AC – 11 July, 2022
Item No. – 6.31 (R)

University of Mumbai

Revised Syllabus for

M.E.

(Electronics & Telecommunication Engineering)

Semester – (Sem. - I to IV)

(Choice Based Credit System)

(With effect from the academic year 2022-23)

University of Mumbai

O: _____ Title of Course	M.E. (Electronics and Telecommunication Engineering)
O: _____ Eligibility	Passed B.E. / B.Tech. as per the Ordinance O.5134
R: _____ Passing Marks	45%
No. of years/Semesters:	02 Years / 4 semesters
Level:	P.G. / ~~U.G./~~ ~~Diploma / Certificate~~
Pattern:	~~Yearly~~ / Semester
Status:	~~New~~ / Revised
To be implemented from Academic Year:	With effect from Academic Year : 2022-23

Dr Faruk Kazi
Chairman
of Ad-hoc Board of Studies in Electronics and Telecommunication Engineering

Dr. Suresh K. Ukarande
Associate Dean,
Faculty of Science and Technology

Dr Anuradha Majumdar
Dean,
Faculty of Science and Technology

Semester I

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC101	Advanced Digital Signal Processing and Applications	3	--	--	3	--	--	3
ETC102	Optical Communication Network	3		--	3		--	3
ETPE101	Program Elective 1	3	--	--	3	--	--	3
ETPE102	Program Elective 2	3	--	--	3	--	--	3
ETIE101	Institute Elective 1	3	--	--	3	--	--	3
ETL101	Program Lab-I	--	2	--	--	1	--	1
ETSBL101	Skill Based Lab-I	--	4[$]	--	--	2	--	2
Total		**15**	**06**	**--**	**15**	**03**	**--**	**18**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test-1	Test-2	Avg					
ETC101	Advanced Digital Signal Processing and Applications	20	20	20	80	3	--	--	100
ETC102	Optical Communication Network	20	20	20	80	3	--	--	100
ETPE101X	Program Elective 1	20	20	20	80	3	--	--	100
ETPE102X	Program Elective 2	20	20	20	80	3	--	--	100
ETIE101X	Institute Elective 1	20	20	20	80	3	--	--	100
ETL101	Program Lab-I	--	--	--	--	--	25	25	50
ETSBL101	Skill Based Lab-I	--	--	--	--	--	50	50	100
Total		**--**	**--**	**100**	**400**	--	**75**	**75**	**650**

Subject Code ETPE101X	**Program Elective 1**
ETPE1011	Next Generation Networks
ETPE1012	Advanced Antenna Design
ETPE1013	Statistical Signal Processing

Subject Code ETPE102X	**Program Elective 2**
ETPE 1021	Image Analysis using Machine learning
ETPE 1022	Embedded Communication Systems Design
ETPE 1023	Optimization Methods in Signal Processing for Communication Systems

Subject code ETIE101X	Institute Elective 1
ETIE1011	Product Life cycle Management
ETIE1012	Reliability Engineering
ETIE1013	Management Information System
ETIE1014	Design of Experiments
ETIE1015	Operation Research
ETIE1016	Cyber Security and Laws
ETIE1017	Disaster Management & Mitigation Measures
ETIE1018	Energy Audit and Management

Semester II

Course Code	Course Name	Teaching Scheme(Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC201	RF Engineering	3	--	--	3	--	--	3
ETC202	Modern Digital Communication	3		--	3		--	3
ETPE201X	Program Elective 3	3	--	--	3	--	--	3
ETPE202X	Program Elective 4	3	--	--	3	--	--	3
ETIE201X	Institute Elective 2	3	--	--	3	--	--	3
ETL201	Program Lab-II	--	2	--	--	1	--	1
ETSBL201	Skill Based Lab-II	--	4[$]	--	--	2	--	2
Total		**15**	**06**	**--**	**15**	**03**	**--**	**18**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test-1	Test-2	Avg					
ETC201	RF Engineering	20	20	20	80	3	--	--	100
ETC202	Modern Digital Communication	20	20	20	80	3	--	--	100
ETPE201X	Program Elective 3	20	20	20	80	3	--	--	100
ETPE202X	Program Elective 4	20	20	20	80	3	--	--	100
ETIE201X	Institute Elective 2	20	20	20	80	3	--	--	100
ETL201	Program Lab-II	--	--	--	--	--	25	25	50
ETSBL201	Skill Based Lab -II	--	--	--	--	--	50	50	100
Total		**--**	**--**	**100**	**400**	**--**	**75**	**75**	**650**

Note 1: Skill Based Lab- I and II are focused on the learning through experience. SBL shall facilitate the learner to acquire the fundamentals of practical engineering in his or her specialization in a project-oriented environment. The learning through skill based labs can be useful in facilitating their research work and hence useful in early completion of their dissertation work

Subject Code **ETPE201X**	**Program Elective 3**
ETPE2011	Satellite Networking
ETPE2012	Network and Cyber Security
ETPE2013	Remote Sensing

Subject Code **ETPE202X**	**Program Elective 4**
ETPE2021	Error Control Coding
ETPE2022	Wireless Adhoc and Sensor Networks
ETPE2023	Cognitive Radio

Subject Code ETIE201X	**Institute Level Optional Course 2**
ETIE2011	Project Management
ETIE2012	Finance Management
ETIE2013	Entrepreneurship Development and Management
ETIE2014	Human Resource Management
ETIE2015	Professional Ethics and CSR
ETIE2016	Research Methodology
ETIE2017	IPR and Patenting
ETIE2018	Digital Business Management
ETIE2019	Environmental Management

Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETMP301	Major Project: Dissertation -I	--	20	--	--	10	--	10
Total		**00**	**20**	**00**	**00**	**10**	**--**	**10**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test-1	Test-2	Avg					
ETMP301	Major Project: Dissertation -I	--	--	--	--	--	100	--	100
Total		**--**	**--**	**--**	**--**	**--**	**100**	**--**	**100**

Online Credit Courses

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETOCC301	Online Credit Course - I	--	--	--	--	--	--	3
ETOCC301	Online Credit Course - II	--	--	--	--	--	--	3
Total		**--**	**--**	**--**	**00**	**00**	**00**	**06**

Note 2: It is mandatory to complete the Online Credit Courses (OCC) available on NPTEL / Swayam /MOOC or similar platform approved by UoM. These two courses shall be completed in any semester I or II or III, but not later end of the Semester III. University shall make a provision that credits earned with OCC- I and OCC-II shall be accounted in the third semester grade-sheet with actual names of courses. The learner shall be allowed to take up these courses from his or her institute or organisation/ industry where his / her major project is carried out. The students shall complete the courses and shall qualify the exam conducted by the respective authorities/ instructor from the platform. The fees for any such courses and the corresponding examination shall be borne by the learner.

Online Credit Course – I

The learner shall opt for the course in the domain of Research Methodology **or** Research & Publication Ethics or IPR. The opted course shall be of 3 credits of equivalent number of weeks.

Online Credit Course –II

The learner shall opt for the course recommended by Faculty Advisor/ Project Supervisor from the institute. The opted course shall be of 3 credits of equivalent number of weeks.

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETMP401	Major Project : Dissertation -II	--	32	--	--	16	--	16
Total		**--**	**32**	**--**	**--**	**16**	**--**	**16**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test-1	Test-2	Avg					
ETMP401	Major Project : Dissertation -II	--	--	--	--	--	100	100	200
Total		**--**	**--**	**--**	**--**	**--**	**100**	**100**	**200**

Total Credits: 68

Note 3: The Dissertation -II submission shall not be permitted till the learner completes all the requirements ME course.

Note 4: The contact hours for the calculation of load of the teacher for Major Project are as follows: Major Project Dissertation I and II - 02 Hour / week / student

Guidelines for Dissertation-I

Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literatures 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 Problem definition 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 and external examiner 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 Problem definition and Feasibility of problem solution
- Relevance to the specialization or current Research / Industrial trends
- Clarity of objective and scope
- Quality of work attempted or learner contribution

- Validation of results
- Quality of Written and Oral Presentation

Students should publish at least one paper based on the work in referred National/ International conference/Journal of repute.

Dissertation II should be assessed by internal and External Examiners appointed by the University of Mumbai.

Subject Code	Subject Name	Credits
ETC101	**Advanced Digital Signal Processing and Applications**	**03**

Course Pre-requisite:

- Signals & Systems
- Discrete Time Signal Processing

Course Objectives:

- To develop in-depth understanding of techniques of power spectrum estimation.
- To provide adequate knowledge on adaptive filtering, wavelet transforms and theirs applications.
- To provide knowledge about applications of signal processing to real world problems

Course Outcome:

Learners will be able to:

- Illustrate the techniques of power spectrum estimation and adaptive filtering for various applications.
- Explain and implement wavelet transforms and their applications.
- Apply Signal processing tools to biomedical signal processing and musical sound processing.

Module	Detailed Content	Hours
1	**Power Spectrum Estimation** • Non- Parametric methods of Power Spectral Estimation: Estimation of spectra from finite duration observation of signals, Non-parametric Methods for Periodogram estimation: Bartlett, Welch and Blackman and Tukey methods. • Parametric Methods of Power Spectrum Estimation: AR, MA & ARMA models for power spectrum estimation. Yule-Walker method for the AR model parameter	08
2	**Introduction to Adaptive systems** • Introduction, Characteristics, Examples of Adaptive systems, Applications. The adaptive system -linear combiner- Description, Weight vectors, desired response performance function- Gradient and mean square error.	06
3	**Adaptive Signal Processing and Applications** • FIR Adaptive filters - Adaptive Direct Form FIR Filters based on steepest descent method -Widrow Hoff LMS Adaptive algorithm. Adaptive Direct Form FIR Filters-RLS Algorithms. • Applications: System Identification, Adaptive channel equalization - Adaptive echo canceller.	06
4	**Wavelet Theory** • Fourier Transform and its Limitations – Short Time Fourier Transform – Introduction to time frequency analysis- Continuous Wavelet Transform	07

	– Discrete Time Wavelet Transform- Multi-resolution analysis– Haar Wavelet Transforms – Daubechies Wavelet, Filter bank theory. • Application of wavelet theory to signal denoising, speckle removal, and signal and image compression.	
5	**Application of Digital Signal Processing to Biomedical Signal Processing** • Introduction to various Bio-electric signals: ECG, EEG, EOG, and their pre-processing, Artifacts and interferences in ECG and their removal, Detection of fetal heartbeats during labor- Fetal ECG, QRS template, QRS detection methods, performance measure for QRS detection. • Adaptive removal of ocular artifacts from human EEGs- Methods for removal and control of ocular artefacts, online Ocular Artifacts Removal (OAR) algorithm and system,	8
6	**Application of Digital Signal Processing in Musical Sound Processing** • Musical sound processing - Time domain operations- single echo filter, multiple echo filter, Reverberation, Flanging, Chorus generator, Frequency domain operations-Analog filters, First order digital filters and Equalizers, Second order digital filters and Equalizers.	04
	Total	39

Textbooks and References:

Textbooks:

1. John G. Proakis and Dimitris G. Manolakis, –*Digital Signal Processing*‖, PHI, 2005.
2. Bernard Widrow and Samuel D.Strearns, –*Adaptive Signal Processing*‖, Pearson Edu Asia 2002.
3. S. M. Kay, *Modern Spectrum Estimation Theory and Application*‖, PHI.
4. K. P. Soman, K.I. Ramchandran and N. G. Reshmi, –*Insight into Wavelets: From theory to practice*, Third Edition PHI, 2010.
5. Raghuveer. M. Rao and Ajit S.Bopardikar, –*Wavelet Transforms -Introduction to theory and applications*, Pearson Education, Asia, 2000.
6. Rangaraj M. Rangayyan, –*Biomedical Signal Analysis- A Case Study Approach*‖, Wiley 2002.
7. Willis J. Tompkins, *Biomedical Digital Signal Processing*, PHI, 1999
8. Sen M Kuo, Bob H Lee and W Tian, –*Real Time Signal processing: Fundamentals, Implementations and Applications*‖ Springer, Wiley Publishers, Third Edition 2013.
9. S. K. Mitra, –*Digital Signal Processing*‖, TMH, 2001
10. Emmanuel C. Ifeachor, Barrie W. Jervis, –*Digital Signal Processing, A Practical Approach*‖, Pearson Education, 2008.

Reference Books:

1. Simon Haykin, –*Adaptive Filter Theory*‖, Pearson Edu, 2013
2. D. C. Reddy, *Biomedical Signal Processing Principles and Techniques*, Tata Mc Graw-Hill, 2005
3. A. H. Sayed, –*Adaptive filters*‖, Wiley Student Edition, 2010

4. S. Thomas Alexander, *Adaptive signal processing-Theory and Applications*, Springer –Verlag.
5. I. Daubechies, Ten Lectures on Wavelets, Society for Industrial and Applied Mathematics, Philadelphia, PA, 1992.
6. Mark Kahrs, Karlheinz Brandenburg, *–Applications of Digital Signal Processing to Audio and Acoustics*‖, Kluwer Academic Publishers, 2002
7. Mallat, Stéphane. *–A wavelet tour of signal processing*.‖ Academic press, Third Ed. 2008.
8. Torrence, Christopher, and Gilbert P. Compo, "*A practical guide to wavelet analysis*." Bulletin of the American Meteorological society Jan. 1998
9. Burrus, C. Sidney, Ramesh A. Gopinath, and Haitao Guo. "*Introduction to wavelets and wavelet transforms*." Prentice Hall Inc. 1997
10. Paul S. Addison, *–The illustrated wavelet transform handbook: introductory theory and applications in science, engineering, medicine and finance*.‖ CRC press, 2002

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) 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, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three 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 Communication Network**	**03**

Course Pre-requisite:

- Wave theory and Propagation
- Analog Communication
- Digital Communication

Course Objectives:

To teach students:

- The issues related to signal degradation due to Linear Impairments
- System impairments due to nonlinear effect in fiber.
- System optimization by controlling dispersion and Nonlinear Effects.
- High data rate WDM optical Transport Networks.

Course Outcome:

The course enables the students to:

- Apply the fundamental principles of optics and light wave to design optical fiber communication systems.
- Identify the issues related to signal degradation due to multiplexing.
- Identify working principle of various components of all optical network.
- Explore concepts of designing and operating principles of modern optical communication systems and networks.

Module	Detailed Content	Hours
1	**A Review of Optical Fibers** • Introduction • Signal Degradation • Fiber dispersion • Multimode fiber • Single mode fiber • Dispersion Management • Dispersion compensating Fibers	06
2	**Non Linear Optics** • General Overview of Nonlinearities • Effective area and length • Stimulated Raman Scattering • Stimulated Brillouin Scattering • Self Phase modulation	8

	• Cross –Phase modulation • Four wave mixing and its mitigation • Applications of Nonlinear Effects • Solitons properties of Solitons, Properties of Solitons, Loss managed Soliton ,Dispersion managed Soliton, Optical Switching, Parametric amplification	
3	**Optical Network Components** • Sources: Quantum well lasers, Charge capture in Quantum well lasers, Multi Quantum well Laser diodes, Surface Emitting Lasers: Vertical cavity Surface Emitting Lasers • Detectors: 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 • Optical Amplifiers: Optical Pumping, Erbium Doped Amplifier, Semiconductor Laser Amplifier, Raman Amplifier, • Integrated Optics: Directional couplers and Photonic Switch, Optical Modulators • WDM network components: WADM, Optical Crossconnects	8
4	**Introduction to Optical Network** • Overview of generations of optical Networks • SONET& SDH: Multiplexing hierarchy, Multiplexing structure – Functional components, Problem detection, Virtual tributaries & containers • Optical Transport Network: Hierarchy, Frame structure, Multiplexing	05
5	**WDM Network Design** • Cost Trade-offs: A detailed Ring Network example • LTD and RWA Problems • Routing and Wavelength assignment • Dimensioning wavelength networks • Statistical wavelength routing networks- First passage model, Blocking model • Maximum load dimensioning models- offline lightpath request, online RWA in Rings	06
6	**Deployment Consideration** • Architectural choices for next generation transport Network • Designing the transmission Layer using SDM,TDM and WDM • Unidirectional versus bidirectional WDM Systems- Long haul networks case study, Long Haul Undersea Networks • Metro Networks, Metro Ring Case study	06
	Total	39

Textbooks and References:

1. –*Optical Fiber Communications*‖-Gerd Keiser-Fourth Edition-TATA McGRAW
2. –*Optical Fiber Communications Principles and Practice*‖-John.M.Senior-Pearson Education HILL
3. –*Fiber Optics Communication System*‖-G.P.Agarwal-Wiley Publications
4. –*Fiber Optics Communications*‖- Harold Kolimbris-Pearson Education
5. –*Opto-Electronics, an introduction*‖-Wilson and Hawkes,Prentice Hall
6. –*Nonlinear Fiber Optics*‖ G.P.Agarwal-Academic Press
7. ―*Applications of Nonlinear Optics*‖, Academic press-G.P. Agarwal
8. –*Optical Networks, A Practical Perspective*‖, Third edition- Rajiv Ramaswami, Kumar N. Sivarajan, Elsevier
9. *"Optical Networks, Third generation Transport Systems*‖,by Uyless Black, Pearson
10. –*Optical Fiber Communication System: Theory and Practice with MATLAB and Simulink*‖ by Le Nguyen Binh, CRC Press, 2010

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) 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, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
ETPE1011	**Next Generation Networks**	**03**

Course Pre-requisite:

- Computer Networks
- Wireless Networks
- Mobile Communication

Course Objectives:

The aim of this course is

- To relate the paradigm shift from circuit switched network to packet switched network.
- To apply the advancement in networks field.
- To examine new technologies in telecommunication.
- To appraise the NGN Standards

Course Outcome:

Learners will be able to:

- Relate and compare the core differences between traditional and new telecommunication technologies.
- Analyze, implement and apply the components of NGN architecture with NGN standards.

Module	Detailed Content	Hours
1	**Next Generation Technologies, Networks and Services** • Introduction, • Next Generation (NG) Technologies, • Wire line NG Technologies, • FTTP, Long-Haul Managed Ethernet.	06
2	**Wireless NG Technologies** • Long Term Evolution (LTE), • Enhanced HSPA Evolution Data Optimized (EVDO), Ultra Mobile Broadband (UMB), • SDR and cognitive radio • IoT, VOIP, IPTV, Quality of Services, Quality of Experiences in NGN.	7
3	**Next Generation Multiservice Technology Overview** • MPLS &QoS, MPLS services and components, overview of VPN, layer2 VPN, layer 3 VPN	06

4	**ITU NGN Standards and Architectures** • Main drivers to Next Generation Networks – NGN , ITU NGN standards • All-IP network concept for NGN , • NGN control architectures and protocols(TISPAN),Numbering, naming and addressing for all NGN	06
5	**Control and Signalling Protocols for NGN** (SIP, Diameter) • NGN security(AAA, identity management) , • Service convergence • Fixed-Mobile Convergence (FMC) in NGN, • IP Multimedia Subsystem (IMS) for NGN	07
6	**Transition to NGN and Future Evolution** • Migration of PSTN networks to NGN , • Transition of IP networks to NGN, • IPv6, NGN Evolution.	07
	Total	39

Textbooks and References:

Textbooks:

1. *Wireless communication and Networking*-Vijay Garg, ELSEVIER Inc.
2. Next Generation Telecommunications Network, Parliament office of Science and Technology (Postnote). Dec 2007, No. 296 Ref. www.parliament.uk.

Reference Books

1. ITU Manual
2. *Next Generation Telecommunications Networks, Services, and Management* by Thomas Plevyak, VeliSahin, ISBN: 978-0-470-57528-4 , Wiley-IEEE Press
3. *Next Generation Wireless Systems and Networks:* Hsiao – Hwa Chen, Mohsen Guizani – Wiley
4. *IP-Based Next-Generation Wireless Networks: Systems, Architectures, and Protocols*- Jyh- Cheng Chenand Tao Zhang- Wiley

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) 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, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
ETPE1012	**Advanced Antenna Design**	**03**

Course Pre-requisite:

- Wave Theory and Propagation
- RF and Antenna

Course Objectives:

The aim of this course is

- To provide state-of-art knowledge in microstrip antennas,
- To explain various methodologies presently prevalent for design of microstrip antennas
- To enable students to make design decisions in microstrip antennas

Course Outcome:

Learners will be able to:

- Design and analyze microstrip antennas,
- Correlate the fundamental design of antenna to advanced communication applications

Module	Detailed Content	Hours
1	**Review of Antennas** • Antenna parameters • Infinitesimal dipole antenna • Half wave dipole antenna	03
2	**Microstrip Antennas** • Introduction, Rectangular patch and Circular patch design • Quality factor, Bandwidth, Efficiency, Input impedance, and Coupling • Analytical models for MSAs transmission line models, cavity model, Multimode network model.	6

3	**Circular Polarization Technique** • Dual-Feed circularly polarized MSAs, Square MSA with two feeds, Effect of amplitude and phase imbalance, Square MSA with four feeds, CMSA with multiple feeds • Single-feed circularly polarized MSA, Diagonally fed nearly square MSA, Square MSA with modified edges, Square MSA with modified corners, Square MSA with a diagonal slot. • Broadband circularly polarized MSA, Dual-feed planar multiresonator MSA, Stacked MSA for circular polarization, Aperture coupled circularly polarized MSA, Sequentially rotated MSA.	7
4	**Planar Monopole Antennas**	7
	• 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 (RM) Antennas, Radiation Pattern of RM Antennas • Various Planar RMs with Equal Areas, Planar Circular Monopole Antennas.	
5	**Broadband and Compact Microstrip Antennas** • Mechanism of Parasitic Coupling for Broad BW, Gap-Coupled RMSAs, Radiating-Edge Gap-Coupled RMSAs, Multilayer Broadband MSA, Design Examples. • 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	08
6	**Next generation Antennas** • Introduction to smart antennas, smart Antenna configurations-switched beam antennas and adaptive antenna approach, Smart Antennas‘ Benefits and draw backs, Antenna Beam forming, Architecture of Smart antenna system. • Metamaterial Antennas: Introduction, Negative Refractive Index (NRI) Metamaterials, Metamaterial Antennas Based on NRI concepts. • Applications of Smart Antennas: Smart antennas for Code Division Multiple Access Systems, Smart antennas for automatic radio frequency identification readers, Mutual coupling reduction techniques in MIMO.	08
	Total	39

Textbooks and References:

1. *Antenna Theory*- C. A. Balanis- Wiley and sons
2. *Antennas* – John. D. Krauss- TMH ed.
3. *Microstrip Antenna Design Handbook* - Ramesh Garg- Artech House.
4. *Handbook of Microstrip Antennas* - James R. James, Peter S. Hall-IEE Electromagnetic wave series.
5. *Broadband Microstrip antennas* – Girish Kumar and K.P. Ray, Artech House
6. *Smart Antennas for Wireless Communications with MATLAB*: Frank Gross, McGRAW Hill.
7. *Handbook on Advancements in Smart Antenna Technologies for Wireless Networks*- Chen Sun, Jun Cheng and Takashi Ohira, Information science reference, New York.

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) 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, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
ETPE1013	**Statistical Signal Processing**	**03**

Course Pre-requisite:

- Matrix theory
- Fundamentals of probability
- Signals and systems

Course Objectives:

The aim of this course is to provide knowledge of statistical techniques necessary to explain and explore the important applications in signal processing and telecommunication.

Course Outcome:

Learner will be able to:

- Understand basics of linear algebra in communication engineering.
- Apply appropriate statistical tools for handling design and analysis of systems that involve randomness.
- Analyze random processes for LTI systems and estimation theory.
- Evaluate role of probability models in engineering design.

Module	**Detailed Content**	**Hours**

1	**Linear Algebra** • Signal spaces, metric spaces, vector spaces, norms and normed vector spaces, inner-product spaces, orthogonality, orthogonal subspaces, linear transformations: range and null space, orthogonalization of vectors, representation and approximation in vector spaces, matrix representation of least squares, geometry of linear equations, four fundamental subspaces of linear operator, properties of matrix inverses, results on matrix rank, pseudo inverses, matrix condition number, singular value decomposition(SVD), pseudoinverse and the SVD.	8
2	**Review of Random Variables and Processes** • Random variables, distribution and density function, functions of random variables, sums of independent random variables, central limit theorem, discrete time stochastic process, stationarity, random signal variability, time averages, ergodicity, autocorrelation function of a real WSS process and its properties, cross-correlation function, frequency domain description of stationary process, general correlation matrices, correlation matrices from random process, correlation matrices of stationary process.	07
3	**Analysis and processing of random signals** • Linear time invariant system with WSS process as an input stationarity of the output, auto-correlation and power-spectral density of the output; examples with white-noise as input; linear shift-invariant discrete-time system with WSS sequence as input, examples of random processes: white noise process and white noise sequence; Gaussian process.	04
4	**Whitening and Innovations Representation** • Transformations using eigen-decomposition, transformations using triangular decomposition, generation of real valued random vectors with given second-order moments, discrete Karhunen-Loève transform and its application, optimal reduced-basis representation, periodic random sequences.	07
5	**Principles of Estimation Theory** • Estimation in signal processing, the mathematical estimation problem, assessing estimator performance, unbiased and consistent estimators, confidence interval, efficient estimator, minimum variance unbiased estimation, existence of minimum variance unbiased estimator, estimator accuracy considerations, Cramer-Rao lower bound(CRLB) theorem, computation of CRLB for different examples, general CRLB for signals in white-Gaussian noise, vector parameter CRLB.	7

6	**The Kalman Filter** • The state space signal model, Kalman filter I: The Bayes approach, Kalman filter II: innovations approach, Estimation using the innovations process, innovations for processes with state space models. Discrete-time Kalman filter.	06
	Total	39

Textbooks and References:

1. Todd K. Moon and Wynn C. Stirling, ―*Mathematical Methods and Algorithms for Signal Processing*‖, Pearson Education, Inc., 2000.
2. Dimitris. G. Manolakis, Vinay Ingale, and Stephen M. Kogon, ―*Statistical and Adaptive Signal Processing*‖, Artech House, Inc., 2005.
3. Peyton Z. Peebles, ―*Probability, Random Variables and Random Signal Principles*‖, Mc-Graw Hill, 2000.
4. Steven M. Kay, ―*Fundamentals of Statistical Signal Processing: Estimation Theory* Vol 1, Prentice Hall, Englewood Cliffs, NJ, 2010.
5. Alberto Leon-Garcia, ―*Probability and Random Processes for Electrical Engineering*‖, Pearson Education, 2007.

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) 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, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
ETPE1021	**Image Analysis using Machine learning**	**03**

Course Pre-requisite:

- Image and Video processing

Course Objectives:

The aim of this course is

- To provide exposure to students in gaining knowledge on concepts and understanding of Image Analysis.
- To give necessary knowledge of digital image analysis for further research within the area and to be able to use digital image analysis within other research areas such as computer graphics, image coding, video coding and industrial image processing problems.
- To prepare the student for further studies in e.g. computer vision, multispectral image analysis and statistical image analysis.

Course Outcome:

Learners will be able to:

- Demonstrate good capability to independently identify problems which can be solved with methods from image analysis, and be able to choose an appropriate method.
- Independently apply basic methods in image processing to problems which are relevant in industrial applications or research.
- Explain the solution to a problem in image analysis in a well structured manner and with clear logic.

Module	Detailed Content	Hours
1	**Introduction to Image Processing** • Basic mathematical concepts: Image transforms, Discrete Fourier Transform, Fast Fourier Transform. • Image enhancement: Grey level transforms, filtering. Extraction of special features: Filtering, edge and corner detection. Image Segmentation and mathematical morphology.	05
2	**Image Representation** • Boundary Representation: Chain Code, Polygonal Approximations, Signatures, Bending Energy, Statistical Moments, Region Representation • Boundary Descriptions: Simple Descriptor, Shape Number, Fourier Descriptor, Run-length Code, Projection, Concavity Tree.	06
	• Component Labelling: Component counting, Recursive Algorithm, Sequential Algorithm.	
3	**Feature Extraction** • Histogram (or Brightness) Features, Shape Features, Spatial Moment, Central Moment, Topological Features, Geometrical Features, Transform Features, Texture Features, Syntactic and Structural Features	07
4	**Evaluating Hypotheses** • Estimating Hypothesis Accuracy, Basics of Sampling Theory, Deriving confidence intervals, difference in error of two hypotheses, Comparing Learning Algorithms.	06
5	**Learning Algorithms** • Decision Tree Learning : Building Single and Multiple Decision Trees Selecting the Decision Tree to be Built, Obtaining Prules from Decision Trees, Missing Attribute Values, Classifying with Relabelled Nodes, Error Rates on Recall Sets, Pruning Decision Trees, Issues in decision tree learning. • Bayes Learning : Bayes Theorem and concept learning, Bayesian Belief Networks, Naive Bayes with Binary Attributes, Performance of Bayes Classifier • Instance Based Leaning : K-nearest neighbour learning, case based learning, radial basis functions • Deep Learning Algorithm : Deep Networks, Deep Belief Networks, Convolutional Networks,	07

6	**Image Classification** Image Classification using • Neural network: Issues in neural network learning, perceptrons, multilayer network & Back propagation Algorithm. • Fuzzy Systems: Fuzzy logic, Fuzzification, Fuzzy inference, fuzzy rule based system, defuzzification • Support Vector Machine : Linear Classifiers, Classifier Margin, Solving the Optimization Problem, Hard Margin and Soft Margin, Linear and Non Linear SVMs, Kernel functions, • Genetic Algorithms : Genetic operators, genetic programming, models of evolution & learning, parallelizing genetic algorithm	8
	Total	39

Textbooks and References:

Textbooks:

1. Mitchell, Tom. *Machine Learning*. New York, NY: McGraw-Hill, 1997. ISBN: 9780070428072.
2. Haykin, Simon S. Neural Networks and Learning Machines, 3rd edition Pearson 2008.
3. Sonka, Milan. Hlavac Vaclav. Boyle Roger. *Image Processing, Analysis and Machine Vision*, New Delhi: Thomson Learning, 2001. ISBN: 9812400613.
4. Rajasekaran S, Vijaylakshmi Pai G.A. Neural Networks, Fuzzy Logic and Genetic Algorithms Synthesis and Application. New Delhi, Prentice Hall of India.
5. Valluru, Sudarshan K. Rao Nageswara T., Introduction to Neural Networks, Fuzzy Logic & Genetic algorithms, Jaico Publishing House 2010.

Reference Books:

1. Bishop, Christopher. *Pattern recognition and machine learning*, Springer Verlag, 2006.
2. Shinghal Rajjan, Pattern Recognition Techniques and Applications. New Delhi Oxford University Press, 2011. ISBN 9780195676853.
3. Richards John, Jia Xiuping, *Remote Sensing Digital Image Analysis*, Springer 2006. ISBN : 9783540251286

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) 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, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits

ETDLO1014	Embedded Communication System Design	04

Course Pre-requisite:

- Microcontrollers and Programming language

Course Objectives:

The aim of this course is

- To impart the concepts and architecture of embedded systems and to make the students capable of designing embedded systems product.
- To achieve this, system design, architecture and programming of industry popular ARM Cortex is covered in detail.

Course Outcome:

Learners will be able to:

- Understand the embedded concepts and architecture of embedded systems
- Understand the architecture and programming of ARM Cortex microcontroller
- Understand the open source RTOS and their usage
- Able to design an embedded systems application
- Able to usage of the development and debugging tools

Module	Detailed Content	Hours
1	**Overview of Product Design** • Need, design challenges, product survey, specifications of product need of hardware and software, partitioning of the design into its software and hardware components, iteration and refinement of the partitioning.	06
2	**Software and Hardware** • Tradeoffs, custom single-purpose processors, general-purpose processors, memory, interfacing, design technology-hardware design, cost reduction, re-engineering, optimization, maintenance, validation and development, prototyping, turnkey product design.	06
3	**Embedded Systems and ARM Architecture** • Embedded concepts, architecture of embedded systems, ARM architecture, Cortex-M3 basics, exceptions, instruction sets, NVIC, interrupt behavior, Cortex-M3/M4 programming, memory protection unit and other Cortex-M3 features, STM32xxx ARM Cortex M3/M4 microcontroller memory and peripherals, development & debugging tools.	8
4	**Communication and Security** • Embedded systems security and secured hardware structures. Communications security in embedded systems.	04

	Embedded systems time constraints	

5	**Multi core Architecture** • Multi-Core architecture for embedded systems, Programming models for Multi-Core, Embedded Multi-Core processing for networking.	04
6	**Open Source RTOS** • Basics of RTOS: Real-time concepts, Hard Real time and Soft Real-time, differences between general purpose OS & RTOS, basic architecture of an RTOS, scheduling systems, inter-process communication, performance Matric in scheduling models, interrupt management in RTOS environment, memory management, file systems, I/O systems, advantage and disadvantage of RTOS. POSIX standards, RTOS issues –selecting a Real Time Operating System, RTOS comparative study. • Interfacing Modules: Sensor and actuator interface, data transfer and control, GPS, GSM, Bluetooth,	11
	Total	39

Textbooks and References:

1. *The Definitive Guide to the ARM Cortex-M3,* Joseph Yiu, Second Edition, Elsevier Inc. 2010.
2. Andrew N Sloss, Dominic Symes, Chris Wright, *"ARM System Developer's Guide -Designing and Optimizing System Software",* 2006, Elsevier.
3. *Communicating Embedded Systems: Networks Applications,* Francine Krief (Editor) February 2010, Wiley-ISTE
4. Frank Vahid and Tony Givargis, *"Embedded System Design: A Unified Hardware/Software Introduction",* John Wiley publication
5. P Marwedel, *"Embedded System Design",* Springer publication
6. Christopher Hallinan, *"Embedded Linux Primer: A Practical Real-World Approach* Second Edition, Pearson Education Publication

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) 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, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted

bject Code	Subject Name	Credits
ETPE1023	**Optimization Methods in Signal Processing for Communication**	**03**

	Systems	

Course Pre-requisite:

- Linear Algebra

Course Objectives:

The aim of this course is

1. To develop understanding of fundamental linear algebra concepts, geometrical concepts, and basic calculus which are essential for optimization course.
2. To develop understanding of formulating a typical unconstrained and constrained optimization problem.
3. To develop understanding of types of convex optimization problems such as linear programming, geometric programming, quadratic programming, second-order cone programming, and semi definite programming.
4. To develop understanding of Lagrange's duality concepts and interior-point methods for convex optimization problems.

Course Outcomes:

Learners will be able to:

1. Apply the concepts of linear algebra for modeling research problems in the field of communications and signal processing.
2. Identify the appropriate convex optimization problem for modeling typical research problems in the field of communications and signal processing.
3. Develop algorithms for modern wireless communications and networking, e.g., optimal resource allocation, energy efficiency maximization, sum-rate maximization, optimal beam forming, etc.
4. Model and analyze the research problems for 5G and beyond wireless networks, e.g., massive MIMO networks, mm Wave networks, energy harvesting networks, UAV networks, etc.
5. Apply the optimization theory for typical signal processing applications, e.g., blind source separation for biomedica and hyper spectral image analysis, filter design, etc.

Module No.	Topics	Hrs.
1.0	**Fundamentals of Geometry and Calculus**	**08**

	Geometrical Concepts: Lines and line segments, Affine sets and affine hull, Convex sets and convex hull, Cone and conic hull, Hyper planes and half spaces, Neighborhood (Euclidean ball) and ellipsoid, Interior point, Boundary point, Open and closed sets, Boundary set, Compact set, Polyhedra, Separating and supporting hyper planes, Basics of Calculus: Sequences and limits, Affine functions, Differentiability, Derivative matrix, Hessian, Level sets and gradients, Graph, Taylor's series, Mean value theorem.	
2.0	**Introduction to Optimization**	**08**
	1) Basics of an optimization problem, Conditions for local minimizers: First order necessary condition (FONC), Second order necessary condition (SONC), Second order sufficient condition (SOSC). 2) Unconstrained Optimization Algorithms: One dimensional search algorithms: Exhaustive search, Golden section method, Fibonacci method, Bisection method, Newton's method, Secant method, Bracketing, Gradient methods: Gradient descent algorithm, Steepest descent method, Newton's method (revisited): Levenberg-Marquardt modification, Conjugate direction and gradient algorithms.	
3.0	**Convex Optimization-I**	**4**
	Convex and quasi-convex functions, Convexity preserving operations, Basic structure of convex optimization problems, Equivalent representations and transforms, Convex problems with inequality constraints.	
4.0	**CONVEX OPTIMIZATION -II**	**07**
	Linear Programming: Standard form of linear program (LP), Transformation to standard form using surplus and slack variables, Geometry of LP, Basic solutions, Fundamental theorem of LP, Graphical solution, Simplex method: Canonical augmented matrix, Updating procedure for augmented matrix, Simplex algorithm, Matrix form of Simplex method, Two-phase Simplex method, Dual LP, Non-simplex methods, Integer linear programming.	
5.0	**Convex Optimization-III**	**05**
	1) Second-order cone programming (SOCP), Semidefinite Programming (SDP): QCQP and SOCP as SDP via Schur complement, S-procedure. 2) Duality: Lagrange dual function and conjugate function, Lagrange dual problems, Strong duality: Slater's condition, S-Lemma, Karush-Kuhn-Tucker (KKT) optimality conditions.	
6.0	**Optimization Techniques**	**07**

	1) Lagrange dual optimization, Alternating direction method of multipliers (ADMM), Duality of problems with generalized inequalities, Theorems of alternatives. 2) Interior-point Methods: Inequality and equality constrained convex problems, Newton's method and barrier function, Central path, Barrier method, Primal-dual interior point method.		
		TOTAL	**39**

ESSENTIAL READING

1. C. -Y. Chi, W. -C. Li, and C. -H. Lin, Convex Optimization for Signal Processing and Communications: From Fundamentals to Applications, CRC Press , 1st Edition, 2017
2. E. K. P. Chong, and S. H. Zak, An Introduction to Optimization, Wiley , 4th Edition, 2013

SUPPLEMENTARY READING

1. S. Boyd and L. Vandenberghe, Convex Optimization, Cambridge University Press , 1st Edition, 2004
2. Gilbert Strang, Linear Algebra and its Applications, Cengage Learning , 4th Edition, 2006

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) 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, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by

Subject Code	Subject Name	Credits
ETIE1011	**Product Life Cycle management**	**03**

Course Pre-requisite:

- Microcontrollers and Programming language

Course Objectives:

The aim of this course is

- To familiarize the students with the need, benefits and components of PLM
- To acquaint students with Product Data Management & PLM strategies
- To give insights into new product development program and guidelines for designing and developing a product
- To familiarize the students with Virtual Product Development

Course Outcome:

Learners will be able to:

- Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
- Illustrate various approaches and techniques for designing and developing products.
- Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
- Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module	Detailed Content	Hours
1	**Introduction to Product Lifecycle Management (PLM)** • Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies** • Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM.	10
2	**Product Design** • Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic	09

	Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	
3	**Product Data Management** • Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
4	**Virtual Product Development Tools** • For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05
5	**Integration of Environmental Aspects in Product Design** • Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	05
6	**Life Cycle Assessment and Life Cycle Cost Analysis** • Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

Textbooks and References:

1. John Stark, ―*Product Lifecycle Management: Paradigm for 21st Century Product Realisation*‖, Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, ―*Product Design for the environment-A life cycle approach*‖, Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, Immonen Anselmie, ―*Product Life Cycle Management*‖, Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, ―*Product Lifecycle Management: Driving the next generation of lean thinking*‖, Tata McGraw Hill, 2006, ISBN: 0070636265

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) 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, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by

Subject Code	Subject Name	Credits
ETIE1012	**Reliability Engineering**	**03**

Course Objectives:

The aim of this course is

- To familiarize the students with various aspects of probability theory
- To acquaint the students with reliability and its concepts
- To introduce the students to methods of estimating the system reliability of simple and complex systems
- To understand the various aspects of Maintainability, Availability and FMEA procedure

Course Outcome:

Learners will be able to:

- Understand and apply the concept of Probability to engineering problems
- Apply various reliability concepts to calculate different reliability parameters
- Estimate the system reliability of simple and complex systems
- Carry out a Failure Mode Effect and Criticality Analysis

Module	Detailed Content	Hours
1	**Probability theory** • Probability: Standard definitions and concepts; Conditional Probability, Baye‘s Theorem. **Probability Distributions** • Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion** • Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08

2	**Reliability Concepts** • Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis** • Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models** • Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
3	**System Reliability** • System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
4	**Reliability Improvement** • Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. • System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
5	**Maintainability and Availability** • System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. • Availability – qualitative aspects.	05
6	**Failure Mode, Effects and Criticality Analysis** • Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	05

Textbooks and References:

1. L.S. Srinath, –*Reliability Engineering*‖, Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, –*Reliability and Maintainability Engineering*‖, Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, –*Engineering Reliability*‖, John Wiley & Sons, 1980.
4. P.D.T. Conor, –*Practical Reliability Engg*.‖, John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, –*Reliability in Engineering Design*‖, John Wiley & Sons.

6. Murray R. Spiegel, –*Probability and Statistics*‖, Tata McGraw-Hill Publishing Co. Ltd.

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) 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, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by

Subject Code	Subject Name	Credits
ILO1013	**Management Information System**	**03**

Course Objectives:
The aim of this course is

- The course is blend of Management and Technical field.
- Discuss the roles played by information technology in today‘s business and define various technology architectures on which information systems are built
- Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
- Identify the basic steps in systems development

Course Outcome:
Learners will be able to:

- Explain how information systems Transform Business
- Identify the impact information systems have on an organization
- Describe IT infrastructure and its components and its current trends
- Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
- Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Detailed Content	Hours
1	**Introduction To Information Systems (IS)** • Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	04
2	**Data and Knowledge Management** • Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. **Business intelligence (BI)** • Managers and Decision Making, BI for Data analysis and Presenting Results	07
3	**Ethical issues and Privacy** • Information Security, Threat to IS, and Security Controls	07
4	**Social Computing (SC)** • Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	07
5	**Computer Networks:**	06

	• Wired and Wireless technology, Pervasive computing, Cloud computing model.	
6	**Information System within Organization** • Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. • Acquiring Information Systems and Applications: Various System development life cycle models.	08

Textbooks and References:

1. Kelly Rainer, Brad Prince, *Management Information Systems*, Wiley
2. K.C. Laudon and J.P. Laudon, *Management Information Systems: Managing the Digital Firm*, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, *Managing Information Systems: Strategy and Organization*, Prentice Hall, 2008

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) 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, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by

Course Code	Course Name	Credits
ETIE1014	Design of Experiments	03

Objectives:

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to…

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
02	**Fitting Regression Models** 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08

03	**Two-Level Factorial Designs and Analysis** 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07
04	**Two-Level Fractional Factorial Designs and Analysis** 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	07
05	**Conducting Tests** 5.1 Testing Logistics 5.2 Statistical aspects of conducting tests 5.3 Characteristics of good and bad data sets 5.4 Example experiments 5.5 Attribute Vs Variable data sets	07
06	**Taguchi Approach** 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition,John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss
6. Phillip J Ross, –Taguchi Technique for Quality Engineering,‖ McGrawHill
7. Madhav S Phadke, ― Quality Engineering using Robust Design,‖ Prentice Hall

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) 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, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by student.

Subject Code	Subject Name	Credits
ETIE1015	**Operations Research**	**03**

Course Objectives:

The aim of this course is

- Formulate a real-world problem as a mathematical programming model.
- Understand the mathematical tools that are needed to solve optimization problems.
- Use mathematical software to solve the proposed models.

Course Outcome:

Learners will be able to:

- Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
- Perform sensitivity analysis to determine the direction and magnitude of change of a model‘s optimal solution as the data change.
- Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.

  Understand the applications of integer programming and a queuing model and compute important performance measures

Module	Detailed Content	Hours
1	**Introduction to Operations Research** • Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming** • Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem** • Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel‘s approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem** • Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines	14

	Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem** • Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	
2	**Queuing models** • Queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
3	**Simulation** • Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05
4	**Dynamic programming** • Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
5	**Game Theory** • Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
6	**Inventory Models** • Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

Textbooks and References:

1. Taha, H.A. "*Operations Research - An Introduction*", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "*Operations Research: Principles and Practice*", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "*Introduction to Operations Research*", Tata McGraw Hill, 2002.
4. *Operations Research*, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. *Operations Research*, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) 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, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by student.

ject Code	Subject Name	Credits
ETIE1016	**Cyber Security and Laws**	**03**

Course Objectives:

The aim of this course is

- To understand and identify different types cybercrime and cyber law
- To recognized Indian IT Act 2008 and its latest amendments
- To learn various types of security standards compliances

Course Outcome:

Learners will be able to:

- Understand the concept of cybercrime and its effect on outside world
- Interpret and apply IT law in various legal issues
- Distinguish different aspects of cyber law
- Apply Information Security Standards compliance during software design and development

Module	Detailed Content	Hours
1	**Introduction to Cybercrime** • Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	04
2	**Cyber offenses & Cybercrime** • How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in • Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	09
3	**Tools and Methods Used in Cyberline** • Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	06
4	**The Concept of Cyberspace** • E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber	08

	Law, The Evidence Aspect in Cyber Law, The Criminal Aspect in Cyber Law, Global Trends in Cyber Law, Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	
5	**Indian IT Act.** • Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	06
6	**Information Security Standard compliances** • SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	06

Textbooks and References:

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi.
2. *The Indian Cyber Law* by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. *The Information technology Act*, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. *Cyber Law & Cyber Crimes* By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security & Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security*, Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional: https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) 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, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by student.

Subject Code	Subject Name	Credits
ETIE1017	**Disaster management and Mitigation Measures**	**03**

Course Objectives:

The aim of this course is

- To understand physics and various types of disaster occurring around the world
- To identify extent and damaging capacity of a disaster
- To study and understand the means of losses and methods to overcome /minimize it.
- To understand role of individual and various organization during and after disaster
- To understand application of GIS in the field of disaster management
- To understand the emergency government response structures before, during and after disaster

Course Outcome:

Learners will be able to:

- Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
- Plan of national importance structures based upon the previous history.
- Get acquainted with government policies, acts and various organizational structure associated with an emergency.
- Get to know the simple do‘s and don‘ts in such extreme events and act accordingly.

Module	Detailed Content	Hours
1	**Introduction** • Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
2	**Natural Disaster and Manmade disasters:** • Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion • Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
3	**Disaster Management, Policy and Administration** • Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management.	06

	• Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	
4	**Institutional Framework for Disaster Management in India:** • Importance of public awareness, Preparation and execution of emergency management programme. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. • Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	06
5	**Financing Relief Measures:** • Ways to raise finance for relief expenditure, role of government agencies and NGO‘s in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO‘s and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. • International relief aid agencies and their role in extreme events.	09
6	**Preventive and Mitigation Measures:** • Pre-disaster, during disaster and post-disaster measures in some events in general • Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication • Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. • Do‘s and don‘ts in case of disasters and effective implementation of relief aids.	06

Textbooks and References:

1. ‗*Disaster Management*‘ by Harsh K.Gupta, Universities Press Publications.
2. ‗*Disaster Management: An Appraisal of Institutional Mechanisms in India*‘ by O.S.Dagur, published by Centre for land warfare studies, New

Delhi, 2011.
3. _*Introduction to International Disaster Management*‘ by Damon Copolla, Butterworth Heinemann Elseveir Publications.
4. _*Disaster Management Handbook’* by Jack Pinkowski, CRC Press Taylor and Francis group.
5. _*Disaster management & rehabilitation’* by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. _*Natural Hazards and Disaster Management*, Vulnerability and Mitigation – R B Singh, Rawat Publications

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) 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, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by student.

Subject Code	Subject Name	Credits
ETIE1018	**Energy Audit and Management**	**03**

Course Objectives:

The aim of this course is

- To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
- To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
- To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Course Outcome:

Learners will be able to:

- To identify and describe present state of energy security and its importance.
- To identify and describe the basic principles and methodologies adopted in energy audit of a utility.
- To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
- To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
- To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Detailed Content	Hours
1	**Energy Scenario** • Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
2	**Energy Audit Principles** • Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. • Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08

3	**Energy Management and Energy Conservation in Electrical System** • Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** • Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10
4	**Energy Management and Energy Conservation in Thermal Systems:** • Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. • General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
5	**Energy Performance Assessment** • On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
6	**Energy conservation in Buildings** • Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Textbooks and References:

1. *Handbook of Electrical Installation Practice*, Geofry Stokes, Blackwell Science
2. *Designing with light: Lighting Handbook*, By Anil Valia, Lighting System
3. *Energy Management Handbook*, By W.C. Turner, John Wiley and Sons
4. *Handbook on Energy Audits and Management*, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. *Energy Management Principles*, C.B.Smith, Pergamon Press
6. *Energy Conservation Guidebook*, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. *Handbook of Energy Audits*, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) 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, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by student.

Subject Code	Subject Name	Credits
ETL101	**Program Lab-I**	**01**

Course Code	Course Name		Examination Scheme		
			Term Work	Practical and Oral	Total
ETL 101	Program Lab-1		25	25	50

Course Objectives:

1. To learn the concept of impedance matching and RF filters
2. To learn Microwave amplifiers, oscillators and mixer

Course Outcomes: Learners will be able to ...

1. Analyze Bio medical signal using simulation software.
2. Analyze the performance of per processing tools using simulation software.

Term Work:

At least 08 experiments covering the entire syllabus must be given ―Batch Wise‖. Computation/simulation based experiments are also encouraged. Teacher should refer the suggested list of experiments and can design additional experiments to acquire practical design skills. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Sr. No.	Title of Experiment
1	Estimation of Periodogram and Spectrogram and Demonstrate their applications.
2	Pre-processing of Bio-electric signals
3	Wavelet analysis for denoising of Bio-electric signals
4	Wavelet transform for audio signal compression
5	Simulation of adaptive filtering and their applications
6	Generation of Chorus and flanging effects for voice record
7	Implementation of equalizers
8	Simulated generation of ECG signal and isolation of QRS complex
9	Analysis of EEG signals

- Out of 9 Experiments any 8 Experiments have to be performed.

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners. (Examiners will be from PG recognized teachers)

Subject Code	Subject Name	Credits
ETC201	**RF Engineering**	**03**

Course Pre-requisite:

- Electromagnetics and Antenna
- Microwave Engineering

Course Objectives:

The aim of this course is

- To provide state-of-art knowledge in RF circuits and microwave systems.
- To explain various methodologies presently prevalent for design of active and passive RF circuits.
- To enable students to make system level design decisions.
- To expose students to state-of-art simulation systems.
- To teach students Computer aided design tools for analysis and design of circuits

Course Outcomes:

Learners will be able to:

- Characterize devices at higher frequencies.
- Design and analyze RF circuits and components.
- Design and analyze amplifiers, oscillators and mixers at microwave frequencies.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to RF, Impedance Matching and RF Filter**	**08**
	1.1	**Introduction** Characteristics of RF Waves and applications, RF Components and Circuits: Equivalent Circuits of Concentrated Passive Components like Resistors, Capacitors, Inductors.	
	1.2	**RF Filter Design and Implementation:** Butterworth Filter, Chebyshev Filter, Stepped Impedance Filter.	
	1.3	**Analysis and design:** Strip lines, Microstrip lines and coupled lines.	
	1.4	**Impedance Matching:** Causes and effects, Techniques using L-C and distributed Parameters.	
2.0		**Device Characterization**	**06**
	2.1	Multi-port Network representation, S-parameters: Properties and characterization.	
	2.2	Spectrum Analyzer and Vector Network Analyzer Basics	
	2.3	Noise Characterization: Noise Figure, Noise temperature, Noise parameters, Noise Correlation matrix.	
3.0		**Amplifier Design**	**10**
	3.1	Two-port power gains, Stability Determination: Mathematical and Graphical	
	3.2	Single stage amplifier design: Design for Maximum Gain, Design for Specified Gain, Low Noise Amplifier design	
	3.3	Power amplifiers: Characteristics of power amplifier and classes of amplifiers, Design of Class A power amplifier	
4.0		**Frequency Generation and Mixers**	**06**
	4.1	One-port and two-port microwave oscillator design, Analysis of phase noise in oscillators.	
	4.2	Mixers: Characteristics, Types of Mixers: Single ended diode mixers, FET mixers, Balanced mixers, and Image reject mixers.	
5.0		**Electromagnetic Interference in RF circuits**	**05**
	5.1	Natural and Nuclear Sources of EMI, EMI From Apparatus and Circuits.	
	5.2	Elements Of Interference including Antennas, Transmitters, Receivers and Propagation.	
	5.3	**EMI Coupling**: **Common-Mode Coupling**: Common-Mode Coupling Mechanisms Including Field to Cable, Ground Impedance, Ground Loop and Coupling Reduction Techniques. Differential-Mode Coupling: Differential-Mode Coupling Mechanisms Including Field to Cable, Cable to Cable and Coupling Reduction Techniques.	
	5.4	**Other Coupling mechanisms:** Power Supplies and Victim Amplifiers.	
6.0		**Electromagnetic Compatibility**	**04**
	6.1	The Importance of Grounding for achieving EMC, Grounding	

		Schemes (Single Point, Multi-Point and Hybrid), Shield Grounding and Bonding. Shielding Effectiveness, Shielding Considerations (Reflective and Absorptive), Shielding Compromises (I.E., Apertures, Gaskets, Waveguide Beyond Cut-Off).	
	6.2	**EMC Specifications, Standards and Measurements.** A Review Of MIL-Standards, FCC And CISPR Requirements.	
		Total	**39**

Textbooks and References:

1. David Pozar, –*Microwave Engineering*‖, Wiley Publication, Fourth Edition
2. Matthew M. Radmanesh, –*Radio Frequency and Microwave Electronics*‖, Pearson Education.
3. David Weston F. Giannini, G. Leuzzi, –*Non-linear Microwave Circuit Design*‖, Wiley Publication.
4. David Weston –*Electromagnetic Com*patibility, Principles and Applications‖ Marcel Dekker,Second Edition

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) 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, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by student.

Subject Code	Subject Name	Credits
ETC202	**Modern Digital Communication**	**03**

Course Pre-requisite:

- Digital communication
- Random Signal Analysis

Course Objectives:

The aim of this course is to let the students obtain

- Fundamentals of modern communication system
- Ability to analyze and design digital communication systems

Course Outcome:

Learners will be able to:

- Explain and implement different source coding techniques
- Analyze waveform receivers for coherent and non-coherent communication
- Describe and design of band-limited channels
- Evaluate the detection and estimation of signals in the presence of noise.
- Explain the characteristics of fading channels.

Module	Detailed Content	Hours
1	**Source Coding** • Average ,mutual information & entropy • Coding for discrete sources • The Lempel algorithm(LZ-77,LZ-78,LZW) • Coding for analog sources -Temporal waveform coding • Spatial waveform coding	06

2	**Coherent Communication with Waveforms** • Binary cross-correlation receivers • Matched filter receivers • M-ary waveform receivers • Time-sampling approach • Karhunen-Loeve(K-L) Expansion approach • Whitening approach • Real and complex signal models • Effect of Data Imperfect Carrier Synchronization • Effect of Data Imperfect bit synchronization	07
3	**Non Coherent Communication with Waveforms** • Non Coherent receivers in random phase channels • Optimum M-FSK receivers • Non coherent receivers in random amplitude and phase channels • Optimum receivers in Rayleigh channels • Optimum receivers in Rician channels	07
4	**Signal Design for Channel and Equalization** • Design of band limited signals with controlled ISI • Symbol by symbol sub optimum detection • Introduction to linear equalizer • Means square error (MSE) criterion • Iterative equalization and decoding • Introduction to adaptive equalization • The LMS Algorithm	07
5	**Optimum Detection and Estimation** • Noise vector in signal space • Bayes detection of received signal • Decision region & minimum error probability • Optimum detection of several special comm. signals	06
6	**Fading Channels** • Small scale multipath propagation • Parameters of mobile multipath channels • Types of small scale fading • Rayleigh and Rician distribution	06
	Total	39

Textbooks and References:

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, Fundamental & Application* by Bernard Sklar,

Pabitra Kumar Ray, 2nd Edition , Pearson Publication
4. *Wireless communication principles and practice* by Theodore S. Rappaport, 2nd Edition , Pearson Publication

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) 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, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by student.

Subject Code	Subject Name	Credits
ETPE2011	**Satellite Networking**	**04**

Course Pre-requisite:

- Satellite Communication and Networks
- Internet Voice and Mobile Communication

Course Objectives:

The aim of this course is

- To understand and learn advanced networking techniques with satellite systems
- To be able to devise link budget model of satellite communication for specific applications
- To be able to apply knowledge to upgrade satellite communication systems

Course Outcome:

Learners will be able to:

- Perform link budget for specific satellite application
- Learn different advanced satellite networking concepts
- Understand usage of lasers in satellites and satellite service applications

Module	Detailed Content	Hours
1	**Introduction** • Origin of satellite communications, Development, space and ground segments, types of orbits, evolution of satellite communication, Development of satellite services and Launching mechanism in the Geostationary orbit, Orbits and orbital perturbations	08
2	**System Segment and Link Analysis** • AOCS, TTC, Equipment Reliability and Space qualifications, Link analysis	06
3	**Satellite Networks Architecture and organization** • Applications and services of satellite network, network reference models, Architecture, On board connectivity, frame organisation, Window organization	06
4	**Laser Satellite Communications** • Link introduction, optical satellite link transmitter, Receiver, satellite beam acquisition, Tracking and positioning, Single hop satellite connections, multi hop satellite connections, inter satellite links	07
5	**Specific Satellite Network** • Study of IRIDIUM and GLOBALSTAR Synchronous Digital Hierarchy (SDH), Integrated services digital networks (ISDN),	06

	ISDN over satellite, Interworking with heterogeneous networks, Case studies - satellite image analysis and photogrammetry.	
6	**Satellite Applications** • Communication applications (ATM service, DTH service, TV broadcast), Earth observation applications (Urban planning, Oceanography, resource management, agriculture services), Meteorology applications weather forecasting,	06
	Total	39

Textbooks and References:

1. *Satellite Communication Systems, Techniques and Technology* -5th Edition by Gerard Maral and Michel Bousquet, John Wiley Publication (Text book for chapter-1 to 5)
2. *Mobile Satellite Communication Networks* – By Ray Sheriff, Y. Fun Hu, John Wiley Publication (Text book for chapter-1 to 3)
3. *Satellite Networking: Principles and Protocols* 2nd Edition by Zhili Sun, John Wiley Publication (Text book for chapter-3 & 5)
4. *Satellite Communications* by Roddy Dennis, 5th Edition, McGraw Hill Education Publication (Reference book)
5. *Satellite Communication* – Timothy Pratt, C. Boustian, J. Allmuti, Wiley Publication (Reference Book)

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) 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, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by student.

Subject Code	Subject Name	Credits
ETDLO2022	**Network and Cyber Security**	**04**

Course Pre-requisite:

- Computer Communication Networks
- Operating System
- Probability Theory and Random Processes

Course Objectives:

The aim of this course is

- To introduce advanced techniques to implement security mechanisms using IDS, Firewall, and Antivirus and Biometrics, Incident handling and Forensics
- To discuss security implications on Organizations, security standards and Cyber laws.

Course Outcome:

Learners will be able to:

- Describe security threats and apply security techniques using cryptosystems.
- Explain the key terms and concepts in cyber law, intellectual property and cyber crimes, trademarks and domain theft
- Build and configure firewall and intrusion detections systems‘ using GNU open source security tools.
- Incorporate approaches for incident analysis and response, for risk management and best practices and digital evidence collection, and evidentiary reporting in forensic acquisition

Module	Detailed Content	Hours
1	**Introduction to Network and Cyber Security** • Need for network security, Attacks and Their classification, • Network Vulnerabilities and control • Security services and mechanisms, • Impact of Security on Enterprises • Risk Factors and Cost Analysis.	04
2	**Cryptography and Cryptosystems** • Classical and modern cryptography, stream and block ciphers, • Message digest, digital signature, digital certificate, certificate authority, cryptanalysis • DES/AES/RSA/RC4/MD5/SHA algorithms • Secure protocols SSL, IPSec, VPN,PKI	7
3	**Ethical Hacking and Network Differences**	8

	• Cybercrimes, Cybercriminals, Cyberoffences, Cybercrimes in Mobile and Wireless Devices, Tools and Methods used in Cybercrimes • Network reconnaissance, scanning and sniffing, gaining access. • Security Technologies: Firewall, IDS and Antivirus, Reverse proxy • L7 content filtering firewall, NAT & reverse proxy, Firewall deployment and limitations, selection of firewalls. Performance analysis of firewall. • Signature and Anamoly based IDSs, IDS deployment, zone diagram, performance analysis of IDS, strengths and limitations of IDS	
4	**Cybersecurity Principles and best Practices** • Layered Defense, Surveillance and Reconnaissance Outsider/Internal Threat Protection, • Privacy, Intellectual Property, Professional Ethics, Freedom of Speech, Fair User and Ethical Hacking, Trademarks ,Internet Fraud ,Electronic Evidence.	6
5	**Cybersecurity Implications on Organizations, Standards and Cyber laws** • Risk Management: Asset Evaluation and Business Impact Analysis, Risk Identification, Risk Quantification, Risk Response Development and Control Security Policy, Compliance, and Business Continuity. • Cyber Incident Preparation: Incident Detection and Analysis, Containment, Eradication, and Recovery ,Proactive and Post-Incident Cyber Services • Forensics: Forensic Technologies ,Digital Evidence Collection ,Evidentiary Reporting • The Indian IT Act and new amendments.	8
6	**System Security and Case Study** • Security Operations Center (SOC), Network Operations Center (NOC), • Network Security Audit • SET, Biometric Security, Digital Immune System • Cloud Security. Wi-Fi Security, Mobile and Cellular Security.	6

Textbooks and References:

1. *Cryptography and Network Security* by Behrouz Forouzan McGrawHill Publications
2. *Security in Computing* by Pfleeger and Pfleeger, Pearson Publications
3. *Management of Information Security* by M. Whitman Cengage Publications
4. Cengage Learning India, *Network Security and Cryptography* by B. Menezes.

5. *Computer Security* by Matt Bishop, Pearson Publication
6. *Cryptography and Network Security* by William Stallings, Pearson publications.
7. *Cyber Security* by Nina Godbole, John Wiley Publications
8. *Information Security: Principles and Practice,* 2nd edition by Mark Stamp and Deven Shah.
9. *Data Communication & Network Security* by Houston Carr and Charles Snyder, McGraw-Hill Publication.

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) 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, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by student.

Subject Code	Subject Name	Credits
ETPE2013	**Remote Sensing**	**03**

Course Pre-requisite:

- Digital Image Processing

Course Objectives:

The aim of this course is

- To provide exposure to students in gaining knowledge on concepts and applications of Remote Sensing
- To give exposure to participants for Digital Image Processing with more emphasis on classification
- To acquire skills in advance techniques such as hyper spectral, thermal and microwave for mapping and monitoring.

Course Outcome:

Learners will be able to:

- Demonstrate detailed, integrated knowledge of the application and history of remote sensing
- Discuss the nature of electromagnetic radiation and its interaction with the earth's surface and atmosphere
- Demonstrate a critical understanding of the differences between remote sensing systems and be aware of their characteristics and limitations
- Critically identify specific applications where remote processing may be used as a tool for monitoring and research.

Module	Detailed Content	Hours

1	**Introduction to Remote Sensing** • What is Remote Sensing (RS)? Characteristics/elements of RS systems, Electromagnetic Radiation Electromagnetic Spectrum, Polarization, Interactions with the Atmosphere (Absorption, Scattering: Rayleigh, Mie, Non selective, absorption), Radiation - Target interactions, Passive vs. Active Sensing, Basic Image processing concepts: Image as a matrix, B/W and Colour (RGB)	06
2	**Sensors** • Ground and Air, Satellite Characteristics: orbits, swaths, Spatial Resolution, Pixel Size (IFOV, resolution cell), Spectral, Radiometric, Temporal Resolution, Cameras and Aerial Photography, Multispectral and Hyperspectral Scanning, Thermal Imaging, Geometric Distortion, Different Satellites:	08
	All Weather Satellites, Land Observation, Marine Observation, LIDAR, FLIR, RADAR, Side looking Radar.	
3	**Microwave Remote Sensing** • Introduction, RADAR Basics, Viewing Geometry, RADAR Image Distortions, Target Interaction and Image Appearance, RADAR Image Properties, RADAR Polarimetry (Polarization, Signatures, Backscatter, Parameters Affecting Backscatter, Applications), Synthetic Aperture RADAR (SAR), Airborne and Spaceborne Radars.	7
4	**Image Transforms** • Visual Image Analysis (tone, shape, size, pattern, texture, shadow, and Association), Digital Image Processing steps (Pre-processing, Enhancement, Transformation and Classification), Contrast Enhancement: Global, Local Techniques, Filtering, Image Transformations: Arithmetic Operations (Subtraction, Spectral Ratio, NDVI, PCT, FT,)	07
5	**Image Classification and Analysis** • Visual Interpretation, Image Classification: Optimum band selection, Supervised (Minimum Distance, Parallelopiped and Maximum Likelihood), Assessment of Classification Accuracy (Confusion or Error Matrix, Omission and Commission Error, Kappa Coefficient), Unsupervised Classification techniques: K-means,	7
6	**Applications of Remote Sensing** • Agriculture, Forestry, Land Cover/ Land Use Mapping, Water Resources, Snow and Glacier, Wetland Management, Oceans and Coastal, Soil Moisture	04

	Total	39

Textbooks and References:

Textbooks:

1. *Fundamentals of Remote Sensing***,** George Joseph, Universities Press; Second Edition, ISBN-10: 817371535, ISBN-13: 978-8173715358
2. *Remote Sensing: Models and Methods for Image Processing***,** Robert A. Schowengerdt, Academic Press, Third Edition, ISBN-10: 8131203182, ISBN-13: 978-8131203187
3. *Remote Sensing and Image Interpretation***,** Lillesand, Kiefer, Chipman, Wiley, Sixth Edition, ISBN-10: 8126532238, ISBN-13: 978-8126532230

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) 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, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by student.

Subject Code	Subject Name	Credits
ETPE2021	**Error Control Coding**	**03**

Course Pre-requisite:

- Digital Communication
- Applied Maths

Course Objectives:

The aim of this course is

- To provide students a sound knowledge of traditional and modern coding theory, the motivation behind synthesis of channel coding techniques.

Course Outcome:

Learners will be able to:

- Design channel codes for the physical layer and storage applications
- Design new channel codes for wired/wireless communication systems

Module	Detailed Content	Hours
1	**Introduction to Algebra** • Groups, Fields, Binary Field Arithmetic, Construction of Galois Field GF (2m) and its basic properties, Computation using Galois Field GF (2m) Arithmetic, Vector spaces and Matrices.	06

2	**Linear Codes** • 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, Decoding circuits, Hamming Codes, Reed – Muller codes, Golay code, Product codes and Interleaved codes. • Cyclic Codes: Introduction, Generator and Parity check Polynomials, Encoding using Multiplication circuits, Systematic Cyclic codes – Encoding using Feedback shift register circuits, Generator matrix for Cyclic codes, Syndrome computation and Error detection, Meggitt decoder, Error trapping decoding, Cyclic Hamming codes, Golay code, Shortened cyclic codes.	08
3	**BCH Codes** • Binary primitive BCH codes, Decoding procedures, Implementation of Galois field Arithmetic, Implementation of Error correction. Non – binary BCH codes: q – ary Linear Block Codes, Primitive BCH codes over GF (q), Reed – Solomon Codes, Decoding of Non – Binary BCH and RS codes: The Berlekamp - Massey Algorithm.	06
4	**Convolutional Codes** • Encoding of Convolutional codes, Structural properties, Distance properties, Viterbi Decoding Algorithm for decoding, Soft – output Viterbi Algorithm, Stack and Fano sequential decoding Algorithms, Majority logic decoding.	07
5	**Concatenated Codes and Turbo Codes** • Single level Concatenated codes, Multilevel Concatenated codes, Soft decision Multistage decoding, Concatenated coding schemes with Convolutional Inner codes.	06
6	**Burst Error Correcting Codes** • Burst and Random error correcting codes, Concept of Inter – leaving, cyclic codes for Burst Error correction – Fire codes, Convolutional codes for Burst Error correction.	06
	Total	39

Textbooks and References:

1. Shu Lin & Daniel J. Costello, Jr. *"Error Control Coding"* Prentice Hall, Second Edition, 2004.
2. S. B Wicker, *Error Control Systems for Digital Communication and Storage*, Prentice

Hall International, 1995.
3. Blahut R. E, *Theory and Practise of Error Control Codes*, Addisson Wesley, 1983
4. Blahut R.E., *Algebraic codes for Data transmission*, Cambridge University Press, 2003.

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) 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, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by student.

Subject Code	Subject Name	Credits
ETPE2022	**Wireless Adhoc and Sensor Networks**	**03**

Course Pre-requisite:

- Computer Networks
- Wireless Networks

Course Objectives:

The aim of this course is to let the students

- To understand the Wireless adhoc and sensor Network.
- To understand the major challenges and designing issues in designing wireless sensor and adhoc networks.
- To understand various MAC and routing protocols in wireless sensor and adhoc networks.
- To Understand Heterogeneous network architecture including MANET, WLAN, Cellular Networks.

Course Outcome:

Learners will be able to:

- Understand and explain the concept of adhoc and sensor networks and their applications.

- Set up and evaluate performance of various protocols in wireless sensor and adhoc networks.
- Understand TCP performance over adhoc network.
- Understand integration of MANET, cellular Network and WLAN.

Module	Detailed Content	Hours
1	**Introduction to MANET and Wireless Sensor Network** • Challenges and Applications of MANET, Design issues and application of sensor Network, Sensing and Communication Range, Energy and Clustering of sensors, Wireless mesh Network, Architecture and Challenging technologies.	06
2	**Routing in Adhoc Networks** • Introduction, Topology-Based versus Position-Based Approaches, Topologies-Based Routing Protocols, Position-Based Routing, Other Routing Protocols, Wireless LAN, Wireless PAN, Wireless BAN .	06
3	**Broadcasting, Multicasting, Geocasting and QoS in MANET** • Introduction, The Broadcast Storm, Multicasting, Geocasting, QOS requirements, objectives and Architecture	06
4	**TCP over Adhoc Networks** • Introduction, TCP Protocol Overview, TCP and MANETs,	06
	Solutions for TCP over Adhoc.	
5	**Design Consideration in Sensor Network** • Introduction, Classifications of WSNs, MAC Layer, Routing Layer, High Level Application Layer Support, Adapting to the Inherent Dynamic Nature of WSNs, Cognitive Radio based sensor Networks. Nano Sensor Networks.	09
6	**Integrating MANETs, WLANs and Cellular Networks** • Introduction, Ingredients of a Heterogeneous Architecture, Protocol Stack, Comparison of the Integrated Architectures.	06
	Total	39

Textbooks and References:

1. *Adhoc & Sensor Networks Theory and Applications* by Cordeiro, Agrawal, Cambridge University Press India Pvt. Ltd, Edition 2010.
2. *Adhoc Wireless Networks Architecture and Protocols* by C.Siva Ram Murthy and B.S.Manoj, Pearson.
3. *Adhoc & Sensor Networks* by Houda Labiod, Wiley.
4. *Wireless Communication and Networking*-Vijay Garg, Elsevier Inc.

5. *Wireless and Mobile Networks, Concepts and Protocols* by Manvi, Kakkasageri, second edition, Wiley.

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) 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, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by student.

Subject Code	Subject Name	Credits
ETPE2023	**Cognitive Radio**	**03**

Course Pre-requisite:

- Digital communication

Course Objectives:

The aim of this course is to let the students

- This subject introduces the fundamentals of multi rate signal processing and cognitive radio.
- To understand the working of cognitive radio.
- To understand the major challenges and designing issues in using the bandwidth

Course Outcome:

Learners will be able to:

- Gain knowledge on multirate systems.
- develop the ability to analyze, design, and implement any application using
- Be aware of how signal processing concepts can be used for efficient FPGA based system design.
- understand the rapid advances in Cognitive radio technologies

- explore DDFS, CORDIC and its application

Text Books

1. J. H. Reed, –Software Radio‖, Pearson, 2002.
2. U. Meyer – Baese , –Digital Signal Processing with FPGAs‖, Springer, 2004.
3. H. Arslan –Cognitive Radio, Software Defined Radio and Adaptive Wireless Systems‖, University of South Florida, USA, Springer, 2007.

Reference Books

1. S. K. Mitra, –Digital Signal processing‖, McGrawHill, 1998
2. K.C.Chen, R.Prasad , –Cognitive Radio Networks‖ , Wiley, 2009-06-15.
3. T. W. Rondeau, C.W.Bostian, ―Artificial Intelligence in Wireless Communications‖ ,2009.
4. Tusi, –Digital Techniques for Wideband receivers‖, Artech House, 2001.
5. T. DarcChiueh, P. Yun Tsai,‖ OFDM baseband receiver design for wireless communications‖, Wiley, 2007

Module	Detailed Content	Hours
1	Filter banks-uniform filter bank. direct and DFT approaches. Introduction to ADSL Modem. Discrete multitone modulation and its realization using DFT. QMF.STFT.Computation of DWT using filter banks.	08
2	DDFS- ROM LUT approach. Spurious signals, jitter. Computation of special functions using CORDIC. Vector and rotation mode of CORDIC.CORDIC architectures.	06
3	Block diagram of a software radio. Digital down converters and demodulators Universal modulator and demodulator using CORDIC. Incoherent demodulation - digital approach for I and Q generation, special sampling schemes. CIC filters. Residue number system and high speed filters using RNS. Down conversion using discrete Hilbert transform. Under sampling receivers, Coherent demodulation schemes	09
4	Concept of Cognitive Radio, Benefits of Using SDR, Problems Faced by SDR, Cognitive Networks,Cognitive Radio Architecture. Cognitive Radio Design, Cognitive Engine Design,	04

5	A Basic OFDM System Model, OFDM based cognitive radio, Cognitive OFDM Systems, MIMO channel estimation, Multi-band OFDM, MIMO-OFDM synchronization and frequency offset estimation.	06
6	Spectrum Sensing to detect Specific Primary System, Spectrum Sensing for Cognitive OFDMA Systems.	06
	Total	39

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) 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, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by student.

Subject Code	Subject Name	Credits
ETIE2011	**Project Management**	**03**

Course Objectives:

The aim of this course is

- To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
- To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Course Outcome:

Learners will be able to:

- Apply selection criteria and select an appropriate project from different options.

- Write work break down structure for a project and develop a schedule based on it.
- Identify opportunities and threats to the project and decide an approach to deal with them strategically.
- Use Earned value technique and determine & predict status of the project.
- Capture lessons learned during project phases and document them for future reference

Module	Detailed Content	Hours
1	**Project Management Foundation:** • Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	05
2	**Initiating Projects:** • How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	06
3	**Project Planning and Scheduling** • Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).	8
4	**Planning Projects** • Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. • Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	06

5	**Executing Projects:** • Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. • Team management, communication and project meetings. **Monitoring and Controlling Projects:** • Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **Project Contracting** • Project procurement management, contracting and outsourcing	08
6	**Project Leadership and Ethics:** • Introduction to project leadership, ethics in projects. • Multicultural and virtual projects. **Closing the Project:** • Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	06

Textbooks and References:

1. Jack Meredith & Samuel Mantel, *Project Management: A managerial approach*, Wiley India, 7th Ed.
2. *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*, 5th Ed, Project Management Institute PA, USA
3. Gido Clements, *Project Management*, Cengage Learning.

4. Gopalan, *Project Management*, , Wiley India
5. Dennis Lock, *Project Management*, Gower Publishing England, 9th Ed.

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 paper. Minimum 80% syllabus syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

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Subject Code	Subject Name	Credits
ETIE2012	**Finance Management**	**03**

Course Objectives:

The aim of this course is

- Overview of Indian financial system, instruments and market
- Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
- Knowledge about sources of finance, capital structure, dividend policy

Course Outcome:
Learners will be able to:

- Understand Indian finance system and corporate finance
- Take investment, finance as well as dividend decisions

Module	Detailed Content	Hours
1	**Overview of Indian Financial System** • Characteristics, Components and Functions of Financial System. **Financial Instruments** • Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets** • Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions** • Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
2	**Concepts of Returns and Risks** • Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous • Discounting	06

3	**Overview of Corporate Finance** • Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis** • Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	09
4	**Capital Budgeting** • Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management** • Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity‘s Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	10
5	**Sources of Finance** • Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure** • Factors Affecting an Entity‘s Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	05
6	**Dividend Policy** • Meaning and Importance of Dividend Policy; Factors Affecting an Entity‘s Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon‘s Approach, Walter‘s Approach, and Modigliani-Miller Approach	03

Textbooks and References:

1. *Fundamentals of Financial Management*, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. *Analysis for Financial Management*, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. *Indian Financial System*, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. *Financial Management*, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

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 paper. Minimum 80% syllabus syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Credits
ETIE2013	**Entrepreneurship Development and Management**	**03**

Course Objectives:

The aim of this course is

- To acquaint with entrepreneurship and management of business
- Understand Indian environment for entrepreneurship
- Idea of EDP, MSME.

Course Outcome:

Learners will be able to:

- Understand the concept of business plan and ownerships
- Interpret key regulations and legal aspects of entrepreneurship in India
  Understand government policies for entrepreneurs

Module	Detailed Content	Hours
1	**Overview Of Entrepreneurship** • Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership • Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
2	**Business Plans And Importance Of Capital To Entrepreneurship** • Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur • **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
3	• Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05

4	**Indian Environment for Entrepreneurship** • Key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08
5	**Effective Management of Business** • Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
6	**Achieving Success In The Small Business** • Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

Textbooks and References:

1. Poornima Charantimath, *Entrepreneurship development- Small Business Enterprise*, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, *Entrepreneurship,* latest edition, The McGrawHill Company
3. Dr TN Chhabra, *Entrepreneurship Development*, Sun India Publications, New Delhi
4. Dr CN Prasad, *Small and Medium Enterprises in Global Perspective*, New century Publications, New Delhi
5. Vasant Desai, *Entrepreneurial development and management*, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, *Entrepreneurship*, Excel Books
7. Rashmi Bansal, *STAY hungry STAY foolish*, CIIE, IIM Ahmedabad
8. *Law and Practice relating to Micro, Small and Medium enterprises*, Taxmann Publication Ltd.
9. Kurakto, *Entrepreneurship- Principles and Practices*, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

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 paper. Minimum 80% syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Credits
ETIE2014	**Human Resource Management**	**03**

Course Objectives:
The aim of this course is

- To introduce the students with basic concepts, techniques and practices of the human resource management.
- To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations.
- To familiarize the students about the latest developments, trends & different aspects of HRM.
- To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.

Course Outcome:
Learners will be able to:

- Understand the concepts, aspects, techniques and practices of the human resource management.
- Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
- Gain knowledge about the latest developments and trends in HRM.
- Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Content	Hours
1	**Introduction to HR** • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	05
2	**Organizational Behavior (OB)** • Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness	07

	• Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior. • Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor) • Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study	
3	**Organizational Structure &Design** • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	06
4	**Human resource Planning** • Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. • Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning. • Training & Development: Identification of Training Needs, Training Methods	05
5	**Emerging Trends in HR** • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment • Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	06

6	**HR & MIS** • Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM** • Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals **Labor Laws & Industrial Relations**	05
	• Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	

Textbooks and References:

1. Stephen Robbins, *Organizational Behavior*, 16th Ed, 2013
2. V S P Rao, *Human Resource Management*, 3rd Ed, 2010, Excel publishing
3. Aswathapa, *Human resource management: Text & cases*, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, *Dynamics of Industrial Relations in India*, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, *Essentials of Human Resource management and Industrial relations*, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, *Management & Organizational Behavior*, Latest Ed, 2016, Pearson Publications

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 paper. Minimum 80% syllabus syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Credits
ETIE2015	**Professional Ethics and Corporate Social Responsibility (CSR)**	**03**

Course Objectives:
The aim of this course is

- To understand professional ethics in business
- To recognized corporate social responsibility

Course Outcome:
Learners will be able to:

- Understand rights and duties of business
- Distinguish different aspects of corporate social responsibility
- Demonstrate professional ethics
- Understand legal aspects of corporate social responsibility

Module	Detailed Content	Hours
1	**Professional Ethics and Business:** • The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
2	**Professional Ethics in the Marketplace** • Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment** • Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
3	**Professional Ethics of Consumer Protection** • Markets and Consumer Protection; Contract View of Business Firm‘s Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination** • Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
4	**Introduction to Corporate Social Responsibility** • Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. • Trajectory of Corporate Social Responsibility in India	05

5	**Corporate Social Responsibility** • Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
6	**Corporate Social Responsibility in Globalizing India** • Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility— Companies Act, 2013.	08

Textbooks and References:

1. *Business Ethics: Texts and Cases from the Indian Perspective (2013)* by Ananda Das Gupta; Publisher: Springer.
2. *Corporate Social Responsibility: Readings and Cases in a Global Context (2007)* by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. *Business Ethics: Concepts and Cases*, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. *Corporate Social Responsibility in India (2015)* by Bidyut Chakrabarty, Routledge, New Delhi.

Assessment

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Subject Code	Subject Name	Credits
ETIE2016	**Research Methodology**	**03**

Course Objectives:

The aim of this course is

- To understand Research and Research Process
- To acquaint students with identifying problems for research and develop research strategies
- To familiarize students with the techniques of data collection, analysis of data and interpretation

Course Outcome:

Learners will be able to:

- Prepare a preliminary research design for projects in their subject matter areas
- Accurately collect, analyze and report data
- Present complex data or situations clearly
  Review and analyze research findings

Module	Detailed Content	Hours
1	**Introduction and Basic Research Concepts** • Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle.Research methods vs Methodology • Need of Research in Business and Social Sciences • Objectives of Research • Issues and Problems in Research • Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	09
2	**Types of Research** • Basic Research • Applied Research • Descriptive Research • Analytical Research • Empirical Research • Qualitative and Quantitative Approaches	07
3	**Research Design and Sample Design** • Research Design – Meaning, Types and Significance • Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	07

4	**Research Methodology**
	• Meaning of Research Methodology
	• Stages in Scientific Research Process:
	  • Identification and Selection of Research Problem
	  • Formulation of Research Problem
	  • Review of Literature
	  • Formulation of Hypothesis
	  • Formulation of research Design
	  • Sample Design
	  • Data Collection
	  • Data Analysis
	  • Hypothesis testing and Interpretation of Data
	  • Preparation of Research Report
		08

5	**Formulating Research Problem** • Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	04
6	**Outcome of Research** • Preparation of the report on conclusion reached • Validity Testing & Ethical Issues • Suggestions and Recommendation	04

Textbooks and References:

1. Dawson, Catherine, 2002, *Practical Research Methods*, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, *Research Methodology-Methods and Techniques*, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, *Research Methodology-A Step-by-Step Guide for Beginners*, (2nded), Singapore, Pearson Education

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Subject Code	Subject Name	Credits
ETIE2017	**IPR and Patenting**	**03**

Course Objectives:
The aim of this course is

- To understand intellectual property rights protection system
- To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
- To get acquaintance with Patent search and patent filing procedure and applications

Course Outcome:
Learners will be able to:

- Understand Intellectual Property assets
- Assist individuals and organizations in capacity building
- Work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Content	Hours
1	**Introduction to Intellectual Property Rights (IPR)** • Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment** • Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
2	**Enforcement of Intellectual Property Rights** • Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement **Indian Scenario of IPR** • Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
3	**Emerging Issues in IPR** • Challenges for IP in digital economy, e-commerce, human	05

	genome, biodiversity and traditional knowledge etc.	
4	**Basics of Patents** • Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
5	**Patent Rules** • Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
6	**Procedure for Filing a Patent (National and International)** • Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication etc, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases** • Important websites, Searching international databases	07

Textbooks and References:

1. Rajkumar S. Adukia, 2007, *A Handbook on Laws Relating to Intellectual Property Rights in India*, The Institute of Chartered Accountants of India
2. Keayla B K, *Patent system and related issues at a glance*, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, *Intellectual Property Law in India*, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, *Intellectual Property and Human Development: Current Trends and Future Scenario*, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, *Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right*, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, *The enforcement of Intellactual Property Rights: A Case Book*, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, *Intellectual Property Rights*, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, *Intellectual Property Rights*, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, *Intellectual Property Rights*, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, *Fundamentals of IPR for Engineers*, 1st Edition, BS Publications

11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, *A Manual on Intellectual Property Rights*.
12. Mathew Y Maa, 2009, *Fundamentals of Patenting and Licensing for Scientists and Engineers*, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi**,** *IPR: Drafting, Interpretation of Patent Specifications and Claims***,** New India Publishing Agency
14. Vivien Irish, 2005, *Intellectual Property Rights for Engineers*, IET
15. Howard B Rockman, 2004, *Intellectual Property Law for Engineers and scientists*, Wiley-IEEE Press

Assessment

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Subject Code	Subject Name	Credits
ETIE2018	**Digital Business Management**	**03**

Course Objectives:

The aim of this course is

- To familiarize with digital business concept
- To acquaint with E-commerce
- To give insights into E-business and its strategies

Course Outcome:

Learners will be able to:

- Identify drivers of digital business
- Illustrate various approaches and techniques for E-business and management
- Prepare E-business plan

Module	Detailed Content	Hours
1	**Introduction to Digital Business** • Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts • Difference between physical economy and digital economy, **Drivers of digital business** • Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) • Opportunities and Challenges in Digital Business,	09
2	**Overview of E-Commerce** • **E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement • B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals • Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing • EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06
3	**Digital Business Support services**	06

	• ERP as e –business backbone, knowledge Tope Apps, Information and referral system **Application Development** • Building Digital business Applications and Infrastructure	
4	**Managing E-Business** • Managing Knowledge, Management skills for e-business, Managing Risks in e –business • Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	**E-Business Strategy** • E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, • E-business strategy into Action, challenges and E-Transition • (Process of Digital Transformation)	04
6	**Materializing e-business** • From Idea to Realization-Business plan preparation • Case Studies and presentations	08

Textbooks and References:

1. A textbook on E-commerce**,** Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. *E-commerce from vision to fulfilment*, Elias M. Awad, PHI-Restricted, 2002
3. *Digital Business and E-Commerce Management*, 6th Ed, Dave Chaffey, Pearson, August 2014
4. *Introduction to E-business-Management and Strategy*, Colin Combe, ELSVIER, 2006
5. *Digital Business Concepts and Strategy*, Eloise Coupey, 2nd Edition, Pearson
6. *Trend and Challenges in Digital Business Innovation*, Vinocenzo Morabito, Springer
7. *Digital Business Discourse* Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. *Perspectives the Digital Enterprise –A framework for Transformation*, TCS consulting journal Vol.5
10. *Measuring Digital Economy-A new perspective* -DOI:10.1787/9789264221796-en OECD Publishing

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End Semester Examination:	Some guidelines for setting the question paper. Minimum 80% syllabus syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Credits
ETIE2019	**Environmental Management**	**03**

Course Objectives:

The aim of this course is

- Understand and identify environmental issues relevant to India and global concerns
- Learn concepts of ecology
- Familiarise environment related legislations

Course Outcome:

Learners will be able to:

- Understand the concept of environmental management
- Understand ecosystem and interdependence, food chain etc.
- Understand and interpret environment related legislations

Module	Detailed Content	Hours
1	**Introduction and Definition of Environment** • Significance of Environment Management for contemporary managers, Career opportunities. • Environmental issues relevant to India, Sustainable Development, The Energy scenario.	10
2	**Global Environmental concerns** • Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
3	**Concepts of Ecology** • Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
4	• Scope of Environment Management, Role & functions of Government as a planning and regulating agency. • Environment Quality Management and Corporate Environmental Responsibility	10
5	• Total Quality Environmental Management, ISO-14000, EMS certification.	05
6	• General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

Textbooks and References:

1. *Environmental Management: Principles and Practice*, C J Barrow, Routledge Publishers London, 1999
2. *A Handbook of Environmental Management* Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. *Environmental Management*, T V Ramachandra and Vijay Kulkarni, TERI Press
4. *Indian Standard Environmental Management Systems* — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. *Environmental Management: An Indian Perspective*, S N Chary and Vinod Vyasulu, Maclillan India, 2000
6. *Introduction to Environmental Management*, Mary K Theodore and Louise Theodore, CRC Press
7. *Environment and Ecology*, Majid Hussain, 3rd Ed. Access Publishing.2015

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.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETL201	Program Lab-1	--	2 hrs	--	--	1	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ETL201	Program Lab-1	--	--	--	--	--	25	25	50

Course Objectives:

3. To learn the concept of impedance matching and RF filters
4. To learn Microwave amplifiers, oscillators and mixer

Course Outcomes: Learners will be able to ...

3. Analyze impedance matching networks using simulation software.
4. Analyze RF filter, amplifiers, oscillators and mixer using simulation software.

Term Work:

At least 08 experiments covering the entire syllabus must be given ―Batch Wise‖. Computation/simulation based experiments are also encouraged. Teacher should refer the suggested list of experiments and can design additional experiments to acquire practical design skills. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Suggested List of experiments:

1. To Study the non-ideal characteristics of Lumped elements using spectrum/network analyzer.
2. Analysis of the Low-Pass and High pass composite filter design using simulation software.
3. Analysis of the filter design by Insertion Loss method using simulation software.
4. Study the impedance matching in case of real and imaginary loads using simulation software.
5. Analysis of a Low Noise Amplifier (LNA)using simulation software.
6. Analysis of Microwave Oscillator using simulation software and its demonstration using spectrum analyzer.
7. Measurement of gain factor & tunable bandwidth of voltage control oscillator (VCO) using spectrum analyzer.
8. Analysis of simple mixer using time domain and frequency domain response using simulation software.
9. Demonstrate the different stages of microwave amplifier using spectrum analyzer. Common-Mode Currents and Radiated Emissions of Cables