Savitribai Phule Pune University

Faculty of Science & Technology

Syllabus for

M.E

Electronics and Communication

(Advanced Communication Technology)

(2017 Course)

(w.e.f. June 2023)

Objectives

I. To serve the University, the Nation, and the Engineering profession by providing high quality educational programs to all students; engaging in research and scholarship that will extend knowledge; and assisting the economic development of the regional, state, and national economies through technology transfer.

II. To provide Post-graduate students with an excellent education through research and co-operative work experience/culture to enable successful, innovative, and life-long careers in Electronics and Telecommunication.

III. To sculpture Post-graduates students, to acquire the advanced level academic expertise and practical engineering experience necessary to function as Electronics and Telecommunication professional in a modern, ever-evolving world. Engrave Post-graduate students, to demonstrate competence by being selected for employment by industrial, academic or government entities or pursue further professional/doctoral studies.

IV. To understand the broad, social, ethical and professional issues of contemporary engineering practice. Post-graduation program will inculcate a mastery of underlying Electronics and Telecommunication Engineering and related technologies, as well as professional, ethical, and societal responsibilities.

Outcomes

a) Masters students of this program have ability to apply knowledge of mathematics, sciences and engineering to Electronics and Telecommunication problems.
b) Post graduate students gain an ability to design and conduct experiments, as well as to analyze and interpret data.
c) Learners of this program built an ability to design a system, component, devices, or process to meet desired needs.
d) Masters students of this program have an ability to function on multi-disciplinary teams and also as an individual for solving issues of Electronics and Telecommunication.
e) Learners of this program have an ability to identify, formulate, and solve Engineering problems by applying mathematical foundations, algorithmic principles, and Electronics and Telecommunication theory in the modeling and design of Electronics systems in a way that demonstrates comprehension of the tradeoffs involved in design choices.
f) Post graduates have an ability to communicate effectively orally and in writing and also understanding of professional and ethical responsibility.
g) Develop an ability to use the techniques, skills, and modern engineering EDA tools necessary for Electronics and Telecommunication practices.
h) Learners of this program have an ability to evaluate Electronics and Telecommunication Engineering problems with cost effectiveness, features, user friendly to cater needs for product development.
i) Igniting master's students to peruse inventive concept to provide solutions to industrial, social oration problem.
j) Masters of this program generate an ability to identify, inspect, analyze, and interpret and communicate research results.
k) Post graduates recognize the need and an ability to engage in life-long learning and knowledge of contemporary issues.
l) Masters of this program put on the broad education necessary to understand the impact of Electronics and Telecommunication solutions in a global, economic, environmental, and societal prospective**.**

The following is the list of UG Courses which are eligible for taking admission in this PG Course B.E. or B. Tech in

1) Electronics & Telecommunication Engineering
2) Electronics & Communication Engineering
3) Electronics Engineering
4) IT Engineering
5) Electronics and Communication Technology
6) Computer Science Engineering
7) Computer Engineering
8) Instrumentation Engineering
9) Electrical Engineering
10) Electrical and Electronics Engineering
11) Electronics Instrumentation and Control

Syllabus Structure

First Year – Semester I

Sr. No.	Subject Code	Subject	Examination Scheme					Total	Credits
				Paper					
			L/P	ISA	ESA	TW	OR		
1	504601	Digital Modulation and Coding Techniques	4	50	50	-	-	100	4
2	504602	Estimation and Detection Theory	4	50	50	-	-	100	4
3	504603	5G-Technology-1	4	50	50	-	-	100	4
4	504604	Smart Antennas for 5G communications	4	50	50	-	-	100	4
5	504605	Elective I	5	50	50	-	-	100	5
6	504606	Lab Practice-I	4	-	-	50	50	100	4
		Total	**25**	**250**	**250**	**50**	**50**	**600**	**25**

Elective I:

1. RF Engineering
2. Mathematical Foundations for
3. Communication Engineers
4. Advanced Wireless Communication
5. Wireless optical communication

First Year – Semester II

Sr. No.	Subject Code	Subject	Examination Scheme						Credits
				Paper				Total	
			L/P	ISA	ESA	TW	OR		
1	504607	5G-Technology-2	4	50	50	-	-	100	4
2	504608	Research Methodology and IPR	4	50	50	-	-	100	4
3	504609	5G-Mobile Communication	4	50	50	-	-	100	4
4	504610	Elective-II	5	50	50	-	-	100	5
5	504611	Lab Practice-II	4			50	50	100	4
6	504612	Seminar I	4			50	50	100	4
		Total	**25**	**200**	**200**	**100**	**100**	**600**	**25**

Elective II:

1. Telecom Network Management
2. VLSI System Design
3. Advanced Computer Networks
4. Fuzzy Systems and Neural Networks
5. Mobile Handset Design

Second Year – Semester I

Sr. No.	Subject Code	Subject	Examination Scheme						Credits
				Paper				Total	
			L/P	ISA	ESA	TW	OR		
1	604601	Advanced Antenna Technology	4	50	50			100	4
2	604602	Wireless Sensor Networks	4	50	50			100	4
3	604603	Elective-III	5	50	50			100	5
4	604604	Seminar II	4			50	50	100	4
5	604605	Project Stage I	8			50	50	100	8
		Total	**25**	**150**	**150**	**100**	**100**	**500**	**25**

Elective III:

1. Satellite Communication
2. Smart Antennas
3. Wavelet Signal Processing

Second Year – Semester II

Sr. No.	Subject Code	Subject	Examination Scheme						Credits
				Paper				Total	
			L/P	ISA	ESA	TW	OR		
1	604606	Seminar III	5	-	-	50	50	100	5
2	604607	Project Stage II	20	-	-	150	50	200	20
		Total	**25**			**200**	**100**	**300**	**25**

First Year Semester-I

Subject Name: Digital Modulation and Coding Techniques	
Course Code :504601	**Semester: I**
Weekly Teaching Hours: Theory : 04	**Scheme of Marking Theory: 100 Marks** **Insem 50 Marks** **Endsem 50 Marks**
Credit : 4	**Scheme of Marking PR: -- 50**

Content		Hours
Unit 1	Elements of a Digital Communication System, mathematical models for communication channels, Communication channels and their characteristics, Representation of bandpass signals and system, Signal space representations, representation of digitally modulated signals, Memory less modulation methods, Linear modulation with memory.	6
Unit 2	Nonlinear modulation methods with memory-CPFSK, CPM, Spectral Characteristics of digitally modulated signals, Correlation receiver, Matched filter receiver, numerical examples, Discrete PAM signals, Nyquist's criterion for distortion less baseband binary transmission, Duo binary encoding.	7
Unit 3	Tamed FM, partial response signaling, amplitude modulation of the partial response signal, 8-PSK, FBPSK, Q2PSK, GMSK, Carrier recovery and symbol synchronization in signal demodulation, Baseband M-ary PAM systems, Eye pattern, Multicarrier modulation with overlapping sub channels, Mitigation of subcarrier fading, Discrete implementation of multicarrier modulation, challenges in multicarrier systems-ICI, PAPR.	7
Unit 4	Overview of different methods reducing ICI and PAPR, Spread spectrum principles, Direct sequence spread spectrum (DSSS), Frequency Hopping Spread Spectrum (FHSS), Multiuser DSSS systems Cellular phone standards.	8
Unit 5	Introduction to course, Coding Algebra, Fields: A Prelude, Galois Field Construction, Linear Feedback Shift Registers, Irreducible and Primitive Polynomials. Block codes, Basic Definitions, The Generation Matrix Description of Linear block Codes, The Parity Check Matrix, Some Simple Bounds on Block Codes, Error Detection, Error Correction: The Standard Array, Single Error –Correcting Hamming Codes.	7
Unit 6	Precoding and coding for dispersive channels,- Trellis Coded Modulation(TCM), Adding Redundancy by Adding Signals, ackground on signal constellations, TCM example, The set partitioning Idea, Some Error Analysis for TCM Codes, Modulation codes for storage systems, Constrained systems and Codes, Constraints for ISI Channels, Channels with Colored Noise and Intertrack Interference.	7

Books:
1. Digital communications- JG PROAKIS, 4/e, MGH, 2001 2. Mobile Radio Communication, 2/e, R. STEELE, John Wiley, 1999. 3. Algorithms for Communication Systems & Applications, N. BENVENUTO, G. CHERUBINI, J.Willey, 2005. 4. Digital communications – B.SKLAR, Pearson, 2001 5. Digital Modulation and coding- SG WILSON, PHI, 1996 6. Todd K. Moon ,Error Control coding, John Wiley, 2005 7. B. Vasic, Emkurts, Coding and signal processing for magnetic recording Systems, CRC Press, 2005.

Subject Name: Estimation and Detection Theory	
Course Code :504602	**Semester: I**
Weekly Teaching Hours: Theory : 04	**Scheme of Marking Theory: 100 Marks** **Insem 50 Marks** **Endsem 50 Marks**
Credit : 4	

Content		Hours
Unit 1	Estimation Theory, Parameter Estimation, Mathematical formulation, Minimum Variance Unbiased Estimation(MVUE), methods of finding MVU estimators, Cramer-Rao Lower Bound (CRLB), CRLB for signals in White Gaussian Noise, extension to vector parameter, application examples.	7
Unit 2	Linear models, General MVUE, sufficient statistics, Best Linear Unbiased Estimation (BLUE), Maximum likelihood estimation (MLE), extension to vector parameter, application examples.	7
Unit 3	Least Squares, Method of Moments, Bayesian estimators, Kalman filters, extension to vector parameter, application examples.	7
Unit 4	Detection theory, Mathematical formulation, Hypothesis Testing, Neyman Pearson Theorem, Bayes criterion, minimum probability of error criterion, likelihood ratio test, application examples	7
Unit 5	Detection of deterministic and random signals in noise, Composite Hypothesis Testing, generalized likelihood ratio test, application examples.	7
Unit 6	Bayesian approach in detection, detection of deterministic and random signals with unknown parameters, application examples.	7

Books

1. Timothy Pratt and Others, “Satellite Communications”, Wiley India, 2nd edition,2010.
2. .S. K. Raman, “Fundamentals of Satellite Communication”, PearsonEducation India, 2011. Tri T. Ha, “Digital Satellite Communications”, Tata McGraw Hill, 2009
3.DennisRoddy, “Satellite Communication”, McGraw Hill, 4th Edition, 2008

Subject Name: 5G-Technology-1	
Course Code :504603	**Semester: I**
Weekly Teaching Hours: Theory : 04	**Scheme of Marking Theory: 100 Marks** **Insem: 50 Marks** **Endsem: 50 Marks**
Credit : 4	

Content		Hours
Unit 1	3G and 4G(LTE) overview- Introduction to 5G – Use Cases - Evolving LTE to 5G Capability- 5G NR and 5G core network (5GCN) - 5G Standardization - 3GPP and IMT2020 - Spectrum for 5G – 5G deployment - Options, Challenges and Applications.	7
Unit 2	OFDM and OFDMA – MIMO OFDM – Generalized Frequency Division Multiplexing (GFDM) – Non-Orthogonal Multiple Access (NOMA) - Universal Filtered OFDM –Filter bank multicarrier (FBMC)-	7
Unit 3	Sparse Code Multiple Access (SCMA) –Comparison of multiple access methods, 5G NR requirements - 5G Core Network Architecture - Radio-Access Network (RAN)- Radio Protocol Architecture -User Plane Protocols-	7
Unit 4	Radio Link Control - Medium-Access Control – Physical Layer functions -Control Plane Protocols - Network Slicing- RAN virtualization-Spectrum Management in 5G Channel Hierarchy in 5G NR – Logical Channels and Transport	7
Unit 5	Channels in 5G NR -Physical Layer Data Channels in 5G NR - Downlink Physical Channel and Uplink Physical Channels - Propagatio Channel models for 5G	7
Unit 6	Device-to-Device (D2D) Communication - 5G for Massive Machine Type Communication and Massive IoT- V2X Communication - Full Duplex and Green Communication -mmWave Communications - Massive MIMO and Beamforming Techniques	7

Books
R. Vannithamby and S. Talwar, “Towards 5G: Applications, Requirements and Candidate Technologies”, John Willey & Sons, 1st Edition, 2017.
Robert W. Heath Jr., Angel Lozano, “Foundations of MIMO Communication”, Cambridge University Press, 1st Edition, 2019.
Long Zhao, Hui Zhao, Kan Zheng, Wei Xiang, “Massive MIMO in 5G Networks:

Selected Applications", Springer, 1st Edition, 2018.
Jonathan Rodriguez, "Fundamentals 5G Mobile Networks", John Wiley & Sons, 1st Edition, 2015.
Erik Dahlman, Stefan Parkvall, Johan Skold "5G NR: The Next Generation Wireless Access Technology", Academic Press, 1st Edition, 2018.
Saad Z. Asif, "5G Mobile Communications Concepts and Technologies, CRC Press, 1st Edition, 2019.

Subject Name: Smart Antennas for 5G communications	
Course Code :504604	**Semester: I**
Weekly Teaching Hours: Theory : 04	**Scheme of Marking Theory: 100 Marks** **Insem: 50 Marks** **Endsem : 50 Marks**
Credit : 4	

Content		Hours
Unit 1	Introduction to Smart Antennas, Architecture of a Smart Antenna System: Transmitter and Receiver, Types of Smart Antennas, Benefits and Drawbacks of Smart Antennas, Applications of Smart Antennas.	6
Unit 2	Fixed Sidelobe Canceling, Retrodirective Arrays, Beamforming, Adaptive Arrays, Butler Matrix, Spatial Filtering with Beamformers, Switched Beam Systems, Multiple Fixed Beam System. Uplink Processing,	8
Unit 3	Diversity Techniques, Angle Diversity, Maximum Ratio Combining, Adaptive Beamforming, Fixed Multiple Beams versus Adaptive Beamforming, Downlink Processing.	8
Unit 4	Fundamentals of Matrix Algebra, Array Correlation Matrix, AOA Estimation Methods: Bartlett AOA Estimate, Capon AOA Estimate, Linear Prediction AOA Estimate, Maximum Entropy AOA Estimate, Pisarenko Harmonic Decomposition AOA Estimate, Min-Norm AOA Estimate, MUSIC AOA Estimate, ESPRIT AOA Estimate.	7
Unit 5	Introduction, Multiple-Antenna MS Design, RAKE Receiver Size, Mutual Coupling Effects, Dual-Antenna Performance Improvements, Downlink Capacity Gains,	7
Unit 6	Principles of MIMO systems: SISO, SIMO, MISO,MIMO, Hybrid antenna array for mmWave massive MIMO: Massive Hybrid Array Architectures, Hardware Design for Analog Subarray.	7

Books
1. Ahmed El Zooghby, 'Smart Antenna Engineering', ARTECH HOUSE, INC, 2005. 2. Frank B. Gross, 'Smart antenna with MATLAB', 2nd Edition, McGraw-Hill, 2015. 3. Lal Chand Godara , "SMART ANTENNAS" , CRC PR ESS, 2004 4. Shahid Mumtaz, Jonathan Rodriguez, Linglong Dai mmWave Massive MIMO: A Paradigm for 5G

Elective - I

Subject Name: RF Engineering	
Course Code :504605-1	**Semester: I**
Weekly Teaching Hours: Theory : 04	**Scheme of Marking Theory: 100 Marks** **Insem : 50 Marks** **Endsem : 50 Marks**
Credit : 4	

Content		Hours
Unit 1	Scattering and chain scattering matrices, Generalized scattering matrix, Analysis of two port Networks, scattering matrix, representation of microwave components (directional coupler, circulators, hybrids, and isolators).	7
Unit 2	Microstrip lines: Geometry of microstrip, quasi-TEM mode of propagation, Static-TEM parameters, Characteristic impedance, effective permittivity, synthesis formulae, analysis formulae, dispersion in microstrip.	7
Unit 3	Filter design using Insertion loss method, characterization by power loss ratio, Maximally flat low pass filter, Equal-ripple low pass filter, Filter transformations: impedance and frequency scaling, bandpass and bandstop transformations,	7
Unit 4	Filter implementation: Richard's transformation, Kuroda's identities. Basic properties of dividers and Couplers. Even mode and odd mode analysis,	7
Unit 5	Wilkinson power divider, quadrature hybrid, and coupled line directiona coupler.	7
Unit 6	Instrumentation concepts and measurement techniques in Spectrum analyzer, Signal generator, Vector network analyzer, and Noise figure analyzers.	7

Books
1. D. M. Pozar, Microwave Engineering, 3nd Edition, John Wiley & Sons. 2. R. Sorrentino and G. Bianchi, Microwave and RF Engineering, John Wiley & Sons. Department of ECE Scheme and Syllabi w.e.f. 2021-22 3. Reinhold Ludwig and Gene Bogdanvov, ―RF Circuit Design – Theory and Application, 2nd Edition, Pearson, 2012. 4. E.da Silva, ―High Frequency and Microwave Engineering, Butterworth Heinmann publications, Oxford 2001. 5. T. C. Edwards, Foundations of Interconnects and Microstrip lines, John Wiley & Sons.

Subject Name: Mathematical Foundations for Communication Engineers	
Course Code :504605-2	**Semester: I**
Weekly Teaching Hours: Theory : 04	**Scheme of Marking Theory: 100 Marks** **Insem 50 Marks** **Endsem 50 Marks**
Credit : 4	

Content		Hours
Unit 1	Meaning of probability, Axioms of Probability, Conditional Probability, Concept of a Random Variable, Expected values for discrete and continuous random variables, Function of one Random Variable, Two Random variables, conditional probability density functions.	7
Unit 2	Classification, Auto Correlation, Cross Correlation, Stationary and wide sense stationary random process, Gaussian random process, Poisson random process.	7
Unit 3	Vector spaces, Linear combination of vectors, Linear dependence, Basis and dimensions, finite dimensional vector spaces,	7
Unit 4	Linear Transformations. Norms and normed vector spaces, Inner products and inner product spaces	7
Unit 5	Matrix factorizations, LU factorization, unitary matrices and QR factorization. Eigen values and Eigen vectors,	7
Unit 6	Linear dependence of Eigen vectors, diagonalization of matrix. Singular value decomposition, pseudo inverses and the SVD.	7

TEXT BOOKS :

[1]. A. Papoulis and S. Unnikrishnan Pillai, ``Probability, Random Variables and Stochastic Processes," Fourth Edition, McGraw Hill. (Indian Edition is available).

[2]. GibertStrang," Linear Algebra and its applications", Thomson Learning Inc, 4th Edition.

[3]. H.Stark and J. Woods, 'Probability and Random Processes with Applications to Signal Processing," Third Edition, Pearson Education. (Indian Edition is available).

[4]Steven M. Kay, " Intuitive Probability and Random Process using Matlab", Springer Publications.

[5]. Todd K Moon, Wynn C. Stirling" Mathematical Methods and Algorithms for Signal Processing, Prentice Hall.

Subject Name: Advanced Wireless Communication	
Course Code :504605-3	**Semester: I**
Weekly Teaching Hours: Theory : 04	**Scheme of Marking Theory: 100 Marks** **Insem 50 Marks** **Endsem 50 Marks**
Credit : 4	

Content		Hours
Unit 1	Radio wave propagation, Physical modeling for wireless channels, Path loss and Shadowing, outage probability under path loss and shadowing, time and frequency coherence, Statistical multipath channel models, narrowband fading models, wideband fading models, Discrete-time model, Space-time channel models.	7
Unit 2	AWGN channel capacity, capacity of flat fading channels, channel distribution Information known at transmitter or receiver and both capacity comparisons, Capacity of frequency selective fading channels-time invariant- time variant.	7
Unit 3	SNR and bit/symbol energy, error probability for BPSK, QPSK, MPSK MPAM, MQAM, Index Modulation over fading channels. Error probability for FSK and CPFSK, error probability approximation for coherent modulations and differential modulation,	7
Unit 4	Q-function representation, outage probability, average probability of error, inter symbol interference, Receiver diversity: selection combining (SC), threshold combining, maximal ratio combining (MRC), equal gain combining (EGC), transmitter diversity: channel known at the transmitter, channel unknown at the transmitter	7
Unit 5	Alamouti scheme, moment generating functions(MGF) in diversity analysis ,diversity analysis using MGF for SC-EGC-MRC, diversity analysis for non-coherent and differentially coherent modulation..	7
Unit 6	Equalizer noise enhancement, equalizer types, zero forcing equalizer, MMSE equalizer, maximum likelihood sequence estimation, decision feedback equalization, adaptive equalizers.	7

Books
1. Andrea goldsmith, `Wireless Communication`, South Asia Edition 2015, Cambridge University Press 2. Theodore S. Rappaport, 'Wireless Communications Principles and Practice," Third Edition, Pearson Education. (Indian Edition is available). 3. David Tse, PramodViswanath, "Fundamentals of Wireless Communication", Cambridge University Press 4. Todd K Moon, Wynn C. Stirling" Mathematical Methods and Algorithms for Signal Processing, Prentice Hall

Subject Name: Wireless Optical Communication	
Course Code :504605-4	**Semester: I**
Weekly Teaching Hours: Theory : 04	**Scheme of Marking Theory: 100 Marks** **Insem: 50 Marks** **Endsem: 50 Marks**
Credit : 4	

Content		Hours
Unit 1	Introduction to wireless optical communication (WOC), wireless optical channels: atmospheric channel, underwater optical channel, atmospheric losses, weather condition influence, atmospheric turbulence effects i.e. scintillation, beam spreading, etc. wireless optical communication application areas, WOC challenges	7
Unit 2	LED structure, planar and dome LED, LED efficiencies, LASER diode, Modes and Threshold conditions, structure of common Laser Types: Fabry– Perot Laser, distributed feedback Laser.	7
Unit 3	PIN Photo detector, avalanche photo diode, photo detection noises, comparison of photo detectors. linear time invariant model, channel transfer function, models of turbulence induced fading such aslog-normal turbulence model,.	7
Unit 4	exponential, K distribution, gamma gammaistribution,indoor optical wireless communication channel: LOS propagation model, Non-LOS propagation model, spherical model, analogue intensity modulation, digital baseband modulation techniques: baseband modulations, on–off keying, error performance on Gaussian channels	7
Unit 5	power efficiency, BW efficiency, bit versus symbol error rates, differen modulation schemes such as M-PPM, DPPM, DAPPM schemes, subcarrier modulation, optical polarization shift keying: binary PolSK, bit error rate analysis.	7
Unit 6	direct detection optical receivers, PIN/APD, coherent techniques i.e. homodyne and heterodyne, bit error rate evaluation in presence of atmospheric turbulence,spatial diversity receivers, effect of turbulence and weather conditions i.e. drizzle, haze fog on error performance and channel capacity.	7

Books
1. Z.Ghassemlooy, W.Popoola, S.Rajbhandari, Optical Wireless Communications, CRC Press,2013. 2. Gerd Keiser, Optical Fiber Communication, 4th Edition, Tata McGraw-Hill Ltd., 2008 (Indian Edition). 3. L.C.Andrews, R.L.Phillips, Laser Beam Propagation through Random Media, SPIE Press,USA, 2005.

Subject Name:Lab Practice-I	
Course Code :504606	**Semester: I**
Weekly Teaching Hours: Theory : 04	**Scheme of Marking Theory: 100 Marks Tw: 50 Marks OR: 50 Marks**
Credit : 4	

Assignment/Experiments	
1	Communication system Design for Band limited Channels - Signal Design for Zero ISI (Ideal Nyquist channel) and Controlled ISI - Partial Response Signalling.
2	Digital passband Modulation techniques -BER of coherent binary modulation schemes - BPSK, BFSK & BASK
3	Digital passband Modulation techniques -coherent M-ary Modulation techniques-QPSK QAM, 8-PSK,16-PSK etc
4	Non coherent orthogonal modulation schemes-Simulation of NC-BFSK, DPSK
5	ModelingandSimulationofRadioChannelsMultipathFadingChannels-Jake'sModel
6	Frequency non-selective and OFDM system simulation, BER performancein fading channels
7	Channel estimationin OFDM frequency selective fading channels realization.
8	Synchronization in OFDM
9	Ethernet and Token Ring simulation and Evaluation
10	SchedulingandQueuingDisciplinesinPacketSwitchedNetworks:FIFO,FairQueuing, RED

The laboratory work will be based on completion of minimum two assignments/experimentsconfined to the courses of that semester.

First Year Semester-II

Subject Name: 5G-Technology-2	
Course Code :504601	**Semester: II**
Weekly Teaching Hours: Theory : 04	**Scheme of Marking Theory: 100 Marks** **Insem 50 Marks** **Endsem 50 Marks**
Credit : 4	**Scheme of Marking PR: -- 50**

Content		Hours
Unit 1	Modeling requirements and scenarios, Channel model requirements, Propagation scenarios, Relaying multi-hop and cooperative communications: Principles of relaying, fundamentals of relaying, Cognitive radio: Architecture, spectrum sensing, Software Defined Radio (SDR).	6
Unit 2	Introduction to Multi-antenna Systems, Motivation, Types of multi-antenna systems, MIMO vs. multi-antenna systems. Diversity, Exploiting multipath diversity, Transmit diversity, Space-time codes, The Alamouti scheme, Delay diversity, Cyclic delay diversity, Space-frequency codes, Receive diversity, The rake receiver, Combining techniques, Spatial Multiplexing	7
Unit 3	Introduction, NFV and SDN, Basics about RAN architecture, High-level requirements for the 5G architecture, Functional architecture and 5G flexibility Functional split criteria, Functional split alternatives, Functional optimization for specific applications, Integration of LTE and new air interface to fulfill 5G Requirements, Enhanced Multi-RAT coordination features, Physical architecture and 5G deployment.	7
Unit 4	D2D: from 4G to 5G, D2D standardization: 4G LTE D2D, D2D in 5G: research challenges, Radio resource management for mobile broadband D2D, RRM techniques for mobile broadband D2D, RRM and system design for D2D, 5G D2D RRM concept: an example, Multi-hop D2D communications fo proximity and emergency, services, National security and public safety requirements in 3GPP and METIS, Device discovery without and with networ assistance	8
Unit 5	Access design principles for multi-user communications, Orthogonal multiple access systems, Spread spectrum multipleaccess systems, Capacity limits of multiple-access methods, Sparse code multiple access (SCMA), Interleave division multiple access (IDMA), Radio access for dense deployments, OFDM numerology for small-cell deployments,	7
Unit 6	Network deployment types, Ultra-dense network or densification, Moving networks, Heterogeneous networks, Interference management in 5G, Interference management in UDN, Interference management for moving relay nodes, Interference cancelation, mobility management in 5G, User equipment controlled versus network-controlled handover, Mobility management in heterogeneous 5G networks	7

Books
1.Afif Osseiran, Jose F. Monserrat, Patrick Marsch, 5G Mobile and Wireless Communications Technology Second Edition,2011
2. Erik Dahlman, Stefan Parkvall, Johan Sko¨ld, 5G NR: The Next Generation Wireless Access Technology Elsevier, First Edition, 2016
3. Jonathan Rodriguez,Fundamentals of 5G Mobile Networks, Wiley, First Edition, 2010

Subject Name: Research Methodology and IPR	
Course Code :504602	**Semester: II**
Weekly Teaching Hours: Theory : 04	**Scheme of Marking Theory: 100 Marks** **Insem 50 Marks** **Endsem 50 Marks**
Credit : 4	

Content		Hours
Unit 1	Objectives of research, research process – observation, analysis, inference, hypothesis, axiom, theory, experimentation, types of research (basic, applied, qualitative, quantitative, analytical etc). Features of translational research, the concept of laboratory to market (bench to public) and Industrial R&D.	7
Unit 2	Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, Plagiarism, Research ethics	7
Unit 3	Importance and scientific methodology in recording results, importance of negative results, different ways of recording, industrial requirement, artifacts versus true results, types of analysis (analytical, objective, subjective), outcome as new idea, hypothesis, concept, theory, model	7
Unit 4	Effective technical writing, how to write a manuscript/ responses to reviewers comments, preparation of research article/ research report, Writing a Research Proposal - presentation and assessment by a review committee	7
Unit 5	Nature of Intellectual Property: Patents, Designs, Trade Mark and Copyright. Process of Patenting and Development: technological research, innovation, patenting & development. Procedure for grants of patents, Patenting under PCT.	7
Unit 6	Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System.	7

Books
1.Kothari, C. R. Research Methodology - Methods and Techniques, New Age International publishers, Nev Delhi, 2004
2.Ranjit Kumar, Research Methodology- A step by step guide for beginners, Pearson Education, Australia, 2005
3.Ann M. Korner, Guide to Publishing a Scientific paper, Bioscript Press 2004
4.T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

Subject Name: 5G-Mobile Communication	
Course Code :504603	**Semester: II**
Weekly Teaching Hours: Theory : 04	**Scheme of Marking Theory: 100 Marks** **Insem 50 Marks** **Endsem 50 Marks**
Credit : 4	

Content		Hours
Unit 1	5G RADIO SPECTRUM: 5G spectrum landscape and requirements, Spectrum access modes and sharing scenarios, 5G spectrum technologies. 5G CHANNEL MODEL: The 5G wireless Propagation Channels: Channel modeling requirements, propagation scenarios and challenges in the 5G modeling.	7
Unit 2	RADIO INTERFACE ARCHITECTURE: 5G architecture options, core network architecture, RAN architecture. 5G PHYSICAL LAYER: Physical channels and signals, 5G frame structure	7
Unit 3	5G RADIO-ACCESS TECHNOLOGIES: Access design principles for multi-user communications, multi-carrier with filtering: a new waveform	7
Unit 4	INTRODUCTION TO 5G NETWORK SLICING: Network Slicing, E2E Slicing, SDN and NFV Slicing VEHICULAR COMMUNICATIONS: From V2V to AV2X, key standards, VC architectures	7
Unit 5	MOBILITY AND HANDOFF MANAGEMENT IN 5G: Network deploymen types	7
Unit 6	Interference management in 5G, Mobility management in 5G, Dynamic network reconfiguration in 5G	7

Books
1.Afif Osseiran, Jose F Monserrat, Patrick Marsch, "5G Mobile and Wireless Communications Technology", Cambridge University Press, 2016
2.Saad Z. Asif, "5G Mobile Communications Concepts and Technologies", CRC Press, Taylor & Francis Group, First Edition, 2018
3.Harri Holma, AnttiToskala, Takehiro Nakamura, "5G Technology 3GPP NEW RADIO", John Wiley Son First Edition,2020

Elective II

Subject Name: Telecom Network Management	
Course Code :504604-1	**Semester: II**
Weekly Teaching Hours: Theory : 04	**Scheme of Marking Theory: 100 Marks** **Insem 50 Marks** **Endsem 50 Marks**
Credit : 4	

Content		Hours
Unit 1	Overview of Network Management: Case histories on network, system and service management, challenges of IT managers, Network Management: Goals, organization and functions, Network management architecture and organization network management perspectives	6
Unit 2	OSI Network Management: Network management standards, Network management models, Organization model, Information model, Communication model and functional model, Abstract syntax notation – encoding structure, macros functional model CMIP/CMISE	8
Unit 3	Internet Management (SNMP): SNMP-organizational model, System overview, Information model, communication model, functional model	8
Unit 4	Broadband Network Management: Broadband networks and services, ATM Technology – VP, VC, ATM Packet, Integrated service, ATM LAN emulation Virtual LAN, ATM Network Management – ATM network reference model, integrated local management interface. ATM management information base	7
Unit 5	Network Management Applications: Configuration management, Fault management, Performance management, Event correlation techniques, security management	7
Unit 6	Telecommunication Management Networks(TMN): Need for TMN, Conceptual model, TMN standards, TMN management services architecture and TMN implementation	7

Books
1.Mani Subramaniam, ―Network Management Principles and Practise", Addison Wisely, New York, 200
2. Lakshmi G. Raman, ― Fundamental of Telecommunications Network Management" Eastern Economy Edition, IEEE Press New Delhi.
3. SalhAiidarons, Thomas Plevoyak ―Telecommunications Network Technologies and implementations" Eastern Economy Edition, IEEE press New Delhi-1998

Subject Name: VLSI System Design	
Course Code :504604-2	**Semester: II**
Weekly Teaching Hours: Theory : 04	**Scheme of Marking Theory: 100 Marks Insem 50 Marks Endsem 50 Marks**
Credit : 4	

Content		Hours
Unit 1	Introduction: Basic VLSI design cycle, design styles, review of transistor biasing.	7
Unit 2	MOS Transistor Theory: Current voltage relationship, different regions of operation of MOSFET, channel length modulation, body bias effect, small signal model, device capacitances	7
Unit 3	CMOS Processing Technology: Overview of integrated circuit processing, photolithography, self-aligned MOSFET, isolation and wells CMOS process flow, mask design, layout, latch-up, defects and yield considerations, twin well and triple well processes, scaling aspects	7
Unit 4	CMOS Circuit and Logic Design: Basic circuit and DC operation, CMOS inverter transfer characteristics, propagation delay, power dissipation, driving large capacitive loads, CMOS NAND, NOR gates, Exclusive-OR gate, efficient combinational logic circuits, transmission gates	7
Unit 5	CMOS sequential logic circuits, dynamic logic circuit concepts, charge sharing, clock feed through, domino logics.	7
Unit 6	Analog IC design: Biasing techniques, single stage amplifier, CS amplifier with diode connected load, source degenerated CS amplifier, current mirror, sources and sinks, cascode amplifier, differential amplifier, double ended to single ended conversion, Introduction to OP amp, band-gap reference circuits. Testing: Significance of DFT, Different types of errors, faults, BIST, reliability aspects.	7

Books
1. Pucknel and Eshraghian, Basic VLSI Design, PHI, 3 rd Edition,1995
2. Neil H.E. Weste and Kamran Eshraghian, Principles of CMOS VLSI Design, Wesley, 2000.
3. Wayne Wolf, Modern VLSI Deisgn,Pearson Education Asia, 2002.

Subject Name: Advanced Computer Networks	
Course Code :504604-3	**Semester: II**
Weekly Teaching Hours: Theory : 04	**Scheme of Marking Theory: 100 Marks** **Insem 50 Marks** **Endsem 50 Marks**
Credit : 4	

Content		Hours
Unit 1	Review of computer networks and the Internet: What is the Internet. Access Networks and Physical media, ISPs and Internet Backbones, Delay and Loss circuit, message, and packet switched Networks. History of computer networking and the Internet - 5-layer TCP/IP Model, 7-Layer OSI Model, Internet Protocols and Addressing, Equal-Sized Packets Model: ATM, Networking Devices: Multiplexers, Modems and Internet Access Devices, Switching and Routing Devices, Router Structure.	7
Unit 2	Data link layer protocols, bit and byte oriented, stop-and-wait, go-back-N, selective repeat and sliding window techniques- their performances with and without errors, error detection and correction, CRC, framing, HDLC and X.25, link layer addressing.	7
Unit 3	Multiple Access Techniques - Introduction - Narrowband Channelized Systems – Frequency Division Multiple Access - Frequency Division Duplex (FDD) and Time Division Multiple Access - Time Division Duplex (TDD) System - Spectral Efficiency - Multiple Access Spectral Efficiency - Overall Spectral Efficiency of FDMA and TDMA Systems Wideband Systems - Comparisons of FDMA, TDMA, and DSCDMA - Capacity of DS-CDMA System - Comparison of DS-CDMA vs. TDMA System Capacity - Random	7
Unit 4	Access Methods - Pure ALOHA - Slotted ALOHA. Carrier Sense Multiple Access (CSMA) - Carrier Sense Multiple Access with Collision Detection - Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) - Idle Signal Casting Multiple Access - Packet	7

	Reservation Multiple Access – IEEE 802.3 – IEEE 802.4 – IEEE 802.5 – IEEE 802.11 – FDDI – SONET.	
Unit 5	Routing: Network–Layer Routing, Least-Cost-Path algorithms, Non-Least-Cost-Path algorithms, Intradomain Routing Protocols, Interdomain Routing Protocols, Congestion Control at Network Layer.	7
Unit 6	Wireless Networks and Mobile IP: Infrastructure of Wireless Networks Wireless LAN Technologies, IEEE 802.11 Wireless Standard, Mobile IP, Wireless Mesh Networks (WMNs), Bluetooth networks, WiMax, and RFID.	7

Books
1. William Stallings, Data and Computer Communication, Prentice Hall of India.
2. Behrouz A. Forouzan, Data Communication and Networking, McGraw-Hill.
3. Andrew S. Tanenbaum, Computer Networks, Prentice Hall.
4. James F. Kurose, Keith W.Ross, Computer Networking: A Top-Down Approach Featuringthe Internet, Pearson Education.
5. S.Keshav, An Engineering Approach to Computer Networking, Pearson Education.

Subject Name: Fuzzy systems and neural networks	
Course Code :504604-4	**Semester: II**
Weekly Teaching Hours: Theory : 04	**Scheme of Marking Theory: 100 Marks** **Insem 50 Marks** **Endsem 50 Marks**
Credit : 4	

Content		Hours
Unit 1	Introduction: Background and History; Knowledge-based Information processing; Neural Information Processing; Hybrid Intelligence.	7
Unit 2	Basic Neural Computational Models: Basic concepts of Neural Nets (such as node properties, Network properties and Dynamics); Inference and learning (Data representation and functional classification); Classification models (Single layer Perceptrons, multi_layerperceptrons); Association models (Hop field Nets, Bi-directional associative memories); Self organizing models (Kohonen Networks, Competitive learning, Hebbian learning).	7
Unit 3	Learning: Supervised and Unsupervised learning; Statistical learning; Neural Network learning (Back propagation, Radial basis Function Networks, ART Networks); Genetic Algorithms.	7

Unit 4	Knowledge Based Neural Networks: Rule-based Neural networks; Network Training; Decision Tree Based NN's; Incremental Learning: Principles; Symbolic methods; Neural Network Approaches (Probabilistic NN's); Incremental RBCN.	7
Unit 5	Nn Applications: Signal Processing; Computer Vision; Medical Applications; Automated Inspection and Monitoring; Business and Finance.	7
Unit 6	Fuzziness Vs Probability: Fuzzy Sets & Systems; The Geometry of Fuzzy sets; The Fuzzy Entropy theorem; The subset hood Theorem; The Entropy Subset hood theorem. 1. Fuzzy Associative Memories: Fuzzy & Neural Function Estimators; Fuzzy Hebbian FAMs; Adaptive FAMs. 2. Comparison Of Fuzzy & Neural Systems: Case studies.	7

Books
Neural Networks in Computer Intelligence by Limin Fu, McGraw Hill Co., 1994.
Neural Networks & Fuzzy systems by B.Kosko, Prentice Hall (India) Ltd., 1992.

Subject Name:Lab Practice-II	
Course Code :504605	**Semester: II**
Weekly Teaching Hours: Theory : 04	**Scheme of Marking Theory: Tw: 50 Marks OR: 50 Marks**
Credit : 4	

Lab Practice-II	
1	5G Communications Link Analysis with Ray Tracing using MATLAB
2	Wireless Connectivity in the 5G Era for WLAN using MATLAB
3	MIMO Wireless System Design for 5G using MATLAB
4	5G Waveforms generation using MATLAB
5	5G Beamforming Design
6	Frame Structure of 5G technology
7	Numerology in 5G
8	Spatial Multiplexing and Hybrid Beamforming for 5G Wireless Communications
9	Tutorial on Understanding 5G technologies
10	MATLAB Project on Massive MIMO System Implementation with Perfect CSI

The laboratory work will be based on completion of minimum two assignments/experiments confined to the courses of that semester.

Second Year Semester-I

Subject Name:Advanced Antenna Technology	
Course Code :604601	**Semester: III**
Weekly Teaching Hours: Theory : 04	**Scheme of Marking Theory: 100 Marks Insem 50 Marks Endsem 50 Marks**
Credit : 4	

Content		Hours
Unit 1	Biconical antenna, discone& conical skirt monopole, equiangular spiral antenna, fractal antenna concept & technology, corrugated horn antenna, multimode horn antenna, smart antenna benefit, drawbacks & design, adaptive beam forming, MANET, array theory, Electrically small & big antenna	11
Unit 2	Artificial dielectric lens antenna, Luneburg & Einstein lenses, electrically & physically small antenna, ground plane antenna, sleeve antenna, turnstile antenna, submerged antenna, surface wave & leaky wave antenna, weather-vane antenna, flagpote antenna, chimney antenna, ILS antenna, sugar-scoop antenna, asteroid detection antenna, embedded antenna, plasma antenna	12
Unit 3	Microstrip and other planar antennas, Various types of feeding methods for microstrip antenna (Co-axial, Inset, Aperture/Slot Coupled, Proximity coupled and Corporate feeding for Arrays); Analysis of rectangular Patch Antenna, Cavity/ Modal Expansion Technique, micro strip antenna array	11
Unit 4	Conventional Scanning Techniques, Feed Networks for phased Arrays, Frequency Scanned Array Design, Search Patterns	8

Books

Sr No.	**Name of Authors**	**Title of the Book**	**Publisher**
1	C. Balanis	Antennas Theory – Analysis and Design	Wiley India
2	J. D. Kraus & others	Antennas	McGraw Hill-Special Indian Edition
3	A. A. Olliner and G.H. Knittel	Phased Array Antennas	Artech House

Subject Name:Wireless Sensor Networks	
Course Code :604602	**Semester: III**
Weekly Teaching Hours: Theory : 04	**Scheme of Marking Theory: 100 Marks Insem 50 Marks Endsem 50 Marks**
Credit : 4	

Content		Hours
Unit 1	Introduction and overview of sensor network architecture and its applications, sensornetwork comparison with Ad Hoc Networks, Sensor node architecture with hardware and software details. Hardware: Examples like mica2, micaZ, telosB, cricket, Imote2, tmote, btnode, and Sun SPOT, Software (Operating Systems): tinyOS, MANTIS, Contiki, and RetOS.	11
Unit 2	Programming tools: C, nesC. Performance comparison of wireless sensor networkssimulation and experimental platforms like open source (ns-2) and commercial (QualNet, Opnet)	12
Unit 3	Overview of sensor network protocols (details of atleast 2 important protocol per layer):Physical, MAC and routing/ Network layer protocols, node discovery protocols, multi-hop and cluster based protocols, Fundamentals of 802.15.4, Bluetooth, BLE (Bluetooth low energy), UWB.	11
Unit 4	Data dissemination and processing; differences compared with other database management systems, data storage; query processing.	8

Books			
Sr No.	**Name of Authors**	**Title of the Book**	**Publisher**
1	H. Karl and A. Willig	Protocols and Architectures for Wireless Sensor Networks	John Wiley & Sons, India, 2012
2	C. S. Raghavendra, K. M. Sivalingam, and T. Znati, Editors	Wireless Sensor Networks	Springer Verlag, 1st Indian reprint, 2010
3	YingshuLi, MyT. Thai, Weili Wu	Wireless sensor Network and Applications	Springer series on signals and communication technology, 2008
4	F. Zhao and L. Guibas	Wireless Sensor Networks: An Information Processing Approach	Morgan Kaufmann, 1st Indian reprint, 2013

Subject Name: Satellite Communication	
Course Code :604603	**Semester: III**
Weekly Teaching Hours: Theory : 04	**Scheme of Marking TH: 100 ISE: 50 ESE: 50**
Credit : 4	

	Content	Hours
Unit 1	Architecture of Satellite Communication System: Principles and architecture of satellite Communication, Brief history of Satellite systems, advantages, disadvantages, applications, and frequency bands used for satellite communication and their advantages/drawbacks	10
Unit 2	Orbital Analysis: Orbital equations, Kepler's laws of planetary motion, Apogee andPerigee for an elliptical orbit, evaluation of velocity, orbital period, angular velocity etc of a satellite, concepts of Solar day and Sidereal day.	10
Unit 3	Satellite sub-systems: Architecture and Roles of various sub-systems of a satellite systemsuch as Telemetry, tracking, command and monitoring (TTC & M), Attitude and orbit control system (AOCS), Communication sub-system, power sub-systems, antenna sub-system.	11
Unit 4	Typical Phenomena in Satellite Communication: Solar Eclipse on satellite, its effects,remedies for Eclipse, Sun Transit Outage phenomena, its effects and remedies, Doppler frequency shift phenomena and expression for Doppler shift.	10
Unit 5	Satellite link budget: Flux density and received signal power equations, Calculation ofSystem noise temperature for satellite receiver, noise power calculation, Drafting of satellite link budget and C/N ratio calculations in clear air and rainy conditions, Case study of Personal Communication system (satellite telephony) using LEO. Modulation and Multiple Access Schemes used in satellite communication.Typicalcasestudies of VSAT, DBS-TV satellites and few recent communication satellites launched by NASA/ ISRO. GPS.	11

Books
1. Timothy Pratt and Others, "Satellite Communications", Wiley India, 2nd edition,2010.
2. .S. K. Raman, "Fundamentals of Satellite Communication", PearsonEducation India, 2011. Tri T. Ha, "Digital Satellite Communications", Tata McGraw Hill, 2009
3.DennisRoddy, "Satellite Communication", McGraw Hill, 4th Edition, 2008

Subject Name: Smart Antennas	
Course Code :604604	**Semester: III**
Weekly Teaching Hours: Theory : 04	**Scheme of Marking TH: 100 ISE: 50 ESE: 50**
Credit :	

Content		Hours
Unit 1	Spatial processing for wireless systems. Adaptive antennas. Beam forming networks. Digital radio receiver techniques and software radios	8
Unit 2	Coherent and non-coherent CDMA spatial processors. Dynamic re-sectoring. Range and capacity extension – multi-cell systems	8
Unit 3	Spatio – temporal channel models. Environment and signal parameters. Geometrically based single bounce elliptical model.	8
Unit 4	Optimal spatial filtering – adaptive algorithms for CDMA. Multitarget decision – directed algorithm.	8
Unit 5	DOA estimation – conventional and subspace methods. ML estimation techniques. Estimation of the number of sources using eigen decomposition. Direction finding and true ranging PL systems. Elliptic and hyperbolic PL systems. TDOA estimation techniques.	11

Books
1.T.S.Rappaport&J.C.Liberti, Smart Antennas for Wireless Communication, Prentice Hall (PTR) , 1999.
2R.Janaswamy, Radio Wave Propagation and Smart Antennas for Wireless Communication, Kluwer, 2001.
3M.J. Bronzel, Smart Antennas, John Wiley, 2004

Subject Name: Wavelet Signal Processing	
Course Code :604605	**Semester: III**
Weekly Teaching Hours: Theory : 04	**Scheme of Marking TH: 100 ISE: 50 ESE: 50**
Credit :	

Content		Hours
Unit 1	Limitations of standard Fourier analysis. Windowed Fourier transform. Continous wavelet transform. Time-frequency resolution.	11
Unit 2	Wavelet bases. Balian-Low theorem. Multiresolution analysis. (MRA). Construction of wavelets from MRA. Fast wavelet algorithm	12
Unit 3	Compactly supported wavelets. Cascade algorithm. Franklin and spline wavelets. Wavelet packets. Hilbert space frames. Frame representation. Representation of signals by frames. Iterative reconstruction. Frame algorithm	10
Unit 4	Wavelet methods for signal processing. Noise suppression. Representation of noise-corrupted signals using frames. Algorithm for reconstruction from corrupted frame representation. Wavelet methods for image processing. Burt- Adelson and Mallat's pyramidal decomposition schemes. 2D-dyadic wavelet transform.	9

Books
1.E.Hernandez&G.Weiss, A First Course on Wavelets, CRC Press, 1996.
2. L.Prasad&S.S.Iyengar, Wavelet Analysis with Applications to Image Processing, CRC Press, 1997

Subject Name: **Seminar II**	
Course Code :604606	**Semester: III**
Weekly Teaching Hours: Theory : 04	**Scheme of Marking TW: 50** **ORAL: 50**
Credit : 4	

Content
Seminar II shall be on the topic relevant to latest trends in the field of concerned branch, preferably on the topic of specialization based on the electives selected by him/her approved by authority. The student shall submit the seminar report in standard format, duly certified for satisfactory completion of the work by the concerned guide and head of the Department/Institute.

Subject Name: **Project Stage- I**	
Course Code :604607	**Semester: III**
Weekly Teaching Hours: Theory : 04	**Scheme of Marking TW: 50** **ORAL: 50**
Credit : 8	

Content
Project Stage – I is an integral part of the project work. In this, the student shall complete the partial work of the project which will consist of problem statement, literature review, project overview, scheme of implementation (Mathematical Model/SRS/UML/ERD/block diagram/ PERT chart, etc.) and Layout & Design of the Set-up. As a part of the progress report of Project work Stage-I, the candidate shall deliver a presentation on the advancement in Technology pertaining to the selected dissertation topic. The student shall submit the duly certified progress report of Project work Stage-I in standard format for satisfactory completion of the work by the concerned guide and head of the Department/Institute.

Second Year Semester-II

Subject Name: **Seminar III**	
Course Code :604608	**Semester: IV**
Weekly Teaching Hours: Theory : 04	**Scheme of Marking TW: 50** **ORAL: 50**
Credit : 5	

Content
Seminar III shall preferably an extension of seminar II. The student shall submit the dulycertified seminar report in standard format, for satisfactory completion of the work by the concerned guide and head of the Department/Institute

Subject Name: **Project Stage-II**	
Course Code :604609	**Semester: IV**
Weekly Teaching Hours: Theory : 04	**Scheme of Marking TW: 150** **ORAL: 50**
Credit : 20	

Content
Project Stage –II In Project Stage – II, the student shall complete the remaining part of the project which will consist of the fabrication of set up required for the project, work station, conducting experiments and taking results, analysis & validation of results and conclusions The student shall prepare the duly certified final report of project work in standard format for satisfactory completion of the work by the concerned guide and head of the Department/Institute.