DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW

EVALUATION SCHEME & SYLLABUS
FOR

B. TECH. III YEAR

ELECTRONICS ENGINEERING/ ELECTRONICS & COMMUNICATION ENGINEERING/ ELECTRONICS & TELECOMMUNICATION ENGINEERING

ON

CHOICE BASED CREDIT SYSTEM (CBCS)

[Effective from the Session: 2018-19]

EVALUATION SCHEME

B.TECH. ELECTRONICS ENGINEERING, B.TECH. ELECTRONICS & COMMUNICATION ENGINEERING, B.TECH. ELECTRONICS & TELECOMMUNICATION ENGINEERING

YEAR 3rd/ SEMESTER V

Sr. No.	Sub Code	Subject Name	L-T-P	Th/Lab Marks	Sessional		Total	Credit
				ESE	CT	TA		
1	RAS501	Managerial Economics	3--0--0	70	20	10	100	3
2	RAS502 /RUC501	Sociology/Cyber Security	3--0--0	70	20	10	100	3
3	REC501	Integrated Circuits	3--0--0	70	20	10	100	3
4	REC502	Principles of Communication	3--1--0	70	20	10	100	4
5	REC503	Digital Signal Processing	3--0--0	70	20	10	100	3
6	REC051-055	Deptt. Elective Course 1	3--1--0	70	20	10	100	4
7	REC551	Integrated Circuits Lab	0--0--2	50		50	100	1
8	REC552	Communication Lab – I	0--0--2	50		50	100	1
9	REC553	Digital Signal Processing Lab	0--0--2	50		50	100	1
10	REC554	CAD of Electronics Lab-I	0--0--2	50		50	100	1
	TOTAL			620	120	260	1000	24

DEPTT ELECTIVE COURSE–1

1. **REC051 - Antenna & wave propagation**
2. **REC052 - Computer Architecture and Organization**
3. **REC053- Real Time Systems**
4. **REC054- Artificial Neural Networks**
5. **REC055- Advance Semiconductor devices**

EVALUATION SCHEME

B.Tech. Electronics Engineering, B.Tech. Electronics & Communication Engineering, B.Tech. Electronics & Telecommunication Engineering

YEAR 3rd/ SEMESTER VI

Sr. No	Sub Code	Subject Name	L-T-P	Th/LAB Marks	Sessional		Total	Credit
				ESE	CT	TA		
1	RAS601	Industrial Management	3--0--0	70	20	10	100	3
2	RAS602 / RUC601	Sociology /Cyber Security	3--0--0	70	20	10	100	3
3	RIC603	Control System I	3--0--0	70	20	10	100	3
4	REC601	Microwave Engineering	3--1--0	70	20	10	100	4
5	REC602	Digital Communication	3--0--0	70	20	10	100	3
6	REC061 - 065	Deptt. Elective Course 2	3--1--0	70	20	10	100	4
7	REC-651	Microwave Engg Lab	0--0--2	50		50	100	1
8	REC-652	Communication Lab- II	0--0--2	50		50	100	1
9	RIC-653	Control System Lab-I	0--0--2	50		50	100	1
10	RIC-651	Microcontrollers For Embedded Systems Lab	0--0--2	50		50	100	1
	TOTAL			620	120	260	1000	24

DEPTT ELECTIVE COURSE–2

1. **REC061 - Industrial Electronics**
2. **REC062 - Microcontroller for Embedded Systems**
3. **REC063 - Analog Signal Processing**
4. **REC064 - Advance Digital Design Using Verilog**
5. **REC065- RADAR Engineering**

REC501	INTEGRATED CIRCUITS	
Unit	Topic	Lectures
I	**Analog Integrated circuit Design: an overview:** Current Mirrors using BJT and MOSFETs, Simple current Mirror, Base current compensated current Mirror, Wilson and Improved Wilson Current Mirrors, Widlar Current source and Cascode current Mirror **The 741 IC Op-Amp:** Bias circuit, short circuit protection circuitry, the input stage, the second stage, the output stage, and device parameters; D**C** Analysis of 741: Small Signal Analysis of input stage, the second stage, the output stage; Gain, Frequency Response of 741; a Simplified Model, Slew Rate, Relationship Between ft and SR	10
II	**Linear Applications of IC op-amps:** An Overview of Op-Amp (ideal and non-ideal) based Circuits V-I and I-V converters, generalized Impedance converter, simulation of inductors. **Filters:** First and second order LP, HP, BP BS and All pass active filters, KHN.	8
III	**Digital Integrated Circuit Design- An Overview**: CMOS Logic Gate Circuits**:** Basic Structure CMOS realization of Inverters, AND, OR, NAND and NOR Gates **Latches and Flip flops:** The Latch, The SR Flip-flop, CMOS Implementation of SR Flip- flops, A Simpler CMOS Implementation of the Clocked SR Flip-flop, D Flip-flop Circuits.	8
IV	**Non-Linear applications of IC Op-amps:** Log–Anti Log Amplifiers, Precision Rectifiers, Peak Detectors, Simple and Hold Circuits, AnalogMultipliersand their applications. Op- amp as a comparator, Zero crossing detector, Schmitt Trigger, Astable multi vibrator, Mono stable multi vibrator, Generation of Triangular Waveforms	7
V	**D/A and A/D converters Integrated Circuit Timer:** The 555 Circuit, Implementing a Mono stable Multi-vibrator Using the 555 IC, Astable Multi vibrator Using the 555 IC. **Phase locked loops (PLL):** Ex-OR Gates and multipliers as phase detectors**,** Block Diagram of IC PLL, Working of PLL and Applications of PLL.	7

Text Book:

1. Sedra and Smith, "Microelectronic Circuits", 6th Edition, Oxford University Press.
2. Michael Jacob, "Applications and Design with Analog Integrated Circuits", PHI, 2nd Edition.
3. A. K. Maini, Analog Circuits, Khanna Publishing House, Delhi.

Reference Books:

1. Jacob Millman and Arvin Grabel, "Microelectronics", 2nd Edition, Tata McGraw Hill.
2. BehzadRazavi, "Fundamentals of Microelectronics", 2nd Edition, Wiley.
3. Mark N. Horenstein, "Microelectronic Circuits and Devices", PHI.
4. Paul R. Gray, Paul J. Hurst, Stephen H. Lewis and Robert G. Meyer, "Analysis and Design of Analog Integrated Circuits", Wiley.
5. Data Sheet: http://www.ti.com/lit/ds/symlink/tl082.pdf
6. Application Note: http://www.ti.com/lit/an/sloa020a/sloa020a.pdf
7. MPY634 Data Sheet: http://www.ti.com/lit/ds/symlink/mpy634.pdf
8. Application Note: http://www.ti.com/lit/an/sbfa006/sbfa006.pdf
9. ASLK Pro Manual: ASLK Manual

REC502	PRINCIPLES OF COMMUNICATION	
Unit	Topic	Lectures
I	Introduction: Overview of Communication system, Communication channels, Need for modulation, Baseband and Pass band signals, Amplitude Modulation: Double sideband with Carrier (DSB-C), Double side band without Carrier DSB-SC, Single Side Band Modulation SSB, Modulators and Demodulators, Vestigial Side Band (VSB), Quadrature Amplitude Modulator, Radio Transmitter and Receiver	10
II	Angle Modulation, Tone Modulated FM Signal, Arbitrary Modulated FM Signal, Bandwidth of FM Signals using Bessel's Function, FM Modulators and Demodulators, Approximately Compatible SSB Systems, Stereophonic FM Broadcasting.	7
III	Pulse Modulation, Digital Transmission of Analog Signals: Sampling Theorem and its applications, Pulse Amplitude Modulation (PAM), Pulse Width Modulation, Pulse Position Modulation, Their generation and Demodulation, Digital Representation of Analog Signals Pulse Code Modulation (PCM), PCM System Issues in digital transmission: Frequency Division Multiplexing Time Division Multiplexing, T1 Digital System, TDM Hierarchy	9
IV	Differential Pulse Code Modulation, Delta Modulation. Adaptive Delta Modulation, Voice Coders, Sources of Noises, Frequency domain representation of Noise, Super position of Noises, Linear filtering of Noises, Mathematical Representation of Noise.	7
V	Noise in Amplitude Modulation: Analysis, Signal to Noise Ratio, Figure of Merit. Noise in Frequency Modulation: Pre-emphasis, De-Emphasis and SNR Improvement, Phase Locked Loops Analog and Digital.	7

Text Book:

1. Herbert Taub and Donald L. Schilling, "Principles of Communication Systems", Tata McGraw Hill.
2. Rishabh Anand, Communication Systems, Khanna Publishing House, Delhi

Reference Books:

1. B.P.Lathi,"ModernDigitalandAnalogcommunicationSystems",3rd Edition, Oxford University Press.
2. Simon Haykin, "Communication Systems", 4th Edition, Wiley India.
3. H.P.Hsu& D. Mitra "Analog and Digital Communications", 2nd Edition, Tata McGraw-Hill.

REC503	DIGITAL SIGNAL PROCESSING	
Unit	Topics	Lectures
I	Realization of Digital Systems: Introduction, direct form realization of IIR systems, cascade realization of an IIR systems, parallel form realization of an IIR systems, Ladder structures: continued fraction expansion of H (z), example of continued fraction, realization of a ladder structure, example of a ladder realization, FIR Filter Realization: Direct & Cascade, FIR Linear Phase Realization.	8
II	Design of Infinite Impulse Response Digital Filters: Introduction to Filters, Impulse Invariant Transformation, Bi-Linear Transformation, All- Pole Analog Filters: Butterworth and Chebyshev, Design of Digital Butterworth and ChebyshevFilters, Frequency Transformations.	8
III	Finite Impulse Response Filter Design: Windowing and the Rectangular Window, Other Commonly Used Windows, Examples of Filter Designs Using Windows, The Kaiser Window, Finite Word length effects in digital filters.	8
IV	DFT & FFT: Definitions, Properties of the DFT, Circular Convolution, Linear Convolution using Circular Convolution, Decimation in Time (DIT) Algorithm, Decimation in Frequency (DIF) Algorithm.	8
V	Multirate Digital Signal Processing: Introduction, Decimation, Interpolation, Sampling rate conversion: Single and Multistage, SubbandCoding of Speech signals, Quadrature mirror filters.	8

Text Book:

1. Johnny R. Johnson, .Digital Signal Processing., PHI Learning Pvt Ltd., 2009.

Reference Books:

1. John G Prokias, Dimitris G Manolakis, .Digital Signal Processing. Pearson Education.
2. Oppenheim & Schafer, . Digital Signal Processing. PHI

LABORATORY

REC551 INTEGRATED CIRCUITS LAB

Objective: - To design and implement the circuits to gain knowledge on performance of thecircuit and its application. These circuits should also be simulated on Pspice and implemented using TL082, LM741, NE555, ASLK, MPY634 KP connecting wires, Power Supply, function generator and oscilloscope.

1. Design and test a function generator that can generate square wave and triangular wave output for a given frequency and cascade a multiplier MPY634KP in feedback loop to form VCO
2. Voltage to current and current to voltage convertors.
3. Second order filters using operational amplifier in universal active filter topology for-
    - **a)** Low pass filter of specified cut off frequency.
    - **b)** High pass filter of specified frequency.
    - **c)** Band pass filter with unit gain of specified pass band
    - **d)** Design a notch filter to eliminate 50Hz power line frequency.
4. Wien bridge oscillator using operational amplifier.
5. Astable and mono-stable multivibrators using IC 555.
6. Design the following amplifiers:
    - **a)** A unity gain amplifier.
    - **b)** A non-inverting amplifier with a gain of "A".
    - **c)** An inverting amplifier with a gain of "A".
    - **d)** Log and antilog amplifiers.
    - **e)** Voltage comparator and zero crossing detectors.
7. Design and test a PLL to get locked to a given frequency „f". Measure the locking range of the system and also measure the change in phase of the output signal as input frequency is varied within the lock range.
8. Design and test the integrator for a given time constant.
9. Design and test a high-Q Band pass self-tuned filter for a given center frequency.
10. Design and test an AGC system for a given peak amplitude of sine-wave output.
11. Design and test a Low Dropout regulator using op-amps for a given voltage regulation characteristic and compare the characteristics with TPS7250IC.
12. Design of a switched mode power supply that can provide a regulated output voltage for a given input range using the TPS40200 IC.

Note: All listed experiments are compulsory. In addition to it, the Institutes may include more experiments based on the expertise.

REC552 **COMMUNICATION LAB-I**

List of Experiments

1. To study DSB/ SSB amplitude modulation & determine its modulation factor & power in side bands.
2. To study amplitude demodulation by linear diode detector.
3. To study frequency modulation and determine its modulation factor.
4. To study PLL 565 as frequency demodulator.
5. To study sampling and reconstruction of Pulse Amplitude modulation system.
6. To study the Sensitivity, Selectivity, and Fidelity characteristics of super heterodyne receiver.
7. To study Pulse Amplitude Modulation.
    a) using switching method
    b) by sample and hold circuit
8. To demodulate the obtained PAM signal by 2nd order LPF.
9. To study Pulse Width Modulation and Pulse Position Modulation.
10. To study Pulse code modulation and demodulation technique.
11. To study Delta modulation and demodulation technique.
12. Design and implement an FM radio receiver in 88-108 MHz

REC553 **DIGITAL SIGNAL PROCESSING LAB**

List of Experiments

1. To study about DSP Processors and architecture of TMS320C6713 DSP processor.
2. Introduction to MATLAB and Code Composer Studio or its equivalent open source software.
   OR
   Introduction to Scilab Open Source Software (Using Spoken Tutorial MOOCs)
3. Write a Program for the generation of basic signals such as unit impulse, unit step, ramp, exponential, sinusoidal and cosine.
4. To study matrix multiplication using code composer studio.
5. Evaluate 4 point DFT of and IDFT of $x(n) = 1, 0 \leq n \leq 3; 0$ elsewhere.
6. To implement FFT algorithm.
7. Verify Blackman and Hamming windowing techniques.
8. Implement IIR Butterworth analog Low Pass for a 4 KHz cut off frequency.
9. Verify Circular Convolution using code composer studio.
10. Verify Linear convolution of two sequence using code composer studio.
11. To implement Tone Generation.
12. To implement floating point arithmetic.

Spoken Tutorial (MOOCs):

Spoken Tutorial MOOCs, ' Course on Scilab', IIT Bombay (http://spoken-tutorial.org/)

REC554CAD OF ELECTRONICS LAB- I

PSPICE Experiments

1. (a)Transient Analysis of BJT inverter using step input.
   (b)DC Analysis (VTC) of BJT inverter with and without parameters.
2. (a)Transient Analysis of NMOS inverter using step input.
   (b)Transient Analysis of NMOS inverter using pulse input.
   (c)DC Analysis (VTC) of NMOS inverter with and without parameters.
3. (a) Analysis of CMOS inverter using step input.
   (b)Transient Analysis of CMOS inverter using step input with parameters.
   (c)Transient Analysis of CMOS inverter using pulse input.
   (d)Transient Analysis of CMOS inverter using pulse input with parameters.
   (e)DC Analysis (VTC) of CMOS inverter with and without parameters.
4. Transient &DC Analysis of NOR Gate inverter.
5. Transient & DC Analysis of NAND Gate.
6. Design and Simulation of a Differential Amplifier (with Resistive Load, Current Source Biasing)
7. Analysis of frequency response of Common Source amplifiers.
8. Analysis of frequency response of Source Follower amplifiers.
9. Analysis of frequency response of Cascode amplifiers.
10. Analysis of frequency response of Differential amplifiers.

DEPARTMENTAL ELECTIVE COURSE 1

REC051	ANTENNA AND WAVE PROPAGATION	
Unit	Topic	Lectures
I	Antennas Basics:Introduction, Basic Antenna Parameters, Patterns, Beam Area (or Beam Solid Angle) ΩA, Radiation Intensity, Beam Efficiency, Directivity D and Gain G, Directivity and Resolution, Antenna Apertures, Effective Height, The radio Communication link, Fields from Oscillating Dipole, Single-to-Noise Ratio(SNR), Antenna Temperature, Antenna Impedance.	5
II	Application to an Isotropic Source, Radiation Intensity, Arrays of Two Isotropic Point Sources, Non-isotropic but Similar Point Sources and the Principle of Pattern Multiplication, Pattern Synthesis by Pattern Multiplication, Linear Arrays of n Isotropic Point Sources of Equal Amplitude and Spacing, Linear Broadside Arrays with Non-uniform Amplitude Distributions. General Considerations.	8
III	Electric Dipoles, Thin Liner Antennas and Arrays of Dipoles and Apertures: The Short Electric Dipole, The Fields of a Short Dipole, Radiation Resistance of Short Electric Dipole, Thin Linear Antenna, Radiation Resistance of λ/2 Antenna, Array of Two Driven λ/2 Elements: Broadside Case and End-Fire Case, Horizontal Antennas Above a Plane Ground, Vertical Antennas Above a Plane Ground, Yagi-Uda Antenna Design, Long-Wire Antennas, folded Dipole Antennas.	8
IV	The Loop Antenna:Design and its Characteristic Properties, Application of Loop Antennas, Far Field Patterns of Circular Loop Antennas with Uniform Current, Slot Antennas, Horn Antennas, Helical Antennas, The Log-Periodic Antenna, Micro strip Antennas. Reflector Antennas: Flat Sheet Reflectors, Corner Reflectors, The Parabola-General Properties, A Comparison Between Parabolic and Corner Reflectors, The Paraboloidal Reflector, Patterns of Large Circular Apertures with Uniform Illumination, Reflector Types (summarized), Feed Methods for Parabolic Reflectors.	9
V	Ground Wave Propagation: Plane Earth Reflection, Space Wave and Surface Wave. Space Wave Propagation: Introduction, Field Strength Relation, Effects of Imperfect Earth, Effects of Curvature of Earth. Sky wave Propagation**:** Introduction structural Details of the ionosphere, Wave Propagation Mechanism, Refraction and Reflection of Sky Waves by ionosphere, Ray Path, Critical Frequency, MUF, LUF, OF, Virtual Height and Skip Distance, Relation Between MUF and the Skip Distance, Multi-Hop Propagation, Wave Characteristics	10

Text Book:

1. John D Krauss, Ronald J Marhefka and Ahmad S. Khan, “Antennas and Wave Propagation”, Fourth Edition, Tata McGraw Hill.

Reference Books:

1. A. R. Harish, M. Sachidananda, “Antennas and Wave Propogation”, Oxford University Press.
2. Edward Conrad Jordan and Keith George Balmain, “Electromagnetic Waves and Radiating Systems”, PHI.
3. R.L. Yadava, Electromagnetic Waves, Khanna Publishing House, Delhi.
4. A. Das, Sisir K. Das, “Microwave Engineering”, Tata McGraw Hill.

REC052	Computer Architecture and Organization	
Unit	**Topic**	**Lectures**
I	Introduction to Design Methodology: System Design - System representation, Design Process, the gate level (revision), the register level components and PLD (revision), register level design The Processor Level: Processor level components, Processor level design.	8
II	Processor basics: CPU organization- Fundamentals, Additional features Data Representation - Basic formats, Fixed point numbers, Floating point numbers. Instruction sets - Formats, Types, Programming considerations.	8
III	Data path Design: Fixed point arithmetic - Addition and subtraction, Multiplication and Division, Floating point arithmetic, pipelining.	8
IV	Control Design: basic concepts - introduction, hardwired control, Micro programmed control -introduction, multiplier control unit, CPU control unit, Pipeline control- instruction pipelines, pipeline performance.	8
V	Memory organization: Multi level memories, Address translation, Memory allocation, Caches - Main features, Address mapping, structure vs performance, System Organization: Communication methods- basic concepts, bus control. Introduction to VHDL.	8

TextBooks:

1. John P Hayes "Computer Architecture and Organisation", McGraw Hill Publication.

Reference Books:

1. M Morris Mano, "Computer System Architecture", Pearson Publication.
2. Carl Hamacher, ZvonkoVranesic and SafwatZaky, "Computer Organization and Embedded Systems", McGraw Hill Publication.
3. David A. Patterson and John L. Hennessy, "Computer Organization and Design: The Hardware/Software Interface", Elsevier Publication.
4. I. Singh, Computer Organisation and Architecture, Khanna Publishing House, Delhi

REC053	REAL TIME SYSTEMS	
Units	**Topic**	**Lectures**
I	**Introduction to Real Time** System Introduction to Real time Embedded System, need for a real-time system, different kinds (reactive, time driven, deadline driven, etc.,) Embedded system Design cycle, Types of Real Time systems, Real Time Applications and features, Issues in real time computing, aspects of real-time systems (timeliness, responsiveness, concurrency, predictability, correctness, robustness, fault tolerance and safety, resource limitations, RTOS necessity), real-time requirement specifications, modelling/verifying design tools (UML, state charts, etc.,).	8
II	**Embedded Hardware for Real Time** System Selection criteria for Real time system - Hardware and Software perspective, need for partitioning, criteria for partitioning (performance, criticality, development ease, robustness, fault tolerance and safety, resource limitations, etc.,), System Considerations, Basic development environment-host vs target concept, CPU features, Architecture, I/O Ports, on-chip peripherals, Memory, Real time implementation considerations, bus architecture, Introduction to Interrupts, Interrupt vector table, interrupt programming, Pipeline and Parallelism concepts.	10
III	**Embedded Hardware** – On chip Peripherals and Communication protocols Role of peripherals for Real time systems, On-Chip peripherals& hardware accelerators, Peripherals [Direct Memory Access, Timers, Analog to Digital Conversion (ADC), DAC, Comparator, Pulse Width Modulation (PWM)], Need of real time Communication, Communication Requirements, Timeliness, Dependability, Design Issues, Overview of Real time communication, Real time Communication Peripherals – I2C, SPI &UART. Introduction to the CCS IDE: its features, project options and basic examples Analog-to-Digital Converter Lab: Build a data acquisition system Control Peripherals Lab: Generate and graph a PWM waveform Direct Memory Access (DMA) Lab: Use DMA to buffer ADC results.	12
IV	**Embedded Software and RTOS** Software Architecture of real time System, Introduction to RTOS, role of RTOS, foreground Back ground system, pros and cons, Real time kernel, qualities of good RTOS, Functionalities of RTOS – Task Management, I/O management, Memory management, Inter Task Communication, Tasks, Task states, Task control block, attributes of TCB, Context switching, Interrupts handling, Multiprocessing and multitasking.	8
V	**Introduction to TI C2000:** Interface with actuators such as motor control enabling real time capabilities of C2000 Program to demonstrate the Task switching Simulation on CCS IDE To demonstrate the blink led application Using Hwi (Hardware Interrupt: periodically to produce an interrupt using Timers) of TI RTOS. Programming: demonstrate the Blink led application Using a Swi (Software interrupt) of TI RTOS To introduce two time-based SYS/BIOS services – Clock and Timestamp in TI RTOS; demonstrate the Task synchronization using Semaphores using TI RTOS; demonstrate Inter Task Communication Using of Mailboxes and Queues using TI RTOS; demonstrate the Communication Protocols – I2C, SPI and USART using TI.	10

Text Book:

1. Real-Time Systems by Jane W. S. Liu Prentice Hall Publication
2. Krishna .C.M "Real Time Systems" Mc-Graw Hill Publication.
3. Hamid A. Toliyat and Steven G. Campbell, "DSP based Electromechanical Motion Control" CRC Press Publication.
4. Jean J Labrosse, "Embedded System Design blocks", CMP books Publication
5. John H Davies, "MSP430 Microcontroller Basics" Newnes Publication.

Reference Book:

1. TMS320C28x CPU and Instruction Set Reference Guide, TI Literature Publication
2. TMS320x28xx, 28xxx DSP Peripheral Reference Guide, TI Literature Publication
3. C2000 Teaching CD ROM from Texas Instruments Publication
4. Introduction to the TI-RTOS Kernel Workshop Lab Manual, by Texas Instruments Publication

REC054	Artificial Neural Network	
Unit	**Topic**	**Lectures**
I	**Introduction to ANN:** Features, structure and working of Biological Neural Network Trends in Computing Comparison of BNN and ANN. **Basics of Artificial Neural Networks** - History of neural network research, characteristics of neural networks terminology, models of neuron McCulloch - Pitts model, Perceptron, Ada line model, Basic learning laws, Topology of neural network architecture	8
II	**Back propagation networks** : (BPN) Architecture of feed forward network, single layer ANN, multilayer perceptron, back propagation learning, input - hidden and output layer computation, back propagation algorithm, applications, selection of tuning parameters in BPN, Numbers of hidden nodes, learning.	8
III	**Activation & Synaptic Dynamics** : Introduction, Activation Dynamics models, synaptic Dynamics models, stability and convergence, recall in neural networks. **Basic functional units of ANN for pattern recognition tasks:** Basic feed forward, Basic feedback and basic competitive learning neural network. Pattern association, pattern classification and pattern mapping tasks.	8
IV	**a)Feedforward neural networks** -- Linear responsibility X-OR problem and solution. - Analysis of pattern mapping networks summary of basic gradient search methods. **b) Feedback neural networks Pattern** Storage networks, stochastic networks and simulated annealing, Boltzmann machine and Boltzmann learning.	8
V	**Competitive learning neural networks** : Components of CL network pattern clustering and feature. Mapping network, ART networks, Features of ART models, character recognition using ART network. **Applications of ANN**: Pattern classification - Recognition of Olympic games symbols, Recognition of printed Characters. Neocognitron - Recognition of handwritten characters. NET Talk: to convert English text to speech. Recognition of consonant vowel (CV) segments, texture classification and segmentation.	8

Text Book:

1. B. Yegnanarayana, "Artificial neural Networks", PHI Publication.

Reference Books:

1. S. Raj Sekaran ,VijayalakshmiPari," Neural networks, Fuzzy logic and Genetic Algorithms", PHI Publication.
2. Elaine Rich and Kevin Knight, "Artificial Intelligence", TMH Publication.

REC055	ADVANCE SEMICONDUCTOR DEVICES	
Unit	Topics	Lectures
I	Physics of Semiconductors, P-N Junction Diode and BJT: Introduction, Crystal Structure, Phonon, Optical, and Thermal Properties,*p-n* Junctions –Junction Breakdown, Transient Behavior and Noise Terminal Functions.BJT:Static Characteristics, Microwave Characteristics, Related Device Structures, Heterojunction Bipolar Transistor.	8
II	MOSFET, Hetero-Junctions and Basics of Nanostructures: MOSFET: Basic Device Characteristics, Nonuniform Doping and Buried Channel Device, Device Scaling and Short-Channel Effects, MOSFET Structures, Circuit Applications, Single Electron Transistor, JFETs. Hetero-junctions:Metal-Semiconductor Contacts, Metal-Insulator-Semiconductor Capacitors. MESFETs and MODFETs. Nanostructures: Basic Equations and Examples.	8
III	TUNNEL Devices and IMPATT Diodes: TUNNEL DEVICES:Tunnel Diode, Related Tunnel Devices, Resonant Tunneling Diode. IMPATT Diodes: Static Characteristics, Dynamic Characteristics, Power and Efficiency Noise Behavior, Device Design and Performance, BARITT Diode, TUNNETT Diode	8
IV	Power devices, Photonic devices:Transferred-Electron and Real-Space-Transfer Devices Thyristors, Power Devices. Photonic Devices and Sensors: Radiative Transitions, Light-Emitting Diode (LED), Laser Physics, Laser Operating Characteristics, Specialty Lasers	8
V	Photodetectors, Solar Cells and Sensors:Photodiodes, Avalanche Photodiode and Phototransistor, Charge-Coupled Device (CCD), Metal- Semiconductor-Metal Photodetector, Quantum-Well Infrared Photodetector, Solar Cell Sensors: Thermal Sensor, Mechanical Sensors, Magnetic Sensors and Chemical Sensors	8

Text Book:

1. S. M. Sze, Kwok K. NG, “Physics of Semiconductor Devices”, 3rd Edition, Wiley Publication

Reference Books:

1. J. P. Colinge and C. A. Colinge, "Physics Of Semiconductor Devices", Kluwer Academic Publishers
2. B. G. Streetman and S. Banerjee “Solid state electronics devices”, 5th Edition, PHI.
3. SupriyoDatta, “Quantum Transport Atom to Transistor”, Cambridge University Press, 2005
4. A.K. Maini, All in One Electronics Simplified, Khanna Publishing House, Delhi

RIC603 CONTROL SYSTEM-I		
Unit	**Topic**	**Lectures**
I	Basic Components of a control system, Feedback and its effect, types of feedback control systems. Block diagrams Reduction and signal flow graphs, Modeling of Physical systems: electrical networks, mechanical systems elements, equations of mechanical systems, sensors and encoders in control systems, DC motors in control systems, Analogous Systems.	8
II	State-Variable Analysis: Vector matrix representation of state equation, state transition matrix, state-transition equation, relationship between state equations and high-order differential equations, relationship between state equations and transfer functions. Similarity Transformation, Decomposition of transfer functions, Controllability and observability, Eigen Value and Eigen Vector, Diagonalization.	8
III	Time domain Analysis of Control Systems: Time response of continuous data systems, typical test signals for the time response of control systems, the unit step response and time-domain specifications, Steady-State error, time response of a first order system, transient response of a prototype second order system.	8
IV	Stability of Linear Control Systems: Bounded-input bounded-output stability continuous data systems, zero-input and asymptotic stability of continuous data systems, Routh Hurwitz criterion. Root-Locus Technique: Introduction, Properties of the Root Loci, Design aspects of the Root Loci.	8
V	Frequency Domain Analysis: Mr (resonant peak) and ωr (resonant frequency) and bandwidth of the prototype Second order system, effects of adding a zero to the forward path, effects of adding a pole to the forward path, Polar Plot, Nyquist stability criterion, relative stability: gain margin and phase margin, stability analysis with the Bode plot.	8

Text Book:

1. B.C. Kuo&FaridGolnaraghi, "Automatic Control Systems", 8th Edition, John Wiley India, 2008.

Reference Books:

1. I. J. Nagrath& M. Gopal, "Control System Engineering", New Age International Publishers
2. A. Ambikapathy, Control Systems, Khanna Publishing House, Delhi.
2. Joseph J. Distefano III, Allen R. Stubberud, Ivan J. Williams, "Control Systems" Schaums Outlines Series, 3rdEdition, Tata McGraw Hill, Special Indian Edition 2010.
3. William A. Wolovich, "Automatic Control Systems", Oxford University Press, 2010.

REC601	MICROWAVE ENGINEERING	
Unit	**Topics**	**Lectures**
I	**Rectangular & circular waveguides:Introduction to microwave communication and EM spectrum**, Rectangular wave guide: Field Components, TE, TM Modes, Dominant TE10 mode, Field Distribution, Power, Attenuation. Circular waveguides: TE, TM modes. Wave velocities, Microstrip transmission line (TL), Coupled TL, Strip TL, Coupled strip line, Coplanar TL, Microwave cavities	11
II	**Passive microwave devices:** Scattering matrix, Passive microwave devices: Microwave hybrid circuits, Terminations, Attenuators, Phase Shifters, Directional couplers: Two-hole directional couplers, S- Matrix of a directional coupler, Hybrid couplers, Microwave propagation in ferrites, Faraday rotation, Isolators, Circulators. S-parameter analysis of all components.	10
III	**Microwave tubes :**Microwave tubes: Limitations of conventional active devices at microwave frequency, Two cavity Klystron, Reflex Klystron, Magnetron, Traveling wave tube, Backward wave oscillators, Gyro Devices: Their schematic, Principle of operation, Performance characteristic and their applications.	7
IV	**Solid state amplifiers and oscillators:** Transferred electron devices: Gunn-effect diodes & modes of operation. Avalanche transit – time devices: IMPATT diode, TRAPPAT diode, BARITT diode.	5
V	**Microwave Measurements:** VSWR meter, Frequency meter, Spectrum analyser, Network analyser,Tunable detector, Slotted line carriage, Power meter, Microwave power measurement, Insertion loss and attenuation measurement, VSWR measurement, Return loss measurement by a reflectometer, Frequency measurement, measurement of cavity Q, Dielectric constant measurement of a solid, EM radiation & measurement.	7

Text Books:

1. G. S. Raghuvanshi, Microwave Engineering; Cengage
2. S.Y. Liao, Microwave Devices & Circuits; PHI 3rd Ed.

Reference Books:

1. A Das and S.K. Das, Microwave Engineering; McGraw Hill Education
2. S. Vasuki, D Margaret Helena, R Rajeswari, Microwave Engineering; MHE
3. M.I. Skolnik, Introduction to Radar Engineering ; TMH
4. Om P. Gandhi, Microwave Engineering and Applications; Pergamon Press

REC602	DIGITAL COMMUNICATION	
Unit	**Topic**	**Lectures**
I	Principles of digital data transmission: Digital Data transmission, Line coding review, Pulse shaping, Scrambling, Digital receivers, Eye diagram, Digital carrier system. Method of generation and detection of coherent & non-coherent binary ASK, FSK & PSK, Differential phase shift keying, Quadrature modulation techniques. (QPSK and MSK), M-ary Digital carrier Modulation.	08
II	Fundamentals of probability theory & random process : Concept of Probability, Random variable, Statistical averages, Correlation, Sum of Random Variables, Central Limit Theorem, Random Process, Classification of Random Processes Power spectral density, Multiple random Processes.	08
III	Performance Analysis of Digital communication system: Optimum linear Detector for Binary polar signaling, General Binary Signaling, Coherent Receivers for Digital Carrier Modulations, Signal Space Analysis of Optimum Detection, Vector Decomposition of White Noise Random processes, General Expression for Error Probability of optimum receivers	08
IV	Spread spectrum Communications: Frequency Hopping Spread Spectrum(FHSS) systems, Direct Sequence Spread Spectrum, Code Division Multiple Access of DSSS, Multiuser Detection, OFDM Communications Introduction to information theory: Measure of Information, Source Encoding, Error Free Communication over a Noisy Channel. Capacity of a discrete and Continuous Memory less channel.	08
V	Error Correcting codes: Hamming sphere, hamming distance and Hamming bound, relation between minimum distance and error detecting and correcting capability Linear block codes: encoding and syndrome decoding. Cyclic codes: encoder and decoder for systematic cyclic codes. Convolution codes, code tree and Trellis diagram, Viterbi and sequential decoding, Burst error correction, Turbo codes.	08

Text Book:

1. B.P. Lathi, “Modern Digital and Analog communication Systems”, 4th Edition, Oxford University Press, 2010.
2. RishabhAnand, Communication Systems, Khanna Publishing House, Delhi.

Reference Books:

1. H. Taub, D L Schilling, GautamSaha, “Principles of Communication”, 3rd Edition, Tata McGraw-Hill Publishing Company Ltd.
2. John G. Proakis, “Digital Communications”, 4th Edition, McGraw-Hill International.
3. Simon Haykin, “Communication Systems”, 4th Edition, Wiley India.
4. H P HSU & D Mitra, “Analog and Digital Communications”, 2nd Edition, Tata McGraw-Hill Publishing Company Ltd.

LABORATORY

REC651 **MICROWAVE ENGINEERING LAB**

List of Experiments

1. To study microwave test bench.
2. To study the characteristics of reflex klystron tube and to determine its electronic tuning range.
3. To determine the frequency and wavelength in a rectangular waveguide working on TE_{01} mode.
4. To study measurement of reflection coefficient and standing wave ratio using double minima method.
5. To study V-I characteristic of Gunn diode.
6. To measure an unknown impedance with Smith chart.
7. Study of Circulator/Isolator.
8. Study of Attenuator (Fixed and Variable type).
9. To study simple dipole $\lambda/2$ antenna and to calculate beam-width, front / back ratio, and gain of the antenna.
10. To study folded dipole antenna and to calculate beam-width, front / back ratio, and gain of the antenna.
11. To study $\lambda/2$ phase array end-fire antenna and to calculate beam-width, front / back ratio, and gain of the antenna.
12. To study broadside array antenna and to calculate beam-width, front / back ratio, and gain of the antenna.

REC652 **COMMUNICATION LAB – II**

List of Experiments

1. To construct a Square wave with the help of Fundamental Frequency and its Harmonic component
2. Study of pulse data coding & decoding techniques for NRZ and RZ formats.
3. Study of Manchester coding and Decoding.
4. Study of Amplitude shift keying modulator and demodulator.
5. Study of Frequency shift keying modulator and demodulator.
6. Study of Phase shift keying modulator and demodulator.
7. Study of single bit error detection and correction using Hamming code.
8. Study of Quadrature Phase shift keying modulator and demodulator.
9. To simulate Differential Phase shift keying technique using MATLAB software.
10. To simulate M-ary Phase shift keying technique using MATLAB software (example8PSK, 16PSK) and perform BER calculations.
11. To simulate convolutional coding using MATLAB software.
12. Design a front end BPSK modulator and demodulator.

RIC653CONTROL SYSTEM LAB-I

List of Experiments:

1. Different Toolboxes in MATLAB, Introduction to Control Systems Toolboxor its equivalent open source freeware software like Scilabusing Spoken Tutorial MOOCs.
2. Determine transpose, inverse values of given matrix.
3. Plot the pole-zero configuration in s-plane for the given transfer function.
4. Determine the transfer function for given closed loop system in block diagram representation.
5. Plot unit step response of given transfer function and find delay time, rise time, peak time and peak overshoot.
6. Determine the time response of the given system subjected to any arbitrary input.
7. Plot root locus of given transfer function, locate closed loop poles for different values of k. Also find out Wd and Wnat for a given root.
8. Create the state space model of a linear continuous system.
9. Determine the State Space representation of the given transfer function.
10. Plot bode plot of given transfer function. Also determine the relative stability by measuring gain and phase margins.
11. Determine the steady state errors of a given transfer function.
12. Plot Nyquist plot for given transfer function and to discuss closed loop stability. Also determine the relative stability by measuring gain and phase margin.

Spoken Tutorial (MOOCs):

Spoken Tutorial MOOCs, ' Course on Scilab', IIT Bombay (http://spoken-tutorial.org/)

RIC651 MICROCONTROLLERS FOR EMBEDDED SYSTEMS LAB

1. Write a program of Flashing LED connected to port 1 of the 8051 Micro Controller
2. Write a program to generate 10 kHz square wave using 8051.
3. Write a program to show the use of INT0 and INT1 of 8051.
4. Write a program for temperature & to display on intelligent LCD display.
5. Write a program to generate a Ramp waveform using DAC with micro controller.
6. Write a program to Interface GPIO ports in C using MSP430 (blinking LEDs , push buttons)
7. Write a program Interface potentiometer with GPIO.
8. Write a program of PWM based Speed Control of Motor controlled by potentiometer connected to GPIO.
9. Write a program of PWM generation using Timer on MSP430 GPIO.
10. Write a program to Interface an accelerometer.
11. Write a program using USB (Sending data back and forth across a bulk transfer-mode USB connection.)
12. Write a program for Master Slave Communication between 2 MSP430s using SPI
13. Write a program of basic Wi-Fi application – Communication between two MSP430 based sensor nodes.
14. Setting up the CC3100 as a HTTP server.
15. Review of User APIs for TI CC3100 & Initialization and Setting of IP addresses.

DEPARTMENTAL ELECTIVE COURSE 2

REC061	INDUSTRIAL ELECTRONICS	
Unit	Topics	Lectures
I	**Power Semiconductor Devices**: Power semiconductor devices their symbols and static characteristics and specifications of switches, types of power electronic circuits Operation, steady state & switch characteristics & switching limits of Power Transistor Operation and steady state characteristics of Power MOSFET and IGBT Thyristor – Operation V- I characteristics, two transistor model, methods of turn-on Operation of GTO, MCT and TRIAC.	8
II	**Phase Controlled Rectifiers:** Phase Angle Control, Single-phase Half-wave Controlled Rectifier (One quadrant), Single-phase Full-wave Controlled Rectifier (Two quadrant Converters),Performance Factors of Line-commutated Converters, The Performance Measures of Two-pulse Converters, Three phase Controlled Converters **Inverters**: Introduction Thyristor Inverter Classification, Series Inverters, Parallel Inverter, Three-phase Bridge Inverters, Three-phase Bridge Inverter with Input-circuit Commutation.	8
III	**Choppers:** Introduction, Principle of Chopper Operation, Control Strategies, stepup/Down Chopper, Jones Chopper. Introduction to basic Cycloconverters. Control of D.C. Drives: Introduction, Basic Machine Equations, Breaking Modes, Schemes for D.C. Motor Speed Control, Single-phase Separately Excited Drives, Braking Operation of Rectifier Controlled Separately excited Motor, Single-phase Separately Excited Drives, Power Factor Improvement, Three-phase Separately Excited Drives, D.C. Chopper Drives	8
IV	**Control of A.C. Drives:** Introduction, basic Principle of Operation, Squirrel-cage Rotor Design, Speed Control of Induction Motors, stator Voltage Control, Variable Frequency control, Rotor Resistance Control, Slip Power Recovery Scheme, Synchronous Motor Drives	8
V	Protection of device and circuits: Introduction, Cooling and heat sinks, Thermal Modeling of Power Switching devices, Snubber Circuits, Reverse Recovery Transients, Supply- and Load- side Transients, Voltage Protection, Current Protections, Electromagnetic Interference.	8

Text Books:

1. M. H. Rashid, “Power Electronics”, 3rd Edition, Pearson Education.
2. M. D. Singh & K. Khanchandani, “Power Electronics”, Tata McGraw Hill.

Reference Books:

1. V.R. Moorthy, “Power Electronics: Devices, Circuits and Industrial Applications”, Oxford University Press,2007.
2. M.S. JamilAsghar, “Power Electronics”,PHI.
3. Chakrabarti&Rai, “Fundamentals of Power Electronics &Drives”DhanpatRai& Sons.
4. Ned Mohan, T.M.Undeland and W.P.Robbins, “Power Electronics:Converters, Applications and Design”, Wiley India.
5. S.N.Singh, “A Text Book of Power Electronics”,DhanpatRai& Sons.

REC602 MICROCONTROLLER FOR EMBEDDED SYSTEMS		
Unit	**Topic**	**Lectures**
I	Introduction , Microcontrollers and Embedded systems, Overview of the 8051, Inside the 8051, Addressing modes, assembly programming, 8051 data types and directives, Interfacing with 8051, Programming the 8051 timers	6
II	MSP430x5x series block diagram, address space, on-chip peripherals (analog and digital), and Register sets. Instruction set, instruction formats, and various addressing modes of 16-bit microcontroller; Sample embedded system on MSP430 microcontroller. Memory Mapped Peripherals, programming System registers, I/O pin multiplexing, pull up/down registers, GPIO control. Interrupts and interrupt programming.	
III	Watch dog timer, system clocks, Timer & Real Time Clock (RTC), PWM control, timing generation and measurements. Analog interfacing and data acquisition ADC and Comparator in MSP430, data transfer using DMA.	10
IV	Serial communication basics, Synchronous/Asynchronous interfaces (like UART, USB, SPI, and I2C). UART protocol, I2C protocol, SPI protocol. Implementing and programming UART, I2C, SPI interface using MSP430, Interfacing external devices.	10
V	Internet of Things (IoT) overview and architecture, Overview of wireless sensor networks and design examples. Various wireless connectivity: NFC, ZigBee, Bluetooth, Bluetooth Low Energy, Wi-Fi. Adding Wi-Fi capability to the Microcontroller, Embedded Wi-Fi, User APIs for Wireless and Networking applications, Building IoT applications using CC3100 user API for connecting sensors.	6

Text Book:

1. Mazidi Ali Muhammad, MazidiGillispie Janice, and McKinlayRolin D " The 8051 Microcontroller and Embedded Systems using Assembly and C", Pearson Publication.
2. John H Davies, "MSP430 Microcontroller Basics" Newnes Publication.

Reference Book:

1. TI MSP430x5xx and MSP430x6xx Family User's Guide.

REC063	ANALOG SIGNAL PROCESSING	
Unit	Topics	Lectures
I	Introduction to domains and the analogue/digital trade off, Introduction to current conveyor, current feedback amplifier. Analog signal filtering: introduction to bilinear transfer functions and active realizations. Second-order filter realization, filter design parameters (Q and ω_0), frequency response, Three op-amp biquad, effect of finite gain of op-amp over filters, Sallen-Key biquad.	10
II	Ideal low-pass filter, Buttreworth and Chebyshev magnitude response, pole locations, low-pass filter specifications, comparison of Maximally flat and Equal ripple responses.	8
III	Delay equalization: equalization procedures, equalization with first-order and second order modules, strategies for equalization design. Definition of Bode sensitivity.	7
IV	The General Impedance Convertor (GIC), optimal design of the GIC, realization of simple ladders, Gorski-Popiel's Embedding Technique, Bruton's FDNR technique, creating negative components.	8
V	Elementary transconductor building blocks, resistors, integrators, amplifiers, summers, Gyrator, First and second order filters, Higher order filters	**7**

Text Book:

1. R. Schaumann and M.E. Valkenberg,"Design of Analog Circuits", Oxford University Press

REC064	ADVANCED DIGITAL DESIGN USING VERILOG	
Unit	**Topic**	**Lectures**
I	ntroduction to Mixed Logic, Logic Representation and Minimization with cost, Multiple output minimization, Entered Variable K- Map including don't care handling, XOR Pattern Handling.	8
II	Combinational Circuit Design, Multiplexers, Decoders, Encoders, Code Comparators, Adders, Subtractors, Multipliers, Introduction to Verilog, Behavioral and Structural specification of logic circuits, Boolean function implementation using Verilog, Timing Analysis, Hazard Detection and Elimination	8
III	Synchronous Sequential Circuits Design, Mapping Algorithm, Synchronous StateMachines, ASM Charts, Asynchronous Sequential Circuit Design, Races, Multi-levelminimization and optimization.	8
IV	Factoring, Decomposition, BDD, Ordered BDD, LPDD, Fault Detection and Analysis incombinational and sequential systems, Path Sensitization method, Boolean DifferenceMethod, Initial State Method.	8
V	Study of programmable logic families, PLD, CPLD, FPGA, ASIC, PLA, Architectures,Design of Combinational and sequential circuits using CPLD and FPGA, Design Examples.	8

Text Books:

1. Richard F. Tinder, "Engineering Digital Design", Academic Press.
2. Parag K. Lala, "Digital system Design Using PLDs", PHI India Ltd.
3. Stephen Brown and ZvonkoVranesiv, "Fundamental of Digital Logic with Verilog Design", Tata McGraw Hill.

Reference Books:

1. John Williams, "Digital VLSI Design with Verilog", Springer Publication.
2. Eugene Fabricius, "Modern Digital Design and Switching Theory", CRC Press.
3. Samuel C. Lee, "Digital Circuit and Logic Design", PHI India Ltd.
4. Alexander Miczo, "Digital Logic Testing and Simulation",WileyInterscience.

REC065RADAR ENGINEERING

Unit	Topics	Lectures
I	**Introduction to Radar:** Basic radar, The simple form of radar equation, Radar block diagram, Radar frequencies, Applications to radar.	5
II	**Radar Equation:** Introduction, Detection of signal in noise, Receiver noise and the signal to noise ratio, Probability density functions, Probabilities of detection and false alarm, Integration of Radar pluses, Radar cross section of targets, Radar cross section fluctuations, Transmitter power, Pulse repetition frequency, antenna parameters, system losses, Other Radar equation considerations.	9
III	**MTI and Pulse Doppler Radar:** Introduction to Doppler and MTI Radar, Delay-Line cancelers, Staggered pulse repetition frequencies, Doppler filter banks, Digital MTI processing, Moving target detector, Limitation of MTI performance, MTI from a moving platform, Pulse Doppler Radar, CW Radar.	9
IV	**Tracking Radar:** Tracking with Radar, Mono-pulse tracking, Conical scan and sequential lobbing, Limitation to tracking accuracy, Low-angle tracking, Tracking in range, Comparison of trackers, Automatic tracking with Surveillance Radar (ADT)	8
V	**Information from Radar signals:** Basic Radar measurements, Ambiguity diagram, Pulse compression, Target recognition. **Radar Clutter:** Land clutter, Sea clutter, Weather clutter and detection of targets in clutter.	9

Text Book:

1. Merrill I. Skolnik“ Introduction to Radar Systems” Third Edition.

Reference Book:

1 J.C. Toomay , Paul J. Hannen “ Principles of Radar” Third Edition.
2 GottapuSasibhusanaRao, “Microwave and Radar Engineering, Pearson.
3 Bernard Davis,George Kennedy, Electronic Communication Systems, Tata McGraw-Hill Education Pvt. Ltd.