DEPARTMENT OF
ELECTRONICS & COMMUNICATION ENGINEERING

Scheme of Instruction
and
Syllabi of

M.E. (ECE)

COMMUNICATION ENGINEERING
AND
SIGNAL PROCESSING
(With effect from 2014-2015)

VASAVI COLLEGE OF ENGINEERING
(Autonomous Institution Under UGC)
Ibrahimbagh, Hyderabad - 500 031
Andhra Pradesh

Scheme of Instruction & Examination
M.E. – Four Semester Course (Regular)

S. No.	Subject	Periods per week		Duration (Hours)	Max. Marks		Credits
		L/T	D/P		Ext. Exam	Sessional	
Semester – I							
1.	Core	4	--	3	70	30	3
2.	Core	4	--	3	70	30	3
3.	Core / Elective	4	--	3	70	30	3
4.	Core / Elective	4	--	3	70	30	3
5.	Core / Elective	4	--	3	70	30	3
6.	Elective	4	--	3	70	30	3
7.	Lab – I	--	3	--	--	50	2
8.	Lab - II	--	3	--	--	50	2
9.	Seminar – I	--	3	--	--	50	2
	Total	**24**	**9**	**--**	**420**	**330**	**24**
Semester – II							
1.	Core	4	--	3	70	30	3
2.	Core	4	--	3	70	30	3
3.	Core / Elective	4	--	3	70	30	3
4.	Core / Elective	4	--	3	70	30	3
5.	Core / Elective	4	--	3	70	30	3
6.	Elective	4	--	3	70	30	3
7.	Lab – III	--	3	--	--	50	2
8.	Lab - IV	--	3	--	--	50	2
9.	Seminar – II	--	3	--	--	50	2
	Total	**24**	**9**	**--**	**420**	**330**	**24**
Semester – III							
1.	Dissertation + Project Seminar*	--	-- 6	--	--	-- 100**	-- 6
	Total	**--**	**6**	**--**	**--**	**100****	**6**
Semester – IV							
1.	Dissertation	--	--	Viva-voce	Grade***	-	10
	Total	**--**	**--**	**--**	**--**	**--**	**10**

Note: Six core Subjects and Six Elective subjects should be completed by the end of Semester – II.

* One Project Seminar presentation.

** 50 marks to be awarded by guide and 50 marks to be awarded by Viva committee with guide and two internal faculty members.

*** Excellent / Very Good /Good/ Satisfactory / Unsatisfactory.

(i) The syllabus consists of 5 units. Semester end examination will be conducted for 70 marks. The question paper consists of PART - A and PART - B. Part – A is compulsory and should cover the entire syllabus, and carries 20 marks. Part - B will comprise seven questions. There has to be one question in each unit of the syllabus and the remaining two questions may be from the entire syllabus of all 5 units. Student has to answer any five questions out of seven questions and each question carry 10 marks. Theory question paper have total 8 questions out of which candidate has to answer 6 questions including one compulsory question of 20 marks. This compulsory question, consisting of 10 questions, which will cover the entire syllabus. Other questions will be of 10 marks each.

(ii) Two internal examinations will be conducted for 20 marks. The question paper consists of Part - A and Part - B. Student should answer all the questions from Part - A and any two questions from Part - B. Part - A carries 6 marks and it consists of 6 questions. Each question is awarded 01 mark. The question may be definition, problem solving, multiple choice, match the following and filling the blanks type. Part – B carries 14 marks and consists of 3 Questions. Each question carries 7 marks and it may contain 2 sub questions.

List of subjects for M.E. (ECE) course with specialization in COMMUNICATION ENGINEERING AND SIGNAL PROCESSING

S. No.	Syllabus Ref. No.	Subject	Periods per week
Core Subjects			
1.	EC 6010	Signal Compression Theory and Methods	4
2.	EC 6020	Multirate Processing	4
3.	EC 6030	Speech Signal Processing	4
4.	EC 6040	Digital Modulation Techniques	4
5.	EC 6050	Wireless Communications and Networking	4
6.	EC 6060	Principles of Communication Systems Simulation with Wireless Applications	4
7.	EC 6011	Advanced Signal Processing Laboratory	3
8.	EC 6012	Embedded Systems Laboratory	3
9.	EC 6013	Communication Systems Simulation Laboratory	3
10.	EC 6014	DSP Processors Applications Laboratory	3
11.	EC 6015	Seminar – I	3
12.	EC 6016	Seminar – II	3
13.	EC 6017	Project Seminar	6
14.	EC 6018	Dissertation	--
Elective subjects			
15.	EC 6070	Array Signal Processing	4
16.	EC 6080	Spread Spectrum and CDMA Systems	4
17.	EC 6090	Wireless Channel Coding	4
18.	EC 6100	Advanced Optical Communication	4
19.	EC 6110	MIMO Communication Systems	4
20.	EC 6120	Global Navigational Satellite Systems	4
21.	EC 6130	Radar Signal Processing	4
22.	EC 6140	Adaptive Signal Processing	4
23.	EC 6150	CODECS for Multimedia Applications	4
24.	EC 6160	Software Defined and Cognitive Radio	4
25.	EC 6170	Detection and Estimation Theory	4
26.	EC 6180	Coding Theory and Techniques	4
27.	EC 6190	Satellite and Microwave Communication	4
28.	EC 6200	Smart Antennas for Mobile Communications	4
29.	EC 6210	Image and Video Processing	4
30.	EC 6220	Data and Computer Communication Networks	4
31.	EC 6230	DSP Processors – Architecture	4
32.	EC 6240	Statistical Signal Processing	4

EC 6010

SIGNAL COMPRESSION THEORY AND METHODS

Instruction	4 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, Lapped transforms.

UNIT – IV

Transform coding – Sub-band coding – Wavelet transform based Compression - Analysis/Synthesis Schemes.

UNIT – V

Basics of Data Compression standards: Zip, gZip; 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. R.G.Gallager, “Information Theory and Reliable Communication,” John Wiley & Sons, 1968.
5. Martin Vetterli and Jelena Kovacevic, “Wavelets and Subband Coding,” PHI, 1995.

EC 6020

MULTIRATE PROCESSING

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

UNIT – I

Fundamentals of Multirate Theory: The sampling theorem - sampling at sub-Nyquist rate - Basic Formulations and schemes. Basic Multirate operations- Decimation and Interpolation - Digital Filter Banks- DFT Filter Bank- Identities- Poly-phase representation (c) Maximally decimated filter banks: Poly-phase representation, Errors in the QMF bank, Perfect reconstruction (PR) QMF Bank, Design of an alias free QMF Bank.

UNIT – II

M-channel perfect reconstruction filter banks: Uniform band and non uniform filter bank - tree structured filter bank- Errors created by filter bank system- Poly-phase representation- perfect reconstruction systems –

UNIT – III

Perfect reconstruction (PR) filter banks: Para-unitary PR Filter Banks- Filter Bank Properties induced by para-unitarity- Two channel FIR para-unitary QMF Bank- Linear phase PR Filter banks- Necessary conditions for Linear phase property- Quantization Effects: -Types of quantization effects in filter banks. - coefficient sensitivity effects, dynamic range and scaling.

UNIT – IV

Cosine Modulated filter banks: Cosine Modulated pseudo QMF Bank- Alas cancellation- phase - Phase distortion- Closed form expression- Poly-phase structure- PR System

UNIT – V

Introduction to Wavelet Transforms: Short time Fourier Transform, Gabor Transform, Wavelet Transform, Recursive multi resolution decomposition, Haar wavelet, Digital Filter implementation of the Haar wavelet.

Suggested Reading:

1. Robert Cristi, “Modern Digital Signal Processing,” Thomson Books, 2004.
2. F.J. Harris, “Multirate Signal Processing for Communication Systems,” PHI, 2004.
3. N.J. Fliege, “Multirate Digital Signal Processing”, John Wiley 1994.
4. E.C. Ifeachor and B.W.Jervis, Digital Signal Processing: A Practical Approach, Addison-Wesley, 1993.
5. Sanjit K. Mitra, “Digital Signal Processing”, TMH, 1998.

EC 6030

SPEECH SIGNAL PROCESSING

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

UNIT – I

Digital models for the speech signal - mechanism of speech production - acoustic theory - lossless tube models - digital models - linear prediction of speech - auto correlation - formulation of LPC equation - solution of LPC equations - Levinson Durbin algorithm - Levinson recursion - Schur algorithm – lattice formulations and solutions - PARCOR coefficients - Spectral analysis of speech - Short Time Fourier analysis - filter bank design. Auditory Perception : Psychoacoustics- Frequency Analysis and Critical Bands - Masking properties of human ear :

UNIT – II

Speech coding: sub-band coding of speech - transform coding - channel vocoder - formant vocoder – cepstral vocoder - vector quantizer coder- Linear predictive Coder. Speech synthesis - pitch extraction algorithms - gold rabiner pitch trackers - autocorrelation pitch trackers - voice/unvoiced detection

UNIT – III

Homo-morphic speech processing – homo-morphic systems for convolution - complex cepstrums - pitch extraction using homo-morphic speech processing. Sound Mixtures and Separation - CASA, ICA & Model based separation.

UNIT – IV

Speech Transformations - Time Scale Modification - Voice Morphing. Automatic speech recognition systems - isolated word recognition - connected word recognition -large vocabulary word recognition systems - pattern classification - DTW, HMM - speaker recognition systems - speaker verification systems – speaker identification Systems.

UNIT – V

Audio Processing: Non speech and Music Signals - Modeling -Differential, transform and sub-band coding of audio signals & standards - High Quality Audio coding using Psychoacoustic models - MPEG Audio coding standard. Music Production - sequence of steps in a bowed string instrument - Frequency response measurement of the bridge of a violin. Audio Data bases and applications - Content based retrieval.

Suggested Reading:

1. Rabiner L.R. & Schafer R.W., “Digital Processing of Speech Signals,” Pearson, 2011.
2. Ben Gold & Nelson Morgan, “Speech and Audio Signal Processing,” John Wiley & Sons, 2007.
3. Thomas F. Quatieri, “Discrete-time Speech Signal Processing: Principles and Practice,” PHI, 2006.
4. Marina Bosi and Richard E. Goldberg, “Introduction to Digital Audio Coding and Standards,” Springer, 2010.
5. Thomas W. Parsons, “Voice and Speech Processing,” McGraw Hill, 1986.

EC 6040

DIGITAL MODULATION TECHNIQUES

Instruction	4 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 6050

WIRELESS COMMUNICATIONS AND NETWORKING

Instruction	4 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 6060

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 6011

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 6012

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 6013

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 6014

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 6015

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 6016

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 6017

PROJECT 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 6018

DISSERTATION

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 6070

ARRAY SIGNAL PROCESSING

Instruction	4 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 6080

SPREAD SPECTRUM AND CDMA SYSTEMS

Instruction	4 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 6090

WIRELESS CHANNEL CODING

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

UNIT – I

Overview of wireless communications. Characterization of wireless channels: Path Loss and shadowing models, Statistical fading models, Narrowband/Wideband fading models. Capacity of Wireless Channels. Performance of Digital Modulation. Diversity in Fading Channels.

UNIT – II

Multiple Antenna and Space-Time Communications: Narrowband MIMO Model, Parallel Decomposition of MIMO Channel, MIMO diversity Gain: Beam forming, Space-Time modulation and coding. Frequency-Selective MIMO communications, Smart Antennas, MIMO Channel Capacity.

UNIT – III

Coding for Wireless Channels: Channel Coding and its potential. Coding in a signal space. Coded modulation and coding with interleaving. Basic error control coding & concerned mathematics. Linear block codes, Cyclic codes, BCH and Reed-Solomon codes.

UNIT – IV

Trellis representation of codes, Coding on a trellis, Convolutional Codes, Trellis coded modulation. Codes on graphs and Concatenated codes. Turbo Codes and LDPC codes.

UNIT – V

Adaptive modulation and coding: Adaptive techniques, Variable-Rate Variable-Power MQAM: adaptive rate and power techniques, Adaptive coded modulation, adaptive techniques in combined fast and slow fading.

Suggested Reading:

1. Ezio Biglieri, “Coding for Wireless Channels,” Springer, 2005.
2. D.Tse, and P. Viswanath, “Fundamentals of Wireless Communication,” CUP, 2005.
3. A. Goldsmith, “Wireless Communications,” CUP, 2005.
4. M.K. Simon and M.S. Alouini, “Digital Communication over Fading channels: A Unified approach to performance analysis,” Wiley, 2000.
5. Theodore S. Rapport, “Wireless Communications- Principles and practice,” 2/e, PHI, 2002.

EC 6100

ADVANCED OPTICAL COMMUNICATION

Instruction	4 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 6110

MIMO COMMUNICATION SYSTEMS

Instruction	4 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 6120

GLOBAL NAVIGATION SATELLITE SYSTEMS

Instruction	4 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 6130

RADAR SIGNAL PROCESSING

Instruction	4 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.
4. August. W Rihaczek, “Principles of High Resolution Radar”, Artech House, 1996.

EC 6140

ADAPTIVE SIGNAL PROCESSING

Instruction	4 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 6150

CODECS FOR MULTIMEDIA APPLICATIONS

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

UNIT – 1

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 – 2

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 – 3

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 – 4

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

UNIT – 5

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 6160

SOFTWARE DEFINED AND COGNITIVE RADIO

Instruction	4 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 6170

DETECTION AND ESTIMATION THEORY

Instruction	4 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 6180

CODING THEORY AND TECHNIQUES

Instruction	4 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. S.B. Wicker, Error control systems for Digital communication and storage,
2. Prentice-hall 1995. E. Biglieri, Coding for Wireless Channels, Springer,2007.
3. K.L.Du & M.N.S.Swamy, Wireless Communication Systems: From RF
4. Subsystems to G Enabling Technoligies, Cambridge,2010.
5. J.G. Proakis & M. Salehi, Digital Communications, Mc Graw-Hill, 2008.

EC 6190

SATELLITE AND MICROWAVE COMMUNICATION

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

UNIT – I

Introductory concepts: Transmission problem, simplified transmission system, the decibel and basic derived decibel unit, Neper, practical transmission, speech, SNR, Noise figure and noise temperature, EIRP and conversion factors, CCITT modulation plan, loading of FDM system, pilot tones, noise calculation, through super group techniques, compandors, characteristics of carrier equipment.

UNIT – II

Line-of-sight communication systems: Link engineering, propagation characteristics in free space, path calculations, feeding, diversity reception, noise power ratio and its measurements, frequency planning. Path and link reliability, rainfall and other precipitation attenuation, radio link repeaters, antenna towers and masts, plain reflectors as passive repeaters, noise planning on radio links.

UNIT – III

Tropospheric scatter communication system: Introduction, phenomenon of tropospheric scatter, tropospheric fading, path loss calculations, aperture to medium coupling loss take of angle, equipment configuration, isolation, inter modulation, typical tropospheric scatter parameters. Frequency assignment. Earth station technology: The satellite earth space window, path loss considerations of the up-link and down path calculations.

UNIT – IV

Earth station, G/T, C/N, link calculation, C/N for the complete link, and design of communication systems via satellites, Modulation, Multiplexing and multiple access techniques: TDMA, FDMA, CDMA, SSMA, SPADE.

UNIT – V

Reliability, Redundancy, Quality assurance, Echo control and Echo suppression, introductory concepts of VSATS, GIS, GPS and Future trends, Pay load engineering – Definition, constraints, specification and configurations.

Suggested Reading:

1. Roger L Free man, “Telecommunication transmission handbook”, John Wiley, 4th Edition, 1998.
2. T.Pratt & C.W. Bostian, “Satellite Communication Systems”, PHI, 1st edition, 1986.
3. B.G.Evans, Satellite communication system edited, 3rd edition, IET, U.K., 2008.
4. Dennis Roddy, “Satellite Communication Systems”, Mc Graw Hill publications, 4th Edition, 2006.
5. Wayne Tomasi “Advanced Electronics Communication System” Pearson Education, 6th Edition, April 2003.

EC 6200

SMART ANTENNAS FOR MOBILE COMMUNICATIONS

Instruction	4 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 6210

IMAGE AND VIDEO PROCESSING

Instruction	4 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 6220

DATA AND COMPUTER COMMUNICATION NETWORKS

Instruction	4 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 6230

DSP PROCESSORS – ARCHITECTURE

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

UNIT – I

Introduction to DSP Processors: Differences between DSP and other μp architectures, their comparison and need for special ASP^{s} , RISC & CISC CPUs .

UNIT – II

Overview of DSP processor design: fixed point DSP^{s} – Architecture of TMS 320C 5X, C54X Processors, addressing modes, Assembly instructions, Pipelining and on-chip peripherals. Floating point DSP^{s}: Architecture of TMS 320 – IX.

UNIT – III

Data formats, F.P. operations, addressing modes, instructions, pipelining and peripherals.

UNIT – IV

DSP interfacing & software development tools: I/O interfacing with A/D converters, PC^{s}, Dual port RAM^{S}, EPGA^{s}, DSP tools – Assembler, debugger, c-compiler, linker, editor, code composer studio.

UNIT – V

Applications using DSP^{s} adaptive filtering, spectrum analysis, Echo cancellation modems, voice synthesis and recognition. Brief ideas of AD, Motorola DSP CPU^{s} and their comparison with TI CPU^{S}.

Suggested Reading:

1. C. Marren & G. Ewess, “A Simple Approach to Digital Signal Processing”, WILEY Inter-science, 1996.
2. K. Shin, “DSP Applications with TMS 320 Family”, Prentice Hall, 1987.
3. B. Ventakaramani, M. Bhaskar, “Digital Signal Processes, Architecture Processing and Applications”, Tata Mc Graw Hill, 2002.

EC 6240

STATISTICAL SIGNAL PROCESSING

Instruction	4 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).