VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2020 - 21
Choice Based Credit System (CBCS) and Outcome Based Education(OBE)

Programme: M.TECH IN SIGNAL PROCESSING (ESP)

I SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	20ELD11	Advanced Engineering Mathematics	04	--	03	40	60	100	4
2	PCC	20ECS12	Advanced Digital Signal Processing	04	--	03	40	60	100	4
3	PCC	20EVE13	Advanced EmbeddedSystem	04	--	03	40	60	100	4
4	PCC	20ESP14	Multirate Systems and Filter Banks	04	--	03	40	60	100	4
5	PCC	20ESP15	Digital Compression	04	--	03	40	60	100	4
6	PCC	20ESPL16	Advanced Digital Signal Processing Lab	-	04	03	40	60	100	2
7	PCC	20RMI17	Research Methodology and IPR	02	--	03	40	60	100	2
			TOTAL	**22**	**04**	**21**	**280**	**420**	**700**	**24**

Note: PCC: Professional core.

Internship: All the students have to undergo mandatory internship of 6 weeks during the vacation of I and II

semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed credit shall be counted for the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.
Note: (i) Four credit courses are designed for 50 hours Teaching – Learning process. (ii) Three credit courses are designed for 40 hours Teaching – Learning process.

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Choice Based Credit System (CBCS) and Outcome Based Education(OBE)

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II SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment/ Project	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	20ESP21	Image Processing and Machine Vision	04	--	03	40	60	100	4
2	PCC	20ESP22	DSP System Design	04	--	03	40	60	100	4
3	PCC	20ECS23	Error Control Coding	04	--	03	40	60	100	4
4	PEC	20XXX24X	Professional elective 1	04	--	03	40	60	100	4
5	PEC	20XXX25X	Professional elective 2	04	--	03	40	60	100	4
6	PCC	20ESPL26	Image Processing Lab	--	04	03	40	60	100	2
7	PCC	20ESP27	Technical Seminar	--	02	--	100	--	100	2
TOTAL				**20**	**06**	**20**	**340**	**360**	**700**	**24**

Note: PCC: Professional core, PEC: Professional Elective.

Professional Elective 1		Professional Elective 2	
Course Code under 20XXX24X	**Course title**	**Course Code under 20XXX25X**	**Course title**
20ECS241	Wireless Sensor Networks	20ESP251	Biomedical Signal Processing
20EVE242	Nanoelectronics	20ECS252	Statistical Signal Processing
20ECS243	Cryptography and Network Security (20EVE334)	20ELD253	Micro Electro Mechanical Systems
20ELD244	Reconfigurable Computing	20ESP254	Detection and Estimation

Note:

1. Technical Seminar: CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Participation in the seminar by all postgraduate students of the same and other semesters of the programme shall be mandatory.

The CIE marks awarded for Technical Seminar, shall be based on the evaluation of Seminar Report, Presentation skill and Question and Answer session in the ratio 50:25:25.

2. Internship: All the students shall have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed credit shall be counted in the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

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Choice Based Credit System (CBCS) and Outcome Based Education(OBE)

Programme: M.TECH IN SIGNAL PROCESSING (ESP)

III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	20ESP31	Adaptive Signal Processing	04	--	03	40	60	100	4
2	PEC	20XXX32X	Professional elective 3	04	--	03	40	60	100	3
3	PEC	20XXX33X	Professional elective 4	04	--	03	40	60	100	3
4	Project	20ESP34	Project Work phase -1	--	02	--	100	--	100	2
5	PCC	20ESP35	Mini-Project	--	02	--	100	--	100	2
6	Internship	20ESPI36	Internship	(Completed during the intervening vacation of I and II semesters and /or II and III semesters.)		03	40	60	100	6
TOTAL				**12**	**02**	**12**	**260**	**240**	**500**	**20**

Note: PCC: Professional core, PEC: Professional Elective.

Professional elective 3		Professional elective 4	
Course Code under 20XXX32X	**Course title**	**Course Code under 20XXX33X**	**Course title**
20ESP321	Array Signal Processing	20EVE331	VLSI Design for Signal Processing
20EIE322	Medical Imaging	20ESP332	Pattern Recognition & Machine Learning
20ELD323	Business Intelligence and its Applications	20ECS333	Internet of Things
20ESP324	Speech and Audio Processing	20ESP334	Communication System Design using DSP Algorithms

Note:

1. Project Phase-1: Students in consultation with the guide/co-guide if any, shall pursue literature survey and complete the preliminary requirements of selected Project work. Each student shall prepare relevant introductory project document, and present a seminar.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.

SEE (University examination) shall be as per the University norms.

2. Internship: Those, who have not pursued /completed the internship shall be declared as fail in internship course and have to complete the same during subsequent University examinations after satisfying the internship requirements. Internship SEE (University examination) shall be as per the University norms.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2020 - 21
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Programme: M.TECH IN SIGNAL PROCESSING (ESP)

IV SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks Viva voce	Total Marks	
1	Project	20ESP41	Project work phase -2	--	04	03	40	60	100	20
			TOTAL	--	**04**	**03**	**40**	**60**	**100**	**20**

Note:

1. Project Phase-2:

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a Senior faculty of the department. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report subjected to plagiarism check, Project Presentation skill and Question and Answer session in the ratio 50:25:25.

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY
BELAGAVI

Scheme of Teaching and Examinations and Syllabus
M.Tech in Signal Processing (ESP)
(Effective from Academic year 2020 - 21)

M.TECH IN Signal Processing (ESP)

Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
(Effective from the academic year 2020-21)

SEMESTER -I

ADVANCED ENGINEERING MATHEMATICS

CourseCode	**20ELD11**	CIEMarks	40
Lecture Hours/Week	**04**	SEE Marks	60
Total Number of LectureHours	**50**	Exam Hours	03
Credits - 04			

Module-1

Linear Algebra-I
Introduction to vector spaces and sub-spaces, definitions, illustrative example. Linearly independent and dependent vectors- Basis-definition and problems. Linear transformations-definitions. Matrix form of linear transformations-Illustrative examples (Text Book1).

Module-2

Linear Algebra-II
Computation of eigen values and eigen vectors of real symmetric matrices-Given's method. Orthogonal vectors and orthogonal bases. Gram-Schmidt orthogonalization process (Text Book1).

Module-3

Calculus of Variations
Concept of functional- Eulers equation. Functional dependent on first and higher order derivatives, Functional on several dependent variables. Isoperimetric problems-variation problems with moving boundaries. (TextBook2).

Module-4

Probability Theory: Review of basic probability theory. Definitions of random variables and probability distributions, probability mass and density functions, expectation, moments, central moments, characteristic functions, probability generating and moment generating functions-illustrations. Poisson, Gaussian and Erlang distributions examples (Text Book 3).

Module-5

Engineering Applications on Random processes: Classification. Stationary, WSS and ergodic random process. Auto-correlation function - properties, Gaussian random process (Text Book 3).

Course outcomes:

At the end of the course the student will be able to:

1. Understand vector spaces, basis, linear transformations and the process of obtaining matrix of linear transformations arising in magnification and rotation of images.
2. Apply the technique of singular value decomposition for data compression, least square approximation in solving inconsistent linear systems.
3. Utilize the concepts of functional and their variations in the applications of communication systems, decision theory, synthesis and optimization of digital circuits.
4. Learn the idea of random variables (discrete/continuous) and probability distributions in analyzing the probability models arising in control systems and system communications.
5. Analyze random process through parameter-dependent variables in various random processes.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

1. 'Linear Algebra and its Applications', David C Lay, Steven R Lay and J J McDonald, Pearson Education Ltd., 5th Edition, 2015
2. 'Differential Equations and Calculus of Variations', Elsgolts L, MIR Publications, 3rd Edition, 1977
3. 'Probability, Statistics and Random Process', T Veerarajan, Tata Mc-Graw Hill Co., 3rd Edition, 2016

Reference Books:

1. 'Introduction to Linear Algebra', Gilbert Strang, Wellesley-Cambridge Press, 5th Edition, 2016
2. 'Schaum's Outlines of Theory and Problems of Matrix Operations', Richard Bronson, McGraw-Hill, 1988
3. 'Probability and Random Process with application to Signal Processing', Scott L Miller, Donald G Childers, Elsevier Academic Press, 2nd Edition, 2013

Advanced Digital Signal Processing

CourseCode	**20ECS12**	CIEMarks	40
Lecture Hours/Week	**04**	SEE Marks	60
Total Number of LectureHours	**50**	Exam Hours	03
Credits - 04			

Module-1

Multirate Digital Signal Processing: Introduction, decimation by a factor 'D', Interpolation by a factor 'I', sampling rate conversion by a factor 'I/D', Implementation of sampling rate conversion, Multistage implementation of sampling rate conversion, Applications of multirate signal processing, Digital filter banks, two channel quadrature mirror filter banks, M-channel QMF bank (Text 1).

Module-2

Linear prediction and Optimum Linear Filters: Random signals, Correlation Functions and Power Spectra, Innovations Representation of a Stationary Random Process. Forward and Backward Linear Prediction. Solution of the Normal Equations. The Levinson-Durbin Algorithm. Properties of the Linear Prediction-Error Filters (Text 1).

Module-3

Adaptive filters: Applications of Adaptive Filters-Adaptive Channel Equalization, Adaptive noise cancellation, Linear Predictive coding of Speech Signals, Adaptive direct form FIR filters-The LMS algorithm, Properties of LMS algorithm. Adaptive direct form filters- RLS algorithm (Text 1).

Module-4

Power Spectrum Estimation: Non parametric Methods for Power Spectrum Estimation - Bartlett Method, Welch Method, Blackman and Tukey Methods.
Parametric Methods for Power Spectrum Estimation: Relationship between the auto correlation and the model parameters, Yule and Walker methods for the AR Model Parameters, Burg Method for the AR Model parameters, Unconstrained least-squares method for the AR Model parameters, Sequential estimation methods for the AR Model parameters, ARMA Model for Power Spectrum Estimation (Text 1).

Module-5

WAVELET TRANSFORMS: The Age of Wavelets, The origin of Wavelets, Wavelets and other reality transforms, History of wavelets, Wavelets of the future.

Continuous Wavelet and Short Time Fourier Transform: Wavelet Transform, Mathematical preliminaries, Properties of wavelets.

Discrete Wavelet Transform: Haar scaling functions, Haar wavelet function, Daubechies Wavelets (Chapters 1, 3 & 4 of Text 2).

Course outcomes:

At the end of the course the student will be able to:

1. Design adaptive filters for a given application
2. Design multirate DSP Systems
3. Implement adaptive signal processing algorithm
4. Design active networks
5. Understand advanced signal processing techniques, including multi-rate processing and time-frequency analysis techniques

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

1. 'Digital Signal Processing, Principles, Algorithms and Applications', John G. Proakis, Dimitris G.Manolakis, Pearson, Fourth edition, 2007
2. 'Insight into Wavelets- from Theory to Practice', K P Soman, Ramachandran, Resmi, PHI, Third Edition, 2010

Advanced Embedded System

CourseCode	**20EVE13**	CIEMarks	40
Lecture Hours/Week	**04**	SEE Marks	60
Total Number of LectureHours	**50**	Exam Hours	03
Credits - 04			

Module-1

Embedded System: Embedded vs General computing system, classification, application and purpose of ES. Core of an Embedded System, Memory, Sensors, Actuators, LED, Opto coupler, Communication Interface, Reset circuits, RTC, WDT, Characteristics and Quality Attributes of Embedded Systems (Text 1: Selected Topics from Ch -1, 2, 3).

Module-2

Hardware Software Co-Design, embedded firmware design approaches, computational models, embedded firmware development languages, Integration and testing of Embedded Hardware and firmware, Components in embedded system development environment (IDE), Files generated during compilation, simulators, emulators and debugging (Text 1: Selected Topics from Ch-7, 9, 12, 13).

Module-3

ARM-32 bit Microcontroller: Thumb-2 technology and applications of ARM, Architecture of ARM Cortex M3, Various Units in the architecture, General Purpose Registers, Special Registers, exceptions, interrupts, stack operation, reset sequence (Text 2: Ch 1, 2, 3).

Module-4

Instruction Sets: Assembly basics, Instruction list and description, useful instructions, Memory Systems, Memory maps, Cortex M3 implementation overview, pipeline and bus interface (Text 2: Ch-4, 5, 6).

Module-5

Exceptions, Nested Vector interrupt controller design, Systick Timer, Cortex-M3 Programming using assembly and C language, CMSIS (Text 2: Ch-7, 8, 10).

Course outcomes:

At the end of the course the student will be able to:

1. Understand the basic hardware components and their selection method based on the characteristics and attributes of an embedded system.
2. Explain the hardware software co-design and firmware design approaches.
3. Understand the suitability of the instruction sets of ARM processors to design of embedded systems.
4. Acquire the knowledge of the architectural features of ARM CORTEX M3, a 32-bit microcontroller including memory map, interrupts and exceptions.
5. Apply the knowledge gained for Programming ARM CORTEX M3 for different applications.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Students have to conduct the following experiments as a part of CIE marks along with other Activities:

ARM Cortex M3 Programs - Programming to be done using Keil uVision 4 and download the program on to a M3 evaluation board such as NXP LPC1768 or ATMEL ARM

a) Write an Assembly language program to calculate the sum and display the result for the addition of first ten numbers. SUM = 10+9+8+.....+1

b) Write an Assembly language program to store data in RAM

c) Write a C program to output the “Hello World” message using UART

d) Write a C program to operate a buzzer using Cortex M3

e) Write a C program to display the temperature sensed using Cortex M3.

f) Write a C program to control stepper motor using Cortex M3.

Textbooks:

1. ‘Introduction to embedded systems’, K. V. Shibu, TMH education Pvt. Ltd., 2009
2. ‘The Definitive Guide to the ARM Cortex-M3’, Joseph Yiu, Newnes, (Elsevier), 2nd edn, 2010.

Reference Book:

‘Embedded systems - A contemporary design tool’, James K. Peckol, John Wiley, 2008

Multirate Systems and Filter Banks

CourseCode	**20ESP14**	CIEMarks	40
Lecture Hours/Week	**04**	SEE Marks	60
Total Number of LectureHours	**50**	Exam Hours	03
Credits - 04			

Module-1

Fundamentals of Multirate Systems: Basic multi-rateoperations, interconnection of building blocks, poly-phaserepresentation, multistage implementation, applications ofmulti-rate systems, special filters and filter banks (Text 1).

Module-2

Maximally decimated filter banks: Errors created in the QMF bank, alias-free QMF system, power symmetric QMFbanks, M-channel filter banks, poly-phase representation,perfect reconstruction systems, alias-free filter banks, tree structured filter banks, trans-multiplexers (Text 1).

Module-3

Para-unitary Perfect Reconstruction Filter Banks: Losslesstransfer matrices, filter bank properties induced by paraunitariness,two channel Para-unitary lattices, M-channel FIRPara-unitary QMF banks, transform coding (Text 1).

Module-4

Linear Phase Perfect Reconstruction QMF Banks: Necessary conditions, lattice structures for linear phase FIRPR QMF banks, formal synthesis of linear phase FIR PR QMFlattice (Text 1).

cosine Modulated Filter Banks: Pseudo-QMF bank and itsdesign, efficient poly-phase structures, properties of cosinematrices, cosine modulated perfect reconstruction systems(Text 1).

Module-5

Wavelet Transform: Short-time Fourier transform, Wavelet transform, discrete-time Ortho-normal wavelets, continuoustime Ortho-normal wavelets (Text 2).

Course outcomes:

At the end of the course the student will be able to:

1. Comprehendthe theory of sampling rate conversion, fundamentals of multirate signal processing and itsapplications,
2. Developmethods for decimation, interpolation& realization of efficient polyphase implementations ofsampling rate converters.
3. Explain multirate filter banks, the theoretical and practical aspects ofmultirate signal processing and the applications of filter banks.
4. Design perfect reconstruction filterbank system.
5. Assess the computational efficiency of multirate systems& also Analyze thequantization effects in filter banks.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

1. 'Multirate Systems and Filter Banks', PPVaidyanathan, PearsonEducation (Asia) Pvt.Ltd, 2004.
2. 'Wavelets and Filter Banks',Gilbert Strang and Truong Nguyen,Wellesley-Cambridge Press,1996.

Reference Books:

1. 'Multirate Digital Signal Processing', N. J. Fliege,John Wiley & Sons,2000.
2. 'Multiresolution and MultirateSignal Processing: Introduction, Principles and Applications', Vikram Gadre & Aditya Abhyankar, McGrawHill Education, First edition, 2017.
3. 'Modern Spectral Estimation', Steven M. Kay Pearson Education, Firstedition, 2017.

Digital Compression

CourseCode	**20ESP15**	CIEMarks	40
Lecture Hours/Week	**04**	SEE Marks	60
Total Number of LectureHours	**50**	Exam Hours	03
Credits - 04			

Module-1

Introduction: Compression techniques, Modelling& coding,Distortion criteria, Differential Entropy, Rate Distortion Theory,Vector Spaces, Information theory, Models for sources,Codinguniquely decodable codes, Prefix codes, Kraft McMillanInequality.

Quantization: Quantization problem, Uniform Quantizer, AdaptiveQuantization, Non-uniform Quantization; Entropy codedQuantization, Vector Quantization, LBG algorithm, Treestructured VQ, Structured VQ.

Module-2

Differential Encoding: Basic algorithm, Prediction in DPCM,Adaptive DPCM,Delta Modulation, Speech coding–G.726, Imagecoding.

Transform Coding: Transforms–KLT, DCT, DST, DWHT;Quantization and coding of transform coefficients, Application to Image compression–JPEG, Application to audio compression.

Module-3

Sub-band Coding: Filters, Sub-band coding algorithm, Design offilter banks,Perfect reconstruction using two channel filter banks, M-band QMF filter banks, Poly-phase decomposition, Bitallocation, Speech coding– G.722, Audio coding–MPEG audio,Image compression.

Module-4

Wavelet Based Compression: Wavelets, Multi resolutionanalysis & scalingfunction, Implementation using filters, Imagecompression–EZW, SPIHT, JPEG 2000.

Analysis/Synthesis Schemes: Speech compression–LPC10,CELP,MELP.

VideoCompression: Motion compensation, Video signalrepresentation, Algorithms for video conferencing & videophones–H.261, H.263, Asymmetric applications–MPEG 4, MPEG7, Packet video.

Module-5

Loss less Coding: Huffman coding, Adaptive Huffman coding,Golomb codes, Rice codes, Tunstall codes, Applications ofHuffman coding, Arithmetic coding,

Algorithm implementation,Applications of Arithmetic coding, Dictionary techniques–LZ77,LZ78, Applications of LZ78– JBIG, JBIG2, Predictive coding–Prediction with partial match, Burrows Wheeler Transform, Applications– CALIC, JPEG-LS.

Course outcomes:

At the end of the course the student will be able to:

1. Explain the evolution and fundamental concepts of Data Compression and Coding techniques.
2. Acquire contemporary knowledge in Data Compression and Coding.
3. Analyze the operation of a range of commonly used Coding and Compression techniques
4. Identify the basic software and hardware tools used for data compression.
5. Analyze and evaluate the performance of different Data Compression and Coding methods.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook:

'Introduction to Data Compression', KSayood, Harcourt India Pvt. Ltd.& Morgan Kaufmann Publishers, 1996.

Reference Books:

1. 'Digital Coding of Waveforms: Principles and Applications to Speech and Video', NJayantandPNoll, Prentice Hall, USA, 1984.
2. 'Data Compression: The Complete Reference', DSalomon,Springer, 2000.
3. 'Fundamentals of Multimedia', ZLiandMSDrew, Pearson Education(Asia) Pvt.Ltd., 2004.

Advanced Digital Signal Processing Lab

CourseCode	**20ESPL16**	CIEMarks	40
Teaching Hours/Week	**04** (2 Hrs Tutorial + 2 Hrs Practical)	SEE Marks	60
		Exam Hours	03
Credits - 02			

Sl.No	Experiments
1	Generate various fundamental discrete time signals.
2	Basic operations on signals (Multiplication, Folding,Scaling).
3	Find out the DFT & IDFT of a given sequence without using inbuilt instructions.
4	Interpolation & decimation of a given sequence.
5	Generation of DTMF (Dual Tone Multiple Frequency)signals.
6	Estimate the PSD of a noisy signal using periodogram and modified periodogram.
7	Estimation of PSD using different methods (Bartlett, Welch, Blackman-Tukey).
8	Design of Chebyshev Type I,II Filters.
9	Cascade Digital IIR Filter Realization.
10	Parallel Realization of IIR filter.
11	Estimation of power spectrum using parametric methods (Yule-Walker & Burg).
12	Design of LPC filter using Levinson-Durbin algorithm.
13	Time-Frequency Analysis with the Continuous Wavelet Transform.
14	Signal Reconstruction from Continuous Wavelet Transform Coefficients.

Course outcomes:

At the end of the course the student will be able to carry out:

1. Filter design.
2. Filter Realization
3. Signal Manipulations
4. Wavelet Transforms
5. Estimating the PSD using various techniques

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and Marks allotted to the procedure part to be made zero.

Research Methodology and IPR

CourseCode	**20RMI17**	CIEMarks	40
Lecture Hours/Week	**02**	SEE Marks	60
		Exam Hours	03
Credits - 02			

Module-1

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India.

Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration.

Module-2

Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed.

Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs.

Module-3

Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs.

Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement Tools, Scaling, Scale Classification Bases, Scaling Technics, Multidimensional Scaling, Deciding the Scale.

Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method.

Module-4

Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis.

Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi Square Tests.

Module-5

Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.

Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights (TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO.

Course outcomes:

At the end of the course the student will be able to:

1. Discuss research methodology and the technique of defining a research problem
2. Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.
3. Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.
4. Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports
5. Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

1. 'Research Methodology: Methods and Techniques', C.R. Kothari, Gaurav Garg, New Age International, 4th Edition, 2018
2. 'Research Methodology a step-by-step guide for beginners. (For the topic Reviewing the literature under module 2)', Ranjit Kumar, SAGE Publications, 3rd Edition, 2011
3. Study Material (For the topic Intellectual Property under module 5) Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013.

Reference Books:

1. ‘Research Methods: the concise knowledge base’, Trochim, Atomic Dog Publishing, 2005
2. ‘Conducting Research Literature Reviews: From the Internet to Paper’, Fink A, Sage Publications, 2009

M.TECH IN Signal Processing (ESP)

Choice Based Credit System (CBCS) and Outcome Based Education(OBE)
(Effective from the academic year 2020-21)

SEMESTER -II

Image Processing and Machine Vision

CourseCode	**20ESP21**	CIEMarks	40
Lecture Hours/Week	**04**	SEE Marks	60
Total Number of LectureHours	**50**	Exam Hours	03
Credits - 04			

Module-1

The image mathematical and physical background: Linearity, The Dirac distribution and convolution, Linear integraltransforms, Images as linear systems,
Introduction to linear integral transforms: 2D Fouriertransform, Sampling and the Shannon constraint, Discrete cosinetransform, Wavelet transform, Eigen-analysis, Singular valuedecomposition, Principal component analysis, Other orthogonal imagetransforms,Images as stochastic processes.

Module-2

Image pre-processing: Scale in image processing, Canny edge detection, Parametric edge models, Edges in multi-spectralimages, Pre-processing in frequency domain, Line detection,Corner detection, Maximally stable extremal regions,
Image restoration: Degradations that are easy to restore,Inverse filtration, Wiener filtration.

Module-3

Image segmentation: Threshold detection methods, Optimalthresholding, Multi-spectral thresholding, Edge-basedsegmentation, Edge image thresholding, Edge relaxation, Bordertracing, Border detection as graph searching, Border detection asdynamic programming, Hough transforms, Border detectionusing border location information, Region construction fromborders, Region-based segmentation, Region merging, Regionsplitting, Splitting and merging, Watershed segmentation, Regiongrowing post-processing.**Matching**: Matching criteria, Control strategies of matching.
Evaluation issues in segmentation: Supervised evaluation,Unsupervised evaluation

Module-4

Advanced segmentation: Mean Shift Segmentation, Activecontour models-snakes, Traditional snakes and balloons, Extensions, Gradient vector flow snakes, Geometric deformablemodels-level sets and geodesic active contours, FuzzyConnectivity,

Contour-based shape representation and description: Chaincodes, Simple geometric border representation, Fouriertransforms of boundaries, Boundary description using segmentsequences, B-spline representation, Other contour-based shapedescription approaches, Shape invariants.

Module-5

Knowledge representation: Statistical pattern recognition, Classification principles, Classifier setting, Classifier learning,Support Vector Machines, Cluster analysis

Neural nets: Feed-forward networks, Unsupervised learning,Hopfield neural nets

Optimization techniques in recognition: Genetic algorithms,Simulated annealing

Fuzzy systems: Fuzzy sets and fuzzy membership functions,Fuzzy set operators, Fuzzy reasoning, Fuzzy system design andtraining.

Course outcomes:

At the end of the course the student will be able to:

1. Comprehend the basics of image analysis and computer vision.
2. Relate to low-level vision (early processing) techniques such asbinary image analysis, filtering, edge detection and texture analysis.
3. Understand mid-level vision topics such as image segmentationand feature extraction.
4. Apply Image processing techniques to image retrieval, imageclassification, and object recognition with emphasis on featureextraction and image representations for recognition.
5. Implement a complete image-processing package using standard concepts.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.

- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook:

'Image Processing, Analysis, and Machine Vision', Milan Sonka, Vaclav Hlavac, Roger Boyle, Cengage Learning, ISBN: 978-81-315-1883-0, 2013

Reference Books:

1. 'Computer Vision and Image Processing', ScottEUmbaugh, Prentice Hall, 1997.
2. 'Fundamentals of Digital Image Processing', A KJain, Pearson, 2004.
3. 'Digital Image Processing', S Jayaraman, S Esakkirajan, T Veerakumar, Tata McGraw Hill, 2011.

DSP System Design

CourseCode	**20ESP22**	CIEMarks	40
Lecture Hours/Week	**04**	SEE Marks	60
Total Number of LectureHours	**50**	Exam Hours	03
Credits - 04			

Module-1

Introduction to popular DSP CPU Architecture: CPU Data Paths and Control-Timers-Internal Data/Program MemoryExternalMemory Interface-Programming –Instructionset andAddressing Modes-Code Composer Studio-Code GenerationTools –Code Composer Studio Debugtools –Simulator (Text 1).

Module-2

SHARC Digital Signal Processor: A popular DSP from Analog Devices - SHARC-Architecture - IOP Registers - Peripherals - Synchronous SerialPort Interrupts - Internal/External/Multiprocessor MemorySpace - Multiprocessing - Host Interface - Link Ports(Text 2).

Module-3

Digital Signal Processing Applications: FIR and IIR Digital Filter Design, Filter Design Programs using MATLAB- FourierTransform: DFT, FFT programs using MATLAB (Text 1).

Module-4

Real Time Implementation: Implementation of Real Time Digital Filters using DSP-Implementation of FFT Applicationsusing DSP – DTMF Tone Generation and Detection (Text 1).

Module-5

Current trends: Current trends in Digital Signal Processor, DSPController-Architecture and their applications (Text 1).

Course outcomes:

At the end of the course the student will be able to:

1. Understand fundamental concepts of ‘DSP Architecture’ and ‘SHARC Digital Signal Processor’
2. Analyze the concept of IIR type digital filters, FIR type digital filters, DFT and FFT

3. Apply a design technique of Real-Time Digital Filters, FFT.
4. Use the "MATLAB" language and "signal processing toolboxes" for analyzing, designing and implementing Digital Signal Processing (DSP)systems such as digital filters.
5. Design real-time signal processing algorithms using the latestfixed-point processor.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

1. 'Digital Signal Processing and Application with C6713and C6416 DSK', Rulph Chassaing, Wiley-Interscience Publication
2. 'Digital Signal Processing- A StudentGuide', T.J. Terreland Lik- Kwan Shark, 1st Edition; Macmillan Press Ltd.

Reference Books:

1. 'Digital Signal Processing: A System Design Approach', DavidJ DeFattaJ,Lucas JosephG &Hodkiss WilliamS, 1st Edition,JohnWiley.
2. 'Digital Signal Processing-A Practical Guide for Engineers andScientists', Steven K Smith, Newnes, Elsevier Science.
3. 'DSP Applications using 'C' and the TMS320C6X DSK', Rulph Chassaing, 1st Edition.
4. 'Digital Signal Processing Design', AndrewBateman,WarrenYates,1st Edition
5. 'Digital Signal Processing Implementation using the TMS320C6000 DSP Platform', Naim Dahnoun, 1st Edition.

Error Control Coding

CourseCode	**20ECS23**	CIEMarks	40
Lecture Hours/Week	**04**	SEE Marks	60
Total Number of LectureHours	**50**	Exam Hours	03
Credits - 04			

Module-1

Information theory: Introduction, Entropy, Source coding theorem, discrete memoryless channel, Mutual Information, Channel Capacity Channel coding theorem (Chap. 5 of Text 1).

Introduction to algebra: Groups, Fields, binary field arithmetic, Construction of Galois Fields GF (2^m) and its properties, (Only statements of theorems without proof) Computation using Galois field GF (2^m) arithmetic, Vector spaces and Matrices (Chap. 2 of Text 2).

Module-2

Linear block codes: Generator and parity check matrices, Encoding circuits, Syndrome and error detection, Minimum distance considerations, Error detecting and error correcting capabilities, Standard array and syndrome decoding, Single Parity Check Codes (SPC),Repetition codes, Self dual codes, Hamming codes, Reed-Muller codes. Product codes and Interleaved codes(Chap. 3 of Text 2).

Module-3

Cyclic codes: Introduction, Generator and parity check polynomials, Encoding of cyclic codes, Syndrome computing and error detection, Decoding of cyclic codes, Error trapping Decoding, Cyclic hamming codes, Shortened cyclic codes (Chap. 4 of Text2).

Module-4

BCH codes: Binary primitive BCH codes, Decoding procedures, Implementation of Galois field arithmetic. (6.1,6.2,6.7 of Text 2) Primitive BCH codes over GF (q),

Reed -Solomon codes (7.2,7.3 of Text 2).

Majority Logic decodable codes: One -step majority logic decoding, Multiple-step majority logic (8.1,8.4 of Text 2).

Module-5

Convolution codes: Encoding of convolutional codes: Systematic and Nonsystematic Convolutional Codes, Feedforward encoder inverse, A

catastrophic encoder, Structural properties of convolutional codes: state diagram, state table, state transition table, tree diagram, trellis diagram.
Viterbi algorithm, Sequential decoding: Log Likelihood Metric for Sequential Decoding (11.1,11.2, 12.1,13.1 of Text 2).

Course outcomes:
At the end of the course the student will be able to:
1. Understand the concept of the Entropy, information rate and capacity for the Discrete memoryless channel.
2. Apply modern algebra and probability theory for the coding.
3. Compare Block codes such as Linear Block Codes, Cyclic codes, etc. and Convolutional codes.
4. Detect and correct errors for different data communication and storage systems.
5. Analyze and implement different Block code encoders and decoders, and also convolutional encoders and decoders including soft and hard Viterbi algorithm.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Students have to conduct the following experiments as a part of CIE marks along with other Activities:
Software to be used: SCILAB/MATLAB

1. Simulate the BER performance of (7, 4) Hamming code on AWGN channel. Use QPSK modulation scheme. Channel decoding is to be performed through maximum-likelihood decoding. Plot the bit error rate versus SNR (dB), i.e. $P_{e,b}$ versus E_b/N_0.Consider binary input vector of size 5 lakh bits. Use the following parity check matrix for the (7, 4) Hamming code.

$$H = \begin{bmatrix} 1001110 \\ 0100111 \\ 0011101 \end{bmatrix}$$

Also find the coding gain.
(Refer: http://www.dsplog.com/2012/03/15/hamming-code-soft-hard-decode/)

2. Simulate the BER performance of (2, 1, 3) binary convolutional code with generator sequences $g^{(1)}$ =(1 0 1 1) and $g^{(2)}$ =(1 1 1 1) on AWGN channel. Use QPSK modulation scheme. Channel decoding is to be performed through Viterbi decoding. Plot the bit error rate versus SNR(dB), i.e. $P_{e,b}$ versus E_b/N_0.Consider binary input vector of size 3 lakh bits. Also find the coding gain.

3. Simulate the BER performance of rate 1/3 Turbo code. Turbo encoder uses two recursive systematic encoders with $G(D) = \left[1, \frac{1+D^4}{1+D+D^2+D^3+D^4}\right]$ and pseudo-random interleaver. Use QPSK modulation scheme. Channel decoding is to be performed through maximum a-posteriori (MAP) decoding algorithm. Plot the bit error rate versus SNR(dB), i.e. $P_{e,b}$ versus E_b/N_0.Consider binary input vector of size of around 3 lakh bits and the block length as 10384 bits. Also find the coding gain.

4. Use a MATLAB simulation to confirm that SOVA (Soft Output Viterbi Algorithm) is inferior to MAP decoding in terms of bit error performance, and give the reason why. Consider a rate ½ Turbo code punctured from the rate 1/3 Turbo code. The puncturing matrix is [1 0 ; 0 1] . Demonstrate the decoding process of the code. (Refer: Example 6.1 from 'A Practical Guide to Error-control Coding Using MATLAB', Yuan Jiang, ISBN: 9781608070886, Artech House Publishers, 2010)

Textbooks:

1. 'Digital Communication systems', Simon Haykin, Wiley India Private. Ltd, ISBN 978-81-265-4231-4, First edition, 2014
2. 'Error control coding', Shu Lin and Daniel J. Costello. Jr, Pearson, Prentice Hall, 2nd edition, 2004

Reference Books:

1. 'Theory and practice of error control codes', Blahut. R. E, Addison Wesley, 1984
2. 'Introduction to Error control coding', Salvatore Gravano, Oxford University Press, 2007
3. 'Digital Communications - Fundamentals and Applications', Bernard Sklar, Pearson Education (Asia) Pvt. Ltd., 2nd Edition, 2001

Professional Elective 1

Wireless Sensor Networks

CourseCode	**20ECS241**	CIEMarks	40
Lecture Hours/Week	**04**	SEE Marks	60
Total Number of LectureHours	**50**	Exam Hours	03
Credits - 04			

Module-1

Introduction: Sensor Mote Platforms, WSN Architecture and Protocol Stack (Chap. 1Text 1).
WSN Applications: Military Applications, Environmental Applications, Health Applications, Home Applications, Industrial Applications (Chap. 2 Text 1).

Module-2

Factors Influencing WSN Design: Hardware Constraints Fault Tolerance Scalability Production Costs WSN Topology, Transmission Media, Power Consumption (Chap. 3 Text 1).
Physical Layer: Physical Layer Technologies, Overview of RF Wireless Communication, Channel Coding (Error Control Coding), Modulation, Wireless Channel Effects, PHY Layer Standards (Chap. 4 of Text 1).

Module-3

Medium Access Control: Challenges for MAC, CSMA Mechanism, Contention-Based Medium Access, Reservation-Based Medium Access, Hybrid Medium Access (Chap. 5 of Text 1).
Network Layer: Challenges for Routing, Data-centric and Flat Architecture Protocols, Hierarchical Protocols, Geographical Routing Protocols (Chap. 7 of Text 1).

Module-4

Transport Layer: Challenges for Transport Layer, Reliable MultiSegment Transport (RMST) Protocol, Pump Slowly, Fetch Quickly (PSFQ) Protocol, Congestion Detection and Avoidance (CODA) Protocol, Event-to-Sink Reliable Transport (ESRT) Protocol, GARUDA (Chap. 8 Text 1).

Application Layer: Source Coding (Data Compression), Query Processing, Network Management (Chap. 9 Text 1).

Module-5

Time Synchronization: Challenges for Time Synchronization, Network Time Protocol, Timing-Sync Protocol for Sensor Networks (TPSN), Reference-Broadcast Synchronization (RBS), Adaptive Clock Synchronization (ACS) (Chap. 11 of Text1).

Localization; Challenges in Localization, Ranging Techniques, Range-Based Localization Protocols, Range-Free Localization Protocols. (Chap. 12 Text 1).

Course outcomes:

At the end of the course the student will be able to:

1. Acquire knowledge of characteristics of mobile/wireless communication channels
2. Apply statistical models of multipath fading
3. Understand the multiple radio access techniques, radio standards and communication protocols to be used for wireless sensor
4. Design wireless sensor network system for different applications under consideration.
5. Understand the hardware details of different types of sensors and select right type of sensor for various applications.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

1. 'Wireless Sensor Networks', Ian F. Akyildiz and Mehmet Can Vuran, John Wiley & Sons Ltd. ISBN 978-0-470-03601-3 (H/B), 2010
2. 'Wireless Sensor Networks:Signal Processing and Communications Perspectives', Ananthram Swami, et. al., John Wiley & Sons Ltd., ISBN 978-0470-03557-3, 2007

Nanoelectronics

CourseCode	**20EVE242**	CIEMarks	40
Lecture Hours/Week	**04**	SEE Marks	60
Total Number of LectureHours	**50**	Exam Hours	03
Credits - 04			

Module-1

Introduction: Overview of nanoscience and engineering. Development milestones in microfabrication and electronic industry. Moores' law and continued miniaturization, Classification of Nanostructures, Electronic properties of atoms and solids: Isolated atom, Bonding between atoms, Giant molecular solids, Free electron models and energy bands, crystalline solids, Periodicity of crystal lattices, Electronic conduction, effects of nanometer length scale, Fabrication methods: Top down processes, Bottom up processes methods for templating the growth of nanomaterials, ordering of nanosystems (Text 1).

Module-2

Characterization: Classification, Microscopic techniques, Field ion microscopy, scanning probe techniques, diffraction techniques: bulk and surface diffraction techniques, spectroscopy techniques: photon, radiofrequency, electron, surface analysis and dept profiling: electron, mass, Ion beam, Reflectometry, Techniques for property measurement: mechanical, electron, magnetic, thermal properties (Text1).

Module-3

Inorganic semiconductor nanostructures: overview of semiconductor physics. Quantum confinement in semiconductor nanostructures: quantum wells, quantum wires, quantum dots, super-lattices, band offsets, electronic density of states (Text1).
Carbon Nanostructures: Carbon molecules, Carbon Clusters, Carbon Nanotubes, application of Carbon Nanotubes (Text 2).

Module-4

Fabrication techniques: requirements of ideal semiconductor, epitaxial growth of quantum wells, lithography and etching, cleaved-edge over growth, growth of vicinal substrates, strain induced dots and wires, electrostatically induced dots and wires, Quantum well width fluctuations, thermally annealed quantum

wells, semiconductor nanocrystals, colloidal quantum dots, self-assembly techniques.

Physical processes: modulation doping, quantum hall effect, resonant tunneling, charging effects, ballistic carrier transport, Inter band absorption, intra band absorption, Light emission processes, phonon bottleneck, quantum confined stark effect, nonlinear effects, coherence and dephasing, characterization of semiconductor nanostructures: optical electrical and structural (Text1).

Module-5

Methods of measuring properties: atomic, crystallography, microscopy, spectroscopy (Text 2).

Applications: Injection lasers, quantum cascade lasers, single-photon sources, biological tagging, optical memories, coulomb blockade devices, photonic structures, QWIPs, NEMS, MEMS (Text1).

Course outcomes:

At the end of the course the student will be able to:

1. Know the principles behind Nanoscience engineering and Nanoelectronics.
2. Apply the knowledge to prepare and characterize nanomaterials.
3. Know the effect of particles size on mechanical, thermal, optical and electrical properties of nanomaterials.
4. Design the process flow required to fabricate state of the art transistor technology.
5. Analyze the requirements for new materials and device structure in the future technologies.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

1. 'Nanoscale Science and Technology', Ed Robert Kelsall, Ian Hamley, Mark Geoghegan, John Wiley, 2007
2. 'Introduction to Nanotechnology', Charles P Poole, Jr, Frank J Owens, John Wiley, Copyright 2006, Reprint 2011.

Reference Book:

'Hand Book of Nanoscience Engineering and Technology', Ed William A Goddard III, Donald W Brenner, Sergey E. Lyshevski, Gerald J Iafrate, CRC Press, 2003

Cryptography and Network Security

CourseCode	**20ECS243**	CIEMarks	40
Lecture Hours/Week	**04**	SEE Marks	60
Total Number of LectureHours	**50**	Exam Hours	03
Credits - 04			

Module-1

Foundations: Terminology, Steganography, substitution ciphers and transpositions ciphers, Simple XOR, One-Time Pads, Computer Algorithms (Text 2: Chapter 1: Section 1.1 to 1.6).
SYMMETRIC CIPHERS: Traditional Block Cipher structure, Data encryption standard (DES), The AES Cipher. (Text 1: Chapter 2: Section2.1, 2.2, Chapter 4).

Module-2

Introduction to modular arithmetic, Prime Numbers, Fermat's and Euler's theorem, primality testing, Chinese Remainder theorem, discrete logarithm. (Text 1: Chapter 7: Section 1, 2, 3, 4, 5).
Principles of Public-Key Cryptosystems, The RSA algorithm, Diffie - Hellman Key Exchange, Elliptic Curve Arithmetic, Elliptic Curve Cryptography (Text 1: Chapter 8, Chapter 9: Section 9.1, 9.3, 9.4).

Module-3

Pseudo-Random-Sequence Generators and Stream Ciphers: Linear Congruential Generators, Linear Feedback Shift Registers, Design and analysis of stream ciphers, Stream ciphers using LFSRs, A5, Hughes XPD/KPD, Nanoteq, Rambutan, Additive generators, Gifford, Algorithm M, PKZIP (Text 2: Chapter 16).

Module-4

One-Way Hash Functions: Background, Snefru, N-Hash, MD4, MD5, Secure Hash Algorithm [SHA], One way hash functions using symmetric block algorithms, Using public key algorithms, Choosing a one-way hash functions, Message Authentication Codes. Digital Signature Algorithm, Discrete Logarithm Signature Scheme (Text 2: Chapter 18: Section 18.1 to 18.5, 18.7, 18.11 to 18.14 and Chapter 20: Section 20.1, 20.4).

Module-5

E-mail Security: Pretty Good Privacy-S/MIME (Text 1: Chapter 17: Section 17.1, 17.2).
IP Security: IP Security Overview, IP Security Policy, Encapsulation Security Payload (ESP), Combining security Associations. (Text 1: Chapter 18: Section 18.1 to 18.4).
Web Security: Web Security Considerations, SSL (Text 1: Chapter 15: Section 15.1, 15.2).

Course outcomes:
At the end of the course the student will be able to:

1. Understand the basics of symmetric key and public key cryptography.
2. Use basic cryptographic algorithms to encrypt the data.
3. Generate some pseudorandom numbers required for cryptographic applications.
4. Provide authentication and protection for encrypted data.
5. Understand the techniques and features of Email, IP and Web security.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

1. 'Cryptography and Network Security Principles and Practice', William Stallings, Pearson Education Inc., ISBN: 978-93325-1877-3, 6th Edition, 2014
2. 'Applied Cryptography Protocols, Algorithms, and Source code in C', Bruce Schneier, Wiley Publications ISBN: 9971-51348-X, 2nd Edition

Reference Books:

1. 'Cryptography and Network Security', Behrouz A. Forouzan, TMH, 2007
2. 'Cryptography and Network Security', Atul Kahate, TMH, 2003

Reconfigurable Computing

CourseCode	**20ELD244**	CIEMarks	40
Lecture Hours/Week	**04**	SEE Marks	60
Total Number of LectureHours	**50**	Exam Hours	03
Credits - 04			

Module -1

Introduction: History, Reconfigurable vs Processor based system, RC Architecture.
Reconfigurable Logic Devices: Field Programmable Gate Array, Coarse Grained Reconfigurable Arrays.
Reconfigurable Computing System: Parallel Processing on Reconfigurable Computers, A survey of Reconfigurable Computing System (Text 1).

Module-2

Languages and Compilation: Design Cycle, Languages, HDL, High Level Compilation, Low level Design flow, Debugging Reconfigurable Computing Applications (Text 1).

Module -3

Implementation: Integration, FPGA Design flow, Logic Synthesis.
High Level Synthesis for Reconfigurable Devices: Modelling, Temporal Partitioning Algorithms (Text 2).

Module-4

Partial Reconfiguration Design: Partial Reconfiguration Design, Bitstream Manipulation with JBits, The modular Design flow, The Early Access Design Flow, Creating Partially Reconfigurable Designs, Partial Reconfiguration using Hansel-C Designs, Platform Design (Text 2).

Module -5

Signal Processing Applications: Reconfigurable computing for DSP, DSP application building blocks, Examples: Beamforming, Software Radio, Image and video processing, Local Neighbourhood functions, Convolution (Text 1).
System on a Programmable Chip: Introduction to SoPC, Adaptive Multiprocessing on Chip(Text 2).

Course Outcomes:

At the end of the course the student will be able to:

1. Understand the fundamental principles and practices in reconfigurable architecture.
2. Simulate and synthesize the reconfigurable computing architectures.
3. Understand the FPGA design principles, and logic synthesis
4. Integrate hardware and software technologies for reconfiguration computing focusing on partial reconfiguration design.
5. Design digital systems for a variety of applications on signal processing and system on chip configurations.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text Books:

1. 'Reconfigurable Computing:Accelerating Computation with Field-Programmable Gate Arrays', M. Gokhale and P. Graham, Springer, ISBN: 978-0-387-26105-8, 2005.
2. 'Introduction to Reconfigurable Computing: Architectures, Algorithms and Applications', C. Bobda, Springer, ISBN: 978-1-4020-6088-5, 2007.

Reference Books:

1. 'Practical FPGA Programming in C', D. Pellerin and S. Thibault, Prentice-Hall, 2005.
2. 'FPGA Based System Design',W. Wolf, Prentice-Hall, 2004.
3. 'Rapid System Prototyping with FPGAs: Accelerating the Design Process', R. Cofer and B. Harding, Newnes, 2005.

Professional Elective 2

Biomedical Signal Processing

CourseCode	**20ESP251**	CIEMarks	40
Lecture Hours/Week	**04**	SEE Marks	60
Total Number of LectureHours	**50**	Exam Hours	03
Credits - 04			

Module-1

Introduction-Genesis and significance of bio electric potentials, ECG, EEG, EMG and their monitoring and measurement,Spectral analysis.

Module-2

Filtering- Digital and Analog filtering, Correlation andEstimation techniques, AR / ARMA models.

Module-3

ECG-Pre-processing, Measurements of amplitude and time intervals, Classification, QRS detection, ST segment analysis,Base line wander removal, waveform recognition, morphologicalstudies and rhythm analysis, automated diagnosis based ondecision theory ECT compression, Evoked potential estimation.

Module-4

EEG: Evoked responses, Epilepsy detection, Spike detection, Hjorth parameters, averaging techniques, removal of Artifactsby averaging and adaptive algorithms, pattern recognition ofalpha, beta, theta and delta waves in EEG waves, sleep stages.

Module-5

EMG-Wave pattern studies, bio feedback, Zero crossings, Integrated EMG. Time frequency methods and Wavelets inBiomedical Signal Processing.

Course outcomes:

At the end of the course the student will be able to:

1. Model a biomedical system.
2. Understand various methods of acquiring bio signals.
3. Understand various sources of bio signal distortions and its remedialtechniques.

4. Analyze ECG and EEG signal with characteristic feature points.
5. Understand use of bio signals in diagnosis, patient monitoring and physiological investigation.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook:

'Biomedical Digital Signal Processing', Willis J Tompkins, PrenticeHall ofIndia,1996.

Reference Books:

1.'Biomedical Signal Processing (in IV parts)',R E Challis and RI Kitney,Medical and Biological Engg. and current computing, 1990-91.
2. Special issue on 'Biological Signal Processing', Proc. IEEE 1972.
3.'Biomedical Signal Processing', Arnon Cohen, Volumes I &II, CRCPress.
4.'Time frequency and Wavelets in Biomedical Signal Processing', Metin Akay,IEEE Press, 1999.Current Published literature.

Statistical Signal Processing

CourseCode	**20ECS252**	CIEMarks	40
Lecture Hours/Week	**04**	SEE Marks	60
Total Number of LectureHours	**50**	Exam Hours	03
Credits - 04			

Module-1

Random Processes: Random variables, random processes, white noise, filtering random processes, spectral factorization, ARMA, AR and MA processes (Text 1).

Module 2

Signal Modeling: Least squares method, Padé approximation, Prony's method, finite data records, stochastic models, Levinson-Durbin recursion; Schur recursion; Levinson recursion (Text 1).

Module 3

Spectrum Estimation: Nonparametric methods, minimum-variance spectrum estimation, maximum entropy method, parametric methods, frequency estimation, principal components spectrum estimation (Text 1).

Module 4

Optimal and Adaptive Filtering: FIR and IIR Wiener filters, Discrete Kalman filter, FIR Adaptive filters: Steepest descent, LMS, LMS-based algorithms (Text 1).

Module 5

Array Processing: Array fundamentals, beam-forming, optimum array processing, performance considerations, adaptive beamforming, linearly constrained minimum-variance beam-formers, side-lobe cancellers (Text 2).

Course Outcomes:

At the end of the course the student will be able to:

1. Design statistical DSP algorithms to meet desired needs
2. Apply vector space methods to statistical signal processing problems
3. Understand Wiener filter theory and design discrete and continuous Wiener filters
4. Understand Kalman Filter theory and design discrete Kalman filters

5. Use computer tools (such as MATLAB) in developing and testing stochastic DSP algorithms

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text Books:

1. 'Statistical Digital Signal Processing and Modeling', Monson H Hayes, John Wiley & Sons (Asia) Pvt. Ltd., 2002.
2. 'Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering and Array Processing', Dimitris G. Manolakis, Vinay K. Ingle, and Stephen M. Kogon, McGraw Hill International Edition, 2000.

Micro Electro Mechanical Systems

CourseCode	**20ELD253**	CIEMarks	40
Lecture Hours/Week	**04**	SEE Marks	60
Total Number of LectureHours	**50**	Exam Hours	03
Credits - 04			

Module 1

Overview of MEMS and Microsystems: MEMS and Microsystem, Typical MEMS and Microsystems Products, Evolution of Microfabrication, Microsystems and Microelectronics, Multidisciplinary Nature of Microsystems, Miniaturization. Applications and Markets.

Module 2

Working Principles of Microsystems: Introduction, Microsensors, Microactuation, MEMS with Microactuators, Microaccelerometers, Microfluidics.

Engineering Science for Microsystems Design and Fabrication: Introduction, Atomic Structure of Matters, Ions and Ionization, Molecular Theory of Matter and Inter-molecular Forces, Doping of Semiconductors, The Diffusion Process, Plasma Physics, Electrochemistry.

Module 3

Engineering Mechanics for Microsystems Design: Introduction, Static Bending of Thin Plates, Mechanical Vibration, Thermomechanics, Fracture Mechanics, Thin Film Mechanics, Overview on Finite Element Stress Analysis.

Module 4

Scaling Laws in Miniaturization:
Introduction, Scaling in Geometry, Scaling in Rigid-Body Dynamics, Scaling in Electrostatic Forces, Scaling of Electromagnetic Forces, Scaling in Electricity, Scaling in Fluid Mechanics, Scaling in Heat Transfer.

Module 5

Overview of Micro-manufacturing: Introduction, Bulk Micro-manufacturing, Surface Micromachining, The LIGA Process, Summary on Micromanufacturing.
Microsystem Design: Introduction, Design Considerations, Process Design, Mechanical Design, Using Finite Element Method.

Course Outcomes:

At the end of the course the student will be able to:

1. Understand the technologies related to Micro Electro Mechanical Systems.
2. Relate to the scaling laws in miniaturization.
3. Analyse the MEMS devices and develop suitable mathematical models
4. Understand the various application areas for MEMS devices
5. Describe the design and fabrication processes involved with MEMS devices.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text Book:

'MEMS and Micro systems: Design, Manufacture and Nanoscale Engineering', Tai-Ran Hsu, John Wiley & Sons, ISBN: 978-0470-08301-7, 2nd Edition, 2008

Reference Books:

1. 'Micro and Nano Fabrication: Tools and Processes', Hans H. Gatzen, Volker Saile, Jurg Leuthold, Springer, 2015
2. 'Micro Electro Mechanical Systems (MEMS)', Dilip Kumar Bhattacharya, Brajesh Kumar Kaushik, Cengage Learning.

Detection and Estimation

CourseCode	**20ESP254**	CIEMarks	40
Lecture Hours/Week	**04**	SEE Marks	60
Total Number of LectureHours	**50**	Exam Hours	03
Credits - 04			

Module 1

Classical Detection and Estimation Theory: Introduction, simple binary hypothesis tests, M Hypotheses, estimation theory,composite hypotheses, general Gaussian problem, performancebounds and approximations (Text 1).

Module 2

Representations of Random Processes: Introduction, orthogonal representations, random process characterization,homogenous integral equations and Eigen functions, periodicprocesses, spectral decomposition, vector random processes(Text 2).

Module 3

Detection of Signals & Estimation of Signal Parameters: Introduction, detection and estimation in white Gaussian noise,detection and estimation in nonwhite Gaussian noise, signalswith unwanted parameters, multiple channels and multipleparameter estimation (Text 1).

Module 4

Estimation of Continuous Waveforms: Introduction, derivation of estimator equations, lower bound on the mean-squareestimation error, multidimensional waveform estimation, non-random waveformestimation(Text1).

Module 5

Linear Estimation: Properties of optimum processors, realizable linear filters, Kalman-Bucyfilters, fundamental role of optimumlinear filters. (Text 1).

Course Outcomes:

At the end of the course the student will be able to:

1. Acquire basics of statistical decision theory used for signal detection and estimation.
2. Examine the detection of deterministic and random signals using statistical models.
3. Comprehend the elements and structure of nonparametric detection.

4. Examine the performance of signal parameters using optimal estimators.
5. Analyze signal estimation in discrete-time domain using filters.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text Books:

1. 'Detection, Estimation, and Modulation Theory',Part I, Harry L. Van Trees,John Wiley & Sons, USA, 2001.
2. 'Random Signals: Detection,Estimation and Data Analysis', K Sam Shanmugam, Arthur M Breipohl,John Wiley & Sons, 1998.

Reference Books:

1. 'Introduction to Statistical Signal Processing with Applications', M.D. Srinath, P.K. Rajasekaran and R. Viswanathan, Pearson Education(Asia) Pvt. Ltd. /Prentice Hall of India, 2003.
2. 'Fundamentals of Statistical Signal Processing,' VolumeI: 'Estimation Theory', Steven M. Kay, Prentice Hall, USA, 1998.
3. 'Fundamentals of Statistical Signal Processing', VolumeII: 'Detection Theory,' Steven M. Kay,Prentice Hall, USA, 1998.

Image Processing Lab

CourseCode	**20ESPL26**	CIEMarks	40
TeachingHours/Week	**04** (2 Hrs Tutorial + 2 Hrs Practical)	SEE Marks	60
		Exam Hours	03
Credits - 02			

Laboratory Experiments:

Sl.No.	**Experiments**
1	Study the effects of a) Boolean operations on binary images b) Quantization of gray level images
2	Study the effects of Contrast enhancement using a)Histogram equalization b) Histogram stretching.
3	Using connected component labelling algorithms,expressPixelneighborhood relationships in terms of a graph
4	Create a binary image from image by replacing all valuesabove a determined threshold level using a) globalthresholding b) adaptive thresholding technique
5	Transform an image given using Spatial Transformation
6	Study how to compute forward 2D FFT and a) Find the log magnitude & phase and the inverse 2D FFT ofan image. b) Compute the forward 2D FFT of the filter kernel. c) Design a Laplacian High Pass Filter d) Study the Two Dimensional Filter Design using filterdesign functions
7	Determine the suitability of homomorphic filtering using a lowpass filter for image enhancement to fix non- uniform ofillumination
8	Implement inverse, Wiener, Regular, and Lucy-Richardson forimage restoration. And formulate how noise information in animage can be used to restore a degraded image.
9	Study different methods of edge detection for use on noisyimages, specifically, a) Motion blurb) Gaussian noise c)Filtered Gaussian noise via averaging.
10	Write an algorithm for recognizing of circles and triangles.

Course outcomes:

At the end of the course the student will be able to:

1. Perform basic transformations for Image enhancement
2. Apply histogram equalization for image enhancement
3. Model the image restoration problem in both time and frequency domains
4. Describe spatial transformations using images
5. Implement different recognition tasks using image processing.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. The experiments can be conducted in MATLAB or using any other related tools.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and Marks allotted to the procedure part to be made zero.

Technical Seminar

CourseCode	**20ESP27**	CIEMarks	100
Number of Contact Hours/Week	**02**	SEE Marks	-
		Exam Hours	-
Credits - 02			

Course objectives:
The objective of the seminar is to inculcate self-learning, face audience confidently, enhance communication skill, involve in group discussion and present and exchange ideas.

Each student, under the guidance of a Faculty, is required to

- Choose, preferably through peer reviewed journals, a recent topic of his/her interest relevant to the Course of Specialization.
- Carryout literature survey, organize the Course topics in a systematic order.
- Prepare the report with own sentences.
- Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities.
- Present the seminar topic orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

The CIE marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill, participation in the question and answer session and quality of report) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculties from the department with the senior most acting as the Chairperson.

Marks distribution for CIE of the course 20ESP27 seminar:

Seminar Report: 50 marks
Presentation skill: 25 marks
Question and Answer:25 marks

M.TECH IN Signal Processing (ESP)

Choice Based Credit System (CBCS) and Outcome Based Education(OBE)
(Effective from the academic year 2020-21)

SEMESTER -III

Adaptive Signal Processing

CourseCode	**20ESP31**	CIEMarks	40
Lecture Hours/Week	**04**	SEE Marks	60
Total Number of LectureHours	**50**	Exam Hours	03
Credits - 04			

Module -1

Adaptive systems: Definitions and characteristics - applications -properties- examples - adaptive linear combiner input signal and weight vectors - performance function-gradient and minimum meansquare error - introduction to filtering-smoothing and prediction -linear optimum filtering-orthogonality - Wiener – Hopf equationperformanceSurface.

Module -2

Searching performance surface-stability and rate of convergence: learning curve-gradient search - Newton's method -method of steepest descent - comparison - gradient estimation -performance penalty - variance - excess MSE and time constants –mis adjustments.

Module -3

LMS algorithm convergence of weight vector: LMS/Newton algorithm - properties - sequential regression algorithm – adaptiverecursive filters - random-search algorithms - lattice structure -adaptive filters with orthogonal signals.

Module -4

Applications-adaptive modeling:Multipath communication channel, geophysical exploration, FIR digitalfilter synthesis.

Module -5

Applications: inverse adaptive modelling, deconvolution and equalization, General Description of Inverse Modeling, Adaptive Equalization of Telephone Channels, Adapting Poles and Zeros for IIR Digital Filter Synthesis.

Course Outcomes:

At the end of the course the student will be able to:

1. Design optimal minimum mean square estimators and in particular linearestimators.
2. Implement adaptive filters (FIR, IIR, non-causal, causal) and evaluate theirperformance.
3. Identify applications in which it would be possible to use the differentadaptive filtering approaches.
4. Analyze basic non-recursive adaptive filter, that is, the adaptive linearcombiner.
5. Understand adaptive modelling and system identification; inverseadaptive modelling, de-convolution and equalization.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text Books:

'Adaptive Signal Processing',Bernard Widrow and Samuel DStearns,Pearson Education, 2005.

Reference Books:

1. 'Theory andDesign of Adaptive Filters', John RTreichler, CRichard Johnson, Michael GLarimore,Prentice-HallofIndia,2002
2. 'Adaptive Signal Processing-Theory andApplication', SThomas Alexander, Springer-Verlag.
3. 'Statistical and AdaptiveSignal Processing', D. G. Manolakis, V. K. Ingle and S. M. Kogar, McGraw Hill International Edition, 2000.
4. 'Adaptive Filter Theory', Simon Haykin,Pearson Education, 2003.

Professional Elective 3

Array Signal Processing

CourseCode	**20ESP321**	CIEMarks	40
Lecture Hours/Week	**03**	SEE Marks	60
Total Number of LectureHours	**40**	Exam Hours	03
Credits - 03			

Module 1

Spatial Signals: Signals in space and time, Spatial Frequency vs Temporal Frequency, Review of Co-ordinate Systems, Maxwell's Equation, Wave Equation. Solution to Wave equation in Cartesian Co-ordinate system –Wave number vector, Slowness vector.

Module 2

Wave number-Frequency Space Spatial Sampling: Spatial Sampling Theorem-Nyquist Criteria, Aliasing in Spatial frequency domain, Spatial sampling of multidimensional signals.

Module 3

Sensor Arrays: Linear Arrays, Planar Arrays, Frequency – Wave number Response and Beam pattern, Array manifold vector, Conventional Beam former, Narrowband beam former.

Module 4

Uniform Linear Arrays: Beam pattern in θ, u and ψ -space, Uniformly Weighted Linear Arrays.

Beam Pattern Parameters: Half Power Beam Width, Distance to First Null, Location of side lobes and Rate of Decrease, Grating Lobes, Array Steering.

Module 5

Array Design Methods: Visible region, Duality between Time -Domain and Space -Domain Signal Processing, Schelkunoff's Zero Placement Method, Fourier Series Method with windowing, Woodward -Lawson Frequency-Sampling Design.

Non parametric method -Beam forming, Delay and sum Method, Capons Method.

Course outcomes:

At the end of the course the student will be able to:

1. Comprehend the basics of signals in space and time.

2. Understand the important concepts of array signal processing.
3. Describe the various array design techniques.
4. Understand the basic principle of direction of arrival estimation techniques.
5. Explain the Concepts of Spatial Frequency along with the Spatial Samplings.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text Book:

'Optimum Array Processing Part IV of Detection, Estimation, and Modulation Theory', Harry L. Van Trees, John Wiley & Sons, ISBN: 9780471093909, 2002.

Reference Books:

1. 'Array Signal Processing: Concepts and Techniques', Don H. Johnson, Dan E. Dugeon, Prentice Hall Signal Processing Series, 1st Edition, ISBN-13: 978-0130485137.
2. 'Spectral Analysis of Signals', Petre Stoica and Randolph L. Moses, Prentice Hall, ISBN: 0-13-113956-8, 2005.
3. 'Electromagnetic Waves and Antennas', Sophocles J. Orfanidis, ECE Department, Rutgers University, 94 Brett Road Piscataway, NJ 88548058. http://www.ece.rutgers.edu/~orfanidi/ewa/

Medical Imaging

CourseCode	**20EIE322**	CIEMarks	40
Lecture Hours/Week	**03**	SEE Marks	60
Total Number of LectureHours	**40**	Exam Hours	03
Credits - 03			

Module 1

Generation and Detection of X-Rays: X-Ray generation and X-Ray generators, Filters, Beam Restrictors and Grids, Screens, X-RayDetectors.
X-Ray Diagnostic Methods: Conventional X-Ray Radiography,Fluoroscopy, Angiography, Mammography, Xeroradiography, ImageSubtraction.
X-Ray Image Characteristics: Spatial Resolution, Image Noise,Image contrast.
Biological Effects of Ionizing Radiation: Determination ofbiological effects, Short term and Long term effects.

Module 2

X-Ray Tomography: Conventional Tomography, Computed Tomography - Projection function, Algorithms for ImageReconstruction, CT number, Image Artifacts.
Digital Radiography: Digital Subtraction Angiography (DSA), DualEnergy Subtraction, K-Edge subtraction, 3-D Reconstruction.
Recent Developments: Dynamic Spatial Reconstructor (DSR),Imatron or Fastrac Electron Beam CT.

Module 3

Generation and Detection of Ultrasound: Piezoelectric effect,Ultrasonic Transducers, Transducer Beam Characteristics, Axial and Lateral resolution, Focusing and Arrays.
Ultrasonic Diagnostic Methods: Pulse Echo systems - A mode, Bmode, M mode and C mode, Transmission Methods, Dopplermethods, Duplex Imaging.
Biological Effects of Ultrasound: Acoustic phenomena at highintensity levels, Ultrasound Bioeffects.

Module 4

Generation and Detection of Nuclear Emission: Nuclear Sources, Radionuclide Generators, Nuclear Radiation Detectors, Collimators.
Diagnostic methods using Radiation Detector Probes: ThyroidFunction test, Renal function test, Blood volume measurement.

New Radio Nuclide Imaging methods: Longitudinal SectionTomography, SPECT and PET
Characteristics of Radionuclide Images: Spatial Resolution, Imagecontrast, Image Noise.

Module 5

Generation and Detection of NMR signal: The NMR Coil/Probe, The transmitter and the Receiver, Data acquisition.
Magnetic Resonance Imaging methods: Spin Echo Imaging,Gradient Echo Imaging, Blood flow Imaging.
Characteristics of MRI images: Spatial Resolution, Image Contrast.
Imaging Safety.

Course outcomes:
At the end of the course the student will be able to:
1. Understand the Generation and Detection of X-Rays, the DiagnosticMethods, Characteristics of X-ray images and Biological effects of X-rays.
2. Analyze Computed tomography and Digital Radiography.
3. Learn the techniques of Generation and Detection of Ultrasound, Pulse Echo Systems and Ultrasonic Diagnostic Methods.
4. Understand the principles of various radiological imaging techniques such as SPECT and PET.
5. Understand the principles of Magnetic Resonance Imaging, the concepts of Radionuclide Generation and Detection.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text Book:
'Principles of MedicalImaging', Kirk Shung, Michael B Smith, Benjamin M W Tsui, Academic Press, 2012.

Reference Books:

1. 'Fundamentals of Medical Imaging',Zhong Hicho and Manbir Singh, John Wiley, 1993.
2. 'Nuclear Medicine Introductory Text',Peter Josefell & Edwards Sydney, William Blackwell Scientific Publishers, London.

Business Intelligence and its Applications

CourseCode	**20ELD323**	CIEMarks	40
Lecture Hours/Week	**03**	SEE Marks	60
Total Number of LectureHours	**40**	Exam Hours	03
Credits - 03			

Module 1

Development Steps, BI Definitions, BI Decision Support Initiatives, DevelopmentApproaches, Parallel Development Tracks, BI Project Team Structure, Business Justification,Business Divers, Business Analysis Issues, Cost – Benefit Analysis, Risk Assessment,Business Case Assessment Activities, Roles Involved In These Activities, Risks of NotPerforming Step, Hardware, Middleware, DBMS Platform, Non-Technical InfrastructureEvaluation

Module 2

Managing The BI Project, Defining And Planning The BI Project, Project PlanningActivities, Roles And Risks Involved In These Activities, General Business Requirement,Project Specific Requirements, Interviewing Process.

Module 3

Differences in Database Design Philosophies, Logical Database Design, Physical DatabaseDesign, Activities, Roles And Risks Involved In These Activities, Incremental Rollout,Security Management, Database Backup And Recovery.

Module 4

Growth Management, Application Release Concept, Post Implementation Reviews, Release Evaluation Activities, The Information Asset and Data Valuation, Actionable Knowledge –ROI, BI Applications, The Intelligence Dashboard.

Module 5

Business View of Information technology Applications: Business Enterprise excellence, Key purpose of using IT, Type of digital data, basics of enterprise reporting, BI road ahead.

Course outcomes:

At the end of the course the students will be able to:

1.Evaluate the key elements of a successful business intelligence (BI) program

2. Apply a BI meta model that turns outcomes into actions

3. Extract and transform data from an operational data to a data business data

4. Evaluate business analytics and performance measurement tools

5. Demonstrate a business scenario, identify the metrics, indicators and make recommendations to achieve the business goal.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text Books:

1. 'Business Intelligence Roadmap: The Complete ProjectLifecycle for Decision Support Applications', Larissa T Moss and ShakuAtre, Addison Wesley Information Technology Series, 2003.
2. 'Fundamentals of Business Analytics', R N Prasad, SeemaAcharya, Wiley India, 2011.

Reference Books:

1. 'Business Intelligence: The Savvy Manager's Guide', David Loshin, Publisher: MorganKaufmann, ISBN 1-55860-196-4.
2. 'Delivering Business Intelligence with Microsoft SQL Server2005', Brian Larson, McGraw Hill,2006.
3. 'Foundations of SQL Server 2008', Lynn Langit, Business Intelligence – Apress,ISBN13: 978-14302-3324-4,2011.

Speech and Audio Processing

CourseCode	**20ESP324**	CIEMarks	40
Lecture Hours/Week	**03**	SEE Marks	60
Total Number of LectureHours	**40**	Exam Hours	03
Credits - 03			

Module 1

Digital Models for the Speech Signal: Process of speech production, Acoustic theory of speech production, Losslesstube models, and Digital models for speech signals (Text 1).

Time Domain Models for Speech Processing: Timedependent processing of speech, Short time energy and averagemagnitude, Short time average zero crossing rate, Speech vssilence discrimination using energy & zero crossings, Pitchperiod estimation, Short time autocorrelation function, Shorttime average magnitude difference function, Pitch periodestimation using autocorrelation function, Median smoothing(Text 1).

Module 2

Digital Representations of the Speech Waveform: Sampling speech signals, Instantaneous quantization, Adaptivequantization, Differential quantization, Delta Modulation,Differential PCM, Comparison of systems, direct digital codeconversion(Text 1).

Short Time Fourier Analysis: Linear Filtering interpretation, Filter bank summation method, Overlap addition method,Design of digital filter banks, Implementation using FFT,Spectrographic displays, Pitch detection, Analysis by synthesis,Analysis synthesis systems (Text 1).

Module 3

Homomorphic Speech Processing: Homomorphic systems for convolution, Complex cepstrum, Pitch detection, Formantestimation, Homomorphic vocoder.

Linear Predictive Coding of Speech: Basic principles of linear predictive analysis, Solutionof LPC equations, Prediction error signal, Frequency domaininterpretation, Relation between the various speechparameters, Synthesis of speech from linear predictiveparameters, Applications (Text 1).

Module 4

Speech Enhancement: Spectral subtraction & filtering, Harmonic filtering, parametric re-synthesis, Adaptive noisecancellation.
Speech Synthesis: Principles of speech synthesis,Synthesizer methods, Synthesis of intonation, Speechsynthesis for different speakers, Speech synthesis in otherlanguages, Evaluation, Practical speech synthesis (Text 1).

Module 5

Automatic Speech Recognition: Introduction, Speech recognition vs. Speaker recognition, Signal processing andanalysis methods, Pattern comparison techniques, HiddenMarkov Models, Artificial Neural Networks (Text 2).

Audio Processing: Auditory perception and psychoacoustics -Masking, frequency and loudness perception, spatialperception, Digital Audio, Audio Coding - High quality, low-bitrateaudiocodingstandards,MPEG,AC-3,Multichannelaudio-Stereo, 3D binaural and Multichannel surround sound(Text3).

Course outcomes:
At the end of the course the students will be able to:

1. Understand basic concepts of speech production, speech analysis and synthesis
2. Analyze Speech coding techniques,Speech and speaker recognition systems.
3. Explain Concepts of Audio Processing and learn modelling
4. Implement Applications such as New audiogram matching techniques
5. Develop systems for various applications of speech processing.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text Books:

1. 'Digital Processing of Speech Signals',L. R. Rabiner and R. W. Schafer,Pearson Education (Asia) Pvt. Ltd., 2004.
2. 'Fundamentals of Speech Recognition', L. R. Rabiner and B. Juang, Pearson Education (Asia) Pvt. Ltd., 2004.
3. 'Fundamentals of Multimedia', Z. Li and M.S. Drew, Pearson Education(Asia) Pvt. Ltd., 2004.

Reference Book:

'Speech Communications: Human and Machine',D. O'Shaughnessy,Universities Press, 2001.

Professional elective 4

VLSI Design for Signal Processing

CourseCode	**20EVE331**	CIEMarks	40
Lecture Hours/Week	**03**	SEE Marks	60
Total Number of LectureHours	**40**	Exam Hours	03
Credits - 03			

Module 1

Introduction to DSP Systems: Typical DSP Algorithms, DSP Application Demands and Scaled CMOS Technologies, Representations of DSP Algorithms.

Iteration Bounds: Data flow graph Representations, loop bound and Iteration bound. Algorithms for Computing Iteration Bound, Iteration Bound of multi rate data flow graphs.

Module 2

Pipelining and Parallel Processing: pipelining of FIR Digital Filters, parallel processing, Pipelining and parallel processing for low power.

Retiming: Definition and Properties, Solving Systems of Inequalities, Retiming Techniques.

Module 3

Unfolding: An Algorithm for Unfolding, Properties of Unfolding, Critical path, Unfolding and Retiming, Application of Unfolding.

Folding: Folding Transformation, Register Minimization Techniques, Register Minimization in Folded Architectures, Folding of Multirate Systems.

Module 4

Systolic Architecture Design: systolic array design Methodology, FIR systolic array, Selection of Scheduling Vector, Matrix-Matrix Multiplication and 2D systolic Array Design, Systolic Design for space representation containing Delays.

Fast convolution: Cook-Toom Algorithm, Winograd Algorithm, Iterated convolution, cyclic convolution Design of fast convolution Algorithm by Inspection.

Module 5

Pipelined and Parallel Recursive and Adaptive Filter: Pipeline Interleaving in Digital Filter, first order IIR digital Filter, Higher order IIR digital Filter, parallel processing for IIR filter, Combined pipelining and parallel processing for IIR Filter, Low power IIR Filter Design Using Pipelining and parallel processing, pipelined adaptive digital filter.

Course outcomes:

At the end of the course the students will be able to:

1. Illustrate the use of various DSP algorithms and addresses their representation using block diagrams, signal flow graphs and data-flow graphs.
2. Use pipelining and parallel processing in design of high-speed /low-power applications.
3. Apply unfolding in the design of parallel architecture.
4. Evaluate the use of look-ahead techniques in parallel and pipelined IIR Digital filters.
5. Develop an algorithm or architecture or circuit design for DSP applications.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text Book:

'VLSI Digital Signal Processing systems, Design and implementation', Keshab KParthi, Wiley, 1999.

Reference Books:

1. 'Analog VLSI Signal and Information Processing', Mohammed Isamail and Terri Fiez, Mc Graw-Hill, 1994.
2. 'VLSI and Modern Signal Processing', S.Y. Kung, H.J. White House, T. Kailath, Prentice Hall, 1985.
3. 'Design of Analog - Digital VLSI Circuits for Telecommunication and Signal Processing', Jose E. France, Yannis Tsividis, Prentice Hall, 1994.
4. 'DSP Integrated Circuits', Lars Wanhammar, Academic Press Series in Engineering, 1st Edition.

Pattern Recognition & Machine Learning

CourseCode	**20ESP332**	CIEMarks	40
Lecture Hours/Week	**03**	SEE Marks	60
Total Number of LectureHours	**40**	Exam Hours	03
Credits - 03			

Module 1

Introduction: Probability Theory, Model Selection, The Curse of Dimensionality, Decision Theory, Information Theory
Distributions: Binary and Multinomial Variables, The Gaussian Distribution, The Exponential Family, Nonparametric Methods (Ch. 1,2).

Module-2

Supervised Learning
Linear Regression Models: Linear Basis Function Models, The Bias-Variance Decomposition, Bayesian Linear Regression, Bayesian Model Comparison
Classification & Linear Discriminant Analysis: Discriminant Functions, Probabilistic Generative Models, Probabilistic Discriminative Mode (Ch. 3,4).

Module-3

Supervised Learning
Kernels: Dual Representations, Constructing Kernels, Radial Basis Function Network, Gaussian Processes
Support Vector Machines: Maximum Margin Classifiers, Relevance Vector Machines
Neural Networks: Feed-forward Network, Network Training, Error Backpropagation (Ch. 5,6,7).

Module-4

Unsupervised Learning
Mixture Models: K-means Clustering, Mixtures of Gaussians, Maximum likelihood, EM for Gaussian mixtures, Alternative View of EM.
Dimensionality Reduction: Principal Component Analysis, Factor/Component Analysis, Probabilistic PCA, Kernel PCA, Nonlinear Latent Variable Models (Ch. 9,12).

Module-5

Probabilistic Graphical Models: Bayesian Networks, Conditional Independence, Markov Random Fields, Inference in Graphical Models, Markov Model, Hidden Markov Models (Ch.8,13).

Course outcomes:

At the end of the course the students will be able to:

1. Identify areas where Pattern Recognition and Machine Learning can offer a solution.
2. Describe the strength and limitations of some techniques used in computational Machine Learning for classification, regression and density estimation problems.
3. Describe and model data.
4. Solve problems in Regression and Classification.
5. Discuss main and modern concepts for model selection and parameter estimation in recognition, decision making and statistical learning problems.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text Book:

'Pattern Recognition and Machine Learning', Christopher Bishop, Springer, 2006.

Internet of Things

CourseCode	**20ECS333**	CIEMarks	40
Lecture Hours/Week	**03**	SEE Marks	60
Total Number of LectureHours	**40**	Exam Hours	03
Credits - 03			

Module-1

What is IoT ?
Genesis, Digitization, Impact, Connected Roadways, Buildings, Challenges
IoT Network Architecture and Design
Drivers behind new network Architectures, Comparing IoT Architectures, M2M architecture, IoT world forum standard, IoT Reference Model, Simplified IoT Architecture.

Module-2

IoT Network Architecture and Design
Core IoT Functional Stack, Layer1 (Sensors and Actuators), Layer 2 (Communications Sublayer), Access network sublayer, Gateways and backhaul sublayer, Network transport sublayer, IoT Network management.
Layer 3 (Applications and Analytics) – Analytics vs Control, Data vs Network Analytics, IoT Data Management and Compute Stack

Module-3

Engineering IoT Networks
Things in IoT – Sensors, Actuators, MEMS and smart objects.
Sensor networks, WSN, Communication protocols for WSN
Communications Criteria, Range, Frequency bands, power consumption, Topology, Constrained Devices, Constrained Node Networks
IoT Access Technologies, IEEE 802.15.4
Competitive Technologies – Overview only of IEEE 802.15.4g, 4e, IEEE 1901.2a
Standard Alliances – LTE Cat 0, LTE-M, NB-IoT

Module-4

Engineering IoT Networks
IP as IoT network layer, Key Advantages, Adoption, Optimization, Constrained Nodes, Constrained Networks, IP versions, Optimizing IP for IoT.

Application Protocols for IoT – Transport Layer, Application Transport layer, Background only of SCADA, Generic web based protocols, IoT Application Layer
Data and Analytics for IoT – Introduction, Structured and Unstructured data, IoT Data Analytics overview and Challenges.

Module-5

IoT in Industry (Three Use cases)
IoT Strategy for Connected manufacturing, Architecture for Connected Factory
Utilities – Power utility, IT/OT divide, Grid blocks reference model, Reference Architecture, Primary substation grid block and automation.
Smart and Connected cities –Strategy, Smart city network Architecture, Street layer, city layer, Data center layer, services layer, Smart city security architecture, Smart street lighting.

Course outcomes:
At the end of the course the student will be able to:

1. Understand the basic concepts IoT Architecture and devices employed.
2. Analyze the sensor data generated and map it to IoT protocol stack for transport.
3. Apply communications knowledge to facilitate transport of IoT data over various available communications media.
4. Design a use case for a typical application in real life ranging from sensing devices to analyzing the data available on a server to perform tasks on the device.
5. Apply knowledge of Information technology to design of IoT applications (Operational Technology).

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text Book:

‘CISCO, IoT Fundamentals – Networking Technologies, Protocols, Use Cases for IoT’, David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, Pearson Education, ISBN: 978-9386873743, First edition, 2017

Reference Book:

‘Internet of Things – A Hands on Approach’, Arshdeep Bahga and Vijay Madisetti, Orient Blackswan Private Limited - New Delhi, First edition, 2015

Communication System Design using DSP algorithm

CourseCode	**20ESP334**	CIEMarks	40
Lecture Hours/Week	**03**	SEE Marks	60
Total Number of LectureHours	**40**	Exam Hours	03
Credits - 03			

Module 1

Introduction to the course: Digital filters, Discrete time convolution and frequency responses, FIR filters - Using circular buffers to implement FIR filters in C and using DSP hardware, Interfacing C and assembly functions, Linear assembly code and the assembly optimizer. IIR filters - realization and implementation, FFT and power spectrum estimation: DTFT window function, DFT and IDFT, FFT, Using FFT to implement power spectrum.

Module 2

Analog modulation scheme: Amplitude Modulation - Theory, generation and demodulation of AM, Spectrum of AM signal, Envelope detection and square law detection, Hilbert transform and complex envelope, DSP implementation of amplitude modulation and demodulation.
DSBSC: Theory generation of DSBSC, Demodulation, and demodulation using coherent detection and Costas loop. Implementation of DSBSC using DSP hardware.
SSB: Theory, SSB modulators, Coherent demodulator, Frequency translation, Implementation using DSP hardware.

Module 3

Frequency modulation: Theory, Single tone FM, Narrow band FM, FM bandwidth, FM demodulation, Discrimination and PLL methods, Implementation using DSP hardware.
Digital Modulation scheme: PRBS, and data scramblers: Generation of PRBS, Self-synchronizing data scramblers, Implementation of PRBS and data scramblers. RS-232C protocol and BER tester: The protocol, error rate for binary signaling on the Gaussian noise channels, Three-bit error rate tester and implementation.

Module 4

PAM and QAM: PAM theory, baseband pulse shaping and ISI, Implementation of transmit filter and interpolation filter bank. Simulation and theoretical exercises for PAM, Hardware exercises for PAM.

QAM fundamentals: Basic QAM transmitter, 2 constellation examples, QAM structures using passband shaping filters, Ideal QAM demodulation, QAM experiment. QAM receivers-Clock recovery and other frontend sub-systems. Equalizers and carrier recovery systems.

Module 5

Experiment for QAM receiver frontend, Adaptive equalizer, Phase splitting, Fractionally spaced equalizer. Decision directed carrier tracking, Blind equalization, Complex cross coupled equalizer and carrier tracking experiment. Echo cancellation for full duplex modems: Multicarrier modulation, ADSL architecture, Components of simplified ADSL transmitter, A simplified ADSL receiver, Implementing simple ADSL Transmitter and Receiver.

Course outcomes:

At the end of the course the students will be able to:

1. Realize communication systems, including algorithms that are particularly suited to DSP implementation
2. Implement DSP algorithms on TI DSP processors
3. Implement FIR, IIR digital filtering and FFT methods
4. Implement modulators and demodulators for AM, DSBSC-AM, SSB and FM
5. Design digital communication methods leading to the implementation of a line communication system.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Text Book:

'Communication System Design using DSP Algorithms with Laboratory Experiments for the TMS320C6713 DSK', Steven A Tretter, Springer, 2008.

Reference Books:

1. 'Modern Digital Signal Processing', Roberto Cristi, Cengage Publishers, India, 2003.
2. 'Digital Signal Processing: A Computer Based Approach', S. K. Mitra, TMH, India, 3rd edition, 2007.
3. 'Digital Signal Processing: A Practitioner's approach', E.C. Ifeachor, and B. W. Jarvis, Pearson Education, India, Second Edition, 2002,
4. 'Digital Signal Processing', Proakis and Manolakis, Prentice Hall, 3rd edition, 1996.

Project Work Phase – 1

CourseCode	**20ESP34**	CIEMarks	100
Number ofcontactHours/Week	**02**	SEE Marks	-
		Exam Hours	-
Credits - 02			

Course objectives:

- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organisation, time management, and presentation skills.
- Impart flexibility and adaptability.
- Inspire independent and team working.
- Expand intellectual capacity, credibility, judgement, intuition.
- Adhere to punctuality, setting and meeting deadlines.
- Instil responsibilities to oneself and others.
- Train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Phase-1 Students in consultation with the guide/s shall carry out literature survey/ visit industries to finalize the topic of the Project. Subsequently, the students shall collect the material required for the selected project, prepare synopsis and narrate the methodology to carry out the project work.

Seminar: Each student, under the guidance of a Faculty, is required to

- Present the seminar on the selected project orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Revised Bloom's Taxonomy Level	L_3 – Applying, L_4 – Analysing, L_5 – Evaluating, L_6 – Creating.

Course outcomes:

At the end of the course the student will be able to:

1. Demonstrate a sound technical knowledge of their selected project topic.
2. Undertake problem identification, formulation and solution.
3. Design engineering solutions to complex problems utilising a systems approach.
4. Communicate with engineers and the community at large in written an oral forms.
5. Demonstrate the knowledge, skills and attitudes of a professional engineer.

Continuous Internal Evaluation

CIE marks for the project report (50 marks), seminar (25 marks) and question and answer (25 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

MINI PROJECT

CourseCode	**20ESP35**	CIEMarks	40
Number of contact Hours/Week	**02**	SEE Marks	60
		Exam Hours/ Batch	03
Credits - 02			

Course objectives:

- To support independent learning and innovative attitude.
- To guide to select and utilize adequate information from varied resources upholding ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Mini-Project: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

Course outcomes:

At the end of the course the student will be able to:

1. Present the mini-project and be able to defend it.
2. Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
3. Habituated to critical thinking and use problem solving skills.
4. Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
5. Work in a team to achieve common goal.
6. Learn on their own, reflect on their learning and take appropriate actions to improve it.

CIE procedure for Mini - Project:
The CIE marks awarded for Mini - Project, shall be based on the evaluation of Mini - Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.The marks awarded for Mini - Project report shall be the same for all the batch mates.

Semester End Examination
SEE marks for the mini-project shall be awarded based on the evaluation of Mini-Project Report, Presentation skill and Question and Answer session in the ratio 50:25:25 by the examiners appointed by the University.

Internship / Professional Practice

CourseCode	**20ESPI36**	CIEMarks	40
Number of contact Hours/Week	**02**	SEE Marks	60
		Exam Hours	03
Credits - 06			

Course objectives:
Internship/Professional practice provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc. The objectives are further,

- To put theory into practice.
- To expand thinking and broaden the knowledge and skills acquired through course work in the field.
- To relate to, interact with, and learn from current professionals in the field.
- To gain a greater understanding of the duties and responsibilities of a professional.
- To understand and adhere to professional standards in the field.
- To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality.
- To identify personal strengths and weaknesses.
- To develop the initiative and motivation to be a self-starter and work independently

Internship/Professional practice: Students under the guidance of internal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.

Seminar: Each student, is required to

- Present the seminar on the internship orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit the report duly certified by the external guide.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Course outcomes:

At the end of the course the student will be able to:

- Gain practical experience within industry in which the internship is done.
- Acquire knowledge of the industry in which the internship is done.
- Apply knowledge and skills learned to classroom work.
- Develop a greater understanding about career options while more clearly defining personal career goals.
- Experience the activities and functions of professionals.
- Develop and refine oral and written communication skills.
- Identify areas for future knowledge and skill development.
- Expand intellectual capacity, credibility, judgment, intuition.
- Acquire the knowledge of administration, marketing, finance and economics.

Continuous Internal Evaluation

CIE marks for the Internship/Professional practice report (20 marks), seminar (10 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

Semester End Examination

SEE marks for the Internship Report (30 Marks), Seminar (15 Marks) and Question and Answer Session (15 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University.

M.TECH IN Signal Processing (ESP)

Choice Based Credit System (CBCS) and Outcome Based Education(OBE)
(Effective from the academic year 2020-21)

SEMESTER -IV

PROJECT WORK PHASE -2

CourseCode	**20ESP41**	CIEMarks	40
Number of contact Hours/Week	**04**	SEE Marks	60
		Exam Hours	03
Credits - 20			

Course objectives:

- To support independent learning.
- To guide to select and utilize adequate information from varied resources maintaining ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Work Phase - II: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

Course outcomes:
At the end of the course the student will be able to:

- Present the project and be able to defend it.

- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it.

Continuous Internal Evaluation:

Project Report: 20 marks. The basis for awarding the marks shall be the involvement of the student in the project and in the preparation of project report. To be awarded by the internal guide in consultation with external guide if any.

Project Presentation: 10 marks.

The Project Presentation marks of the Project Work Phase -II shall be awarded by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

Question and Answer: 10 marks.

The student shall be evaluated based on the ability in the Question and Answer session for 10 marks.

Semester End Examination

SEE marks for the project report (30 marks), seminar (15 marks) and question and answer session (15 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University.