VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination – 2018-19
M.Tech in Communication Systems/ Digital Communication & Networking/ Digital Communication Engineering/ Digital Electronics & Communication Systems/ Digital Electronics & Communication (ECS)
Choice Based Credit System (CBCS)

I SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	18ELD11	Advanced Engineering Mathematics	04	--	03	40	60	100	4
2	PCC	18ECS12	Advanced Digital Signal Processing	04	--	03	40	60	100	4
3	PCC	18EVE13	Advanced Embedded System	04	--	03	40	60	100	4
4	PCC	18ECS14	Advanced Communication Systems-1	04	--	03	40	60	100	4
5	PCC	18ECS15	Advanced Communication Networks	04	--	03	40	60	100	4
6	PCC	18ECSL16	Advanced Digital Signal Processing Lab	-	04	03	40	60	100	2
7	PCC	18RMI17	Research Methodology and IPR	02	--	03	40	60	100	2
			TOTAL	**22**	**04**	**21**	**280**	**420**	**700**	**24**

Note: PCC: Professional core

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

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II SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	18ECS21	Advanced Communication Systems-2	04	--	03	40	60	100	4
2	PCC	18ECS22	Antenna Theory and Design	04	--	03	40	60	100	4
3	PCC	18ECS23	Error Control Coding	04	--	03	40	60	100	4
4	PEC	18XXX24X	Professional Elective 1	04	--	03	40	60	100	4
5	PEC	18XXX25X	Professional Elective 2	04	--	03	40	60	100	4
6	PCC	18ECSL26	Advanced Communication Lab	--	04	03	40	60	100	2
7	PCC	18ECS27	Technical Seminar	--	02	--	100	--	100	2
TOTAL				**20**	**06**	**18**	**340**	**360**	**700**	**24**

Note: PCC: Professional core, PEC: Professional Elective

Professional Elective 1		**Professional Elective 2**	
Course Code under 18XXX24X	**Course title**	**Course Code under 18XXX25X**	**Course title**
18ECS241	Wireless Sensor Networks	18ECS251	Multimedia Over Communication links
18EVE242	Nanoelectronics	18ESP252	Statistical Signal Processing
18ECS243	Cryptography and Network Security	18ELD253	Micro Electro Mechanical Systems

Note:

1. Technical Seminar: CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Participation in the seminar by all postgraduate students of the same and other semesters of the programme shall be mandatory.
The CIE marks awarded for Technical Seminar, shall be based on the evaluation of Seminar Report, Presentation skill and Question and Answer session in the ratio 50:25:25.

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

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III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	18ECS31	LTE 4G Broadband	04	--	03	40	60	100	4
2	PEC	18XXX32X	Professional Elective 3	04	--	03	40	60	100	4
3	PEC	18XXX33X	Professional Elective 4	04	--	03	40	60	100	4
4	Project	18ECS34	Evaluation of Project phase -1	--	02	--	100	--	100	2
5	Internship	18ECSI35	Internship	(Completed during the intervening vacation of I and II semesters and /or II and III semesters.)		03	40	60	100	6
TOTAL				12	02	12	**260**	**240**	**500**	**20**

Note: PCC: Professional core, PEC: Professional Elective

Professional Elective 3		**Professional Elective 4**	
Course Code under 18XXX32X	**Course title**	**Course Code under 18XXX33X**	**Course title**
18ECS321	Advances in Image Processing	18ECS331	RF and Microwave Circuit Design
18ESP322	Array Signal Processing	18ESP332	Pattern Recognition & Machine Learning
18ECS323	Real Time Systems	18ECS333	IoT

Note:
1. Project Phase-1: Students in consultation with the guide/co-guide if any, shall pursue literature survey and complete the preliminary requirements of selected Project work. Each student shall prepare relevant introductory project document, and present a seminar.
CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.
SEE (University examination) shall be as per the University norms.
2. Internship: Those, who have not pursued /completed the internship shall be declared as failed and have to complete during subsequent University examinations after satisfying the internship requirements. Internship SEE (University examination) shall be as per the University norms.

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IV SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks Viva voce	Total Marks	
1	Project	18ECS41	Project work Phase -2	--	04	03	40	60	100	20
			TOTAL	--	**04**	**03**	**40**	**60**	**100**	**20**

Note:

1. Project Phase-2:

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

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

FIRST SEMESTER SYLLABUS

ADVANCED ENGINEERING MATHEMATICS [As per Choice Based Credit System (CBCS) Scheme] SEMESTER – I			
Course Code	**18ELD11**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course objectives: This course will enable students to:

- To learn principles of advanced engineering mathematics through linear algebra and calculus of variations.
- To understand probability theory and random process that serve as an essential tool for applications of electronics and communication engineering sciences

Modules	**Revised Bloom's Taxonomy (RBT) Level**
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 Book:1).	**L1,L2**
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. Book:1).	**L1,L2**
Module -3	
Calculus of Variations : - Concept of functional-Eulers equation**.**Functionaldependent on first and higher order derivatives, Functional on several dependent variables. Isoperimetric problems-variation problems with moving boundaries. (Text.Book:2)	**L1,L2**
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-	**L1,L2**

Module -5	
Engineering Applications on Random processes:- Classification. Stationary, WSS and ergodic random process. Auto-correlation function-properties, Gaussian random process. (Text Book: 3)	**L1,L2**

Course Outcomes: After studying this course, students will be able to:

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

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

1. David C.Lay, Steven R.Lay and J.J.McDonald: "LinearAlgebra and its Applications", 5th Edition, Pearson Education Ltd., 2015
2. Elsgolts, L.:"Differential Equations and Calculus of Variations", MIR Publications, 3rd Edition, 1977.
3. T.Veerarajan: "Probability, Statistics and Random Process",3rd Edition,Tata Mc-Graw Hill Co.,2016.

Reference Books:

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

4. E. Kreyszig, “Advanced Engineering Mathematics”, 10th edition, Wiley, 2015.

Web links:

1. http://nptel.ac.in/courses.php?disciplineId=111
2. http://www.class-central.com/subject/math(MOOCs)
3. http://ocw.mit.edu/courses/mathematics/
4. www.wolfram.com

ADVANCED DIGITAL SIGNAL PROCESSING **[As per Choice Based Credit System (CBCS) Scheme** **SEMESTER – I**			
Course Code	**18ECS12**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50** **(10 Hours per Module)**	**Exam Hours**	**03**
Credits – 04			

Course objectives: This course will enable students to

- Understand Multirate digital signal processing principles and its applications.
- Estimate the various spectral components present in the received signal using different spectral estimation methods such as Parametric and Nonparametric.
- Design and implement an optimum adaptive filter using LMS and RLS algorithms.
- Understand the concepts and mathematical representations of Wavelet transforms.

Modules	**RBT Levels**
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)	L1, L2, L3
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)	L1, L2, L3
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)	L1, L2, L3
Module-4	
Power Spectrum Estimation: Non parametric Methods for Power Spectrum Estimation - Bartlett Method, Welch Method, Blackman and Tukey Methods.	L1, L2,

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)	L3
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)	L1, L2, L3

Course Outcomes: After studying this course, students will be able to:

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

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

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

ADVANCED EMBEDDED SYSTEM **[As per Choice Based Credit System (CBCS) scheme] SEMESTER – I**			
Subject	**18EVE13**	**CIE**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course objectives: This course will enable students to:

- Understand the basic hardware components and their selection method based on the characteristics and attributes of an embedded system.
- Describe the hardware software co-design and firmware design approaches
- Explain the architectural features of ARM CORTEX M3, a 32 bit microcontroller including memory map, interrupts and exceptions.
- Program ARM CORTEX M3 using the various instructions, for different applications.

Modules	**Revised Bloom's Taxonomy (RBT) Level**
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).	**L1, L2, L3**
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).	**L1, L2, L3**
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)	**L1, L2, L3**
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).	**L1, L2, L3**
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).	**L1, L2, L3**

Course Outcomes: After studying this course, students will be able to:

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

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

1. K. V. Shibu, "Introduction to embedded systems", TMH education Pvt. Ltd. 2009.

2. Joseph Yiu, “The Definitive Guide to the ARM Cortex-M3”, 2nd edn, Newnes, (Elsevier), 2010.

Reference Book:

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

Advanced Communications Systems -1(Theory & Practice)						
Course Code	**:**	**18ECS14**		**CIE Marks**	**:**	**40**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**60**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Understand different modulation, demodulation and equalization techniques and use them to analyze the error performance of digital modulation techniques in presence of AWGN noise.
2. Analyze and demonstrate the model of discrete time channel with ISI & the model of discrete time channel by equalizer.
3. Apply various types of equalizers used for channel modeling and adjusting the filter coefficients
4. Develop the concept of Spread Spectrum Communications over wideband channels.

Module -1	**10 Hrs**

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	**10 Hrs**

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	**10 Hrs**

Bandlimited Channels: Bandlimited channel characterization, signalling 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

Unit – IV	**10 Hrs**

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]

Unit – V	**10 Hrs**

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]

Expected Course Outcomes:

After going through this course the student will be able to:

- 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.
- Evaluate Receiver performance for various types of single carrier symbol modulations through ideal and AWGN Non-bandlimited and bandlimited channels.
- 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.
- 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.

Text Books

1.	John G. Proakis, MasoudSalehi,"Digital Communications ",5e,Pearson Education(2014),ISBN:978-9332535893

Reference Books

2.	Bernard Sklar,"Digital Communications: Fundamentals and Applications: Fundamentals &Applications",2e,Pearson Education(2009),ISBN:978-8131720929
3.	Simon Haykin ,"Digital Communications Systems",1e,Wiley(2014),ISBN:978-8126542314

ADVANCED COMPUTER COMMUNICATION NETWORKS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER –I

Subject Code	18ECS15	IA Marks	40
Number of Lecture Hours/Week	04	Exam Marks	60
Total Number of Lecture Hours	50 (10 Hours Per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to:

- Develop an awareness towards current practice in Networking
- Learn various aspects involved in wireless networks
- Develop an awareness regarding the Packet Processing ,Routing issues in computer networks
- Understand some of the shortest path routing protocols
- Develop an awareness towards the network control and traffic management
- Understand the congestion control and flow control mechanisms

Modules	Revised Bloom's Taxonomy
Module -1	
Functional Elements and Current Practice in Networking: Networking as Resource Sharing, Analogy with the Operating System of a Computer, The Functional Elements: Multiplexing, Switching, Routing, Network Management, Traffic Controls and Timescales, Current Practice: Network Infrastructure, Networking Architectures, Telephone and ISDN Networks, X.25 and Frame Relay Networks, The Internet, Asynchronous Transfer Mode (ATM) Networks. (Text 1)	**L1, L2, L3**
Module -2	
Wireless Networks: Bits over a Wireless Network, TCP Performance over Wireless Links, Adaptive and Cross-Layer Techniques, Random Access: Aloha, S-Aloha, and CSMA/CA, Wireless Local Area Networks, Wireless Ad Hoc Networks, Link Scheduling and Network Capacity, Scheduling Constraints, Centralized Scheduling, Capacity of a WANET, Wireless Sensor Networks: An Overview (Text 1)	**L1, L2, L3**
Module -3	
Packet Processing: Addressing and Address Lookup, Addressing, Addressing in IP Networks: Subnets and Classless Inter domain Routing, Efficient Longest Prefix Matching: Level-Compressed Tries, Hardware-Based Solutions, Packet Classification **Routing:** Engineering Issues, Shortest Path Routing of Elastic Aggregates, Elastic Aggregates and Traffic Engineering, Optimal Routing, Algorithms for Shortest Path Routing: Dijkstra's Algorithm, The Bellman–Ford Algorithm, Routing Protocols, Distance Vector Protocols, Link State Protocols.(Text 1)	**L1, L2, L3**
Module -4	

Traffic Management: Introduction, framework for traffic management, traffic models, traffic classes, traffic scheduling (Text 3). **Control of Networks:** Objectives and methods of control, routing optimization in circuit and datagram networks, Queuing models in circuit and datagram networks (Text 2).	**L1, L2, L3**
Module -5	
Congestion and flow control: Congestion control ,Window congestion control, Rate congestion control, control problems in ATM Networks (Text 2), flow control model, flow control classification, open loop flow control, closed loop flow control (Text 3).	**L1, L2, L3, L4**

Course outcomes: After studying this course, students will be able to:

- Choose appropriate Network Infrastructure and Networking Architectures which suits current practice in networking
- Identify the suitable random access methods which suits wireless networks
- Identify IP configuration for the network with suitable routing mechanisms
- Analyze and develop various network traffic management and control techniques
- Analyze and develop various congestion and flow control

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

1. Anurag Kumar, D. Manjunath, Joy Kuri, “Communication Networking : An Analytical Approach” , Morgan Kaufmann publications, ISBN: 0-12-428751-4, 2004.
2. J. Walrand and P. Varaya, "High performance communication networks", Harcourt Asia (Morgan Kaufmann), 2000.
3. S. Keshav “An Engineering Appproach to Computer Networking”, Pearson Education, ISBN: 978-81-317-1145-3, 2011.

Reference Book:

1. Andrew S Tanenbaum , “Computer Networks”, 4th edition , Pearson Education

Advanced Digital Signal Processing Lab **[As per Choice Based Credit System (CBCS) scheme]** **SEMESTER – I**			
Course Code	**18ECSL16**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**01Hr Tutorial (Instructions) + 03 Hours Laboratory**	**SEE Marks**	**60**
Total Number of Lecture Hours		**Exam Hours**	**03**

Credits – 02

Course objectives: This laboratory courseenables students to get practical Experience in Digital Signal processing ,analysis and realization of LTI systems .

Laboratory Experiments:	**RBT Levels**
01. Generate various fundamental discrete time signals.	L1, L2,L3
02. Basic operations on signals (Multiplication, Folding, Scaling).	
03. Find out the DFT & IDFT of a given sequence without using inbuilt instructions.	
04. Interpolation & decimation of a given sequence.	
05. Generation of DTMF (Dual Tone Multiple Frequency) signals.	
06. Estimate the PSD of a noisy signal using periodogram and modified periodogram.	
07. Estimation Of PSD using different methods (Bartlett, Welch, Blackman-Tukey).	
08. Design of Chebychev Type I,II Filters.	
09. 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: On the completion of this laboratory course, the students will be able to have hands on experience on,

- Filter design.
- Filter Realization
- Signal Manipulations
- Wavelet Transforms
- Estimating PSD using various techniques

Conduct of Practical Examination:

- All laboratory experiments are to be included for practical examination.
- The experiments can be conducted in Matlab or using any other related tools.
- Strictlyfollowtheinstructionsasprintedonthecoverpageofanswerscriptforbr eakupofmarks.
- Change of experiment is allowed only once and Marks allotted to the Procedure part will be made zero.

RESEARCH METHODOLOGY AND IPR

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER –I

Course Code	18RMI17	CIE Marks	40
Number of Lecture Hours/Week	02	Exam Hours	03
Total Number of Lecture Hours	25	SEE Marks	60
Credits - 02			

Course objectives:

- To give an overview of the research methodology and explain the technique of defining a research problem
- To explain the functions of the literature review in research.
- To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
- To explain various research designs and their characteristics.
- To explain the details of sampling designs, and also different methods of data collections.
- To explain the art of interpretation and the art of writing research reports.
- To explain various forms of the intellectual property, its relevance and business impact in the changing global business environment.
- To discuss leading International Instruments concerning Intellectual Property Rights.■

Module-1	**Teaching Hours/ RBT Level**
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. ■	**05** **L1, L2**
Module-2	

Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration. **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. ■	**05** **L1, L2**
Module-3	
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. **Design of Sample Surveys:** Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs. ■	**05** **L1, L2**
Module-4	
Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method. **Interpretation and Report Writing:** Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout. **Interpretation and Report Writing (continued):** of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports. ■	**05** **L1, L2, L3, L4**
Module-5	

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. ■	**05** **L1, L2, L3, L4**

Course outcomes:

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

- Discuss research methodology and the technique of defining a research problem
- Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.
- Explain various research designs and their characteristics.
- Explain the art of interpretation and the art of writing research reports
- Discuss various forms of the intellectual property, its relevance and

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

SECOND SEMESTER SYLLABUS

ADVANCED COMMUNICATIONS SYSTEMS -2 **[As per Choice Based Credit System (CBCS) scheme]** **SEMESTER – II**			
Course Code	**18ECS21**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
Credits – 04			

Course Learning Objectives (CLO):

Students shall be able to

1. Describe modelsfor fading channels, and concepts of diversity in time, frequency and space.
2. Demonstrate the concept of synchronization, maximal ratio combining, Rake Receivers, multicarrier OFDM and MIMO.
3. Analyze the capacity and error performance and implementation of maximal ratio combining, Rake receivers, OFDM and MIMO in presence of AWGN noise
   Design simple MIMO-OFDM system for a deterministic multipath channel.

Modules	**RBT Levels**
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]	**L1,L2**
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	**L1,L2**

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]	**L1,L2**
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 V-BLAST 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]	**L1,L2**

Expected Course Outcomes:

After going through this course the student will be able to:

- Explain the concepts of multi-channel signaling (including OFDM) scheme and synchronization for carrier and symbol timing recovery at receiver.
- Evaluate the capacity and degradation in performance of various symbol signaling schemes in a multipath fading environment.
- Develop & analyze schemes to improve performance in a multipath fading environment including maximal ratio combining, RAKE receivers, OFDM and MIMO.
- Develop and evaluate the performance of aOFDM MIMO scheme to meet specified rate in a given multipath environment.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.

- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

1. John G. Proakis, MasoudSalehi,"Digital Communications ",5e,Pearson Education(2014),ISBN:978-9332535893
2. David Tse, PramodViswanath, "Fundamentals of Wireless Communication",1e,Cambridge University Press(2005), ISBN:0521845270

Reference Books

Simon Haykin ,"Digital Communications Systems",Wiley(2014),ISBN:978-0-471-64735-5

ANTENNA THEORY AND DESIGN
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – I

Subject Code	**18ECS22**	**IA Marks**	**20**
Number of Lecture Hours/Week	**04**	**Exam Marks**	**80**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**

CREDITS – 04

Course objectives: This course will enable students to:

- Introduce and discuss different types of Antennas, various terminologies, excitations.
- Study different types of Arrays, Pattern-multiplication, Feeding techniques.
- Calculate gain of aperture antennas, Reflector antennas and analyze general feed model.
- Define, describe, and illustrate principle behind antenna synthesis.
- Introduction of Method of moments, Pocklington's integral equation, Source modeling.

Modules	**Revised Bloom's Taxonomy (RBT) Level**
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.	**L1,L2**
Module -2	
Arrays: Array factor for linear arrays, Uniformly excited equally spaced linear arrays, Pattern multiplication, Directivity of linear arrays, Non-uniformly 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.	**L1,L2,L3, L4**
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.	**L1,L2,L3, L4**

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.	**L1,L2,L3, L4**
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.	**L1,L2**

Course Outcomes: After studying this course, students will be able to:

- Classify different types of antennas
- Define and illustrate various types of array antennas
- Design antennas like Yagi-Uda, Helical antennas and other broad band antennas
- Describe different antenna synthesis methods
- Apply methods like MOM

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

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

Reference Books:

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

ERROR CONTROL CODING
[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER – 2

Subject Code	**18ECS23**	**CIE Marks**	**20**
Number of Lecture Hours/Week	**04**	**SEE marks**	**80**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**

CREDITS – 04

Course objectives: This course will enable students to:

- Understand the concept of the Entropy, information rate and capacity for the Discrete memoryless channel.
- Apply modern algebra and probability theory for the coding.
- Compare Block codes such as Linear Block Codes, Cyclic codes etc and Convolutional codes.
- Detect and correct errors for different data communication and storage systems.
- Implement different Block code encoders and decoders.
- Analyze and implement convolutional encoders and decoders.
- Analyze and apply soft and hard Viterbi algorithm for decoding of convolutional codes.

Modules	**RBT Level**
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 filed GF (2^m) arithmetic, Vector spaces and Matrices. (Chap. 2 of Text 2)	L1,L2,L3
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)	L1,L2,L3
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)	L1,L2,L3
Module 4	
BCH codes: Binary primitive BCH codes, Decoding procedures, Implementation of Galois field arithmetic. (Chap. 6 (6.1,6.2,6.7) of Text	

2) Primitive BCH codes over GF (q), **Reed -Solomon codes.** (Chap. 7 (7.2,7.3) of Text 2) **Majority Logic decodable codes**: One -step majority logic decoding, Multiple-step majority logic. (Chap. 8 (8.1,8.4) of Text 2)	L1,L2,L3
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)	L1,L2,L3

Course Outcomes: After studying this course, students will be able to:

- Analyse a discrete memoryless channel, given the source and transition probabilities.
- Apply the concept of modern linear algebra for the error control coding technique.
- Construct and Implement efficient LBC, Cyclic codes etc encoder and decoders.
- Apply decoding algorithms for efficient decoding of Block codes and Convolutional codes.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

4. David C.Lay, Steven R.Lay and J.J.McDonald: "LinearAlgebra and its Applications",
   5thEdition, Pearson Education Ltd., 2015
5. Elsgolts, L.:"Differential Equations and Calculus of Variations", MIR Publications, 3rd
   Edition, 1977.
6. T.Veerarajan: "Probability, Statistics and Random Process",3rd Edition,Tata Mc-Graw Hill
   Co.,2016.

Reference Books:

5. Gilbert Strang: Introduction to Linear Algebra, 5thEdition, Wellesley-Cambridge Press., 2016
6. Richard Bronson: "Schaum's Outlines of Theory and Problems of Matrix Operations", McGraw-Hill, 1988.
7. Scott L.Miller,DonaldG.Childers: "Probability and Random Process with application to Signal Processing", Elsevier Academic Press,2nd Edition,2013.
8. E. Kreyszig, "Advanced Engineering Mathematics", 10th edition, Wiley, 2015.

Professional Elective 1

Wireless Sensor Networks **[As per Choice Based Credit System (CBCS) scheme]** **SEMESTER – II**			
Course Code	**18ECS241**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**03**	**SEE Marks**	**60**
Total Number of Lecture Hours	**40 (08 Hours per Module)**	**Exam Hours**	**03**
Credits – 04/03			

Course Outcomes:

At the end of this course, students will be able to

- Design wireless sensor network system for different applications under consideration.
- Understand the hardware details of different types of sensors and select right type of sensor for various applications.
- Understand radio standards and communication protocols to be used for wireless sensor

Modules	RBT Levels
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)	L1, L2, L3
Module-2	
Factors InfluencingWSN 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)	L1, L2, L3
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)	L1, L2, L3

Module-4	
Transport Layer: Challenges for Transport Layer, Reliable Multi-Segment 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)	L1, L2, L3
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)	L1, L2, L3

Course Outcomes: After studying this course, students will be able to:

- Acquire knowledge of characteristics of mobile/wireless communication channels
- Apply statistical models of multipath fading
- Understand the multiple radio access techniques

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as see marks is 60.

Text books:

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

NANOELECTRONICS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject Code	**18EVE242**	**CIE**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**

CREDITS – 04

Course objectives: This course will enable students to:

- Enhance basic engineering science and technological knowledge of nanoelectron ics.
- Explain basics of top-down and bottom-up fabrication process, devices and systems.
- Describe technologies involved in modern day electronic devices.
- Appreciate the complexities in scaling down the electronic devices in the future.

Modules	**Revised Bloom's Taxonomy (RBT) Level**
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).	**L1, L2**
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, Reflectrometry, Techniques for property measurement: mechanical, electron, magnetic, thermal properties(Text1)	**L1,L2,L3**
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).	**L1-L3**
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, collidal 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).	**L1-L3**
Module -5	
Methods of measuring properties: atomic, crystollography, microscopy, spectroscopy (Text 2). **Applications**: Injection lasers, quantum cascade lasers, single-photon sources, biological tagging, optical memories, coulomb blockade devices, photonic structures, QWIP's, NEMS, MEMS (Text1).	**L1-L3**

Course outcomes: After studying this course, students will be able to:

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

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

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

Reference Book:

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

CRYPTOGRAPHY AND NETWORK SECURITY
[As per Choice Based credit System (CBCS) Scheme]
SEMESTER – II

Subject Code	**18ECS243**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours Per Module)**	**Exam Hours**	**03**

CREDITS – 04

Course Objectives: This course will enable students to:

- Understand the basics of symmetric key and public key cryptography.
- Understand some basic mathematical concepts and pseudorandom number generators required for cryptography.
- Authenticate and protect the encrypted data.
- Enrich knowledge about Email, IP and Web security.

Modules	**RBT Level**
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)	L1,L2,L3
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)	L1,L2,L3
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)	L1,L2, L3
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)	L1,L2,L3

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).	L1,L2, L3

Course Outcomes: After studying this course, students will be able to:

- Use basic cryptographic algorithms to encrypt the data.
- Generate some pseudorandom numbers required for cryptographic applications.
- Provide authentication and protection for encrypted data.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

1. William Stallings , "Cryptography and Network Security Principles and Practice", Pearson Education Inc., 6th Edition, 2014, ISBN: 978-93-325-1877-3

2. Bruce Schneier, "Applied Cryptography Protocols, Algorithms, and Source code in C", Wiley Publications, 2nd Edition, ISBN: 9971-51-348-X

Reference Books:

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

Professional Elective 2

MULTIMEDIA OVER COMMUNICATION LINKS [As per Choice Based credit System (CBCS) Scheme] SEMESTER – II			
Subject Code	**18ECS251**	**CIE Marks**	**20**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**80**
Total Number of Lecture Hours	**50 (10 Hours Per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course Objectives: This course will enable students to:

- Gain fundamental knowledge in understanding the basics of different multimedia networks, applications, media types like text and image.
- Analyse media types like audio and video and gain knowledge on multimedia systems.
- Analyse Audio compression techniques required to compress Audio.
- Analyse compression techniques required to compress video.
- Gain fundamental knowledge about the Multimedia Communications in different Networks.

Modules	**RBT Level**
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)	L1, L2, L3
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)	L1,L2, L3
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)	L1,L2, L3
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	L1,L2, L3

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).	L1,L2, L3

Course Outcomes: After studying this course, students will be able to:

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

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

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

Reference Book:

Raif steinmetz, Klara Nahrstedt, “Multimedia: Computing, Communications and Applications”, Pearson education, 2002, ISBN -9788177584417.

STATISTICAL SIGNAL PROCESSING
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – II

Course Code	**18ESP252**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**

Credits – 04

Course objectives: This course will enable students to:

- Understand random processes and its properties
- Understand the basic theory of signal detection and estimation
- Identify the engineering problems that can be put into the frame of statistical signal processing
- Solve the identified problems using the standard techniques learned through this course,
- Make contributions to the theory and the practice of statistical signal processing.

Modules	RBT Levels
Module-1	
Random Processes: Random variables, random processes, white noise, filtering random processes, spectral factorization, ARMA, AR and MA processes(Text 1).	**L1, L2**
Module-2	
Signal Modeling: Least squares method, Padé approximation, Prony's method, finite data records, stochastic models, Levinson-Durbin recursion; Schurrecursion; Levinsonrecursion(Text 1).	**L2, L3**
Module-3	
Spectrum Estimation: Nonparametric methods, minimum-variance spectrum estimation, maximum entropy method, parametric methods, frequency estimation, principal components spectrum estimation(Text 1).	**L1, L2**
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).	**L2, L3**
Module-5	
Array Processing: Array fundamentals, beam-forming, optimum array processing, performance considerations, adaptive beam-forming, linearly constrained minimum-variance beam-formers, side-lobe cancellers. (Text 2).	**L2, L3**

Course outcomes: After studying this course, students will be able to:

- Characterize an estimator.
- Design statistical DSP algorithms to meet desired needs
- Apply vector space methods to statistical signal processing problems
- Understand Wiener filter theory and design discrete and continuous Wiener filters
- Understand Kalman Filter theory and design discrete Kalman filters
- Use computer tools (such as Matlab) in developing and testing stochastic DSP algorithms

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Book:

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

MICRO ELECTRO MECHANICAL SYSTEMS
[As per Choice Based credit System (CBCS) Scheme]
SEMESTER – II

Subject Code	**18ELD253**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**

CREDITS – 04

Course Objectives: This course will enable students to:

- Know an overview of microsystems, their fabrication and application areas.
- Teach working principles of several MEMS devices.
- Develop mathematical and analytical models of MEMS devices
- Know methods to fabricate MEMS devices
- Expose the students to various application areas where MEMS devices can be used.

Modules	**RBT Level**
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.	L1, L2
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.	L1, L2
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.	L1,L2,L3
Module 4	
Scaling Laws in Miniaturization:	L1,L2,L3

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 Micro-manufacturing. **Microsystem Design:** Introduction, Design Considerations, Process Design, Mechanical Design, Using Finite Element Method.	L1,L2,L3

Course Outcomes: After studying this course, students will be able to:

- Understand the technologies related to Micro Electro Mechanical Systems.
- Describe the design and fabrication processes involved with MEMS devices.
- Analyse the MEMS devices and develop suitable mathematical models
- Understand the various application areas for MEMS devices

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Book:

Tai-Ran Hsu, MEMS and Micro systems: Design, Manufacture and Nanoscale Engineering, 2nd Ed, John Wiley & Sons, 2008. ISBN: 978-0-470-08301-7

Reference Books:

1. Hans H. Gatzen, Volker Saile, JurgLeuthold, Micro and Nano Fabrication: Tools and Processes, Springer, 2015.
2. Dilip Kumar Bhattacharya, Brajesh Kumar Kaushik, Micro electromechanical Systems (MEMS), Cenage Learning.

ADVANCED COMMUNICATION LAB
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – II

Laboratory Code	**18ECSL26**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**01Hr Tutorial (Instructions)+ 03 Hours Laboratory**	**SEE Marks**	**60**
		Exam Hours	**03**

CREDITS – 02

Course objectives: This laboratory course enables students to get practical experience in

- Radiation pattern of antennas.
- Determining gain and directivity of a given antenna.
- Working of Klystron source.
- S-parameters of some microwave passive devices.

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.	**Revised Bloom's Taxonomy (RBT) Level**
1. Matlab/C implementation to obtain the radiation pattern of an antenna.	L3,L4
2. Study of radiation pattern of different antennas.	L2, L3
3. Determine the directivity and gains of Horn/ Yagi/ dipole/ Parabolic antennas.	L3,L4
4. Impedance measurements of Horn/Yagi/dipole/Parabolic antennas.	L3,L4
5. Study of radiation pattern of E & H plane horns.	L2, L3
6. Significance of Pocklington's integral equation.	L1,L2
7. Study of digital modulation techniques using CD4051 IC.	L2, L3
8. Conduct an experiment for Voice and data multiplexing using optical fiber.	L3,L4
9. Determination of the modes transit time, electronic timing range and sensitivity of Klystron source.	L3, L4
10. Determination of VI characteristics of GUNN diode, and measurement of guide wave length, frequency, and VSWR.	L3,L4
11. Determination of coupling coefficient and insertion loss of directional couplers and Magic tree.	L3,L4
12. Build a hardware pseudo-random signal source and determine statistics of the generated signal source.	L1,L2,L3,L4

Course outcomes: On the completion of this laboratory course, the students will be able to:

- Plot the radiation pattern of some antennas using Matlab and wave guide setup
- Obtain the S-parameters of Magic tee and directional couplers.
- Test the IC CD4051 for modulation techniques.
- Study 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.

THIRD SEMESTER SYLLABUS

LTE 4G Broadband **[As per Choice Based Credit System (CBCS) Scheme]** **SEMESTER – III**			
Subject Code	**18ECS31**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours Per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course objectives: This course will enable students to:

- Explain the system architecture of LTE and E-UTRAN as per the standards
- Understand the Multiple Access process incorporated in the radio physical layer.
- Associate MAC of LTE radio interface protocols to set up, reconfigure and release the Radio Bearer and for transferring to the EPS bearer.
- Explain the mobility principles and procedures in the idle and active state.
- Analyse the main factors affecting LTE performance including mobile speed and

Modules	**RBT Level**
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.	**L2, L3**
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.	**L2, L3**
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.	**L1, L2, L3**
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.	**L2, L3**
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.	**L1, L2, L3**

Course outcomes:

- Understand the system architecture and the function standard specified components of the system of LTE 4G.
- 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.
- Demonstrate the UTRAN and EPS handling processes from set up to release including mobility management for a variety of data call scenarios.
- Test and Evaluate the Performance of resource management and packet data processing and transport algorithms.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Book:

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

Reference Books:

1. 'Fundamentals of LTE', by Arunabha Ghosh, Jun Zhang, Jeffrey G. Andrews), Rias Muhamed, 1st Edition, Sept 2010, Prentice Hall Communications Engineering and Emerging Technologies Series from Ted Rappaport,ISBN13: 9780137033119, ISBN10: 0137033117.
2. ' LTE – The UMTS Long Term Evolution ; From Theory to Practice' by Stefania Sesia, Issam Toufik, and Matthew Baker, 2009 John Wiley & Sons Ltd, ISBN 978-0-470-69716-0.

Professional Elective 3

Advances in Image Processing **[As per Choice Based credit System (CBCS) Scheme** **SEMESTER – III**			
Subject Code	**18ECS321**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours Per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course Objectives: This course will enable students to:

1. Acquire fundamental knowledge in understanding the representation of the digital image and its properties
2. Equip with some pre-processing techniques required to enhance the image for further analysis purpose.
3. Select the region of interest in the image using segmentation techniques.
4. Represent the image based on its shape and edge information.
5. Describe the objects present in the image based on its properties and structure.

Modules	**RBT Level**
Module 1	
The image, its representations and properties: Image representations a few concepts, Image digitization, Digital image properties, Color images.	L1
Module 2	
Image Pre-processing: Pixel brightness transformations, geometric transformations, local pre-processing.	L1, L2
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.	L1, L2, L3
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.	L1, L2, L3
Module 5	
Mathematical Morphology: Basic morphological concepts, Four morphological principles, Binary dilation and erosion, Skeletons	L1, L2, L3

and object marking, Morphological segmentations and watersheds.	

Course Outcomes: After studying this course, students 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.
5.Describe the objects present in the image based on its properties and structure.
6.Use morphological operations to simplify images, and quantify and preserve the main shape characteristics of the objects.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

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

Reference Books:

1. Geoff Doughertry, Digital Image Processing for Medical Applications, Cambridge university Press, 2010
2. S.Jayaraman, S Esakkirajan, T.Veerakumar, Digital Image Processing, Tata McGraw Hill, 2011.

Array Signal Processing **[As per Choice Based Credit System (CBCS) scheme]** **SEMESTER – III**			
Course Code	**18ESP322**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
Credits – 04			

Course Objectives: This course will enable students to:

- Understand various aspects of array signal processing.
- Explain the Concepts of Spatial Frequency along with the Spatial Samplings
- Describe array design methods and direction of arrival estimation techniques.

Modules	**RBT Level**
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.	**L1,L2**
Module 2	
Wave number-Frequency Space Spatial Sampling: Spatial Sampling Theorem-Nyquist Criteria, Aliasing in Spatial frequency domain, Spatial sampling of multidimensional signals.	**L1,L2**
Module 3	
Sensor Arrays: Linear Arrays, Planar Arrays, Frequency – Wave number Response and Beam pattern, Array manifold vector, Conventional Beam former, Narrowband beam former.	**L1,L1**
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.	**L1,L1**
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.	**L2,L3**

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

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

- Understand the important concepts of array signal processing
- Understand the various array design techniques
- Understand the basic principle of direction of arrival estimation techniques

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

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

Reference Books:

1. Don H. Johnson Dan E. Dugeon, "Array Signal Processing: Concepts and Techniques", Prentice Hall Signal Processing Series, 1st Edition ,ISBN-13: 978-0130485137.
2. Petre Stoica and Randolph L. Moses "Spectral Analysis of Signals" Prentice Hall, 2005,ISBN: 0-13-113956-8.
3. Sophocles J. Orfanidis, "Electromagnetic Waves and Antennas", ECE Department Rutgers University, 94 Brett Road Piscataway, NJ 08854-8058. http://www.ece.rutgers.edu/~orfanidi/ewa/

Real Time Systems **[As per Choice Based credit System (CBCS) Scheme** **SEMESTER – III**			
Subject Code	**18ECS323**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours Per Module)**	**Exam Hours**	**03**

CREDITS – 04

Course Objectives: This course will enable students to:

- Understand basics of Real Time systems.
- Distinguish a real-time system with other systems.
- Identify the functions of operating system
- Evaluate the need for Real time operating system.
- Design and develop embedded applications by means of real-time operating systems.

Modules	**RBT Level**
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.	L1, L2
Module 2	
Processing: Preemptive Fixed-Priority Policy, Feasibility, Rate Montonic 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.	L1, L2
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.	L1, L2
Module 4	
Embedded System Components: Firmware components, RTOS system 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.	L1, L2, L3

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.	L1, L2, L3

Course Outcomes: After studying this course, students will be able to:

- Analyze Real time operating systems.
- Describe the functions of Real time operating systems.
- Demonstrate embedded system applications.
- Design a Real Time operating system.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Book:

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

Reference Books:

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

Professional Elective 4

RF AND MICROWAVE CIRCUIT DESIGN [As per Choice Based Credit System (CBCS) Scheme] SEMESTER – III			
Subject Code	**18ECS331**	**IA Marks**	**40**
Number of Lecture Hours/Week	**04**	**Exam marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
CREDITS – 04			

Course Objectives: This course will enable students to

- Understand waves propagating in Networks.
- Use the Smith Chart for various applications.
- Understand the basic considerations in active networks
- Design active networks.
- Understand RF/MW Frequency Mixer and Phase Shifter Design

Modules	**RBT Level**
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.	L1,L2
Module 2	
Smith chart and its Applications: Introduction, Smith Chart, Derivation of Smith Chart, Smith Chart Circular and Radial Scales, Application of Smith chart.	L1,L2
Module 3	
Basic consideration in active networks: Stability Considerations, Gain Considerations and Noise Considerations.	L1,L2
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.	L1,L2,L3
Module 5	
RF/Microwave Control Circuit Design: Introduction, PN Junction Devices, Phase shifters, Digital phase shifters,	L1,L2,L3

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: After studying this course, students will be able to:

- Discuss and analyse waves propagation in Networks
- Apply the Smith Chart for finding various parameters in transmission lines
- Analyse the basic considerations in active networks
- Describe and design active networks
- Design RF/MW Frequency Mixers and phase shifters

Question paper pattern:

- The question paper will have 10 full questions carrying equal marks.
- Each full question consists of 16 marks with a maximum of four sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Book:

Matthew M. Radmanesh, "RF and Microwave Electronics Illustrated", Pearson Education edition, 2004.

Reference Book:

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

PATTERN RECOGNITION and MACHINE LEARNING **[As per Choice Based Credit System (CBCS) scheme]** **SEMESTER – III**			
Course Code	**18ESP332**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**
Credits – 04			

Course objectives: The objective of the course is to discusses main and modern concepts for model selection and parameter estimation in recognition, decision making and statistical learning problems. Special emphasis will be given to regression, classification, regularization, feature selection and density estimation in supervised mode of learning.

Modules	**RBT Levels**
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)**	**L1,L2**
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)**	**L1,L2,L3**
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)**	**L1,L2,L3**
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,	**L1,L2,L3**

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)**	**L1,L2,L3**

Course Outcomes: At the end of this course, students will be able to

- Identify areas where Pattern Recognition and Machine Learning can offer a solution.
- Describe the strength and limitations of some techniques used in computational Machine Learning for classification, regression and density estimation problems.
- Describe and model data.
- Solve problems in Regression and Classification.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Book:

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

IoT

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Course Code	**18ECS333**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**

Credits – 04

Course objectives: This course will enable students to:

- Introduce concept of IOT and its applications in today's scenario.
- Understand IOT content generation and transport through networks
- Understand the devices employed for IOT data acquisition and communication access technologies
- Introduce some use cases of IOT

Module-1	**RBT**
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.	**L1, L2**
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	**L2,L3**
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 Cat0, Cat-M, NB-IOT	**L2,L3**

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.	**L3,L4**
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.	**L3,L4**

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Course Outcomes: After studying this course, students will be able to:

- Understand the basic concepts IOT Architecture and devices employed.
- Analyze the sensor data generated and map it to IOT protocol stack for transport.
- Apply communications knowledge to facilitate transport of IOT data over various available communications media.
- 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.

Text Book:

Cisco, IOT Fundamentals – Networking Technologies, Protocols, Use Cases for IOT, Pearson Education; First edition (16 August 2017). ISBN-10: 9386873745, ISBN-13: 978-9386873743

Reference Books:

Arshdeep Bahga and Vijay Madisetti, 'Internet of Things – A Hands on Approach', Orient Blackswan Private Limited - New Delhi; First edition (2015), ISBN-10: 8173719543, ISBN-13: 978-8173719547