DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
Vasavi College of Engineering (A), Hyderabad 500031

SCHEME OF INSTRUCTION AND EXAMINATION FOR
M.E. (ECE) – CE&SP
With effect from Academic year 2016-17

Sl. No.	Category	Subject code	Subject Title	Scheme of Instruction			Scheme of Examination			Total	Credits
				L	T	P	Duration in Hrs	CIE	Sem end Exam		
I – SEMESTER											
			Theory								
1.	PC		Professional Core	3	0	0	3	30	70	100	3
2.	PC		Professional Core	3	0	0	3	30	70	100	3
3.	PC		Professional Core	3	0	0	3	30	70	100	3
4.	PE		Professional Core / Elective	3	0	0	3	30	70	100	3
5.	PE		Professional Elective	3	0	0	3	30	70	100	3
6.	PE		Professional Elective	3	0	0	3	30	70	100	3
7.	EEC		Finishing School - I: Soft Skills	2	0	0	2	15	35	50	1
			Laboratory								
8.	PC		Advanced Signal Processing Laboratory	0	0	3	3	25	0	25	2
9.	PC		Embedded Systems Laboratory	0	0	3	3	25	0	25	2
10.	EEC		Seminar – I	0	0	2	0	25	0	25	1
				20	0	8	-	270	455	725	**24**
II – SEMESTER											
			Theory								
1.	PC		Professional Core	3	0	0	3	30	70	100	3
2.	PC		Professional Core	3	0	0	3	30	70	100	3
3.	PC		Professional Core / Elective	3	0	0	3	30	70	100	3
4.	PE		Professional Elective	3	0	0	3	30	70	100	3
5.	PE		Professional Elective	3	0	0	3	30	70	100	3
6.	PE		Professional Elective	3	0	0	3	30	70	100	3
7.	EEC		Finishing School – II: Soft Skills	2	0	0	1.5	15	35	50	1
			Laboratory								
8.	PC		Communication Systems Simulation Laboratory	0	0	3	3	25	0	25	2
9.	PC		DSP Processors Applications Laboratory	0	0	3	3	25	0	25	2
10.	EEC		Seminar –II	0	0	2	0	25	0	25	1
				20	0	8	-	270	455	725	**24**
III – SEMESTER											
1.	PC		Dissertation seminar	0	0	4	0	50	0	50	2
2.	PC		Dissertation – Phase I	0	0	16	0	100	0	100	8
				0	0	20	-	150	0	150	**10**
IV - SEMESTER											
1.	PC		Dissertation – Phase II	0	0	30	-	Viva-voce (Grade)			15
				0	0	30	-	--			**15**

S. No.	Syllabus Ref. No.	Subject	Periods per week
Professional Core Subjects			
1.	EC 6000	Microcontrollers and DSP Processors – Architecture	3
2.	EC 6001	Advance Digital Signal Processing	3
3.	EC 6002	Coding Theory and Techniques	3
4.	EC 6003	Advance Digital Modulation Techniques	3
5.	EC 6004	Wireless Communications and Networking	3
6.	EC 6005	Image and Video Processing	3
7.	EC 6007	Advanced Signal Processing Laboratory	3
8.	EC 6017	Embedded Systems Laboratory	3
9.	EC 6027	Communication Systems Simulation Laboratory	3
10.	EC 6037	DSP Processors Applications Laboratory	3
11.	EC 6018	Seminar – I	3
12.	EC 6028	Seminar – II	3
13.	EC 6038	Dissertation seminar	4
14.	EC 6019	Dissertation – Phase I	16
15.	EC 6029	Dissertation – Phase II	30
Professional Electives : Communication Engineering			
16.	EC 6100	Spread Spectrum and CDMA Systems	3
17.	EC 6101	Advanced Optical Communication	3
18.	EC 6102	MIMO Communication Systems	3
19.	EC 6103	Global Navigational Satellite Systems	3
20.	EC 6104	Network Security and Cryptography	3
21.	EC 6105	Software Defined and Cognitive Radio	3
22.	EC 6106	Detection and Estimation Theory	3
23.	EC 6110	Principles of Communication Systems Simulation with Wireless Applications	3
24.	EC 6111	Advanced Wireless Communication	3
25.	EC 6112	Smart Antennas for Mobile Communications	3
26.	EC 6113	Data and Computer Communication Networks	3
Professional Electives : Signal Processing			
27.	EC 6200	Array Signal Processing	3
28.	EC 6201	Adaptive Signal Processing	3
29.	EC 6202	Audio and Speech Signal Processing	3
30.	EC 6203	Bio-Medical Signal Processing	3
31.	EC 6204	Statistical Signal Processing	3
32.	EC 6205	Radar Signal Processing	3
33.	EC 6206	Data Compression Methods	3
34.	EC 6210	Wavelets & Applications	3
35.	EC 6211	CODECS for Multimedia Applications	3
36.	EC 6212	Soft Computing Techniques	3
37.	EC 6213	Internet of Things	3

EC 6000

MICROCONTROLLERS AND DSP PROCESSORS - ARCHITECTURE

Instruction	3 Periods per week	External Examination - Duration	3 Hours
Sessionals	30 Marks	External Examination - Marks	70 Marks
Credits	03		

UNIT – I

C51 Architecture, Instruction set, Addressing modes, Programming on-chip peripherals: Timers and counters, serial communication, Interrupt programming in Embedded- C.

UNIT – II

C51 interfacing with External Memory, Expansion of I/O ports with PPI (8255), C51 real world interfacing using Embedded C: ADC 0804, DAC, LCD, Keyboard, Stepper motor.

UNIT – III

Architectural features of programmable Digital signal processing Devices: Introduction, Basic Architectural features, DSP computational building blocks-Multipliers, shifter, MAC, ALU, Bus architecture and memory-on-chip memory, organization of on-chip memory, Data addressing capabilities, Address generation unit, Programmability and program execution, Speed issues, Q-notation.

UNIT – IV

Programmable Digital signal processors: Introduction, Commercial Digital Signal Processing Devices, Data addressing modes of TMS320C54XX processors, Memory space of TMS320C54XX processors, Program Control, TMS320C54XX Instructions and programming.

UNIT – V

Programmable Digital Signal processors on-chip peripherals, Interrupts of TMS320C54XX processors, pipeline operation of TMS320C54XX processors.
Applications using DSPs: FIR, IIR filter Design.

Suggested Reading:

1. Mazidi M.A and Mazidi J.G,"The 8051 Microcontroller and Embedded Systems", Pearson 2007.
2. Avtar Singh, S. Srinivasan "Digital Signal Processing Implementations: Using DSP Microprocessors--With Examples from TMS320C54xx", Cengage Learning (2004)
3. Kenneth Ayala,"The 8051 Microcontroller" 3rd Edition, Cengage Learning (2004).
4. B. Venkataramani, M. Bhaskar, "Digital Signal Processors, Architecture Programming and Applications", Tata Mc Graw Hill,2002.

EC 6001

ADVANCE DIGITAL SIGNAL PROCESSING

Instruction	3 Periods per week	External Examination - Duration	3 Hours
Sessionals	30 Marks	External Examination - Marks	70 Marks
Credits	03		

UNIT – I

Review of discrete time signals and systems: Linearity, Time invariance, Stability, Causality, LTI systems, Discrete convolution, Correlation, Linear constant coefficient difference equations, Fourier transform for discrete time signals, Frequency response, Discrete Fourier transform, DFT computation Using the Goertzel Algorithm and the Chirp Transform, The Sampling Process of Analog Signals, Sample and Hold, Quantization, Analysis of Quantization Errors, Effect of sampling in frequency domain, Nyquist sampling theorem, The sampling of Bandpass Signals, Discrete-time processing of continuous time signals, Z-transform, Rational transfer function, Frequency response from poles and zeros of the transfer function.

UNIT – II

Digital filters design: Design of Optimal FIR filters, Structures for FIR filters realization, Design Two-Band Digital Crossover Using FIR Filters, IIR Filters Design using bilinear transformation Method and structures for IIR filters realization, Finite word length effects in IIR filter, Application examples.

UNIT – III

Basics of multirate signal processing: Down sampling, Up sampling, Relation between the Fourier transform of the input and output of the down sampling and up sampling, Representation of decimator and interpolator, Changing the sampling rate by noninteger factor, Multistage approach to sampling rate conversion, Design of practical sampling rate converters, Polyphase decomposition of decimator and interpolator, Oversampling ADC analysis, Application examples.

UNIT – IV

Multirate Filter banks: Uniform DFT filter banks, Two channel quadrature mirror filter (QMF) bank, Filter bank structure, Analysis of two channel QMF filter bank. Design of linear phase perfect reconstruction QMF filter banks, Cosine modulated filter banks, Maximally decimated filter banks, Tree structured filter banks, Octave-band filter banks, Application examples.

UNIT – V

Wavelet transforms: Time frequency representation of signals, short-time Fourier transform (STFT), The Gabor transform, Scaling functions and wavelets, Discrete wavelet transform (DWT), Multi-resolution analysis (MRA), Wavelet reconstruction, design of decomposition and reconstruction filters for Haar, Daubechies and biorthogonal wavelets, Digital filter implementation of wavelets, Application examples.

Suggested Reading:

1. K. Deergha Rao and MNS Swamy, "Digital Signal Processing", Jaico Publishing House, 2012.
2. Sanjit K. Mitra, "Digital Signal Processing", 3/e, Tata McGraw-Hill Edition, 2006.
3. Alan V. Oppenheim & Ronald W. Schafer, "Discrete-Time Signal Processing", 2/e, Pearson Education, 2002.
4. Emmanuel C. Ifeachor & Barrie W. Jervis, "Digital Signal Processing", 2/e Pearson Education, 2003.
5. P.P. Vaidyanathan, "Multirate Systems and Filter Banks", Pearson Education, 2004.

EC 6002

CODING THEORY AND TECHNIQUES

Instruction	3 Periods per week	External Examination - Duration	3 Hours
Sessionals	30 Marks	External Examination - Marks	70 Marks
Credits	03		

UNIT – I

Introduction: Digital communication system, Wireless channel statistical models, BER performance in AWGN and fading channels for different modulation schemes, BER performance of CDMA, FH – CDMA in AWGN and fading channels, capacity of fading channels with CSI, Diversity reception, channel coding Theorem, Channel coding gain.

UNIT – II

Block Coding: Galois fields, polynomials over Galois fields, RS codes, Decoding Techniques for RS codes, LDPC encoder and decoder, Performance analysis of RS and LDPC codes. BCH codes.

UNIT – III

Convolution codes: Linear convolution encoders, Structural properties of Convolution codes, Viterbi decoding technique for convolution codes – Soft / Hard decision, concatenation of block codes and convolutional codes, performance analysis, concept of Trellis coded modulation.

UNIT – IV

Turbo Codes: Parallel concatenation, Turbo encoder, Iterative decoding using BCJR algorithm, Performance analysis.

UNIT – V

Space – Time Coding: MIMO systems, MIMO fading channels, rate gain & diversity gain, transmit diversity, Alamouti scheme, OSTBC codes, Linear space – time codes, trellis space – time codes, Space – time codes with no CSI

Suggested Reading:

1. K. Deergha Rao, Channel Coding Techniques for Wireless Communications, Springer, 2015.
2. E. Biglieri, Coding for Wireless Channels, Springer, 2007.
3. S.B. Wicker, Error control systems for Digital communication and Storage, Prentice Hall, 1995.
4. K.L.Du & M.N.S.Swamy, Wireless Communication: From RF to 4G Enabling Technologies, Cambridge, 2010.
5. J.G. Proakis & M. Salehi, Digital Communications, Mc Graw-Hill, 2008.

EC 6004

DIGITAL MODULATION TECHNIQUES

Instruction	3 periods per week	External Examination – Duration	3 Hours
Sessionals	30 Marks	External Examination – Marks	70 Marks
Credits	03		

UNIT – I

Review of fundamental concepts and parameters in Digital Communication. Digital modulation schemes, Power spectra of digital modulation signals.

UNIT – II

Performance of carrier modulation schemes : Performance of BPSK and QPSK in AWGN Channel, Performance of Binary FSIC in M-ary PSK in AWGN Channel, Minimum Shift keying (MSK) Modulation, GMSK continuous phase modulation(CPM) schemes.

UNIT – III

Channel characterization and modeling: Optimum receivers for AWGN Channels, Equalization techniques, Orthogonal Frequency Division Multiplexing (OFDM). Carrier Synchronization, Timing synchronization.

UNIT – IV

Introduction to spread spectrum modulation, Direct Sequence modulation, spreading codes, Advantage of CDMA for wireless, Code Synchronization, Code Acquisition and tracking. Channel estimation, Power control, the near-far problem, FEC coding and CDMA, Frequency Hopping spread spectrum, Complex baseband representation of FHSS, slow and fast frequency hopping, Processing gain.

UNIT – V

Spread spectrum as a Multiple access technique: Multi channel and Multi carrier systems; Digital Communication through fading multipath channels; Multi user communications. 'Space diversity on Receiver' technique, MIMO antenna systems, Space time codes for MIMO wireless Communication, Differential space time block codes, SDMA, Smart antennas.

Suggested Reading:

1. John G. Proakis and Masoud Salehi, "Digital Communications," McGraw Hill, 5/e, 2008.
2. Stephen G. Wilson, "Digital Modulation and coding," Pearson Education, 2010.
3. Simon Haykin and Michael Moher, "Modern Wireless Communications," Pearson Education, 2005.
4. Marvin K. Simon, Sami M. Hinedi and W. C. Lindsay, "Digital Communication Techniques," Eastern Economy Edition, 2010.
5. Andrew J Viterbi, "CDMA principles spread spectrum communications," Adison Wesley, 1995.

EC 6004

WIRELESS COMMUNICATIONS AND NETWORKING

Instruction	3 Periods per week	External Examination - Duration	3 Hours
Sessionals	30 Marks	External Examination - Marks	70 Marks
Credits	03		

UNIT - I

Radio Propagation Characteristics: Models for path loss, shadowing and multipath fading (delay spread, coherence band width, coherence time, Doppler spread), Jakes channel model, Digital modulation for mobile radio, analysis under fading channels:

UNIT – II

Wireless Communication Techniques: Diversity techniques and RAKE demodulator, channel coding techniques, multiple access techniques used in wireless mobile communications. Space time propagation, wireless channel, channel as a space time random field, space time channel and signal models, capacity of space time channels, spatial diversity, space time receivers, space time coding with channel knowledge, space time OFDM.

UNIT – III

Wireless networks: WLAN, Bluetooth. Suitable mini-projects in the areas of Space-Time codes and OFDM. The cellular concept: Frequency reuse: The basic theory of hexagonal cell layout: Spectrum efficiency, FDM / TDM cellular systems: Channel allocation schemes, Handover analysis, Erlang capacity comparison of FDM / TDM systems and cellular CDMA. GSM and CDMA cellular standards.

UNIT – IV

Signaling and call control: Mobility management, location tracking. Wireless data networking, packet error modeling on fading channels, performance analysis of link and transport layer protocols over wireless channels.

UNIT – V

Wireless/Wireline interworking: Mobile IP, WAP, Mobile ad-hoc networks. Wireless data in GSM, IS – 95 and GPRS. Space time Wireless Communications.

Suggested Reading:

1. Theodore S. Rappaport, "Wireless Communications: Principles and Practice," Pearson Education, 2011.
2. John G. Proakis and Masoud Salehi, "Digital Communications," McGraw Hill, 5/e, 2008.
3. William Stallings, "Wireless Communications and Networking," PHI, 2006.
4. C Sivarama Murthy and B S Manoj, "Ad-Hoc Wireless Networks: Architectures and Protocols," Pearson Education, 2011.
5. Jon W. Mark and Weihua Zhuang, "Wireless Communications and Networking," PHI, 2005.
6. Vijay K. Garg, "Wireless Communications and Networking," Elsevier, 2011.

EC 6005

IMAGE AND VIDEO PROCESSING

Instruction	3 Periods per week	External Examination - Duration	3 Hours
Sessionals	30 Marks	External Examination - Marks	70 Marks
Credits	03		

UNIT – I

Fundamentals of Image Processing and Image Transforms: Basic steps of Image Processing System, Sampling and Quantization of an image, relationship between pixels. Image Transforms: 2 D- Discrete Fourier Transform, Discrete Cosine Transform (DCT), Wavelet Transforms: Continuous Wavelet Transform, Discrete Wavelet Transforms.

UNIT – II

Image Processing Techniques: Image Enhancement: Spatial domain methods: Histogram processing, Fundamentals of Spatial filtering, Smoothing spatial filters, Sharpening spatial filters. Frequency domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening, Selective filtering. Image Segmentation: Segmentation concepts, Point, Line and Edge Detection. Thresholding, Region Based segmentation.

UNIT – III

Image Compression: Image compression fundamentals - Coding Redundancy, Spatial and Temporal redundancy, Compression models: Lossy & Lossless, Huffman coding, Arithmetic coding, LZW coding, Run length coding, Bit plane coding, Transform coding, Predictive coding, Wavelet coding, JPEG Standards.

UNIT – IV

Basic concepts of Video Processing: Analog Video, Digital Video. Time-Varying Image Formation models: Three-Dimensional Motion Models, Geometric Image Formation, Photometric Image Formation, Sampling of Video signals, Filtering operations.

UNIT – V

2-D Motion Estimation**:** Optical flow, General Methodologies, Pixel Based Motion Estimation, Block- Matching Algorithm, Mesh based Motion Estimation, Global Motion Estimation, Region based Motion Estimation, Multi resolution motion estimation, Waveform based coding, Block based transform coding, Predictive coding, Application of motion estimation in Video coding.

Suggested Reading:

1. Gonzaleze and Woods, Digital Image Processing , 3rd ed., Pearson.
2. Yao Wang, Joem Ostermann and Ya–quin Zhang,Video processing and communication, 1st Ed., PH Int.
3. M. Tekalp, Digital Video Processing, Prentice Hall International.

EC 6007

ADVANCED SIGNAL PROCESSING LABORATORY

Instruction	3 Periods per week	External Examination – Duration	-
Sessionals	50 Marks	External Examination – Marks	-
Credits	02		

Section - 1:

1. Generating basic waveforms (impulse, step, ramp, exponential, sin, …)
2. Digital FIR Filter implementation and realizations: with and without windows.
3. Design of IIR filters (Butterworth, Chebychev, IIR, …).
4. Generation of musical effects using digital filters.
5. Using the Simulink generate the basic waveforms (impulse, step, ramp, exponential, sin, …) observe the waveforms on the CRO.
6. Using Simulink generate the modulated waveforms.
7. Study and implementation of sigma - delta modulator/ Transmultiplexer.

Section – 2:

1. Declaring and initializing the variables and moving the data to and from Memory (register to memory, memory to register).
2. Setting up Circular buffering , hardwared loops:
    a. Adding the 10 consecutive numbers
    b. Splitting he numbers
    c. Bit level operations.
3. Underatsatding the DSP MAC capabilities.
    a. Windowing, Convolution, FIR filtering
4. Underatsatding the DSP parallel instruction optimisation.
    a. FFT without parallel instructions
    b. FFT with parallel instructions
5. Creation of periodic waveforms and noise sequences using the DSP kit.
6. Interfacing the DSP processor in real time.
7. Initialization of Audio codec.

Note: The experiments will be decided and modified if necessary and conducted by the lecturer concerned.

EC 6017

EMBEDDED SYSTEMS LABORATORY

Instruction	3 Periods per week	External Examination – Duration	-
Sessionals	50 Marks	External Examination – Marks	-
Credits	02		

List of Experiments using Embedded C/Embedded C++:

1. To toggle LEDs connected to GPIOs of AT89S52 with some intentional Delay.
2. To design & implement 4x3 matrix Keypad Device Driver for ASCII mapping.
3. To design & implement 2x16 LCD Device Driver for displaying below text:

   Line-1: "**Welcome@ESD Lab!**"

   Line-2:"**Enter to Proceed**"
4. To Configure Timer0 and Timer1 for intended delay without interrupts.
5. To design & demonstrate the UART drivers for data transmission and data reception at 9600bps full duplex baud.
6. To design & implement the concept of writing Interrupt Service Routine (ISR) for external interrupt INT0, INT1.
7. To design & implement the concept of mixing of external ISRs with Internal ISRs and understanding the ISR handling process.
8. To design & implement LED Seven Segment driver with adjustable delay.
9. To design & implement User Centric template Menu designs in Embedded C
10. To design & implement User Centric template Menu designs in Embedded C++.

Suggested tools for use:

1. Hardware Target CPU – AT89S52
2. Embedded Software Development – Keil µVision4 IDE
3. Embedded Debugger – Keil µVision4 Debugger
4. Hardware Simulator – Proteus

Note: The experiments will be decided and modified if necessary and conducted by the lecturer concerned.

EC 6027

COMMUNICATION SYSTEMS SIMULATION LABORATORY

Instruction	3 Periods per week	External Examination - Duration	-
Sessionals	50 Marks	External Examination - Marks	-
Credits	02		

Section - 1:

1. Simulation study of wavelength division multiplexing and de-multiplexing.
2. Study of digital modulation schemes using Spectrum analyzer.
3. Study and implementation of different simulation techniques.
4. Error detection codes in data communications.
5. Analysis of error coding, parity check and hamming check.
6. Simulation of a communication channel using convolutional encoding and Viterbi decoding using MATLAB.
7. Simulation of Channel coding / decoding using MATLAB and SIMULINK.

Section – 2:

1. Study of wireless LAN
2. Using Wireless digital communication trainer, study of:
   a) Baseband digital communication link
   b) Quadrature modulation schemes
   c) Adaptive equalization techniques
   d) GSM and Basics of DS-CDMA
   f) Basics of OFDM.
3. Implementation of DPSK modulators and demodulators using MATLAB.
4. Simulation of software radio system using MATLAB.
5. Simulation study of collaborative transmission schemes for Multiuser wireless systems using MATLAB.

Note: The experiments will be decided and modified if necessary and conducted by the lecturer concerned.

EC 6037

DSP PROCESSORS APPLICATIONS LABORATORY

Instruction	3 Periods per week	External Examination – Duration	-
Sessionals	50 Marks	External Examination – Marks	-
Credits	02		

List of Experiments:

1. Introduction and Preview: Digital Signal Processing and Digital Signal Processors
2. Design space exploration: How many DSP processors and which types? How much on-chip/off-chip memory? What type of bus and other hardware components, etc. Consider timing, power, area and cost.
3. DSP Algorithms, TMS320C6000 Family
4. Code Composer Studio and the DSK
5. Architectural features of DSP processors (arithmetic, memory organization, pipe lining, and use of special on-chip hardware)
6. Amplitude quantization effects (in A/D and D/A conversion, waveform generation and digital filter implementation)
7. Special on-chip hardware (serial ports, host ports, and timers)
8. Programming of DSP processors
9. Optimal code generation: the most time and power efficient codes for DSP processors.
10. Design and implementation of FIR and IIR filters
11. Realization of an FIR filter (any type) to meet given specification. The input can be a signal from function generator/speech signal.
12. FFT usage
13. Impulse response of a given system of first and second order.
14. Real-time concepts (interrupts, critical sections, threads of execution, etc.).
15. Data Transfers from/to Codec
16. Noise removal: Add noise above 3 kHz and then remove; Interference suppression using 400 Hz tone.

Note: The experiments will be decided and modified if necessary and conducted by the lecturer concerned.

Suggested Reading:

1. Dahnoun, D. Digital Signal Processors TMS320C6000. Collection of the PowerPoint Shows. Bristol : University of Bristol, 2002, Copyrighted by the Texas Instruments, Inc.
2. Chassaing, R. DSP Applications Using C and the TMS320C6x. First Edition. New York : John Wiley & Sons, Inc., 2002.
3. Porat, B. A Course in Digital Signal Processing. New York : John Wiley & Sons, Inc., 1997

EC 6018

SEMINAR - I

Instruction	3 Periods per week	External Examination – Duration	-
Sessionals	50 Marks	External Examination – Marks	-
Credits	02		

Oral presentation and technical report writing are two important aspect of engineering education. The objective of the seminar is to prepare the student for a systematic and independent study of the state of the art topics in the advanced fields of Communication Engineering and related topics.

Seminar topics may be chosen by the students with advice from the faculty members. Students are to be exposed to the following aspects for a seminar presentation.

- Literature survey
- Organization of the material
- Presentation of OHP slides / LCD presentation
- Technical writing

Each student required to:

1. Submit a one page synopsis before the seminar talk for display on the notice board.
2. Give a 20 minutes time for presentation following by a 10 minutes discussion.
3. Submit a detailed technical report on the seminar topic with list of references and slides used.

Seminars are to be scheduled from the 3rd week to the last week of the semester and any change in schedule shall not be entertained.

For award of sessional marks, students are to be judged by at least two faculty members on the basis of an oral and technical report preparation as well as their involvement in the discussions.

EC 6028

SEMINAR - II

Instruction	3 Periods per week	External Examination – Duration	-
Sessionals	50 Marks	External Examination - Marks	-
Credits	02		

Oral presentation and technical report writing are two important aspect of engineering education. The objective of the seminar is to prepare the student for a systematic and independent study of the state of the art topics in the advanced fields of Communication Engineering and related topics.

Seminar topics may be chosen by the students with advice from the faculty members. Students are to be exposed to the following aspects for a seminar presentation.

- Literature survey
- Organization of the material
- Presentation of OHP slides / LCD presentation
- Technical writing

Each student required to:

1. Submit a one page synopsis before the seminar talk for display on the notice board.
2. Give a 20 minutes time for presentation following by a 10 minutes discussion.
3. Submit a detailed technical report on the seminar topic with list of references and slides used.

Seminars are to be scheduled from the 3rd week to the last week of the semester and any change in schedule shall not be entertained.

For award of sessional marks, students are to be judged by at least two faculty members on the basis of an oral and technical report preparation as well as their involvement in the discussions.

EC 6038

DISSERTATION SEMINAR

Instruction	6 Periods per week	External Examination – Duration	-
Sessionals	100 Marks	External Examination - Marks	-
Credits	06		

The main objective of the Project Seminar is to prepare the students for the dissertation to be executed in 4th semester. Solving a real life problem should be focus of Post Graduate dissertation. Faculty members should prepare the project briefs (giving scope and reference) at the beginning of the 3rd semester, which should be made available to the students at the departmental library. The project may be classified as hardware / software / modeling / simulation. It may comprise any elements such as analysis, synthesis and design.

The department will appoint a project coordinator who will coordinate the following:

- Allotment of projects and project guides.
- Conduct project - seminars.

Each student must be directed to decide on the following aspects

- Title of the dissertation work.
- Organization.
- Internal / External guide.
- Collection of literature related to the dissertation work.

Each student must present a seminar based on the above aspects as per the following guidelines:

1. Submit a one page synopsis before the seminar talk for display on the notice board.
2. Give a 20 minutes presentation through OHP, PC followed by a 10 minutes discussion.
3. Submit a report on the seminar presented giving the list of references.

Project Seminars are to be scheduled from the 3rd week to the last week of the semester.
The internal marks will be awarded based on preparation, presentation and participation.

EC 6019

DISSERTATION – PHASE I

Instruction	--	External Examination – Duration	--
Sessionals	--	External Examination - Marks	Grade+
Credits	10		

The students must be given clear guidelines to execute and complete the project on which they have delivered a seminar in the 3rd semester of the course.

All projects will be monitored at least twice in a semester through student's presentation. Sessional marks should be based on the grades/marks, awarded by a monitoring committee of faculty members as also marks given by the supervisor.

Efforts be made that some of the projects are carries out in industries with the help of industry coordinates.

Common norms will be established for documentation of the project report by the respective department.

The final project reports must be submitted two weeks before the last working day of the semester.

The project works must be evaluated by an external examiner and based on his comments a viva voice will be conducted by the departmental committee containing of HOD, two senior faculty and supervisor.

+ Excellent /Very Good / Good/Satisfactory / Unsatisfactory

EC 6029

DISSERTATION – PHASE II

Instruction	--	External Examination – Duration	--
Sessionals	--	External Examination - Marks	Grade+
Credits	10		

The students must be given clear guidelines to execute and complete the project on which they have delivered a seminar in the 3rd semester of the course.

All projects will be monitored at least twice in a semester through student's presentation. Sessional marks should be based on the grades/marks, awarded by a monitoring committee of faculty members as also marks given by the supervisor.

Efforts be made that some of the projects are carries out in industries with the help of industry coordinates.

Common norms will be established for documentation of the project report by the respective department.

The final project reports must be submitted two weeks before the last working day of the semester.
The project works must be evaluated by an external examiner and based on his comments a viva voice will be conducted by the departmental committee containing of HOD, two senior faculty and supervisor.

\+ **Excellent /Very Good / Good/Satisfactory / Unsatisfactory**

EC 6100

SPREAD SPECTRUM AND CDMA SYSTEMS

Instruction	3 Periods per week	External Examination - Duration	3 Hours
Sessionals	30 Marks	External Examination - Marks	70 Marks
Credits	03		

UNIT – I

Fundamentals of Spread Spectrum: Introduction to spread spectrum communication, pulse noise jamming, low probability of detection, direct sequence spread spectrum, frequency-hopping and time-hopping spread spectrum systems , correlation functions, spreading sequences- maximal-length sequences, gold codes, Walsh orthogonal codes- properties and generation of sequences Synchronization and Tracking: delay lock and tau-dither loops, coarse synchronization- principles of serial search and match filter techniques.

UNIT – II

Performance Analysis of SS system: Performance of spread spectrum system under AWGN, multi-user Interference, jamming and narrow band interferences

Low probability of intercept methods, optimum intercept receiver for direct sequence spread spectrum, Error probability of DS-CDMA system under AWGN and fading channels, RAKE receiver

UNIT – III

Capacity & Coverage of Spread Spectrum Multiple Access Networks: Basics of spread spectrum multiple access in cellular environments, reverse Link power control, multiple cell pilot tracking, soft and hard handoffs, cell coverage issues with hard and soft handoff, spread spectrum.

UNIT – IV

Control of Spread Spectrum Multiple Access Networks: Multiple access outage, outage with imperfect power control, Erlang capacity of forward and reverse links. Multi-user Detection -MF detector, decorrelating detector, MMSE detector. Interference Cancellation: successive, Parallel Interference Cancellation, performance analysis of multiuser detectors and interference cancellers.

UNIT – V

CDMA Systems: General aspects of CDMA cellular systems, IS-95 standard, Downlink and uplink, Evolution to Third Generation systems, WCDMA and CDMA-2000 standards, Principles of Multicarrier communication, MCCDMA and MC-DS-CDMA.

Suggested Reading:

1. R. L. Peterson, R. Ziemer and D. Borth, "Introduction to Spread Spectrum Communications," PHI, 1995.
2. J. Viterbi, "CDMA - Principles of Spread Spectrum Communications," Addison-Wesley, 1997.
3. Vijay K. Garg, Kenneth Smolik, and Joseph E. Wilkes, "Applications of CDMA in Wireless/Personal Communications," PHI, 1995.
4. S. Verdu, " Multiuser Detection," Cambridge University Press, 1998
5. M. K. Simon, J. K. Omura, R. A. Scholts and B. K. Levitt, " Spread Spectrum Communications Handbook," McGraw- Hill, 1994.
6. G. R. Cooper and C. D. McGillem, "Modern Communications and Spread Spectrum," McGraw-Hill,1985.

EC 6101

ADVANCED OPTICAL COMMUNICATION

Instruction	3 Periods per week	External Examination - Duration	3 Hours
Sessionals	30 Marks	External Examination - Marks	70 Marks
Credits	03		

UNIT – I

Solution to Maxwell's equation in a circularly symmetric step index optical fiber, linearly polarized modes, single mode and multimode fibers, concept of V number, graded index fibers, total number of guided modes (no derivation), attenuation mechanisms in fibers, dispersion in single mode and multimode fibers, dispersion shifted and dispersion flattened fibers, attenuation and dispersion limits in fibers, Kerr nonlinearity, self phase modulation, combined effect of dispersion and self phase modulation.

UNIT – II

Optical sources - LED and laser diode - Principles of operation, concepts of line width, phase noise, switching and modulation characteristics. Optical detectors - PN detector, pin detector, avalanche photodiode - Principles of operation, concepts of responsivity, sensitivity and quantum efficiency, noise in detection, typical receiver configurations (high impedance and trans-impedance receivers).

UNIT – III

Coherent systems - Homodyne and heterodyne systems, coherent systems using PSK, FSK, ASK and DPSK modulations.

UNIT – IV

Noise Effects in coherent systems: Related noise effects, performance degradation induced by laser phase and intensity noise, degradation due to fiber dispersion, degradation induced by nonlinear effects in fiber propagation.

UNIT – V

Optical amplifiers - semiconductor amplifier, rare earth doped fiber amplifier (with special reference to erbium doped fibers), Raman amplifier, Brillouin amplifier - principles of operation, amplifier noise, signal to noise ratio, gain, gain bandwidth, gain and noise dependencies, inter modulation effects, saturation induced crosstalk, wavelength range of operation.

Suggested Reading:

1. John Senior, "Optical Fiber Communications: Principles and Practice," 3/e, Pearson, 2010.
2. Govind P. Agrawal, "Fiber-Optic Communication Systems," 3/e, John Wiley & Sons, 2002.
3. Gerd Keiser, "Optical Fibre Communications," 3/e, McGraw Hill, 2000.
4. John Gowar, "Optical Communication Systems," 2/e, PHI, 1993.

EC 6102

MIMO COMMUNICATION SYSTEMS

Instruction	3 Periods per week	External Examination - Duration	3 Hours
Sessionals	30 Marks	External Examination - Marks	70 Marks
Credits	03		

UNIT – I

Information theoretic aspects of MIMO: Review of SISO communication - MIMO channel models - Classical i.i.d. and extended channels – Frequency selective and correlated channel models - Capacity of MIMO channels - Ergodic and Outage Capacity - Capacity bounds - Influence of channel properties on capacity.

UNIT – II

MIMO Diversity and Spatial Multiplexing: Space Time Diversity Aspects - Sources and types of diversity - analysis under Rayleigh fading – Diversity and Channel knowledge - MIMO Spatial multiplexing - Space Time receivers - ML - MMSE - ZF – Sphere decoding - BLAST receivers - DMG tradeoff in MIMO systems.

UNIT – III

Space Time Block Codes: Alamouti's code for two transmit antennas - Comparison with dual-branch receive diversity STBC based on real/complex orthogonal designs - Code Design Criteria for quasi-static Channels (Rank, Determinant and Euclidean Distance).

UNIT – IV

Orthogonal Designs: Generalized Orthogonal Designs - Quasi-Orthogonal Designs - Performance Analysis. Representation of STTC- shift register, generator matrix, state-transition diagram, trellis

UNIT – V

Space Time Trellis Codes: Diagram - Code construction. Delay diversity as a special case of STTC- Performance Analysis.

Suggested Reading:

1. Paulraj R. Nabar and D. Gore, “Introduction to Space Time Wireless Communications,” Cambridge University Press, 2003.
2. B.Vucetic and J. Yuan, “Space-Time Coding,” John Wiley, 2003.
3. E.G. Larsson and P. Stoica, “Space-Time Block Coding for Wireless Communications,” Cambridge University press.
4. H. Jafarkhani, “Space-Time Coding: Theory and Practice,” Cambridge University Press.
5. D. Tse and P. Viswanath, “Fundamentals of Wireless Communication,” Cambridge University Press.

EC 6103

GLOBAL NAVIGATION SATELLITE SYSTEMS

Instruction	3 Periods per week	External Examination - Duration	3 Hours
Sessionals	30 Marks	External Examination - Marks	70 Marks
Credits	03		

UNIT – I

GPS fundamentals: INS, Trilaiteration, Hyperbolic navigation, Transit, GPS principle of operation, architecture, operating frequencies, orbits, Keplerian elements. Solar and Sidereal days, GPS and UTC Time

UNIT – II

GPS Signals: Signal structure, C/A and P-Code, ECEF and ECI coordinate systems and WGS 84 and Indian datums, Important components of receiver and specifications, link budget.

UNIT – III

GPS Error Models: Ionospheric error, Tropospheric error, Ephemeris error, Clock errors, Satellite and receiver instrumental biases, Antenna Phase center variation, multipath; estimation of Total Electron Content (TEC) using dual frequency measurements, Various DOPs, UERE. Spoofing and Anti-spoofing. : Future GPS satellites, new signals and their benefits GPS integration – GPS/GIS, GPS/INS, GPS/pseudolite, GPS/cellular.

UNIT – IV

GPS data processing, DGPS and Applications: RINEX Navigation and Observation formats, Code and carrier phase observables, linear combination and derived observables, Ambiguity resolution, cycle slips, Position estimation. principle of operation of DGPS, architecture and errors,

UNIT – V

Other Constellations and Augmentation systems Other satellite navigation constellations GLONASS and Galileo IRNS System. : Relative advantages of SBAS and GBAS, Wide area augmentation system (WAAS) architecture, GAGAN, EGNOS and MSAS. Local area augmentation system (LAAS) concept.

Suggested Reading:

1. B.Hofmann Wollenhof, H.Lichtenegger, and J.Collins, “GPS Theory and Practice”, Springer Wien, new York, 2000.
2. Pratap Misra and Per Enge, “Global Positioning System Signals, Measurements, and Performance,” Ganga-Jamuna Press, Massachusetts, 2001.
3. Ahmed El-Rabbany, “Introduction to GPS,” Artech House, Boston, 2002.
4. Bradford W. Parkinson and James J. Spilker, “Global Positioning System: Theory and Applications,” Volume II, American Institute of Aeronautics and Astronautics, Inc., Washington, 1996.

EC 6104

NETWORK SECURITY AND CRYPTOGRAPHY

Instruction	3 Periods per week	External Examination - Duration	3 Hours
Sessionals	30 Marks	External Examination - Marks	70 Marks
Credits	03		

UNIT- I

Introduction : Attacks, Services and Mechanisms, Security attacks, Security services, A Model for Internetwork security, Classical Techniques: Conventional Encryption model, Steganography, Classical Encryption Techniques.

Modern Techniques : Simplified DES, Block Cipher Principles, Data Encryption standard, Strength of DES, Block Cipher Design Principles.

UNIT- II

Encryption : Triple DES, International Data Encryption algorithm, Blowfish, RC5, Characteristics of Advanced Symmetric block cifers.

Conventional Encryption

Placement of Encryption function, Traffic confidentiality, Key distribution, Random Number Generation.

UNIT – III

Public Key Cryptography Principles, RSA Algorithm, Key Management, Diffie-Hellman Key exchange, Elliptic Curve Cryptograpy. Number Theory Prime and Relatively prime numbers, Modular arithmetic, Fermat's and Euler's theorems, Testing for primality, Euclid's Algorithm, the Chinese remainder theorem, Discrete logarithms.

UNIT- IV

Message Authentication and Hash Functions Authentication requirements and functions, Message Authentication, Hash functions, Security of Hash functions and MACs. Hash and Mac Algorithms MD File, Message digest Algorithm, Secure Hash Algorithm. Digital signatures and Authentication protocols: Digital signatures, Authentication Protocols, Digital signature standards. Authentication Applications Kerberos, Electronic Mail Security: Pretty Good Privacy, S/MIME.

UNIT – V

IP Security Overview, Architecture, Authentication, Encapsulating Security Payload, Key Management. Web Security: Web Security requirements, Secure sockets layer and Transport layer security, Secure Electronic Transaction. Intruders, Viruses and Worms: Intruders, Viruses and Related threats. Fire Walls: Fire wall Design Principles, Trusted systems.

Suggested Reading:

1. Cryptography and Network Security: Principles and Practice - William Stallings, Pearson Education.
2. Network Security Essentials (Applications and Standards) by William Stallings Pearson Education.
3. Fundamentals of Network Security by Eric Maiwald (Dreamtech press)
4. Principles of Information Security, Whitman, Thomson.
5. Introduction to Cryptography, Buchmann, Springer.

EC 6105

SOFTWARE DEFINED AND COGNITIVE RADIO

Instruction	3 Periods per week	External Examination - Duration	3 Hours
Sessionals	30 Marks	External Examination - Marks	70 Marks
Credits			

UNIT – I

Introduction to SDR: What is Software-Defined Radio, The Requirement for Software-Defined Radio, Legacy Systems, The Benefits of Multi-standard Terminals, Economies of Scale, Global Roaming, Service Upgrading, Adaptive Modulation and Coding, Operational Requirements, Key Requirements, Reconfiguration Mechanisms, , Handset Model, New Base-Station and Network, Architectures, Separation of Digital and RF, Tower-Top Mounting, BTS Hoteling, Smart Antenna Systems, Smart Antenna System Architectures, Power Consumption Issues, Calibration Issues, Projects and Sources of Information on Software Defined Radio,

UNIT – II

Basic Architecture of a Software Defined Radio: Software Defined Radio Architectures, Ideal Software Defined Radio Architecture, Required Hardware Specifications, Digital Aspects of a Software Defined Radio, Digital Hardware, Alternative Digital Processing Options for BTS Applications, Alternative Digital Processing Options for Handset Applications, Current Technology Limitations, A/D Signal-to-Noise Ratio and Power Consumption, Derivation of Minimum Power Consumption, Power Consumption Examples, ADC Performance Trends, Impact of Superconducting Technologies on Future SDR Systems.

UNIT – III

Signal Processing Devices and Architectures: General Purpose Processors, Digital Signal Processors, Field Programmable Gate Arrays, Specialized Processing Units, Tilera Tile Processor, Application-Specific Integrated Circuits, Hybrid Solutions, Choosing a DSP Solution. GPP-Based SDR, Non real time Radios, High-Throughput GPP-Based SDR, FPGA-Based SDR, Separate Configurations, Multi-Waveform Configuration, Partial Reconfiguration, Host Interface, Memory-Mapped Interface to Hardware, Packet Interface, Architecture for FPGA-Based SDR, Configuration, Data Flow, Advanced Bus Architectures, Parallelizing for Higher Throughput, Hybrid and Multi-FPGA Architectures, Hardware Acceleration, Software Considerations, Multiple HA and Resource Sharing, Multi-Channel SDR.

UNIT – IV

Cognitive Radio : Techniques and signal processing History and background, Communication policy and Spectrum Management, Cognitive radio cycle, Cognitive radio architecture, SDR architecture for cognitive radio, Spectrum sensing Single node sensing: energy detection, cyclostationary and wavelet based sensing- problem formulation and performance analysis based on probability of detection Vs SNR. Cooperative sensing: different fusion rules, wideband spectrum sensing- problem formulation and performance analysis based on probability of detection Vs SNR.

UNIT V

Cognitive Radio: Hardware and applications: Spectrum allocation models. Spectrum handoff, Cognitive radio performance analysis. Hardware platforms for Cognitive radio (USRP, WARP), details of USRP board, Applications of Cognitive radio

Suggested Reading:

1. "RF and Baseband Techniques for Software Defined Radio" Peter B. Kenington, ARTECH HOUSE, INC, 2005.
2. "Implementing Software Defined Radio", Eugene Grayver, Springer, New York Heidelberg Dordrecht London, ISBN 978-1-4419-9332-8 (eBook) 2013.
3. "Cognitive Radio Technology", by Bruce A. Fette, Elsevier, ISBN 10: 0-7506-7952-2, 2006.
4. "Cognitive Radio, Software Defined Radio and Adaptive Wireless Systems", Hüseyin Arslan, Springer, ISBN 978-1-4020-5541-6 (HB), 2007.

EC 6106

DETECTION AND ESTIMATION THEORY

Instruction	3 Periods per week	External Examination - Duration	3 Hours
Sessionals	30 Marks	External Examination - Marks	70 Marks
Credits			

UNIT – I

Classical Detection Theory: Binary hypothesis testing; Baye's, Minimax and Neyman – Pearson tests. Composite hypothesis testing.

UNIT – II

Signal Detection in Discrete Time : Models and Detector structures; Detection of deterministic signals in independent noise; Detection in Gaussian noise. Detection of signals with random parameters. Detection of stochastic signals. Performance evaluation of detection procedures.

UNIT – III

Parameter Estimation: Bayesian Parameter Estimation; MMSE, MMAE and MAP estimation procedures. Non random parameter estimation, general structure. Exponential families; completeness theorem. The information inequality. Maximum likelihood Estimation (MLE). Asymptotic properties of MLE's

UNIT – IV

Signal Estimation in discrete – Time: The discrete – time Kalman – Bucy filter. Linear estimation; Orthogonality Principle. Wiener – Kolmogrov filtering; Causal and non-causal filters.

UNIT – V

Signal Detection in Continuous Time : Detection of deterministic signals in Gaussian noise; Coherent detection. Detection of signals with unknown parameters.

Suggested Reading:

1. H.V. Poor, "An Introduction to Signal Detection and Estimation", Springer – Verlag, 2nd edition, 1998.
2. M.D. Srinath & P.K. Rajasekaran, "An introduction to statistical signal processing with applications", Prentice Hall, 2002.
3. H.L. Vantrees, "Detection, Estimation & Modulation Theory", Part-I, John Wiley & Sons, 1968.

EC 6110

PRINCIPLES OF COMMUNICATION SYSTEMS SIMULATION WITH WIRELESS APPLICATIONS

Instruction	4 Periods per week	External Examination - Duration	3 Hours
Sessionals	30 Marks	External Examination - Marks	70 Marks
Credits	03		

UNIT – I

The Role of Simulation: Examples of Complexity, Multidisciplinary Aspects of Simulation, Models, Deterministic and Stochastic Simulation, The role of simulation, Simulation Methodology: Introduction, Aspects of Methodology, Performance estimation, Sampling and Quantizing: Sampling, Quantizing, Reconstruction and Interpolation, The Simulation Sampling Frequency.

UNIT – II

Low pass Simulation Models for Band pass Signals and Systems: The Low pass Complex Envelope for Band pass Signals, Linear Band pass Systems, Multicarrier Signals, Nonlinear and Time-Varying Systems, Filter Models and Simulation Techniques: Introduction, IIR and FIR Filters, IIR and FIR Filter Implementations, IIR Filters: Synthesis Techniques and Filter Characteristics, FIR Filters: Synthesis Techniques and Filter Characteristics.

UNIT – III

Case Study: Phase-Locked Loops and Differential Equation Methods: Basic Phase-Locked Loop Concepts, First-Order and Second-Order Loops, Case Study: Simulating the PLL, Solving Differential Equations Using Simulation, Generating and Processing Random Signals: Stationary and Ergodic Processes, Uniform Random Number Generators, Mapping Uniform RVs to an Arbitrary PDF, Generating Uncorrelated Gaussian Random Numbers, Generating Correlated Gaussian Random Numbers, Establishing a PDF and a PSD, PN Sequence Generators, Signal Processing.

UNIT – IV

Post processing: Basic Graphical Techniques, Estimation, Coding, Introduction to Monte Carlo Methods: Fundamental Concepts, Application to Communications Systems-The AWGN Channel, Monte Carlo Integration.

UNIT – V

Monte Carlo Simulation of Communication Systems: Two Monte Carlo Examples, Semi analytic Techniques, Methodology for Simulating A Wireless System: System-Level Simplifications and Sampling Rate Considerations, Overall Methodology.

Suggested Reading:

1. William H. Tranter, K. Sam Shanmugan, Thodore S. Rappaport and Kurt L. Kosbar, “Principles of Communication systems simulation with Wireless applications,” Pearson Education, 2004.
2. Roger L. Peterson, Rodger E. Zeimer and David E. Borth, “Introduction to spread spectrum communications,” PHI, 1995.
3. William H. Tranter, “Principles of Communications: systems, Modulation and Noise, 5/e, Wiley, 2007.

EC 6111

ADVANCED WIRELESS COMMUNICATION

Instruction	3 Periods per week	External Examination - Duration	3 Hours
Sessionals	30 Marks	External Examination - Marks	70 Marks
Credits	03		

UNIT – I

Mathematical preliminaries: Review of probability theory, Essentials of (convex) optimization theory, Essentials of information theory,

UNIT – II

Wireless channel models and latest multiple access technologies, Introduction to various channel models (namely frequency flat, frequency selective, Rayleigh and Ricean fading models), Introduction to CDMA and associated standards, Introduction to OFDM.

UNIT - III

Capacity of scalar wireless channels, Introduction to the notion of channel capacity, Capacity of time invariant channels, Capacity of time varying (or fading) channels, Capacity of vector (MISO, SIMO, MIMO) channels and spatial multiplexing, Capacity of MISO and SIMO channels for both time varying and time invariant cases, Capacity of MIMO systems, V-BLAST and D-BLAST, STBC and STTC.

UNIT – IV

Multiuser detection (MUD), Introduction to MUD, Linear decorrelator, MMSE MUD, Adaptive MUD.

UNIT - V

Application of convex optimization to wireless design, Minimizing PAPR in OFDM systems via convex optimization, Applications of convex optimization to MAC and flow control problems.

Suggested Reading:

1. Fundamentals of wireless communications by David Tse and Pramod Viswanath.
2. Convex optimization by Steven Boyd and L. Vandenberge.
3. Wireless Communications by Andrea Goldsmith.
4. Introduction to space-time wireless communications by Arogyaswami Paulraj, Rohit Nabar and Dhananjay Gore.
5. Multiuser detection by S. Verdu.

EC 6112

SMART ANTENNAS FOR MOBILE COMMUNICATIONS

Instruction	3 Periods per week	External Examination - Duration	3 Hours
Sessionals	30 Marks	External Examination - Marks	70 Marks
Credits	03		

UNIT – I

Cellular Radio concepts – Spread Spectrum CDMA – Antenna Systems – Radio wave propagation – fading – Cellular CDMA – IS-95 CDMA system work – Reverse Traffic Transmission – Forward Channel Signal – Evaluation of CDMA 2000.

UNIT – II

Introduction to Smart Antennas – Spatial processing for wireless systems – Fixed beam forming networks – Switched beam systems – Adaptive Antenna Systems – Wide band Smart Antennas – Digital Radio Receiver techniques - Array calibrations.

UNIT – III

Smart Antennas Techniques for CDMA: Non Coherent CDMA – Coherent CDMA –Multi user spatial processing – Re sectoring using Smart Antennas – Down link beam forming for CDMA.

UNIT – IV

CDMA System Range and Improvements using Spatial Filtering – Range extensions in CDMA – Spatial filtering at IS-95 base station – Reverse channel performance – Spatial filtering at WLL subscriber unit – Range and Capacity Analysis.

UNIT – V

Optimal Spatial Filtering and Adaptive Algorithms – Array performance in Multipath – under loaded , over loaded adaptive arrays – Adaptive algorithms for CDMA – Multi Target Decision Directed Algorithms – Estimation Algorithms – RF position location systems.

Suggested Reading:

1. Joseph C. Liberti Jr., Theodore S Rappaport, “Smart Antennas for wireless communications IS-95 and third generation CDMA applications”, PTR – PH publishers, 1st edition, 1989.
2. T.S Rappaport, “Smart Antennas Adaptive arrays algorithms and wireless position location”, IEEE press 1998, PTR – PH publishers 1999.
3. Garg, “IS-95 CDMA and CDMA 2000, “Cellular / PCs systems implementation”, Pearson Education, 2002.

EC 6113

DATA AND COMPUTER COMMUNICATION NETWORKS

Instruction	3 Periods per week	External Examination - Duration	3 Hours
Sessionals	30 Marks	External Examination - Marks	70 Marks
Credits	03		

UNIT – I

Data Communications and Networks Overview: Data Communications Model Communication Tasks, Basic concepts of Networking and Switching, Networking configurations, Protocols and Architecture, Key Elements of a Protocol, Protocols in Simplified Architecture, Protocol Data Units (PDU), Operation of a Protocol Architecture, Operation of a Protocol Architecture, Standardized Protocol Architectures, OSI and TCP/IP Architectures, Comparisons between OSI and TCP/IP, TCP/IP Addressing Concepts, concepts of Frequency, Spectrum and Bandwidth, Modem, Codec and Shannon Capacity.

UNIT – II

Line Configuration, Interfacing, Characteristics of Physical Layer Interface, Flow Control, Sliding Window Flow Control, Error control, CRC, ARQ Protocols, Data Link Control, Bit stuffing, HDLC Operation; Hierarchy of FDM schemes, WDM Operation, TDM Link Control, Hierarchy of TDM, DS-1 Transmission Format, SONET/SDH Frame Formats. Asymmetrical Digital Subscriber Line, xDSL.

UNIT – III

Circuit Switching and Packet Switching: Circuit Switching concepts, Circuit Switching applications, Circuit Switch Elements, Three Stage Space Division Switch, Blocking and Non-blocking switching, Time Division Switching, Control Signaling Functions, In Channel Signaling, Common Channel Signaling, Introduction to Signaling System Number 7 (SS7), Packet Switching Principles, Datagram and Virtual Circuit switching, Effects of variable packet size, X.25, X.25 Protocol Control Information. Routing: Routing in Circuit Switched Network, Routing in Packet Switched Network, Routing Strategies, Least Cost Algorithms, Bellman-Ford Algorithm.

UNIT – IV

LAN Architecture. Topologies, Choice of Topology, Ring and Star Usage, MAC and LLC, Generic MAC Frame Format, Bridge, Bridge Operation, Bridges and LANs with Alternative Routes, Spanning Tree, Loop resolution in bridges, Hubs, Two Level Star Topology, Layer 2 Switches, Wireless LAN, Multi cell Wireless LANs, IEEE 802.11 Architecture, IEEE 802.11 Medium Access Control logic.

UNIT – V

ATM, Architecture of ATM, Congestion Control and Quality of Service in ATM, Internetworking, IPv4, IPv6 comparison , Transport layer protocols, UDP Operation, TCP features, Flow Control, Error Control, Congestion Control, Network Management System, SNMP, SIP, and H.323 architectures, *Security in the Internet,* IP Security, Firewalls.

Suggested Reading:

1. William Stallings, "Data and Computer Communications", Eigth Edition, Pearson Prentice Hall, 2007.
2. Behrouz A. Forouzan, "Data Communications and Networking", Fourth Edition, Tata Mc Graw Hill, 2007.

EC 6200

ARRAY SIGNAL PROCESSING

Instruction	3 Periods per week	External Examination - Duration	3 Hours
Sessionals	30 Marks	External Examination - Marks	70 Marks
Credits	03		

UNIT – I

Spatial Signals: Array fundamentals. Signals in space and time. Signal models. Spatial frequency, Propagation Signal Direction Vs Spatial Frequency. Wave fields. Far field and Near field signals.

UNIT – II

Sensor Arrays: Spatial sampling, Spatial sampling theorem. Aliasing in spatial frequency domain. Sensor arrays. Uniform Linear Arrays (ULA) basic idea of Direction of Arrival using Uniform Linear Array. Array transfer (steering) vector. Array steering vector for ULA. Planar and Random Arrays. Broadband arrays.

UNIT – III

Spatial Frequency: Spatial Frequency Transform, Spatio-Temporal Filter. Spatial spectrum. Spatial Domain Filtering, Spatial smoothing, Smoothing filters, Sharpening filters. Spatially white signal.

UNIT – IV

Direction of Arrival Estimation: Conventional Beam Forming, Tapered and optimum Beam Forming, Eigen analysis, Interference cancellation, Side lobe canceller. Non parametric methods - Beam Forming and Capon methods. Resolution of Beam Forming.

UNIT – V

Subspace methods: Maximum likely hood estimation, Pisaranko's method, MUSIC, Minimum Norm and ESPRIT techniques and algorithms.

Suggested Reading:

1. Don H. Johnson and Dan E. Dugeon, "Array Signal Processing: Concepts and Techniques," PHI, 2010.
2. Prabhakar S. Naidu, "Sensor Array Signal Processing," 2/e, CRC Press, 2009.
3. Simon Haykin, "Array Signal Processing," PHI, 1984.
4. Petre Stoica and Randolph L. Moses, "Spectral Analysis of Signals," PHI, 2005.

EC 6201

ADAPTIVE SIGNAL PROCESSING

Instruction	3 Periods per week	External Examination - Duration	3 Hours
Sessionals	30 Marks	External Examination - Marks	70 Marks
Credits	03		

UNIT – I

Approaches to the development *of* adaptive filter theory. Introduction to filtering, smoothing and prediction. Wiener filter theory, introduction; Error performance surface; Normal equation; Principle of orthogonality; Minimum mean squared error; example.

UNIT – II

Gradient algorithms; Learning curves; LMS gradient algorithm; LMS stochastic gradient algorithms; convergence of LMS algorithms.

UNIT – III

Applications of adaptive filter to adaptive noise canceling, Echo cancellation in telephone circuits and adaptive beam forming.

UNIT – IV

Kalman Filter theory; Introduction; recursive minimum mean square estimation for scalar random variables; statement of the Kalman filtering problem: the innovations process; Estimation of state using the innovations process; Filtering examples.

UNIT – V

Vector Kalman filter formulation. Examples. Application of Kalman filter to target tracking.

Suggested Reading:

1. Sophoclas, *J*. Orphanidies, “Optimum signal processing an introduction”, McMillan, 1985.
2. Simon Haykins, “Adaptive signal processing”, PHI, 1986.
3. Bernard Widrow, “Adaptive signal processing”, PHI,1986.
4. Bozic. SM., Digital and kalman Filtering.

EC 6202

AUDIO AND SPEECH SIGNAL PROCESSING

Instruction	3 Periods per week	External Examination - Duration	3 Hours
Sessionals	30 Marks	External Examination - Marks	70 Marks
Credits	03		

UNIT – I

Fundamentals of Digital Speech Processing: Anatomy & Physiology of Speech Organs, The Process of Speech Production, The Acoustic theory of speech production- Uniform lossless tube model, effect of losses in vocal tract, effect of radiation at lips, Digital models for speech signals. Perception : Anatomical pathways from the Ear to the Perception of Sound, The Peripheral Auditory system, Hair Cell and Auditory Nerve Functions, Properties of the Auditory Nerve. Block schematics of the Peripheral Auditory system.

UNIT – II

Time Domain models for Speech Processing: Introduction – Window considerations, Short time energy, average magnitude, average zero crossing rate, Speech vs Silence discrimination using energy and zero crossing, pitch period estimation using a parallel processing approach, the short time autocorrelation function, average magnitude difference function, pitch period estimation using the autocorrelation function. Linear Predictive Coding (LPC) Analysis : Basic principles of Linear Predictive Analysis : The Autocorrelation Method, The Covariance method, Solution of LPC Equations : Cholesky Decomposition Solution for Covariance Method, Durbin's Recursive Solution for the Autocorrelation Equations, comparison between the methods of solution of the LPC Analysis Equations, Applications of LPC Parameters : Pitch Detection using LPC Parameters, Formant Analysis using LPC Parameters.

UNIT – III

Homomorphic Speech Processing: Introduction , Homomorphic Systems for Convolution : Properties of the Complex Cepstrum, Computational Considerations , The Complex Cepstrum of Speech, Pitch Detection , Formant Estimation, The Homomorphic Vocoder. Speech Enhancement: Speech enhancement techniques : Single Microphone Approach, Spectral Subtraction, Enhancement by re-synthesis, Comb filter, Wiener filter, Multi Microphone Approach.

UNIT – IV

Automatic Speech Recognition: Basic pattern recognition approaches, parametric representation of Speech, Evaluating the similarity of Speech patterns, Isolated digit Recognition System, Continuous word Recognition system. Elements of HMM, Training & Testing of Speech using HMM. Automatic Speaker Recognition: Recognition techniques, Features that distinguish speakers, MFCC, delta MFCC, Speaker Recognition Systems: Speaker Verification System , Speaker Identification System, Performance Metrics.

UNIT – V

Audio Coding : Lossless Audio Coding, Lossy Audio coding, Psychoacoustics , ISO-MPEG-1 Audio coding , MPEG - 2 Audio coding, MPEG - 2 Advanced Audio Coding, MPEG - 4 Audio Coding.

Suggested Reading:

1. Digital Processing of Speech Signals - L.R. Rabiner and S. W. Schafer. Pearson Education.
2. Digital Audio Signal Processing – Udo Zolzer, 2nd Edition, Wiley.
3. Speech & Audio Signal Processing- Ben Gold & Nelson Morgan, 1st Ed., Wiley
4. Discrete Time Speech Signal Processing: Principles and Practice - Thomas F. Quateri, 1st Ed., PE.
5. Digital Processing of Speech Signals. L.R Rabinar and R W Jhaung, 1978, PHI.

EC 6203

Bio-Medical Signal Processing

Instruction	3 Periods per week	External Examination - Duration	3 Hours
Sessionals	30 Marks	External Examination - Marks	70 Marks
Credits	03		

UNIT –I

Random Processes: Stationary random process, Ergodicity, Power spectral density and autocorrelation function of random processes. Noise power spectral density analysis, Noise bandwidth and noise figure of systems.

UNIT –II

Data Compression Techniques: Lossy and Lossless data reduction Algorithms. ECG data compression using Turning point, AZTEC, CORTES, Huffman coding, vector quantisation, DICOM Standards

UNIT -III

Cardiological Signal Processing: Pre-processing, QRS Detection Methods, Rhythm analysis, Arrhythmia Detection Algorithms, Automated ECG Analysis, ECG Pattern Recognition.
Adaptive Noise Cancelling: Principles of Adaptive Noise Cancelling, Adaptive Noise Cancelling with the LMS Adaptation Algorithm, Noise Cancelling Method to Enhance ECG Monitoring, Fetal ECG Monitoring.

UNIT –IV

Signal Averaging, Polishing – Mean and trend removal, Prony's method, Prony's Method based on the Least Squares Estimate, Linear prediction, Yule – Walker (Y –W) equations, Analysis of Evoked Potentials.

UNIT –V

Neurological Signal Processing: Modelling of EEG Signals, Detection of spikes and spindles Detection of Alpha, Beta and Gamma Waves. Auto Regressive (A.R.) modelling of seizure EEG. Sleep Stage analysis, Inverse Filtering, Least squares and polynomial modelling.

Suggested Reading:

1. Probability, Random Variables & Random Signal Principles – Peyton Z. Peebles, 4th Ed., 2009, TMH.
2. Biomedical Signal Processing- Principles and Techniques - D. C. Reddy, 2005, TMH.
3. Digital Bio Dignal Processing - Weitkunat R, 1991, Elsevier.
4. Biomedical Signal Processing - Akay M , IEEE Press.
5. Biomedical Signal Processing -Vol. I Time & Frequency Analysis - Cohen.A, 1986, CRC Press.

EC 6204

STATISTICAL SIGNAL PROCESSING

Instruction	3 Periods per week	External Examination - Duration	3 Hours
Sessionals	30 Marks	External Examination - Marks	70 Marks
Credits	03		

UNIT – I

Optimum Linear Filters: Representation of stationary random process – Rational power spectra, Filter parameters and autocorrelation sequence. Forward and backward predictors, Reflection coefficients, AR Process and Linear Prediction. Solution of normal equations – Levinson & Durbin Algorithms, Schur Algorithm. Properties of linear prediction error filters. AR Lattice and ARMA Lattice – Ladder filters. FIR and IIR Wiener filtering and prediction.

UNIT – II

Power Spectrum Estimation: Estimation of Spectra from finite duration observation of a signal. Periodogram. DFT in power spectrum estimation. Non-parametric methods – Bartlett's welch's and Blackman-Turkey methods; Computational requirements and performance characteristics. Parametric methods – Relation between auto correlation sequence and model parameters. Methods for AR model parameters. Yule – walker, Burg and unconstrained, Least squares methods. Sequential estimation methods. Selection of AR model order; Moving average (MA) and ARMA models. Capon's minimum variance method. Pisarenko's harmonic decomposition method. Eigen structure methods – Music and ESPIRIT. Order selection criteria.

UNIT – III

Array Signal Processing: Array fundamentals – Spatial signals, Signal models, Spatial sampling. Conventional beam forming-Spatial matched filter, Tapered Beam forming. Optimum Beam forming, Eigen Analysis, Interference cancellation, sidelobe canceller. Performance considerations for optimum beam forming. Basic ideas of direction of arrival estimation using a uniform linear array. Maximum likelihood estimate. Pisarenko's method. MUSIC.

UNIT – IV

Adaptive Filters: Applications of adaptive filters-Prediction, System modeling, Interference cancellation, Channel equalization. Adaptive direct form FIR filters – MMSE extension, LMS algorithm, properties of LMS algorithm, Recursive Least Squares (RLS) algorithm and its properties. Adaptive Lattice – Ladder filters, properties of lattice – Ladder algorithm.

UNIT – V

Introduction. Moments, cumulant and polyspectra. Higher Order Moments (HOM) and LIT systems, HOM‟s of linear signal methods. Blind deconvolution. Blind equalization algorithm. Conventional estimators for HOS. Parametric method for estimation of HOS – MA, AR & ARMA methods. Ceptra of HOS. Phase and magnitude retrieval from the bispectrum.

Suggested Reading:

1. John G. Proakis et.al, "Introduction to Digital Signal Processing", PHI, 1997.
2. D.G. Manolakis, Ingle & S.M. Kogon, "Statistical and Adaptive Signal Processing", McGraw Hill, Int. edition, 2000.
3. John G. Proakis, Rader, et.al, "Algorithms for Statistical Signal Processing", Pearson Education, Asia Publishers, Indian edition, 2002.
4. S. Kay: Modern Spectral Estimation, "Theory & Applications", PH publication, 1st edition, 1987.
5. Simon Haykins, "Array Signal Processing", P.H. Publication 1985. (Chapters 2,3 and 4).

EC 6205

RADAR SIGNAL PROCESSING

Instruction	3 Periods per week	External Examination - Duration	3 Hours
Sessionals	30 Marks	External Examination - Marks	70 Marks
Credits	03		

UNIT-I

Introduction: Classification of Radars based on functions, principles of operation etc., performance measures and interplay between Radar parameters, Target parameters and Environment parameters. Classical Detection and Estimation Theory, Binary Hypotheses Testing, Likely hood Ratio Test, Neymon square, MAP, Maximum Likelihood Estimation of parameters, Cramer-Rao Bounds, Chemo of Bounds.

UNIT – II

Representation of Signals, K-L expansion, Equivalent Low-pass representation of Band pass signals and noise. Detection of Slowly Fluctuating point Targets in white noise and coloured noise. Swerling Target models. Optimum receivers. Correlator and Band pass Matched Filter Receivers. PD – PF performance; Coherent and non-coherent Integration sub-optimum Reception. Radar Power – Aperture product.

UNIT – III

Range and Doppler Resolution : Ambiguity function and its properties. Local and Global Accuracy. Signal Design. LFM. Polyphase coded signals Detection of a Doppler shifted slowly fluctuating point target return in a discrete scatterer environment.

UNIT – IV

Dobly dipersive Fading Target and Clutter models-Scattering function description. Land clutter-pulse length limited and Beam width limited clutter. Sea clutter.

UNIT – V

Optimum / Sub optimum reception of Range Spread / Doppler Spread / Doubly spread targets in the presence of noise and clutter. Introduction to Adaptive Detection and CFAR Techniques.

Suggested Reading:

1. Di Franco. JV and Rubin, WL., "Radar Detection", Artech House, 1980.
2. Gaspare Galati (Ed), "Advanced Radar Techniques and Systems", Peter Perigrinus Ltd., 1993.
3. Ramon Nitzberg, "Radar Signal Processing and Adaptive Systems", Artech House, 1999. August. W Rihaczek, "Principles of High Resolution Radar", Artech House, 1996.

EC 6206

DATA COMPRESSION METHODS

Instruction	3 Periods per week	External Examination - Duration	3 Hours
Sessionals	30 Marks	External Examination - Marks	70 Marks
Credits	03		

UNIT – I

Review of Information Theory, The discrete memory less information source - Kraft inequality; optimal codes Source coding theorem. Compression Techniques - Lossless and Lossy Compression - Mathematical Preliminaries for Lossless Compression -Huffman Coding - Optimality of Huffman codes - Extended Huffman Coding – Adaptive Huffman Coding - Arithmetic Coding - Adaptive Arithmetic coding, Run Length Coding, Dictionary Techniques - Lempel-Ziv coding, Applications - Predictive Coding - Prediction with Partial Match – Burrows Wheeler Transform, Dynamic Markov Compression.

UNIT – II

Rate distortion theory: Rate distortion function R(D),Properties of R(D); Calculation of R(D) for the binary source and the Gaussian source, Rate distortion theorem, Converse of the Rate distortion theorem, Quantization - Uniform & Non-uniform - optimal and adaptive quantization, vector quantization and structures for VQ, Optimality conditions for VQ, Predictive Coding - Differential Encoding Schemes.

UNIT – III

Mathematical Preliminaries for Transforms, Sub-bands and Wavelets, Karhunen Loeve Transform, Discrete Cosine and Sine Transforms, Discrete Walsh Hadamard Transform.

UNIT – IV

Transform coding – Sub-band coding – Wavelet transform based Compression.

UNIT – V

Basics of Compression standards: Audio Compression standards: MPEG, Dolby AC3; and Video Compression Standards: MPEG, H.261, H.263 and H.264.

Suggested Reading:

1. Khalid Sayood, “Introduction to Data Compression,” Morgan Kaufmann Publishers., 3/e, 2011.
2. David Salomon, “Data Compression: The Complete Reference,” Springer Publications, 4/e, 2006.
3. Toby Berger, “Rate Distortion Theory: A Mathematical Basis for Data Compression,” PHI, 1971.
4. S. Mallat, A wavelet Tour of Signal Processing, 2/e, Academic Press, 1999.
5. Martin Vetterli and Jelena Kovacevic, “Wavelets and Subband Coding,” PHI, 1995.

EC 6210

WAVELETS & APPLICATIONS

Instruction	3 Periods per week	External Examination - Duration	3 Hours
Sessionals	30 Marks	External Examination - Marks	70 Marks
Credits	03		

UNIT – I

Introduction: Stationary and non-stationary signals, Signal representation using basis and frames, Brief introduction to Fourier transform and Short time Fourier transform, Time-frequency analysis, Bases of time frequency: orthogonal, Filter banks, Multi resolution formulation: Wavelets from filters, Classes of wavelets: Haar, Daubechies, bi-orthogonal.

UNIT – II

Continuous Wavelet Transform: Continuous wavelet transform (CWT), Time and frequency resolution of the continuous wavelet transform, Construction of continuous wavelets: Spline, orthonormal, bi-orthonormal, Inverse continuous wavelet transform, Redundancy of CWT, Zoom property of the continuous wavelet transform, Filtering in continuous wavelet transform domain.

UNIT – III

Discrete Wavelet Transform And Filterbanks: Orthogonal and bi-orthogonal two-channel filter banks, Design of two-channel filter banks, Tree-structured filter banks, Discrete wavelet transform, Non-linear approximation in the Wavelet domain, multi resolution analysis, Construction and Computation of the discrete wavelet transform, the redundant discrete wavelet transform.

UNIT – IV

Multi Resolution Analysis: Multirate discrete time systems, Parameterization of discrete wavelets, Bi-orthogonal wavelet bases, Two dimensional, wavelet transforms and Extensions to higher dimensions, wave packets

UNIT – V

Applications: Signal and Image compression, Detection of signal changes, analysis and classification of audio signals using CWT, Wavelet based signal de-noising and energy compaction, Wavelets in adaptive filtering, Adaptive wavelet techniques in signal acquisition, coding and lossy transmission, Digital Communication and Multicarrier Modulation, Trans multiplexers , Image fusion, Edge Detection and object isolation.

Suggested Reading:

1. A Wavelet Tour of Signal Processing, 2nd edition, S. Mallat, Academic Press, 1999.
2. Wavelet transforms: Introduction, Theory and applications, Raghuveer rao and Ajit S.Bopardikar, Pearson Education Asia, 2000.
3. Fundamentals of Wavelets: Theory, Algorithms, and Applications, J.C. Goswami and A.K. Chan, 2nd ed., Wiley, 2011.
4. Wavelets and their Applications, Michel Misiti, Yves Misiti, Georges Oppenheim, Jean-Michel Poggi, John Wiley & Sons, 2010 .
5. Multirate Systems and Filter Banks, P. P. Vaidyanathan, Pearson Education, 2004.

EC 6211

CODECS FOR MULTIMEDIA APPLICATIONS

Instruction	3 Periods per week	External Examination - Duration	3 Hours
Sessionals	30 Marks	External Examination - Marks	70 Marks
Credits	03		

UNIT – I

Introduction to multimedia: components of multimedia; overview of multimedia software tools; Graphics and Image Data Representations: Graphics/image data types, popular file formats; Fundamental Concepts in Video: analog and digital video.

Basics of Digital Audio – Storage requirements for multimedia applications; Need for Compression - Taxonomy of compression techniques

UNIT – II

Digital audio: audio compression techniques; μ-Law and A-Law, companding, ADPCM.

Speech compression: waveform codecs; source codecs; hybrid codecs; Shorten: lossless speech compressor, MPEG-1 audio layers

UNIT – III

Image Transforms – orthogonal transforms- DCT, JPEG, progressive image compression- JBIG, JBIG2 standards , Vector quantization, Differential lossless compression –DPCM Wavelet based compression- Filter banks, DWT, Multiresolution decomposition, SPIHT and EZW Coders, JPEG 2000 standard

UNIT – IV

Video signal components - Video compression techniques – MPEG Video Coding– Motion Compensation – H.261 , H.263 Standard , .MPEG4 and H.264 codecs.

UNIT – V

PLL, Image Processing, FSK modems, Voice detection and reverse play back, multi-rate filters, Current trends in digital signal processors.

Suggested Reading:

1. David Salomon, “Data Compression – The Complete Reference,” Springer Verlag New York Inc.,3rd Edition, 2008.
2. L. Hanzo, P. J. Cherriman and J. Streit, “Video Compression and Communications From Basics toH.261, H.263, H.264,MPEG4 for DVB and HSDPA-Style Adaptive Turbo Transceivers,” Second Edition, IEEE Communications Society, John Wiley & Sons Ltd, 2007.
3. Peter Symes, “Digital Video Compression,” McGraw Hill Pub., 2004.

EC 6212

SOFT COMPUTING TECHNIQUES

Instruction	3 Periods per week	External Examination - Duration	3 Hours
Sessionals	30 Marks	External Examination - Marks	70 Marks
Credits	03		

UNIT – I

Fundamentals of Neural Networks & Feed Forward Networks: Basic Concept of Neural Networks, Human Brain, Models of an Artificial Neuron, Learning Methods, Neural Networks Architectures, Single Layer Feed Forward Neural Network :The Perceptron Model, Multilayer Feed Forward Neural Network :Architecture of a Back Propagation Network(BPN), The Solution, Backpropagation Learning, Selection of various Parameters in BPN. Application of Back propagation Networks in Pattern Recognition & Image Processing.

UNIT – II

Associative Memories & ART Neural Networks: Basic concepts of Linear Associator, Basic concepts of Dynamical systems, Mathematical Foundation of Discrete-Time Hop field Networks(HPF), Mathematical Foundation of Gradient-Type Hopfield Networks, Transient response of Continuous Time Networks, Applications of HPF in Solution of Optimization Problem: Minimization of the Traveling salesman tour length, Summing networks with digital outputs, Solving Simultaneous Linear Equations, Bidirectional Associative Memory Networks; Cluster Structure, Vector Quantization, Classical ART Networks, Simplified ART Architecture.

UNIT – III

Fuzzy Logic & Systems: Fuzzy sets, Crisp Relations, Fuzzy Relations, Crisp Logic, Predicate Logic, Fuzzy Logic, Fuzzy Rule based system, Defuzzification Methods, Applications: Greg Viot's Fuzzy Cruise Controller, Air Conditioner Controller.

UNIT – IV

Genetic Algorithms : Basic Concepts of Genetic Algorithms (GA), Biological background, Creation of Offsprings, Working Principle, Encoding, Fitness Function, Reproduction, Inheritance Operators, Cross Over, Inversion and Deletion, Mutation Operator, Bit-wise Operators used in GA, Generational Cycle, Convergence of Genetic Algorithm.

UNIT – V

Hybrid Systems: Types of Hybrid Systems, Neural Networks, Fuzzy Logic, and Genetic Algorithms Hybrid, Genetic Algorithm based BPN: GA Based weight Determination, Fuzzy Back Propagation Networks: LR-type fuzzy numbers, Fuzzy Neuron, Fuzzy BP Architecture, Learning in Fuzzy BPN, Inference by fuzzy BPN.

Suggested Reading:

1. Neural Networks, Fuzzy Logic & Genetic Algorithms: Synthesis & Applications - S.Rajasekaran, G.A. Vijayalakshmi Pai, July 2011, PHI, New Delhi.
2. Genetic Algorithms by David E. Gold Berg, Pearson Education India, 2006.
3. Neural Networks & Fuzzy Sytems- Kosko.B., PHI, Delhi, 1994.
4. Artificial Neural Networks - Dr. B. Yagananarayana, 1999, PHI, New Delhi.
5. An introduction to Genetic Algorithms - Mitchell Melanie, MIT Press, 1998.

EC 6212

INTERNET OF THINGS

Instruction	3 Periods per week	External Examination - Duration	3 Hours
Sessionals	30 Marks	External Examination - Marks	70 Marks
Credits	03		

UNIT – I

M2M to IoT: The Vision-Introduction, From M2M to IoT, M2M towards IoT-the global context, A use case example, Differing Characteristics.

UNIT – II

M2M to IoT – A Market Perspective: Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. M2M to IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

UNIT – III

M2M and IoT Technology Fundamentals: Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service(XaaS), M2M and IoT Analytics, Knowledge Management

UNIT – IV

IoT Architecture-State of the Art – Introduction, State of the art, Architecture Reference Model- Introduction, Reference Model and architecture, IoT reference Model

UNIT – V

IoT Reference Architecture: Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints- Introduction, Technical Design constraints-hardware is popular again, Data representation and visualization, Interaction and remote control. Industrial Automation- Service-oriented architecture-based device integration, SOCRADES: realizing the enterprise integrated Web of Things, IMC-AESOP: from the Web of Things to the Cloud of Things, Commercial Building Automation- Introduction, Case study: phase one-commercial building automation today, Case study: phase two- commercial building automation in the future.

Suggested Reading:

1. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1st Edition, Academic Press, 2014.
2. Vijay Madisetti and Arshdeep Bahga, “Internet of Things (A Hands-on-Approach)”, 1stEdition, VPT, 2014.
3. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1st Edition, Apress Publications, 2013.