VISVESVARAYA TECHNOLOGICAL UNIVERSITY
BELAGAVI

Scheme of Teaching and Examinations and Syllabus
M.Techin Digital Communication & Networking (ECS)
(Effective from Academic year 2020 - 21)

M.TECH IN DIGITAL COMMUNICATION & NETWORKING
(ECS)

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

Advanced Communication Systems -1 (Theory & Practice)

CourseCode	**20ECS14**	CIEMarks	40
Lecture Hours/Week	**04**	SEE Marks	60
Total Number of LectureHours	**50**	Exam Hours	03
Credits - 04			

Module-1

Signal Representation: Low pass representation of bandpass signals, Low pass representation of bandpass random process [Text 1, Chapter 2:2.1, and 2.9 only].

Modulation: Representation of digitally modulated Signals, Modulation Schemes without memory (Band Limited Schemes - PAM, BPSK, QPSK, MPSK, MQAM, Power Limited Schemes – FSK, MFSK, DPSK, DQPSK), modulation schemes with memory (Basics of CPFSK and CPM – Full Treatment of MSK), Transmit PSD for Modulation Schemes. (Section 3.4) [Text 1, Chapter 3:3.1, 3.2 and 3.3].

Module-2

Demodulation: Vector Channel, Vector Channel +AWGN, Performance parameters, Optimum Coherent Detection for power limited and Bandlimited schemes, Optimal Coherent detection for schemes with memory, Optimal Non – Coherent detection for schemes without and with memory (FSK, DPSK, DQPSK), Comparison of detection schemes [Text 1, Chapter 4: 4.1, 4.2.- 4.2.2, 4.3, 4.4, 4.5.1, 4.5.2, 4.5.5 and 4.6].

Module-3

Bandlimited Channels: Bandlimited channel characterization, signaling through band limited linear filter channels, Sinc, RC, Duobinary and Modified Duobinary signaling schemes, Optimum receiver for channel with ISI and AWGN.

Linear Equalizers: Zero forcing Equalizer, MSE and MMSE, Baseband and Passband Linear Equalizers. Performance of ZFE and MSE (Excluding 9.4-3, 9.4-4) [Text 1, Chapter 9: 9.1, 9.2 - 9.2.1, 9.2.2, 9.2.3, 9.3-9.3.1, 9.3.2 and 9.4].

Module-4

Non-Linear Equalizers: Decision - feedback equalization, Predictive DFE, Performance of DFE [Text 1, Chapter 9: 9.5: 9.5-1 only] .

Adaptive equalization: Adaptive linear equalizer, adaptive decision feedback equalizer, Adaptive Fractionally spaced Equalizer (Tap Leakage Algorithm), Adaptive equalization of Trellis - coded signals [Text 1, Chapter 10: 10.1, 10.1-1, 10.1-2, 10.1-3, 10.1-6,10.1-7, 10.2, 10.3].

Module-5

Spread spectrum signals for digital communication: Model of spread spectrum digital communication system, Direct sequence spread spectrum signals, some applications of DS spread spectrum signals, generation of PN sequences, Frequency hopped spread spectrum signals, Time hopping SS, Synchronization of SS systems[Text 1, Chapter 12: 12.1, 12.2 (except 12.2.1), 12.2.2, 12.2.5, 12.3, 12.4, 12.5].

Course outcomes:

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

1. Explain the concept of low pass and Bandpass signals representations at the Transmitter, the process of Detection and Estimation at the receiver in the presence of AWGN only.
2. Evaluate Receiver performance for various types of single carrier symbol modulations through ideal and AWGN Non-bandlimited and bandlimited channels.
3. Analyze and demonstrate the model of discrete time channel with ISI & the model of discrete time channel by equalizer.
4. Design single carrier equalizers for various symbol modulation schemes and detection methods for defined channel models, and compute parameters to meet desired rate and performance requirements.
5. Design and Evaluate Non band limited and Non power limited spread spectrum systems for communications in a Jamming environment, multiuser situation and low power intercept environment.

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:

'Digital Communications', John G. Proakis, Masoud Salehi, Pearson Education, ISBN:978-9332535893, 5th edition, 2014

Reference Books:

1. 'Digital Communications: Fundamentals and Applications: Fundamentals & Applications', Bernard Sklar, Pearson Education, ISBN:9788131720929, 2nd edition, 2009
2. 'Digital Communications Systems', Simon Haykin, Wiley, ISBN:9788126542314, 1st edition, 2014

Advanced Computer Communication Networks

CourseCode	**20ECS15**	CIEMarks	40
Lecture Hours/Week	**04**	SEE Marks	60
Total Number of LectureHours	**50**	Exam Hours	03
Credits - 04			

Module-1

Foundation: Building a Network, Applications, Requirements, Network Architecture, Implementing Network Software, Performance (Text 1: Chapter 1.1, 1.2, 1.3, 1.4, 1.5).

Module-2

Advanced Internetworking: The Global Internet, Multicast, Multicast addresses, Multicast, Multiprotocol Label Switching (MPLS)
End-to-End protocols: Simple Demultiplexer (UDP), Reliable Byte Stream (TCP) (Text 1: Chapter 4.1, 4.2, 4.3, 5.1, 5.2).

Module-3

Congestion Control and Resource Allocation: Allocating Resources, Issues in Resource allocation, Queuing Disciplines, TCP Congestion Control, Congestion-Avoidance Mechanisms, Quality of Service. (Text 1: Chapter 6.1, 6.2, 6.3, 6.4 and 6.5).

Module-4

Applications: Traditional Applications: Electronic Mail (SMTP, POP, IMAP, MIME), World Wide Web (HTTP), Multimedia Applications, Infrastructure Services (Domain Name System (DNS), Network Management (SNMP), Overlay Networks (Text 1: Chapter 9.1, 9.2, 9.3, 9.4. Text 2: Chapter 23.1 to 23.16, Chapter 24, Chapter 25, Chapter 27.1 to 27.8).

Module-5

End-to End data: Presentation formatting, Multimedia DataNetwork Security: Security attacks, Cryptographic building blocks, Key Predistribution, Authentication protocols, Firewalls (Text 1: Chapter 7.1, 7.2, 8.1, 8.2, 8.3, 8.5).

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

1. Classify network services, protocols and architectures, explain why they are layered.
2. Knowledge on Advanced Internetworking applications and their protocols, and ability to work on their own applications (e.g. Client Server applications, Web Services).
3. To analyse various techniques for Congestion avoidance and Resource Allocation.
4. Gain the knowledge of application layer protocols.
5. Understand the concept of Network Security through cryptographic blocks, authentication protocols and Firewalls.

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. 'Computer Networks: A System Approach', Larry Peterson and Bruce S Davis, 5th Edition, Elsevier -2014.
2. 'Internetworking with TCP/IP, Principles, Protocols and Architecture', Douglas E Comer, 6th Edition, PHI – 2014

Reference Books:

1. 'Computer Networks, Protocols, Standards and Interfaces',UylessBlack, 2nd Edition, PHI.
2. 'TCP /IP Protocol Suite', Behrouz A Forouzan, 4th Edition, Tata McGraw-Hill

Advanced Digital Signal Processing Lab

CourseCode	**20ECSL16**	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 COMMUNICATION SYSTEMS/
DIGITAL COMMUNICATION & NETWORKING/
DIGITAL COMMUNICATION ENGINEERING/
DIGITAL ELECTRONICS & COMMUNICATION SYSTEMS/
DIGITAL ELECTRONICS & COMMUNICATION (ECS)

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

SEMESTER -II

Advanced Communication Systems -2

CourseCode	**20ECS21**	CIEMarks	40
Lecture Hours/Week	**04**	SEE Marks	60
Total Number of LectureHours	**50**	Exam Hours	03
Credits - 04			

Module-1

Synchronization – Signal Parameter estimation, Carrier Phase Estimation, Symbol Timing Recovery, Performance of ML estimators. [Text 1, Chapter 5]
Fading – Large scale, small scale; Statistical characterization of multipath channels – Delay and Doppler spread, classification of multipath channels, scattering function; Binary signaling over frequency non selective Rayleigh fading channel [Text 1, Chapter 13].

Module-2

Fading Contd.: - Diversity techniques for performance improvement with binary signaling over FNS, Slow fading channels – power combining and Maximal ratio combining; Frequency selective channels – Rake receivers, Performance, Tap weight Synchronization, Application to CDMA [Text 1, Chapter 13].
Multicarrier Signalling: A brief overview of Frequency Diversity [Text 2, Sec 3.4.1, 3.4.2].
Multicarrier Communications in AWGN channel- Single carrier vs Multicarrier, OFDM, FFT Implementation, Spectral Characteristics, Power and bit allocation, Peak to Average Power Ratio, Channel Coding Considerations [Text 1, 11.2.1 to 11.2.9] and [Text 2, Sec 3.4.4].

Module-3

Capacity of wireless channel: AWGN channel capacity [Sec 5.1 All subsections], Resources of AWGN channel [5.2 All sub sections], Linear time invariant Gaussian channel [5.3 All sub sections], Capacity of Fading Channels [Sec5.4 All subsections] [Text 2 Chapter 5].

Module-4

MIMO spatial multiplexing and channel modeling: Multiplexing capability of deterministic MIMO channels, Physical modeling of MIMO channels, Modeling of MIMO fading channels[Text 2, Chapter 7].

Module-5

MIMO capacity and multiplexing architectures: The VBLAST architecture, Fast fading MIMO channel, Capacity with CSI at receiver, Performance gains, Full CSI, Performance gains in a MIMO channel, Receiver architectures – (Linear decorrelator, Successive cancellation, Linear MMSE receiver), Information theoretic optimality, Connections with CDMA multiuser detection and ISI equalization, Slow fading MIMO channel [Sections 8.1 to 8.4, Text 2].

Course outcomes:

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

1. Describe models for fading channels, and concepts of diversity in time, frequency and space.
2. Explain the concepts of multi-channel signaling (including OFDM) scheme and synchronization for carrier and symbol timing recovery at receiver.
3. Evaluate the capacity and degradation in performance of various symbol signaling schemes in a multipath fading environment.
4. Develop & analyze schemes to improve performance in a multipath fading environment including maximal ratio combining, RAKE receivers, OFDM and MIMO.
5. Develop and evaluate the performance of a OFDM MIMO scheme to meet specified rate in a given multipath environment.

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 Communications', John G. Proakis, Masoud Salehi, Pearson Education, ISBN:978-9332535893, 5th edition, 2014
2. 'Fundamentals of Wireless Communication', David Tse, Pramod Viswanath, Cambridge University Press, ISBN:0521845270, 1st edition, 2005

Reference Book:

'Digital Communication Systems', Simon Haykin, Wiley, ISBN:978-0471-64735-5, 2014

Antenna Theory and Design

CourseCode	**20ECS22**	CIEMarks	40
Lecture Hours/Week	**04**	SEE Marks	60
Total Number of LectureHours	**50**	Exam Hours	03
Credits - 04			

Module-1

Antenna Fundamentals and Definitions: Radiation Mechanisms, Overview, EM Fundamentals, Solution of Maxwell's Equations for Radiation Problems, Ideal Dipole, Radiation patterns, Directivity and Gain, Antenna impedance, Radiation efficiency, Antenna polarization.

Module-2

Arrays: Array factor for linear arrays, Uniformly excited equally spaced linear arrays, Pattern multiplication, Directivity of linear arrays, Nonuniformly excited equally spaced linear arrays, Mutual coupling.

Antenna Synthesis: Formulation of the synthesis problem, Synthesis principles, Line sources shaped beam synthesis, Linear array shaped beam synthesis, Fourier series, Woodward - Lawson sampling method, Comparison of shaped beam synthesis methods, low side lobe narrow main beam synthesis methods, Dolph Chebyshev linear array, Taylor line source method.

Module-3

Resonant Antennas: Wires and Patches, Dipole antenna, Yagi-Uda antennas, Micro-strip antenna.

Broadband antennas: Traveling wave antennas Helical antennas, Biconical antennas, Sleeve antennas, and Principles of frequency independent antennas, Spiral antennas, and Log - periodic antennas.

Module-4

Aperture antennas: Techniques for evaluating gain, Reflector antennas-Parabolic reflector antenna principles, Axi-symmetric parabolic reflector antenna, Offset parabolic reflectors, Dual reflector antennas, Gain calculations for reflector antennas, Feed antennas for reflectors, Field representations, Matching the feed to the reflector, General feed model, Feed antennas used in practice.

Module-5

CEM for antennas: The method of moments: Introduction of the methods moments, Pocklington's integral equation, Integral equation and Kirchhoff's networking equations, Source modeling weighted residual formulations and computational consideration, Calculation of antenna and scatter characteristics.

Course outcomes:

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

1. Classify different types of antennas
2. Define and illustrate various types of array antennas
3. Design antennas like Yagi-Uda, Helical antennas and other broad band antennas
4. Describe different antenna synthesis methods
5. Apply methods like Method of Moments, Pocklington's integral equation, Source modeling.

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:

'Antenna Theory and Design', Stutzman and Thiele, John Wiley, 2nd Edition, 2010

Reference Books:

1. 'Antenna Theory Analysis and Design', C. A. Balanis, John Wiley, 2nd Edition, 2007
2. 'Antennas and Wave Propagation', J. D. Krauss, McGraw Hill TMH, 4th Edition, 2010
3. 'Antennas and propagation', A.R.Harish, M.Sachidanada, Pearson Education, 2015

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

Optical Communication and Networking

CourseCode	**20ECS244**	CIEMarks	40
Lecture Hours/Week	**04**	SEE Marks	60
Total Number of LectureHours	**50**	Exam Hours	03
Credits - 04			

Module -1

Introduction to optical networks: Optical Networks, optical packet switching, **Propagation of signals in optical fiber:** Different losses, Nonlinear effects, Solitons. **Optical Components (Part-1):** Couplers, Isolators and Circulators (1.3, 1.6, 2.1 up to 2.6, 3.1, 3.2 of Text).

Module-2

Optical Components (Part-2): Multiplexers and Filters, Optical Amplifiers, detectors. **Modulation - Demodulation:** Formats, Ideal receivers, Practical direct detection receivers, Optical preamplifiers, Bit error rates, Coherent detection (3.3, 3.4, 3.6, 4.1, 4.4.1, 4.4.2, 4.4.5, 4.4.6, 4.4.7 of Text).

Module -3

Transmission System Engineering: System model, Power penalty, Transmitter, Receiver, Crosstalk.
Client Layers of optical layer: SONET/SDH: Multiplexing, layers, Frame structure. **Asynchronous Transfer Mode:** ATM functions, Adaptation layers, Quality of Service (QoS) and flow control,Signaling and Routing (5.1 up to 5.4, 5.6, 6(introduction), 6.1(introduction), 6.1.1, 6.1.3, 6.1.4, J.1 up to J.5 of Text).

Module-4

WDM network elements: Optical line terminals, Optical line amplifiers, Optical Add/ Drop Multiplexers, Optical cross connects.
WDM Network Design: Cost trade-offs, LTD and RWA problems, Routing and wavelength assignment, Wavelength conversion (Chapter 7 (full), 10 (introduction), 10.1, 10.2 of Text).

Module -5

Control and Management (Part-1): Network management functions, management framework, Information model, management protocols, Layers within optical layer.

Control and Management (Part-2): Performance and fault management, Impact of transparency, BER measurement, Optical trace, Alarm management, Configuration management, Optical Safety (8(introduction), 8.1, 8.3, 8.5 (introduction), 8.5.1 up to 8.5.4, 8.6, 8.7 of Text).

Course Outcomes:

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

1. Comprehend the various optical devices and their working strategies
2. Recognize and select various optical networking components according to the prescribed design specifications
3. Learn the aspects of data transmission, loss hindrances and other artifacts affecting the network operation
4. Learn the issues involved in setting up and maintenance of access part of optical network with the latest trends in the data communication
5. Design a WDM network and study the component and network management aspects

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:

'Optical Networks', Rajiv Ramaswami, Kumar N. Sivarajan and Galan H Sasaki, Morgan Kaufman Publishers, 3rd edition, 2010.

Reference Books:

1. 'Optical fiber communication', John M. Senior, Pearson edition, 2000.
2. 'Optical fiber Communication', Gerd Keiser, John Wiley, New York, 5th Edition, 2017.
3. 'Fiber Optic Networks', P. E. Green, Prentice Hall, 1994.

Professional Elective 2

Multimedia Over Communication Links

CourseCode	**20ECS251**	CIEMarks	40
Lecture Hours/Week	**04**	SEE Marks	60
Total Number of LectureHours	**50**	Exam Hours	03
Credits - 04			

Module 1

Multimedia Communications: Introduction, Multimedia information representation, multimedia networks, multimedia applications, Application and networking terminology (Chap. 1 of Text1).
Information Representation: Introduction, Text, Images
(Chap. 2- Sections 2.2 and 2.3 of Text 1).

Module 2

Information Representation: Audio and Video (Chap. 2 - Sections 2.4 and 2.5 of Text 1).
Distributed multimedia systems: Introduction, main Features of a DMS, Resource management of DMS, Networking, Multimedia operating systems (Chap. 4 - Sections 4.1 to 4.5 of Text 2).

Module 3

Multimedia Processing in Communication: Introduction, Perceptual coding of digital Audio signals, Transform Audio Coders, Audio Sub band Coders(Chap. 3 - Sections 3.1, 3.2, 3.6, 3.7 of Text 2).

Module 4

Multimedia Communication Standards: Introduction, MPEG approach to multimedia standardization, MPEG-1, MPEG-2, Overview of MPEG-4
(Chap. 5 - Sections 5.1 to 5.4 and 5.5.1 of Text 2).

Module 5

Multimedia Communication Across Networks: Packet audio/video in the network environment, Video transport across generic networks, Multimedia Transport across ATM Networks (Chap. 6 - Sections 6.1, 6.2, 6.3 of Text 2).

Course Outcomes:

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

1. Understand basics of different multimedia networks and applications.
2. Analyze media types like audio and video to represent in digital form.
3. Understand different compression techniques to compress audio.
4. Understand different compression techniques to compress audio video.
5. Describe the basics of Multimedia Communication Across Networks

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. 'Multimedia Communications', Fred Halsall, Pearson education, 2001, ISBN -9788131709948.
2. 'Multimedia Communication Systems', K. R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, Pearson education, 2004. ISBN-9788120321458.

Reference Book:

Ralf Steinmetz, Klara Nahrstedt, 'Multimedia: Computing, Communications and Applications', Pearson education, 2002, ISBN - 9788177584417.

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.

Simulation, Modelling and Analysis

CourseCode	**20ECS254**	CIEMarks	40
Lecture Hours/Week	**04**	SEE Marks	60
Total Number of LectureHours	**50**	Exam Hours	03
Credits - 04			

Module 1

Basic Simulation Modeling: Nature of simulation, Systems, Models and Simulation, Discrete- Event Simulation, Simulation of Single Server Queuing System, Simulation of inventory system, Parallel and distributed simulation and the high level architecture, Steps in sound simulation study, and Other types of simulation, Advantages and disadvantages.
(1.1, 1.2, 1.3, 1.4, 1.4.1, 1.4.2, 1.4.3, 1.5, 1.5.1, 1.5.2, 1.6, 1.7, 1.8, 1.9 of Text).

Module 2

Review of Basic Probability and Statistics: Random Variables and their properties, Simulation Output Data and Stochastic Processes, Estimation of Means, Variances and Correlations, Confidence Intervals and Hypothesis tests for the Mean
Building valid, credible and appropriately detailed simulation models: Introduction and definitions, Guidelines for determining the level of models detail, Management's Role in the Simulation Process, Techniques for increasing model validity and credibility, Statistical procedure for comparing the real world observations and simulation output data.
(4.2, 4.3, 4.4, 4.5, 5.1, 5.2, 5.4, 5.5, 5.6, 5.6.1, 5.6.2 of Text).

Module 3

Selecting Input Probability Distributions: Useful probability distributions, activity I, II and III. Shifted and truncated distributions; Specifying multivariate distribution, correlations, and stochastic processes; Selecting the distribution in the absence of data, Models of arrival process.
(6.2, 6.4, 6.5, 6.6, 6.8, 6.10, 6.11, 6.12 of Text).

Module 4

Random Number Generators: Linear congruential Generators, Other kinds, Testing number generators.
Generating the Random Variates: General approaches,Generating continuous random variates, Generating discrete random variates, Generating random vectors, and correlated random variates; Generating arrival processes.
(7.2, 7.3, 7.4, 8.2, 8.3, 8.4, 8.5, 8.6 of Text).

Module 5

Output data analysis for a single system: Transient and steady state behavior of a stochastic process; Types of simulations with regard to analysis; Statistical analysis for terminating simulation; Statistical analysis for steady state parameters; Statistical analysis for steady state cycle parameters; Multiple measures of performance, Time plots of important variables. (9.2, 9.3, 9.4, 9.4.1, 9.4.3, 9.5, 9.5.1, 9.5.2, 9.5.3, 9.6, 9.7, 9.8 of Text).

Course Outcomes:

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

1. Define the need of simulation and modeling.
2. Comprehend the simulation of deterministic and probabilistic models, with a focus on statistical data analysis and simulation data.
3. Describe various simulation models.
4. Discuss the process of selecting of probability distributions.
5. Perform output data analysis.

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:

'Simulation modeling and analysis', Averill Law, McGraw Hill, 4th edition, 2007.

Reference Books:

1. 'Simulation modeling and analysis with ARENA', TayfurAltiok and Benjamin Melamed, Elsevier, Academic press, 2007.
2. 'Discrete event system Simulation', Jerry Banks, Pearson, 2009
3. 'Applied simulation modeling', Seila Ceric and Tadikamalla, Cengage, 2009.
4. 'Discrete event simulation', George. S. Fishman, Springer, 2001.
5. 'System modeling and simulation', Frank L. Severance, Wiley, 2009.

Advanced Communication Lab

CourseCode	**20ECSL26**	CIEMarks	40
TeachingHours/Week	**04** (2 Hrs Tutorial + 2 Hrs Practical)	SEE Marks	60
		Exam Hours	03
Credits - 02			

Laboratory Experiments:

NOTE: Experiments can be done using Hardware tools such as Spectrum analyzers, Signal sources, Power Supplies, Oscilloscopes, High frequency signal sources, Fiber optic kits, Microwave measurement benches, DSP processor kit, FPGA kit, Logic analyzers, PC setups, etc. Software tools based experiments can be done using, FEKO or equivalent open source simulator, MATLAB etc.

Sl.No.	**Experiments**
1	MATLAB/C implementation to obtain the radiation pattern ofan antenna.
2	Study of radiation pattern of different antennas.
3	Determine the directivity and gains of Horn/ Yagi/ dipole/ Parabolic antennas.
4	Impedance measurements of Horn/Yagi/dipole/Parabolic antennas.
5	Study of radiation pattern of E& H plane horns.
6	Significance of Pocklington's integral equation.
7	Study of digital modulation techniques using CD4051 IC.
8	Conduct an experiment for Voice and data multiplexing using optical fiber.
9	Determination of the modes transit time, electronic timing range and sensitivity of Klystron source.
10	Determination of VI characteristics of GUNN diode, and measurement of guide wave length, frequency and VSWR.
11	Determination of coupling coefficient and insertion loss of directional couplers and Magic tee.
12	Build a hardware pseudo-random signal source and determine statistics of the generated signal source.

Course outcomes:

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

1. Plot the radiation pattern of specified antennas using MATLAB and wave guide setup.
2. Determine gain and directivity of a given antenna.
3. Obtain the S-parameters of Magic tee and directional couplers.
4. Test the IC CD4051 for modulation techniques.
5. Comprehend the multiplexing techniques using OFC kit.

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.

Technical Seminar

CourseCode	**20ECS27**	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 20ECS27 seminar:

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

M.TECH IN COMMUNICATION SYSTEMS/
DIGITAL COMMUNICATION & NETWORKING/
DIGITAL COMMUNICATION ENGINEERING/
DIGITAL ELECTRONICS & COMMUNICATION SYSTEMS/
DIGITAL ELECTRONICS & COMMUNICATION (ECS)
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
(Effective from the academic year 2020-21)

SEMESTER -III

LTE 4G Broadband

CourseCode	**20ECS31**	CIEMarks	40
Lecture Hours/Week	**04**	SEE Marks	60
Total Number of LectureHours	**50**	Exam Hours	03
Credits - 04			

Module -1

Evolution Beyond Release 8, LTE-Advanced for IMT-Advanced, LTE Specifications and 3GPP Structure.

System Architecture Based on 3GPP SAE:

Basic System Architecture Configuration with only E-UTRAN Access Network, System Architecture with E-UTRAN and Legacy 3GPP Access Networks, System Architecture with E-UTRAN and Non-3GPP Access Networks, IMS Architecture, PCC and QoS.

Module -2

Introduction to OFDMA, SC-FDMA and MIMO in LTE:

LTE Multiple Access Background, OFDMA Basics, SC-FDMA Basics MIMO Basics.

Physical Layer:

Transport Channels and their Mapping to the Physical Channels, Modulation, Uplink User Data Transmission, Downlink User Data Transmission, Uplink Physical Layer Signaling Transmission, PRACH Structure, Downlink Physical Layer Signaling Transmission.

Module -3

Physical Layer Procedures, UE Capability Classes and Supported Features, Physical Layer Measurements and Parameter Configuration.

LTE Radio Protocols:

Protocol Architecture, The Medium Access Control, The Radio Link Control Layer, Packet Data Convergence Protocol.

Module -4

Radio Resource Control (RRC): X2 Interface Protocols Understanding the RRC ASN.1 Protocol Definition, Early UE Handling in LTE.
Mobility: Mobility Management in Idle State, Intra-LTE Handovers 190, Inter-system Handovers Differences in E-UTRAN and UTRAN Mobility.

Module -5

Radio Resource Management:
Overview of RRM Algorithms, Admission Control and QoS Parameters, Downlink Dynamic Scheduling and Link Adaptation, Uplink Dynamic Scheduling and Link Adaptation, Interference Management and Power Settings, Discontinuous Transmission and Reception (DTX/DRX), RRC Connection Maintenance.
Performance:
Layer 1 Peak Bit Rates, Terminal Categories Link Level Performance, Link Budgets Spectral Efficiency Latency, LTE Reframing to GSM Spectrum Dimensioning.

Course Outcomes:
At the end of the course the student will be able to:
1. Describe the system architecture and the function standard specified components of the system of LTE 4G.
2. Comprehend the Multiple Access process incorporated in the radio physical layer.
3. Analyze the role of LTE radio interface protocols and EPS Data convergence protocols to set up, reconfigure and release data and voice from a number of users.
4. Demonstrate the UTRAN and EPS handling processes from set up to release including mobility management for a variety of data call scenarios.
5. Test and Evaluate the Performance of resource management and packet data processing and transport algorithms.

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

Note: The experiments and the commands are based on MATLAB communication toolbox. Certain modifications may be allowed if other equivalent software is used.

1. LTE modulation mappers, which specify how the modulation symbols are assignedto each bit sequence.
   function y=Modulator(u, Mode)

2. LTE Demodulator function, we use the same three modulation types used in LTE, and depending on the modulation mode, we process the input symbols to generate the demodulated output. Demodulation can be based on either hard-decision decoding or soft-decision decoding. function
   y=DemodulatorHard(u, Mode) and
   function y=DemodulatorSoft(u, Mode, NoiseVar)

3. LTE scrambling and descrambling operations with components of the Communications System Toolbox.
   function y = Scrambler(u, nS) and
   function y = DescramblerSoft(u, nS)

4. LTE Turbo Encoding and Decoding with all their specifications, using System objects of the Communications System Toolbox.
   function y=TurboEncoder(u, intrlvrIndices) and
   function y=TurboDecoder(u, intrlvrIndices, maxIter)

5. Implementation of the three features of rate matching as specified in the LTE standard: subblock interleaving, Parity bit interlacing, and rate matching with a circular buffer bit selection. function y= RateMatcher(in, Kplus, Rate) and function out = RateDematcher(in, Kplus)

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:

'LTE for UMTS Evolution to LTE-Advanced', HarriHolma and Antti Toskala, John Wiley & Sons, Ltd., Second Edition - 2011, Print ISBN: 9780470660003.

Reference Books:

1. 'Fundamentals of LTE', Arunabha Ghosh, Jun Zhang, Jeffrey G. Andrews, Rias Muhamed, Prentice Hall Communications Engineering and Emerging Technologies Series from Ted Rappaport, 1st Edition, Sept 2010.
2. 'LTE – The UMTS Long Term Evolution; From Theory to Practice' by Stefania Sesia, IssamToufik, and Matthew Baker, John Wiley & Sons Ltd, 2009.

Professional elective 3

Advances in Image Processing

CourseCode	**20ECS321**	CIEMarks	40
Lecture Hours/Week	**03**	SEE Marks	60
Total Number of LectureHours	**40**	Exam Hours	03
Credits - 03			

Module-1

The image, its representations and properties: Image representations a few concepts, Image digitization, Digital image properties, Color images.

Module-2

Image Pre-processing: Pixel brightness transformations, geometric transformations, local pre-processing.

Module-3

Segmentation: Thresholding; Edge-based segmentation – Edge image thresholding, Edge relaxation, Border tracing, Hough transforms; Region – based segmentation – Region merging, Region splitting, Splitting and merging, Watershed segmentation, Region growing post-processing.

Module-4

Shape representation and description: Region identification; Contour-based shape representation and description – Chain codes, Simple geometric border representation, Fourier transforms of boundaries, Boundary description using segment sequences, B-spline representation; Region-based shape representation and description – Simple scalar region descriptors, Moments, Convex hull.

Module-5

Mathematical Morphology: Basic morphological concepts, Four morphological principles, Binary dilation and erosion, Skeletons and object marking, Morphological segmentations and watersheds.

Course outcomes:

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

1. Understand the representation of the digital image and its properties.
2. Apply pre-processing techniques required to enhance the image for its further analysis.
3. Use segmentation techniques to select the region of interest in the image for analysis.

4. Represent the image based on its shape and edge information and also describe the objects present in the image based on its properties and structure.
5. Use morphological operations to simplify images, and quantify and preserve the main shape characteristics of the objects.

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:

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

Reference Books:

1. 'Digital Image Processing for Medical Applications', Geoff Doughertry, Cambridge university Press, 2010.
2. 'Digital Image Processing', S Jayaraman, S Esakkirajan, T Veerakumar, Tata McGraw Hill, 2011.

Array Signal Processing

CourseCode	**20ECS322**	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', PetreStoica 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/

Real Time Systems

CourseCode	**20ECS323**	CIEMarks	40
Lecture Hours/Week	**03**	SEE Marks	60
Total Number of LectureHours	**40**	Exam Hours	03
Credits - 03			

Module 1

Introduction to Real-Time Embedded Systems: Brief history of Real Time Systems, A brief history of Embedded Systems.
System Resources: Resource Analysis, Real-Time Service Utility, Scheduling Classes, The Cyclic Executive, Scheduler Concepts, Preemptive Fixed Priority Scheduling Policies, Real-Time OS, Thread Safe Re-entrant Functions.

Module 2

Processing: Preemptive Fixed-Priority Policy, Feasibility, Rate Monotonic least upper bound, Necessary and Sufficient feasibility, Deadline – Monotonic Policy, Dynamic priority policies.
I/O Resources: Worst-case Execution time, Intermediate I/O, Execution efficiency, I/O Architecture.
Memory: Physical hierarchy, Capacity and allocation, Shared Memory, ECC Memory, Flash file systems.

Module 3

Multi-resource Services: Blocking, Deadlock and livestock, Critical sections to protect shared resources, priority inversion.
Soft Real-Time Services: Missed Deadlines, QoS, Alternatives to rate monotonic policy, Mixed hard and soft real-time services.

Module 4

Embedded System Components: Firmware components, RTOSsystem software mechanisms, Software application components.
Debugging Components: Exceptions assert, Checking return codes, Single-step debugging, kernel scheduler traces, Test access ports, Trace ports, Power-On self-test and diagnostics.

Module 5

Performance Tuning: Basic concepts of drill-down tuning, hardware – supported profiling and tracing, Building performance monitoring into software, Path length.

High availability and Reliability Design: Reliability and Availability, Similarities and differences, Reliability, Reliable software, Available software, Design tradeoffs, Hierarchical applications for Fail-safe design.

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

1. Analyze Real time operating systems.
2. Distinguish a real-time system with other systems.
3. Describe the functions of Real time operating systems.
4. Demonstrate embedded system applications.
5. Design a Real Time operating 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:

"Real-Time Embedded Systems and Components", Sam Siewert, Cengage Learning India Edition, 2007.

Reference Books:

1. "Real time systems", Krishna CM and Kang Singh G, Tata McGraw Hill, ISBN: 0-07-114243-64, 2003.
2. "Real-Time Concepts for Embedded Systems", Qing Li and Carolyn Yao, CMP Books, ISBN:1578201241, 2003.
3. "Real Time Systems", Jane W. S. Liu, Prentice Hall, ISBN: 0130996513, 2000.
4. "Real-Time Systems Design and Analysis", Phillip A. Laplante, John Wiley & Sons, 2004.

RF MEMS

CourseCode	**20ECS324**	CIEMarks	40
Lecture Hours/Week	**03**	SEE Marks	60
Total Number of LectureHours	**40**	Exam Hours	03
Credits - 03			

Module 1

Review: Introduction to MEMS: Fabrication for MEMS transducers and actuators, Microsensing for MEMS, Materials for MEMS.
MEMS materials and fabrication techniques: Metals, Semiconductors, Thin films, Materials for polymer MEMS, Bulk machining for Silicon based MEMS, Surface machining for Silicon based MEMS, Micro stereo-lithography for polymer MEMS.

Module 2

RF MEMS Switches and micro-relays: Switch parameters, Basics of switching, Switches for RF and Microwave applications, Actuation mechanisms, Micro-relays and micro-actuators, Dynamic of switch operations, MEMS switch design and design consideration, MEMS inductors and capacitors.

Module 3

Micro machined RF filters and phase shifters: RF filters, Modelling of mechanical filters, Micro-mechanical filters, SAW filters - Basic, Design consideration. Bulk acoustic wave filters, Micro-machined filters for millimetre wave frequencies. Micro-machined phase shifters, Types and limitations, MEMS and Ferroelectric phase shifters, Applications.

Module 4

Micromachined transmission line and components: Micromachined transmission line: Losses in transmission line, coplanar lines, Microshield and membrane supported lines, Microshield components, Micromachined waveguides, Directional couplers and Mixers, Resonators and Filters.

Module 5

Micromachined antennas: design, Fabrication and measurements. Integration and packaging for RF MEMS. Roles and types of packages, Flip chip techniques, Multichip module packaging and Wafer bonding, Reliability issues and thermal issues.

Course outcomes:

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

1. Comprehend the need for micromachining and MEMS based systems for RF and microwave applications
2. Describe the micromachining techniques and their use in the fabrication of micro switches, capacitors and inductors
3. Design MEMS based microwave components aimed at reducing insertion loss and increasing bandwidth.
4. Realize high Q micromechanical filters for frequencies up to and beyond 10 MHz, and micromachined surface acoustic wave (SAW) filters filling the gap up to 2 GHz.
5. Describe the packaging approaches used for these RF 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:

'RF MEMS and their Applications', Vijay K Varadan, K. J. Vinoy and K. A. Jose, Wiley India Pvt. Ltd., ISBN - 10 : 8126529911, 2011.

Reference books:

1. 'RF MEMS circuit design', J De Los Santos, Artech House, 2002.
2. 'Transaction Level Modelling with System C: TLM concepts and applications for Embedded Systems', Frank Ghenassia, Springer, 2005.
3. 'Networks on chips: Technology and Tools', Luca Beninid, Morgan Kaufmann Publishers, 2006.

Professional elective 4

RF and Microwave Circuit Design

CourseCode	**20ECS331**	CIEMarks	40
Lecture Hours/Week	**03**	SEE Marks	60
Total Number of LectureHours	**40**	Exam Hours	03
Credits - 03			

Module 1

Wave propagation in networks: Introduction, Reasons for using RF/Microwaves, Applications, RF Waves, RF and Microwave circuit design, Introduction to Components Basics, Analysis of Simple Circuit in Phasor Domain, RF Impedance Matching, Transmission Media, High Frequency Parameters, Formulation of S-parameters, Properties of S-Parameters, Transmission Matrix, Generalized S-parameters.

Module 2

Smith chart and its Applications: Introduction, Smith Chart, Derivation of Smith Chart, Smith Chart Circular and Radial Scales, Application of Smith chart.

Module 3

Basic consideration in active networks:Stability Considerations – Stability Circles, Graphical and analytical solution of stability criteria;**Gain Considerations**– power gain concepts, mismatch factor, input and output VSWR, Maximum gain design, unilateral figure of merit; and **Noise Considerations** - sources of noise, noise model of a noisy resistor, equivalent noise temperature, noise figure, noise figure of cascaded networks, constant noise figure circles.

Module 4

RF/Microwave Amplifiers: Small Signal Design: Introduction, Types of amplifier, Design of different types of amplifiers

RF/Microwave Frequency Conversion: Mixers: Introduction, Mixer Types, Conversion Losses for SSB Mixers, SSB versus DSB mixers, One diode mixers, Two diode Mixers.

Module 5

RF/Microwave Control Circuit Design: Introduction, PN Junction Devices, Phase shifters, Digital phase shifters, Semiconductor phase shifters, PIN diode attenuators.

RF and Microwave IC design: MICs, MIC materials, Types of MICs, Hybrid verses Monolithic ICs, Chip mathematics

Course outcomes:

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

1. Discuss and analyze waves propagation in Networks
2. Apply the Smith Chart for finding various parameters in transmission lines
3. Analyze the basic considerations in active networks
4. Describe and design active networks
5. Design RF/MW Frequency Mixers and phase shifters

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:

'Radio Frequency and Microwave Electronics (Illustrated)', Matthew M. Radmanesh, Pearson India, 2015.

Reference Book:

'RF circuit design theory and applications', Reinhold Ludwig, and Pavel Bretchko, Pearson Education edition, 2004.

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’, ArshdeepBahga and Vijay Madisetti, Orient Blackswan Private Limited - New Delhi, First edition, 2015

Communication System design using DSP algorithm

CourseCode	**20ECS334**	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	**20ECS34**	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	**20ECS35**	CIEMarks	100
Number of contact Hours/Week	**02**	SEE Marks	--
		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.

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Internship / Professional Practice

CourseCode	**20ECSI36**	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 COMMUNICATION SYSTEMS/
DIGITAL COMMUNICATION & NETWORKING/
DIGITAL COMMUNICATION ENGINEERING/
DIGITAL ELECTRONICS & COMMUNICATION SYSTEMS/
DIGITAL ELECTRONICS & COMMUNICATION (ECS)

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

SEMESTER -IV

PROJECT WORK PHASE -2

CourseCode	**20ECS41**	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.