**
- **To foster relationship with other leading institutes of learning and research, alumni and industries in order to contribute to National and International development.**

Department Vision

To establish global leadership in the field of Electrical, Electronics & Communication Engineering and to develop competent human resources for providing service to society.

Department Mission

- **To provide student with comprehensive knowledge for taking up challenges in the field of Electrical Engineering with a multi-disciplinary approach.**
- **To create an intellectually stimulating environment for research, industry interaction, creativity, innovation and professional activity.**
- **To foster relationship with renowned institutes of learning and research, alumni and industries in order to contribute to National and International development.**

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

Electronics Engineering Graduates will have ability to

• Apply analysis, design, optimization and implementation skills in order to formulate and solve Electronics Engineering and multidisciplinary problems.

• Take up higher studies, innovation, research & development and other such creative efforts in technology.

• Use their skills in professional manner to raise the satisfaction level of stake holders.

PROGRAM OUTCOMES (POs)

Engineering Graduate will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

Electronics Engineering Graduate will be able to:

1. Design, develop and test electronic systems in the areas related to analog and digital electronics, electronic instrumentation, signal processing and VLSI design.
2. Analyze, design and implement electronic systems to strive balance between increasing complexity, robustness and performance of systems.
3. Design electronic software and hardware systems, components or process to meet desired needs within realistic constraints.

Scheme of Instruction and Evaluation

T Y B. Tech (Electronics Engineering) SEMESTER V								
Scheme of Instruction				Scheme of Evaluation				
S. No.	**Course Code**	**Course Title**	**L-T-P (Hours/week)**	**Credits**	**TA**	**MST**	**ESE**	**ESE hours**
1.	R4EC3003S	Principles of Communication Systems	3-1-0=4	4	20	20	60	3
2.	R4EC3002S	Electromagnetic Field and Waves	3-0-0=3	3	20	20	60	3
3.	R4EC3004T	Analog Integrated Circuits	3-0-0=3	3	20	20	60	3
	R4EC3004P	Analog Integrated Circuits Lab	0-0-2=2	1	60	-	40	2
4.	R4EC3005T	Microprocessor Systems	3-0-0=3	3	20	20	60	3
	R4EC3005P	Microprocessor Systems Lab	0-0-2=2	1	60	-	40	2
5.	R4EC3001T	Digital Signal Processing	3-0-0=3	3	20	20	60	3
	R4EC3001P	Digital Signal Processing Lab	0-0-2=2	1	60	-	40	2
6.	R4EC3007L	Electronic Engineering Practice	0-0-2=2	1	60	-	40	2
7	R4EC3008A	Financial Planning, Taxation and Investment	2-0-0=2	P/NP				
		Total	**17-1-8=26**	**20**				

T Y B. Tech (Electronics Engineering) SEMESTER VI								
Scheme of Instruction				Scheme of Evaluation				
S. No.	**Course Code**	**Course Title**	**L-T-P (Hours/week)**	**Credits**	**TA**	**MST**	**ESE**	**ESE hours**
1.	R4EC3011S	Control Systems	3-0-0=3	3	20	20	60	3
2.	R4EC3012T	Data Science	2-0-0=2	2	20	20	60	3
	R4EC3012P	Data Science Lab	0-0-2=2	1	60	-	40	2
3.	R4EC3013T	Power Electronics	3-0-0=3	3	20	20	60	3
	R4EC3013P	Power Electronics Lab	0-0-2=2	1	60	-	40	2
4.	R4EC3016L	Electronics in Service to Society	2-0-2=4	3	60	-	40	2
5.	R4HM3002L	Professional Communication Skills	1-0-2=3	2	60	-	40	2
6		Program Elective I	3-0-0=3	3	20	20	60	3
		Program Elective I Lab	0-0-2=2	1	60	-	40	2
7.		Open Elective I	3-0-0=3	3				
		Total	**17-0-10=27**	**22**				

B. Tech (Electronics Engineering) SEMESTER VI -VII– summer term								
Scheme of Instruction				Scheme of Evaluation				
S. No.	**Course Code**	**Course Title**	**Total duration**	**Credits**	**TA**	**MST**	**ESE**	**ESE hours**
1.	R4EC4701I	Internship	6 - 8 weeks	2	-	-	100*	

*Examination will be held in first week of semester VII

*Abbreviations: **L**: Lecture, **T**: Tutorial, **P**: Practical, **TA**: Teacher Assessment / Term work Assessment, **MST**: Mid Semester Test, **ESE**: End Semester Written Examination*

Program Elective I

S. No.	Course Code	Course Title
1.	R4EC3101T	Image and Video Processing
	R4EC3101P	Image and Video Processing Lab
2.	R4EC3104T	Virtual Instrumentation
	R4EC3104P	Virtual Instrumentation Lab
3.	R4EC3105T	Internet of Things
	R4EC3105P	Internet of Things Lab

Open Elective I

S. No.	Course Code	Course Title
1.	R4EC3601S	Transducers and Sensors

Programme Name	T.Y. B.Tech (Electronics Engineering), SEMESTER - V
Course Code	R4EC3003S
Course Title	PRINCIPLES OF COMMUNICATION SYSTEMS

COURSE OUTCOMES

After completion of course, the student should be able to:

- Compute noise figure and system equivalent noise temperature for communication systems.
- Describe amplitude modulators and demodulators, and different types of amplitude modulation.
- Describe frequency and phase modulation, along with FM modulators and demodulators.
- Describe the operation of receiver circuits, such as TRF and super-heterodyne receivers..
- Compute quantization noise and analyze signal-to-noise ratio in PCM, DPCM, DM and ADM systems, along with bandwidth considerations.

COURSE CONTENTS

Module 1	**Introduction**
	Elements of a communication system, modulation and demodulation, Noise in Communication systems, Signal-to-Noise ratio, Noise factor and Noise Figure, Equivalent Noise Temperature.
Module 2	**Amplitude Modulation**
	DSB Full carrier AM – principles, modulator circuits, transmitters, different types of AM modulators, Suppressed – carrier AM, SSB, ISB – Principles, transmitters, VSB Modulation. Effect of noise.
Module 3	**Angle Modulation**
	Frequency modulation, Phase modulation, Effect of noise, FM modulators, Transmitters, FM demodulators. Pre-emphasis & De-emphasis.
Module 4	**Radio Receivers**
	Receiver characteristics, TRF and Super-heterodyne receivers, AM detectors, FM detectors, Receiver circuits.
Module 5	**Radio Wave Propagation**
	Electromagnetic waves, Properties of radio waves, Propagation of waves, Propagation terms and definitions.
Module 6	**Analog Pulse Modulation**
	Sampling Theorem for Low – pass and Band – pass signals – proof with spectrum, Aliasing. Sampling Techniques – principle, generation, demodulation, spectrum. PAM, PWM, PPM – generation and detection.

Module 7	**Digital Transmission**
	Quantization, Quantization error, Non-uniform quantizing, Encoding. PCM, DPCM, Delta modulation, Adaptive Delta modulation – transmission system, bandwidth.
Module 8	**Multiplexing**
	TDM, FDM – Principles, Hierarchy.
	TEXT BOOKS:
1	Herbert Taub and Donald Schilling, Principles of Communication Systems, Tata McGraw-Hill, second edition.

2	Roy Blake, Electronic Communication Systems, Thomson Asia Pte. Ltd., Singapore, second edition, 2002.
	ADDITIONAL READING
1	Leon W Couch, Digital and Analog Communication Systems, Pearson Education, sixth edition
2	Herbert Taub and Donald Schilling, Principles of Communication Systems, Tata McGraw-Hill, second edition.

Programme Name	T Y B Tech (Electronics Engineering), SEMESTER - V
Course Code	R4EC3002S
Course Title	ELECTROMAGNETIC FIELDS AND WAVES

COURSE OUTCOMES

After completion of course, the student should be able to:

- Represent a vector in different coordinate systems and compute area, volume, divergence and curl.
- State the Coulomb's and Gauss' laws and the Maxwell's equation.
- Describe conduction and convection current in conductors and polarization in dielectrics. Demonstrate understanding of continuity equation and boundary condition.
- State Faraday's law and demonstrate understanding of Maxwell's equations and analogies between electric and magnetic fields
- Describe electromagnetic wave propagation and define various terms related to it.

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 and Magnetostatics**
	Review of Coulomb's law and field intensity, Electric flux density, Applications of Gauss's law, Relation between E and V 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
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 superconductance, The Earth capacitor : an automatic electrostatic pilot.
Module IV	**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 fields,

Module V	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 Poynting vector, Propagation based on frequency variation, Reflection of plane wave at normal incidence.
	TEXT BOOKS
1.	Matthew N. O. Sadiku, "Elements of Electromagnetics", second edition, 1985, Oxford university press.
2.	Edminister, "Schaum's series in Electromagnetics", McGraw Hill, third edition, 1986.
	ADDITIONAL READING
1.	William Hayt, "Engineering Electromagnetics", McGraw Hill, fourth edition, 1987
2.	Edward C. Jordan, Keith G. Balmain, "Electromagnetic Waves and Radiating Systems", Second edition, Prentice-Hall

Programme Name	Bachelor of Technology in Electronics Engineering	SEMESTER – V
Course Code	R4EC3004T	
Course Title	ANALOG INTEGRATED CIRCUITS	

COURSE OUTCOMES

After completion of the course, the students should be able to:

- Analyze differential amplifier circuits and describe basic OPAMP configuration and characteristics
- Design linear and nonlinear circuits using OPAMPS.
- Design active filters and waveform generators using OPAMPS.
- Describe the operation of various voltage regulators.

COURSE CONTENTS

Module 1	**Fundamentals for OPAMP**
	Analysis of differential amplifiers using current mirror circuits with active loads. Basic OPAMP configuration, Ideal OPAMP circuit characteristics and analysis. Feedback in OPAMP circuits, IC741 study.
Module 2	**Linear applications of OPAMP**
	Amplifiers, Current to Voltage converters, Voltage to Current converters, Difference amplifier, Instrumentation amplifiers, Summing and scaling amplifiers, Integrator, Differentiator.
Module 3	**Non Linear Circuit Applications**
	Voltage Comparators, Comparator applications, Schmitt triggers, Precision rectifiers (Half wave & Full wave), Peak detectors, Sample & Hold circuits, Clippers and clampers using OPAMP, Log - Antilog amplifiers, PLL (IC565), Analog MUX and DEMUX
Module 4	**Active Filters**
	Classification, Transfer Function, First order Butterworth filters, Standard second order response, KRC filters (Low pass, High pass, Band pass filters, band stop filters, notch filters), Multiple feedback filters, State variable and Biquad filters.
Module 5	**Waveform Generation using OPAMP and Special ICs (IC-555, IC XR-2206)**
	Sine wave generation using OPAMP, Multivibrators using OPAMPs, Timer IC 555 in detail with internal diagram, applications of IC 555 in monostable & astable mode. Triangular & Sawtooth waveform generator, Monolithic Waveform Generator IC XR – 2206.

Module 6	**Analog to Digital and Digital to Analog Convertors**
	Analog switches, Digital to analog conversion techniques (R-2R, Binary Weighted). Analog to Digital Conversion techniques (Dual Slope ADC, Flash type ADC, Ramp ADC, Successive Approximation ADC, Delta modulation etc)
Module 7	**Voltage Regulators**
	Performance Specification, Linear Regulator (IC 78xx & IC 79xx, LM317), Voltage reference and its applications, Adjustable voltage regulators, switching regulators, monolithic switching regulator IC LM337, Special regulator and ICs.
	TEXT BOOKS
1	William D. Stanley, Operational Amplifiers with Linear Integrated Circuits, Pearson Education, fourth edition, 2004
2	Ramakant A. Gayakwad, Op-Amps and Linear Integrated Circuits, Prentice Hall/Pearson Education, fourth edition, 2002
3	Sergio Franco, Design with Operational Amplifiers and Analog Integrated Circuits, TATA McGraw-Hill fourth edition, 2014
	ADDITIONAL READING
1.	Millman, Microelectronics, TATA McGraw-Hill fourth edition

Programme Name	**:**	**Bachelor of Technology in Electronics Engineering**	**SEMESTER – V**
Course Code	**:**	**R4EC3004P**	
Course Title	**:**	**ANALOG INTEGRATED CIRCUITS LAB**	

COURSE OUTCOMES

After completion of the course, the students should be able to:

- Analyze and design various linear, non-linear applications of OPAMP using IC741, IC311.
- Design first-order active filters using OPAMPS.
- Design and construct waveform generator using OPAMP, timer IC 555, XR -2206.
- Design a regulator using IC 78/79xx, LM337.
- Design PLL using IC565.

COURSE CONTENTS

Module 1	**Linear applications of OPAMP**
	Design inverting and non-inverting amplifier using IC 751, Calculation of OPAMP bandwidth in inverting and non-inverting configuration mode, design of summing and difference amplifiers with gain.
Module 2	**Differentiator and Integrator Circuits**
	Design of integrator and differentiator, for specific cutoff frequencies and find out the range in which circuit will act as differentiator and integrator.
Module 3	**Non-Linear Operational amplifier circuits**
	Voltage comparators, Schmitt triggers, window detectors using IC 311, Precision rectifiers, Peak detectors, sample and hold circuit.
Module 4	**Active Filters:**
	First order active filters, second order low pass and high pass butterworth KRC filters, standard second order band pass and bandstop filters.
Module 5	**Waveform Generators:**
	Sine wave generation using IC 741 (Oscillators), Multivibrators using OPAMP and timer IC555, triangular waveform generation using OPAMP, Monolithic waveform generator IC XR-2206.
Module 6	**Nonlinear Amplifiers and PLL**
	Regulator design using IC 78/79xx, IC723 low voltage and high voltage designs, switching regulators.

Module 7	**Voltage Regulators**
	Log, antilog amplifiers, Phase Lock Loop using IC565
Module 8.	**ADC and DAC:**
	Dual slope ADC, staircase RAMP type ADC, flash type ADC, successive approximation ADC, R-2R DAC, weighted resistor DAC.
	TEXT BOOKS
1	William D. Stanley, Operational Amplifiers with Linear Integrated Circuits, Pearson Education, fourth edition, 2004
2	Ramakant A. Gayakwad, Op-Amps and Linear Integrated Circuits, Prentice Hall/Pearson Education, fourth edition, 2002
3	Sergio Franco, Design with Operational Amplifiers and Analog Integrated Circuits, TATA McGraw-Hill fourth edition, 2014
	ADDITIONAL READING
1.	Millman, Microelectronics, TATA McGraw-Hill fourth edition

Programme Name	Bachelor of Technology in Electronics Engineering	Semester – V
Course Code	R4EC3005T	
Course Title	MICROPROCESSOR SYSTEMS	

COURSE OUTCOMES

After completion of the course, the students should be able to:

- Describe architecture of 16-bit microprocessors.
- Design microprocessor systems consisting of a 16-bit microprocessor/microcontroller, memory , I/O and other relevant devices.
- Design and implement assembly language programs for 8086/ARM 7 microprocessors.
- Design and implement I/O data transfer techniques.

COURSE CONTENTS

Module 1	**Intel 8086/8088 microprocessor family**
	Architecture and organisation of 8086/8088 microprocessor family. Study of its Instruction set. Assembly language programming, 8086 family minimum and maximum mode operation. Timing diagram for 8086 family, detailed study of maximum mode connection: study of 8288 bus controller. 8086 interrupt structure.
Module 2	**8086 Memory & I/O design:**
	Memory system design for 8086 family, timing considerations for memory interfacing. Connection of I/O Controllers 8255AH programmable peripheral Interface, Programmable Interrupt Controller 8259A, programmable D.M.A. Controller 8237
Module 3	**8087 Math Co-processor**
	Study of architecture of 8087 floating point co- processor. Data types supported by 8087. Host and co - processor interface, Assembly language Programming for 8086 - 8087 based systems.
Module 4	**Introduction to 8086 based Multiprocessor systems:**
	Multiprocessor configurations. Study of the 8289 bus arbiter. Design of 8086 based multiprocessor systems (without timing considerations).
Module 5	**ARM7TDMI Architecture**
	Architectural Block diagram and Features of ARM 7 TDMI, processor operating states, Memory formats, Data types, Operating modes, registers , Pipelining, Program status registers, exceptions, interrupt latencies. Memory system design.

Module 6	ARM7TDMI Assembly Language Programming
	8,16,32 bit and floating point numbers processing, Conversions between Hexadecimal, BCD, ASCII, Data movement/copy operations, block transfer of data, data swap/exchange Arithmetic, Logical, and Stack operation, loops, condition evaluation and decision making based on flags, control transfers (Call, Return, Jumps), processor state changing between ARM and THUMB, Exceptions, interrupts and its handling.

	TEXT BOOKS
1	John Uffenback, 8086 / 8088 Design, Programming and Interfacing, second edition, ninth Indian reprint, Prentice Hall of India, 2001
2	Sloss, Symes, Wright, ARM System Developers Guide- Elsevier Morgan Kaufman, first edition, 2004
	RECOMMENDED READING
1	Douglas Hall, Microprocessors Interfacing and Programming, Tata McGraw Hill, third edition, 2002
2	William Hohl, ARM Assembly Language: Fundamentals and Techniques, CRC press, 2009

Programme Name	Bachelor of Technology in Electronics Engineering	Semester – V
Course Code	R4EC3005P	
Course Title	MICROPROCESSOR SYSTEMS LAB	
Prerequisites	Microprocessors and Microcontrollers	

COURSE OUTCOMES

After successful completion of this course, students should be able to

- Write programs for data transfer, arithmetic and logic operations and floating point operations for 8086 / 8087 and ARM 7 microprocessors

COURSE CONTENTS

Module 1	Any five programs on data transfer operations, Arithmetic & Logic operations for 8086
Module 2	Any three programs on floating point operations involving 8087
Module 3	Any three programs on data transfer operations, arithmetic & logic operations and I/O involving ARM 7
	TEXT BOOKS
1	John Uffenback, 8086 / 8088 Design, Programming and Interfacing, second edition, ninth Indian reprint, Prentice Hall of India, 2001
2	William Hohl, ARM Assembly Language: Fundamentals and Techniques, CRC press, 2009

Programme Name	T.Y. B.Tech (Electronics Engineering), SEMESTER - V
Course Code	R4EC3001T
Course Title	DIGITAL SIGNAL PROCESSING

COURSE OUTCOMES

After completion of course, the students should be able to:

- Analyze DT systems in the frequency domain, using analytical and graphical techniques.
- Design linear phase systems to meet the desired specifications.
- Compute DFT using FFT algorithms
- Design FIR and IIR filters to meet the given specifications and determine the extent of quantization effects due to finite processor word length.

COURSE CONTENTS

Module 1	**Frequency Domain Analysis of DT Systems**
	Pole-zero diagram, Frequency domain analysis using Analytical & graphical techniques, System classification based on pass-band as low pass, high pass, Band pass & band reject, System classification based on phase response as Minimum phase , maximum phase , mixed phase or linear phase systems, Finite word-length effect on system poles
Module 2	**Linear Phase FIR Systems**
	Need for linear phase, concept of phase delay & group delay, Condition for Linear Phase, Magnitude & phase response for Four types of Linear Phase systems, Location of zeros.
Module 3	**Discrete Fourier Transform and Fast Fourier Transform**
	DFT and its Properties, Relation between DFT and Z-Transform, FFT: Decimation in Time (DIT) and Decimation in Frequency (DIF), 8-point DFT using Radix-2 DIT FFT and Radix-2 DIF FFT, Computation of Inverse DFT using FFT.
Module 4	**FIR Filter Design**
	FIR versus IIR filters, Design of FIR filters by windowing technique: (Gibb's phenomenon, Use of different windows: rectangular, triangular, hamming, hanning, Kaiser), Design of FIR filters using Frequency sampling techniques, Design of optimal linear phase FIR filters, Structures for implementation: canonic and lattice

Module 5	**Design of IIR filters**
	The design process Methodology, Different types of analog approximations: Butterworth, chebyshev, inverse chebyshev, elliptical, Bessel etc., Spectral transformations, Conversion techniques like bilinear transformation, impulse invariance, matched Z-transform, Intuitive approaches ,Structures for implementation: canonic and lattice,
Module 6	**Quantization Effects**
	Quantization methods, Limit cycle oscillations due to Quantization, Errors in frequency response due to coefficient Quantization.
	TEXT BOOKS
1	J. G. Proakis, D. G. Manolakis, Digital Signal Processing : Principles, Algorithms and Applications, Prentice Hall of India, third edition, 1995
	ADDITIONAL READING
1	Oppenheim and Schafer with Buck, Discrete- Time Signal Processing, Prentice Hall of India, 2000
2	A. Nagoor Kani, Digital Signal Processing, McGraw-Hill Education Second edition 2013
3	A. Antoniou, Digital Filters: Analysis Design and Applications, Tata McGraw-Hill, .2001.
4	Ashok Ambardar, Analog and Digital Signal Processing, Thomson Learning, second edition, 2001

Programme Name	T.Y. B.Tech (Electronics Engineering), SEMESTER - V
Course Code	R4EC3001P
Course Title	DIGITAL SIGNAL PROCESSING LAB

COURSE OUTCOMES

Students will be able to write programs to

- Implement and plot frequency response of FIR and IIR systems and obtain their transfer functions
- Implement DITFFT and DIFFFT
- Implement simple programs on DSP processors

COURSE CONTENTS

Module 1	Frequency response of FIR and IIR system
Module 2	Transfer function and pole-zero plots of FIR and IIR systems
Module 3	Implementation DITFFT and DIFFFT
Module 4	**Linear Phase FIR filters**
	Magnitude & phase response for Four types of Linear Phase systems
Module 5	**FIR Filter Design**
	a) Design of FIR filters by windowing technique: b) Use of different windows: rectangular, triangular, hamming, hanning, Kaiser c) Design of FIR filters using Frequency sampling techniques
Module 6	**Design of IIR filters**
	a) Different types of analog approximations: Butterworth, Chebyshev, Inverse Chebyshev b) Conversion techniques like bilinear transformation, impulse invariance, matched Z-transform
Module 7	Implementation of simple programs on DSP processors
	TEXT BOOKS
1	J. G. Proakis, D. G. Manolakis, Digital Signal Processing : Principles, Algorithms and Applications, Prentice Hall of India, third edition, 1995
	ADDITIONAL READING
1	Oppenheim and Schafer with Buck, Discrete- Time Signal Processing, Prentice Hall of India, 2000
2	A. Nagoor Kani, Digital Signal Processing, McGraw-Hill Education Second edition 2013
3	A. Antoniou, Digital Filters: Analysis Design and Applications, Tata McGraw-Hill, .2001.
4	Ashok Ambardar, Analog and Digital Signal Processing, Thomson Learning, second edition, 2001

Programme Name	Bachelor of Technology in Electronics Engineering	Semester – V
Course Code	R4EC3007L	
Course Title	ELECTRONIC ENGINEERING PRACTICE	
Prerequisites	Digital Design I & II, Microprocessors and Microcontrollers	

COURSE OUTCOMES

After completion of course, the student should be able to:

- Implement digital circuits in a high level descriptive language
- Program Arduino and Raspberry Pi boards and implement mini projects
- Design, implement and program 8/16 bit microcontroller and microprocessor systems

COURSE CONTENTS

Module 1	Design and implement in VHDL / Verilog, digital circuits like Arithmetic / Logic Unit, Finite state machines
Module 2	Program Arduino boards / Raspberry Pi boards, interface shields / daughter boards
Module 3	Mini Project: Design, fabricate, implement and test an 8 bit / 16 bit microcontroller or microprocessor based system.
	TEXT BOOKS
1.	John F. Wakerley, Digital Design Principles and Practices, fourth edition, Pearson Education India, 2008
2.	Kenneth Ayala, The 8051 Microcontroller & Embedded Systems Using Assembly and C, Cengage Learning, first edition, 2010
3.	Massimo Banzi, Getting Started with Arduino: The Open Source, Shroff Publishers & Distributors Pvt Ltd, first edition, July 2014

SEM VI

PROGRAMME	**T.Y. B.Tech. (Electronics), SEMESTER : VI**
COURSE CODE	**R4EC3011S**
COURSE TITLE	**CONTROL SYSTEMS**

COURSE OUTCOMES

After completion of course, the student should be able to:

- Model systems in the frequency domain and compute transfer functions of various electrical and mechanical systems
- Represent a system by means of block diagram and signal flow graph
- Compute steady-state errors of systems and perform their root-locus analysis.
- Sketch Nyquist diagrams and compute stability.
- Perform state-space analysis of systems.

COURSE CONTENTS

Module 1	**Introduction to Control Systems**
	Analysis and design objectives, Open loop systems, Closed loop systems, The design process,
Module 2	**Modeling in Frequency Domain**
	Laplace transform review, Transfer function, Electric network transfer function, Translational mechanical system transfer function, Rotational mechanical system transfer function, Electromechanical system transfer function, Electrical circuit analogs.
Module 3	**Time Response Analysis**
	Poles, Zeros, System response, First order system, Second order system : Introduction, The general second order system, Underdamped second order system, System response with additional poles, System response with zeros.
Module 4	**Reduction of Multiple Subsystems**
	Block diagrams, Analysis and design of feedback system, Signal flow graphs, Mason's rule, Signal flow graphs of state equations.
Module 5	**Stability of the Systems**
	Introduction to concept of stability, Routh Hurwitz criterion, Special cases in RH criterion, Absolute stability, Relative stability.
Model 7	**Root Locus Analysis**
	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 6	**Steady State Errors**
	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.

Model 8	**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, Constant gain and phase loci, Nichol's chart and their use in stability study of systems.
Module 9	**State Space Analysis of the System**
	The General state-space representation, Applying the state-space representation, Converting the transfer function to state-space, Converting from state-space to transfer function, Stability in State Space.
	TEXT BOOKS
1.	Norma S. Nise, Control Systems Engineering, John Wiley and Sons, third edition
	ADDITIONAL READING
1.	K. Ogata, Modern Control Engineering, Prentice Hall of India, third edition
2.	Benjamin C. Kuo, Automatic Control Systems, Prentice Hall of India, seventh edition
3.	Madan Gopal, Control Systems Principles and Design, Tata McGraw Hill, seventh edition, 1997

Programme Name	T.Y.B. Tech. (Electronics Engineering), SEMESTER - VI
Course Code	R4EC3012T
Course Title	Data Science

COURSE OUTCOMES

After completion of this course, students will be able to

- Communicate data driven findings
- Process and transform raw data into suitable formats
- Describe statistical theories used in data analysis
- Interpret features of interest in numerical data
- Apply data analysis techniques in practical problems

COURSE CONTENTS

Module I	**Introduction**
	Revision to theory of probability for data analysis using case studies, central limit theorem, Review of Linear Algebra, Linear Transformations
Module II	**Data Visualization**
	Understanding experimental data, importing data, wrangling, string processing, Decision Theory, ROC Curves
Module III	**Statistical methods**
	Random walks and Monte Carlo simulations, Linear and Quadratic Discriminants, Fisher Discriminant, Multilinear Analysis, Maximum Likelihood and Bayesian Parameter Estimation, Linear Discriminant/Perceptron Learning, Optimization by Gradient Descent, Mixture modelling, Expectation maximization
Module IV	**Inference and Modelling**
	Sampling and error, Bayesian statistics and predictive modelling
Module V	**Machine Learning**
	Introduction, regression analysis, regularization models, building models, introduction to recommender systems; a case study
Module VI	**Classification and clustering**
	Bayesian classification and support vector machines, Feature selection, Bayesian interpretation of regularization, RBF interpolation schemes, clustering, kernel based techniques, density estimation
Module VII	**Applications**
	Information extraction and feature selection, remotely sensed data for image interpretation, morphable models
Text Books:	
1.	Guttag, John. *Introduction to Computation and Programming Using Python: With Application to Understanding Data*. 2nd ed. MIT Press, 2016. ISBN: 9780262529624.
2.	Gelman, Andrew, et al. *Bayesian Data Analysis*. 2nd ed. Chapman and Hall/CRC, 2003. ISBN: 9781584883883.
Reference Books:	
1.	Hastie, Trevor, Robert Tibshirani, and Jerome Friedman. *The Elements of Statistical Learning: Data Mining, Inference, and Prediction: with 200 full-color illustrations*. New York, NY: Springer, c2001. ISBN: 0387952845.
2.	Duda, Richard O., Peter E. Hart, and David G. Stork. *Pattern Classification*. New York, NY: John Wiley & Sons, 2000. ISBN: 9780471056690.
3.	Vapnik, V. N. *The Nature of Statistical Learning Theory*. Springer, 1995.

Programme Name	**T.Y.B. Tech. (Electronics Engineering), SEMESTER - VI**
Course Code	**R4EC3012L**
Course Title	**Data Science Lab**

COURSE OUTCOMES

After completion of this course, students will be able to

- Process and transform raw data into suitable formats
- Implement Bayesian techniques for data analysis
- Implement regularization techniques with interpretation
- Implement clustering methods
- Implement Monte Carlo simulation

List of Experiments

Sr. No.	**Experiments**
1	Fundamentals of Python programming
2	Implement data visualization and wrangling (ggplot)
3	Implement linear regression with different regularization techniques
4	Implement Bayesian classifier with different densities
5	Implement SVM classifier with feature kernel techniques
6	Implement clustering using different methods
7	Implement Monte Carlo Simulation

Programme Name	**:**	**T. Y. B. Tech. (Electronics Engineering)**	**SEMESTER – VI**
Course Code	**:**	**R4EC3013T**	
Course Title	**:**	**POWER ELECTRONICS**	

COURSE OUTCOMES

After completion of this course, students should be able to

- Make a comparative study of performance of various devices on the basis of the circuit requirement including its rating and specifications.
- Analyse single phase and three phase converters with different loads and solve problems related to it.
- Comprehend the inverters with different loads and configurations and solve related problems.
- Describe the concept of chopper with its types and solve the problems.

COURSE CONTENTS

Module 1	**Switching devices**
	SCR: Principle of operation, Static, dynamic and gate characteristics, Methods of turning on , firing circuits, commutation circuits, Protection of SCR Other power switches –(TRIAC, DIAC, GTO, MOSFET, IGBT, power BJT etc.): Principle of operation, Characteristics (v-I, switching), Rating, specifications and applications, Driver circuits
Module 2	**Converters – Controlled rectifiers**
	Half wave controlled rectifier with R and R-L load, Full wave controlled rectifiers(half controlled and fully controlled) with R, R-L Load, Single phase dual converter, Three phase half controlled and fully controlled rectifier, Numerical analysis essential Converters – Cyclo converters: Introduction, Single phase and three phase cyclo-converters, Applications
Module 3	**Inverters**
	Introduction to VSI and CSI, Single phase half / full bridge VSI with R and R-L load, Three phase bridge inverters with R and R-L load (120 and 180), Voltage control of single phase inverter using PWM techniques, Numerical analysis
	essential, Introduction to multi level inverters.
Module 4	**Choppers**
	Introduction to DC-DC switching mode regulators, Buck, Boost, Buck-Boost, Cuk, SEPIC, Flyback, forward, push-pull regulators, Numericals essential

	TEXT BOOKS
1	M. H. Rashid, "Power Electronics" , Academic Press,2001 Pearson Education India, 2009.
	ADDITIONAL READING
2	P. C. Sen "Power Electronics" Tata McGraw-Hill Education, 1987.
3	N. Mohan, T.M. Undeland, W.P Robbins, "Power Electronics, Converters, Applications & Design," Wiley India Pvt. Ltd. 2002.

Programme Name	T.Y. B.Tech (Electronics Engineering), SEMESTER - VI
Course Code	R4EC3013P
Course Title	POWER ELECTRONICS LAB

COURSE OUTCOMES

After completion of this course, students should be able to

- Make a comparative study of performance of various power electronic devices and its driver circuits on the basis of the circuit requirement.
- Design and analyse the waveforms of converters and cycloconverters.
- Design a AC voltage controllers
- Design and analyse the waveforms of different inverters.
- Design and analyse the waveforms of choppers

COURSE CONTENTS

Module 1	**Characterictics, triggring/ driver circuits and protection of power devices**
	1. Switching characteristics of a) power MOSFET b) SCR & TRIAC c) IGBT 2. Commutation circuit for SCR 3. Protection circuits of power devices
Module 2	**Controlled rectifier**
	1. Single phase half controlled rectifier. 2. Single phase fully controlled bridge rectifier.
Module 3	**AC voltage controller**
	Single phase ac voltage controller (using TRIAC or anti parallel thyristors)
Module 4	**Inverter**
	1. Single phase series inverter using SCR 2. Single phase parallel inverter using SCR 3. Single phase voltage source inverter using PWM technique 4. Three phase voltage source inverter using PWM technique (simulation)
Module 5	**Converters**
	1. Buck Converter 2. Boost Converter 3. Morgan Chopper

Module 6	**Cycloconverter**
	1. Single phase cycloconverter with resistive load 2. Three phase Cycloconverter (simulation)
Module 7	**Speed control of AC Motors**
	1. Speed control of single phase AC motor using PI controller Speed control of single phase AC motor using PID controller
	TEXT BOOKS
1.	M.H.Rashid, "Power Electronics" , Academic Press,2001 Pearson Education India, 2009.
2	P.C.Sen "Power Electronics" Tata McGraw-Hill Education, 1987.

Programme Name	Bachelor of Technology in Electronics Engineering	Semester – VI
Course Code	R4EC3016L	
Course Title	ELECTRONICS IN SERVICE TO SOCIETY	
Prerequisites	Electronic Engineering Practice	

COURSE OUTCOMES

After completion of course, the students should be able to:

1. Analyze the needs of various sections of society who can benefit from Electronic interventions.
2. Translate the need into an idea of electronic systems
3. Design and implement electronic systems using analog and digital components and sensors / transducers.

COURSE CONTENTS

Module 1	**Analysis of an electronic aid / instrument / system**
	Requirements analysis to gather inputs to understand needs of various sections of society. Understand Government of India Schemes like - Make in India, Digital India, Start up India, Stand up India, Smart cities mission, Electronic manufacturing mission, Software parks, hardware parks, Facilities and support provided by various government agencies for these schemes.
Module 2	**Design, fabricate and test an electronic system**
	Understand UN sustainable development goals. Design, fabricate, implement and test an electronic system with both analog and digital electronic components which will be a prototype of a product useful to society and confirming to UN sustainable development goals.

Programme Name	**T.Y. B.Tech (Electronics Engineering), SEMESTER - VI**
Course Code	**R4HM3002L**
Course Title	**PROFESSIONAL COMMUNICATION SKILLS**

Course Objectives:

- 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 Outcomes:

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. Group Discussion b. Presentation c. Interviews d. None verbal Communication e. 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
References:		
1.	Basic Managerial Skills for All	E.H. McGrath, PHI Learning Pvt Ltd
2.	Professional Ethics	R. Subramanian,OUP
3.	Personality Development and Soft Skills	Barun K. Mitra, Second Edition, OUP
4.	*https://learnenglish.britishcouncil.org/en/english-grammar*	

OPEN ELECTIVE

Programme Name	T Y B Tech (Electronics Engineering), SEMESTER - VI
Course Code	R4EC3601S
Course Title	TRANSDUCERS AND SENSORS

COURSE OUTCOMES

After learning the course students should be able to:

- Classify and characterize different types of transducers and sensors.
- Identify transducers and sensors for measurement of various quantities.
- Analyze the use of transducers and sensors for various applications in electronics engineering.
- Design schematic diagrams and circuits using transducers and sensors for various applications.

COURSE CONTENTS

Module 1	**Introduction**
	Measurement systems, Basic electronic measuring system, Classification of transducers, General transducer characteristics, Criteria for transducer and sensor selection.
Module 2	**Resistive, Capacitive and Inductive Transducers**
	• Resistance Potentiometers-Principles of operation, construction, theory, advantages and disadvantages, applications of Potentiometers • Strain gauges, (metallic and semi-conductor type) • Resistance Thermometer and Thermistors. • Types of Inductive transducer, Principles of operation, construction, Advantages & disadvantages and applications. Various variable Inductive Transducers, LVDT (Linear variable differential transformer). • Types of capacitive transducer, Principles of operation, construction, advantages,disadvantages and applications of capacitive transducers .
Module 3	**Elastic and Active Transducer**
	Principle of operation, construction, theory, advantages and disadvantages and applications of following transducers: • Thermocouple, Piezo-electric transducer. • Spring bellows, diaphragm, bourdon tube – their special features and application.
Module 4	**Other Important Transducers**
Module 5	**Capacitive Sensors**
	• Capacitive sensors: variable distance-parallel plate type, variable area-parallel plate, serrated plate/teeth type and cylindrical type, variable dielectric constant type. • Stretched diaphragm type: microphone.

	• Proximity sensor.
Module 6	**Thermal sensors**
	• Various types and applications
Module 7	**Magnetic sensors:**
	• Sensors based on • Villari effect.Wiedemann effect , Thomson effect, Hall effect and applications • Radiation sensors.
Module 8	**Introduction to smart sensors**
	• Introduction • Components of smart sensors • Architecture and evolutions of smart sensors • Advantages and disadvantages • Industrial applications
	TEXT BOOKS
1	Sensor & transducers, D. Patranabis, 2nd edition, PHI 2009 .
2	Transducers and Instrumentation by D. V. S. Murthy, **Publisher**: Prentice Hall India Learning Private Limited; 2 **edition** (2008); Language: English; ISBN-10: 8120335694; ISBN-13:
	ADDITIONAL READING
1	Instrument transducers, H. K. P. Neubert, Oxford University press 1975.
2	Measurement systems: application & design, E. A. Doebelin, Mc Graw Hill, Publisher: **McGraw-Hill** Higher Education; 5 edition (1 September 2003); Language: English; ISBN-10: 0071194657; ISBN-13: 978-
3	Electrical and Electronics Measurements and Instrumentation, by Sawhney A K, Dhanpat Rai and Sons, New Delhi,2010.
4	Electronic Instrumentation by Kalsi H S, Tata McGraw Hill, New Delhi, 4th Ed 2010.

Elective 1

Programme Name	T Y B Tech(Electronics Engineering), SEMESTER - VI
Course Code	R4EC3101T
Course Title	IMAGE AND VIDEO PROCESSING

Course Outcomes:

After completion of course, the students should be able to:

- Perform convolution, filtering and Fourier transform in 2-D, and summarize the human visual system
- Perform 2-D decomposition using various transforms.
- Describe different image and video compression and motion estimation techniques.
- Describe various image enhancement and restoration techniques.
- Summarize morphological image analysis.

COURSE CONTENTS

Module I	Introduction to multidimensional signal processing
	2-D convolution and filtering 2-D discrete-time Fourier transform 2-D filter design 2-D sampling and reconstruction The human visual system: Brightness perception, acuity Temporal properties of vision
Module II	**2-D Block transforms, Filter banks and Wavelets**
	DFT DCT, types I-IV Walsh-Hadamard transform Karhunen Loeve transform Discrete Hartley transform 2-D two-band decompositions 2-D tree structured decompositions 2-D implementation issues.
Module III	**Image Compression**
	Concept and techniques for entropy coding Scalar and vector quantization methods for image coding JPEG image compression standard Subband/wavelet image compression
Module IV	**Motion Estimation**
	Block matching algorithms Fast search techniques Optical flow schemes

Module V	**Compression of video**
	Motion compensated prediction methods MPEG standards 3-D subband coding methods
Module VI	**Image Enhancement**
	Noise reduction methods Contrast enhancement methods Edge sharpening methods
Module VII	**Image Restoration**
	Inverse filtering Least squares restoration Constrained least squares method Iterative methods Extrapolation and super resolution methods
Module VIII	**Morphological Analysis**
	Dilation, Erosion Introduction to color image processing
	Text books
1	Gonzalez, Rafael C, Digital image processing, Pearson Education India, 2009.
2	Schalkoff, Robert J, Digital image processing and computer vision, Wiley New York, 1989.
3	Jain, Anil K, Fundamentals of digital image processing, Prentice-Hall, Inc., 1989.

Programme Name	**T.Y. B.Tech (Electronics Engineering), SEMESTER - VI**
Course Code	**R4EC3101P**
Course Title	**IMAGE AND VIDEO PROCESSING LAB**

COURSE OUTCOMES

After successfully completing this course, students will be able to:

1) Perform software implementation of algorithms for image enhancement, restoration and compression

2) Implement filter bank concepts for image analysis.

3) Perform image analysis using binary morphology.

COURSE CONTENTS

Module 1	Image Enhancement Techniques in Spatial Domain
Module 2	Image Enhancement Techniques in Frequency Domain
Module 3	Image Analysis using Wavelets, Denoising, Filtering, Segmentation Applications
Module 4	Image Compression Techniques
Module 5	Image Analysis using binary morphology
Module 6	Analysis of motion estimation and video compression standards
	TEXT BOOKS
1	Gonzalez, Rafael C, Digital image processing, Pearson Education India, 2009.

Programme Name	T.Y.B.Tech (Electronics Engineering), SEMESTER - VI
Course Code	R4EC3104T
Course Title	Virtual Instrumentation

COURSE OUTCOMES

After completion of course, the students should be able to:

1. Implement virtual instrumentation with LabVIEW programming
2. Write programs involving use of structures, arrays, file IO and data acquizition..

COURSE CONTENTS

1. Introduction to Virtual Instrumentation- LabVIEW
2. SubVI and Express VI
3. Structures
4. Arrays and Clusters
5. Charts and Graphs
6. Signal generation, processing and analysis using LabVIEW
7. File input and outputs
8. Data acquisition
9. Basic applications of Virtual Instruments.

References:

1. www.ni.com
2. Virtual Instrumentation using LABVIEW-Sanjay Gupta and Joseph John, TMH Publications, 2013.
3. LabVIEW for Everyone: Graphical Programming Made Easy and Fun by Jeffrey Travis , Jim Kring, Prentice Hall Publications,2006.
4. Learning with LabVIEW 2009,by Robert H. Bishop Prentice Hall Publication,1st edition,2009
5. LabVIEW Applications and Solutions by Rahman Jamal, Herbert Pichlik ,Prentice Hall Publications,1999.
6. LabVIEW Signal Processing by Mahesh L. Chugani,Abhay.R.Samant, Michael Cerna, Prentice Hall Publications,1998.
7. Basic Concepts of LabVIEW, by Leonard Sokoloff ,Prentice Hall publications,1997.

Programme Name	T.Y.B.Tech (Electronics Engineering), SEMESTER - VI
Course Code	R4EC3105T
Course Title	Internet of Things

Course Outcomes:

At the end of successful completion of the course, students will be able to

- Define Internet of Things and its components.
- Perform IoT Systems management
- Design IoT systems
- Analyse the system through Data Analytics tools.

Module No.	Unit No.	Topics
1	1.1	**Introduction to IoT –** Definition, Characteristics, Physical and Logical Designs, IoT Protocols, IoT Communications Models and API, IoT Enabling Technologies, IoT Levels and Deployment Templates, IoT Examples, M2M
	1.2	**RFID Technology** – Working of RFID, Components of an RFID system, RFID Transponder (tag) classes, Standards, System architecture, Localization and Handover Management, Technology considerations, Performance Evaluation, Applications
	1.3	**Wireless Sensor Networks** – History, Sensor Nodes, Connecting Nodes, Networking Nodes, Securing Communication
2	2.1	**IoT System Management** – SNMP, Network Operator Requirements,
	2.2	**IoT System Management** – NETCONF, YANG
	2.3	**IoT Platform Design Specification –** Requirements, Process, Domain Model, Service, IoT Level, Function, Operational view, Device and Component Integration, Application Development
3	3.1	**IoT Systems Logical Design** – Python Data Types, Type conversion, Control Flow
	3.2	**IoT Systems Logical Design** – Python Functions, Modules, File Handling, Classes, Python Packages for IoT.
	3.3	**IoT Physical Servers –** Cloud Storage Models, Communication APIs, WAMP, Xively Cloud, Django
4	4.1	**IoT Cloud Services** - RESTful Web API, Amazon Web Services for IoT
	4.2	**IoT Data Analytics** – Apache Hadoop, Batch Data Analysis, Hadoop YARN
	4.3	**IoT Data Analytics** – Apache Oozie, Apache Spark, Apache Storm, Chef, Chef Case Studies, Puppet**,** NETCONF-YANG
5	5.1	**Arduino Programming Building Blocks** – Basics, Internet Connectivity, Communication Protocols.
	5.2	**IoT Patterns**: Real-time Clients, Remote control, On-demand Clients, Web Apps.
	5.3	**IoT Patterns:** Machine to Human, Machine to Machine, Platforms