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UNIVERSITY OF MUMBAI

Revised Syllabus for the

M. E. (Electronics and Telecommunication Engineering)

Programme: M.E.

Course: Electronics and Telecommunication Engineering

(As per Credit Based Semester and Grading System with effect from the academic year 2012–2013)

University of Mumbai
Program Structure for
ME Electronics and Telecommunication Engineering
(w.e.f. A.Y. 2012-2013)

Semester I

Subject Code	Subject Name	Teaching Scheme (Contact Hours/week)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC101	Statistical Signal Analysis	04	--	--	04	--	--	04
ETC102	Optical Fiber Communication#	04	--	--	04	--	--	04
ETC103	Digital Signal Processing and its Applications	04	--	--	04	--	--	04
ETE101X	Elective I	04	--	--	04	--	--	04
ETE102X	Elective II	04	--	--	04	--	--	04
ETL101	Laboratory I - Optical Fiber Communication	--	02	--	--	01	--	01
ETL102	Laboratory II - Modeling and Simulation of Communication System	--	02	--	--	01	--	01
Total		**20**	**04**	**--**	**20**	**02**	**--**	**22**

Subject Code	Subject Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem.Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
ETC101	Statistical Signal Analysis	20	20	20	80	03	--	--	100
ETC102	Optical Fiber Communication#	20	20	20	80	03	--	--	100
ETC103	Digital Signal Processing and its Applications	20	20	20	80	03	--	--	100
ETE101X	Elective I	20	20	20	80	03	--	--	100
ETE102X	Elective II	20	20	20	80	03	--	--	100
ETL101	Laboratory I - Optical Fiber Communication	--	--	--	--	--	25	25	50
ETL102	Laboratory II - Modeling and Simulation of Communication System	--	--	--	--	--	25	25	50
Total		**100**	**100**	**100**	**400**	**--**	50	**50**	**600**

Subject Code	Elective I	Subject Code	Elective II
ETE1011	Image and Video Processing and Broadcasting	ETE1021	Speech Processing
ETE1012	Modeling and Simulation of Communication System	ETE1022	Micro Electro Mechanical Systems
ETE1013	VLSI and Mixed Signal Circuits and System	ETE1023	Embedded System**$**
ETE1014	Advanced Satellite Communication	ETE1024	Next Generation Networks

#and$- Common for Electronics and Telecommunication Engineering and Electronics Engineering

Semester II

Subject Code	Subject Name	Teaching Scheme (Contact Hours/week)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC201	Advanced Digital Communications	04	--	--	04	--	--	04
ETC202	Mobile and Wireless Communications	04	--	--	04	--	--	04
ETC203	Microwave and Millimeter wave Communication Systems	04	--	--	04	--	--	04
ETE201X	Elective III	04	--	--	04	--	--	04
ETE202X	Elective IV	04	--	--	04	--	--	04
ETL201	Laboratory III – Mobile and Wireless Communications	--	02	--	--	01	--	01
ETL202	Laboratory IV - Advanced Antenna and Arrays	--	02	--	--	01	--	01
Total		**20**	**04**	**--**	**20**	**02**	**--**	**22**

Subject Code	Subject Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem.Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
ETC201	Advanced Digital Communications	20	20	20	80	03	--	--	100
ETC202	Mobile and Wireless Communications	20	20	20	80	03	--	--	100
ETC203	Microwave and Millimeter wave Communication Systems	20	20	20	80	03	--	--	100
ETE201X	Elective III	20	20	20	80	03	--	--	100
ETE202X	Elective IV	20	20	20	80	03	--	--	100
ETL201	Laboratory III - Mobile and Wireless Communications	--	--	--	--	--	25	25	50
ETL202	Laboratory IV - Advanced Antenna and Arrays	--	--	--	--	--	25	25	50
Total		**100**	**100**	**100**	**400**	**--**	**50**	**50**	**600**

Subject Code	Elective III	Subject Code	Elective IV
ETE2031	Adaptive Signal Processing	ETE2041	Wavelets
ETE2032	Nano-electronics	ETE2042	Cloud Computing
ETE2033	Advanced Antenna and Arrays	ETE2043	Sensor Array Networks
ETE2034	Optical Networks	ETE2044	Network Security

Semester III

Subject Code	Subject Name	Teaching Scheme (Contact Hours/week)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETS301	Seminar	--	06	--	--	03	--	03
ETD301	Dissertation I	--	24	--	--	12	--	12
Total		--	30	--	--	15	--	15

Subject Code	Subject Name	Examination Scheme						
		Theory				Term Work	Pract. / Oral	Total
		Internal Assessment			End Sem.Exam.			
		Test1	Test 2	Avg.				
ETS301	Seminar	--	--	--	--	50	50	100
ETD301	Dissertation I	--	--	--	--	100	--	100
Total		--	--	--	--	**150**	**50**	**200**

Semester IV

Subject Code	Subject Name	Teaching Scheme (Contact Hours/week)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETD401	Dissertation II	--	30	--	--	15	--	15
Total		--	30	--	--	15	--	15

Subject Code	Subject Name	Examination Scheme						
		Theory				Term Work	Pract. / Oral	Total
		Internal Assessment			End Sem.Exam.			
		Test1	Test 2	Avg.				
ETD401	Dissertation II	--	--	--	--	100	100	200
Total		--	--	--	--	**100**	**100**	**200**

Note:

- In case of Seminar (ETD301), 01 Hour / week / student should be considered for the calculation of load of a teacher
- In case of Dissertation I (ETD301) and Dissertation II (ETD401), 02 Hour / week / student should be considered for the calculation of load of a teacher

Subject Code	Subject Name	Credits
ETC101	**Statistical Signal Analysis**	**04**

Module	Detailed content	Hours
1	**Review of following topics** • Basic concepts of probability theory (definitions, conditional probability, independent of events, sequential experiments) • Random variables (cumulative distribution function, probability density function, some important random variables, functions of random variables, the expected value of random variable, transform methods) • Multiple random variables (vector random variables, conditional probability and conditional expectation, joint distribution, independence, functions of several random variables, expected value of functions of random variables) • Sums of random variables (mean, variance, &pdf of random variables, the central limit theorem proof, confidence intervals)	14
2	**Random processes** • Definition of random process • Specifying a random process • Examples of discrete- and continuous-time random processes • Stationary random processes • Time averages of random processes &ergodic theorems	10
3	**Analysis and processing of random signals** • Power spectral density • Response of linear systems to random signals • Amplitude modulation by random signals • Optimum linear systems • The Kalman filter	10
4	**Markov chains** • Markov processes • Discrete Markov chains • Continuous time Markov chains	06
5	**Introduction to queueing theory** • The elements of queueing system • Little's formula • The M/M/1 queue • Multi-server systems • Finite-source queueing systems • M/G/1 queueing systems	08

Text & Reference Books:

Text Books:

1. *Probability and Random Processes for Electrical Engineer* byAlberto Leon-Garcia, *Pearson Education*, 2007 (2^{nd}ed).
2. *Probability and Random Processes with Applications to Signal Processing & Communications* by Scott L. Miller and Donald G. Childers, *Academic Press*, 2004.
3. *Probability, Random Variables and Stochastic Processes* by A. Papoulis and S.U. Pillai, 4th Edition, McGraw-Hill, 2002.
4. *Probability and Random Processes with Applications to Signal Processing* by H. Stark and J.W. Woods, 3e, Pearson Education.

Reference Book:

1. *Random Processes: A Mathematical Approach for Engineers* by R. M. Gray and L. D. Davisson , Prentice-Hall, Englewood Cliffs, N.J., 1986.

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students.Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
ETC102	**Optical Fiber communication**	**04**

Module	Detailed content	Hours
1	**A Review of Optical Fibers** • Introduction • Ray theory • Theory of optical wave propagation • Classification of optical fibers • Signal Degradation • Non Zero Dispersion Shifted Fibers • Plastic optical fibers • Splicing efficiency and optical fiber alignment • Fiber optic cable	04
2	**Advanced Optical Sources and Detectors** • Quantum well lasers • Charge capture in Quantum well lasers • Multi Quantum well Laser diodes • Surface Emitting Lasers: Vertical cavity Surface Emitting Lasers • Resonant cavity enhancement (RCE) Photo Detector • Material requirement for RCEPD • Wavelength selectivity • High speed comparison of conventional and RCEPD • RCE Schottky Photodiode • RCE Avalanche Photodiode	08
3	**Optical Amplification** • Properties of Erbium Doped glass • Optical Pumping • Erbium Doped Amplifier • Semiconductor Laser Amplifier • Raman Amplifier • Raman Gain and Bandwidth • Multiple pump Raman Amplifier • Raman Induced signal gain • Noise Figure of Raman Amplifier • Optical Signal to noise ratio • Electrical Signal to noise ratio • Application	08
4	**Integrated Optics** • Planar and channel waveguides • Coupled mode theory for waveguides • Beam Splitters, Directional couplers and Photonic Switch • Optical Modulators • Arrayed waveguide Grating (AWG) • Multimode interference coupler (MMI) • Opto Electronic Integration • Fabrication Techniques • Material	06

5	**Non linear Optics** • General Overview of nonlinearties • Effective area and length • Stimulated Raman Scattering • Stimulated Brillouin Scattering • Self Phase modulation • Cross –Phase modulation • Four wave mixing and its mitigation • Solitons • Properties of Solitons • Loss managed Soliton • Dispersion managed Soliton • Dispersion Management: • Dispersion problems and its solution, • Dispersion compensating Fibers ,its design, • Fiber Brag Grating, • Dispersion Equalizing Filters • Optical Phase conjugation • PMD Compensation	10
6	**Optical Networks** • Network concepts • Network Topologies • FDDI • SONET/SDH • DWDM Networks	06
7	**Advanced Topics in OFC:** • Biophotonics • Optical computing • Optical MEMS • Photonics Crystals Fibers and Waveguides	06

#-Common for Electronics and Telecommunication Engineering and Electronics Engineering

Text & Reference Books:

1. "Optical Fiber Communications"-Gerd Keiser-Fourth Edition-TATA McGRAW HILL
2. "Fiber Optics Communication System"-G.P.Agarwal-Wiley Publications
3. "An Introduction to Fiber Optic Systems"-John Power-McGrawHill-
4. "Fiber Optics Communications"- Harold Kolimbris-Pearson Education
5. "Optical Fiber Communications Principles and Practice"-John.M.Senior-Pearson Education
6. "Fundamentals of Optoelectronics"-Pollock-Irwin Publications
7. "Opto-Electronics, an introduction"-Wilson and Hawkes,Prentice Hall
8. "Nonlinear Fiber Optics" G.P.Agarwal-Academic Press
9. "An Introduction to Nonlinear Optics"-Geoffrey New-Cambridge University Press
10. "Photonic Crystal Fibers"-Anders,Bjarkler and JesBrong-Kluwer Academic Publishers
11. "Optical Fiber Communication System: Theory and Practice with MATLAB and Simulink" by Le Nguyen Binh, CRC Press, 2010
12. "Introduction to Biophotonics", Paras N. Prasad, Wiley-Interscience, 2003

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End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students.Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
ETC103	**Digital Signal Processing and its Applications**	**04**

Module	Detailed content	Hours
1	**Review of following topics with relevant numerical examples** • A typical real-time DSP system • DFT, its computation (DIT & DIF algorithms), & important properties • FIR filter design– Window & frequency sampling method • IIR filter design – Impulse invariant & Bilinear z-transform method • Realization structures for FIR & IIR filters	14
2	**Multirate DSP** • Introduction & concept of multirate processing • Design of practical sampling rate converters • Sample rate conversion using polyphase filter structure	08
3	**Spectrum estimation & analysis** • Introduction • Principles of spectrum estimation • Traditional methods • Modern parametric estimation methods • Autoregressive spectrum estimation	08
4	**General- and special-purpose digital signal processors** • Introduction • Computer architecture for signal processing • General purpose digital signal processors • Selecting digital signal processors • Special purpose DSP hardware	06
5	**Analysis of finite wordlength effect in fixed-point DSP systems** • Introduction • DSP arithmetic • ADC quantization noise & signal quality • Finite wordlength effects in IIR & FIR digital filters	08
6	**Overview of real-world applications of DSP** • Audio applications of DSP • Telecommunication applications of DSP • Biomedical applications of DSP	04

Text & Reference Books:

Text Books:

1. Digital Signal Processing, A Practical Approach by Emmanuel C. Ifeachor, Barrie W. Jervis, *Pearson Education*
2. Discrete Time signal Processing by Alan V. Oppenheim, Ronald Schafer, *Pearson Education*
3. Digital Signal Processing, Principles, algorithms and applications - J. Proakis, D. G. Manolakis, D. Sharma, *Pearson Education*

Reference Books:

1 Fundamentals of Digital Signal Processing using MATLAB- Robert Schilling, Sandra Harris, *Cengage Learning*
2. Digital Signal Processing, S. K. Mitra, *Tata McGraw Hill Publication 2001*
3. Digital Signal Processing by Chen, OxfordUniversity Press
4. A Practical Approach to Digital Signal Processing, Padmanabhan K., New Age International

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Subject Code	Subject Name	Credits
ETL101	**Optical Fiber Communication**	**01**

Module	Detailed content
	Simulation of the Following
1	Designing of Single mode fiber
2	Designing of Planar Channel waveguides
3	Designing of AWG
4	Designing of Fiber Brag Grating
5	Designing of MZI modulator
6	Performance analysis of Optical Link upto 40 Gbps
7	Performance Analysis of Optical Link with Different Sources
8	Performance Analysis of Optical Link with Different Detectors
9	Performance Analysis of Optical Amplifier
10	Performance Analysis of DWDM System
11	Performance Analysis ofSoliton Communication System
12	Designing of Optical MEMS

- Out of 12 Modules any 8 Modules have to be performed.

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners

Subject Code	Subject Name	Credits
ETL102	**Modeling and Simulation of Communication System**	**01**

Module	Detailed content
1	Study and Analysis of different types of Analog Communication Circuit using Simulation Software (any two circuits)
2	Study and Analysis of different of Digital Communication Systems using Simulation Software (any three)
3	Study and Analysis of Frequency hopped Spread Spectrum System
4	Study and Analysis of Direct Sequence Spread Spectrum System
5	Study and Designing of Equalizers for Digital Communication
6	Study of Eye Pattern using Simulation
7	Study and Implementation of Convolution Codes using Simulation
8	Study and Implementation of Cyclic Codes using Simulation Method
9	Study and Implementation of Linear Block Codes using Simulation
10	Study and Implementation of Optimum Receiver used for Digital Communication
11	Study and Implementation of Lempel Algorithm using Simulation
12	Study and Design of Band Limited Signals with controlled ISI

- Out of 12 Modules any 8 Modules have to be performed.

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners

Subject Code	Subject Name	Credits
ETE 1011	**Image and Video Processing and Broadcasting**	**04**

Module	Detailed Content	Hours
1	**Digital Signal Processing,Frequency Domain Image Filtering and Enhancement:** 2-D signals and systems, 2D symmetry and periodicity,2D DFT, symmetry and other properties, 2-D FIR filters, frequency response, circular symmetry, Visual Perception and Color Spaces (1 week) Physiological characteristics of the eye and image formation, Human color vision	10
2	**Spatial Domain Image Enhancement and Filtering& Restoration:** Image decimation and interpolation, multi-resolution pyramids Image sampling, Spatio-temporal (M-D) sampling theory Edge detection, Image enhancement, Noise filtering, Image restoration:Image degradation model , Inverse Filtering , Wiener filtering	10
3	**Fundamentals of image Compression Entropy coding:** Lossless image compression, JPEG image compression, JPEG-2000 image compression, Multi-resolution and Wavelet Transform	8
4	**Video Processing:** Video sampling, flicker, spatial frequency response, Motion modeling and estimation, Optical flow modeling and estimation, Block matching, feature matching, Parametric motion estimation, Video filtering , Deinterlacing, Denoising)	8
5	**Video Compression & Broadcasting Standards:** MC-DCT video compression: MPEG-1, MPEG-2 video compression, H.263/MPEG-4 video compression: Compression efficiency, MPEG-4 AVC/H.264 video compression, Scalable video coding (SVC), Error-resilient compression, Video over IP	8
6	**Color models:** Color models: CIE, RGB, CMYK, HSI, HSV, L*a*b*	4

Text & Reference Books:

Text Books:

1. **Handbook of Image and Video Processing**, Ed. Al Bovik, Academic Press, 2000. ISBN 0-12-119790-5
2. **Digital Image Processing**, Gonzalez and Woods, Addison-Wesley, 2001. ISBN 0201-18075-8

Reference Books:

1. **Multidimensional Signal, Image and Video Processing and Coding,** J. W. Woods, Academic Press, 2006. ISBN 0-12-088516-6
2. **Video Processing and Communications,** Y. Wang, J. Ostermann, and Y.-Q. Zhang, Prentice Hall, 2002. ISBN 0-13-017547-1
3. **Digital Video Processing,**A. M. Tekalp, Prentice Hall, 1995. ISBN 0-13-190075-7

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Subject Code	Subject Name	Credits
ETE 1012	**Modeling and Simulation of Communication System**	**04**

Module	Detailed content	Hours
1	**Introduction:** Concept of simulation and modeling, Roles of Simulation, Types of Simulation, Limits of Simulation, Simulation Languages (High Level versus Low Level), Real-time Simulation	08
2	**Simulation Methodology** Problem solving in Simulation Environment, Performance evaluation techniques, Parameters Estimation, What-if Questions, Design, Validation … Error Sources in Simulation, Validation, Consistency …. Replication, Elimination of Initial Bias, Variance Reduction Techniques Design of Simulation Experiment: Data Stream Selection, Simulation Length of Run, Simulation Sampling Frequency	08
3	**Digital Issues in Simulation** Quantization, Number representation, Underflow, Overflow, Processing Delay, Signal Scaling	08
4	**Generation of Data Signals, Random Numbers and Processes** Data Sources, Symbol Mapping, Pulse Shaping, Pseudo Random Numbers, Generation of Random Numbers, Generation of Random Variables using Common Distributions, Generation of Random Processes, Generation of Correlated Noise.	08
5	**Representation of Signals and Systems in Simulation** Analog / Discrete, Baseband / Passband, Deterministic / Stochastic, Time Domain / Frequency Domain … Elements of Communication Systems, Basic building blocks	08
6	**Monte Carlo Methods** Fundamental Concepts, Monte Carlo Estimations, Monte Carlo Integration, Convergence,	08

Text & Reference Books:

1. "Principles of Communication systems Simulation with Wireless Applications", W.H. Tranter, K.S. Shanmugan, T.S. Rappaport, K.L. Kosbar, Prentice Hall, 2004, ISBN 0-13-494790-8.
2. "Simulation of Communication Systems, Modeling, Methodology and Techniques", M.C. Jeruchim, P.Balaban, K.S. Shanmugan, Cluwer Academic Publishers, 2nd Edition 2002, ISBN 0-306-46267-2.

References:

1. “Simulation Techniques, Models of Communications, Signals and Process”, F.M. Gardner, J.D. Baker, John Wiley & Sons Inc. 1997, ISBN 0-471-51764-9

2. “Contemporary Communication Systems Using Matlab and Simulink”, J.G. Proakis, M.Salehi, G.Bauch, CL-Engineering 2003, ISBN 0-534-40617-3.

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Subject Code	Subject Name	Credits
ETE1013	**VLSI and Mixed Signal Circuits and System**	**04**

Module	Detailed Content	Hours
1	**Motivation forAMS Design:** Review of Moore's law and CMOS scaling, benefits of system-on-chip integration in terms of cost, power, and performance. Comparison on System-on-Board, System-on-Chip, and System-in-Package. Typical goals in AMS design – cost reduction, power reduction, design effort reduction, performance maximization. Productivity gap issues and the ways to improve the gap – IP based design and design reuse.	6
2	**Basics of Digital CMOS Design:** Combinational MOS Logic circuits-Introduction, CMOS logic circuits with a MOS load, CMOS logic circuits, complex logic circuits, Transmission Gate. Sequential MOS logic Circuits - Introduction, Behaviour of hi stable elements, SR latch Circuit, clocked latch and Flip Flop Circuits, CMOS D latch and triggered Flip Flop. Dynamic Logic Circuits - Introduction, principles of pass transistor circuits, Dynamic CMOS circuit techniques	10
3	**Basics of Analog CMOS Design:** Basic integrated circuit building blocks, switches, active resistors, current source and sink, passive and active current mirror ,differential amplifier, output amplifier, two stage operational amplifier(OTA) analysis and design	10
4	**Analog signal Processing circuits :** Switched capacitive circuits –General considerations, sampling switches ,Switched capacitor amplifier and integrator . Oscillator - types of oscillator, Voltage controlled oscillator . Simple PLL -Phase detector, Basic PLL topology ,Dynamics of PLL, Charged pump PLL	12
5	**Short channel effects and device models:** Scaling theory, short channel effects, MOS device models: Level1, Level2 and Level3,BSIM . Analog design in the digital world	5
6	**AMS Design Flow:** Design rules,Analog layout techniques, verification and integration, hardware-software co-design, interconnects, power management problems, and packaging related problems.	5

Text & Reference Books:

Text Books:

1.P. Uyemura, **Introduction to VLSI Circuits and Systems**, John Wiley & Sons, 2002.

2.Neil Weste and K. Eshragian, **Principles of CMOS VLSI Design: A System Perspective**, 2nd edition, Pearson Education (Asia) Pte. Ltd., 2000.

3. B. Razavi, **Design of Analog CMOS Integrated Circuits**, Tata McGraw Hill 2002

4.David A Johns, Ken MartinR. Jacob Baker,**CMOS: Mixed-Signal Circuit Design**,John Wiley & Sons,

5. Phillip E. Allen, Douglas R. Holberg, **CMOS analog circuit design**,"Oxford University Press, 2002.

6.Sung Mo Kang &YosufL, **CMOS Digital Integrated Circuits: Analysis and Design**, McGraw-Hill (Third Edition)

7. Wayne, Wolf, "**Modern VLSI design: System on Silicon" Pearson Education**", Second Edition

Reference Books:

1. Jan M Abaey, **Digital integrated Circuits :A design perspective**, Prentice Hall of India Pvt Ltd .

2. R. JacbobBaker ,**CMOS circuit design, layout and simulation**, Wiley Publication

3.Yuan Taur**, Fundamentals of Modern VLSI Devices**, Cambridge University Press

4. Douglas A Pucknell& Kamran Eshragian,**Basic VLSI Design**, PHI 3rd Edition (original Edition – 1994)

5. R. Best,**Phase Locked Loops**, second edition, New york;McGraw hill,1999

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Subject Code	Subject Name	Credits
ETE 1014	**Advanced Satellite Communication**	**04**

Module	Detailed content	Hours
1	**Introduction:** • Origin of satellite communication, • Development, Space segment,Ground segment, • Types of orbit, • Evolution of satellite communications,Development of service.	08
2	**Link Analysis:** • Characteristic parameters of an antenna, Received signal power at receiver input, • Carrier to noise ratio fat the receiving input, Influence of the propagation medium, • Compensation for the effects of the propagation medium constraints, Signal to noise ratio for a station-to-station link	10
3	**Regenerative Satellite Networks** • Transparent and regenerative repeaters, • Comparison of link budgets on board processing, Impact to the earth segment. **Orbits** • Keplerian orbitsUseful orbits for satellite communication. • Perturbations of the orbits.	10
4	**Earth Stations** : • Station organization, Radio frequency characteristics, Antenna subsystems, • Radio frequency subsystem, Communication subsystem.	08
5	**Communication Payload** • Mission and characteristics of the payload, • Transparent repeaters, Multibeam satellite repeaters, Regenerative – repeater , • Antenna coverage, Antenna Characteristics. **Platform** • Subsystems, Attitude control, Propulsion subsystem, Electric power supply, Telemetry, tracking and command, Thermal control and structure.	08
6	**Satellite Installation And Space Environment** • Installation in orbit, Vacuum,Mechanical environment, Radiation flux of high energy particles, Environment during installation, Satellite system availability, Component reliability.	08

Text & Reference Books:

1. Satellite Communication Systems Techniques and Technology (3rd edition, Maral and M. Bousquet. John Wiley and sons

2. VASAT Networks G. Maral, John Wiley and sons

3. Satellite Communication. Firs quarter century of service David W.E. Rees John Wiley and Sons

4. Satellite Communications Systems Design principles – Richard M. McGraw Hill

5. CDMA, Principles of Spread Spectrum Communication – Andrew J Virebi, Addision – wiley 1995.

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End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students.Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
ETE1021	**Speech Processing**	04

Module	Contents	Hours
1	**SPEECH PRODUCTION AND ACOUSTIC PHONETICS** The process of speech production, Acoustic theory of speech production, Digital models of speech signals of speech signal,Articulator phonetics, Acoustic Phonetics, Co- articulation, Prosody	**10**
2	**SPEECH ANALYSIS** Time and frequency domain analysis of speech, Linear predictive coding (LPC) analysis, Cepstral analysis, Speech parameter (pitch) estimation,	**08**
3	**SPEECH SYNTHESIS** Principles of speech synthesis, Articulatory synthesis, Formant synthesis and LPC synthesis	**06**
4	**CODING OF SPEECH SIGNALS** Introduction, Quantization, Speech redundancies, Time domain waveform coding, Linear predictive coding, Linear delta modulation, Adaptive delta modulation, Adaptive differential pulse code modulation, Filter bank analysis, Phase vocoders and Channel vocoders	**10**
5	**SPEECH ENHANCEMENT** Introduction, Nature of interfering sounds, speech enhancement techniques, spectral subtraction and filtering, harmonic filtering, Spectral subtraction, Adaptive noise cancellation	**06**
6	**SPEECH RECOGNITION** Introduction, Baye's rule, Segmental feature extraction, MFCC, DTW, HMM approaches for speech recognition	**08**

Recommended Books:

Text:

1. Speech Communications: Human & Machine, Douglas O'Shaughnessy, Universities Press.
2. Digital Processing of Speech Signals, Rabiner and Schafer, Prentice Hall, 1978.

References

1. Discrete-Time Speech Signal Processing: Principles and Practice , Thomas F. Quatieri , Publisher: Prentice Hall
2. Speech and Audio Signal Processing : Processing and Perception of Speech and Music , Nelson Morgan and Ben Gold, John Wiley & Sons
3. Speech Analysis Synthesis and Perception, J. L. Flanagan, Second edition, Springer-Verlag (1972).
4. Speech and Audio Signal Processing, Gold & Morgan, 1999, Wiley and Sons

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Subject Code	Subject Name	Credits
ETE1022	**Micro Electro Mechanical Systems**	**04**
Module	**Detailed content**	**Hours**
1	**SWITCHING:** RF MEMS relays and switches: Switch parameters, Actuation mechanisms, Bistable relays and micro actuators, Dynamics of switching operation.	**9**
2	**COMPONENTS – I:** MEMS inductors and capacitors: Micromachined inductor, Effect of inductor layout, Modeling and design issues of planar inductor, Gap tuning and area tuning capacitors, Dielectric tunable capacitors.	**9**
3	**COMPONENTS - II** MEMS phase shifters: Types. Limitations, Switched delay lines, Micromachined transmission lines, coplanar lines, Micromachined directional coupler and mixer.	**10**
4	**FILTERS** Micromachined RF filters: Modeling of mechanical filters, Electrostatic comb drive, Micromechanical filters using comb drives, Electrostatic coupled beam structures.	**10**
5	**ANTENNAS** Micromachined antennas: Microstrip antennas – design parameters, Micromachining to improve performance, Reconfigurable antennas.	**10**

REFERENCES:

1. V.K.Varadanetal, RFMEMS and their Applications,John Wiley & Sons, Ltd, 2003.
2. H.J. De LOS SANTOS, RF MEMS circuit Design for Wireless Communications, Artech House, 2002.
3. G.M.REBEIZ, RF MEMS Theory, Design and Technology, John Wiley& Sons, Ltd, 2003.

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Subject Code	Subject Name	Credits
ETE1023	**Embedded Systems**	**04**

Module	Detailed content	Hours
1	**EMBEDDED ARCHITECTURE** Embedded Computers – Characteristics of Embedded Computing Applications – Challenges in Embedded Computing system design- Embedded memories – Embedded System design process – Requirements – Specification – Architectural Design – Designing Hardware and Software Components – System Integration –Design Example	04
2	**EMBEDDED PROCESSOR AND COMPUTING PLATFORM** MSP 430 RISC Controllers, parallel I/O, external interrupts. ARM processor fundamentals – introduction to ARM and THUMB instruction set--processor and memory organization – CPU Bus configuration – ARM Bus –Memory devices – Input/output devices – Component interfacing – designing with microprocessor development and debugging –Design Example. Instruction set with enhanced DSP features with ARM core, mix mode programming as Thumb+ ARM core, Assembly programming concept, compare with ARM7, ARM9, ARM11 with new features additions.	08
3	**INTERFACING** Sensors and interfacing techniques, Analog interfacing and data acquisition , Timing generation and measurements, --Distributed Embedded Architecture – Networks for Embedded Systems- serial bus protocols like I2C, RS485, CAN and USB--wireless protocols and interfacing of IRDA and SMART card – Design Example wireless protocols and interfacing of IRDA and SMART card – Serial communications: I2C – CAN Bus – Design Example	08
4	**REAL TIME CONCEPTS** Real-time concepts, hard and soft real time systems, real-time operating systems, Required RTOS services/capabilities (in contrast with traditional OS). Resource Management/scheduling paradigms: static priorities, static schedules, dynamic scheduling Real-world issues: blocking, unpredictability, interrupts, caching, Examples of OSs for embedded systems	08
5	**SYSTEM DESIGN** Design Methodologies – Requirement Analysis – Specification – System Analysis and Architecture Design – modeling techniques --Testing and debugging ---Quality Assurance – Design Example: Data base applications (smart cards), process-control (Fuzzy logic), robotics (wireless), CCD camera (data compression), network appliances (e-server), MSP 430 applications e.g. electricity metering, wireless communication, capacitive touch screen as examples of embedded systems.	08

$- Common for Electronics and Telecommunication Engineering and Electronics Engineering

References:

1. Introduction to Embedded Systems, Jonathan W. Valvano , Cengage 2009,
2. ARM System Developer's Guide, 1st Edition, Sloss&Symes& Wright , 2004, Morgan Kaufmann
3. Embedded Real Time Systems: Concepts, Design & Programming, Dr.K.V.K.K. Prasad, Dreamtech Publication.
4. Introduction to embedded systems, shibu k v, 2009, McGraw-Hill
5. An Embedded Software Primer, David E. Simon, Pearson Education Publication.
6. Embedded Systems-James K Peckol(Wiley)
7. Embedded Systems Design, 2nd Edition, S Heath, 2002 , Newnes Publication
8. Building Parallel, Embedded, and Real-Time Applications with Ada, John W. McCormick Frank Singhoff , JérômeHugues , Cambridge University Press
9. TEXAS MSP430, ARM Technical Publications
10. Embedded system design by Frank Vahid& Tony Givargis, Pearson Education
11. KriteeRamamritham – Real Time Operating Systems, IEEE Press

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Subject Code	Subject Name	Credits
ETE1024	**Next Generation Networks**	**04**

Module	Detailed Content	Hours
1	**ITU NGN standards and architectures --** Main drivers to Next Generation Networks – NGN , ITU NGN standards	**04**
2	All-IP network concept for NGN , NGN control architectures and protocols (TISPAN)	**06**
3	Numbering, naming and addressing for all NGN	**04**
4	**NGN Services:Technology,Business and Regulatory Aspects ---** Services and service capabilities in NGN (VoIP,IPTV, rich multimedia, future web) , Quality of Service (QoS), Quality of Experience (QoE) in NGN	**06**
5	Control and Signaling protocols for NGN (SIP,Diameter) , NGN security (AAA, identity management) , Service convergence , Business and regulatory aspects of NGN	**04**
6	**Mobile Next Generation Networks** Next Generation Mobile Networks (LTE, WiMaXAdvanced) , Fixed-Mobile Convergence (FMC) in NGN, IP Multimedia Subsystem (IMS) for NGN	**06**
7	Mobility Management in NGN (terminal, personal, session, and service mobility), Next Generation mobile services (mobile TV, Mobile rich multimedia, presence, location-based and content-based services	**06**
8	**Transition to NGN and future evolution**: Migration of PSTN networks to NGN , Transition of IP networks to NGN , Carrier grade open environment	**06**
9	NGN business challenges , Future packet based network (IPv6 NGN) , NGN evolution	**06**

Text & Reference Books :

Text Books :

1. Wireless Communications - Theodore S. Rappaport, Prentice Hall of India, PTR publication
2. Principles of Wireless Networks-KavehPahlavan, Prashant Krishnamurthy, PHI
3. Wireless communication and Networking-Vijay Garg, ELSEVIER Inc.
2 TCP/IP Protocol Suite -Forouzan-Fourth Edition-Tata Mc

Reference Books:

1. Wireless Communication - Singal_- TMH
2. Next Generation Wireless Systems and Networks: Hsiao – Hwa Chen, Mohsen Guizani – Wiley
3. Wireless and Mobile Networks-Concepts and protocols: DrSunilkumar S. Manvi, Mahabaleshwar S. Kakkasageri-- Wiley
4. IP-Based Next-Generation Wireless Networks: Systems, Architectures, and Protocols- **Jyh- Cheng Chen** and Tao Zhang- Wiley
5. Fundamentals of Wireless Communication- David Tse**&**PramodViswanath- Cambridge University press

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Subject Code	Subject Name	Credits
ETC 201	**Advanced Digital Communications**	**04**

Module	Detailed content	Hours
1	**Source coding** • Average ,mutual information & entropy • Coding for discrete sources • The Lempel algorithm • Coding for analog sources temporal waveform coding • Spatial waveform coding	08
2	**Coherent Communication with waveforms** • Optimum waveform receivers in white Gaussain Noise • Optimum waveform receivers in coloured Gaussain Noise • In Phase an quadarate modulation & demodulation • Derivation of the symbol error probability for polyphase signals	08
3	**Non -Coherent Communication with waveforms** • Non –coherent receivers in random phase channels • Performance of non coherent receivers in random phase channels • Non coherent receivers in random amplitude & phase channels. • Perfornace of non-coherent receivers on random amplitude & phase channels • Useful probability density functions	08
4	**Signal Design for Band limited Channel** • Nyquist criteria for zero ISI • Design of band limited signals with controlled ISI • Data detection for controlled ISI	08
5	**Optimum Detection & Estimation** • Noise vector in signal space • Bayes detection of received signal • Optimum MRA receiver signal • Decision region & minimum error probability • Optimum detection of severalspecial comm. signals	08
6	**Estimation- Non linear & linear estimation** • Fading Channels • Signal time spreading • Time variance of channel caused by motion • Mitigating the degradation effects of fading • Application of mitigating the effects of frequency selective trading	08

Text & Reference Books:

1. Digital Communication by John G.Proakis,3rd Edition McGraw –Hill International Editions.
2. Digital Communication Techniques Signal Design & Detection by Marvin K. Simon, Sami M Hindei, William C Lindesy , PHI Learning Private Limited.
3. Digital Communications, 2nd Edition Fundamental & Application by Bernard Sklar, Pabitra Kumar Ray, Pearson Publication.

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Subject Code	Subject Name	Credits
ETC 202	**Mobile and Wireless Communications**	**04**

Module	**Detailed content**	**Hours**
1	**Digital Cellular Mobile System** • Introduction to Mobile communication system. • GSM, The EuropeanTDMA Digital cellular standard. • IS-136 the North AmericanTDMA • PDC the Japanese TDMA • IS-95 The North American COMA	06
2	**IMT -2000 Third Generation Mobile Communication System** • Introduction • 2.5 G TDMA Evolution Path • GPRS Technology • EDGE Technology • 2.5G CDMA one cellular N/W • Need of 3G Cellular N/w • IMT 2000 Global Standard • UNITS Technology • W-CDMA Aire interface • TD-SCDMA Technology • CDMA 2000 Cellular Technology	08
3	**Cellular Antenna System Design Consideration** • Antenna Characteristics • Antennas at cell cite • Mobile Antennas • Design of Omni –directional Antenna cellular system • Design of Directional Antenna cellular system	08
4	**Equalisation,Diversity and channel coding** • Fundamentals of Equalisation • Algorithms for adaptive equalization • Diversity Techniques • RAKE Recivers • Fundamental of channel coding	10
5	**Intelligent Cell concept and application** • Intelligent cell concept • Application of intelligent Microcell systems • In building communication • CDMA Cellular Radio Network	08

6	**Emerging Wireless Network Technology** • IEEE 802.11 WLAN • ETSI HIPER LAN Technology • IEEE 802.15 WPAN Technology • IEEE 802.16 WMANTechnology • Mobile Adhoc Network • Mobile IP and Mobility Management • Mobile TCP • Wireless Sensor Networks • RFID Technology	08

Text & Reference Books:

1) Mobile & Personal Communication system & Services by Raj Pandya , Prentice –Hall of India (PHI) Private Limited
2) Wireless Communication by T.L..Signal ,Tata McGraw Hill Publication.
3) Wireless Communication Principles & Practice by Rappaport Theodore S., Pearson education 2nd edition.

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Subject Code	Subject Name	Credits
ETC203	**Microwave and Millimeter Wave Communication Systems**	**04**
Module	**Detailed content**	**Hours**
1	**MICROWAVE RADIO SYSTEM**: Transmitter & receivers block diagram, FM microwave repeater, diversity protection switching microwave terminal station, repeater station Microwave links: Block diagram, path characteristics, system gain, free space path loss, S/N ratio.	8
2	**MILLIMETER WAVE CHARACTERISTICS**: Millimeter Wave Characteristics, Channel Performance at 60 GHz, Gigabit Wireless Communications, Development of Millimeter Wave Standards, Coexistence with Wireless Backhaul. REVIEW OF MODULATIONS FOR MILLIMETER WAVE COMMUNICATIONS: On/Off Keying (OOK), Phase Shift Keying (PSK), Frequency Shift Keying (FSK), Quadrature Amplitude Modulation (QAM), Orthogonal Frequency Division Multiplexing (OFDM).	6
3	**MILLIMETER WAVE TRANSCEIVERS**: Millimeter Wave Link Budget, Transceiver Architecture, Transceiver Without Mixer, Receiver Without Local Oscillator, Millimeter Wave Calibration, Research Trend: Transceiver Siliconization.	4
4	**MILLIMETER WAVE ANTENNAS**: Path Loss and Antenna Directivity, Antenna Beamwidth, Maximum Possible Gain-to-Q, Polarization, Beam Steering Antenna, Millimeter Wave Design Consideration, Production and Manufacture. MILLIMETER WAVE MIMO: Spatial Diversity of Antenna Arrays, Multiple Antennas, Multiple Transceivers, Noise Coupling in a MIMO System.	10
5	**ADVANCED DIVERSITY OVER MIMO CHANNELS**: Potential Benefits for Millimeter Wave Systems, Spatial and Temporal Diversity, Spatial and Frequency Diversity, Dynamic Spatial, Frequency, and Modulation Allocation.	4

6	**ADVANCED BEAM STEERING AND BEAM FORMING**: The Need for Beam-Steering/Beam-Forming, Adaptive Frame Structure, Advanced Beam Steering Technology, Advanced Antenna ID Technology, Advanced Beam Forming Technology.	4
7	**SINGLE-CARRIER FREQUENCY DOMAIN EQUALIZATION**: Advantages of SC-FDE over OFDM for Millimeter Wave Systems, Preamble Design, Adaptive Channel Estimation, Frequency Domain Equalization, Decision Feedback Equalization.	6

References

1. Millimeterwave communication systems.
   Huang K., Wang Z., Wiley-IEEE Press, 2011
2. Advanced Electronic Communication Systems. W Tomasi , PHI, 1988
3. Electronic Communication Systems, II Edition,Roy Blake Thomsar
4. Electronic Communication, Kemealy & Dakis, TMH

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Subject Code	Subject Name	Credits
ETL201	**Mobile and Wireless Communications**	**01**

Module	Detailed content
1	Study of GSM Technology using Simulation Software
2	Study of CDMA Technology using Simulation Software
3	Study of 3G Technology like WCDMA using Simulation Software
4	Case study of Sim Card
5	Case study of Mobile Handset used for 2G and 3G Technology
6	Case study of Frequency Planning in 2G Technology
7	Case study of Close Loop and Open Loop Power Control of Mobile Phone in 2G Technology
8	Case study on In-building Solutions
9	Study and Implementation of WLAN using Simulation Method
10	Study and Implementation of WPAN using Simulation Method
11	Case Study for RFID Technology
12	Study and Implementation of RAKE Receiver using Simulation Method

- **Out of 12 Modules any 8 Modules have to be performed.**

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners

Subject Code	Subject Name	Credits
ETL202	**Advanced Antenna and Arrays**	**01**

Module	Detailed content
1	Design and Analysis of Half and Full Dipole Antenna
2	Radiation Pattern for the Broadside and End Fire Array
3	Simulation and Understanding the Pattern Multiplication Technique in End Arrays
4	Synthesis of Antenna for Low Side Lobes and Narrow Beam.
5	Design and Simulation of Rectangular and Circular Microstrip Antenna
6	Simulation of Broadband Antennas
7	Design and Simulation of Shorted Microstrip Antenna
8	Simulation of Radiation Pattern for Monopole Antennas
9	Smart Antennas for Cell Phone / Mobile Phones
10	Case Study for the Antennas using Satellite Communication
11	Case Study for the Antennas using Radar Communication
12	Case Study for the Antennas using Navigation and Instrument Landing System

- **Out of 12 Modules any 8 Modules have to be performed.**

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners

Subject Code	Subject Name	Credits
ETE2031	**Adaptive Signal Processing**	**04**

Module	Contents	Hours
1	**INTRODUCTION TO ADAPTIVE SYSTEMS AND BASICS OF ESTIMATIONTHEORY** Definitions, Characteristics, Applications, Examples of adaptive systems, Gradient error, least absolute deviation, least mean square minimization, Mean square error, Cramer Rao bound, Maximum likelihood estimate(MLE)	**08**
2	**NON ADAPTIVE FILTERS** Wiener filtering, LLSE, Principle of orthogonality, Wiener-Hopf equation, Solution of Wiener Hopf equation, Error performance surface and MMSE. Levinson filtering, Levinson-Predictor, Levinson-Durbin Recursion, Gram-Schmidt orthogonalisation, Kalman filtering and its derivation	**10**
3	**ADAPTIVE FILTERS** Principle of adaptive filters, Method of steepest decent, Newton's type of algorithm, LMS algorithm and its applications, Convergence of LMS algorithm, Normalized LMS(NLMS),RLS algorithm, convergence analysis of RLS algorithm, Application of RLS algorithm	**15**
4	**ADAPTIVE EQUALISATION** Decision feedback equalizer, Adaptive blind equalizer, Sato algorithm, Constant modulus algorithm, CM equalizer and carrier tracking	**10**
5	**APPLICATION OF ADAPTIVE FILTERS** Echo cancellation, Equalisation of data communication channels, Linear predictive coding and Noise cancellation	**05**

Recommended Books:

Text:

1. Adaptive Filter Theory, S. Haykin, Prentice-Hall, 4-th edition
2. Statistical and Adaptive Signal Processing, Manolakis, D. G., Ingle, V. K., and Kogon, S. M. (2005), Artech House INC., 2005.

References

3. Adaptive Signal Processing, B. Widrow, S. Stearns, Prentice-Hall, 1985
4. Adaptive signal processing – Theory and Applications , S Thomas Alexander,Springer-Verlag
5. Adaptive filters- A H Sayed, John Wiley

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Subject Code	Subject Name	Credits
ETE2032	**Nano-electronics**	**04**

Module	Detailed content	Hours
1	Review of VLSI: basic CMOS Process flow, MOS Scaling theory, Issues in scaling MOS transistors, Short channel effects,Introduction to Nano electronics, requirements for Non classical MOS transistor, Nano devices, Nano materials, Nano characterization.	06
2	MOS capacitor, Role of interface quality and related process techniques, Gate oxide thickness scaling trend, SiO2 vs High-k gate dielectrics. Integration issues of high-k.Interface states, bulk charge, band offset, stability, reliability, CV and IV techniques.	10
3	Metal gate transistor: Motivation, requirements, Integration Issues.Transport in Nano MOSFET, velocity saturation, ballistic transport, injection velocity, velocity overshoot.	06
4	SOI - PDSOI and FDSOI.Ultrathin body SOI - double gate transistors, integration issues. Circuit Design with SOI. SOI based SRAM design.	08
5	Vertical transistors - FinFET and Surround gate FET. Carbon nanotube electronics, bandstructure & transport, devices, applications. Circuit design with FinFET and CNTFET. SRAM design.	12
6	Germanium Nano MOSFETs: strain, quantization, Advantages of Germanium over Silicon, PMOS versus NMOS. Compound semiconductors - material properties, MESFETs Compound semicocnductors MOSFETs in the context of channel quantization and strain, Hetero structure MOSFETs exploiting novel materials, strain, quantization.	06

Text & Reference Books:

Text Books:

1. *FinFETs and Other Multigate Transistors*, Jean-Pierre Colinge, Springer.
2. *Nanoelectronic Circuit Design*,Niraj K. Jha, Deming Chen, Springer.
3. *SOI Circuit Design Concepts*, Kerry Bernstein and N. J. Rohrer, Kluwer Academic Publishers.
4. *Silicon VLSI Technology*, Plummer, Deal , Griffin , Pearson Education India.

Reference Books:

1. *The Physics of Low-Dimensional Semiconductors*, John H. Davies, Cambridge University Press.
2. *Fundamentals of Modern VLSI Devices*, Y. Taur and T. Ning, Cambridge University Press

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Subject Code	Subject Name	Credits
ETE2033	**Advanced Antennas and Arrays**	**04**
Module	**Detailed content**	**Hours**
1	**Review of wired antennas:** Antenna Parameters, Infinitesimal dipole antenna, half wave half wave dipole antenna, small loop antenna, helical antenna.	**3**
2	**ANTENNA ARRAYS** N element linear arrays – uniform amplitude and spacing- - Directivity of Broadside and End fire arrays. Three dimensional characteristics - Pattern multiplication- Binomial arrays and Dolph- Tchebycheff arrays. Circular array. Mutual coupling in arrays, multidimensional arrays- phased arrays and array feeding techniques.	**8**
3	**ANTENNA SYNTHESIS** Synthesis problem-Line source based beam synthesis methods - Fourier transform and Woodward-Lawson sampling method – Linear array shaped beam synthesis method – Low side lobe, narrow main beam synthesis methods-discretization of continuous sources. Schelkunoff polynomial method.	**7**
4	**Microstrip antennas:** Introduction,Rectangular Patch, Circular Patch, Quality Factor, Bandwidth, and Efficiency,Input Impedance,Coupling, Circular Polarization, Arrays and Feed Networks, Corporate and Series Feeds, Reflectarray.	**6**

5	**Broadband microstrip antennas** Introduction, Mechanism of Parasitic Coupling for Broad BW, Gap-Coupled RMSAs, Radiating-Edge Gap-Coupled RMSAs, Nonradiating-Edge Gap-Coupled RMSAs, Gap- and Hybrid-Coupled MSA,Multilayer Broadband MSA, Electromagnetically Coupled MSAs, stack multi resonator MSA , Design Examples.	**6**
6	**Compact microstrip antennas** Introduction, Compact Shorted RMSAs, Partially Shorted RMSAs, Effect of Dimensions of RMSAs with a Single Shorting Post, Effect of the Position of the Single Shorting Post, Compact Shorted CMSA and Its Variations.	**6**
7	**Planar monopole antennas** Introduction, Planar Rectangular and Square Monopole Antennas, RMSA Suspended in Air with Orthogonal Ground Plane, Calculation of the Lower Frequency of the Planar Monopole Antennas, Effect of Various Parameters of Planar Rectangular Monopole Antennas, Radiation Pattern of RM Antennas, Various Planar RMs with Equal Areas, Planar Circular Monopole Antennas.	**6**
8	**Smart antennas** Introduction, Smart-Antenna Analogy, Cellular Radio Systems Evolution, Signal Propagation,Smart Antennas' Benefits and draw backs,Antenna Beam forming, Multiple-Input Multiple-Output (MIMO) System, Reconfigurable Arrays	**6**

References

1. 1.Broadband Microstrip antennas – Girish Kumar and K.P. Ray, Artech House
2. Antenna Theory- C. A. Balanis- Wiley and sons
3. Antennas – John. D. Krauss- TMH ed.
4. Antenna Arrays: A Computational Approach' By Randy L.
5. Haupt, John Wiley and Sons

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Subject Code	Subject Name	Credits
ETE2034	**Optical Networks**	**04**

Module	Detailed Content	Hours
1	**SONET & SDH:** Brief history of SONET& SDH, Multiplexing hierarchy, Multiplexing structure – Functional components, Problem detection, Virtual tributaries & containers, Concatenation.	04
2	**Architecture of OTN:** Digital wrapper, control planes, Control signaling, Multiplexing, hierarchies, Current digital hierarchy, revised hierarchies, Optical & Digital Transporthierarchies, Functionality stacks, Encapsulation & Decapsulation, GFP.	06
3	**WDM, DWDM Topologies** : Relationship with SONET / SDH, EDF, WDM Amplifiers, Multiplexers, WADM I/P & O/P ports, spanloss & chromatic, dispersion, TunableDWDM lasers	08
4	**Network Topologies & Protection schemes** : Non-negotiable requirements of robust networks, Line & Path protection switching, Type of Topologies, Optical Channel Concatenation, Meshed topologies, PON's, Optical Ethernets, Wide area Backbones,Metro optical networking	06
5	**MPLS & Optical networks:** Label switching, FEC, Scalability & granuility: labels & wavelength, MPLS nodes, Distribution & Binding methods, MPLS support of virtual private networks, Traffic Engineering, MPLS, Relationships of OXC, MPLS operation, MPLS & optical Traffic Engineering, Similarities. Control & Dataplanes interworking	08
6	**Architecture of IP & MPLS based optical transport Networks** : IP, MPLS & Optical control planes Interworking, The three control planes, Framework for IP Vs. Optical networks, Generalized MPLS use in optical networks, Bidirectional LSP's in optical network, Next horizon of GMPLS, ODVK General communication channels, Traffic parameters	05
7	**Link Management protocol (LMP) :** What is managed, Data Bearing links, Basic function of LMP, LMP messages, LMP message header, TLW's control channelManagement, LPC, LCV, Fault management, Extending LMP operations to optical links.	06
8	**Optical compilers :** Building blocks, Serial Binary adder with carry delay, Fiber delay line memory loop, Bit serial, optical counter design, Lumped delay design, Distributed delay design, Time multiplex multiprocessor, Time slot interchange with 2 log 2 (N-1) switch, Hatch design support system	05

Text Books:

1. R.Ramaswami,K.N.Sivarajan, “Optical Networks”,Elsevier, 2002.
2. P.E Green, “Optical Networks” Prentice Hall, 1994.
3. “Opto Electronic-Computing System” by Jordan
4. Uyless Black “Optical Networks Third Generation Transport Systems” Prentice Hall

Reference Books

1. C.S.Murthy & M.Gurusamy, “WDM Optical Networks”,PHI,2002.
2. TanenbaumAndrew S “Computer Networks” Prentice Hall(India).

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Subject Code	Subject Name	Credits
ETE2041	**Wavelets**	**04**
Module	**Contents**	**Hours**
1	Introduction to time frequency analysis; conventional methods like Fourier transform their limitations andthe how, what and why about wavelets.	7
2	Short-time Fourier transform, Wigner-Ville transform. Properties and mathematical conditions of wavelet functions. Some popular wavelet functions.	7
3	Continuous time wavelet transform, Discrete wavelet transform, tiling of the time-frequency plane and wavepacket analysis.	10
4	Construction of wavelets. Multiresolution analysis. Introduction to frames and biorthogonal wavelets.	10
5	Multirate signal processing and filter bank theory.	8
6	Application of wavelet theory in to signal denoising, image and video compression, multi-tone digital communication, transient detection. Commercial applications in which wavelet approach is established.	6

Text Books:

1. Y.T. Chan, Wavelet Basics, Kluwer Publishers, Boston, 1993.
2. M. Vetterli and J. Kovacevic, "Wavelets and Sub-band Coding," Prentice Hall, 1995.

References:

1. I.Daubechies, Ten Lectures on Wavelets, Society for Industrial and Applied Mathematics, Philadelphia, PA, 1992.
2. Gerald Kaiser, A Friendly Guide to Wavelets, Birkhauser, New York, 1995.
3. P. P. Vaidyanathan, Multirate Systems and Filter Banks, Prentice Hall, New Jersey, 1993.
4. S. Mallat, "A Wavelet Tour of Signal Processing," Academic Press, Second Edition, 1999.
5. G. Strang and T. Q. Nguyen, "Wavelets and Filter Banks," Wellesley-Cambridge Press, Revised Edition, 1998.
6. B.Boashash, Time-Frequency signal analysis, In S.Haykin, (editor), Advanced Spectral Analysis, Prentice Hall, New Jersey, 1991.

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Subject Code	Subject Name	Credits
ETE2042	**Cloud Computing**	**04**

Module	Detailed content	Hours
1	**Overview of Distributed Computing** Definition, Goals, H/W Concepts, S/W Concepts, Client-Server Model. Synchronization: Clock Synchronization, Logical Clocks, Global State. Distributed File System: NFS, CODA, XFS. Distributed Parallel computing System, Scalable Computing towards Massive Parallelism.	06
2	**Introduction to Cloud Computing** What's Cloud Computing, NIST Definition, properties and Service Model, Characteristics, Components, Cloud provider, SAAS, PAAS, IAAS and Others, Organizational scenarios of clouds, Administering & Monitoring cloud services, benefits and limitations, Deploy application over cloud, Comparison among SAAS, PAAS, IAAS. Cloud computing platforms: Infrastructure as service: Amazon EC2,Platform as Service: Google App Engine, Microsoft Azure, Utility Computing, Elastic Computing.	08
3	**Cloud Technologies** Web services, AJAX and mashups: Web services: SOAP and REST, SOAP versus REST, AJAX: asynchronous 'rich' interfaces, Mashups: user interface services Virtualization Technology: Virtual machine technology, virtualization applications in enterprises, Pitfalls of virtualization. Multitenant software: Multi-entity support, Multi-schema approach, Multitenance using cloud data stores, Data access control for enterprise application.	08
4	**Issues in cloud Computing** Implementing real time application over cloud platform, Issues in intercloud environments, QoS Issues in cloud, Dependability, data Migration, streaming in cloud, QoS monitoring in cloud computing environment. Cloud Middleware, A grid of clouds, Load Balancing in cloud, Sky Computing, resource optimization, resource dynamic reconfiguration.	08
5	**Security architecture and Challenges** Architectural Considerations- General Issues, Trusted Cloud computing, Secure Execution Environments and Communications, Micro-architectures; Identity Management and Access control-Identity management, Access control, Autonomic Security. Virtualization security management- virtual threats, VM Security Recommendations, VM-Specific Security techniques, Secure Execution Environments and Communications in cloud.	06
6	**Programming support of Google App Engine** Programming the Google App Engine, Google file system(GFS), Bigtable, Googles NOSQL system. Chuby, Google's Distributed lock service.	06
7	**Programming on Amazons AWS and Microsoft Azure** Programming on Amazon EC2, Amazon simple storage service(S3), Amazon Elastic block store(EBS), and SimpleDB. Microsoft AzureProgramming support.	06

Text Books:

1."Distributed Systems: Principles and Paradigms, 2nd Edition", by Andrew S. Tanenbaum, Maarten van Steen, ISBN: 01323-92275, Prentice Hall, 2006.
2."Distributed And Cloud Computing From parallel processing to the internet of things" , Kai Hwang, Geoffrey C. Fox, Jack J. Dongarra, ISBN : 9780123858801, ELSEVIE MK publishers, 2011.

Reference Books

1. "Cloud Computing for Dummies", by Judith Hurwitz, R.Bloor, M.Kanfman, F.Halper (Wiley India Edition)
2. "Enterprise Cloud Computing", by Gautam Shroff,Cambridge
3. "Cloud Computing : A Practical Approach", by Antohy T Velte, et.al McGraw Hill.
4. "Google Apps", by Scott Granneman,Pearson.

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students.Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
ETE2043	**Sensor Array Networks**	**04**
Module	**Detailed content**	**Hours**
1	**Spatial Signals** Signals in space and time. Spatial frequency, Direction vs. frequency. Wave fields. Far field and near field signals.	12
2	**Sensor Arrays** Spatial sampling, Nyquist criterion. Sensor arrays. Uniform linear arrays, planar and random arrays. Array transfer (steering) vector. Array steering vector for ULA. Broadband arrays.	12
3	**Spatial Frequency** Aliasing in spatial frequency domain. Spatial Frequency Transform, Spatial spectrum. Spatial Domain Filtering. Beam Forming. Spatially white signal.	12
4	**Direction of Arrival Estimation** Non parametric methods - Beam forming and Capon methods. Resolution of Beam forming method. Subspace methods - MUSIC, Minimum Norm and ESPRIT techniques. Spatial Smoothing.	12

References

1. Dan E. Dugeon and Don H. Johnson. (1993). Array SignalProcessing: Concepts and Techniques. Prentice Hall.
2. PetreStoica and Randolph L. Moses. (2005, 1997) Spectral Analysis of Signals. Prentice Hall.
3. Prabhakar S. Naidu. (2000). Sensor Array SignalProcessing: CRC Press.

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students.Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
ETE2044	**Network Security**	**04**

Module	Detailed content	Hours
1	**Introduction** Introduction to Information Security, Network Security Domains	8
2	**Security Architecture** Enterprise Security Architecture, Network LAN/WAN & User Access Security, Cryptography and Cryptanalysis, Various Security Protocols, Network Security Audit / Security RISK Management, Security Operations.	12
3	**Security Mechanisms for Network Defense and Countermeasures** Telecommunications Overview, Equipment Security Testing, Core Network Security Testing, Regulation, TRAI, Telecom License	10
4	**Security in Networks** Network security basics, TCP/IP Model and Port no., Protocol flaws, Enterprise wide network Design and Vulnerabilities. Reconnaissance of network, Packet sniffing, Session Hijacking, ARP Spoofing Web site and web server vulnerabilities, Denial of Service, SSL and IPSec protocol Firewall, intrusion detection system and Honey pots.	6
5	**Introduction to Biometrics for Security** Signature verification,Finger print recognition,Voice recognition, Iris recognition system.	6
6	**Legal,Privacy, and Ethical Issues in Network Security** Protecting programs and data, Information and law, Rights of employees and employers, Software failures, Computer crime, Privacy, Ethical issues in computer society, Case studies of ethics.	6

References:

1. Stallings, “Cryptography and Network Security: Principles and Practice”
2. C.P. Pfleeger and S.L.Pfleeger, “ Security in Computing”, Pearson Education
3. Matt Bishop, “Computer Security: Art and Science”, Pearson Education
4. Kaufman, Perlman, Speciner, “Network Security”
5. Eric Malwald, “Network Security: A Beginner’s Guide”, TMH
6. Bruce Schneier, “Applied Cryptography”, John Wiley
7. Macro Pistoia , “ Java network security”, Pearson Education
8. Whitman, Mattord, “Principles of Information security”, Thomson
9. Cryptography and Data Security, D Denning, Addison Wesley

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
ETS301	**Seminar**	**03**

Guidelines for Seminar

- Seminar should be based on thrust areas in Electronics and Telecommunication Engineering
- Students should do literature survey and identify the topic of seminar and finalize in consultation with Guide/Supervisor. Students should use multiple literature and understand the topic and compile the report in standard format and present infront of Panel of Examiners appointed by the Head of the Department/Institute of respective Programme.
- Seminar should be assessed based on following points
  - Quality of Literature survey and Novelty in the topic
  - Relevance to the specialization
  - Understanding of the topic
  - Quality of Written and Oral Presentation

IMPORTANT NOTE:

1. Assessment of Seminar will be carried out by a pair of Internal and External examiner. The external examiner should be selected from approved panel of examiners for Seminar by University of Mumbai, OR faculty from Premier Educational Institutions /Research Organizations such as IIT, NIT, BARC, TIFR, DRDO, etc. OR a person having minimum Post-Graduate qualification with at least five years' experience in Industries.

2. Literature survey in case of seminar is based on the broader area of interest in recent developments and for dissertation it should be focused mainly on identified problem.

3. At least 4-5 hours of course on Research Methodology should be conducted which includes Literature Survey, Problems Identification, Analysis and Interpretation of Results and Technical Paper Writing in the beginning of 3rd Semester.

Subject Code	Subject Name	Credits
ETD301 / ETD401	**Dissertation (I and II)**	**12 + 15**

Guidelines for Dissertation

- Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literature and understand the problem. Students should attempt solution to the problem by analytical/simulation/experimental methods. The solution to be validated with proper justification and compile the report in standard format.

Guidelines for Assessment of Dissertation I

- Dissertation I should be assessed based on following points
  - Quality of Literature survey and Novelty in the problem
  - Clarity of Problemdefinition and Feasibility of problem solution
  - Relevance to the specialization
  - Clarity of objective and scope
- Dissertation I should be assessed through a presentation by a panel of Internal examiners appointed by the Head of the Department/Institute of respective Programme.

Guidelines for Assessment of Dissertation II

- Dissertation II should be assessed based on following points
  - Quality of Literature survey and Novelty in the problem
  - Clarity of Problemdefinition and Feasibility of problem solution
  - Relevance to the specialization or current Research / Industrial trends
  - Clarity of objective and scope
  - Quality of work attempted
  - Validation of results
  - Quality of Written and Oral Presentation
- Dissertation II should be assessed through a presentation jointly by Internal and External Examiners appointed by the University of Mumbai

Students should publish at least one paper based on the work in reputed International / National Conference (desirably in Refereed Journal)