BMS COLLEGE OF ENGINEERING, BENGALURU-19

Autonomous Institute, Affiliated to VTU

Department of Electronics and Communication Engineering

Scheme and Syllabus: M. Tech. (Digital Communication Engineering)

Batch 2016 onwards

INSTITUTE VISION

Promoting Prosperity of mankind by augmenting human resource capital through Quality Technical Education & Training.

INSTITUTE MISSION

Accomplish excellence in the field of Technical Education through Education, Research and Service needs of society.

DEPARTMENT VISION

To emerge as a Centre of Academic Excellence in Electronics, Communication and related domains through Knowledge acquisition and Knowledge dissemination meeting the global needs and standards.

DEPARTMENT MISSION

Imparting quality education through state of the art curriculum, conducive learning environment and Research with scope for continuous improvement leading to overall Professional Success.

PROGRAM EDUCATIONAL OBJECTIVES

PEO1:
Graduates shall be capable of building their career in related industries, R&D establishments as well as in Teaching with their scholarly knowledge with respect to advanced topics in Communication systems and Networking.

PEO-2:
Graduates shall be capable of conceptualizing and analysing engineering problems of societal importance related to wireless networks, RF & Microwave Communications and Signal processing, conduct independent research leading to technology solutions and communicate the outcomes through verbal and written mechanisms.

PEO-3:
Graduates shall be able to collaborate, manage and execute projects in teams using appropriate tools/technologies with utmost professionalism and acceptable good practices.

PROGRAM OUTCOMES

Program Outcomes (POs), are attributes acquired by the student at the time of graduation. The POs are aligned to the Graduate Attributes (GAs) specified by National Board of Accreditation (NBA). These attributes are measured at the time of Graduation, and hence computed every year for the outgoing Batch. The POs are addressed and attained through the Course Outcomes (COs) of various courses of the curriculum.

1: Acquire scholarly knowledge in the discipline of Digital Communications, beginning with fundamentals up to the global perspective in the context of Electronics and Digital Communications.

2: Think critically, and shall be able to plan and conduct research oriented experiments along with collection and analysis of results.

3: Conceptualize and solve contemporary engineering problems and propose optimal solutions in communications and related areas.

4: Acquire necessary research skills and contribute individually/in group(s) to the development of technology in his/her core area of expertise.

5: To select, learn and apply appropriate techniques, resources, and modern engineering and IT tools in the domain of Digital Communications and allied areas.

6: Collaborate and develop a capacity for self-management and team work.

7: Manage and execute projects efficiently at engineering, financial and personnel levels.

8: Demonstrate effective verbal and written communication skills, in the form of technical documentation, presentations, standards compliance etc.

9: Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously

10: Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.

11. Observe and examine critically the outcomes of one’s actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback.

Total Number of Credits (I Sem – IV Sem) = 100 Credits

Distribution of credits:

Category	No of Credits
Program Core Course	28
Program Elective Course	16
Institution Core Course	02
Institution Elective Course	04
Internship	21
Technical Seminar	02
Project Work	27

Scheme of Teaching

M. Tech. (Digital Communication Engineering)

I Semester **CREDIT BASED**

Subject Code	Course Title	Credits				CREDITS
		L	T	P	S	
16ECDCGCAM/ 16ECELGCAM	Advanced Mathematics	3	0	0	0	3
16ECDCPCAT	Antenna Theory and Computational Electromagnetics	3	0	1	0	4
16ECDCPCOC	Optical Communication and Networks	3	1	0	0	4
16ECDCPCDC	Advanced Digital Communication	3	0	0	1	4
16ECDCPEZZ	Elective -1	3	1	0	0	4
16ECDCPEZZ	Elective - 2	3	1	0	0	4
16APRDICRM	Research Methodology	2	0	0	0	2
	Total					**25**

Note : Two electives to be chosen from the list below:

Elective will be offered for a minimum strength of six candidates (out of 18) / eight candidates (out of 24)

Course Elective		Course Elective	
16ECDCPEEC	Error Control Coding	16ECDCPEWC	OFDM for Wireless Communication
16ECDCPEWM	Wireless and Mobile Networks	16ECDCPESC	Advanced Satellite Communication
16ECDCPESS	Spread Spectrum Communication	16ECDCPESD	Software Defined Radio
16ECDCPESA	Simulation, Modelling, and Analysis	16ECDCPESN	Wireless Sensor Networks

Pl. Note: The Course Code: 16 (year) EC (Electronics and Communication Engineering) DC (Digital Communication Engineering) PC (Program core) ZZ (course abbreviation), AP (All programme), RD(Research & Development), IC(Institution Core).

M. Tech. (Digital Communication Engineering)

II Semester **CREDIT BASED**

Subject Code	Course Title	Credits				CREDITS
		L	T	P	S	
16ECDCPCAW	Advanced Wireless Communication	3	0	1	1	5
16ECDCGCAD/ 16ECELGEAD	Advanced DSP	3	0	0	1	4
16ECDCPCRF	R F and Microwave Circuits	3	1	0	0	4
16ECDCPEZZ	Elective -3	3	1	0	0	4
16 ECDCPEZZ	Elective -4	3	1	0	0	4
16 ECDCPEIT	Institution Elective	4	0	0	0	4
Total						**25**

Note : Two electives to be chosen from the list below:
Elective will be offered for a minimum strength of six candidates (out of 18) / eight candidates (out of 24)

Course Elective		Course Elective	
16 ECDCPEWR	Advanced Techniques for Wireless Reception	16 ECDCPEMT	Multimedia Compression Techniques
16 ECDCGEAN/ 16 ECELGEAN	Advanced Computer Networks	16 ECDCPESE	Security Engineering
16 ECDCPEEN	LTE – Long Term Evolution Networks	16 ECDCPEGR	Green Radio Communication Networks
16 ECDCGEDE/ 16 ECELGEDE	Detection and Estimation Techniques	16 ECDCPEMC	Wireless MIMO communications

Institution Elective

16ECDCIEQR	Quality and Reliability of Engineering systems

Pl. Note: The Course Code: 16 (year), EC (Electronics & Communication), DC(Digital Communication Engineering), PC/PE (Programme core / Programme elective) ZZ(course abbreviation), GC/GE-Group Core/Group Elective

M. Tech. (Digital Communication Engineering)

III Semester **CREDIT BASED**

Subject Code	Course Title	Credits				CREDITS
		L	T	P	S	
16ECDCPCIN	Internship					21
16 ECDCPCP1	Project work (I-phase)					4
	Total					**25**

M. Tech. (Digital Communication Engineering)

IV Semester **CREDIT BASED**

Subject Code	Course Title	Credits				CREDITS
		L	T	P	S	
16 ECDCPCP2	Project work (final phase)					23
16 ECDCPCTS	Technical Seminar					02
	Total					**25**

I SEMESTER

PROGRAM CORE SYLLABUS

Course Code	**16ECDCPCAM / 16ECDCGCAM**	**Course Title**	**Advanced Mathematics**
Credits	**03**	**L-T-P-S**	**3-0-0-0**

CO1	Ability to thoroughly understand the concepts, types and characterization of random variables and stochastic processes, along with expectation operator.	PO1
CO2	Ability to develop an analytical approach for solving real life problems using the theoretical concepts of probability and statistics	PO1
CO3	Ability to model engineering domains and their dynamics, mathematically, using multidimensional space and the associated linear transformations	PO2
CO4	Ability to analyze engineering data amidst fitment and variability using SVD and PCA techniques for data reduction, data interpretation and system identification with real life case studies	PO2
CO5	Ability towards team work by working on problem sheets in groups throughout the semester	PO6

Random Variables: Discrete and continuous type Random Variables, Distribution and Density Functions: PMF, CDF, PDF, Gaussian random variable, and other standard random variables, Expectation operator, Multiple random variables: Joint PMF, CDF, PDF, Expectation involving multiple Random variables

Random Processes: Definition and characterization, Stationary and Ergodic Random processes, Autocorrelation function and its properties, Example Processes: introduction to Markov process, Gaussian Process, Poisson Process

Vector Spaces and subspaces: Vector spaces, null space, independence, basis and dimension, projections, Least squares approximations, orthonormal bases and Gram-Schmidt

Advanced Matrix Theory: Introduction to Eigen values and eigen vectors, Positive definite matrices, Singular value decomposition, bases and matrices in SVD, Principal component analysis by SVD, geometry of SVD, idea of linear transformation, matrix representation, search for a good basis, example applications.

REFERENCE BOOKS:

1. S L Miller and D C Childers, "Probability and random processes: application to signal processing and communication", Academic Press / Elsevier 2004.

2. A. Papoulis and S U Pillai, "Probability, Random variables and stochastic processes", McGraw Hill 2002

3. Peyton Z Peebles, "Probability, Random variables and Random signal principles", TMH, 4th Edition 2007

4. MIT Open courseware, Introduction to Linear Algebra, Course 18.06

Course Code	**16ECDCPCAT**	**Course Title**	**Antenna Theory and Computational Electromagnetics**
Credits	**04**	**L-T-P-S**	**3-0-1-0**

COURSE OUTCOMES

CO1	Analyse the performance of antennas based on the radiation mechanisms and design different types of antenna arrays.	PO1, PO2
CO2	Apply analytical & numerical approach to understand different types of antennas	PO1,PO2
CO3	Understanding the concept of Computational Electromagnetics	PO1,PO2
CO4	Usage of modern computational tools in electromagnetic scattering, propagation, and radiation.	PO5
CO5	To identify important research topics in the domain, document it and present the same.	PO4,PO6,PO8

Antenna Fundamentals and Definitions: Introduction, Radiation Pattern and Antenna parameters.

Resonant Antennas: Wires and Patches, Dipole, Micro strip Antenna

Arrays: Array factor for linear arrays, uniformly excited equally spaced Linear arrays, pattern multiplication, directivity of linear arrays, non- uniformly excited -equally spaced linear arrays, phased arrays,

Broad band & Aperture Antennas: Traveling - wave antennas, Helical antennas, Reflector antennas – working principle & types

Antenna Synthesis: Formulation of the synthesis problem, synthesis principles, and line sources shaped beam synthesis— Fourier Series, Woodward Lawson sampling method

CEM for Antennas:

Method of Moments- Introduction to method of moments, Pocklington's integral equation, integral equations and Kirchhoff's Networking Equations.

REFERENCE BOOKS:

1.C. A. Balanis: "Antenna Theory Analysis and Design", John Wiley,2nd Edition, 1997
2.Kraus: "Antennas", McGraw Hill, TMH, 3rd/4th Edition.
3.Stutzman and Thiele, "Antenna Theory and Design", 2ndEd, JohnWiley and Sons Inc..
4.Sachidananda et. el, "Antenna and Propagation", Pearson Edu.

Course Code	16ECDCPCOC	Course Title	Optical Communication & Networking
Credits	04	L-T-P-S	3-1-0-0

COURSE OUTCOMES

CO1	Analyze and specify the key goals involved with OFC transmission systems engineering and study the different client layers of optical layer.	PO1, PO2
CO2	Design a WDM network and gain advanced knowledge of the various elements used for establishing a WDM Network.	PO1,PO2, PO3,PO5,PO6
CO3	Design a system as per needs and specification through a thorough understanding of the various aspects involved in control and management of an optical network.	PO1, PO2, PO5 PO6
CO4	Understand free space optics as a telecommunication technique.	PO1

Transmission System Engineering: system model, power penalty, Transmitter, Receiver, Optical amplifiers.

Optical Networks: Client layers of optical layer, SONET/SDH, multiplexing, layers, frame structure, ATM functions, adaptation layers, Quality of service and flow control

WDM Network Elements: Optical line terminal optical line amplifiers, optical cross connectors, WDM network design, cost tradeoffs, LTD and RWA problems, Routing and wavelength assignment.

Control and Management: Network management functions, management frame work, Information model, management protocols, layers within optical layer performance and fault management, impact of transparency, optical trace, Alarm management, configuration management

Fundamentals of FSO Technology: Introduction, Fiber Vs FSO- Overview of FSO Optical Transmitters – Receivers, The Role of FSO in the network – factors affecting FSO – line of sight(LOS) –moving towards edge – and residential areas.

REFERENCE BOOKS:

1. **John M. Senior, "Optical Fiber Communications", Pearson edition,2000.**
2. **Rajiv Ramswami, N Sivaranjan, "Optical Networks", M. KauffmanPublishers, 2000.**
3. **Gerd Keiser, "Optical Fiber Communication", MGH, 1 991.**
4. **Heinz, Phd. Willebrand, "Free Space Optics," Sams, 1st Ed., 2001.**

Course Code	16ECDCPCDC	Course Title	Advanced Digital Communications
Credits	04	L-T-P-S	3-0-0-1

COURSE OUTCOMES

CO1	Ability to acquire a scholarly knowledge of the characterization of fading multipath wireless channels and digital modulation techniques and to compare them in terms of their constellations, power spectra and bandwidth etc	PO1
CO2	Ability to perform critical analysis of forward error correction and spread spectrum methods for performing effective communication on wireless medium	PO1,PO3
CO3	Ability to plan and perform basic and advanced simulations exercises in lab related to digital communications.	PO5,PO6
CO4	Ability to execute a group study of one advanced topic in digital communication (through IEEE journal papers) and prepare and conduct simulation experiments for the work proposed in the paper.	PO2,PO5, PO6,PO9
CO5	Ability to collect and analyze the results; and prepare a technical documentation and presentation for the self-study work performed by the team.	PO8

Digital Modulation Techniques: Digital Modulation Formats, Coherent Binary Modulation Techniques, Coherent Quadrature –Modulation Techniques, Non Coherent Binary Modulation Techniques, M-ary Modulation Techniques, Power Spectra, Bandwidth Efficiency, Bit Versus Symbol Error Probabilities

Coding Techniques: Convolutional Encoding, Convolutional Encoder Representation, Formulation of the Convolutional Decoding Problem, Distance property of convolutional codes, Systematic and Nonsystematic Convolutional Codes, Performance Bounds for Convolutional Codes, Coding Gain. Sequential Decoding, Feedback Decoding Algorithms

Spread Spectrum Signals for Digital Communication: Model of Spread Spectrum Digital Communication System, Direct Sequence Spread Spectrum Signals, Frequency-Hopped Spread Spectrum Signals, CDMA, Synchronization of SS systems.

Digital Communication Through Fading Multi-Path Channels: Characterization of fading multi-path channels, frequency-Nonselective, slowly fading channel, diversity techniques for fading multi-path channels, communication through band limited linear filter channels: Optimum receiver for channels with ISI and AWGN, Linear equalization, Decision-feedback equalization

REFERENCE BOOKS:

1. John G. Proakis, —Digital Communications, 4th edition, Mc GrawHill

2. Bernard Sklar, —"Digital Communications - Fundamentals and Applications", 2nd Edition Pearson Education (Asia) Ptv. Ltd, 2001.

3. Simon Haykin, — Digital Communications, John Wiley and Sons,

4. Andrew J. Viterbi, —CDMA: Principles of Spread Spectrum Communications‖, Prentice Hall, USA, 1995.

Course Code	16APRDICRM	Course Title	Research Methodology
Credits	02	L-T-P-S	2-0-0-0

Module 1:

Meaning, Objectives and Characteristics of research - Research methods Vs Methodology - Types of research - Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual vs. Empirical - Research process - Criteria of good research - Developing a research plan.

Module 2:

Defining the research problem - Selecting the problem - Necessity of defining the problem - Techniques involved in defining the problem - Importance of literature review in defining a problem - **S**urvey of literature - Primary and secondary sources - Reviews, treatise, monographs patents- web as a source - searching the web - Identifying gap areas from literature review - Development of working hypothesis.

Module 3:

IPRs- Invention and Creativity- Intellectual Property-Importance and Protection of Intellectual Property Rights (IPRs)- A brief summary of: Patents, Copyrights, Trademarks, Industrial Designs- Integrated Circuits-Geographical Indications-Establishment of WIPO-Application and Procedures.

Module 4:

Aim of this part of the course: is to strengthen students minds towards high quality research through publications, patents and also to learn research ethics.

Publications (8-9 hours)

Research concepts (2 hour) Research importance on economy, Research in India and abroad, Importance of publications, Why, where, when to publish?

Publication ethics (2 hour), Plagiarism (how to use turn it in effectively), International ethics on research, What and what not to publish, Ethical guidelines, Case studies

Quality vs quantity (2 hour) Searching literature with high quality, Impact factor, Citations (google scholar vs web of science), H-index, Case studies

How to write paper (2 hour), In High quality journals, Conference Articles, Poster preparation, PhD thesis, Inclusion of References

Journal reviewing process (1 hour), Selection of the good journal, Knowledge bout journal template, Refereeing process, Research topic selection, Research today and tomorrow, Lab scale to Industry, Traditional research to Technology based research

Module 5: Self study

Interpretation and report writing - Techniques of interpretation - Structure and components of scientific reports - Different steps in the preparation - Layout, structure and language of the report - Illustrations and tables - Types of report - Technical reports and thesis

REFERENCE BOOKS:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.

2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.

3. Anderson, T. W., An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi

4. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.

5. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.

6. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.

7. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications

8. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.

9. Intellectual Property Rights in the Global Economy: Keith Eugene Maskus, Institute for International Economics, Washington, DC, 2000

10. Subbarau NR-Handbook on Intellectual Property Law and Practice-S Viswanathan Printers and Publishing Private Limited.1998

I SEMESTER
PROGRAM ELECTIVE SYLLABUS

Course Code	**16ECDCPEEC**	**Course Title**	**Error Control Coding**
Credits	**04**	**L-T-P-S**	**3-1-0-0**

COURSE OUTCOMES

CO1	Apply various error control coding techniques for various telecommunication and data storage systems.	PO1
CO2	Analyse error control schemes using principles and techniques developed to identify bottlenecks.	PO2
CO3	Design and evaluate various error control coding schemes.	PO2,PO3
CO4	Proficiency in knowledge development on the specific topic of error control coding using open literature to keep up to date with new advancements.	PO3,PO4

Linear block codes: Generator and parity check matrices, Encoding circuits, Syndrome and error detection, Minimum distance considerations, Standard array and syndrome decoding, decoding circuits, Hamming codes, Reed-Muller codes, Golay codes, 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 code, Syndrome computing and error detection, Meggitt decoder, Error trapping decoding, Cyclic hamming codes, Shortened cyclic codes.

Majority Logic decodable codes: One -step majority logic decoding,
One-step majority logic decodable codes, Two-step majority logic
decoding, Multiple-step majority logic decoding.

Convolution 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.

Burst - error - Correcting codes: Burst and random error correcting codes, Concept of interleaving, cyclic codes for burst error correction – Fire codes, Convolutional codes for burst error correction

Reference books:

1. Shu Lin and Daniel J. Costello. Jr, "Error control coding", Pearson, Prentice Hall, 2nd edition, 2004.

2. Blahut. R. E, "Theory and practice of error control codes", Addison Wesley, 1984.

Course Code	**16ECDCPEWM**	**Course Title**	**Wireless and Mobile Networks**
Credits	**04**	**L-T-P-S**	**3-1-0-0**

COURSE OUTCOMES

CO1	Analyse broad solutions for a range of mobile scenarios.	PO1
CO2	Acquire knowledge on the architecture, components, design, protocol and research issues involved in designing of the different wireless networks.	PO1,PO2
CO3	Recognize the various research potentials involved in designing various wireless networks	PO4
CO4	Ability to write reports and communicate complex and technical information on various wireless systems, using clear and concise language.	PO4,PO8

Review of fundamentals of wireless communication and networks: Wireless network, Architecture, classification, switching technology, communication problems, wireless network issues and standards.

Wireless body area networks: Properties, network architecture, components, technologies, design issues, protocols and applications.

Wireless Personal Area Networks: Architecture, components, requirements, technologies and protocols, Bluetooth and ZigBee.

Wireless Local Area Networks: Network components, design requirements, architectures, standards, protocols, 802.11 p and applications.

Wireless Metropolitan Area Networks: IEEE 802.16, architectures, components, WiMax mobility support, protocols, broadband networks and applications.

Wireless Wide Area Networks: Cellular networks, Satellite networks, applications.

Research issues in wireless networks.

Reference Books:

1. S. S. Manvi, M. S. Kakkasageri, "Wireles and Mobile Network concepts and protocols", Wiley, First edition, 2010.

2. P. Kaveh, Krishnamurthy, "Principles of wireless networks: A Unified approach", PHI, 2006.

3. Iti Saha Mishra, "Wireless communication and networks 3G and beyond ", MGH, 2009
4. P. Nicopolitidis, M. S. Obaidat, etal., "Wireless Networks", Wiley, 2009
5. Yi-Bing Lin, Imrich Chlamtac, " Wireless and Mobile Network Architectures", Wiley, 2009.

Course Code	**16ECDCPESS**	**Course Title**	**Spread Spectrum Communication**
Credits	**04**	**L-T-P-S**	**3-1-0-0**

COURSE OUTCOMES

CO1	Analyze the performance of spread spectrum systems in the presence of various types of interferences.	PO1,PO2
CO2	Apply suitable techniques for reducing the impact of interference on spread spectrum signals.	PO2
CO3	Analyze the performance of multiple access techniques based on spread spectrum and describe major factors influencing the capacity of CDMA wireless networks.	PO2

Review of digital communication concepts, direct sequence and frequency hop spread spectrum systems.

Hybrid direct sequence/frequency hop spread spectrum. Complex envelop representation of spread spectrum signals.

Sequence generator fundamentals, Maximum length sequences. Gold and Kasami codes, Nonlinear Code generators.

Spread spectrum communication system model, Performance of spread spectrum signals in jamming environments, Performance of spread
spectrum communication systems with and without forward error correction.

Diversity reception in fading channels, Cellular radio concept, CDMA cellular systems, Examples of CDMA cellular systems. Multicarrier CDMA systems. CDMA standards.

Reference Books:

1. R. L. Peterson, R. E. Zeimer and D. E. Borth, "Introduction to Spread Spectrum Communications", Pearson, 1995.
2. J. D. Proakis and M. Salehi, "Digital Communication", McGraw Hill, 2008

Course Code	16ECDCPESA	Course Title	Simulation, Modelling and Analysis
Credits	04	L-T-P-S	3-1-0-0

COURSE OUTCOMES

CO1	Ability to understand basics of simulation modeling	PO1
CO2	Analyze various techniques for increasing validity & credibility	PO1,PO2
CO3	Understand different types of Random number generation	PO1
CO4	Ability to select different types of probability distributions and analyze different output data.	PO2

Basic simulation modeling: nature of simulation, system models, discrete event simulation, single server simulation, alternative approaches, other types of simulation.

Building valid, credible and detailed simulation models. Techniques for increasing model validity and credibility, comparing real world observations

Selecting input probability distributions. Useful probability distributions, assessing sample independence, activity I, II and III. Models of arrival process.

Random numbers generators: linear congruential, other kinds, testing random number generators.

Random variate generation: approaches, continuous random variates, discrete random variates, correlated random variates.

Output data analysis. Statistical analysis for terminating simulations, analysis for steady state parameters. Comparing alternative system configurations. Confidence intervals. Variance reduction techniques. Antithetic and Control variates.

Reference Books:

1. Jerry Banks, "Discrete event system simulation", Pearson, 2009
2. Averill Law "Simulation modeling and analysis", MGH 4th edition, 2007
3. Seila, Ceric, Tadikamalla, "Applied simulation modeling", Cengage, 2009.
4. George S. Fishman, "Discrete event simulation", Springer, 2001
5. N. Viswanadham, Y. Narahari, "Performance modeling of automated manufacturing systems",PHI, 2000
6. Frank L. Severance, "System modeling and simulation", Wiley, 2009

Course Code	16ECDCPEWC	Course Title	OFDM for Wireless Communication
Credits	04	L-T-P-S	3-1-0-0

COURSE OUTCOMES

CO1	Study of various wireless channel models and the effects of fading on the transmitted signals.	PO1
CO2	Analysis and design of transmission and receiving algorithms	PO1,PO2
CO3	Apply OFDM techniques for wireless systems.	PO1

OFDM Basics: OFDM principles – system model – Generation of sub carrier using IFFT, guard time and cyclic extensions – windowing - Choice of OFDM parameters - OFDM signal processing.

Coding, Modulation and Channel Estimation: FEC coding – Interleaving – QAM – Coded modulation – Synchronization – Synchronization using cyclic extension and special training symbols – Coherent detection – One and two dimensional channel estimation – Special training symbols – Decision directed channel estimation – Differential detection in the time and frequency domain. Application of OFDM in wireless communication

OFDMA and MC-CDMA : Frequency hopping in OFDMA - OFDMA system description – Channel coding, modulation, time and frequency synchronization, Combination of OFDM and CDMA - MC-CDMA, MT-CDMA and MC-DS CDMA systems - Difference between OFDMA and MC-CDMA

Reference books:

1. **Samuel C Yang, "CDMA RF System Engineering", Artech House, 1998.**
2. **Richard Van Nee and Ramjee Prasad, "OFDM for wireless Multimedia Communication", Artech House, 2000.**
3. **Lajas Hanzo, "OFDM and MC-CDMA for Broadband Multiuser Communications," 2003**
4. **Khaled Fazal and Stephen Kaiser, "Multicarrier and Spread Spectrum Systems," 2008**

Course Code	16ECDCPESC	Course Title	Advanced Satellite Communication
Credits	04	L-T-P-S	3-1-0-0

COURSE OUTCOMES

CO1	To explore the orbital mechanics, space craft sub-systems, satellite link design, Satellite applications.	PO1
CO2	Study of satellite orbits and transponder characteristics	PO1
CO3	Analyze the technical details behind the satellite link and its real time applications	PO1,PO2

Introduction and Satellite Access: Orbits of Satellite: Low - medium - geo-synchronous - angle period - returning period - orbital spacing - delay transponder - earth stations - antennas and earth coverage - altitude and eclipses; Multiple Access: Demand assigned FDMA - spade system - TDMA - satellite switched TDMA - CDMA.

Space Segment and Earth Segment: Space Segment: Power supply - altitude control - station keeping - thermal control - TT and C subsystem - transponders; Earth Segment: Receive only home TV system - outdoor unit, indoor unit - master antenna TV system - community antenna TV system.

Satellite Link Design and VSAT Systems: Link Design: System noise temperature and G/T ratio - design of downlinks - uplink design - C/N - error control for digital satellite link; VSAT Systems: Network architectures - access control protocols - earth station engineering - antennas - link margins - system design procedure.

Antennas for Satellite: Multibeam antennas, On board beam switching.
Applications of Satellite communication: Direct to Home, Intelsat, GSAT

References Books:

1. Timothy Pratt and Charles W. Bostain, "Satellite Communications", 2nd Edition, Wiley, 2012.
2. D. Roddy, "Satellite Communication", 4th Edition (Reprint), McGraw Hill, 2009.
3. Wilbur L. Pritchard, Hendri G. Suyderhoud and Robert A. Nelson, "Satellite Communication Systems Engineering", Prentice Hall/ Pearson, 2007
4. Tri T. Ha, "Digital Satellite Communication", 2nd Edition, McGraw Hill, 1990.
5. Brian Ackroyd, "World Satellite Communication and Earth Station Design", BSP Professional Books, 1990.
7. **Communication Satellites By Donald H. Martin**
8. Satellite Communications Network Design andAnalysis,By Kenneth Y. Jo

e-resources:

1. http://advancedengineering.umd.edu/node/2320
2. http://ece564web.groups.et.byu.net
3. http://personal.stevens.edu/~yyao/syllabus-674.html

4. http://staff.um.edu.mt/carl.debono/lectures.html

Course Code	16ECDCPESD	Course Title	Software Defined Radio
Credits	04	L-T-P-S	3-1-0-0

COURSE OUTCOMES

CO1	Complete understanding of SDR Architecture	PO1,PO2
CO2	Insight into system design from RF perspective	PO1,PO2
CO3	Understand the concept of smart antenna systems.	PO2
CO4	Usage of modern tool to design & implement an end to end communication System.	PO4,PO5,PO6, PO8

INTRODUCTION: – Software Defined Radio- SDR concepts & history,- Characteristics and Benefits of Software Radio – Design Principles of a Software Radio, Ideal SDR architecture, SDR Based End-to-End Communication

Ba**sic Software Defined Radio Architecture** – Introduction – 2G Radio Architectures ,Hybrid Radio Architecture- Basic Software Defined Radio Block Diagram, System Level Functioning, Partitioning

RF System Design – The purpose of the RF Front-End, Dynamic range: The principal challenge of receiver design. RF receiver front-end topologies, Enhanced flexibility of the RF Chain with Software Radios, Importance of the components to overall performance, Transmitter architectures and their Issues, noise and distortion in the RF Chain, ADC and DAC distortion

Smart Antennas Using Software Radio- Introduction- 3G smart Antenna Requirements , Smart Antenna Architectures- Optimum Combining/ Adaptive Arrays- DOA Arrays- Beam Forming for CDMA- Downlink Beam Forming.

Reference Books:

1. Jeffrey H Reed, "Software Radio: A Modern Approach to Radio Engineering", PEA Publication, 2002.
2. Paul Burns, "Software Defined Radio for 3G", Bartech House, 2002.
3. Markus Dillinger, "Software Defined Radio: Architectures, Systems and Functions", 2003.
4. Walter Tuttle bee, "Software Defined Radio: Enabling Technologies", Wiley Publications, 2002.
5. Bard, Kovarik, "Software Defined Radio, The Software Communications Architecture", Wiley, 2007.
6. Paul Burns, Software Defined Radio for 3G, Artech House, 2002.
7. Tony J Rouphael, RF and DSP for SDR, Elsevier Newnes Press, 2008
8. Jouko Vanakka, Digital Synthesizers and Transmitter for Software Radio, Springer, 2005.
9. P Kenington, RF and Baseband Techniques for Software Defined Radio, Artech House, 2005

Course Code	16ECDCPESN	Course Title	Wireless Sensor Networks
Credits	04	L-T-P-S	3-1-0-0

COURSE OUTCOMES

CO1	Analyze the various routing protocols using the fundamentals of wireless communication technology. .	PO1,
CO3	To introduce the various issues in designing a multicast routing protocol.	PO1,PO2
CO4	To introduce a transport layer protocol and the challenges involved for providing QOS in Adhoc wireless networks.	PO1

Cellular and Ad Hoc Wireless Networks: Applicationa of Ad Hoc Wireless Networks, Issues in Ad Hoc Wireless Networks: Medium Acces Scheme-Routing-Multicasting-Transport Layer Protocols-Pricing Scheme-Quality of Service Provisioning-Self Organization-Security-Addressing and Service Discovery Energy management-Scalability-Deployment Considerations, Ad Hoc Wireless Internet.

Sensor Networks : Comparison with Adhoc wireless networks-Challenges for WSNs - Difference between sensor and Traditional sensor networks –Types of Applications –Enabling Technologies for Sensor Networks –Single Node Architectures –Hardware Components – Energy Consumption of Sensor Nodes, Issues in Designing a Multicast Routing Protocol.

Sensor Network Architecture: Data Dissemination-Flooding and Gossiping-Data gathering Sensor Network Scenarios –Optimization Goals and Figures of Merit – Design Principles for WSNs- Gateway Concepts – Need for gateway – WSN to Internet Communication – Internet to WSN Communication –WSN Tunneling

M**AC Protocols :** MAC Protocols for Sensor Networks -Location Discovery-Quality of Sensor Networks-Evolving Standards-Other Issues- Low duty cycle and wake up concepts- The IEEE 802.15.4 MAC Protocols- Energy Efficiency -Geographic Routing Mobile nodes

Routing : Gossiping and Agent based Unicast Forwarding-Energy Efficient Unicast-Broadcast and MulticastGeographic Routing-Mobile nodes-Security-Application Specific Support - Target detection and tracking-Contour/ edge detection-Field Sampling.

Reference Books:

1. **Holger Karl and Andreas Wiilig, "Protocols and Architectures for Wireless Sensor Networks" John Wiley & Sons Limited 2008.**
2. **I.F .Akyildiz and Weillian, "A Survey on Sensor Networks", IEEE Communication Magazine, August 2007.**
3. **Wilson , "Sensor Technology hand book," Elsevier publications 2005.**
4. **Anna Hac "Wireless Sensor Networks Design," John Wiley& Sons Limited Publications 2003.**

5. **C. Siva Ram Murthy and B.S. Manoj "Ad Hoc Wireless Networks," Pearson Edition 2005.**

II SEMESTER

PROGRAM CORE SYLLABUS

Course code	**16ECDCPCAW**	**Course Title**	**Advanced Wireless Communication**
Credits	**05**	**L-T-P-S**	**3-0-1-1**

COURSE OUTCOMES

CO1	Acquire knowledge about wireless II/O models for real time channels .	PO1,PO2
CO2	Ability to analyze the need of diversity and performance factors of fading multipath channels and MIMO systems.	PO1,PO2
CO3	To implement the current research topics in Wireless communication as a team for the purpose of self study, peparationof technical documentation and presentation of the work done	PO4,PO5, PO6,PO8
CO4	Design of wireless models using simulator.	PO5

Wireless channel: Physical modeling for wireless channels, input/output model of wireless channel

Point –to-point communication

- Detection : Coherent and non -coherent detection in a fading channel
- Diversity: Introduction, Micro diversity, Micro diversity Time diversity, Antenna diversity, Frequency diversity

Capacity of wireless channels: AWGN channel capacity, resources of AWGN channel, Linear time invariant Gaussian channels, capacity of fading channels – slow & fast fading channels.

MIMO Systems: Introduction, MIMO system, Capacity in slow fading and fast fading channels, Applications of MIMO

References Books:

1. David Tse, P. Viswanath, "Fundamentals of wireless communication", Cambridge, 2006.

2. Andreas Molisch, "Wireless communications", Wiley, 2009

3.William C Y Lee, "Mobile Communication Engineering Theory and applications", TMGH, 2008

4. Upen Dalal, "Wireless communication", Oxford, 2009

5. Mark Ciampa, Jorge Olenwa, "Wireless communications", Cengage,2007.
6.Ke-Lin Du, ad M.N.S. Swamy, "Wireless communication systems-From RF subsystems to 4G enabling Technologies", Cambridge, South Asian 2010 edition.

Course Code	**16ECDCGCAD/ 16ECELGEAD**	**Course Title**	**Advanced DSP**
Credits	**04**	**L-T-P-S**	**3-0-0-1**

COURSE OUTCOMES

CO1	Student shall be able to understand A/D conversion and D/A conversion of signals, and visualize the time and frequency domain aspects of digital signals.	PO1
CO2	Student shall be able to understand and apply the concepts of DFT/IDFT, its properties and applications including convolution and linear filtering.	PO3
CO3	Student shall be able to design/realize FIR and IIR filters using standard methods.	PO6
CO4	Student shall be able to apply the concepts of multirate DSP by performing decimation/interpolation in time / frequency domain and design appropriate single stage, multi stage, polyphase filter structures for the same.	PO2,PO9
CO5	Student shall be able to understand the concept and numerous applications of adaptive filters starting from Wiener-Hopf equations.	PO8

Introduction: Overview of signals and systems, The concept of frequency in continuous time and discrete time signals, sampling in T/F domain, Analog to digital and digital to analog conversion. Discrete Fourier transform: The DFT / IDFT pair, Properties of DFT, Linear filtering methods based on the DFT. Communication engineering applications.

Design of digital filters: General considerations, design of FIR filters, Design of IIR filters from analog filters.

Multirate digital signal processing: decimation by a factor 'D', Interpolation by a factor 'I', sampling rate conversion by a factor 'I/D', Polyphase implementations, Multistage implementation of sampling rate conversion, Engineering applications of multirate signal processing

Adaptive filter: Adaptive direct form FIR filters, The LMS algorithm (without proof), applications of adaptive filters

Reference Books:

1. Robert. O. Cristi, "Modern Digital signal processing", Cengage Publishers, India, 2003.
2. S. K. Mitra, "Digital signal processing: A computer based approach", 3rd edition, TMH, India, 2007.
3. E.C. Ifeachor, and B. W. Jarvis,"Digital signal processing: A Practitioner's approach", Second Edition, Pearson Education, India, 2002,
4. Proakis, and Manolakis, "Digital signal processing", 3rd edition, Prentice Hall, 1996

Course Code	**16ECDCPCRF**	**Course Title**	**RF and Microwave Circuits**
Credits	**04**	**L-T-P-S**	**3-1-0-0**

COURSE OUTCOMES

CO1	Analyse the component level basics at high frequencies	PO1,PO2
CO2	Design passive circuits and analyze the importance of matching networks	PO3
CO3	Design active circuits taking into account stability and noise consideration.	PO3
CO4	Conceptualize the role of Mixers and MMICs in practical systems	PO1,PO2
CO5	Design of RF systems through the usage of modern tools.	PO4,PO5,PO6, PO8

Wave propagation in network: RF and Microwave circuit design, Introduction to components basics, Analysis of simple circuit phasor domain, RF impedance matching, High frequency parameters, Formulation of S-parameters, Properties, transmission matrix, Generalized S-parameters.

Passive circuit design: Introduction, Smith chart, Scales, Application of Smith chart, Design of matching networks, Definition of impedance matching, Matching using lumped and distributed elements.

Basic consideration in active networks : Stability consideration, gain consideration, Noise consideration.
design of amplifiers, oscillators and detector: Introduction, Types of amplifier, Design of different types of amplifiers, Design of transistor oscillators, Detector losses, detector design.

Mixers & Phase shifters : Mixer types, Conversion loss for SSB mixers, Phase shifters

RF and microwave IC design: MICs, MIC materials, Types of MICs

Reference Books:

1. Matthew M. Radmanesh, "RF and Microwave Electronics Illustrated", Pearson Education edition, 2004.
2. Reinhold Ludwig, and Pavel Bretchko,"RF circuit design theory and applications", Pearson Education edition, 2004.

Text Book:

1.Matthew. M. Radmanesh "RF and microwave electronics illustrated", Pearson Edn Edition, 2004
2.Reinhold Ludwig and Pavel Bretchko, "RF Circuit Design: "Theory and Applications", Pearson Education (Asia) Pte. Ltd., 2004.
3.D K Mishra, "RF Circuit Design", John Wiley, Intl.

II SEMESTER
PROGRAM ELECTIVE SYLLABUS

Course Code	**16 ECDCPEWR**	**Course Title**	**Advanced Techniques for Wireless Reception**
Credits	**04**	**L-T-P-S**	**3-1-0-0**

COURSE OUTCOMES

CO1	Evaluate the performance of wireless signaling environment	PO1
CO2	Apply mathematical formulation to find Optimum detection of wireless signal	PO2
CO3	Develop signal processing algorithms for wireless signal reception.	PO3

Blind Multiuser Detection Wireless signalling environment,: Basic receiver signal processing for wireless reception- matched filter/raked receiver, equalization and MUD. Linear receiver for synchronous CDMA- decorrelating and MMSE detectors. Blind MUD, direct and subspace methods.

Group Blind MUD : Linear group blind MUD for synchronous CDMA, Non-linear group blind multiuser detectors for CDMA-slowest descent search. Group blind multiuser detection in multipath channels- Linear group blind detectors**.**

Space-Time MUD: Adaptive array processing in TDMA systems-Linear MMSE combining, sub-space based training algorithm and extension to dispersive channels. Optimal space time MUD. Linear space time MUD Linear MUD via iterative interference cancellation, single user space-time detection and combined single user/multiuser linear detection**.**

NBI Suppression: Linear predictive techniques-linear predictive methods. Non-linear predictive techniques-ACM filter, Adaptive non-linear predictor, Non-linear interpolating filters and HMM based methods.

Signal Processing for Wireless Reception: Bayesian signal processing- Bayesian framework, batch processing Versus adaptive processing, Monte-Carlo methods. Signal processing for fading channels. Coherent detection in fading channels based on EM algorithm. Decision feedback differential detection in fading channels-Decision feedback differential detection in flat channels, Decision feedback space-time differential decoding.

Reference Books:

1. **X.Wang and H.V.Poor," Wireless Communication Systems," Pearson,2004**
2. **Iti Saha Misra, "Wireless Communications and Networks,"Tata McGraw Hill, 2009.**

Course Code	**16 ECDCGEAN/ 16 ECELGEAN**	**Course Title**	**Advanced Computer Networks**
Credits	**04**	**L-T-P-S**	**3-1-0-0**

COURSE OUTCOMES

CO1	Apply the concepts of Computer Networks and Network Models for Data Communication.	PO1
CO2	Analyze networking architecture and infrastructure for wired and wireless networks.	PO2
CO3	Apply knowledge of channel condition to various network conditions and hence analyze the network.	PO2
CO4	Ability to identify the future opportunities and challenges associated with next generation networks.	PO4

Introduction: Computer network, Telephone networks, networking principles.

Packet switched networks: Ethernet, Token ring, FDDI, DQDB, frame relay.

Circuit switched Networks: Performance of Circuit switched networks, SONET, DWDM.

Internet Protocol: overview of internet protocols, IP, TCP, UDP, performance of TCP/IP Networks.

Wireless Networks: Wireless channel, network design,Routing protocol requirements,

choices, distance vector routing, link state routing, hierarchical routing, multicast routing.

Traffic management: Introduction, framework for traffic management, traffic models, traffic classes, traffic scheduling.

REFERENCES:

1. J. Walrand and P. Varaiya, "High performance communication networks" Harcourt Asia (Morgan Kaufmann), 2000.
2. S. Keshav, "An Engineering approach to Computer Networking", Pearson Education, 1997.
3. A. Leon-Garcia, and I. Widjaja, "Communication network: Fundamental concepts and key architectures", TMH, 2000.
4. J. F. Kurose, and K. W. Ross, "Computer networking: A top down approach featuring the Internet", Pearson Education, 2001

Course Code	**16 ECDCPEEN**	**Course Title**	**Long Term Evolution Networks**
Credits	**04**	**L-T-P-S**	**3-1-0-0**

COURSE OUTCOMES

CO1	Identify the motivations and goals for 4G networks and summarize the basic concepts of LTE Air Interface	PO1
CO2	Sketch the high-level architectures of the evolved LTE Radio network	PO1,PO2
CO3	Walk through a typical LTE call from power-up to service setup to disconnect	PO1

OFDM and OFDMA for LTE : OFDM -Introduction , History of OFDM Development, OFDM Orthogonal Multiplexing Principle, Peak-to- Average Power Ratio and Sensitivity to Nonlinearity , Sensitivity to Carrier Frequency Offset and Time-Varying Channels . Timing Offset and Cyclic Prefix Dimensioning, OFDMA- Introduction - Parameter Dimensioning, Physical Layer Parameters for LTE , Conclusion .

Transmit diversity and MIMO Spatial Multiplexing : Transmit diversity-Transmit diversity schemes , Downlink transmission chain , Code word to layer mapping , Transmit diversity precoding

MIMO spatial multiplexing- MIMO capacity , Code words and layer mapping , Downlink MIMO transmission chain , MIMO precoding , CDD-based precoding, Open-loop spatial multiplexing

Network architecture and protocols : Network architecture, QoS and bearer service , architecture , Layer 2 structure ,Protocol states and states transitions , Seamless mobility support, Multicast broadcast system architecture.

Channel structure and bandwidths: Channel bandwidths, UE radio access capabilities , Frame and slot structure , Frame structure
type 2, Downlink distributed transmission , Uplink hopping , Uplink power control , Downlink power control.

Dataflow and Call flow in LTE: Message flow- IMS registration and attach procedure, VOLTE system architecture- Call flow between legacy network to LTE, call flow within LTE system.

Reference Books:

1. Farooq Khan- "LTE for 4G mobile broadband" – Cambridge University press 2009
2. Stefania Sesia, Issam Toufik, Matthew Baker "LTE-Long Term Evolution –From Theory to Practice " Wiley, 2009
3.Nokia Documents on LTE

Course Code	**16ECDCGEDE/ 16 ECELGEDE**	**Course Title**	**Detection and Estimation Techniques**
Credits	**04**	**L-T-P-S**	**3-1-0-0**

COURSE OUTCOMES

CO1	Acquire the concepts of detection theory, estimation theory and binary/composite hypothesis testing	PO1
CO2	Apply different techniques to perform detection of deterministic / random signals in the presence of noise	PO1,PO2
CO3	Visualize higher applications of the concept in EC engineering applications through study of relevant IEEE papers	PO9

Introduction: the mathematical detection problem, Binary hypothesis testing, Bayesian test, Minimax test, MAP criteria, Bayes' risk, Neyman-Pearson theorem

Detection of deterministic and random signals: Detection of known signals in noise, Matched filter, Performance evaluations, Estimator Correlator for random signals

Composite Hypothesis Testing: Bayesian approach, GLRT. Sinusoidal detection with unknown phase/ amplitude/ frequency, Sequential Detection of Multiple Hypotheses, Signal detection with unknown noise parameters - white Gaussian noise case

Fundamentals of estimation theory: Formulation of the General Parameter Estimation Problem, Relationship between Detection and Estimation, Types of Estimation, Minimum variance unbiased estimation.

Reference books:

1. **Harry L. Van Trees, "Detection, Estimation, and Modulation Theory, Part I," John Wiley & Sons, Inc. 2001.**
2. **Steven M.kay, "Fundamentals of Statistical signal processing, volume-1: Estimation theory". Prentice Hall 1993.**
3. **Steven M.kay, "Fundamentals of Statistical signal processing, volume-2: Detection theory". Prentice Hall 1993**
4. **A.Papolis and S.Unnikrishna Pillai, "Probability, Random Variables and stochastic processes, 4e". The McGraw-Hill 2002.**

Course Code	**16 ECDCPEMT**	**Course Title**	**Multimedia Compression Techniques**
Credits	**04**	**L-T-P-S**	**3-1-0-0**

COURSE OUTCOMES

CO1	Learn about the various compression techniques for audio signals and video signals and their importance	PO1
CO2	Able to understand the concept of requirement for memory space reduction	PO1
CO3	Develop efficient algorithms for Multimedia compression techniques.	PO2,PO3

Introduction to Multimedia – components of multimedia- overview of multimedia software tools Graphics and Image Data Representations –Graphics/image data types, popular file formats Fundamental Concepts in Video – analog and digital video. Basics of Digital Audio – Storage requirements for multimedia applications -Need for Compression - Taxonomy of compression techniques

Data Compression: Adaptive methods – Adaptive Huffman Coding — Adaptive Arithmetic Coding – Dictionary Methods– LZW algorithm.

Audio Compression: Speech compression- waveform codecs-source codecs- hybrid codecs- Shorten compressor MPEG-1 audio layers

Image Compression: Image Transforms – orthogonal transforms- DCT, JPEG, progressive image compression- JBIG, JBIG2 standards , Vector quantization, Differential lossless compression –DPCM Wavelet based compression- Filter banks, DWT, Multiresolution decomposition, SPIHT and EZW Coders, JPEG 2000 standard

Video Compression: Video signal components - Video compression techniques – MPEG Video Coding– Motion Compensation – H.261 , H.263 Standard , .MPEG4 and H.264 codecs .

Reference books:

1. **Mark S.Drew and Ze-Nian Li, "Fundamentals of Multimedia," PHI, 1st Edition, 2008.**
2. **David Salomon, "Data Compression – The Complete Reference," Springer Verlag New York Inc., 3rd Edition, 2008.**
3. **L. Hanzo, P. J. Cherriman and J. Streit, "Video Compression and Communications From Basics to H.261, H.263, H.264,MPEG4 for DVB and HSDPA-Style Adaptive Turbo-Transceivers," Second Edition, IEEE Communications Society, John Wiley & Sons Ltd, 2007.**
4. **Peter Symes, "Digital Video Compression," McGraw Hill Pub., 2004.**
5. **Mark Nelson, "Data compression," BPB Publishers, New Delhi, 1998.**

Course Code	**16 ECDCPESE**	**Course Title**	**Security Engineering**
Credits	**04**	**L-T-P-S**	**3-1-0-0**

COURSE OUTCOMES

CO1	Apply the concept of a security protocols to human-computer interface issues, access controls, cryptology, and distributed system issues.	PO1
CO2	Analyze the various aspects involved in authentication ,access control, challenge-response, ways to attack and defend with important applications such as military communications, medical record systems, cash machines, mobile phones, and pay- TV	PO2,PO3
CO3	Analyse the wireless specific protection mechanisms for the air link of UMTS/LTE and IEEE 802.11 along with the security issues associated during mobility.	PO1

Security engineering: Introduction, case studies- Bank, Air Force Base, Hospital, Home, Definitions.

Protocols: Password Eavesdropping Risks, Simple Authentication, Manipulating the Message, Changing the Environment, Chosen Protocol Attacks, Managing Encryption Keys.

Passwords: Basics, System Issues, Technical Protection of Passwords.

Access control: Introduction, Operating System Access Controls, Hardware Protection.

Wireless Network Security: Special Aspects of Wireless Protection, UMTS and LTE Air Link Protection, IEEE 802.11 Security Solutions, Challenges in Establishing Protection for a Mobile Node, Options for Fast Authentication, Secure Fast BSS Transition in IEEE 802.11, Security in Mobile IP, MIH - Service Protection

Reference Books:

1. Ross Anderson, "Security Engineering", Wiley 2006

2. Lidong Chen, Guang Gong, " Communication System Security", CRC Press, 2012

3. Charlie Kaufman, Radia Perlman and Mike Speciner, "Network Security", Prentice Hall of India, 2002

3. Charles Pfleeger, "Security in Computing", 4th Edition, Prentice Hall of India, 2006

Bruce Schneier and Neils Ferguson, "Practical Cryptography", First Edition, Wiley Dreamtech India Pvt Ltd, 2003.

4. Douglas R Simson "Cryptography – Theory and practice", First Edition, CRC Press, 1995.

REFERENCES:

1. Behrouz A. Ferouzan, "Cryptography & Network Security", Tata Mc Graw Hill, 2007. 2. Man Young Rhee, "Internet Security: Cryptographic Principles", "Algorithms and Protocols", Wiley Publications, 2003.

2. William Stallings, Cryptography and Network Security, 6th Edition, Pearson Education, March 2013.

3. Charles Pfleeger, "Security in Computing", 4th Edition, Prentice Hall of India, 2006

Bruce Schneier and Neils Ferguson, "Practical Cryptography", First Edition, Wiley Dreamtech India Pvt Ltd, 2003.

4. Douglas R Simson "Cryptography – Theory and practice", First Edition, CRC Press, 1995.

Course Code	**16 ECDCPEGR**	**Course Title**	**Green Radio Communication Networks**
Credits	**04**	**L-T-P-S**	**3-1-0-0**

COURSE OUTCOMES

CO1	Analyze the importance of reducing energy consumption, CO_2 emissions and inculcate green concepts for energy efficient approaches while designing next generation wireless networks.	PO1,PO2,PO3
CO2	Design new green radio architectures and radio techniques to reduce the overall energy consumption.	PO3

Introduction: Fundamental Tradeoffs on the Design of Green Radio Networks: Insight from Shannon's capacity formula - impact of practical constraints - latest research and directions; Algorithms for Energy Harvesting Wireless Networks: Energy harvesting technologies - PHY and MAC layer optimization for energy harvesting wireless networks.

Green Modulation and Coding: Modulation: Green modulation and coding schemes in energy constrained wireless networks - energy consumption of uncoded scheme - energy consumption analysis of LT coded modulation

Co-operative Techniques: Co-operative Techniques for Energy Efficient Wireless Communications: Energy efficiency metrics for wireless networks – co-operative networks - optimizing the energy efficiency performance of co-operative networks - energy efficiency in co-operative base stations.

Base Station Power Management Techniques: Base Station Power Management Techniques for Green Radio Networks: Opportunistic spectrum and load management for green radio networks - energy saving techniques in cellular wireless base stations - power management for base stations in a smart grid environment.

References Books:

1. Ekram Hossain, Vijay K. Bhargava and Gerhard P. Fettweis, "Green Radio Communication Networks", Cambridge University Press, 2012.

2. F. Richard Yu, Yu, Zhang and Victor C. M. Leung "Green Communications and Networking", CRC press, 2012.

3. Mazin Al Noor, "Green Radio Communication Networks Applying Radio-Over-Fibre Technology for Wireless Access", GRIN Verlag, 2012.

4. Mohammad S. Obaidat, Alagan Anpalagan and Isaac Woungang, "Handbook of Green Information and Communication Systems", Academic Press, 2012.

5. Jinsong Wu, Sundeep Rangan and Honggang Zhang, "Green Communications: Theoretical Fundamentals, Algorithms and Applications", CRC Press, 2012.

6. Mazin Al Noor, "WiMAX Improvements in Green Radio Communications Utilizing Radio-Over- Fiber", GRIN Verlag, 2012.

7. Ramjee Prasad and Shingo Ohmori, Dina Simunic, "Towards Green ICT", River Publishers, 2010.

Course Code	**16 ECDCPEMC**	**Course Title**	**Wireless MIMO Communications**
Credits	**04**	**L-T-P-S**	**3-1-0-0**

COURSE OUTCOMES

CO1	Analyze basic MIMO communication systems, Space-time block codes, Space-time trellis codes, MIMO systems for frequency-selective (FS) fading channels, Turbo codes and iterative decoding for MIMO systems.	PO1
CO2	Quantify the wireless channel capacities and degrees of freedom regions for different channel models	PO2,PO3
CO3	Design and analyze the cellular systems	PO2

FADING CHANNEL AND DIVERSITY TECHNIQUES Wireless channels: Error/Outage probability over fading channels – Diversity techniques – Channel coding as a means of time diversity – Multiple antennas in wireless communications.

CAPACITY AND INFORMATION RATES OF MIMO CHANNELS: Capacity and Information rates of noisy, AWGN and fading channels – Capacity of MIMO channels – Capacity of non-coherent MIMO channels – Constrained signaling for MIMO communications.

SPACE TIME BLOCK AND TRELLIS CODES: Transmit diversity with two antennas: The Alamouti scheme – Orthogonal and Quasi-orthogonal spacetime block codes – Linear dispersion codes – Generic space-time trellis codes – Basic space-time code design principles – Representation of space-time trellis codes for PSK constellation – Performance analysis for space-time trellis codes – Comparison of space-time block and trellis codes.

CONCATENATED CODES & ITERATIVE DECODING Development of concatenated codes: Concatenated codes for AWGN and MIMO channels – Turbo coded modulation for MIMO channels – Concatenated space-time block coding. SPACE TIME BLOCK CODES FOR

FREQUENCY SELECTIVE FADING CHANNELS MIMO frequency-selective channels: Capacity and Information rates of MIMO FS fading channels – Space - time coding and Channel detection for MIMO FS channels – MIMO OFDM systems.

Reference Books

1. Tolga M. Duman and Ali Ghrayeb, "Coding for MIMO Communication systems", John Wiley & Sons, West Sussex, England, 2007.

2. A.B. Gershman and N.D. Sidiropoulus, "Space-time processing for MIMO communications", Wiley, Hoboken, NJ, USA, 2005.

3. E.G. Larsson and P. Stoica, "Space-time block coding for Wireless communications", Cambridge University Press, 2003.

4. M. Janakiraman, "Space-time codes and MIMO systems", Artech House, 2004.

5. H. Jafarkhani, "Space-time coding: Theory & Practice", Cambridge University Press, 2005.

INSTITUTION ELECTIVE

Course Code	**16ECDCIEQR**	**Course Title**	**Quality and Reliability of Engineering systems**
Credits	**04**	**L-T-P-S**	**4-0-0-0**

COURSE OUTCOMES

CO1	Understand the concepts of quality control, improvement and management and design for quality.	PO1
CO2	Understand the concepts of reliability and carry out reliability data analysis	PO1,PO2
CO3	Learn fundamentals of reliability management and risk assessment and get acquainted with various reliability prediction and evolution methods.	PO1

Introduction: Definition and Importance of Quality and Reliability

Concepts of Reliability: Causes of failure, Life characteristic pattern, Modes of failure, Measures of Reliability, Derivation of the Reliability Function, Reliability Specifications.

Failure Analysis Technique: Failure investigation, Data collections, Data forms, Data Sources, Reliability Analysis, Use of Probability distributions, Calculation of performance parameters, Survival curves and their Calculation, Calculation of failure rate, application of Weibull Distribution.

System Reliability & Modelling: Types of Systems, Series, Parallel, Series-Parallel, and Parallel-Series system, Standby Systems, Types of Standby redundancy. Reliability of different systems, nature of reliability problems in electronic equipment, selection of components.

Simulation & Reliability Prediction: Generation of Random Numbers, Generation of random observations from a probability distribution, Applicability of Monte-Carlo Method, Simulation languages.

M**aintainability and Availability**: Objectives of maintenance, designing for optimum maintainability and measure of maintainability Availability: Uptime ratio, down time ratio and system availability

Quality Reliability and Safety: Reliability and Quality Control, Quality Circles, Safety factor, increasing safety factors and Case Studies.

Text Books:

1. **A.K.Govil, " Reliability Engineering", TMH, 1983**

2. B.S.Dhillion," Reliability Engineering in Systems Design and Operation", Van No strand Reinhold Co., 1983

REFERENCES:

1. A.E.Green and A.J.Bourne ,"Reliability Technology", Wiley-Interscience, 1972

2. Lecture Notes – CEDT Bangalore

III Semester

Course Code	16ECDCPCIN	Course Title	Internship
Credits	21	L-T-P-S	---

COURSE OUTCOMES

CO1	Able to develop a sound theoretical and practical knowledge of new technologies.	PO1,PO2, PO5
CO2	Able develop domain specific problem solving and critical thinking skills	PO2,PO3, PO4
CO3	Able to develop individual responsibility towards their internship goal as well as participate as an effective team member	PO6,PO7
CO4	Gain exposure to professional work culture & practices	PO9,PO10
CO5	Able to develop effective presentation & communication skills, and create proper documentation of the work	PO8,PO11

Course Code	16 ECDCPCP1N	Course Title	Project work (I-phase)
Credits	04	L-T-P-S	---

COURSE OUTCOMES

CO1	Identify a suitable project, making use of the technical and Engineering knowledge gained from previous courses with the awareness of impact of technology on the Society and their ethical responsibilities.	PO1,PO2,PO3PO4, PO5,PO9,PO10
CO2	Collect and disseminate information related to the selected project within given timeframe.	PO6,PO7
CO3	Communicate technical and general information by means of oral as well as written	PO8,PO11

IV Semester

Course Code	16 ECDC PCP2	Course Title	Project work (final phase)
Credits	23	L-T-P-S	---

COURSE OUTCOMES

CO1	Identify the modern tools required for the implementation of the project.	PO5
CO2	Design, examine critically and implement or develop a prototype for the identified problem during Phase I	PO1,PO2,PO3, PO4
CO3	Communicate technical information by means of oral as well as written presentation skills with professionalism and engage in life long learning.	PO8,PO9,PO10, PO11-

Course Code	16 ECDCPCTS	Course Title	Technical Seminar
Credits	02	L-T-P-S	---

CO1	Identify the problem through literature survey by applying depth knowledge of the chosen domain	PO1,PO4
CO2	Analyse, synthesize and conceptualize the identified problem	PO2, PO3
CO3	Communicate clearly, write effective reports and make effective presentations following the professional code of conduct and ethics	PO8,PO10
CO4	Comprehensively study the domains and reflect the same towards the future enhancements of the work	PO11