Society for Computer Technology & Research's (SCTR's)

Pune Institute of Computer Technology (PICT), Pune

An Autonomous Institute affiliated to the Savitribai Phule Pune University
Approved by AICTE & Government of Maharashtra,
Accredited by NAAC (A+) & NBA [All eligible UG Programs]

Syllabus for the

M-Tech – Electronics and Communication

(Wireless Communication Technology-WCT)

(2024-25 Course) *

With effect from (Jun 24)
NEP 2020 and NHEQF Compliant
*Approved by the Board of Studies (BoS) and Academic Council

Contents

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Abbreviations:

Short forms	Longform/ Detail description
CIA	: Continuous Internal Assessment
DIS	Dissertation
ESE	: End-Semester Examination
FP	Field Study
HSS	Humanities Social Science
IKS	: Indian Knowledge System
IP	: Internship
ISE	: In-Semester Examination
L	: Lecture
OEC	: Open Elective Other than particular program
OR	: Oral
P	: Practical
PCC	: Program Core Course
PEC	: Program Elective Course
SEC	:Skill Enhancement Course
T	: Tutorial
TW	: Termwork

Structure
M-Tech– First Year Electronics and Communication (Wireless Communication Technology -WCT)
Semester - 1

	Semester	PG-1	Teaching Scheme (Hours/Week)				Credits/ Grades				Examination Scheme and Marks					
Broad Category of Course	**Course code**	**Name of subjects**	**L**	**P**	**T**	**Total**	**L**	**P**	**T**	**Total**	**Theory**			**Practical**		**Semester**
											ISE	**CIA**	**ESE**	**CIA/ TW**	**ESE P/OR**	**Total**
											[20]	**[30]**	**[50]**	**[50]**	**[50]**	
PCC	**EPG1-001**	Advanced Digital Communications (ADC)	3	0	0	**3**	3	0	0	**3**	20	30	50	0	0	**100**
PCC	**EPG1-002**	Cellular Wireless Communications (CWC)	3	0	0	**3**	3	0	0	**3**	20	30	50	0	0	**100**
PCC	**EPG1-003**	Probability and Stochastic Processes (PSP)	3	0	1	**4**	3	0	1	**4**	20	30	50	0	0	**100**
ISS	**EPG1-004**	Research Methodology (RM)	2	0	1	**3**	2	0	1	**3**	20	30	50	0	0	**100**
PEC	**EPG1-005**	Program Elective Course - I	3	0	0	**3**	3	0	0	**3**	20	30	50	0	0	**100**
SEC	**EPG1-006**	Lab Practice-I (Skill Enhancement Course) (LP-I)	0	8	0	**8**	0	4	0	**4**	0	0	0	50	50	**100**
		Total	**14**	**8**	**2**	**24**	**14**	**4**	**2**	**20**	**100**	**150**	**250**	**50**	**50**	**600**

L: lecture, P: Practical, T: Tutorial, ISE: In-Semester Examination, CIA: Continuous Internal Assessment, ESE: End-Semester Examination, TW: Termwork, OR: Oral

Program Elective Course – I[EPG1-005] (Student may select any one of the following courses or NPTEL MOOCs course from the list recommended by the department). The total credits earned through MOOCs should be equivalent to the allocated credits for the respective Elective. (One credit will be awarded for a four-week MOOCs course).

A. SDR and Cognitive Radio	C. Data Analytics
B. Modern Technologies for 5G Wireless Communications	D. Artificial Intelligence

M-Tech– First Year Electronics and Communication (Wireless Communication Technology -WCT)

Semester - 2

	Semester	PG-2	Teaching Scheme (Hours/Week)				Credits/ Grades				Examination Scheme and Marks					
Broad Category of Course	**Course code**	**Name of subjects**	**L**	**P**	**T**	**Total**	**L**	**P**	**T**	**Total**	**Theory**			**Practical**		**Semester**
											ISE	**CIA**	**ESE**	**CIA/ TW**	**ESE P/OR**	**Total**
											[20]	**[30]**	**[50]**	**[50]**	**[50]**	
PCC	**EPG2-11**	Signal Processing for Wireless Communication (SPWC)	3	0	1	**4**	3	0	1	**4**	20	30	50	0	0	**100**
PCC	**EPG2-12**	Information Theory and Coding (ITC)	3	0	1	**4**	3	0	1	**4**	20	30	50	0	0	**100**
PEC	**EPG2-13**	Program Elective Course - II	3	0	0	**3**	3	0	0	**3**	20	30	50	0	0	**100**
OE	**EPG2-14**	Open Elective Course - I	3	0	0	**3**	3	0	0	**3**	20	30	50	0	0	**100**
SEC	**EPG2-15**	Lab Practice-II(SEC) (LP-II)	0	8	0	**8**	0	4	0	**4**	0	0	0	50	50	**100**
DIS	**EPG2-16**	Mini Project / Seminar-I/Internship (MP/SM-I/IP-I)	0	4	0	**4**	0	2	0	**2**	0	0	0	50	50	**100**
		Total	**12**	**12**	**2**	**26**	**12**	**6**	**2**	**20**	**80**	**120**	**200**	**100**	**100**	**600**

Program Elective Course – II [EPG2-13] (Student may select any one of the following courses or NPTEL MOOCs course from the list recommended by the department). The total credits earnt through MOOCs should be equivalent to the allocated credits for the respective Elective (One credit will be awarded for a four-week MOOCs course)

A. Antennas for Modern Wireless Communications	C. Project Management
B. Machine Learning Techniques	D. Cyber Security

Open Elective Course - I

Students may select any one of the courses of 4 credits offered by any other department in the institute or Industry supported Course.
MOOCs: The total credits earned through MOOCs should be equivalent to the allocated credits for the respective Open Elective Course. (One credit will be awarded for a four-week MOOCs course)

M-Tech– Second Year Electronics and Communication (Wireless Communication Technology -WCT)
Semester – 3

	Semester	PG-3	Teaching Scheme (Hours/Week)				Credits/ Grades				Examination Scheme and Marks					
Broad Category of Course	**Course code**	**Name of subjects**	**L**	**P**	**T**	**Total**	**L**	**P**	**T**	**Total**	**Theory**			**Practical**		**Semester**
											ISE	**CIA**	**ESE**	**CIA/ TW**	**ESE P/OR**	**Total**
											[20]	**[30]**	**[50]**	**[50]**	**[50]**	
PCC	**EPG3-21**	Advanced Wireless Networks (AWN)	3	0	1	**4**	3	0	1	**4**	20	30	50	0	0	**100**
OE	**EPG3-22**	Open Elective Course - II	4	0	0	**4**	4	0	0	**4**	20	30	50	0	0	**100**
HSS	**EPG3-23**	Human Values/Intellectual Peoperty /Professional Ethics (HV/IPR/PE)	2	0	0	**2**	2	0	0	**2**	0	25	25	0	0	**50**
IP	**EPG3-24**	Internship (IP-II)	0	8	0	**8**	0	4	0	**4**	0	0	0	50	50	**100**
HSS	**EPG3-25**	Seminar – II /Employability Skills-I (SM-II/ ES-I)	0	4	0	**4**	0	2	0	**2**	0	0	0	50	50	**100**
DIS	**EPG3-26**	Dissertation (DIS-I)	0	8	0	**8**	0	4	0	**4**	0	0	0	50	50	**100**
		Total	**9**	**20**	**1**	**30**	**9**	**10**	**1**	**20**	**40**	**85**	**125**	**150**	**150**	**550**

Open Elective Course – II
Students may select any one of the courses of 4 credits offered by any other department in the institute or Industry supported Course. MOOCs: The total credits earned through MOOCs should be equivalent to the allocated credits for the respective Open Elective Course. (One credit will be awarded for a four-week MOOCs course)

M-Tech– Second Year Electronics and Communication (Wireless Communication Technology -WCT)
Semester – 4

	Semester	PG-4	Teaching Scheme (Hours/Week)				Credits/ Grades				Examination Scheme and Marks					
Broad Category of Course	**Course code**		**L**	**P**	**T**	**Total**	**L**	**P**	**T**	**Total**	**Theory**			**Practical**		**Semester**
											ISE	**CIA**	**ESE**	**CIA/ TW**	**ESE P/OR**	**Total**
											[20]	**[30]**	**[50]**	**[50]**	**[50]**	
HSS	**EPG4-31**	Seminar – III/Employability Skills-II/Internship-III (SM-III/ ES-II/ IP-III)	0	8	0	**8**	0	4	0	**4**	0	0	0	50	50	**100**
DIS	**EPG4-32**	Dissertation - II (DIS-II)	0	32	0	**32**	0	16	0	**16**	0	0	0	75	75	**150**
		Total	**0**	**40**	**0**	**40**	**0**	**20**	**0**	**20**	**0**	**0**	**0**	**125**	**125**	**250**

Credit distribution:

Broad Category of subject		Sem-1	Sem-2	Sem-3	Sem-4	Total
Program Core Course (PCC)		**10**	**8**	**4**	**0**	**22**
Program Elective Course (PEC)		**3**	**3**	**0**	**0**	**6**
Open Elective Course (OEC)		**0**	**3**	**4**	**0**	**7**
Vocational Skill Enhancement Course (VSEC)		**4**	**4**	**0**	**0**	**8**
Humanities/IKS/Research /VEC (HSS)		**3**	**0**	**2**	**0**	**5**
Independent Study, Seminar, and Ability Enhancement course (ISA)	Seminar (SM)	**0**	**2**	**2**	**0**	**4**
	Internship (IP)	**0**	**0**	**4**	**4**	**8**
	Project/ Dissertation (DIS)	**0**	**0**	**4**	**16**	**20**
Total		**20**	**20**	**20**	**20**	**80**

First Year
Semester-1

M-TECH (Electronics Communication- Wireless Communication Technology)
AY (2024-25) Course
[EPG1-001]: Advanced Digital Communications (ADC)

Semester	Credits	Teaching Scheme	Examination Scheme
1	**03**	**TH: 3 Hrs. / Week**	**ISE: 20 Marks** **CIA: 30 Marks** **ESE: 50 Marks**

Prerequisite: Fundamentals of Signals and Systems, Fourier Transforms, Digital Communications, Probability

Course Objectives

Objective of this course is to provide students with

1. The knowledge and understanding of advanced digital telecommunications systems.
2. Provide a strong foundation of fundamental digital communication system.
3. Detailed analysis of end-to-end digital communication system
4. Performance evaluation of various modulation schemes, optimum receivers, synchronization techniques.

Course Outcomes:

CO1: Model and analyze digital modulation schemes mathematically and carry out comparative analysis of various schemes in terms of Bandwidth, Bit Error Rate, complexity.

CO2: Select an appropriate modulation scheme and optimum receiver as per the given specifications and requirements.

CO3: Formulate and present a case study with reference to the 5th Generation wireless systems, specifying the applications of the advanced digital communication systems.

Course Content

Module I	**Introduction to Digital Communication Systems**	**8 Hrs**
Introduction to digital communication system, block diagram of modern digital communication system, characterization of communication signals, source coding, signal space representation		
Module II	**Modulation Schemes**	**10 Hrs**
Representation and spectral characteristics of digitally modulated signals Memory less Modulation, PAM, Phase modulation, QAM, Linear modulation with memory, CFSK, CPM and MSK.		
Module III	**Optimum Receivers**	**10 Hrs**
Correlation demodulator, matched filter demodulator, optimum detector, MAP detector, Maximum likelihood sequence detector, performance of detectors under AWGN.		
Module IV	**Synchronization, Equalization and Estimation Techniques**	**8 Hrs**
Signal parameter estimation, likelihood function, carrier recovery, carrier phase estimation, ML phase estimation, symbol timing estimation, various types of equalizers. Case Study of 5G systems.		

Textbook

John G Proakis, Masoud Salehi, "Digital Communications", McGraw-Hill, Indian 5th Edition, 2018.

Reference Book

Bernard Sklar, "Digital Communications: Fundamentals & Applications", Prentice Hall

Relevant MOOCs Course

Modern digital communication techniques, By Prof. Suvra Sekhar Das, IIT Kharagpur. https://onlinecourses.nptel.ac.in/noc21_ee11/preview

M-TECH (Electronics Communication- Wireless Communication Technology)
AY (2024-25) Course
[EPG1-002]: Cellular Wireless Communications (CWC)

Semester	Credits	Teaching Scheme	Examination Scheme
1	**03**	**TH: 3 Hrs. / Week**	**ISE: 20 Marks** **CIA: 30 Marks** **ESE: 50 Marks**

Prerequisite: Cellular Technology, Digital Communication

Course Objectives

Objective of this course is to provide students with

1. An overview of cellular systems and traffic engineering.
2. The foundation of wireless communication & 5G architecture.
3. An overview of future generation cellular technology.

Course Outcomes:

CO1: Differentiate the evolution of cellular system and apply knowledge of traffic engineering to calculate the capacity of system.

CO2: Apply the fundamentals of wireless communication to model the channel and calculate the Link budget.

CO3: Compare 4G & 5G technologies.

CO4: Relate future generation technology application in health care, defense, VR/AR/XR etc. Use of Blockchain for Wireless Networks and Green Communications in cellular system.

Course Content

Module-I	Introduction to cellular systems and traffic engineering	8 Hrs

Overview of Cellular Systems and evolution 2G/3G/4G/5G, Cellular Concepts – Frequency reuse, Co-channel and Adjacent channel Interference, C/I, Handoff, Blocking, Erlang Capacity.

Module-II	Fundamentals of wireless communication	8 Hrs

Wireless Channel, Wireless propagation, Link budget, Free-space path loss, Noise figure of receiver, Multipath fading, Shadowing, Fading margin, Shadowing margin, Wireless Channel Capacity, OFDM and LTE, Large Scale Propagation effects and Channel Models.

Module-III	Fundamentals of 5G architecture	8 Hrs

Difference between 4G and 5G, 5G Architecture, Planning of 5G Network, Quality of Service, Radio Network, Requirements, Security, SIM in 5G Era, Specifications, Standardization, Terminal States.

Module-IV	Future Generations	8 Hrs

Future Generations (where is the 6G?), Health Considerations, Identifiers, Interfaces, Key Derivation, Location Based Services, Massive Internet of Things, Measurements, Network Functions Virtualization, Network Slicing, Open Source, User Equipment, Vehicle-to-Vehicle communications (V2V), Virtual Reality (VR/AR/XR). Blockchain for Wireless Networks and Green Communications.

Textbooks:

Theodore S. Rappaport, “Wireless Communications: Principles and Practice”, Pearson, 2 nd Edition.

Reference Book

Aditya K Jagannatham, “Principles of Modern Wireless Communications”, McGraw Hill, 2017

MOOC Courses:

1. https://nptel.ac.in/courses/108105134
2.https://archive.nptel.ac.in/courses/117/104/117104115/

M-TECH (Electronics Communication- Wireless Communication Technology)
AY (2024-25) Course
[EPG1-003]: Probability and Stochastic Processes (PSP)

Semester	Credits	Teaching Scheme	Examination Scheme
1	**04**	**TH: 3 Hrs. / Week** **Tut: 1 Hrs. / Week**	**ISE: 20 Marks** **CIA: 30 Marks** **ESE: 50 Marks**

Prerequisite: Set Theory, Counting principles, Calculus

Course Objectives

Objective of this course is to provide students with

1. The knowledge and understanding of fundamental concepts of probability theory.
2. Provide a strong foundation of random variables and random processes.
3. Detailed analysis of LTI system response to a random process.
4. Spectral Analysis of a random process.

Course Outcomes:

CO1: Apply axiomatic definitions of probability to solve problems involving conditional probability, multiplication rule, total probability rule, and Bayes' theorem.

CO2: Calculate expectations, conditional expected values, and transformations of random variables, and analyze the properties of multiple random variables including joint PMFs, PDFs, and CDFs.

CO3: Differentiate between different types of stationarity (strict sense stationary and weak sense stationary) and analyze the properties of jointly WSS processes. Apply the concept of time-averages and ergodicity to analyze random processes and identify Gaussian random processes and their properties.

CO4: Calculate the mean, mean square value, and autocorrelation function of the system response to random inputs, and analyze cross-correlation functions in the context of linear system response. Analyze the spectral characteristics of random processes using power spectral density (PSD) and cross-power spectral density and apply this understanding to predict the response of linear systems.

Course Content

Module I	Basics of Probability Theory	7 Hrs

Introduction to deterministic and probability models with suitable examples, Random experiment and its sample space: discrete and continuous sample space, Events, Axiomatic definition of probability, Discrete uniform law. Conditional probability, Multiplication rule of probability, Total probability rule, Bayes' theorem for probability, Notion of independence.

Module II	Random Variable	8 Hrs

Definition of random variable, Discrete, continuous and mixed random variable. Probability mass function (PMF), probability density function (PDF), cumulative distribution function (CDF). Standard discrete distributions: Uniform, Bernoulli, Binomial, Geometric and Poisson. Standard continuous distribution: Uniform, exponential, Gaussian, Rayleigh random variable. Function of one random variable: expectations, conditional expected value, and transformations of a random variable. Multiple random variables: introduction, vector random variable, joint PMF, PDF and CDF, marginal, conditional PMF and PDF, independence, sum of two or more random variables. Function of multiple random variables: expectations, correlation, covariance, transformations. Jointly Gaussian random variables, properties, linear transformation of Gaussian random variable, central limit theorem.

Module III	Random Process	9 Hrs

Introduction, Classification, Joint CDF and PDF, Statistical averages: mean variance, mean square value, autocorrelation, autocovariance, cross-correlation, and cross-covariance. Stationarity: strict sense stationary (SSS) and weak sense stationary (WSS) process. Concept of jointly WSS process, Properties of autocorrelation and cross-correlation function. Time-averages and Ergodicity. Gaussian random process and its properties.

Module IV	**Linear System Response to Random Input**	**7 Hrs**

Spectral characteristics of a random process: power spectral density (PSD), cross-power spectral density and their properties, white and colored noise.
Random signal response of a linear system: mean, mean square value and autocorrelation function of system response, cross correlation function.

Textbooks:

1. Peyton Z. Peebles, "Probability, Random Variables, and Random Signal Principles", McGraw Hill, 2nd Edition.
2. Bertsekas, Dimitri, and John Tsitsiklis,"Introduction to Probability", Athena Scientific, 2nd Edition,2008.

Reference Book

1. Athanasios Papoulis, S. Unnikrishna Pillai, "Probability, Random Variables, and Stochastic Process", McGraw Hill, 4th Edition, 2002.
2. Alberto Leon-Gracia, "Probability, Statistics, and Random Processes for Electrical Engineering", Pearson, 3rd Edition, 2008.

MOOC Courses:

1. MIT OCW course on: "Introduction to Probability by Prof.John Tsitsiklis" https://ocw.mit.edu/resources/res-6-012-introduction-to-probability-spring-2018/.
2. NPTEL course on: "Probability and Random Variables/ Processes for Wireless Communications by Prof.Aditya K. Jagannatham" https://nptel.ac.in/courses/117/104/117104117/.

M-TECH (Electronics Communication- Wireless Communication Technology) AY (2024-25) Course [EPG1-004]: Research Methodology (RM)			
Semester	**Credits**	**Teaching Scheme**	**Examination Scheme**
1	**03**	**TH: 2 Hrs. / Week Tut: 1 Hrs. / Week**	**ISE: 20 Marks CIA: 30 Marks ESE: 50 Marks**
Prerequisite: Basics of literature survey, paper writing			
Course Objectives Objective of this course is to provide students with 1. The knowledge of research and its methodologies. 2. Systematic approach for literature survey and technical writing. 3. Strong foundation of research design and applied statistics. 4. Understanding the concepts of plagiarism and IPR.			
Course Outcomes: **CO1:** Propose a well-defined research problem with scope and objectives. **CO2:** Design appropriate experiments for systematic research and critically analyze the data using applied statistical tools. **CO3:** Develop enhanced skills for effective technical /scientific writing, quality manuscript and research proposal.			
Course Content			
Module I	**Introduction to Research, Literature Survey and Problem Definition**		**10 Hrs**
Introduction to research, Types of research, Phases of research, Features of a good research study, Importance of literature survey, Resources for literature survey, Reading scientific paper, white paper and patent, Recording and summarizing the findings and observations, Identifying the gaps, Formulating a problem statement, Defining the scope and objectives of the defined research problem.			
Module II	**Research Design and Applied Statistics**		**10 Hrs**
Introduction to research design, Approaches of research design, Types of research designs, Principles of experimental design, Design of experiments, sampling concepts. Regression analysis, Parameter estimation, Multivariate statistics, Principal component analysis, State vector machines, uncertainty analysis, concepts of mathematical modeling and performance prediction.			
Module III	**Presenting and Publishing the Research Findings**		**10 Hrs**
Types of publications, Journal ranking, Journal metrics, Citation index, various documentation tools, referencing tools and presentation tools, Scientific writing - writing quality research manuscript / paper, report and thesis, Developing a research proposal, related case studies.			
Module IV	**Research Ethics (Plagiarism and Intellectual Property Rights -IPR)**		**10 Hrs**

Introduction to plagiarism, Types of plagiarism, Software used to identify plagiarism, Plagiarism polices, Techniques to avoid plagiarism. Introduction to IPR and its significance, Various forms of IPR, Patent filing process in India, Role of IPR in technology transfer, Recent developments, Case studies related to Plagiarism and IPR.

TUTORIALS:

1. Identify a research problem and prepare a report enumerating the different steps in formulating the research proposal.
2. Carry out an extensive literature review for a given topic, identify the gaps and prepare a survey paper.
3. The procedure of testing hypothesis requires a researcher to adopt several steps. Describe in brief all such steps with the help of an example.
4. Identify and prepare a summary of different software used to identify plagiarism. Enumerate the different techniques to avoid plagiarism.
5. Study of different journal metrics and citation index and prepare a report.

Textbooks:

1.Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction", Juta & Co.Ltd., 2nd Edition.
2.Ranjit Kumar, "Research Methodology: A Step-by-Step Guide for Beginners", Sage Publications,3rd Edition.

Reference Books:

Stuart Melville and Wayne Goddard, "Research Methodology: An introduction for Science & Engineering students", Juta & Co. Ltd

Relevant MOOCs Course:

1.Introduction to research, by professors in IIT Mumbai and IIT Madras https://onlinecourses-archive.nptel.ac.in/noc18_ge12/course.
2.Research Writing, By Prof. A. Malik, IIT Kharagpur https://onlinecourses-archive.nptel.ac.in/noc18_mg13/course.
3.Research Methodology, By Prof. G. S. Bajpai, National Law University, elhihttps://onlinecourses.swayam2.ac.in/cec21_ge16/ preview?
4.MCO-03: Research Methodology and Statistical Analysis (Commerce Category) By Dr. Subodh Kesharwani | Indira Gandhi National Open University,
https://onlinecourses.swayam2.ac.in/nou21_cm03/preview?
5.Patent Drafting for beginners by Prof.Feroz Ali https://onlinecourses.nptel.ac.in/noc20_hs25/preview

M-TECH (Electronics Communication- Wireless Communication Technology) AY (2024-25) Course [EPG1-005 A]: SDR and Cognitive Radio (SCR)			
Semester	**Credits**	**Teaching Scheme**	**Examination Scheme**
1	**03**	**TH: 3 Hrs. / Week**	**ISE: 20 Marks** **CIA: 30 Marks** **ESE: 50 Marks**

Prerequisite: Digital communications systems, Communication Networks, software tools MATLAB/LabVIEW are desirable, but not necessary.

Course Objectives

Objective of this course is to provide students with

1. The knowledge and understanding of SDR Architectures, Challenges, and issues about the implementation of SDR.
2. To analyze the techniques involved in Cognitive Radio Communications and networks.
3. To apply Spectrum Sensing techniques to Detect Primary Systems.
4. To review Cognitive radio in recent applications.

Course Outcomes:

CO1: To Analyze and compare different SDR Architectures.
CO2: To investigate Challenges, and issues regarding the implementation of SDR.
CO3: To analyze the techniques involved in Cognitive Radio Communications and networks for a specific network scenario.
CO4: To compare various Spectrum Sensing techniques and to apply it to detect Primary Systems.
CO5: To design and simulate a Cognitive radio system for given specification and application.

Course Content

Module-I	**Software Defined Radio**	**8 Hrs**

Software Defined Radio Architecture, Digital Signal Processor and SDR Baseband Architecture, Reconfigurable Wireless Communication Systems, Reconfigurable OFDM Implementation, Digital Radio Processing, Digital Radio Processing (DRP) Based System Architecture, Challenges, and issues regarding the implementation of SDR, Processing, programmability (flexibility) vs power consumption. Application of SDR in advanced communication systems, Low-Cost Cognitive Radio Platform, Convergence between military and commercial systems, case study of universal software radio peripheral (USRP)

Module-II	**Cognitive Radio Communications and networks**	**8 Hrs**

Cognitive Radios and Dynamic Spectrum Access, the Capability of Cognitive Radios, Spectrum Sharing Models of DSA, Opportunistic Spectrum Access: Basic Components, Networking the Cognitive Radios, Analytical Approach and Algorithms for Dynamic Spectrum Access, Dynamic Spectrum Access in Open Spectrum, Opportunistic Spectrum Access, Opportunistic Power Control, Fundamental Limits of Cognitive Radios. Network Coding for Cognitive Radio Relay Networks , System Model , Network Capacity Analysis on Fundamental CRRN Topologies , Cognitive Radio Networks Architecture, Network Architecture , IP Mobility Management in CRN , Terminal Architecture of CRN , Cognitive Radio Device Architecture , Radio Access Network Selection , QoS Provisional Diversity Radio Access Networks , cooperative/Collaborative Diversity and Efficient Protocols , Statistical QoS Guarantees over Wireless Asymmetry, Collaborative Relay Networks , Scaling Laws of Ad-hoc and Cognitive Radio Networks ,Network and Channel Models.

Module-III	**Spectrum Sensing and awareness**	**10 Hrs**

Spectrum Sensing to Detect Specific Primary System, Conventional Spectrum Sensing, Power efficiency and energy/battery awareness, Device capability awareness, RF Awareness Interference/noise temperature awareness, channel (medium, radio channel) awareness. Location Awareness, Power Control, Power-Scaling Power Control, Cooperative Spectrum Sensing, Spectrum Sensing for Cognitive OFDMA Systems, Cognitive Cycle, Discrimination of States of the Primary System, Spectrum Sensing Procedure, Spectrum Sensing for Cognitive Multi-Radio Networks, Multiple System, Sensing, Radio Resource Sensing.

Module-IV	**Cognitive radio in recent applications and case study**	**10Hrs**

Medium access control for CR, Applications of cognitive radio, Cognitive features in the standards (like 802.16m, LTE advanced, 802.11n, adaptive frequency hopping in Bluetooth), Femto-cells and relation to cognitive radio, UWB and Cognitive radio (underlay and overlay) systems. Security issues in CRN. CR based Internet of Things (IoT).
Case study: IEEE 802.22 WRAN standard

Textbooks:

1. Kwang-Cheng Chen and Ramjee Prasad Cognitive Radio Networks, John Wiley & Sons Ltd.,2009.
2. PeymanSetoodeh and Simon Haykin, Fundamentals of Cognitive Radio, First Edition, by John Wiley & Sons, Inc, 2017.

Reference Books:

Handbook of Cognitive Radio by Wei Zhang, Springer Singapore,
https://doi.org/10.1007/978-981-10-1389-8

MOOC Courses:

Basic of SDR and Practical applications by Dr. MeenakshiRawat, IIT Roorki,
https://nptel.ac.in/courses/108/107/108107107/

Other Resources/Links

1.Rezwanul Mahmood M., Matin M.A. (2020) Current Research Trends on Cognitive Radio Based Internet of Things (IoT). In: Matin M. (eds) Towards Cognitive IoT Networks. Internet of Things (Technology, Communications and Computing). Springer, Cham, March 2020.
2.Akyildiz, I. F., Lee, W.Y., Vuran, M.C., Mohanty, S., "NeXt Generation/Dynamic SpectrumAccess/Cognitive Radio Wireless Networks: A Survey," Computer Networks (Elsevier) Journal, September 2006.

M-TECH (Electronics Communication- Wireless Communication Technology)
AY (2024-25) Course
[EPG1-005 B]: Modern Technologies for 5G Wireless Communications (MTWC)

Semester	Credits	Teaching Scheme	Examination Scheme
1	**03**	**TH: 3 Hrs. / Week**	**ISE: 20 Marks** **CIA: 30 Marks** **ESE: 50 Marks**

Prerequisite: Wireless Communications, Cellular Networks, Brief overview of 2G to 4G

Course Objectives

Objective of this course is to provide students with

1. Overview and Requirements for 5G.
2. Advanced Techniques and Trends in 5G.
3. The key technologies for 5G. Provide detailed trends of technologies for 5G.
4. State of the art technologies and current status of 5G.

Course Outcomes:

CO1: Appraise the requirements, features, specifications, and architecture of the 5th Generation wireless communication system.

CO2: Explore the application of OFDMA and NOMA for modern wireless communication systems.

CO3: Develop a case study on the applications of modern technologies to 5G and exploring 6G.

Course Content

Module I	**Overview of 5G Technologies**	**8 Hrs**
Evolution of 1G to 5G, Requirements of 5G, 5G Architecture, Functionalities.		
Module II	**Non Orthogonal Multiple Access**	**10 Hrs**
OFDMA, Limitations of OFDMA, NOMA, concept of NOMA, features, mathematical foundation for NOMA, Transmission and Receiver architecture, case study.		
Module III	**Massive MIMO**	**10 Hrs**
Concept of massive MIMO, MIMO architecture, challenges, implementation issues, research trends and applications to 5G.		
Module IV	**mmWave and Visible Light Communications**	**8 Hrs**
Background and concept of mm Wave Communications, Frequency bands, propagation characteristics, channel models, applications, and challenges in 5G.		

Text Books

1. L. Dai, B. Wang, Z. Ding, Z. Wang, S. Chen and L. Hanzo, "A Survey of Non-Orthogonal Multiple Access for 5G," in *IEEE Communications Surveys & Tutorials*, vol. 20, no. 3, pp. 2294-2323, third quarter 2018, doi: 10.1109/COMST.2018.2835558.

2. Robin Chataut, Robert Akl, "Massive MIMO Systems for 5G and beyond Networks—Overview, Recent Trends, Challenges, and Future Research Direction" Sensors, May 2020, doi:10.3390/s20102753

3.A. N. Uwaechia and N. M. Mahyuddin, "A Comprehensive Survey on Millimeter Wave Communications for Fifth-Generation Wireless Networks: Feasibility and Challenges," in *IEEE Access*, vol. 8, pp. 62367-62414, 2020, doi: 10.1109/ACCESS.2020.2984204.

Reference Books

Vincent W.S Wong, Key Technologies for 5G Wireless Systems, Cambridge University Press, April 2017.

M-TECH (Electronics Communication- Wireless Communication Technology) AY (2024-25) Course [EPG1-005 C]: Data Analytics (DA)			
Semester	**Credits**	**Teaching Scheme**	**Examination Scheme**
1	**03**	**TH: 3 Hrs. / Week**	**ISE: 20 Marks** **CIA: 30 Marks** **ESE: 50 Marks**
Prerequisite: Linear Algebra, Probability Theory, and Proficiency in Python and SQL			

Course Objectives

Objective of this course is to provide students with

1. Understand the fundamentals of data analytics and its various types, including descriptive, diagnostic, predictive, and prescriptive analytics, and their significance in decision-making processes.
2. Apply principles of effective data visualization and appropriate measures of central tendency and dispersion to analyze data, and identify patterns, outliers, and relationships, facilitating informed decision-making.
3. Master advanced data analytics techniques such as interpreting box plots, calculating confidence intervals, conducting hypothesis tests, and understanding sampling methods, to derive actionable insights from data and solve real-world problems.
4. Gain insights into data warehousing concepts, including dimensional modeling, data warehouse architecture, design methodologies, and data quality governance, to effectively manage and optimize data for decision support and business intelligence applications.

Course Outcomes:

CO1: Students will understand the role of data analytics in decision-making, differentiate between types of analytics, evaluate their benefits (improved decision-making, cost reduction, efficiency, competitive advantage), and apply this knowledge in implementing data analytics solutions for positive business outcomes.

CO2: Students will proficiently analyze datasets using a range of graphical techniques to identify patterns, outliers, and relationships, thus enhancing their ability to make informed decisions based on exploratory data analysis.

CO3: Students will be proficient in understanding customer satisfaction through data analysis in the retail industry, utilizing statistical techniques such as hypothesis testing, confidence interval calculation, and interpretation, alongside effective data collection methods including survey sampling and observational methods.

CO4: Students will demonstrate mastery in data warehousing concepts, including comprehending the definition and purpose of data warehousing, identifying key components such as data sources, ETL process, data storage, metadata, and query tools, and understanding the benefits, challenges, and various architectures of data warehousing.

Course Content

Module I	**Introduction to Data Analytics**	**6 Hrs**

Overview of Data Analytics, Role, and Importance in Decision-making. Introduction to different types of analytics: Descriptive Analytics Diagnostic Analytics, Predictive Analytics, and Prescriptive Analytics. Benefits of Data Analytics: Improved decision-making, Cost reduction, Enhanced efficiency and productivity, and Competitive advantage.

Case Study 1: Analyzing Sales Data for Predictive Insights (Students apply descriptive, diagnostic, predictive, and prescriptive analytics to sales data to identify trends and make recommendations for improving sales performance.)

Module II	**Professional Practice in Engineering**	**7 Hrs**

Principles of effective data visualization, Types of visualizations and when to use them, Tools for data visualization. Types of data: Nominal, ordinal, interval, ratio. Measures of Central Tendency: Mean, median, mode. Measures of Dispersion, Skewness, and Kurtosis: Range, variance, standard deviation, Skewness, and kurtosis

Case Study 2: Exploratory Data Analysis with Visualization (analyze a dataset using various graphical techniques to identify patterns, outliers, and relationships.)

Module III	Advance Data Analytics Techniques	6 Hrs

Box Plot and Descriptive Stats: Interpretation of box plots, Quartiles, and outliers. Sampling Techniques: Sampling funnel, Sampling variation, Central Limit Theorem. Confidence Interval: Calculation and interpretation of confidence intervals.

Data Collection and Analysis Data Collection Methods: Survey sampling and observational methods. Statistical Techniques for Data Analysis: Hypothesis testing: One-Sample Hypothesis Tests, Two-Sample Hypothesis Tests, Chi-Square Test, Type I and Type II errors, Power of a test

Case Study 3: Understanding Customer Satisfaction through Data Analysis: A Case Study in the Retail Industry

Module IV	Introduction to Data Warehousing	7 Hrs

Definition and purpose of data warehousing, Key components of a data warehouse: data sources, ETL process, data storage, metadata, and query tools. Overview of dimensional modeling and star schema, Benefits, and challenges of data warehousing. Data Warehouse Architecture: centralized, distributed, and federated. Dimensional Modeling and Star Schema. Steps in data warehouse design: requirement gathering, data modeling, schema design, and implementation. Data warehouse design methodologies: Kimball vs. Inmon. Data Quality and Governance in Data Warehousing. Data Warehouse Performance and Optimization.

Case Study 4: Optimizing Retail Operations through Data Warehousing

Textbook

1. Runkler, Thomas A. “Data analytics”. Wiesbaden: Springer Fachmedien Wiesbaden, 2020.
2. Moreira, J., Carvalho, A., & Horvath, T. (2018). “A general introduction to data analytics”. John Wiley & Sons.
3. Kimball, R., & Ross, M. (2019). “The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling”, Ed. Wiley.

Reference Book

1.Bruce, P., Bruce, A., & Gedeck, P. (2020). “Practical statistics for data scientists: 50+ essential concepts using R and Python”. O'Reilly Media.
2.Provost, F., & Fawcett, T. (2013). “Data Science for Business: What you need to know about data mining and data-analytic thinking”. O'Reilly Media, Inc.

Relevant MOOCs Course

1. Course Title: "Introduction to Data Science", Platform: Coursera, Provider: IBM, Description: This course provides an overview of data analytics, including different types of analytics and their applications in decision-making processes. It covers descriptive, diagnostic, predictive, and prescriptive analytics, along with their benefits in improving decision-making and gaining competitive advantage.
2. Course Title: "Data Visualization with Python", Platform: Coursera, Provider: University of Michigan, Description: This course focuses on principles of effective data visualization, types of visualizations, and tools for data visualization using Python programming language. It covers different data types, measures of central tendency and dispersion, and techniques for exploratory data analysis with visualization.

3. Course Title: "Statistics for Data Science and Business Analysis" Platform: Udemy, Provider: 365 Careers, Description: This course covers advanced data analytics techniques such as box plot interpretation, sampling techniques, confidence intervals, and hypothesis testing. It provides hands-on exercises and case studies to apply statistical techniques for data analysis.
4. Course Title: "Data Warehousing Fundamentals", Platform: edX, Provider: University of Colorado Boulder, Description: This course covers the fundamentals of data warehousing, including definition, purpose, key components, dimensional modeling, data warehouse architecture, design methodologies, data quality, and governance. It also explores techniques for data warehouse performance optimization.

M-TECH (Electronics Communication- Wireless Communication Technology) AY (2024-25) Course [EPG1-005 D]: Artificial Intelligence (AI)			
Semester	**Credits**	**Teaching Scheme**	**Examination Scheme**
1	**03**	**TH: 3 Hrs. / Week**	**ISE: 20 Marks** **CIA: 30 Marks** **ESE: 50 Marks**

Prerequisite: Linear Algebra, Probability Theory, and Proficiency in Python

Course Objectives

Objective of this course is to provide students with

1. Understand the basic concept of AI, strength and weakness of problem solving and different search algorithms.
2. Use knowledge and reasoning, NLP and Machine Learning algorithms to design AI based models.
3. Design various Expert Systems and applications to solve real time problems.

Course Outcomes:

CO1: Evaluate Artificial Intelligence (AI) methods, Analyze and illustrate how search algorithms play a vital role in problem solving, inference, perception, knowledge representation and learning.

CO2: Demonstrate knowledge of reasoning and knowledge representation for solving real world problems.

CO3: Illustrate the construction of learning and expert systems.

CO4: Discuss current scope and limitations of AI and societal implications.

Course Content

Module I	**Introduction to AI**	**6 Hrs**

Definitions – Foundation and History of AI, Evolution of AI - Applications of AI, Classification of AI systems with respect to environment. Artificial Intelligence vs Machine learning,
Statistical Analysis: Relationship between attributes: Covariance, Correlation Coefficient, Chi Square.
Intelligent Agent: Concept of Rationality, nature of environment, structure of agents.

Module II	**Problem Solving with Knowledge and Reasoning**	**8 Hrs**

Heuristic Search Techniques: Generate-and-Test; Hill Climbing; Properties of A* algorithm, Best First Search; Problem Reduction.
Constraint Satisfaction problem: Interference in CSPs; Back tracking search for CSPs; Local Search for CSPs; structure of CSP Problem.

Beyond Classical Search: Local search algorithms and optimization problem, local search in continuous spaces, searching with nondeterministic action and partial observation, online search agent and unknown environments.

Knowledge and Reasoning: Building a Knowledge Base: Propositional logic, first order Logic, situation calculus. Theorem Proving in First Order Logic, Planning, partial order planning. Uncertain Knowledge and Reasoning, Probabilities, Bayesian Networks. Probabilistic reasoning over time: time and uncertainty, hidden Markova models.

Module III	**Learning**	**10 Hrs**

Overview of different forms of learning: Supervised learning, Unsupervised learning, Reinforcement learning. Learning Decision Trees, Regression, and classification with linear model, SVM, Kmeans clustering.

Artificial neural network: The Perceptron, Training a Perceptron, Learning Boolean Functions, Multilayer Perceptron, Back propagation Algorithm-Nonlinear Regression, Two-Class Discrimination, Multiclass Discrimination, Multiple Hidden Layers.

Training Procedures-improving Convergence, Overtraining, Structuring the Network, Tuning the Network Size, Bayesian View of Learning, Dimensionality Reduction.

Module IV	**Expert Systems**	**6 Hrs**

Introduction to Expert Systems- Inference - Forward chaining - Backward chaining - Languages and tools - Explanation facilities - Knowledge acquisition.

Applications: Natural Language Processing: General framework for text processing. Case Study: Sentiment Analysis. Computer Vision: General framework for CV application. Case Study: Object Recognition

Textbook

1. Russell, S. and Norvig, P. 2015. Artificial Intelligence - A Modern Approach, 3rd edition, Prentice Hall.
2. J. Gabriel, Artificial Intelligence: Artificial Intelligence for Humans (Artificial Intelligence, Machine Learning), Create Space Independent Publishing Platform, First edition, 2016.
3. Introduction to Machine Learning Edition 2, by Ethem Alpaydin.

Reference Book

1. Introduction to Artificial Intelligence & Expert Systems, Dan W Patterson, PHI.,2010 2. S Kaushik, Artificial Intelligence, Cengage Learning, 1st ed.2011.
2. Ric, E., Knight, K and Shankar, B. 2009. Artificial Intelligence, 3rd edition, Tata McGraw Hill.
3. Luger, G.F. 2008. Artificial Intelligence -Structures and Strategies for Complex Problem Solving, 6th edition, Pearson.
4. Alpaydin, E. 2010. Introduction to Machine Learning. 2nd edition, MIT.
5. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.

Relevant MOOCs Course

1. https://onlinecourses.nptel.ac.in › noc22_cs56
2. https://nptel.ac.in/courses/106/106/106106139/
3. https://nptel.ac.in/courses/106/106/106106202/

M-TECH (Electronics Communication- Wireless Communication Technology) AY (2024-25) Course [EPG1-006]: Lab Practice-I (LP-I)			
Semester	**Credits**	**Teaching Scheme**	**Examination Scheme**
1	**04**	**P: 8 Hrs. / Week**	**CIA: 50 Marks** **ESE(P/OR): 50 Marks**
Laboratory experiments based on the courses being taught. Minimum ten experiments, case studies to be carried out including hardware and simulation-based experiments.			

First Year
Semester-2

M-TECH (Electronics Communication- Wireless Communication Technology)
AY (2024-25) Course
[EPG2-11]: Signal Processing for Wireless Communication (SPWC)

Semester	Credits	Teaching Scheme	Examination Scheme
2	04	TH: 3 Hrs. / Week Tut: 1 Hrs. / Week	ISE: 20 Marks CIA: 30 Marks ESE: 50 Marks

Prerequisite: Linear Algebra, Probability Theory, and Proficiency in Python

Course Objectives

Objective of this course is to provide students with

1. The knowledge and understanding of signal processing for wireless communication.
2. Knowledge of Power spectrum estimation and adaptive filters.
3. Understanding and applying the concept of Hypothesis testing to detection of signals
4. Provide a strong foundation of detection and estimation theory.

Course Outcomes:

CO1: Discuss adaptive filters & Power estimation techniques.
CO2: Apply hypothesis testing to signal detection problems.
CO3: Design and discussDetection of signals in white Gaussian Noise
CO4: Given parameter estimation tasks select the suitable estimator.

Course Content

Module I	Power Spectrum Estimation and Adaptive Filters	8 Hrs

Spectrum Estimation and Modelling: Definition, Problem of PSE, Nonparametric and parametric spectral estimation, AR model, MA model and ARMA model, least mean square estimation. Adaptive Filters: Introduction to steepest descent adaptive filters, LMS algorithm, application to noise cancellation, RLS algorithm.

Module II	Stochastic Signal processing, Hypothesis Testing	10 Hrs

Definition of detection and estimation, review of deterministic and random signal concepts, Transformation of random variables using Gaussian density, Rayleigh density, Cauchy density, Uniform density, Chi squared density, Hypothesis testing, Bayes detection, Max detection, ML detection, Neyman Pearson criterion, Multiple hypothesis testing, composite hypothesis testing, Receiver operating characteristic and performance.

Module III	Detection of Signals in Gaussian white Noise and colored Gaussian noise	10 Hrs

Sign detector and its performance analysis, binary detection problem, matched filters, M-ary communication system, detection of signals with random parameters, Whitening filter, Discrete time detection of known signals in colored gaussian noise, Discrete time colored noise detector, Whitening via spectral factorization.

Module IV	Estimation Theory	10Hrs

Introduction, Basic estimation schemes, MAP estimation, Bayes estimator, Properties of estimator, Waveform estimation

Tutorials:

1. Design an adaptive Filters for any practical application starting from the specification.
2. Numerical on power spectrum estimation.
3. Numerical on Bayes detection, Max detection, ML detection, Neyman Pearson Criteria etc.
4. Design of matched filter.
5. Study of different density functions.

Textbooks

1. M.D.Srinath, P.K.Rajasekaran and R.Vishwanathan, “Introduction to statistical signal processing with application”, Pearson Edition. 2. Ralph D Hippensteil, “Detection Theory applications and Digital Signal Processing”, CRC Press. 3. John G. Proakis, “Digital Signal Processing: Principles, Algorithms, And Applications”, Pearson Education.
Reference Books
E Ifeachor and W.Jervis, “Digital Signal Processing a practical approach”,Prentice Hall.
MOOCS
Signal Detection and estimation theory:https://nptel.ac.in/courses/117103018

M-TECH (Electronics Communication- Wireless Communication Technology)
AY (2024-25) Course
[EPG2-12]: Information Theory and Coding (ITC)

Semester	Credits	Teaching Scheme	Examination Scheme
2	**04**	**TH: 3 Hrs. / Week** **Tut: 1 Hrs. / Week**	**ISE: 20 Marks** **CIA: 30 Marks** **ESE: 50 Marks**

Prerequisite: Digital communications systems, Probability theory and software tools like MATLAB/ LabVIEW are desirable, but not necessary

Course Objectives

Objective of this course is to provide students with

1. Explain various fixed length and variable length source coding algorithms.
2. Understand the concept of a communication channel, Mutual information, and the channel capacity.
3. Give emphasis on coding and decoding of Error control coding techniques like Linear bock code, Cyclic codes, Convolution codes which can correct mainly random errors.
4. Study modern error coding like Turbo codes and LDPC codes

Course Outcomes:

CO1: Identify the need of source coding, Define, Calculate Entropy, Mutual information for various types of sources and channels.

CO2: Apply the various source coding algorithms to Generate code word, Calculate average code word length, efficiency, and redundancy.

CO3: Formulate generator matrix for linear block code and Compute all code words. Determine the error detection and correction capacity for linear block code.

CO4: Design BCH codes for varying error correction capacity and compare the performance with RS codes. Sketch tree diagram, Trellis diagram and state diagram and Apply the concept of Viterbi Decoding.

CO5: To apply LDPC codes to 5G wireless networks for given specification.

Course Content

Module-I	Information Theory & Source Coding	8 Hrs

Introduction: Entropy, Relative Entropy, Mutual Information; Information Inequalities; Block to variable length coding: Prefix-free code, Bounds on optimal code length; Huffman coding. Variable to block length coding, the asymptotic equipartition property, Universal Source Coding: Lempel-Ziv Algorithm-LZ77, Lempel-Ziv Welch Algorithm(LZW). Coding for sources with memory, Channel capacity of discrete memoryless channels. Noisy channel coding theorem; Gaussian Channel; Parallel Gaussian Channel. Rate Distortion Theory; Blahut-Arimoto Algorithm for computation of channel capacity and rate-distortion function.

Module-II	Linear Block Codes and Cyclic codes	12 Hrs

Introduction to error control coding, Introduction to linear block codes &Cyclic Codes, Properties of linear block codes & Cyclic Codes: Syndrome error detection. Decoding of linear block codes& Cyclic Codes, Distance properties of linear block codes & Cyclic Codes. Some simple linear block codes: Repetition codes, Single parity check codes, Hamming codes, ReedMuller codes, Burst error-correcting code. Bounds on size of codes: Hamming bound, Singleton bound, Low density parity check codes, decoding of low-density parity check codes: Belief propagation algorithm on BEC, BSC and AWGN channels.

Module-III	BCH, RS Convolutional and Turbo Code	12 Hrs

Encoding and decoding using BCH code and RS codes, Introduction to convolutional codes: Encoding, state diagram, trellis diagram, Classification, realization, distance properties. Decoding of convolutional codes: Viterbi algorithm, BCJR algorithm. Performance bounds for convolutional codes. Turbo codes: Turbo decoding, Distance properties of turbo codes, Convergence of turbo codes, Applications of linear codes

Module-IV	**Information Theory and coding applications and case study**	**08 Hrs**

Channel coding techniques for 5G wireless networks, LDPC and Polar Codes, Advantages, and drawbacks of LDPC codes and Polar codes. Quasi Cyclic LDPC code. Case study: LDPC (low density parity check) Codes in many of the standards including mMTC (massive machine type communication) and D2D (device to device communication)

Textbooks

1. Shulin and Daniel j, Cistellojr., "Error control Coding", Pearson, 2nd Edition,2010.
2. Ranjan Bose, "Information Theory coding and Cryptography", McGraw-Hill, 2nd Edition.

Reference Books

1. Todd Moon, "Error Correction Coding: Mathematical Methods and Algorithms", Wiley Publication.
2. Bernad Sklar, "Digital Communication Fundamentals & applications", Pearson Education. Second Edition.

MOOCS

NPTEL course on Coding Theory by Dr. Andrew Thangaraj, Department of Electrical Engineering IIT Madras

Tutorial

1. Students can apply the concepts learned to solve numerical based on various topics unit wise. Faculty will facilitate the activity for active engagements and collaborative learning.
2. Continuous assessment will be carried out based on 4 assignments (1 per each Unit)

M-TECH (Electronics Communication- Wireless Communication Technology)
AY (2024-25) Course

[EPG2-13 A]: Antenna for Modern Wireless Communication (AMWC)

Semester	Credits	Teaching Scheme	Examination Scheme
2	**03**	**TH: 3 Hrs. / Week**	**ISE: 20 Marks** **CIA: 30 Marks** **ESE: 50 Marks**

Prerequisite: Electromagnetics, Antenna Fundamentals, Signal Processing

Course Objectives

Objective of this course is to provide students with

1. An overview of antennas and latest trends in modern wireless communications.
2. Provide a strong foundation of Smart antennas, MIMO techniques
3. Performance evaluation of various DOA and comparative study.

Course Outcomes:

CO1: Identify a suitable antenna for the given standards with specifications and Apply the signal processing techniques to antenna arrays.

CO2: Apply beam-forming principles to multiple antennas and Optimize SNR, BER.

CO3: Analyze and apply space time coding techniques to MIMO and Apply estimation and detection techniques using multiple antennas.

CO4: Carry out the analysis of DOA and comparative study.

Course Content

Module-I	Antenna Arrays	10 Hrs

Antenna parameters, array principles, linear, planar arrays, phased arrays, signal processing techniques.

Module-II	Adaptive and Smart Antennas	10 Hrs

Fundamental principle of Adaptive and Smart Antennas, adaptive antenna algorithms, analog and digital beam-forming, transmit and receive beam forming, Meta-material antennas, Re-configurable antennas and Millimeter antennas.

Module-III	Multiple Input Multiple Output Antennas	10 Hrs

Introduction to MIMO systems, SISO, SIMO, MISO, MIMO structures and capacity, MIMO channel models, introduction to space time codes, diversity techniques, detection and estimation for MIMO.

Module-IV	Direction of Arrival Estimation	10 Hrs

Fundamental principle of direction of arrival estimation, mathematical analysis, classification of DOA estimation algorithms, subspace methods, MVDR, MUSIC and its variants, comparative study.

Textbook

1. Rakhesh Singh Kshetrimayum, "Fundamentals of MIMO Wireless Communications", Cambridge University Press, 2017.
2. Theodore S Rappaport, "Smart Antennas: Adaptive Arrays, Algorithms, & Wireless Position Location", IEEE, 1998.

Reference Book

1. Mietzneretal, Multiple Antenna Techniques for Wireless Communications, A Comprehensive Survey, IEEE Communications Surveys & Tutorials, Vol. 11, No. 2, Second Quarter 2009.

Relevant MOOCs Course

https://onlinecourses.nptel.ac.in/noc21_ee102/preview

M-TECH (Electronics Communication- Wireless Communication Technology)
AY (2024-25) Course
[EPG2-13 B]: Machine Learning Techniques (MLT)

Semester	Credits	Teaching Scheme	Examination Scheme
2	**03**	**TH: 3 Hrs. / Week**	**ISE: 20 Marks** **CIA: 30 Marks** **ESE: 50 Marks**

Prerequisite: Mathematical Foundations for Machine Learning: Probability, Random Variables, Stochastic Process, Linear Algebra

Course Objectives

Machine learning is extremely pervasive today and finds its application in almost all the domains, thus emerging as an important field. Machine learning focuses on the development of computer programs that can access data and use it to learn for themselves.

The objective of this course is to provide.

1. A comprehensive introduction to various topics in Machine Learning
2. Knowledge and understanding of supervised/unsupervised/semi-supervised machine learning algorithms.
3. Insights to the Deep learning approaches for object recognition and various other inter-disciplinary problems.
4. Hands on skills to implement machine learning algorithms to the real-world problems.

Course Outcomes:

CO1: Understand the basic concepts in machine learning like parametric/non-parametric modeling, classification, clustering, linear/ nonlinear regression and supervised/unsupervised learning to broadly classify various types of machine learning algorithms.

CO2: Design and implement machine learning solutions to address specified problems of classification, regression, and clustering. Analyze the effect of dimensionality reduction using principal components analysis, factor analysis, multidimensional scaling. Evaluate and interpret the results of the algorithms.

CO3: Apply the fundamentals of Artificial Neural Network (ANN) to design and implement Back propagation algorithm for various applications like classification.

Course Content

Module- I	Introduction to Machine Learning	09 Hrs

Introduction to Machine Learning: Introduction. Different types of learning, Hypothesis space and inductive bias, Evaluation. Training and test sets, cross validation, Concept of over fitting, under fitting, Bias and Variance. Linear Regression: Introduction, Linear regression, Simple and Multiple Linear regression, Polynomial regression, evaluating regression fit.

Module- II	Linear Models for Regression and Classification	09 Hrs

Least Squares and Nearest Neighbors, Linear Basis Function Models, The Bias-Variance Decomposition, Bayesian Linear Regression, Bayesian Model Comparison Linear Models for Classification: Discriminant Functions Probabilistic Discriminative Models. Multivariate Data, Parameter Estimation, Multivariate Classification, Multivariate Regression. Kernel Methods: Support Vector machines and Relevance Vector

Module- III	Clustering	09 Hrs

Dimensionality Reduction: Principal Components Analysis, Factor analysis, Multidimensional Scaling, Linear Discriminant Analysis Clustering: K-Means Clustering, Mixtures of Gaussians
Ensembles: Introduction, Bagging and boosting, Random forest

Module- IV	Artificial Neural Networks	09 Hrs

Introduction, Biological motivation, ANN representation, appropriate problem for ANN learning, Perceptron, Multilayer networks and the Back propagation algorithm, Radial basis function networks.
Textbook
1. Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997. 2. Alpaydin, Ethem. Introduction to machine learning. MIT press, 2020. 3. Laurene Fausett, Fundamentals of Neural Networks: Architectures, Algorithms and Applications, Pearson Education, Inc, 2008.
Reference Book
1. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012 2. Simon Haykin, "Neural Networks, a comprehensive foundation" Prentice Hall International Inc1999. 3. Christopher Bishop, "Pattern Recognition and Machine Learning" Springer, 2007.
Relevant MOOCs Course
https://onlinecourses.nptel.ac.in/noc19_cs18/course, NPTEL online course on Introduction to Machine Learning by Dr. Prof. S. Sarkar .

M-TECH (Electronics Communication- Wireless Communication Technology)
AY (2024-25) Course
[EPG2-13 C]: Project Management (PM)

Semester	Credits	Teaching Scheme	Examination Scheme
2	**03**	**TH: 3 Hrs. / Week**	**ISE: 20 Marks** **CIA: 30 Marks** **ESE: 50 Marks**

Prerequisite: Mathematical Foundations for Machine Learning: Probability, Random Variables, Stochastic Process, Linear Algebra

Course Objectives

The main objectives of this course are: To understand,

- The basics of Project Management and its life cycle.
- The process of Project Identification, Project Selection criteria & Project Planning.
- The organizational structure within a project and issues related to project management.
- The modern project management tools & techniques.

Course Outcomes:

CO1: Summarize the fundamentals of project of Management.

CO2: Interpret and **select** the processes of Project Identification, Project Selection and project planning using the concepts of feasibility study, project Break-even point, project life cycle and work breakdown structure.

CO3: Specify, analyze, and reduce the project risk by various project management tools and manage the project finance by conducting feasibility studies and planning, arranging, and controlling finance package.

CO4: Analyzing the role of computer, project manager in modern project management through performance analysis.

Course Content

Module-I	Introducing Project Management	10 Hrs

Defining what project is-and is not, Defining Project Management, Project management life cycle, Impact of Delays in Project Completions, Essentials of Project Management Philosophy, Project Management Principles, Project planning, selection and evaluation methods and feasibility study, project break-even point, work breakdown structure, management functions

Module-II	Organizational Structures and team building	10 Hrs

Introduction, workflow, organizational structures, organizing and staffing the project office team, case studies

Module-III	ERP and PERT	10 Hrs

Overview, basic philosophy, Microlevel techniques, advantages, limitations, prerequisites, implementation time & cost, impact on organization, applicability/ adaptability, Emerging trends.

Module-IV	Modern Project Management	10 Hrs

Introduction, organizational considerations, project vs project management, role of computer, impact on business organization, role of project manager, project manager selection & training, performance measurement, government, social change, demographics, physical resources.

Textbook

1. H. Kerzer, "Project Management: A Systems Approach to Planning, Scheduling, and Controlling", John Wiley & Sons, Inc., 10th Edition, 2009.
2. Chandra, P., "Projects", Tata McGraw-Hill Education, 8th Edition, 2009.

Reference Book

1. Joseph Phillips," IT Project Management", Tata McGra-Hill, Third edition,2010. 2.Dinesh Seth, Subhash C.Rastogi, "Global Management Solutions", Cengage Learning, Second Edition,2009
Relevant MOOCs Course
1. NPTEL Course "Project Management for Managers", Link: https://nptel.ac.in/courses/110/107/110107081/ 2. NPTEL "Intellectual Property Rights & Competition Law", Link: https://nptel.ac.in/courses/110/105/110105139/

M-TECH (Electronics Communication- Wireless Communication Technology)
AY (2024-25) Course
[EPG2-13 D]: Cyber Security (CS)

Semester	Credits	Teaching Scheme	Examination Scheme
2	**03**	**TH: 3 Hrs. / Week**	**ISE: 20 Marks** **CIA: 30 Marks** **ESE: 50 Marks**

Prerequisite: computer networking and security techniques

Course Objectives

Objective of this course is to provide students with

1. Learn the foundations of Cyber security and the threat landscape.
2. To develop skills in students that can help them plan, implement, and monitor cyber security mechanisms to ensure the protection of information technology assets.
3. To expose students to governance, regulatory, legal, economic, environmental, social and ethical contexts of cyber security.
4. To select suitable ethical principles and commit to professional responsibilities and human values and contribute value and wealth for the benefit of the society.

Course Outcomes:

CO1: Understand the basic terminologies related to cyber security and current cyber security threat landscape. They will also develop understanding about Cyberwarfare and the necessity to strengthen the cyber security of end user machine, critical IT and national critical infrastructure.

CO2: Students will have a complete understanding of the cyberattacks that target computers, mobiles, and persons. They will also develop understanding about the type and nature of cybercrimes and as to how to report these crimes through the prescribed legal and Government channels.

CO3: Students will understand the aspects related to personal data privacy and security. They will also get insight into the Data Protection Bill,2019 and data privacy and security issues related to Social media platforms.

CO4: Understand the main components of a cyber security plan. They will also get insights into risk-based assessment, requirement of security controls and need for cyber security audit and compliance.

Course Content

Module I	Overview of Cyber security	8 Hrs

Cyber security increasing threat landscape, Cyber security terminologies- Cyberspace, attack, attack vector, attack surface, threat, risk, vulnerability, exploit, exploitation, hacker., Non-state actors, Cyber terrorism, Protection of end user machine, Critical IT and National Critical Infrastructure, Cyberwarfare, Case Studies.

Module II	Cyber crimes	8 Hrs

Cybercrimes targeting Computer systems and Mobiles- data diddling attacks, spyware, logic bombs, DoS, DDoS, APTs, virus, Trojans, ransomware, data breach., Online scams and frauds- email scams, Phishing, Vishing, Smishing, Online job fraud, Online sextortion, Debit/ credit card fraud, Online payment fraud, Cyberbullying, website defacement, Cybersquatting, Pharming, Cyber espionage, Crypto jacking, Darknet- illegal trades, drug trafficking, human trafficking., Social Media Scams & Frauds- impersonation, identity theft, job scams, misinformation, fake news cybercrime against persons - cyber grooming, child pornography, cyber stalking., Social Engineering attacks, Cyber Police stations, Crime reporting procedure, Case studies.

Module III	Data Privacy and Data Security	8 Hrs

Defining data, meta-data, big data, nonpersonal data. Data protection, Data privacy and data security, Personal Data Protection Bill and its compliance, Data protection principles, Big data security issues and challenges, Data protection regulations of other countries- General Data Protection Regulations (GDPR), 2016 Personal Information Protection and Electronic Documents Act (PIPEDA)., Social media- data privacy and security issues.

Module IV	**Cyber security Management, Compliance and Governance**	**8 Hrs**

Cyber security Plan- cyber security policy, cyber crises management plan., Business continuity, Risk assessment, Types of security controls and their goals, Cyber security audit and compliance, National cyber security policy and strategy.

Textbook

Reference Book

1. Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Sumit Belapure and Nina Godbole, Wiley India Pvt. Ltd.
2. Information Warfare and Security by Dorothy F. Denning, Addison Wesley.
3. Security in the Digital Age: Social Media Security Threats and Vulnerabilities by Henry A. Oliver, Create Space Independent Publishing Platform.
4. Data Privacy Principles and Practice by Natraj Venkataramanan and Ashwin Shriram, CRC Press.
5. Information Security Governance, Guidance for Information Security Managers by W. KragBrothy, 1st Edition, Wiley Publication.
6. Auditing IT Infrastructures for Compliance By Martin Weiss, Michael G. Solomon, 2nd Edition, Jones Bartlett Learning

Relevant MOOCs Course

NPTEL course on Cyber Security and Privacy

M-TECH (Electronics Communication- Wireless Communication Technology) AY (2024-25) Course [EPG2-14]: Open Elective Courses (OEC-I)			
Semester	**Credits**	**Teaching Scheme**	**Examination Scheme**
2	**03**	**TH: 3 Hrs. / Week**	**ISE: 20 Marks** **CIA: 30 Marks** **ESE: 50 Marks**
Students may select any one of the courses of 4 credits offered by any other department in the institute or Industry supported Course. MOOCs: The total credits earned through MOOCs should be equivalent to the allocated credits for the respective Open Elective Course. (One credit will be awarded for a four-week MOOCs course)			

M-TECH (Electronics Communication- Wireless Communication Technology) AY (2024-25) Course [EPG2-15]: Lab Practice-II (LP-II)			
Semester	**Credits**	**Teaching Scheme**	**Examination Scheme**
2	**04**	**PR: 8 Hrs. / Week**	**CIA: 50 Marks** **ESE(P/OR): 50 Marks**
Laboratory experiments based on the courses being taught. Minimum ten experiments, case studies to becarried out including hardware and simulation-based experiments.			

M-TECH (Electronics Communication- Wireless Communication Technology)
AY (2024-25) Course
[EPG2-16 A]: Mini Project (MP)

Semester	Credits	Teaching Scheme	Examination Scheme
2	**02**	**P: 4 Hrs. / Week**	**CIA: 50 Marks** **ESE: 50 Marks**

Prerequisite: basic electronics components, software languages

Course Objectives

Objective of this course is to provide students with

1. To support independent learning and innovative attitude.
2. To guide to select and utilize adequate information from varied resources upholding ethics.
3. To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
4. To develop interactive, communication, organization, time management, and presentation skills.
5. To impart flexibility and adaptability.
6. To inspire independent and teamwork.
7. To expand intellectual capacity, credibility, judgment, intuition.
8. To adhere to punctuality, setting and meeting deadlines.
9. To instill responsibilities to oneself and others.
10. To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Mini Project: Each student of the project batch shall be involved in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

Course Outcomes:

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

CO1: Present the mini-project and be able to defend it.
CO2: Make links across different areas of knowledge and generate, develop and evaluate ideas and information so as to apply these skills to the project task.
CO3: Habituated to critical thinking and use problem solving skills.
CO4: Communicate effectively and present ideas clearly and coherently in both the written and oral forms.
CO5: Work in a team to achieve common goals.
CO6: Learn on their own, reflect on their learning and take appropriate actions to improve it.

Course Content

Module-1	Execution of Mini Project	

- Project should be taken by individual students and carried out independently.
- Mini Project work should be carried out in the Laboratory.
- Project designs ideas can be necessarily adapted from recent issues of various reputed Conference proceeding / Journals, Application notes from well-known device manufacturers may also be referred.

Module-II	Monitoring (for students and teachers both):	

- Teacher should monitor the project work through the monthly Demonstration and Presentation.
- The logbook for all project activities shall be maintained and shall be produced at the time of continuous evaluation.
- After the Project Completion, a detailed project report in the prescribed format should be prepared and submitted.

In semester examination: Shall be Carried out through continuous internal evaluation**.** **End Semester Examination:** ESE marks for the mini-project shall be awarded based on the evaluation of Mini-Project Report, Presentation skill and Question and Answer session in the ratio 50:25:25 by the examiners appointed by the University.	
Scheduled duration	**Task to be performed (As applicable for HW or SW)**
Week-1	Decision of domain and problem statement Submission of Three (03) project titles
Week-2	Finalization of Project Title, Literature Survey, finalizing the Specifications
Week-3	Preparation of project Synopsis, PPT Seminar-I (Project Idea) Presentation
Week-4	Seminar-I (Project Idea) Presentation Selection of Components/devices, Paper Design
Week-5	Circuit diagram, Software requirements Simulation of Different modules
Week-6	Component Purchasing, Breadboard testing. Algorithm, Flow Chart
Week-7	Testing / Programming PCB layout
Week-8	Testing / Programming PCB layout
Week-9	Assembling, Soldering Testing on PCB
Week-10	Testing on PCB and Programming the board. Designing enclosures
Week-11	Integration of hardware and Software Testing and Troubleshooting
Week-12	Project Demonstration Seminar –II (Project Work) Presentation
Week-13	Seminar –II (Project Work) Presentation Project Report Preparation, Final Submission of Project report

M-TECH (Electronics Communication- Wireless Communication Technology) AY (2024-25) Course [EPG2-16 B]: Seminar-I (SM-I)			
Semester	**Credits**	**Teaching Scheme**	**Examination Scheme**
2	**02**	**P: 4 Hrs. / Week**	**CIA: 50 Marks** **ESE: 50 Marks**
Course Objectives Objective of this course is to provide students with 1. The knowledge and understanding of the subjects. 2. To refer library resources- Journals/Magazines/Transactions. 3. To have hands on practice			
Course Outcomes: **CO1:** To practice the concept learned. **CO2:** To build a project and its implementation. **CO3:** To Contribute to the technical domain.			
Course Content			
Module I	**Literature Survey in current technologies, Scope Identification**		**8 Hrs**
Student must refer to good publications (IEEE Transactions, ACM & Indexed Journals), Findings, Observation, Motivation, Problem Definition.			
Module II	**Resources and Platforms**		**6 Hrs**
Student to identify and learn the resources required to carry out the work.			
Module III	**Implementation, Experimentation and Validation**		**7 Hrs**
Lab work under guidance of teacher.			
Module IV	**Report writing and presentation, Publications**		**7 Hrs**
Lab work under guidance of teacher			
Textbook 1. Journals/ Transactions/ Magazines from Library. 2. Books related to Technical Writing			
Reference Book			
As specified by Teacher/ Mentor/ Guide/PG Committee of the Centre			
Relevant MOOCs Course			
As per courses available			

M-TECH (Electronics Communication- Wireless Communication Technology)
AY (2024-25) Course
[EPG2-16 C]: Internship-I (IP-I)

Semester	Credits	Teaching Scheme	Examination Scheme
2	03	P: 4 Hrs. / Week	CIA: 50 Marks ESE: 50 Marks

Course Objectives

Objective of this course is to provide students with

1. In-depth understanding of the subjects
2. Hands on practice/experience in the field of interest.
3. The exposure to the corporate/industrial environment/practices.

Course Outcomes:

CO1: To apply theoretical knowledge to solve practical engineering problems.
CO2: To design and develop a hardware and/or software system to cater to the requirements of the industry.
CO3: To publish/present/report the work carried out.

Course Content

Module I	**Literature Survey in current technologies**	**4 Hrs**
Students must refer to reputed journals, magazines (IEEE Transactions, ACM & Indexed Journals) to carry out the literature survey on the topic.		
Module II	**Identification of scope and resources required**	**2 Hrs**
Students must study and analyze the findings, observations, challenges from the literature to come up with the problem definition and motivation behind the proposed objective. They further should research on the resource requirement and available resources.		
Module III	**Implementation, Experimentation and Validation**	**14 Hrs**
Students must carry out the actual work under the guidance of an expert.		
Module IV	**Report writing and presentation**	**4 Hrs**
Students must write a report and present the work before the evaluators upon completion of an internship. They should publish a paper in a reputed conference/journal approved by UGC/Institute. Students should submit the feedback regarding the internship.		

Textbook

1. Journals/ Transactions/ Magazines from Library.
2. Books related to Technical Writing

Reference Book

As specified by Teacher/ Mentor/ Guide/PG Committee of the Centre

Relevant MOOCs Course

Courses on Technical Writing

Second Year
Semester-3

M-TECH (Electronics Communication- Wireless Communication Technology) AY (2024-25) Course [EPG3-21]: Advanced Wireless Network (AWN)			
Semester	**Credits**	**Teaching Scheme**	**Examination Scheme**
3	**04**	**TH: 3 Hrs. / Week Tut: 1 Hrs. / Week**	**ISE: 20 Marks CIA: 30 Marks ESE: 50 Marks**

Prerequisite: Digital communication, Computer networks

Course Objectives

Objective of this course is to provide students with

1. The knowledge and understanding of advanced wireless networking fundamentals.
2. Provide a strong foundation of fundamental wireless networking system.
3. Detailed analysis of end-to-end wireless networking system and its frame formats
4. Build an understanding of the various protocol stacks and standards of different wireless networks.
5. Performance evaluation of Wireless networks technologies.

Course Outcomes:

CO1: Understand and familiarize various wireless data networking technologies, analyze IEEE 802.11-physical layer-MAC layer standards, its Security Mechanisms and Comparing their performances.

CO2: Describe and analyze various WPAN and WMAN wireless networks, their specifications, protocol stack understanding, and its Security Mechanisms.

CO3: Represent and analyze various advanced wireless technologies like LoRa, SigFox, NFC, LMDS, MMDS in terms of network architecture, Frame structure, specifications, advantages, disadvantages and their technical Comparison in detail.

CO4: Explain and analyze various advanced wireless technologies like Zigbee, Z-wave, Ultra-Wideband (UWB) in terms of network architecture, Frame structure, specifications, advantages, disadvantages, and their technical Comparison in detail.

Course Content

Module I	**Introduction to wireless data networks and 802.11 WLAN**	**8 Hrs**

Data Networks and Internetworking, Introduction to Wireless Data Networks, MAC layer, Physical layer of IEEE 802.11, The 802.11 Standards (WLAN or WI-FI), Potential Security Issues with Wireless LAN Systems, Overview of 802.11b Security Mechanisms.

Module II	**WPAN and WMAN networks**	**10 Hrs**

Overview of the 802.15 WPAN, Bluetooth Network, Bluetooth technical specifications, High-Level View, The General Requirements of 802.15, How WPANs differ from WLANs, Power Levels and Coverage, Control of the Medium. Lifespan of the Network, 802.15 Security, the 802.16 Wireless MAN Standards, Metropolitan Area Mesh Networks, Implementing Wireless MANs.

Module III	**Wireless Technologies-I**	**10 Hrs**

LoRa network architecture, LoRa Frame structure, LoRa protocol stack, SigFox specifications, SigFox network architecture, SigFox Frame structure, SigFox protocol stack. NFC features, NFC working, NFC network modes, NFC Frame structure, NFC protocol stack, NFC versus RFID, NFC security. LMDS architecture, LMDS advantages and disadvantages, MMDS architecture, MMDS advantages and disadvantages, Comparison between LMDS and MMDS.

Module IV	**Wireless Technologies-II**	**8 Hrs**

Zigbee network overview, Forming the Zigbee Network, Joining the Zigbee Network, zigbee protocol stack, Zigbee Physical and MAC Layer. Z-wave specifications, z-wave frequency bands, z-wave network, z-wave frame structure, z-wave protocol stack. Ultra-Wideband (UWB)wireless working, UWB transmitter, UWB receiver, Modulation Schemes, typical specifications.
Textbook
1. ZigBee® Network Protocols and Applications, Chonggang Wang, Qian Zhang, Tao Jiang, CRC Press, 2. Data communication and Networking, Behrouz A. Foruzan, Tata McGraw-Hill,5th Edition. 3. Wireless Data technologies reference Handbook, Vern Dubendorf, Wiley Publication.
Reference Book
1. Wireless Networking Technology, From Principles to Successful Implementation, Steve Rackley, Elsevier publisher. 2. https://www.rfwireless-world.com/Tutorials
Relevant MOOCs Course
Lecture Series on Wireless Communications by Dr. Ranjan Bose, Department of Electrical Engineering, IIT Delhi.

M-TECH (Electronics Communication- Wireless Communication Technology) AY (2024-25) Course [EPG3-22]: Open Elective Courses-II (OEC-II)			
Semester	**Credits**	**Teaching Scheme**	**Examination Scheme**
3	**04**	**TH: 4 Hrs. / Week**	**ISE: 20 Marks** **CIA: 30 Marks** **ESE: 50 Marks**
Students may select any one of the courses of 4 credits offered by any other department in the institute or Industry supported Course. MOOCs: The total credits earned through MOOCs should be equivalent to the allocated credits for the respective Open Elective Course. (One credit will be awarded for a four-week MOOCs course)			

M-TECH (Electronics Communication- Wireless Communication Technology)
AY (2024-25) Course
[EPG3-23 A]: Human Values (HV)

Semester	Credits	Teaching Scheme	Examination Scheme
3	02	TH: 2 Hrs. / Week	CIA: 25 Marks ESE: 25 Marks

Prerequisite: Universal Human Values-Introduction (UHV-I)

Course Objectives

Objective of this course is to provide students with

1. To help the students appreciate the essential complementarity between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
2. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
3. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature.

Course Outcomes:

CO1: Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual, etc.

CO2: Analyze the value of harmonious relationships based on trust and respect in their life and profession.

CO3: Examine the role of a human being in ensuring harmony in society and nature and Apply the understanding of ethical conduct to formulate the strategy for ethical life and profession.

Course Content

Module I	Introduction-Basic Human Aspiration and its requirement to fulfill basic aspiration	8 Hrs

Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Right Understanding, Relationship and Physical Facility, Happiness and Prosperity – Current Scenario, Method to fulfill the Basic Human Aspirations.

Module II	Harmony in the Human Being	7 Hrs

Understanding Human being as the Co-existence of the Self and the Body, distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health.

Module III	Harmony in the Family and society	8 Hrs

Harmony in the Family – the Basic Unit of Human Interaction, Values in Human–to–Human Relationship, Nine universal values in relationships viz. Trust, Respect, Affection, Care, Guidance, Reverence, Glory, Gratitude, Love. Understanding Harmony in Society, Vision for the Universal Human Order, Human Order Five Dimension.

Module IV	Harmony in the Nature / Existence	7 Hrs

Understanding Harmony in the Nature, self–regulation & mutual fulfillment among the Four orders of Nature, Realizing Existence as co-existence at all levels holistic perception of harmony in existence.

Textbook

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010.
2. A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978–93–87034–47–1.

Reference Book

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
4. On Education – J Krishnamurthy
5. Rediscovering India – by Dharampal Hind Swaraj or Indian Home Rule – by Mohandas K. Gandhi.
6. Hind Swaraj or Indian Home Rule – by Mohandas K. Gandhi

Relevant MOOCs Course

NPTEL:Humanities and Social Sciences - Exploring Human Values: Visions of Happiness and Perfect Society

WEB LINKS AND VIDEO LECTURES (E-RESOURCES):

1. http://madhyasth-darshan.info/postulations/knowledge/knowledge-of-humane-conduct/
2. https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw
3. https://youtu.be/OgdNx0X923I
4. www.coexistence.info

ACTIVITY BASED LEARNING (SUGGESTED ACTIVITIES IN CLASS)

1. Self–exploration– Results in the discovery of the inherent relationship, harmony and co–existence facilitating transformation towards a holistic world vision and 'Human Consciousness'.
2. Sharing about Oneself, Exploring Human Consciousness, Exploring Natural Acceptance.
3. Exploring the difference of Needs of Self and Body, Exploring Sources of Imagination in the Self, Exploring Harmony of Self with the Body.
4. Exploring the Feeling of Trust, Exploring the Feeling of Respect.
5. Role play based on outer triggers for self–decisions.
6. Group Discussion: Exploring the difference of Needs of Self and Body, Exploring Sources of Imagination in the Self, Exploring the Feelings

M-TECH (Electronics Communication- Wireless Communication Technology)
AY (2024-25) Course
[EPG3-23 B] Intellectual Property (IPR)

Semester	Credits	Teaching Scheme	Examination Scheme
3	02	TH: 2 Hrs. / Week	CIA: 25 Marks ESE: 25 Marks

Prerequisite:

Course Objectives

Objective of this course is to provide students with

1. Provide the fundamental concepts and necessity of IP.
2. Outline various methodologies for IP.
3. Assist in writing the IPR, filing and granting.
4. Provide the outline of various legal options involved in IP.

Course Outcomes:

CO1: Understand and appreciate the concept of intellectual property (IP).
CO2: Analyze the nature, scope and different types of IPs, their different utilities and approaches followed to get various benefits.
CO3: Evaluate the rationale and importance of IP in knowledge economy.
CO4: Write a proposal for filing an IPR.

Course Content

Module-I	Introduction to Intellectual Property	15 Hrs

Introduction, Concept of property, Intellectual Property (IP) and Intellectual Property Rights (IPR), Importance of IP and Competitive advantage, Legal basis and rationale behind development of IP system. Historical view of IP system in India, IP system in USA, Europe & other countries, Major forms of IP in India and globally & Various Acts, Copyrights and related rights, Copyright registration, infringement & S. 52 of Indian Copyright Act

Module-II	Patents	15 Hrs

Patent-introduction, Patent –inventions not patentable, Patent filing in India, Conventional patent filing & PCT, patent Infringement and Enforcement Start-ups and IP, Emerging areas in IP, Open Innovation, open-source software

Textbook

1. Indian Patents Act, 1970.
2. Ove Granstrand, The Economic and management of Intellectual Property, (1999).

Reference Book

1. Idris, K. (2003), Intellectual property: a power tool for economic growth, second edition, WIPO publication.
2. Narayanan, V. K., Managing technology and innovation for competitive advantage, first edition, Pearson education, New Delhi, (2006).

Relevant MOOCs Course

Introduction to Intellectual Property, By KAPILA IPR committee, IIT Kharagpur
https://onlinecourses.swayam2.ac.in/aic21_ge20/preview

M-TECH (Electronics Communication- Wireless Communication Technology)
AY (2024-25) Course
[EPG3-23 C]: Professional Ethics (PE)

Semester	Credits	Teaching Scheme	Examination Scheme
3	**02**	**TH: 2 Hrs. / Week**	**CIA: 25 Marks** **ESE: 25 Marks**

Prerequisite: Basic understanding of ethics, Critical thinking skills, Research skills and Ethical Sensitivity

Course Objectives

Objective of this course are,

1. To introduce students to the core principles and essential concepts of professional ethics.
2. To prepare students to grasp their professional duties and responsibilities by gaining insights into ethical philosophies and professional norms.
3. To explore both classical and contemporary ethical dilemmas within the engineering profession.

Course Outcomes:

CO1: Apply ethical reasoning skills to analyze and resolve real-world ethical dilemmas encountered in engineering and other professional domains.
CO2: Apply the ethical obligations and responsibilities of engineers in their professional practice.
CO3: Analyze the social impacts of technology and engineering from a sociological perspective.
CO4: Address the modern challenges in engineering ethics, including environmental concerns and ethical considerations in collaborative research within engineering teams.

Course Content

Module I	Ethics in Engineering: Understanding basic concepts	6 Hrs

Engineering Ethics, Engineering as Profession, Difference between occupation and profession, Professional Ethics - Codes of Ethics in Engineering profession, Introduction to Ethical Reasoning.

Module II	Professional Practice in Engineering	6 Hrs

Central Professional Responsibilities of Engineers, Workplace Rights and Responsibilities, Ethics as Design doing justice to moral problems, Intellectual Property Rights and Ethics.

Module III	Research Ethics	5 Hrs

Social Responsibilities of scientists/ researchers, Research Ethics, Social impact of Technology and Engineering.

Module IV	Environmental Ethics	6 Hrs

Environmental Ethics, Ethics and Sustainable Engineering, Computer Ethics- Analysing ethical problems in research, Ethics in Collaborative Research, Corporate Social Responsibility (CSR).

Textbook

1. Martin, Mike W., and Roland Schinzinger, "Ethics in Engineering", Third edition, McGraw- Hill, New Delhi, 2017)-Indian edition.
2. Govindarajan M, Natarajan S, Senthil Kumar V.S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.
3. Ethics in Engineering practice and Research (2nd Edition) by Caroline Whitbeck Cambridge.

Reference Book

1. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Cengage Learning, 2009.
2. Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004.

Relevant MOOCs Course

1. Ethics in Engineering Practice by Dr. Susmita Mukhopadhyay, IIT Kharagpur, https://nptel.ac.in/courses/110105097.

M-TECH (Electronics Communication- Wireless Communication Technology) AY (2024-25) Course [EPG3-24]: Internship-II (IP-II)			
Semester	**Credits**	**Teaching Scheme**	**Examination Scheme**
3	**04**	**P: 8 Hrs. / Week**	**CIA: 50 Marks** **ESE(OR): 50 Marks**
Prerequisite: Basic understanding of ethics, Critical thinking skills, Research skills and Ethical Sensitivity			
Course Objectives Objective of this course is to provide students with 1. In-depth understanding of the subjects 2. Hands on practice/experience in the field of interest. 3. The exposure to the corporate/industrial environment/practices.			
Course Outcomes: **CO1:** To apply theoretical knowledge to solve practical engineering problems. **CO2:** To design and develop a hardware and/or software system to cater to the requirements of the industry. **CO3:** To publish/present/report the work carried out.			
Course Content			
Module I	**Literature Survey in current technologies**		**6 Hrs**
Students must refer to reputed journals, magazines (IEEE Transactions, ACM & Indexed Journals) to carry out the literature survey on the topic.			
Module II	**Identification of scope and resources required**		**4 Hrs**
Students must study and analyze the findings, observations, challenges from the literature to come up with the problem definition and motivation behind the proposed objective. They further should research on the resource requirement and available resources.			
Module III	**Implementation, Experimentation and Validation**		**32 Hrs**
Students must carry out the actual work under the guidance of an expert.			
Module IV	**Report writing and presentation**		**6 Hrs**
Students must write a report and present the work before the evaluators upon completion of an internship. They should publish a paper in a reputed conference/journal approved by UGC/Institute. Students should submit the feedback regarding the internship.			
Textbook			
1. Journals/ Transactions/ Magazines from library. 2. Books related to Technical Writing			
Reference Book			
As specified by Teacher/ Mentor/ Guide/PG Committee of the Centre			
Relevant MOOCs Course			
Courses on Technical Writing			

M-TECH (Electronics Communication- Wireless Communication Technology)
AY (2024-25) Course
[EPG3-25 A]: Seminar-II (SM-II)

Semester	Credits	Teaching Scheme	Examination Scheme
3	02	P: 4 Hrs. / Week	CIA: 50 Marks ESE (OR): 50 Marks

Prerequisite: Basics and fundamental knowledge of the subjects learned, and seminar topic chosen

Course Objectives

Objective of this course is to provide students with

1. The knowledge and understanding of employability.
2. Provide a strong foundation of fundamental skills.
3. Detailed analysis of the topic/domain/case study chosen.
4. Performance evaluation on the grasping

Course Outcomes:

CO1: To be employable.
CO2: To have skills in the domain chosen.
CO3: Choose an appropriate career.
CO4: Contribute to the profession through work practice

Course Content

Module I	**Introduction to Employability- Entrepreneurship-Skills (EES):**	**6 Hrs**
Student must know different skills required		
Module II	**EES Progression and Collaboration**	**10 Hrs**
Implementation and Variations on required skills and learning resources, Domain identification (Technologies and Services)		
Module III	**EES Analysis, and Imbibing**	**8 Hrs**
Mock Eligibility Test analysis as per requirements of various domain, Implementation and Presentation on achieved skills		
Module IV	**EES Impact, evaluation, and feedback**	**6 Hrs**
Application Orientation and Validation using small case studies/ Project Implementation, Evaluation by mentor, Feedback by Student		

Textbook

1. Mercy V. Chaita: Developing Graduate Employability Skills: Your Pathway to Employment, Universal-Publishers, 2015.
2. John Neugebauer & Jane Evans-Brain: Employability: Making the Most of Your Career Development, SAGE Publications Ltd, 2016.

Reference Book

1. Peter Wide: Mastering Technical Communication Skills: Jenny Stanford Publishing; 1st edition 2016.
2. Vasant Desai: Dynamics of Entrepreneurial Development and Management: Entrepreneurship, Project Management, Finances, Programs, and Problems, Himalaya Publishing House, 2001.

Relevant MOOCs Course

Employability-Skills- Entrepreneurship

M-TECH (Electronics Communication- Wireless Communication Technology)
AY (2024-25) Course
[EPG3-25 B]: Employability Skills-I (ES-I)

Semester	Credits	Teaching Scheme	Examination Scheme
3	02	P: 4 Hrs. / Week	CIA: 50 Marks ESE (OR): 50 Marks

Prerequisite: English grammar, Knowledge of Basic Algebra, Number sequences, logical reasoning Self-Analysis, Use of Microsoft Power Point

Course Objectives:

1. Develop good communication skills – both oral as well as written.
2. Encourage creative and critical thinking among students.
3. Nurture collaborative behavior to work efficiently in groups.

Course Outcomes:

CO1: Define personal and career goals (short-term and long-term) using introspective skills and Perform SWOC assessment.

CO2: Demonstrate effective communication skills through Group Discussion, Extempore Speech, Presentation, self-management attributes, problem solving abilities and team working & building capabilities.

CO3: Analyze multi-cultural environment and Exhibit leadership skills by improving inter-personal relationships and conflict management.

CO4: Exhibit the professional ethics, etiquette & morals.

CO5: Demonstrate the skill set involving lateral & critical thinking, effective presentations, and leadership qualities.

Course Content

Module I	Introspective skills and SWOC analysis	10 Hrs

Introduction to introspective methods, SWOC Analysis, Understanding the importance of soft skills, soft skill vs hard skill, interdisciplinary relevance, emotional quotient and emotional intelligence, personal and career goal setting, aligning aspirations with individual's skill sets, understanding self-esteem and critically evaluating oneself.

Module II	Communications Skills	10 Hrs

Essentiality of good communication skills, Importance of feedback, Different types of communication, Barriers in communication and how to overcome these barriers, Significance of non-verbal messages as augmentation to verbal communication, Group Discussion, Listening Vs Hearing, reading to comprehend, learning to skim and scan to extract relevant information, Effective digital communication.

Module III	Creative and critical Thinking	12 Hrs

Understanding Corporate Culture and Leadership skills, difference between a leader and a manager, Importance of resilience in a professional surrounding, developing empathy and emotional intelligence, being assertive and confident, 4-Ds of decision making, Creative and solution-centric thinking, resolving conflicts, working cohesively as a team to achieve success, 5 Qualities of an Effective team - Positivity, respect for others, trust, goal-focused, supportiveness.

Module IV	Quantitative aptitude	12 Hrs

Numbers, HCF and LCM, Time and distance, Time and work, Clock, Simple interest and compound interest, Boats and steams, Number series, Ratio and proportion, probability, profit and loss, odd man out series, permutations, height and distance, square and cube root matching, selection, verbal reasoning, logical games, logical deductions, logical problems, cause and effect.

Textbook

1. R. S. Aggarwal, "A modern approach to verbal reasoning", S. Chand publications.
2. R. Gajendra Singh Chauhan, Sangeeta Sharma, “Soft Skills- An integrated approach to maximize personality”, ISBN: 987-81-265-5639-7, First Edition 2016, Wiley.

Reference Book

1. Indrajit Bhattacharya, “An Approach to Communication Skills”, Dhanpat Rai.
2. Simon Sweeney, “English for Business Communication”, Cambridge University Press.
3. Sanjay Kumar and Pushpa Lata, “Communication Skills”, Oxford University Press.
4. Atkinson and Hilgard's, “Introduction to Psychology”, 14th Edition.
5. Kenneth G. Mcgee, “Heads Up: How to Anticipate Business Surprises & Seize Opportunities First”, Harvard Business School Press, Boston, Massachusetts.
6. Krishnaswami, N. and Sriraman, “Creative English for Communication”, Macmillan.

Relevant MOOCs Course

1. “Developing Soft skills & Personality” https://nptel.ac.in/courses/109/104/109104107.
2. “Communication Skills” https://nptel.ac.in/courses/109/104/109104030/.
3. “Effective Writing” https://nptel.ac.in/courses/109/107/109107172/.
4. “Interpersonal Skills” https://nptel.ac.in/courses/109/107/109107155/.

M-TECH (Electronics Communication- Wireless Communication Technology)
AY (2024-25) Course
[EPG3-26]: Dissertation-I (DIS-I)

Semester	Credits	Teaching Scheme	Examination Scheme
3	**04**	**P: 8 Hrs. / Week**	**CIA: 50 Marks** **ESE (OR): 50 Marks**

Prerequisite: Domain based subjects

Course Objectives

Course intends to prepare the students

1. To identify the domain of research.
2. To formulate research problems with the help of the guide/mentor elaborating the research.
3. To acquire information and identify scope for the dissertation work.

Course Outcomes:

At the end of the Course Students will be able to:

1. Conduct thorough literature surveys confined to the domain of choice.
2. Analyze the findings, work of various authors confined to the chosen domain and define scope of the dissertation work.
3. Design the system and prepare the technical report of the dissertation work.
4. Develop presentation skills to deliver the technical contents.

Course Content

1. The dissertation topic should be selected from the emerging techniques related to the domain.
2. If the PG scholars are chosen for working in Industry/Research organization the formalities should be completed in the beginning of the third semester with due permission from HOD/Institute.
3. An internal guide will be assigned along with the external supervisor to assess progress.
4. The students will be evaluated in terms of the literature review, Feasibility study and Technology used on the project title selected, by the internal guide and an external examiner.

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

The dissertation stage - I work will be assessed by a panel of examiners of which one is necessarily an external examiner. The assessment will be broadly based on literature study, work undergone, content delivery, presentation skills, documentation and report. The students are expected to validate their study undertaken by publishing it at standard platforms. The investigations and findings need to be validated appropriately at standard platforms – conference and/or peer reviewed journals. The student has to exhibit the continuous progress through regular reporting and presentations and proper documentation of the frequency of the activities in the sole discretion of the PG coordination. The continuous assessment of the progress needs to be documented unambiguously. For standardization and documentation, it is recommended to follow the formats and guidelines in the dissertation workbook approved by the department.

Second Year
Semester-4

M-TECH (Electronics Communication- Wireless Communication Technology)
AY (2024-25) Course
[EPG4-31 A]: Seminar-III (SM-III)

Semester	Credits	Teaching Scheme	Examination Scheme
4	04	P: 8 Hrs. / Week	CIA: 50 Marks ESE(OR): 50 Marks

Prerequisite: Basics and fundamental knowledge of the subjects learned, and seminar topic chosen

Course Objectives

Objective of this course is to provide students with

1. To connect one's potential, understand moral, professional, and personal values.
2. To introduce professional ethics and to get enabled with decision making skills.
3. To understand Business Ethics.
4. To develop a safe comfortable and prosperous and sustainable society

Course Outcomes:

CO1: To be ethical in shaping the chosen profession.
CO1: To practice business ethics based on psychological and philosophical perspective.
CO3: To contribute to the society with the responsibilities they shoulder in creating a sustainable world.

Course Content

Module I	Individual and Professional Ethics	6 Hrs

Introduction to Professional Ethics, Morals, Values and Ethics – Personal and Professional- Sense of Engineering Ethics –Making decisions with ethical dimensions – definition – roadmap to ethical decision making – common standards – internal obstacles – bias – empathy.

Module II	Business Ethics	8 Hrs

Philosophical approaches to Business Ethics – ethical reasoning – ethical issues in business - Social Responsibility of Business conflict of interest – cultural relativism - Ethical leadership - Resisting un-ethical authority and domination - Global Business Ethics.

Module III	Workplace Ethics	8 Hrs

Ethics in changing domains of Research – academic integrity – intellectual honesty - Role of Engineers and Managers - Ethical issues in Diverse workplace – competition – free will - Confidentiality – employee rights – Intellectual property rights – discrimination.

Module IV	Safety, Responsibilities and Rights	8 Hrs

Ecology, Engineering, Economy - Risk benefit analysis and reducing risk SDGs – Corporate social responsibility and Corporate Sustainability - CSR in India - Sustainability Case Studies.

Textbook

1. Subramanian.R. Professional Ethics, Oxford Publication, 2013.
2. Nagarasan. R.S. Professional Ethics and Human Values. New Age International Publications, 2006.
3. Mike W Martin and Roland Schinzinger, Ethics in Engineering,4th edition, Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi,2014.

Reference Book

As suggested by PG coordination committee.

Relevant MOOCs Course

Relevant courses as advised by guide

M-TECH (Electronics Communication- Wireless Communication Technology)
AY (2024-25) Course
[EPG4-31 B]: Employability Skills-II (ES-II)

Semester	Credits	Teaching Scheme	Examination Scheme
4	04	TH: 8 Hrs. / Week	CIA: 50 Marks ESE: 50 Marks

Prerequisite: Wireless communications fundamentals, Concepts of Communications networks

Course Objectives:

1. In-depth understanding of the subjects.
2. Hands on practice/experience in the field of interest.
3. The exposure to the corporate/industrial environment/practices.

Course Outcomes:

CO1: To apply theoretical knowledge to solve practical engineering problems.
CO2: To design and develop a hardware and/or software system to cater to the requirement of the industry.
CO3: To prepare report on the work carried out and present.

Course Content

Module I	**Software Defined Radio**	**6 Hrs**
MANET (Introduction, Self-organizing behavior, Co-operation) MANET (MAC, Routing) MANET (Multicast routing, Mobility model, Transport layer, Opportunistic Mobile Networks) Case Study on Universal Software Radio Peripheral (USRP).		
Module II	**Mobile Network**	**10 Hrs**
Opportunistic Mobile Networks, UAV networks, Wireless Sensor Networks (Introduction, WSN (Coverage, Topology management, Mobile Sensor Networks, Case study on LabVIEW/ Network simulation S/W.		
Module III	**Wireless Network**	**12 Hrs**
WSN (MAC, Congestion control, Routing, WSN (Routing in WSN, Underwater WSN) Implementation of wireless ad hoc /Sensor network using NI-USRP.		
Module IV	**Wireless Sensor Network**	**12 Hrs**
Security of WSN, Structure of sensor nodes, Hardware design of sensor network, Real life deployment of WSN. To prepare Resume and apply for various internships in wireless communication domain, appear interviews.		

Textbook

1. "Ad Hoc Wireless Networks: Architectures and Protocols", S Siva Ram Murti, and B.S. Manoj, Pearson Education India,
2. "Wireless Networks: Design and Integration for LTE, EVDO, HSPA, and WiMAX" by Clint Smith and Daniel Collins, McGraw Hill Education; 3rd edition (18 September 2014)

Reference Book

https://archive.nptel.ac.in/courses/106/105/106105160

Relevant MOOCs Course

Wireless Adhoc And Sensor Networks by Prof. Sudip Misra, IITGKP

M-TECH (Electronics Communication- Wireless Communication Technology) AY (2024-25) Course [EPG4-31 C]: Internship-III (IP-III)			
Semester	**Credits**	**Teaching Scheme**	**Examination Scheme**
4	**04**	**P: 8 Hrs. / Week**	**CIA: 50 Marks** **ESE(OR): 50 Marks**
Prerequisite:			
Course Objectives: 1. In-depth understanding of the subjects. 2. Hands on practice/experience in the field of interest. 3. The exposure to the corporate/industrial environment/practices.			
Course Outcomes: **CO1:** To apply theoretical knowledge to solve practical engineering problems. **CO2:** To design and develop a hardware and/or software system to cater to the requirements of the industry. **CO3:** To publish/present/report the work carried out.			
Course Content			
Module I	**Literature Survey in current technologies**		**6 Hrs**
Students must refer to reputed journals, magazines (IEEE Transactions, ACM & Indexed Journals) to carry out the literature survey on the topic.			
Module II	**Identification of scope and resources required**		**4 Hrs**
Students must study and analyze the findings, observations, challenges from the literature to come up with the problem definition and motivation behind the proposed objective. They further should research on the resource requirement and available resources.			
Module III	**Implementation, Experimentation and Validation**		**32 Hrs**
Students must carry out the actual work under the guidance of an expert.			
Module IV	**Report writing and presentation**		**6 Hrs**
Students must write a report and present the work before the evaluators upon completion of an internship. They should publish a paper in a reputed conference/journal approved by UGC/Institute. Students should submit the feedback regarding the internship.			
Textbook			
1. Journals/ Transactions/ Magazines from library. 2. Books related to Technical Writing			
Reference Book			
As specified by Teacher/ Mentor/ Guide/PG Committee of the Centre			
Relevant MOOCs Course			
Courses on Technical Writing			

M-TECH (Electronics Communication- Wireless Communication Technology) AY (2024-25) Course [EPG4-32]: Dissertation-II (DIS-II)			
Semester	**Credits**	**Teaching Scheme**	**Examination Scheme**
4	**16**	**P: 32 Hrs. / Week**	**CIA: 75 Marks** **ESE: 75 Marks**

Prerequisite:

Course Objectives

Course intends to prepare the students

1. To follow SDLC meticulously and meet the objectives of proposed work.
2. To test rigorously before deployment of the system.
3. To validate the work undertaken.
4. To consolidate the work as a furnished report.

Course Outcomes:

At the end of the Course Students will be able to:

1. Demonstrate a depth knowledge of the domain of choice.
2. Analyze findings, evaluate and present the results and their interpretation.
3. Prepare an independent dissertation report, resulting in publication.
4. Demonstrate an ability to present and defend dissertation work to a panel of experts.

Course Content

1. Students who are working in Industry/Research organization may do so with prior permission from HOD and other students may have to complete their dissertation in the Institution under the respective guides.
2. Project dissertation may be submitted upon successful completion of the project and as per the guidelines provided by the Institute.
3. The project dissertation will be jointly evaluated by an external examiner and internal guide.

In Dissertation Stage–II, the student shall consolidate and complete the remaining part of the dissertation which will consist of selection of technology, installations, implementations, testing, results, measuring performance, discussions using data tables as per parameter considered for the improvement with existing/known algorithms/systems, comparative analysis, validation of results and conclusions. The student shall prepare a certified final report of Dissertation in standard format for satisfactory completion of the work duly signed by the concerned guide and head of the Department/Institute.

The dissertation stage - II work will be assessed by a panel of examiners of which one is necessarily an external examiner. The students are expected to validate their study undertaken by publishing it at standard platforms. The investigations and findings need to be validated appropriately at standard platforms – conference and/or peer reviewed journals. The student has to exhibit the continuous progress through regular reporting, presentations, and proper documentation of the frequency of the activities in the sole discretion of the PG coordination. The continuous assessment of the progress needs to be documented unambiguously. It is recommended to continue with guidelines and formats as mentioned in the Dissertation Workbook approved by the department.