Dr. Babasaheb Ambedkar Technological University

(Established a University of Technology in the State of Maharashtra)
(under Maharashtra Act No. XXIX of 2014)
P.O. Lonere, Dist. Raigad, Pin 402 103,
Maharashtra Telephone and Fax. 02140 - 275142 www.dbatu.ac.in
www.dbatu.ac.in

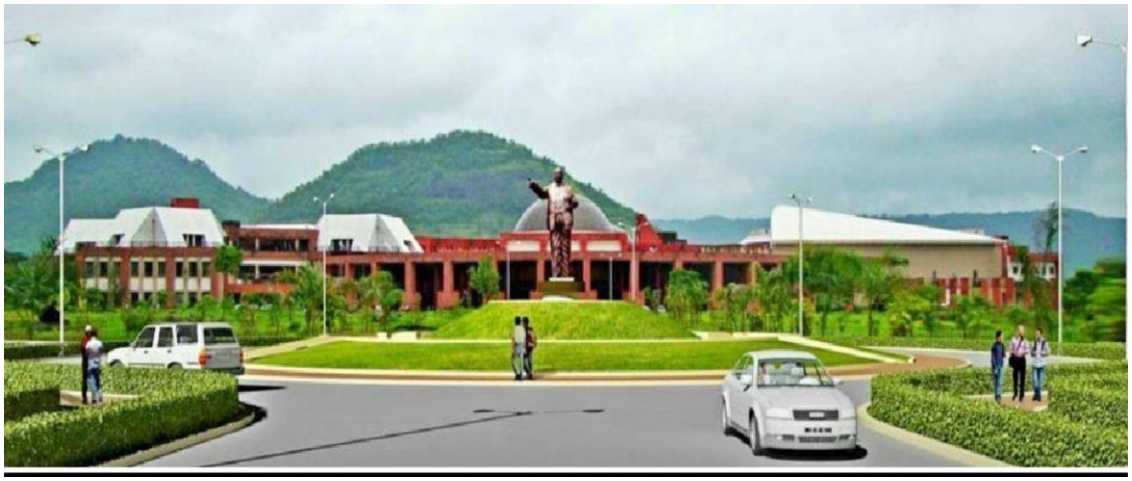
PROPOSED CURRICULUM POST GRADUATE PROGRAMME

M. TECH

Digital Communication

Two Year (Four Semester) Course

In line with New Education Policy 2020 guidelines
WITH EFFECT FROM THE ACADEMIC YEAR 2024-2025



M. Tech. (Digital Communication)

Objectives

1. To serve the society and nation, by providing high-quality engineering educationalprograms to the students, engaging in research and innovations that will enhance the skill and knowledge and assisting the economic development of the region, state, and nation through technology transfer.
2. To equip the postgraduate students with state-of-the-art education through research and collaborative work experience/culture to enable successful, innovative, and life-long careers in Electronics and Telecommunication.
3. To encourage the post-graduates students, to acquire the academic excellence and skills necessary to work as Electronics and Telecommunication professional in a modern, ever-evolving world.
4. To provide a broad understanding of social, ethical and professional issues of contemporary engineering practice and related technologies and professional, moral, and societal responsibilities.
5. To inculcate the skills for perusing inventive concepts to solve industrial, social or national problems.

Outcomes:

1. Students of this program will have the ability to apply knowledge of mathematics,sciences and engineering to Electronics and Telecommunication problems.

2. Postgraduate students will gain the ability to design and conduct experiments, aswell as to analyze and interpret data/results.

3. Learners of this program will built an ability to design and develop a system, components, devices, or process to meet desired needs.

4. Masters students of this program will have an ability to work on multi- disciplinary teams and also as an individual for solving issues related toElectronics and Telecommunication.

5. Learners of this program will have an ability to identify, formulate, and solve Engineering problems by applying mathematical foundations, algorithmic principles, and Electronics and Telecommunication theory in the modeling and design of electronics systems in a way that demonstrates comprehension of thetradeoffs involved in design choices.

6. Postgraduate students will have an ability to communicate effectively orallyand in writing and also understanding of professional and ethical responsibility.

7. Postgraduate students will have an ability to use the techniques, skills, andmodern engineering EDA tools necessary for Electronics and Telecommunication practices.

Dr. Babasaheb Ambedkar Technological University

Teaching and Examination Scheme for

M.Tech. (Digital Communication)

In line with New Education Policy 202 guidelines

(Effective from Academic Year 2024-25)

First Semester

Sr. No	Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme					Credit
				L	T	P	MSE	ESE	IA	OR/ PR	Total	
1	PCC	MTDCC101	5G Technology- 1	3	1	--	20	60	20	--	**100**	4
2	PCC	MTDCC102	Signal Theory	3	1	--	20	60	20	--	**100**	4
3	PCC	MTDCC103	Advanced Digital Communication	3	1	--	20	60	20	--	**100**	4
4	PCE	MTDCC114	Elective - I	3	1	--	20	60	20	--	**100**	3
5	PCE	MTDCC125	Elective - II	3	1	--	20	60	20	--	**100**	3
6	ELC	MTDCC106	Seminar I	--	--	04	--		25	25	**50**	2
7	PCE	MTDCL107	PG Lab I	--	--	04	--		25	25	**50**	2
8	Audit Course	MTDCC108	Yoga for Stress Management	2	--	04	--		--	--	--	--
			Total	**17**	**05**	**12**	**100**	**300**	**150**	**50**	**600**	22

Second Semester

Sr. No	Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme					Credit
				L	T	P	MSE	ESE	IA	OR/ PR	Total	
1	PCC	MTDCC201	5G Technology- 2	3	1	--	20	60	20	--	**100**	4
2	PCC	MTDCC202	Information Theory and Coding	3	1	--	20	60	20	--	**100**	4
3	PCE	MTDCE233	Elective -III	3	1	--	20	60	20	--	**100**	3
4	OE	MTDCE244	Open Elective - I	3	1	--	20	60	20	--	**100**	3
5	PCE	MTDCE255	Research Methodology and IPR	3	1	--	20	60	20	--	**100**	3
6	AEC/VEC/IKS	MTDCC266	IKS Bucket#	3	0	--	20	60	20	--	**100**	2
6	PCE	MTDCL206	PG Lab II	--	--	04	--	--	25	25	**50**	2
7	ELC	MTDCP207	Mini- Project	--	--	04	--	--	25	25	**50**	1
8	Audit Course	MTDCD208	Disaster Management	2	--	--	--	--		--	--	--
			Total	**20**	**05**	**08**	**120**	**360**	**150**	**50**	**700**	22

Third Semester

Sr. No	Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme					Credit
				L	T	P	MSE	ESE	IA	OR/ PR	Total	
1	OE	MTDCE301	Open Elective - II	3	1	--	20	60	20	--	**100**	3
2	MDM	MTDCE 302	Multidisciplinary Minor	3	1	--	20	60	20	--	**100**	3
3	INP	MTDCI 303	Internship	--	--	--	--	--	50	50	**100**	6
4	ELC	MTDCS 304	Seminar II	--	--	--	--	--	50	50	**100**	2
5	ELC	MTDCP305	Project I	--	--	4	--	--	50	50	**100**	6
			Total	**6**	**02**	**4**	**40**	**120**	**190**	**150**	**500**	20

Fourth Semester

Sr. No	Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme					Credit
				L	T	P	MSE	ESE	IA	OR/ PR	Total	
5	ELC	MTDCP401	Project - II	--	--	--	--	--	100	100	**200**	20
			Total	--	--	--	--	--	**100**	**100**	**200**	20
			Grand Total								**2000**	

***** PG Lab-I and PG Lab-II – Practical shall be based on courses of the respective semester.

Abbreviations: PCC (Program Core Course), PEC (Program Elective Course), ELC (Experiential Learning Courses), OE (Open Elective), AEC (Ability Enhancement Courses), VEC (Value Education Courses), IKS (Indian Knowledge System), MDM (Multidisciplinary Minor), INP (Internship)

Credit Distribution				
SEM-I	**SEM-II**	**SEM-III**	**SEM-IV**	**Total**
22	**22**	**20**	**20**	**84**

Elective – I

A) Smart Antennas for 5G communications
B) Radiation and Microwave Techniques
C) Mobile Communication
D) Software Defined Radio
E) Advanced Wireless Communication

Elective - II

A) Digital Communication Techniques
B) Advanced Computer Networks
C) Mobile Handset Design
D) Advanced Digital Signal Processing
E) Optical Communication and Network

Elective – III

A) Advanced Satellite Communication
B) Multi-rate Signal Processing
C) Embedded System Design
D) Estimation and Detection Techniques
E) Wireless Networks

Open Elective – I

A) Advanced Biomedical Signal Processing
B) Audio and Speech Processing
C) Cryptography & Network Security
D) Electromagnetics, Antenna and Propagation
E) Optimization Techniques

Open Elective – II

A) Entrepreneurship
B) Environment and Development
C) Student Psychology
D) Principles Of Economics
E) Business To Business Marketing (B2B)

Multidisciplinary Minor

A) Design Of Mechatronic Systems
B) Sustainable Power Generation Systems
C) Ethical Hacking
D) Artificial Intelligence and Machine Learning
E) Components And Applications of the Internet of Things

Indian Knowledge System (IKS)

A) Indian Knowledge System (IKS): Concepts and Applications in Engineering
B) Indian Knowledge System(IKS): Humanities and Social Sciences

5G TECHNOLOGY 1

Weekly Teaching Hours	**TH: 03**	**Tu: 01**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Course Objectives:

1. This course aims to let the students understand that air Interface is one of the most important elements differentiating between 2G, 3G, 4G, and 5G. While 3G was CDMA-based, 4G was OFDMA-based.
2. This course reveals the contents of the air interface for 5G. While 4G brought in a deluge of infotainment services, 5G aims to provide meager delay services, great service in the crowd, enhanced mobile broadband (virtual reality being made real), ultra-reliable and secure connectivity, ubiquitous QoS, and highly energy-efficient networks.

Course Outcomes:

1. Learn 5G Technology advances and their benefits
2. Learn the key RF, PHY, MAC, and air interface changes required to support 5G
3. Learn Device to device communication and millimeter wave communication
4. Implementation options for 5G

UNIT I

Overview of 5G Broadband Wireless Communications: Evaluation of mobile technologies 1G to 4G (LTE, LTEA, LTEA Pro), An Overview of 5G requirements, Regulations for 5G, Spectrum Analysis and Sharing for 5G.

UNIT II

The 5G wireless Propagation Channels: Channel modeling requirements, propagation scenarios and challenges in the 5G modeling, Channel Models for millimeter Wave MIMO Systems.

UNIT III

Transmission and Design Techniques for 5G: Basic requirements of transmission over 5G, Modulation Techniques – Orthogonal frequency division multiplexing (OFDM), generalized frequency division multiplexing (GFDM), filter bank multi-carriers (FBMC) and universal filtered multi-carrier (UFMC), Multiple Accesses Techniques – orthogonal frequency division multiple accesses (OFDMA), generalized frequency division multiple accesses (GFDMA), non-orthogonal multiple accesses (NOMA).

UNIT IV

Device-to-device (D2D) and machine-to-machine (M2M) type communications – Extension of 4G D2D

standardization to 5G, radio resource management for mobile broadband D2D, multi-hop and multi-operator D2D communications.

UNIT V

Millimeter-wave Communications – spectrum regulations, deployment scenarios, beam forming, physical layer techniques, interference and mobility management, Massive MIMO propagation channel models, Channel Estimation in Massive MIMO, Massive MIMO with Imperfect CSI, Multi-Cell Massive MIMO, Pilot Contamination, Spatial Modulation (SM).

Textbooks / References:

1. Martin Sauter ―From GSM to GSM to LTE–Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband‖, Wiley-Blackwell.
2. Afif Osseiran, Jose.F.Monserrat, Patrick Marsch, ―Fundamentals of 5G Mobile Networks‖, Cambridge University Press.
3. Athanasios G.Kanatos, Konstantina S.Nikita, Panagiotis Mathiopoulos, ―New Directions in Wireless Communication Systems from Mobile to 5G‖, CRC Press.
4. Theodore S.Rappaport, Robert W.Heath, Robert C.Danials, James N.Murdock ―Millimeter Wave Wireless Communications‖, Prentice Hall Communications.
5. Jonathan Rodriguez, ―Fundamentals of 5G Mobile Networks‖, John Wiley & Sons.
6. Amitabha Ghosh and Rapeepat Ratasuk ―Essentials of LTE and LTE-A‖, Cambridge University Press.

SIGNAL THEORY

Weekly Teaching Hours	**TH: 03**	**Tu: 01**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA: 20**	**Total: 100**

Course Objectives:

1. To provide an in-depth understanding of the random nature of a signal using probability and random experiments.
2. To prepare the mathematical background for communication signal analysis.
3. To provide an in-depth understanding of random processes.

Course Outcomes:

1. Learners will be able to apply knowledge of basic probability theory.
2. Learners will be able to understand the concept of Random Variables.
3. Learners will be able to estimate different aspects of Random Variable like Mean,
4. Variance, Moments, distribution function, density function etc.
5. Learners will be able to distinguish multiple Random variables and their properties.
6. Learners will be able to hypothesize the nature of different Random Processes.
7. Learners can adapt basic estimation concepts on multiple and repeated data measurements.

UNIT I

Probability

The meaning of probability, the axioms of probability, and repeated trials.

UNIT II

The Concept of a Random Variable

Introduction, Distribution and density functions, Specific random variables, Conditional distributions, asymptotic approximations for Binomial random variables.

UNIT III

Functions of One Random Variable

The Random Variable g(X), The Distribution of g(X), Mean and variance, Moments, and Characteristic functions.

UNIT IV

Two Random Variables

Bi-variable distribution, One function of two random variables, Two functions of two random variables,

Joint moments, Joint characteristic functions, Conditional distributions, Conditional expected values.

UNIT V

Sequences of Random variables

General concepts conditional densities, Characteristic functions and normality, Mean square estimation stochastic convergence and limit theorem, Random Numbers: Meaning and Generation.

UNIT VI

Stochastic Processes

Introduction, Estimation, Parameter Estimation, Hypothesis Testing General concept, Random walks and other applications, Spectral representation and estimation, Mean square estimation, Markov chains.

Text Books/Reference:

1. Papoulis, S. Pillai, Probability, Random Variables and Stochastic Processes, Tata McGraw Hill
2. T Veerajan, Probability, Statistics and Random Processes
3. R.P.Singh, S.D. Sapre, Communication Systems, Analog &Digital
4. B.P.Lathi, Modern Digital and Analog Communication Systems, Third Ed

ADVANCED DIGITAL COMMUNICATION

Weekly Teaching Hours	**TH: 03**	**Tu: 01**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA: 20**	**Total: 100**

Course Objectives:

1. To provide an in-depth understanding of different techniques in modern digital Communications with applications for wireless transmission
2. To provide an in-depth understanding of mathematical modelling for problems in digital communication, and to explain how this is used to analyze and synthesize methods and algorithms within the field.

Course Outcomes:

1. Learners will be able to analyze different techniques in modern digital Communication.
2. Learners will be able to compare different techniques in digital communication and judge the applicability of different techniques in different situations
3. Learners will be able to formulate advanced mathematical models which are applicable and relevant in the case of a given problem
4. Learners will be able to use a mathematical model to solve a given demanding engineering problem in the digital communication field, and analyze the result and its validity.
5. Learners will be able to demonstrate time and frequency domain models for digital Communications systems with linear channels and additive noise

UNIT I

Introduction

Digital communication system (description of different modules of the block diagram), Complex baseband representation of signals, Gram-Schmidt orthogonalization procedure. M- ary orthogonal signals, bi-orthogonal signals, simplex signal waveforms.

UNIT II

Modulation

Pulse amplitude modulation (binary and M-ary, QAM), Pulse position modulation (binary and M-ary), Carrier modulation (M-ary ASK, PSK, FSK, DPSK), Continuous phase Modulation (QPSK and variants, MSK, GMSK).

UNIT III

Receiver in additive white Gaussian noise channels

Coherent and noncoherent demodulation: Matched filter, Correlator demodulator, square-law, and envelope detection; Detector: Optimum rule for ML and MAP detection Performance: Bit- error-rate, symbol error rate for coherent and noncoherent schemes.

UNIT IV

Band-limited channels

Pulse shape design for channels with ISI: Nyquist pulse, Partial response signaling (duobinary and modified duo binary pulses), demodulation; Channel with distortion: Design of transmitting and receiving filters for a known channel and for time varying channel (equalization); Performance: Symbol by symbol detection and BER, symbol and sequence detection, Viterbi algorithm.

UNIT V

Synchronization

Different synchronization techniques (Early-Late Gate, MMSE, ML and spectral line methods).

UNIT VI

Communication over fading channels

Characteristics of fading channels, Rayleigh and Rician channels, receiver performance- average SNR, outage probability, amount of fading and average bit/symbol error rate.

TEXTBOOKS:

1. J. G. Proakis and M. Salehi, Fundamentals of Communication Systems, Pearson Education, 2005.
2. S. Haykins, Communication Systems, 5th ed., John wiley, 2008.
3. M. K. Simon, S. M. Hinedi and W. C. Lindsey, Digital Communication Techniques: Signaling and detection, Prentice Hall India, N. Delhi, 1995.
4. W. Tomasi, Advanced Electronic Communication Systems, 4th Ed., Pearson Education, 1998.
5. M. K. Simon and M. S. Alumni, Digital Communication over Fading Channels, 2000.

MOOC / e-resources:

1. MIT podcasts by world-renowned Prof Gallager: https://podcasts.apple.com/us/podcast/principles-of-digital-communications-i/id341597796

NPTEL course by IIT Kharagpur and IIT Delhi:

1. https://nptel.ac.in/courses/117/105/117105144/

2. https://nptel.ac.in/courses/108/102/108102120

ELECTIVE-I

SMART ANTENNAS FOR 5G COMMUNICATIONS

Weekly Teaching Hours	**TH: 03**	**Tu: 01**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Course Objectives:

1. Comprehend Smart Antenna Fundamentals: Understand the core principles of smart antennas, including beam forming and MIMO, and their relevance in 5G networks.
2. Design and Optimize 5G Antenna Systems: Develop and optimize smart antenna systems, accounting for factors like interference mitigation and power efficiency.
3. Analyse 5G Smart Antenna Performances: Evaluate smart antenna performance metrics like SNR, SINR, and capacity enhancements in 5G scenarios.
4. Implement Smart Antenna Algorithms: Apply practical knowledge to implement smart antenna algorithms and protocols for improved 5G network performance.

Course Outcomes:

1. To Familiarize with smart and adaptive antennas.
2. Apply different adaptive algorithms for 5G antenna.
3. Understanding the concept of direction of arrival and angle of arrival
4. Design of antenna array architectures to meet 5G requirements.

UNIT I

5G Concepts

5G Objectives and Usage Scenarios, 5G Activities, Channel Access Method/Air Interface, 5G Policy, 5G Timelines, 4G/5G Radio Access Network, 5G system concept, LTE-Advanced, LTE-Advanced Pro, 5G NR, The 5G architecture, Spectrum Analysis and Regulations for 5G

UNIT II

Introduction to smart antenna

Introduction to Smart Antennas, Architecture of a Smart Antenna System: Transmitter and Receiver, Types of Smart Antennas, Benefits and Drawbacks of Smart Antennas, Applications of Smart Antennas.

UNIT III

Smart Antenna Configurations

Fixed Side lobe Canceling, Retro directive Arrays, Beamforming, Adaptive Arrays, Butler Matrix, Spatial Filtering with Beam formers, Switched Beam Systems, and Multiple Fixed Beam Systems. Uplink Processing, Diversity Techniques, Angle Diversity, Maximum Ratio Combining, Adaptive Beam forming, Fixed Multiple Beams versus Adaptive Beamforming, and Downlink Processing.

UNIT IV

Angle-of-Arrival Estimation

Fundamentals of Matrix Algebra, Array Correlation Matrix, AOA Estimation Methods: Bartlett AOA Estimate, Capon AOA Estimate, Linear Prediction AOA Estimate, Maximum Entropy AOA Estimate, Pisarenko Harmonic Decomposition AOA Estimate, Min-Norm AOA Estimate, MUSIC AOA Estimate, ESPRIT AOA Estimate.

UNIT V

MIMO Antennas

Introduction, Multiple-Antenna MS Design, RAKE Receiver Size, Mutual Coupling Effects, Dual-Antenna Performance Improvements, Downlink Capacity Gains, Principles of MIMO systems: SISO, SIMO, MISO, MIMO, Hybrid antenna array for mm-Wave massive MIMO: Massive Hybrid Array Architectures, Hardware Design for Analog Sub array.

References/Text Books:

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

ELECTIVE-I

RADIATION AND MICROWAVE TECHNIQUES

Weekly Teaching Hours	**TH: 03**	**Tu: 01**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA: 20**	**Total: 100**

Course Objectives:

1. To provide an insight into various aspects of the RF, microwave
2. To expose learners to the new emerging topics in the field of RF involving the methodologies adopted for various applications
3. To provide a brief theoretical foundation of Transmission line, RF, and microwave techniques

Course Outcomes:

1. Learner will be able to analyse EM Transmission characteristics of waveguide.
2. Learners will be able to analyse Transmission line circuits at microwave frequency.
3. Learners will be able to demonstrate the use of the Smith chart for solving transmission line problems.
4. Learners will be able to analyse various microstrip line integrated networks and their parameters
5. Learner will be able to formulate microwave communication systems such as satellite and microwave

   antennas
6. Learners will be able to demonstrate different applications of RF and Microwave.

UNIT I

Review of EM Theory

Introduction, Maxwell‘s equations, Wave equations, TEM/TE/TM/HE Wave definitions.

UNIT II

Microwaves

Introduction to microwaves, Microwave transmission lines, Smith chart and its applications at microwaves, Microwave measurements.

UNIT III

Microstrip lines and Antennas

Microstrip Lines: Types of microstrip lines, microwave components using strip lines, Methods of analysis, Design considerations, and Microstrip arrays. Microstrip Antennas: Principle of operation, Methods of analysis, feeding techniques, Polarization, Design considerations.

UNIT IV

Microwave Elements

Microwave integrated circuits, Active and passive microwave elements.

UNIT V

Microwave Communication Systems

Introduction, Analog and digital microwave communication systems, Satellite communication, Microwave antennas

UNIT VI

Radar

Introduction, Classifications, Radar range equation, Modulators, Displays, Scanning and tracking, Doppler Effect, Blind speeds, FMCW radars, and radar antennas.

Textbooks / References:

1. Guro, Hijiroglu, Electromagnetic Field Theory fundamentals; Thomson Publication, 2nd Edition, 2005.
2. Annapurna Das, Sisir Das; Microwave Engineering; TMH Publication, 2009.
3. M. Kulkarni, Microwave and Radar Engineering; Umesh Publications, 5th Edition, 2016.

ELECTIVE- I

MOBILE COMMUNICATION

Weekly Teaching Hours	**TH: 03**	**Tu: 01**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Course Objectives:

1. To provide an in-depth understanding of cellular radio concepts such as frequency reuse, handoff and how interference between mobiles and base stations affects the capacity of cellular systems.
2. To provide in-depth understanding of how to measure and model the impact that signal bandwidth and motion have on the instantaneous received signal through the multipath channel.
3. To provide an in-depth understanding of theoretical aspects (such as the capacity) of wireless channels and basic spread spectrum techniques in mobile wireless systems
4. To provide an in-depth understanding of current and future cellular mobile communication systems.

Course Outcomes:

1. Learners will be able to analyze the concept of a basic cellular mobile system
2. Learners will be able to analyze multipath fading channels.
3. Learners will be able to distinguish types of fading channels with the concept of coherence time
4. Learners will be able to demonstrate the multiple access techniques.
5. Learners will be able to analyze diversity in multipath channels
6. Learners will be able to understand the various standards involved in the evolution of the communication system

UNIT I

Cellular concepts: Cell structure, frequency reuse, cell splitting, channel assignment, handoff, Interference, capacity, power control; Wireless Standards: Overview of 2G and 3Gcellular standards. Signal propagation: Propagation mechanism reflection, refraction, diffraction and scattering, large-scale signal propagation and lognormal shadowing.

UNIT II

Fading channels: multipath and small scale fading-Doppler shift, statistical multipath channel models, narrowband and wideband fading models, power delay profile, average and RMS delay spread

UNIT III

Coherence bandwidth and coherence time, flat and frequency selective fading, slow and fast fading, average fade duration and level crossing rate. Capacity of flat and frequency selective channels.

UNIT IV

Antennas: antennas for mobile terminal- monopole antennas, PIFA, base station antennas and array, Multiple access schemes: FDMA, TDMA, CDMA and SDMA. Modulation schemes: BPSK, QPSK and variants, QAM, MSK and GMSK, multicarrier modulation, OFDM.

UNIT V

Receiver structure: diversity receivers- selection and MRC receivers, RAKE receiver, equalization: linear-ZFE and adaptive, DFE. Transmit diversity-Alamouti scheme. MIMO and space-time signal processing, spatial multiplexing, diversity/multiplexing tradeoff.

UNIT VI

Performance measures: outage, average SNR, average symbol/bit error rate. System examples: GSM, EDGE, GPRS, IS-95, CDMA2000 and WCDMA.

Text Books/Reference:

1. Andrea Goldsmith, Wireless Communications, Cambridge University Press, 2005.

2. T.S. Rappaport, Wireless digital communications: Principles and practice, 2ndEd., Prentice Hall India, 2007.

3. W. C. Y. Lee, Wireless and cellular telecommunications, 3rd Ed., MGH, 2006.

4. G. L. Stuber, Principles of mobile communications, 2nd Ed., Springer, 2007.

5. Simon Haykin and Michael Moher, Modern Wireless Communication, Pearson Education,

ELECTIVE – I
SOFTWARE-DEFINED RADIO

Weekly Teaching Hours	**TH: 03**	**Tu: 01**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Course Objectives:

1. Understand the principles of Software Defined Radio (SDR) technology, including signal processing and modulation techniques.
2. Gain hands-on experience in designing and implementing SDR systems for wireless communication applications.
3. Explore advanced SDR topics such as spectrum sensing, cognitive radio, and security in SDR networks.
4. Analyze the impact of SDR on current and future communication systems, including its role in 5G and beyond.

Course Outcomes:

1. Understand the principles of Software Defined Radio.
2. Choose appropriate digital signals for RF signal processing/ implementation.
3. Apply Digital Signal Synthesis for Generation and Implementation
4. Analyse RF Signals and digital systems.

UNIT I

Introduction to Software Radio: The Need for Software Radios, What Is a Software Radio, Characteristics and Benefits of a Software Radio, Design Principles of a Software Radio.

UNIT II

Radio Frequency Implementation Issues: The Purpose of the RF Front-End, Dynamic Range: The Principal Challenge of Receiver Design, RF Receiver Front-End Topologies, Enhanced Flexibility of the RF Chain with Software Radios, Importance of the Components to Overall Performance, Transmitter Architectures and Their Issues.

UNIT III

Multi-rate Signal Processing: Introduction, Sample Rate Conversion Principles, Polyphone Filters, Digital Filter Banks, Timing Recovery in Digital Receivers Using Multi-rate Digital Filters.

UNIT IV

Digital Generation of Signals: Introduction, Comparison of Direct Digital Synthesis with Analog Signal Synthesis, Approaches to Direct Digital Synthesis, Analysis of Spurious Signals, Spurious Components due to Periodic Jitter, Band pass Signal Generation

UNIT V

Digital Hardware Choices: Introduction, Key Hardware Elements, DSP Processors.

References/Text Book(s)

1. Effrey H.Reed, ―Software Radio: A Modern Approach to Radio Engineering‖ Reprint by Pearson Education & Inc 2002.

2. Joseph Mitola, III, Software Radio Architecture: Object Oriented Approaches to Wireless Systems Engineering, John Wiley and Sons, 2000.

3. Markus Dillinger, K.Madani and N. Alonistioti, Soft Defined Radio, 1st Ed., Wiley.

ELECTIVE- I

ADVANCED WIRELESS COMMUNICATION

Weekly Teaching Hours	**TH: 03**	**Tu: 01**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Course Objective

1. To learn the fundamentals and advanced concepts in wireless communication.
2. Analyze and design wireless communication systems for a variety of applications
3. Select and implement appropriate wireless communication technologies to meet specific requirements

Course Outcomes

1. Review the fundamentals of wireless communication.
2. Compare the performance of different digital modulation techniques over wireless channels.
3. Design OFDM system and data transmission through multicarrier modulation.
4. Describe the OFDMA system, its operation and its applications.

UNIT I

Review of Fundamentals of Wireless Communication: Multipath fading, multipath channel models, and capacity of wireless channels.

UNIT II

Performances of Digital Modulation over Wireless Channels: AGWN channels signal to noise power ratio and bit/symbol energy, error probability for BPSK, QPSK, MPSK, MPAM, MQAM- their comparison.

UNIT III

Multicarrier Modulation: Data transmission using multiple carriers, multicarrier modulation with overlapping sub-channels, mitigation of subcarrier fading, discrete implementation of multicarrier modulation, challenges in multicarrier systems.

UNIT IV

Introduction to Wireless OFDM: OFDM principles, system model, generation of sub-carrier using IFFT, guard time, cyclic extension, windowing, OFDM parameters, OFDM signal processing, coherent and differential detection

UNIT V

OFDMA: frequency hopping in OFDMA, difference between OFDMA and MC-CDMA, OFDMA system description-channel coding, frequency synchronization, initial modulation timing and frequency offset synchronization accuracy, random frequency hopping operation, applications of OFDMA.

References/Textbooks

1. Goldsmith, Wireless Communications, Cambridge Univ. Press, 2005
2. R. Vannee, R. Prasad, OFDM for Wireless Multimedia Communication, Artech House, 2000
3. M. Engels, Wireless OFDM systems, Klumer Academic Publishers, 2002

ELECTIVE – II

DIGITAL COMMUNICATION TECHNIQUES

Weekly Teaching Hours	**TH: 03**	**Tu: 01**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Course Objectives:

1. To know the principles of sampling & quantization
2. To study the various waveform coding schemes
3. To learn the various baseband transmission schemes
4. To understand the various band-pass signalling schemes
5. To know the fundamentals of channel coding

Course Outcomes:

Upon completion of the course, the student should be able to

1. Design of the PCM systems
2. Design and implement base-band transmission schemes
3. Design and implement band pass signalling schemes
4. Analyse the spectral characteristics of band-pass signalling schemes and their noise performance
5. Design error control coding schemes

UNIT I

Base Band Modulation

Base band system, sampling theorem, Sampling and signal reconstruction, Aliasing, Types of sampling, Quantization, PCM, Companding, DPCM, ADPCM, Delta modulation, Adaptive delta modulation, T1 carrier system.

UNIT II

Digital Data Transmission

Components of digital communication system, line coding, pulse shaping, Scrambling, Regenerative Repeater, Eye Diagram, Timing Extraction, Detection Error Probability, M-ary communication, Digital Carrier Systems

UNIT III

Digital Modulation Techniques

Modulation techniques for ASK, QASK, FSK, M-ary FSK, BPSK, DPSK, DEPSK, QPSK, M-ary PSK, QAM, MSK, GMSK

UNIT IV

Probability Theory and Random Variable

Concept of probability, Conditional probability and independent event, random variable, types of random variable, CDF, PDF, Statistical Averages, Chebyshev‘s inequality, Central limit theorem, Concept of correlation.

UNIT V

Information Theory

Measure of information, Entropy, Source encoding, Error free communication over noisy channel, channel capacity of discrete memory less channel, Channel capacity of continuous channel, Practical communication system in lights of Shannon theorem

Reference Books/Text Books:

1. Modern Digital and Analog Communication Systems, B. P. Lathi, (3rd Edition), Oxford Publication
2. Principles of Communication Systems, Taub & Schilling, (2nd Edition), Tata McGraw Hill Publication
3. S. Haykin, Communication systems, John Wiley 2001
4. Bhattacharya Amitabh, "Digital Communication", Tata McGraw-Hill, 1st Ed., 2006.

ELECTIVE – II

ADVANCED COMPUTER NETWORKS

Weekly Teaching Hours	**TH: 03**	**Tu: 01**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Course Objectives

This course is aimed at enabling the students to

1. Gain core knowledge of Network layer routing protocols and IP addressing.
2. Study Session layer design issues, Transport layer services, and protocols.
3. Acquire knowledge of Application layer and Presentation layer paradigms and protocols.
4. Provide the mathematical background of routing protocols.
5. To develop some familiarity with current research problems and research methods in advanced computer networks.
6.

Course Outcomes

After the completion of the course, students will be able to

1. Illustrate reference models with layers, protocols and interfaces
2. Describe the routing algorithms, Sub netting and Addressing of IP and IPV6
3. Describe and Analysis of basic protocols of computer networks, and how they can be used to assist in network design and implementation
4. Describe the concepts of Wireless LANS, WIMAX, IEEE 802.11, Cellular telephony and Satellite networks

UNIT I

Network layer: Network Layer Services, Packet Switching, Performance, provided transport layers, implementation connectionless services, implementation connection-oriented services, comparison of virtual–circuit and datagram subnets.IPV4 Address, Forwarding of IP Packets, Internet Protocol, ICMP v4, Mobile IP

UNIT II

Routing Algorithms– Distance Vector routing, Link State Routing, Path Vector Routing,

Unicast Routing Protocol- Internet Structure, Routing Information Protocol, Open Source Path First, Border Gateway Protocol V4, Broadcast routing, Multicasting routing, Multicasting Basics, Intra domain Multicast Protocols, IGMP.

UNIT III

IPv6 Addressing, IPv6 Protocol, Transition from IPv4 to IPv6.Transport Layer Services, connectionless versus connection-oriented protocols. Transport Layer Protocols: Simple Protocol, Stop and Wait, Go-Back-N, Selective repeat, Piggy Backing. UDP: User datagram, Services, Applications. TCP: TCP services, TCP features, segments, A TCP connection, Flow control, error control, congestion control.

UNIT IV

SCTP: SCTP services SCTP features, packet format, An SCTP association, flow control, and error control. QUALITY OF SERVICE: flow characteristics, flow control to improve QOS: scheduling, traffic shaping, resource reservation, admission control.

UNIT V

WWW and HTTP, FTP, Telnet, Domain name system, SNMP, Multimedia data, Multimedia on the Internet.

References/Text Book(s)

1. Data Communication and Networking, Behrouz A. Forouzan, McGraw Hill, 5th Edition
2. Computer Networks, Andrew S. Tanenbaum, David J. Wetherall, Pearson Education India; 5 editions, 2013.
3. Computer Networks: A Systems Approach, LL Peterson, BS Davie, Morgan-Kauffman, 5th Edition, 2011.
4. Computer Networking: A Top-Down Approach JF Kurose, KW Ross, Addison-Wesley, 5th Edition, 2009.

ELECTIVE – II
MOBILE HANDSET DESIGN

Weekly Teaching Hours	**TH: 03**	**Tu: 01**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Course Objectives:

1. Understand the basic architecture and components of a mobile handset.
2. Explain the operation of the various subsystems in a mobile handset, such as the radio frequency (RF) subsystem, baseband subsystem, and power management subsystem.
3. Identify and analyse the key design considerations for mobile handsets.
4. Apply the principles of mobile handset design to solve real-world problems.

Course Outcomes:

1. Students will be able to explain the basic concepts of mobile handset design.
2. Students will be able to design and implement mobile handset subsystems.
3. Students will be able to apply mobile handset design principles to solve real-world problems.
4. Students will be able to evaluate the performance of mobile handsets.

UNIT I

Introduction to Telecommunication: Basic Elements of Telecommunication. Introduction to Wireless Telecommunication Systems: Generation of Electromagnetic Carrier Waves for Wireless Communication, Concept of the Antenna, Basic Building Blocks of a Wireless Transmitter and Receiver, the Need for a Communication Protocol.

UNIT II

Evolution of Wireless Communication Systems: Introduction of Low Mobility Supported Wireless Phones, Introduction to Cellular Mobile Communication, Introduction to Mobile Handsets. Introduction to Wireless Channels: Impact of Signal Propagation on Radio Channel, Reflection, Diffraction, Scattering, Signal Attenuation and Path Loss, Empirical Model for Path Loss.

UNIT III

Link Budget Analysis, Multipath Effect: Two Ray Ground Reflection Model, Delay Spread, Coherent BW (Bc), Doppler Spread: Coherence Time (Tc), Fading: Large-Scale Fading, Small-Scale Fading, Flat Fading, Frequency-Selective Fading, Fast Fading, Slow Fading.

UNIT IV

Signal Fading Statistics: Rician Distribution, Rayleigh Distribution, Log-Normal Distribution, Interference: Inter-Symbol Interference, Co-Channel Interference, Adjacent Channel Interference, Noise: Noise in a Two-Port Circuit, Thermal Noise, White Noise, Flicker Noise, Phase Noise, Burst Noise, Shot Noise, Avalanche Noise, Noise Figure (NF).

UNIT V

Diversity: Time Diversity, Frequency Diversity, Space Diversity, Channel Estimation and Equalization: Study of Channel Characteristics – Channel Estimation, Equalization, Equalizer Implementation, Signal Model, Types of Equalizers, Different Techniques for Interference Mitigation: Frequency Hopping, Discontinuous Transmission (DTX), Cell Sectorization, Use of Adaptive Multi-Rate (AMR) Codec, MIMO.

References/Text Books

1. Mobile Handset Design, Sajal Kumar Das, John Wiley & Sons, 29-May-2013
2. Mobile Phone Systems Engineering by William C.Y. Lee (2nd Edition, 2007)
3. Mobile Handset Design by Nigel S. Smith (3rd Edition, 2012)
4. Mobile Phone Design by Alan Bensky (2nd Edition, 2014)

ELECTIVE – III
ADVANCED DIGITAL SIGNAL PROCESSING

Weekly Teaching Hours	**TH: 03**	**Tu: 01**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Course Objectives:

1. To provide students with a deep understanding of the theory and practice of advanced digital signal processing techniques.
2. To develop students' ability to design and implement efficient and effective digital signal processing algorithms.
3. To prepare students to apply advanced digital signal processing techniques to solve real-world problems.
4. To develop students' critical thinking and problem-solving skills in the context of advanced digital signal processing.

Course Outcomes:

1. Explain the fundamental concepts of advanced digital signal processing techniques, such as multi-rate signal processing, adaptive filtering, and wavelet analysis.
2. Design and implement efficient and effective digital signal processing algorithms for a variety of applications.
3. Apply advanced digital signal processing techniques to solve real-world problems in areas such as audio processing, image processing, and communication systems.
4. Critically analyze and evaluate digital signal processing algorithms and systems.

UNIT I

Multi-rate Digital Signal Processing Introduction, Decimation by a Factor D, Interpolation by a Factor I, Sampling Rate Conversion by a Rational Factor I/D, Filter Design and Implementation for sampling rate Conversion

UNIT II

Multi-rate Digital Signal Processing Multistage Implementation of Sampling Rate Conversion, Applications of Multi-rate Signal Processing, Sampling Rate Conversion of Band-pass Signals

UNIT III

Linear Prediction And Optimum Linear Filters: Innovations Representation of a Stationary Random Process, Forward and Backward linear prediction, Solution of the Normal Equations, Properties of linear prediction-Error Filter, AR Lattice and ARMA Lattice-Ladder Filters.

UNIT IV

Power Special Estimation: Estimation of Spectra from Finite Duration Observations of a signal, the Periodogram, Use DFT in power Spectral Estimation, Bartlett, Welch and Blackman, Tukey methods, Comparison of performance of Non-Parametric Power Spectrum Estimation Methods

UNIT V

Parametric Method Of Power Spectrum Estimation: Parametric Methods for power spectrum estimation, Relationship between Auto-Correlation and Model Parameters, AR (Auto-Regressive) Process and Linear Prediction, Yule-Walker, Burg and Unconstructrained Least Squares Methods, Sequential Estimation, Moving Average(MA) and ARMA Models Minimum Variance Method, Piscaranko‘s Harmonic Decomposition Methods, MUSIC Method.

References/Text Books

1. Proakis JG and Manolakis DG Digital Signal Processing Principles, Algorithms Application, PHI.
2. Oppenheim AV & Schafer RW, Discrete Time Signal Processing PHI.
3. Samuel D Stearns, ―Digital Signal Processing with examples in Matlab. ― CRC Press.
4. ES Gopi. ―Algorithm Collections for Digital Signal Processing Applications using Matlab, ―Springer.
5. Taan S.Elali, ―Discrete Systems and Digital Signal Processing with Matlab, ―CRC Press, 2005.

ELECTIVE – II

OPTICAL COMMUNICATION AND NETWORK

Weekly Teaching Hours	**TH: 03**	**Tu: 01**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Prerequisites: Sound knowledge of basic optics, optical communication, Electromagnetic Fields and waves

Course Outcomes:

1. To gain knowledge on the design of the latest generation of transmission systems and networks, and the factors limiting the system performance
2. Ability to execute a group study of one advanced topic in Optical communication (through IEEE journal papers) prepare technical documentation and present the same.
3. To gain knowledge of the free space optics engineering PO 3

UNIT 1

Transmission System Engineering: system model, power penalty, Transmitter, Receiver, Optical amplifiers, cross talk, dispersion, fibre nonlinearities, wavelength stabilization, Overall Design considerations.

UNIT 2

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

UNIT 3

WDM Network Elements: Optical line terminal optical line amplifiers, optical cross connectors, WDM network design, cost tradeoffs, LTD and RWA problems, Routing and wavelength assignment, Introduction to DWDM & CWDM

UNIT 4

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

UNIT 5

Fundamentals of FSO Technology: Introduction, Fiber Vs FSO, The Role of FSO in the Network, How FSO Works: An Overview (Block Diagram), factors affecting FSO, Integration of FSO in Optical Networks, Benefits of Next-Generation Optical Networking, Classifying the Global Optical Network, Driving FSO from the Edge, FSO in Metropolitan Optical Networks

TEXTBOOKS:

1. Rajiv Ramswami, N Sivaranjan, Galen H Sasaki, "Optical Networks – A Practical Perspective", 3rd Edition, M. Kaufmann Publishers.
2. John M. Senior, "Optical Fiber Communications", Pearson edition, 2000.
3. Gerd Keiser, "Optical Fiber Communication", MGH, 2008.
4. Heinz, PhD. Willebrand, "Free Space Optics," Sam's, 1st Ed., 2001.

SEMINAR I

Weekly Teaching Hours	**TH: --**	**PR = 4 Hr**	**Credit = 2**	
Scheme of Marking	**TH: --**	**OR/PR = 25**	**IA : 25**	**Total: 50**

The seminar shall be on the state of the art in the area of wireless communication and computing and of the student‘s choice approved by an authority. The student shall submit the duly certified seminar report in standard format, for satisfactory completion of the work duly signed by the concerned guide and head of the Department/Institute.

PG LAB I

Weekly Teaching Hours	**TH: --**	**PR = 4 Hr**	**Credit = 2**	
Scheme of Marking	**TH: --**	**OR/PR = 25**	**IA : 25**	**Total: 50**

Practicals of the Lab - I shall be based on the courses of first semester. The lab work shall consist of hands-on experiments on the different software and hardware platforms related to the syllabus.

YOGA FOR STRESS MANAGEMENT

Weekly Teaching Hours	**TH: 2 Hr.**	**TU = --**		
Scheme of Marking	**PR = 04**	**--**	**IA = --**	**AUDIT**

Course Objectives:

1. Understand the physiological and psychological aspects of stress and its impact on overall well-being.
2. Learn and practice specific yoga postures, breathing exercises, and relaxation techniques to alleviate stress.
3. Explore the connection between mindfulness, meditation, and stress reduction, fostering mental clarity.
4. Discover holistic practices that promote better sleep, nutrition, and overall lifestyle habits for stress management.
5. Develop practical skills to manage stress in daily life, enhancing resilience and promoting emotional balance.

Course Outcomes:

1. Recognize the signs and sources of stress, understanding its effects on mental and physical well-being.
2. Master a variety of yoga techniques, including postures, breathing, and meditation, to effectively manage stress.
3. Acquire relaxation strategies that promote calmness, reduce anxiety, and enhance overall mental clarity.
4. Incorporate healthy habits inspired by yoga principles to foster better sleep, nutrition, and self-care routines.
5. Develop practical skills to navigate and cope with stress, enhancing emotional balance and promoting a more harmonious life.

UNIT I

Introduction to Yoga for Stress Management –

1 Introduction to Yoga for Stress Management - 2 Stress according to Western perspective Stress Eastern Perspective Developmental process: Western and Eastern Perspective Stress Hazards and Yoga

UNIT II

Meeting the challenges of Stress - 1 Meeting the challenges of Stress - 2 Introduction to Stress Physiology Stress, Appetite and Dietary management- Modern and Yogic perspective Sleep and Stress: understanding the relationship for effective management of stress.

UNIT III

Stress Assessment methods- a valuable tool for stress management

Role of Yoga in prevention and management of stress-related disorders – a summary of research evidence. Concept of stress and its management - perspectives from Patanjali Yoga Sutra - Part 1 Concept of stress and its management - perspectives from Patanjali Yoga Sutra - Part 2 Concept of stress and its management - perspectives from Patanjali Yoga Sutra - Part 3

UNIT IV

Concept of stress and its management - perspectives from Bhagavad Gita - Part 1 Concept of stress and its management - perspectives from Bhagavad Gita - Part 2 Concept of stress and its management - perspectives from Bhagavad Gita - Part 3

UNIT V

Bio-Psycho-Socio-Spiritual model of stress management Yoga practices for Stress Management Breathing practices – 1

Hands in and out breathing, Hands stretch breathing, Ankle stretch breathing Breathing practices – 2. Dog Breathing, Rabbit breathing, Tiger breathing, Sashankasana breathing Breathing practices – 3. Bhujangasana breathing, Ardha Shalabhasana breathing (alternate legs), Straight leg raising (alternate legs), Straight leg raising (both legs), Sethubandhasana lumbar stretch, Instant Relaxation Technique (IRT). Loosening Practices – 1

Shoulder Rotation, Side bending, standing twist, Hip rotation, Thigh strengthening Loosening practices – 2. Chakki Chalan, Bhunamasana Chalana, Alternative toe touching Loosening practices – 3. Side leg raising, Pavana muktasana kriya: Wind releasing pose movements, Quick Relaxation Technique (QRT)

UNIT VI

Asana practices – 1

Tadasana, Ardhakati Chakrasana, Ardha Chakrasana, Trikonasana, Vrikshasana Asana practices – 2 Vakarasana, Janu Sirshasana, Ushtrasana, Sashankasana, Asana practices – 3

Ardhamatseyndrasana, Paschimottanasana, Poorvottanasana, Gomukhasana Asana practices – 4. Makarasana, Bhujangasana, Salambha Shalabahasana, Dhanurasana Asana practices – 5 Setubandhasana, Sarvangasana, Mastyasana, Deep Relaxation Technique (DRT) Soorya Namaskar. Pranayama – 1. Kapalbhati kriya and Sectional Breathing Pranayama – 2 Nadishuddhi Pranayama Pranayama – 3. Bhramari, Sheetali, Sitkari and Ujjayi Om Meditation Cyclic Meditation Integrated Yoga Module I Integrated Yoga Module II Integrated Yoga Module III

Textbooks / References:

1. H R Nagendra and R Nagarathna. Yoga for Promotion of Positive Health. Swami Vivekananda Yoga Prakashana. 2011.
2. Contrada, R., & Baum, A. (Eds.). The handbook of stress science: Biology, psychology, and health. Springer Publishing Company. 2010
3. Al'Absi, M. (Ed.). Stress and addiction: Biological and psychological mechanisms. Elsevier. 2011.
4. Van den Bergh, O. Principles, and practice of stress management. Guilford Publications. 2021.
5. Swami Muktibodhananda, Hatha Yoga Pradipika, Bihar Scool of Yoga, 1998
6. Swami Satyananda Saraswati, Four Chapters on Freedom, Bihar Scool of Yoga, 1975.
7. Swami Tapasyananda, Srimad Bhagavat Gita, Sri Ramakrishna Math, 2012

NPTEL PLATFORM:

NPTEL Course	Name of Instructor	Host Institute	Link
Yoga for Stress Management	Dr H R Nagendra, Dr Mithila M V, Dr Rajesh Nair	Swami Vivekananda Yoga Anusandhana Samsthana	https://onlinecourses.swayam2.ac.in/aic23_ge10/preview#:~:text=In%20this%20course%20we%20intend,meeting%20the%20challenges%20of%20stress

5G Technology – 2

Weekly Teaching Hours	**TH: 03**	**Tu: 01**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Course objectives:

1. Understand the fundamental principles of 5G technology and its key components.
2. Explore the applications and potential use cases of 5G networks across various industries.
3. Learn to design and implement 5G networks, considering factors like capacity, latency, and security.
4. Gain insights into the future developments and challenges of 5G technology and its evolution towards 6G.

Course Outcomes:

1. Understand 5G spectrum requirement, its channel model and use cases
2. Familiarize with 5G architecture options and physical layer concepts
3. Examine the multicarrier techniques and new waveform Options for 5G communication.
4. Appraise the current research avenues in 5G domain
5. Illustrate the concept of network slicing and V2V Communication
6. Interpret the Interference and Mobility management in 5G networks

UNIT I

5G Radio Spectrum: 5G spectrum landscape and requirements, Spectrum access modes and sharing scenarios, 5G spectrum technologies.

5G Channel Model: The 5G wireless Propagation Channels: Channel modeling requirements, propagation scenarios and challenges in the 5G modeling. 5G Use Cases and System Concept: Use cases and requirements, 5G system concept.

UNIT II

Radio Interface Architecture: 5G architecture options, core network architecture, RAN architecture. 5G Physical Layer: Physical channels and signals, 5G frame structure, physical layer procedures (MIMO, Power control, link adaptation, beam forming).

UNIT III

5g Radio-Access Technologies: Access design principles for multi-user communications, multi-carrier with filtering: a new waveform, non-orthogonal schemes for efficient multiple access.

UNIT IV

Introduction to 5g Network Slicing: Network Slicing, E2E Slicing, SDN and NFV Slicing. Vehicular Communications: From V2V to AV2X, key standards, VC architectures, and V2X Use cases.

UNIT V

Mobility and Handoff Management In 5G: Network deployment types, Interference management in 5G, Mobility management in 5G, Dynamic network reconfiguration in 5G.

Textbooks/ References:

1. Afif Osseiran, Jose F Monserrat, Patrick Marsch, ―5G Mobile and Wireless Communications Technology‖, Cambridge University Press, 2016
2. Saad Z. Asif, ―5G Mobile Communications Concepts and Technologies‖, CRC Press, Taylor & Francis Group, First Edition, 2018.
3. Harri Holma, Antti Toskala, Takehiro Nakamura, ―5G Technology 3GPP NEW RADIO‖, John Wiley & Sons First Edition,2020.
4. Gordon L. Stuber, ―Principles of Mobile Communication‖, KLUWER ACADEMIC PUBLISHERS, 2nd Edition, 2002
5. Joseph C Liberti, Theodore S. Rappaport, ―Smart Antennas for Wireless Communications‖, Prentice Hall PTR, 1999
6. Ying Zhang, ―Network Function Virtualization Concepts and Applicability in 5G Networks‖, John Wiley & Sons, 2018.

INFORMATION THEORY AND CODING

Weekly Teaching Hours	**TH: 03**	**Tu: 01**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Course Objectives:

1. To provide an in-depth understanding of principles and applications of information Theory.
2. To provide an in-depth understanding of how information is measured in terms of Probability and entropy and how these are used to calculate the capacity of a communication channel.
3. To provide an in-depth understanding of different coding techniques for error detection
   and correction.

Course Outcomes:

1. Learners will be able to formulate equations for entropy mutual information and channel capacity for all types of channels.
2. Learners will be able to distinguish between different types error correcting codes based on the probability of error
3. Learners will be able to design a digital communication system by selecting appropriate error-correcting codes for a particular application.
4. Learners will be able to explain various methods of generating and detecting different types of error-correcting codes
5. Learners will be able to formulate the basic equations of linear block codes.
6. Learners will be able to compare the performance of digital communication systems by evaluating the probability of error for different error-correcting codes

UNIT I

Theory of Probability and Random Processes

Concept of probability, Random variables, Probability models, Statistical averages, Central limit theorem, Correlation, Linear mean square estimation.

UNIT II

Random Processes

Random variable and random process, Power spectral density of a random process, Multiple

random processes, Transmission of random processes through linear systems, Band-pass random processes, Optimum filtering.

UNIT III

Noise in Communication Systems

The behaviour of analog and digital communication systems in the presence of noise, Sources of noise, Noise representation, Noise filtering, Noise bandwidth, and Performance of analog and digital communication systems in the presence of noise.

UNIT IV

Information Theory

Measure of information, Joint entropy and conditional entropy, Relative entropy and mutual information, Markov sources, Source encoding, Shannon-Fano coding and Huffman coding, Shannon's first and second fundamental theorems, and Channel capacity theorem.

UNIT V

Error Correcting Codes

Galois fields, Vector spaces and matrices, Block codes, Cyclic codes, Burst-error detecting and correcting codes, Multiple error correcting codes, Convolutional codes, ARQ, Performance of codes, Comparison of coded and un-coded systems.

UNIT VI

Speech Coding

Characteristics of speech signal, Quantization techniques, Frequency domain coding, Vocoders, Linear predictive coders, Codecs for mobile communication, GSM codec, USDC codec, Performance evaluation of speech coders.

Text Books/Reference:

1. Modern Digital and Analog Communication Systems; B. P. Lathi; Oxford Publication.
2. Principles of Digital Communication; Das, Mullick, Chatterjee; New Age International.
3. Principles of Communication Engineering (2^{nd} Edition); Taub, Schilling; TMH.
4. Elements of Information Theory; Thomas M. Cover, Joy A. Thomas; Wiley Inter-science.
5. Communication systems: Analog and Digital; R.P.Singh, S.D. Sapre; TMH.
6. Wireless Communication: Principles and Practice (2nd Edition); Theodore S. Rappaport; Pearson India.

ADVANCED SATELLITE COMMUNIATION

Weekly Teaching Hours	**TH: 03**	**Tu: 01**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Prerequisites: Basics of digital and satellite communication

Course Outcomes:

1. To explore the orbital mechanics, space craft subsystems, satellite link design, Satellite applications.
2. Analyze the technical details behind the satellite link and its real time application.
3. Ability to independently develop a solution to a defined practical problem.

UNIT 1

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

UNIT 2

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

UNIT 3

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

UNIT 4

Antennas for Satellite: Multi-beam antennas, On board beam switching.

UNIT 5

Applications of Satellite communication: Direct to Home, Intelsat, GSAT

TEXT BOOKS:

1. Timothy Pratt and Charles W. Bostain, “Satellite Communications”, 2nd Edition, Wiley, 2012.

2. D. Roddy, “Satellite Communication”, 4th Edition (Reprint), McGraw Hill, 2009.
3. Wilbur L. Pritchard, Hendri G. Suyderhoud and Robert A. Nelson, “Satellite Communication Systems Engineering”, Prentice Hall/ Pearson, 2007
4. Tri T. Ha, “Digital Satellite Communication”, 2nd Edition, McGraw Hill, 1990.
5. Brian Ackroyd, “World Satellite Communication and Earth Station Design”, BSP Professional Books, 1990.
6. Communication Satellites By Donald H. Martin
7. Satellite Communications Network Design and Analysis, By Kenneth Y. Jo

E-resources:

1. http://advancedengineering.umd.edu/node/2320
2. http://ece564web.groups.et.byu.net
3. http://personal.stevens.edu/~yyao/syllabus-674.html
4. http://staff.um.edu.mt/carl.debono/lectures.html

MULTI-RATE SIGNAL PEOCESSING

Weekly Teaching Hours	**TH: 03**	**Tu: 01**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Course Objectives:

1. To master the fundamentals of multi-rate signal processing and demonstrate the ability to solve problems in sample rate conversion, filter banks, and trans-multiplexers.

Course Outcomes:

1. Learners will be able to develop efficient realizations for up-sampling and down-sampling of signals using the poly-phase decomposition.
2. Learners will be able to design and implement Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) digital filters to meet specifications.
3. Learners will be able to design digital filter banks based on the techniques presented.
4. Learners will be able to analyze fundamental concepts of wavelets.
5. Learners will be able to distinguish between wavelets and multi-rate filter banks, from the point of view of implementation.

UNIT I

Fundamentals of Multi-rate Systems

Introduction, Basic multi-rate operations, Interconnection of building blocks, Polyphase representation, Multistage implementation, Some application of multi-rate systems, Special filter, and filter banks.

UNIT II

Maximally Decimated Filter Banks

Introduction, Errors created in the QMF bank, a simple alias-free QMF system, Power symmetric QMF banks, M-channel filter banks, Poly-phase representation, Perfect reconstruction system, alias-free filter banks, Tree-structured filter banks, Trans-multiplexer.

UNIT III

Paraunitary Perfect Reconstruction Filter Banks

Introduction, Lossless transfer matrices, Filter banks properties induced by paraunitariness, Two channel FIR paraunitary QMF banks, Two channel paraunitary QMF lattice, M - channel FIR para unitary filter banks, Transform coding and LOT.

UNIT IV

Linear Phase and Cosine Modulated Filter Banks

Introduction, Some necessary conditions, Lattice structure for linear phase FIR PR banks, formal synthesis of linear phase FIR PR QMF Lattice. Pseudo QMF banks, Design of the pseudo-QMF bank, Efficient polyphase structure, Cosine modulated perfect reconstruction system.

UNIT V

The Wavelet Transform and its Relation to Multi-rate Filter Banks

Introduction, Background and outline, Short time Fourier transform, The Wavelet transform, DT orthonormal Wavelets, Continuous-time orthonormal Wavelet basis.

UNIT VI

Multidimensional, Multivariable and Lossless Systems

Introduction, Multidimensional signals, Sampling a multidimensional Signals, Multi-rate fundamentals. Review of discrete-time multi-input multi-output LTI System, Paraunitary and lossless system.

Textbooks / References:

1. P.P.Vaidyanathan , Multirate System and Filter Banks, Pearson College Div; 1st edition (January 1, 1992)
2. N.J.Fliege, Multirate Digital Signal Processing, Wiley (January 13, 2000).
3. Raghuveer Rao, Ajit Bopardikar, Wavelet Transforms Introduction to Theory and Application, Longman Pub Group; Har/Dskt edition (January 1, 1998)
4. C. Sidney Burrus, R.A.Gopianath , Introduction to wavelet and wavelet Transform, Pearson; 1st edition (August 14, 1997).

EMBEDDED SYSTEM DESIGN

Weekly Teaching Hours	**TH: 03**	**Tu: 01**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Course Objectives:

1. To introduce students to modern embedded systems and to show how to understand and program such systems using a concrete platform built around a modern embedded processor.

Course Outcomes:

1. Learner will understand fundamental embedded systems design paradigms, architectures, possibilities, and challenges, both with respect to software and hardware.
2. Learner will be able to analyze a wide competence from different areas of technology, especially from computer engineering, study of processor for deep understanding analyze case study of Pentium processor.
3. Learner will be able to demonstrate architecture of 8051, Instruction set, addressing modes. Programming 8051 for various applications. Interfacing of LED/LCD, keyboard, stepper motor, ADC/DAC and sensors, RTC, serial communication with micro-controller.
4. Learner will be able to analyze deep state-of-the-art theoretical knowledge in the areas of real-time systems, artificial intelligence, learning systems, sensor and measuring systems, and their interdisciplinary nature needed for integrated hardware/software development of embedded systems.
5. Learner will have ability to analyze a system both as whole and in the included parts, to understand how these parts interact in the functionality and properties of the system, and understanding and experience of state-of-the-practice industrial embedded systems and intelligent embedded system development.

UNIT I

Fundamentals of Embedded System

Embedded System overview, Design challenges, Processor Technology, IC Technology, Design Technology.

UNIT II

Embedded System Hardware

Evaluation of Processors, Microprocessor architecture overview- CISC and RISC, Case study of Pentium processor architecture.

UNIT III

Microcontroller Architecture and Interfacing

The architecture of 8051, Instruction set, Addressing modes, and Programming Examples. Interfacing of LED/LCD, keyboard, stepper motor, ADC/DAC and sensors, RTC, serial communication with microcontroller.

UNIT IV

Study of semiconductor memory

Memory device characteristics, SRAM, DRAM, SRAM, SDRAM, RDRAM, FLASH, Smart card memory and interfacing of memory with micro-controller.

UNIT V

Introduction to DSP Processors

Architecture, features, instruction set, and typical applications (TMS320XX or ADSP 21010).

UNIT VI

Embedded software and Applications

Introduction to Software Engineering, C cross compiler, Computational models, FSM, Concurrent state model, Concurrent Processes, Communication among processes, synchronization among processes. Introduction to RTOS: Windows CE, VX works.

Applications: Network protocols- TCP/IP, Embedded Ethernet, CANBUS, I2C bus, Mod Bus, Digital Camera.

Textbooks / References:

1. Frank Vahid and Tony Givargis, ―Embedded System Design A Unified Hardware/Software Introduction‖, Wiley; 1. edition (24 Oct. 2001).

2. M.A. Mazidi and J.G. Mazidi, ―The 8051 Micro-controller and Embedded System‖ Pearson Education Asia, 2000

3. K.J. Ayala, ―The 8051 Micro-controllers‖, Cengage India; 3rd edition (8 Nov. 2007).

4. INTEL Microcontroller Manual

5. J. Zimmermann: ―Fuzzy set theory and its applications, second edition, Allied Publishers Limited, New Delhi, 1996.

ESTIMATION AND DETECTION TECHNIQUES

Weekly Teaching Hours	**TH: 03**	**Tu: 01**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA: 20**	**Total: 100**

Prerequisites: Fourier transforms, signals and systems, probabilities and random processes.

Course Outcomes:

1. Acquire the concepts of detection theory, estimation theory and binary/composite hypothesis testing.
2. Apply different techniques to perform the detection of deterministic / random signals in the presence of noise.
3. Ability to independently reproduce the results of the research paper in the domain

UNIT 1

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

UNIT 2

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

UNIT 3

Composite Hypothesis Testing: Bayesian approach, GLRT. Sinusoidal detection with unknown phase/ amplitude/ frequency

UNIT 4

Sequential Detection of Multiple Hypotheses, Signal detection with unknown noise parameters – white Gaussian noise case

UNIT 5

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

TEXTBOOKS:

1. Harry L. Van Trees, "Detection, Estimation, and Modulation Theory, Part I," John Wiley & Sons, 2004.
2. Steven M- Kay, "Fundamentals of Statistical signal processing, volume-1:

Estimation theory". Prentice Hall 1993.

3. Steven M.kay, "Fundamentals of Statistical signal processing, volume-2: Detection theory". Prentice Hall 1993
4. A.Papoulis and S.Unnikrishna Pillai, "Probability, Random Variables and stochastic processes, 4e". The McGraw-Hill 2002.

EBooks:

1. An Introduction to Signal Detection and Estimation, Poor, H. Vincent

WIRELESS NETWORK

Weekly Teaching Hours	**TH: 03**	**Tu: 01**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Prerequisites: Basics of Wireless Networking, Computer Networks

Course Outcomes:

1. To develop the concept of wireless systems in the context of networks.
2. To Learn the concepts of Sensor networks with its Protocol design
3. Able to understand building blocks of Internet of Things, their characteristics and to understand the application areas of IOT •
4. Ability to provide critical analysis of current research topics in the domain of Wireless Networks and prepare a technical document and present the same.

UNIT 1

Introduction: Wireless Body Area Networks, Wireless Personal Area Networks, Wireless Local Area Networks: Network components, design requirements, architecture, standards, protocols.

UNIT 2

Wireless Sensor networks- Introduction, Hardware and Software, Sensor Taxonomy, WN Operating Environment, Issues in Ad Hoc Wireless Networks, Medium Access Schemes, Routing, Transport Layer Protocols, Self-organization, Security, Addressing and Service Discovery, Energy management, and Scalability

UNIT 3

Sensor Network Architecture Data Dissemination, Flooding and Gossiping Data gathering Sensor Network Scenarios, Design Principles for WSNs- Gateway Concepts, Need for Gateway, WSN to Internet Communication, WSN Tunneling.

MAC Protocols for Sensor Networks, Location Discovery, Quality of Sensor Networks, Evolving Standards Other Issues, low duty cycle and wake-up concepts

UNIT 4

IoT: Introduction, State of the art, Reference Model and architecture, IoT reference Model - IoT Reference Architecture, Functional View, Information View, Deployment and Operational View, and Other Relevant architectural views. Real-world design Constraints, Technical Design constraints, Data representation and visualization, Interaction and remote control

UNIT 5

Case Study & Advanced IoT Applications: IoT applications in home automation, cities, environment, energy, retail, logistics, agriculture, industry, Use of Big Data and Visualization in IoT, Industry 4.0 concepts.

Text Books:

1. S. S. Manvi, M. S. Kakkasageri, “Wireless and Mobile Network concepts and protocols”, Wiley.
2. WaltenegusDargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice"
3. Holger Karl and Andreas Wiilig, “Protocols and Architectures for Wireless Sensor Networks” John Wiley & Sons Limited 2008. 2. I.F.
4. Akyildiz and Weillian, “A Survey on Sensor Networks”, IEEE Communication Magazine, August 2007.
5. Vijay Madisetti, ArshdeepBahga, “Internet of Things: A Hands-On Approach”

Reference Books:

1. “Wireless Communication Networks and Systems, Global Edition”, Cory Beard, William Stallings, Pearson, 2016
2. Iti Saha Mishra, “Wireless communication and networks 3G and beyond “, MGH, 2009.
3. P. Nicopolitidis, M. S. Obaidat, etal., “Wireless Networks”, Wiley, 2009.

E books:

1. Analysis and Design of Next-generation Software Architectures, Arthur M Langer
2. An Introduction to IoT

NPTEL/MOOC:

1. https://www.bbvaopenmind.com/en/iot-implementation-and-challenges
2. https://www.ftc.gov/system/files/documents/reports/federal-trade-commission-staff-report november-2013-workshop-entitled-internet-things-privacy/150127iotrpt.pdf

OPEN ELECTIVE – I

ADVANCED BIOMEDICAL SIGNAL PROCESSING

Weekly Teaching Hours	**TH: 03**	**Tu: 01**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Course Objective:

1. To introduce students to the principles of signal processing techniques when applied Specifically to biomedical signals
2. To provide an in depth understanding of methods and tools for extracting information from digitally acquired biomedical signals.

Course Outcome:

1. Learners will be able to demonstrate a systematic knowledge of the complex physical
   and physiological principles that underpin the measurement of biomedical signals.
2. Learners will be able to demonstrate an advanced understanding of the principles of
   digital signal processing.
3. Learners will be able to systematically apply advanced methods to extract relevant information from biomedical signal measurements.
4. Learners will be able to critically assess the appropriateness of cutting-edge biomedical signal-processing techniques for various problems in the field.
5. Learners will be able to evaluate the effectiveness of techniques applied to
   Bio-medical signals against specific benchmarks.

UNIT I

Introduction To Biomedical Signals - Examples of Biomedical signals - ECG, EEG, EMG etc -Tasks in Biomedical Signal Processing - Computer Aided Diagnosis. Origin of biopotentials - Review of linear systems - Fourier Transform and Time-Frequency Analysis (Wavelet) of biomedical signals- Processing of Random & Stochastic signals – spectral estimation – Properties and effects of noise in biomedical instruments - Filtering in biomedical instruments

UNIT II

Concurrent, Coupled and Correlated Processes - illustration with case studies – Adaptive and optimal filtering - Modeling of Biomedical signals - Detection of biomedical signals in

noise -removal of artefacts of one signal embedded in another -Maternal-Fetal ECG - Muscle-contraction interference. Event detection - case studies with ECG & EEG - Independent component Analysis - Cocktail party problem applied to EEG signals - Classification of biomedical signals.

UNIT III

Cardio Vascular applications: Basic ECG - Electrical Activity of the heart- ECG data acquisition – ECG parameters & their estimation - Use of multi-scale analysis for ECG parameters estimation - Noise & Artifacts- ECG Signal Processing: Baseline Wandering, Power line interference, Muscle noise filtering – QRS detection - Arrhythmia analysis

UNIT IV

Data Compression: Lossless & Lossy- Heart Rate Variability – Time Domain measures - Heart Rhythm representation - Spectral analysis of heart rate variability - interaction with other physiological signals.

UNIT V

Introduction to EEG: The electroencephalogram - EEG rhythms & waveform - categorization of EEG activity - recording techniques - EEG applications- Epilepsy, sleep disorders, brain-computer interface.

UNIT VI

EEG Modeling - linear, stochastic models – Nonlinear modelling of EEG - artefacts in EEG & their characteristics and processing – Model-based spectral analysis - EEG segmentation - Joint Time-Frequency analysis – correlation analysis of EEG channels - coherence analysis of EEG channels.

Text Books/Reference:

1. D.C.Reddy, Biomedical Signal Processing: Principles and techniques, Tata McGraw Hill, New Delhi, 2005
2. Willis J Tompkins, Biomedical Signal Processing -, ED, Prentice – Hall, 1993
3. R. Rangayan, Biomedical Signal Analysis, Wiley 2002.
4. Bruce, Biomedical Signal Processing & Signal Modeling, Wiley, 2001
5. Sörnmo, Bioelectrical Signal Processing in Cardiac & Neurological Applications, Elsevier
6. Semmlow, Bio-signal and Biomedical Image Processing, Marcel Dekker
7. Enderle, Introduction to Biomedical Engineering, 2/e, Elsevier, 2005

OPEN ELECTIVE – I

AUDIO AND SPEECH PROCESSING

Weekly Teaching Hours	**TH: 03**	**Tu: 01**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Course Objectives:

1. To provide an in-depth understanding of fundamental concepts of audio and speech Processing.
2. To provide an in-depth understanding of challenges in designing network

Course Outcomes:

1. Learners will be able to analyze the fundamentals of audio and speech signal processing and associated techniques.
2. Learner will be able to demonstrate how to solve practical problems with some basic audio and speech signal processing techniques
3. Learners will be able to design simple systems for realizing some multimedia applications with some basic audio and speech signal processing techniques.
4. Learners will be able to analyze different audio coding techniques.
5. Learners will be able to formulate linear Prediction problems in Time Domain
6. Learners will be able to analyze various applications of LPC parameters.

UNIT I

Introduction - Review Of Signal Processing Theory-Speech production mechanism – Nature of Speech signal– Discrete time modelling of Speech production – Classification of Speech sounds – Phones – Phonemes –Phonetic and Phonemic alphabets – Articulatory features. Absolute Threshold of Hearing - Critical Bands-Simultaneous Masking, Masking-Asymmetry, and the Spread of Masking- Non-simultaneous Masking - Perceptual Entropy Basic measuring philosophy -Subjective versus objective perceptual testing – The perceptual audio quality measure (PAQM) - Cognitive effects in judging audio quality.

UNIT II

Introduction -Analysis-Synthesis Framework for M-band Filter Banks- Filter Banks for Audio Coding: Design Considerations - Quadrature Mirror and Conjugate Quadrature Filters- Tree-

Structured QMF and CQF M-band Banks - Cosine Modulated "Pseudo QMF" M-band Banks - Cosine Modulated Perfect Reconstruction (PR) M-band Banks and the Modified Discrete Cosine Transform (MDCT) - Discrete Fourier and Discrete Cosine Transform - Pre-echo Distortion- Preecho Control Strategies

UNIT III

Lossless Audio Coding-Lossy Audio Coding- ISO-MPEG-1A,2A,2A Advanced, 4Audio Coding – Optimum Coding in the Frequency Domain - Perceptual Transform Coder - Brandenburg-Johnston Hybrid Coder – CNET Coders - Adaptive Spectral Entropy Coding Differential Perceptual Audio Coder - DFT Noise Substitution -DCT with Vector Quantization -MDCT with Vector Quantization

UNIT IV

Time domain parameters of Speech signal – Methods for extracting the parameters: Energy, Average Magnitude – Zero crossing Rate – Silence Discrimination using ZCR and energy Short Time Fourier analysis – Formant extraction – Pitch Extraction using time and frequency domain methods HOMOMORPHIC SPEECH ANALYSIS: Cepstral analysis of Speech – Formant and Pitch Estimation – Homomorphic Vocoders.

UNIT V

Formulation of Linear Prediction problem in Time Domain – Basic Principle – Auto correlation method – Covariance method – Solution of LPC equations – Cholesky method Durbin's Recursive algorithm – lattice formation and solutions – Comparison of different methods.

UNIT VI

Application of LPC parameters – Pitch detection using LPC parameters – Formant analysis VELP – CELP.

Text Books/Reference:

1. Udo Zölzer, A John, Digital Audio Signal Processing, Second Edition, Wiley& sons Ltd Publications
2. Mark Kahrs, Karlheinz Brandenburg, Applications of Digital Signal Processing to Audio And Acoustics, Kluwer Academic Publishers New York, Boston, Dordrecht, London, Moscow.
3. L. R. Rabiner and R.W. Schaffer, Digital Processing of Speech signals, Prentice Hall – 1978

OEPN ELECTIVE - I

CRYPTOGRAPHY AND NETWORK SECURITY

Weekly Teaching Hours	**TH: 03**	**Tu: 01**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Course Objectives:

1. To understand the basics of Cryptography and Network Security.
2. To be able to secure a message over insecure channels by various means.
3. To learn about how to maintain the Confidentiality, Integrity and Availability of data.
4. To understand various protocols for network security to protect against the threats in the networks.

Course Outcomes:

1. Provide security of the data over the network.
2. Do research in the emerging areas of cryptography and network security.
3. Implement various networking protocols.
4. Protect any network from the threats in the world.

UNIT I

Introduction to Cryptography and Block Ciphers

Introduction to security attacks - services and mechanism - introduction to cryptography - Conventional Encryption: Conventional encryption model - classical encryption techniques - substitution ciphers and transposition ciphers – cryptanalysis – steganography - stream and block ciphers - Modern Block Ciphers: Block ciphers principals - Shannon‘s theory of confusion and diffusion - fiestal structure - data encryption standard(DES) - the strength of DES - differential and linear crypt analysis of DES - block cipher modes of operations - triple DES – AES.

UNIT II

Confidentiality and Modular Arithmetic

Confidentiality using conventional encryption - traffic confidentiality - key distribution - random number generation - Introduction to graph - ring and field - prime and relative prime numbers - modular arithmetic - Fermat‘s and Euler‘s theorem - primarily testing - Euclid‘s

Algorithm - Chinese Remainder theorem - discrete algorithms.

UNIT III

Public key cryptography and Authentication requirements

Principles of public key cryptosystems - RSA algorithm - security of RSA - key management – Diffle-Hellman key exchange algorithm - introductory idea of Elliptic curve cryptography – Elgamel encryption - Message Authentication and Hash Function: Authentication requirements - authentication functions - message authentication code - hash functions - birthday attacks – security of hash functions and MACS.

UNIT IV

Integrity checks and Authentication algorithms

MD5 message digest algorithm - Secure hash algorithm (SHA) Digital Signatures: Digital Signatures - authentication protocols - digital signature standards (DSS) - proof of digital signature algorithm - Authentication Applications: Kerberos and X.509 - directory authentication service - electronic mail security-pretty good privacy (PGP) - S/MIME.

UNIT V

IP Security and Key Management

IP Security: Architecture - Authentication header - Encapsulating security payloads - combining security associations - key management.

Text Books/ Reference Books

1. William Stallings, ―Cryptography and Network Security Principles and Practices‖, Pearson/PHI.
2. Wade Trappe, Lawrence C Washington, ―Introduction to Cryptography with coding theory‖, Pearson.
3. W. Mao, ―Modern Cryptography – Theory and Practice‖, Pearson Education.
4. Charles P. Pfleeger, Shari Lawrence Pfleeger – Security in computing – Prentice Hall of India.

OPEN ELECTIVE - I

ELECTROMAGNETICS, ANTENNA AND PROPAGATION

Weekly Teaching Hours	**TH: 03**	**Tu: 01**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Course Objectives:

1. To provide an in-depth understanding of the fundamental solutions of time-varying
   Maxwell's equations, and applies them to design antennas.
2. To provide an in-depth understanding of radio wave propagation phenomena in modern communication systems, and fundamentals of electromagnetic radiation with application to antenna theory and design.

Course Outcomes:

1. Learners will be able to gain knowledge of basic electric field theory
2. Learners will be able to understand basic magnetic fields and combine EMF theory
3. Learners will be able to understand various antennas, arrays and radiation patterns in the Antenna.
4. Learners will be able to understand the basic workings of antenna
5. Learners will be able to understand planar and broadband antennas
6. Learners will be able to design antennas for mobile communication

UNIT I

Introduction, Vector Analysis, Coordinate systems and Transformations, Line, surface and volume integrals, Divergence Theorem, Stoke's theorem, Coulomb's Law, Electric Field, Electric flux density, Gauss's Law with Application, Electrostatic Potential and Equipotential Surfaces, Boundary conditions for Electrostatic fields, Capacitance and Capacitors, Electrostatic Energy and Energy Density, Poisson's and Laplace's Equations, Uniqueness Theorem, Method of Images, Electrostatic boundary value problem

UNIT II

Introduction, Current Density and Ohm's Law, Electromagnetic force and Kirchoff's Voltage Law, Continuity Equation and Kirchoff's Current Law, Power Dissipation and Joule's law, Biot- Savart Law and its Applications, Ampere's Circuital Law and its Applications, Magnetic

Flux Density, Magnetic Scalar and Vector Potentials, Boundary Condition for Magnetic Fields, Inductance and Inductor, Energy stored in Magnetic Field, Faraday's Law of electromagnetic Induction, Maxwell's Equation, Boundary Conditions for Electromagnetic fields, Time Harmonic Fields, The Helmholtz Equation, Plane waves in Lossless medium, Plane waves in a lossy medium, Poynting Vector and Power Flow in Electromagnetic Fields, Polarization of plane wave, Behaviour of Plane waves at the interface of two media

UNIT III

Introduction, Fundamentals of Radiation, Radiated field of an Herzian dipole, Basic Antenna Parameters, Half Wave Dipole Antenna, Quarter Wave Monopole Antenna, Small Loop Antennas, Introduction to Antenna Arrays, Finite difference Method, Basic Concepts of the Method of Moments, Method of Moment for Wire Antennas and Wire Scatterers

UNIT IV

Planar Antennas – Microstrip rectangular and circular patch antennas- Analysis and Design, feeding methods; circularly polarized microstrip antennas, broadband techniques. Printed slot antennas. Array theory- linear array: broadside and end-fire arrays; self and mutual impedance of between linear elements, grating lobe considerations.

UNIT V

Planar Array- array factor, beam width, directivity. Example of microstrip patch arrays and feed networks electronics scanning.

Broadband antennas- folded dipole, sleeve dipole, Biconical antenna – Analysis, characteristics, matching techniques. Yagi array of linear elements and printed version, Log-Periodic dipole array.

UNIT VI

Frequency Independent Antennas- planar spiral antennas, log periodic dipole array. Aperture antennas- field equivalence principle, Babinet’s principle. Rectangular waveguide horn antenna, parabolic reflector antenna.

Antennas for mobile communication- handset antennas, base station antennas. Beam-steering and antennas for MIMO applications. Active and smart microstrip antennas. Design and analysis of microstrip antenna arrays.

Text Books/Reference:

1. C. A. Balanis, Antenna Theory and Design, John Wiley and Sons, 1997.
2. J. D. Kraus, antennas, Mc-Graw-Hill, 1988.
3. R. A. Sainathi, CAD of microstrip antennas for wireless applications, Artech House, 1996.

OPEN ELECTIVE – I

OPTIMIZATION TECHNIQUES

Weekly Teaching Hours	**TH: 03**	**Tu: 01**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Course Objectives:

1. To acquaint the students with the basic concepts of Optimization
2. To introduce methods of optimization to engineering students, including linear Programming, nonlinear programming, and heuristic methods
3. To provide in-depth understanding about balance between theory, numerical computation, problem setup for solution by optimization software, and applications to engineering systems.

Course Outcomes:

1. Learner will be able to identify real-world objectives and constraints based on actual problem descriptions.
2. Learner will be able to create mathematical optimization models.
3. Learner will be able to analyze optimization algorithm; necessary and sufficient Conditions for optimality
4. Learner will be able to make recommendations based on solutions, analyses, and Limitations of models

UNIT I:

Different Types of OR Models, Case studies in engineering applications.

UNIT II

Convex Sets, Graphical Method, Simplex Method, Big–M Method, Two Phase Method, Revised Simplex Method.

UNIT III

Duality Theory, Dual Simplex Method, Sensitivity Analysis

UNIT IV:

Cutting Plane and Branch and Bound Techniques for all Integer and Mixed Integer Programming Problems, 0-1 Integer Problems, Travelling Salesman Problems, and Cargo Loading Problems.

UNIT V

Transportation Problems and Assignment Problems.

UNIT VI

Game Theory: Rectangular Games, Min-max Theorem, Graphical Solution of 2 X n and m X 2 games, Reduction to Linear Programming Problems. Sequencing and Scheduling: Processing of Jobs through Machines, CPM and PERT

Text Books/Reference:

1. Taha, H.A., Operations Research: An Introduction, MacMillan Pub Co., NY, Ninth Edition
2. Ravindran, A., Phillips, D.T. and Solberg, J.J., Operations Research: Principles and Practice, John Wiley and Sons, NY, Second Edition.
3. Pant, J.C., Introduction to Optimization, Jain Brothers, 2012
4. Hillier, F. S. and Lieberman, G. J., Introduction to Operations Research, 9th 2009 Edition, McGraw-Hill
5. Mittal, K.V. and Mohan, C., Optimization Methods in System Analysis and Operations Research
6. Mohan C. and Deep K., Optimization Techniques 2009

RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS

Weekly Teaching Hours	**TH: 03**	**Tu: 01**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Course Outcomes

1. Ability to write and present a substantial technical report/document
2. Able to demonstrate a degree of mastery over the area of specialization

Module 1:

Meaning and sources of research problem, Objectives and Characteristics of research – Errors in selecting research problem, Research methods vs. methodology - Types of research of good research – Developing a research plan.

Module 2:

Investigations of a research problem - Selecting the problem - Necessity of defining the problem – Data collections-analysis- Importance of literature review in defining a problem - Survey of literature -Necessary instrumentations.

Module 3:

How to write paper-conference articles preparation, thesis report writing, inclusion of references, journal reviewing process, journal selection process, filling about journal template, developing effective research proposal- plagiarism-research ethics

Module 4:

Nature of Intellectual property, IPRs- Invention and Creativity - Importance and Protection of Intellectual Property Rights (IPRs) – procedure for grant of patents and patenting under PCT-types of patents-technological research and innovation- international cooperation on IP.

Module 5:

A summary of Patents-Copyrights-Trademarks, patent rights-licensing and transfer of technology databases-case studies on IPR-Geographical indications-new developments in IPR-protection of IPR rights

TEXTBOOKS:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 420p.

3. Anderson, T. W., An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi
4. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications.
5. Subbarau NR-Handbook of Intellectual Property Law and practise- S Viswanathan Printers and Publishing Private Limited 1998.

INDIAN KNOWLEDGE SYSTEM BUCKET#:

CONCEPTS AND APPLICATIONS IN ENGINEERING

Weekly Teaching Hours	**TH: 03**	**Tu: --**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA: 20**	**Total: 100**

Course Objectives:

1. Introduce students to the foundational concepts, philosophies, and components of Indian knowledge systems, including ancient scriptures, philosophies, and traditional practices.
2. Introduce students to Vedic mathematical principles and computational techniques from ancient Indian texts, demonstrating their practical use in engineering calculations.
3. Explore the potential benefits of incorporating yogic and meditative practices into engineering to enhance focus, creativity, and overall well-being.
4. Study architectural concepts from Indian traditions and evaluate how they can inform modern urban planning and sustainable architecture.
5. Encourage students to draw inspiration from IKS to develop innovative engineering solutions that align with ancient wisdom while meeting contemporary needs.

Course Outcomes:

1. Gain a comprehensive understanding of the philosophical, scientific, and technological aspects of Indian Knowledge Systems and their historical development.
2. Understand the philosophical understanding of IKS, including concepts like dharma, karma, and holistic thinking, and explore their relevance to engineering.
3. Understand Vedic mathematical principles and computational methods, and their potential relevance in solving modern engineering problems.
4. Investigate the connections between yoga, meditation, and stress management, and their potential impact on mental well-being in engineering contexts.
5. Reflect on the ethical, cultural, and social dimensions of integrating IKS concepts into engineering practices and applications.

UNIT I

Indian Knowledge System – An Introduction & Vedic Corpus.

What is IKS? Why do we need IKS? Organization of IKS, Historicity of IKS, Some salient aspects of IKS, Introduction to Vedas, A synopsis of the four Vedas, Sub-classification of Vedas, Messages in Vedas, Introduction to Vedāṅgas, Prologue on Śikṣā and Vyākaraṇa, Basics of Nirukta and Chandas, Introduction to Kalpa and Jyotiṣa, Vedic Life: A Distinctive Features.

UNIT II

Number system & Mathematics

Number systems in India - Historical evidence, Salient aspects of Indian Mathematics, Bhūta-Saṃkhyā system, Kaṭapayādi system, Measurements for time, distance, and weight, Piṅgala and the Binary system. Introduction to Indian Mathematics, Unique aspects of Indian Mathematics, Indian Mathematicians and their Contributions, Algebra, Geometry, Trigonometry, Binary mathematics, and combinatorial problems in Chandaḥ Śāstra, Magic squares in India

UNIT III

Engineering Technology: Metal & Other applications

Wootz Steel: The rise and fall of a great Indian technology, The Indian S & T heritage, Mining and ore extraction, Metals and metalworking technology, Iron and steel in India, lost wax casting of idols and artefacts, Apparatuses used for extraction of metallic components.

Irrigation systems and practices in South India, literary sources for science and technology, Physical structures in India, irrigation and water management, dyes and painting technology, the art of making perfumes, Surgical techniques, shipbuilding, sixty-four art forms (64 Kalās) status of Indigenous S & T.

UNIT IV

Town Planning and Architecture:

Perspective of Arthaśāstra on town planning, Vāstu-śāstra – The science of architecture eight limbs of Vāstu, town planning, temples in India: Marvelous stone architecture for eternity, temple architecture in India, Iconography.

UNIT V

Knowledge Framework and Classifications:

Indian scheme of knowledge, The knowledge triangle, Prameya – A vaiśeṣikan approach to physical reality, Dravyas – the constituents of the physical reality, Attributes – the properties of substances and Action – the driver of conjunction and disjunction, Sāmānya, viśēṣa, samavāya, Pramāṇa – the means of valid knowledge, Saṃśaya – ambiguities in existing knowledge, Framework for establishing valid knowledge, Deductive or inductive logic framework, Potential fallacies in the reasoning process, Siddhānta: established tenets in a field of study.

UNIT VI

Linguistics

Introduction to Linguistics, Aṣṭādhyāyī, Phonetics, word generation, computational aspects, Mnemonics, Recursive operations, Rule-based operations, Sentence formation verbs and prefixes, the role of Sanskrit in natural language processing.

Textbooks / References:

1. Mahadevan, B., Bhat Vinayak Rajat, Nagendra Pavana R.N. (2022), ―Introduction to Indian Knowledge System: Concepts and Applications‖, PHI Learning Private Ltd. Delhi.

NPTEL PLATFORM:

NPTEL Course	Name of Instructor	Host Institute	Link
Indian Knowledge System (IKS): Concepts and Applications in Engineering	Prof. B. Mahadevan, Dr. Vinayak Rajat Bhat, Dr. R Venkata Raghavan	(IIMB), Chanakya University, Bangalore	https://onlinecourses.swayam2.ac.in/imb23_mg53/preview

INDIAN KNOWLEDGE SYSTEM BUCKET#:

HUMANITIES AND SOCIAL SCIENCES

Weekly Teaching Hours	**TH: 03**	**Tu: --**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Course Objectives:

1. Introduce students to the diverse range of Indian philosophical, cultural, and social knowledge systems that have evolved over millennia.
2. Encourage students to critically compare Indian knowledge systems with other global philosophies and social theories, fostering a nuanced understanding.
3. Study Vedic texts, ancient scriptures, and philosophical treatises to understand the core ideas and insights that inform Indian knowledge systems.
4. Investigate the intersections of spirituality, psychology, and well-being in Indian knowledge systems, exploring practices like meditation, yoga, and mindfulness.
5. Study the role of language, symbols, and communication in Indian knowledge systems, including Sanskrit as a language of knowledge transmission.

Course Outcomes:

1. Recognize the interdisciplinary nature of IKS, integrating traditional knowledge with contemporary concepts in humanities and social sciences.
2. Explore India's rich cultural heritage, including literature, art, music, dance, and rituals, and analyze their significance in shaping identity and social cohesion.
3. Explore Indian philosophical schools and their insights into consciousness, self-awareness, and psychological well-being.
4. Analyze India's cultural diversity, pluralism, and the coexistence of various belief systems, contributing to tolerance and social harmony.

UNIT I

Indian Knowledge System – An Introduction & Vedic Corpus

What is IKS? Why do we need IKS? Organization of IKS, Historicity of IKS, Some salient aspects of IKS,

Introduction to Vedas, A synopsis of the four Vedas, Sub-classification of Vedas, Messages in Vedas, Introduction to Vedāṅgas, Prologue on Śikṣā and Vyākaraṇa, Basics of Nirukta and

Chandas, Introduction to Kalpa and Jyotiṣa, Vedic Life: A Distinctive Features.

UNIT II

Philosophical Systems

An introduction to philosophical systems, development of philosophy unique features of philosophy, Sāṅkhya approach of philosophy, Introduction to Yoga, tenet of Nyāya philosophy principles of Vaiśeṣika, doctrine of Pūrva-Mīmāṃsā Darśana, thesis of Vedānta and synopsis of Advaita philosophy of Viśiṣṭādvaita.

UNIT III

Wisdom through ages

Gateways of cestral wisdoms, introduction to Purāṇa, the Purāṇic repository, Issues of interest in Purāṇas, Introduction to Itihāsas, Key messages in Itihāsas, Wisdom through Nīti- śāstras, Wisdom through Subhāṣita.

UNIT IV

Health Wellness and Psychology:

Introduction to health, Āyurveda: approach to health, Sapta-dhātavaḥ: seven-tissues, role of agni in health, tri-doṣas, Āyurveda: definition of health, Psychological aspects of health, disease management elements, Dinacaryā: daily regimen for health & wellness, Importance of sleep, Food intake methods and drugs, Approach to lead a healthy life, Indian approach to psychology, the tri guṇa system & holistic picture of the individual, the Nature of Consciousness, consciousness studies and issues

UNIT V

Linguistics:

Introduction to Linguistics, Aṣṭādhyāyī, phonetics, word generation, computational aspects, mnemonics, recursive operations, rule-based operations, sentence formation, verbs and prefixes, role of Sanskrit in natural language processing.

UNIT VI

Governance and Public Administration:

Introduction to raja dharma, Arthaśāstra: a historical perspective, Elements of a kauṭilyan state, The king & the amātya, Janapada & durga, treasury and the state economy (Kośa), danda,

Mitra, the administrative setup, relevance of Arthaśāstra, public administration in Epics.

Textbooks / References:

1. Mahadevan, B., Bhat Vinayak Rajat, Nagendra Pavana R.N. (2022), ―Introduction to Indian Knowledge System: Concepts and Applications‖, PHI Learning Private Ltd. Delhi.
2. Pride of India: A Glimpse into India‘s Scientific Heritage, Samskrita Bharati, New Delhi.
3. Sampad and Vijay (2011). ―The Wonder that is Sanskrit‖, Sri Aurobindo Society, Puducherry.
4. Acarya, P.K. (1996). Indian Architecture, Munshiram Manoharlal Publishers, New Delhi.
5. Kapoor Kapil, Singh Avadhesh (2021). ―Indian Knowledge Systems Vol – I & II‖, Indian Institute of Advanced Study, Shimla, H.P.
6. Dasgupta, S. (1975). A History of Indian Philosophy- Volume 1, Motilal Banarsidass, New Delhi.
7. PLofker, K. (1963). Mathematics in India, Princeton University Press, New Jersey, USA"

NPTEL platform:

NPTEL Course	Name of Instructor	Host Institute	Link
Indian Knowledge System(IKS): Humanities and Social Sciences	Prof. B. Mahadevan, Dr. Vinayak Rajat Bhat, Dr. R Venkata Raghavan	Indian Institute of Management Bangalore (IIMB), Chanakya University, Bangalore	https://onlinecourses.swayam2.ac.in/imb23_mg55/preview

PG LAB - II

Weekly Teaching Hours	**TH: --**	**PR = 04 Hr**		
Scheme of Marking	**TH: --**	**OR/PR = 25**	**IA : 20**	**Total: 50**

Practicals of the Lab - I shall be based on the courses of first semester. The lab work shall consist of hands-on experiments on the different software and hardware platforms related to the syllabus.

MINI-PROJECT

Weekly Teaching Hours	**TH: --**	**PR = 04 Hr**		
Scheme of Marking	**TH: --**	**OR/PR = 25**	**IA : 25**	**Total: 50**

The mini-project shall be based on the recent trends in the industry, research and open problems from the industry and society. This may include mathematical analysis, modelling, simulation, and hardware implementation of the problem identified. The mini-project shall be of the student‘s choice and approved by the guide. The student has to submit the report of the work carried out in the prescribed format signed by the guide and head of the department/institute.

DISASTER MANAGEMENT

Weekly Teaching Hours	**TH: 02**	**PR = --**		
Scheme of Marking	**TH: --**	**OR/PR = --**	**IA : --**	

Course Objectives:

1. Mastering strategies to manage disasters and ensure public safety during emergencies.
2. Identifying hazards, and vulnerabilities, and crafting plans to reduce disaster impact.
3. Collaborative Skills: Working across disciplines to address complex disaster challenges.
4. Developing, improving, and implementing disaster management policies. Community Empowerment: Educating and engaging communities for proactive disaster readiness.

Course Outcomes:

1. Learners will be able to understand the basic concept of disaster(s) and disaster management, their significance, and their types.
2. Learners will develop the analytical skills to study the relationship between vulnerability, disasters, disaster prevention and risk reduction
3. Learners will gain a preliminary understanding of approaches to Disaster Risk Reduction (DRR)
4. Learners will be empowered with the awareness of institutional processes in the country for Disaster Management

UNIT I

Disaster Management: Disaster and Disaster Management – Concepts, Issues Concerned with Disaster Management. Disaster Management: Phases of Disaster Management, Phases of Disaster Management Types of Disasters: Bhopal Disaster: A Case Study, Types of Disasters-An Introduction, Natural Disaster, Man-made Disaster

UNIT II

Types of Disasters: Slow onset Disasters & Rapid onset Disasters, Simple and Complex,

Tsunami: A Case Study Disasters, Tsunami: A Case Study, Cyclone Phallin 2013: A Case Study

UNIT III

Disaster Management in India -An overview: Evolution of Disaster Management in India, Disaster and Disaster Management in India, National Institute of Disaster Management, National Disaster Management Act 2005.

UNIT IV

Disaster Management in India -An Over View: The National Policy on Disaster Management, 2009.

Refugee Problem: National Plan on Disaster Management 2016, Refugee Problems, Impact of Disaster on the lives of Refugees.

Refugee Problem: Problems of Women and Children during disasters, Principles Of Psychosocial Care, Issues And Recovery During Emergency.

Refugee Problem: Relationship between Disasters, Development and Vulnerabilities, Relationship between Disasters, Development and Vulnerabilities.

UNIT V

Refugee Problem: Equity Issues in Disaster.

Refugee Problem: Issues of Rehabilitation and Resettlement among the Disaster Survivors, Stakeholders in Disaster Relief Management - An Introduction.

Stakeholders in Disaster Relief Management: Central Government.

Stakeholders in Disaster Relief Management: State Government, District Administration. Armed Forces.

UNIT VI

Stakeholders in Disaster Relief Management: Para-Military Forces, Fire Services.

Disaster Risk Reduction: Disaster Risk Reduction Strategies, Risk Reduction Preparedness Plans.

Disaster Risk Reduction: Action Plans and Procedures, Early Warning Systems, Components of Disaster Relief, Factors contributing to Vulnerability.

Disaster Risk Reduction: Disaster Risk Reduction - Master Planning for the Future, Capacity Building Rehabilitation measures and long-term reconstruction, Understanding Kerala Disaster

2018.

Textbooks / References:

1. Coppola D P, 2007. Introduction to International Disaster Management, Elsevier Science (B/H), London.
2. Manual on natural disaster management in India, M C Gupta, NIDM, New Delhi
3. An overview on natural & man-made disasters and their reduction, R K Bhandani, CSIR, New Delhi
4. World Disasters Report, 2009. International Federation of Red Cross and Red Crescent, Switzerland
5. Encyclopaedia of disaster management, Vol I, II and IIIL Disaster management policy and administration, S L Goyal, Deep & Deep, New Delhi, 2006
6. Encyclopaedia of Disasters – Environmental Catastrophes and Human Tragedies, Vol. 1 & 2, Angus M. Gunn, Greenwood Press, 2008
7. Disasters in India Studies of grim reality, Anu Kapur & others, 2005, 283 pages, Rawat Publishers, Jaipur.
8. Management of Natural Disasters in developing countries, H.N. Srivastava & G.D. Gupta, Daya Publishers, Delhi, 2006, 201 pages
9. Natural Disasters, David Alexander, Kluwer Academic London, 1999, 632 pages
10. Disaster Management Act 2005, Publisher by Govt. of India
11. Publications of National Disaster Management Authority (NDMA) on Various Templates and Guidelines for Disaster Management
12. NIDM Publications.
13. High Power Committee Report, 2001, J.C. Pant
14. Disaster Mitigation in Asia & Pacific, Asian Development Bank
15. National Disaster Management Policy, 2009, GoI
16. Disaster Preparedness Kit, American Red Cross

NPTEL platform:

NPTEL Course	Name of Instructor	Host Institute	Link
Disaster Management	Naveen Kumar Nanjundan	University Of Hyderabad	https://onlinecourses.swayam2.ac.in/cec19_hs20/preview

OPEN ELECTIVE – II

ENTERPRENEURSHIP

Weekly Teaching Hours	**TH: 03**	**Tu: 1**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Course Objectives:

1. To understand the role of entrepreneurs in driving innovation and economic growth.
2. Guide students through the process of developing a comprehensive business plan, including market research, financial projections, competitive analysis, and risk assessment.
3. 3. Provide students with essential financial literacy skills, including budgeting, financial forecasting, and understanding different funding options such as bootstrapping, loans, venture capital, and angel investment.
4. Guide students through the process of developing, prototyping, and refining their products or services to meet customer needs and expectations.

Course Outcomes:

1. Students will be able to generate innovative business ideas by identifying market gaps, customer needs, and emerging trends.
2. Students will be capable of developing comprehensive business plans that encompass market research, financial projections, and strategic goals.
3. Students will gain skills in budgeting, financial forecasting, and managing financial resources for their entrepreneurial ventures.
4. Students will be able to identify and manage potential risks associated with entrepreneurship, including financial, operational, and market risks.

UNIT I

Entrepreneurial Journey, Entrepreneurial Discovery, Ideation and Prototyping,

UNIT II

Testing, Validation and Commercialization, Disruption as a Success Driver

UNIT III

Technological Innovation and Entrepreneurship – 1, Technological Innovation and

Entrepreneurship – 2, Raising Financial Resources.

UNIT IV

Education and Entrepreneurship, Beyond Founders and Founder-Families, India as a Start-up Nation

UNIT V

National Entrepreneurial Culture, Entrepreneurial Thermodynamics,

UNIT VI

Entrepreneurship and Employment, Start-up Case Studies

Textbooks / References:

1. Zero to One: Notes on Startups, or How the Build the Future by Peter Thiel.
2. The Lean Startup: How Today‘s Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses by Eric Ries.
3. India as Global Start-up Hub: Mission with Passion by C B Rao.
4. Elon Musk: Tesla, Space X, and the Quest for a Fantastic Future by Ashlee Vance.
5. Steve Jobs by Walter Isaacson.
6. Innovation and Entrepreneurship: Practice and Principles by Peter F Drucker.
7. The Innovator‘s Solution: Creating and Sustaining Successful Growth by Clayton M Christensen.

NPTEL Platform:

NPTEL Course	Name of Instructor	Host Institute	Link
Entrepreneurship	Prof. C Bhaktavatsala Rao	IIT Madras	https://onlinecourses.nptel.ac.in/noc20_mg35/preview

OPEN ELECTIVE – II

ENVIRONMENT AND DEVELOPEMENT

Weekly Teaching Hours	**TH: 03**	**Tu: 1**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Course Objectives:

1. To help students comprehend the complex interconnections between environmental factors and development processes, highlighting how they can either support or impede each other.
2. To identify and analyze key environmental challenges arising from development activities, such as pollution, resource depletion, deforestation, loss of biodiversity, and climate change.
3. To study the effect of climate change on environment.
4. To analyze real-world case studies of both successful and unsuccessful attempts to integrate environmental considerations into development projects and policies

Course Outcomes:

1. Demonstrate a deep understanding of the complex interrelationships between environmental factors and socioeconomic development, including how they influence and shape each other.
2. Identify and critically analyze key environmental challenges resulting from development activities, and evaluate their impacts on ecosystems, natural resources, and human well-being.

UNIT I

Environmental movement

Introduction: Development, economic growth and sustainable development, Basic ecosystem ecology, Environmentalism, Environmental Movement, Environmentalism in the global south,

UNIT II

Social ecology

Approaches to environment: Ecofeminism, Feminist political ecology, Marxism and ecology, Debates on environmental ethics: Deep ecology, Gandhi and ecology, social ecology.

UNIT III

Impact of Religion on environment

Religion, environment, and conservation: Religion, environment and historical roots of ecological crisis, Biodiversity conservation ethics in Buddhism and Hinduism, Christian religion in the age of ecological crisis

UNIT IV

Natural Resources & development

Natural resource management, Common property vs. private property, Livelihoods, forests, and conservation, Displacement, dispossession, and development: Conservation-induced displacement, Environment impact assessment and national rehabilitation & resettlement policy, Dispossession, and land acquisition.

UNIT V

Gender & Development, Climate change

Development theory and gendered approach to development, Gender, environment & sustainable development.

Environment and climate change: Climate change interventions and policy framework, Eastern Himalayas, and climate change.

UNIT VI

Belief and local knowledge of environment

Belief and knowledge systems, biodiversity conservation and sustainability: Ecological knowledge, biodiversity conservation and sustainability, Traditional religion and conservation of nature in Northeast India: Case study

Local knowledge in the environment-development discourse: Indigenous knowledge, environment and development, Relevance of indigenous knowledge: case study

Textbooks / References:

1. Arnold, David, and Guha, Ramchandra, (eds.), 1997. Nature, Culture and Imperialism, New Delhi: Oxford University Press.
2. Baviskar, Amita. 1997. In the Belly of the River: Tribal Conflicts over Development in the Narmada Valley, OUP, Delhi.

3. Barnhill, David Landis & Roger S. Gottlieb. (eds.) 2001. Deep Ecology and World Religions: New Essays on Sacred Grounds. State Univ. of New York Press, Albany.
4. Bicker, Alan, Paul Sillitoe and Johan Pottier. 2004. Development and Local Knowledge: New Approaches to Issues in Natural Resources Management, Conservation and Agriculture. Routledge, London & New York.
5. Esteva, G. 1997. Development'in W. Sachs, ed., The Development Dictionary, Orient Longman, pp. 8-34.
6. Gadgil, Madhav and Guha, Ramchandra. 1995. Ecology and Equity: The use and Abuse of Nature in Contemporary India, New Delhi: Oxford University.
7. Gottlieb, Roger S. 2004. This Sacred Earth: Religion, Nature, Environment. Routledge, New York, and London.
8. Merchant, Carolyn. 1994. Ecology: Key Concepts in Critical Theory, Humanities Press, New Jersey.
9. Ramakrishnan, P.S. 1992. Shifting Agriculture and Sustainable Development: An Interdisciplinary Study from North-Eastern India, Man and the Biosphere Series, Volume 10, UNESCO.

NPTEL Platform

NPTEL Course	Name of Instructor	Host Institute	Link
Environment and Development	Prof. Ngamjahao Kipgen	IIT Guwahati	https://onlinecourses.nptel.ac.in/noc21_hs83/preview

OPEN ELECTIVE – II

STUDENT PSYCHOLOGY

Weekly Teaching Hours	**TH: 03**	**Tu: 1**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Course Objectives:

1. Gain an understanding of prominent learning theories and models, enabling you to grasp the foundational concepts that influence effective teaching and learning.
2. Acquire skills to assess and appreciate diverse student characteristics, including learning styles, cultural backgrounds, and individual differences that impact learning.
3. Gain proficiency in understanding, administering, and interpreting psychological tests and inventories to assess cognitive abilities, personality traits, and emotional development in learners
4. Examine psychological theories of motivation and cultivate the skills needed to apply motivational strategies that enhance student engagement, commitment, and achievement.
5. Investigate the stages of physical, cognitive, emotional, and social development in individuals, equipping you to design instructional methods that support comprehensive growth.
6. Acquire an understanding of NLP concepts and techniques that can be used to improve communication, establish rapport, and optimize teaching and learning experiences.

Course Outcomes:

1. Understanding of Psychological Factors: Gain a comprehensive understanding of the psychological factors that influence students' learning, behavior, and overall well- being in educational settings.
2. Recognition of Diverse Student Needs: Develop the ability to recognize and appreciate the diverse cognitive, emotional, and social needs of students, enabling tailored support and fostering inclusive learning environments.
3. Application of Psychological Strategies: Apply psychological theories and principles to address various challenges in student development, including

motivation, learning difficulties, and behavioural issues.

4. Competence in Student Assessment: Acquire skills in utilizing psychological assessment tools to evaluate students' cognitive abilities, emotional states, and learning styles, informing instructional strategies and support plans.
5. Promotion of Positive Learning Experiences: Learn to create positive and conducive learning experiences by integrating insights from student psychology, fostering engagement, motivation, and holistic growth among learners.

UNIT I

Teaching Learning Process

UNIT II

Student Characteristics, Types and Problems

UNIT III

Psychological Tests and Inventories, Student Motivation

UNIT IV

Physical and Cognitive Development

UNIT V

Emotional and Social Development

UNIT VI

Neuro-Linguistic Programming, Counselling Skills, and Summary

Textbooks / References:

1. Sharma, R.A. (2007). Training Technology. Meerut: Surya Publications.
2. Sharma, R.A. (2007). Psychology of Teaching-Learning Process. Meerut: Surya Publications.
3. B. Mukhopadhyay (1997). Motivation in Educational Management. New Delhi: Sterling Publishers.
4. Barki & Mukhopadhyay. (1995). Guidance and Counselling. New Delhi: Sterling Publishers.
5. Agochya, D. (2010). Life competencies for adolescents. New Delhi: Sage

Publications.

6. Davies, I.K. (1971). Management of Learning. Berkshire: McGraw Hill.
7. Dusay. (1980). Egograms. New York: Harper & Row.
8. Goleman, D. (1996). Emotional Intelligence. New York: Bantam Books.
9. Anastasi. (2016). Psychological Testing. New Delhi: Pearson Education. Psychological Tests.

NPTEL Platform

NPTEL Course	Name of Instructor	Host Institute	Link
Student Psychology	Dr. S. Renukadevi	NITTTR, Chennai	https://onlinecourses.swayam2.ac.in/ntr19_ed23/preview

ELECTIVE – II

PRINCIPLES OF ECONOMICS

Weekly Teaching Hours	**TH: 03**	**Tu: 1**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Course Objectives:

1. Introduce essential economic terms and concepts for analyzing real-world situations.
2. Understand market dynamics, supply and demand, and resource allocation.
3. Study national indicators, inflation, unemployment, and government policies' effects.
4. Learn to make informed choices using opportunity cost, utility, and cost analysis.
5. Explore global interdependencies, trade, exchange rates, and policy impacts.

Course Outcomes:

1. Grasp key economic principles, like supply and demand, opportunity cost, and marginal analysis, forming a foundation for economic understanding.
2. Gain insights into market structures, pricing mechanisms, and factors influencing consumer and producer behaviour.
3. Understand the role of government interventions, regulations, and fiscal/monetary policies in shaping economic outcomes.
4. Learn how societies allocate scarce resources efficiently, exploring topics like production, distribution, and factors of production.
5. Develop analytical thinking by applying economic principles to real-world scenarios, and making informed personal and business decisions.

UNIT I

Principles of Economics, Thinking like an Economist; Interdependence and the gains from Trade.

UNIT II

Market forces of supply and Elasticity, Application of elasticity; supply, demand, and government policies

UNIT III

Consumer and producer surplus; cost of taxation and international trade, Externalities, and cost of production

UNIT IV

Competitive market and monopoly market, Game theory and oligopoly measure national income, measuring the cost of living

UNIT V

Production and growth; Saving, Investment and the financial system, the monetary system, Money growth and inflation

Textbooks / References:

1. N. Gregory Mankiw, Principles of Economics.

NPTER Platform

NPTEL Course	Name of Instructor	Host Institute	Link
Principles Of Economics	Prof. Sabuj Kumar Mandal	IIT Madras	Principles Of Economics – Course (nptel.ac.in)

OPEN ELECTIVE – II

BUSINESS TO BUSINESS MARKETING (B2B)

Weekly Teaching Hours	**TH: 03**	**Tu: 1**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Course Objectives:

1. Develop a comprehensive understanding of the unique characteristics, dynamics, and complexities that define business-to-business (B2B) marketing, including the role of intermediaries, supply chains, and collaborative relationships.
2. Learn how to segment B2B markets based on factors such as industry, company size, and purchasing behavior. Understand the significance of effective market segmentation in tailoring marketing strategies to specific B2B customer segments.
3. Explore the elements of the B2B marketing mix, including product/service offerings, pricing strategies, distribution channels, and promotional approaches. Develop the ability to design marketing strategies that align with the unique needs and preferences of B2B customers.
4. Gain insights into relationship-building strategies in B2B contexts. Learn how to nurture long-term, mutually beneficial partnerships with B2B clients through effective communication, trust-building, and value delivery.
5. Acquire skills in B2B sales processes, negotiations, and contract management. Understand the intricacies of negotiation dynamics, procurement processes, and key decision-making factors in B2B transactions.

Course Outcomes:

1. Foundational Knowledge: Gain a strong grasp of the core concepts and theories that form the basis of B2B marketing, enabling practical application.
2. Market Analysis Expertise: Develop skills to analyse B2B markets, segment customers effectively, and make informed marketing decisions.
3. Strategic Implementation: Acquire the ability to design and execute B2B marketing strategies tailored to the unique needs of business customers.
4. Relationship Management: Learn how to build and nurture enduring relationships with B2B clients through effective communication and collaboration.

5. Sales and Negotiation Proficiency: Master the art of B2B sales, negotiation strategies, and contract management for successful transactions.

UNIT I

Introduction to B2B Marketing: Business marketing, Classifying goods for the business market, Business market customers, Market structure, Environment and Characteristics of Business Marketing, Strategic role of marketing, Commercial enterprises, Commercial and institutional customers, B2B vs B2C Marketing.

Organizational Buying and Buyer Behavior: Organizational buyers‘ decision process - A Stepwise Model and A Process Flow Model, Organizational and business markets - Government as a customer - Commercial enterprises - Commercial and institutional customers, Value analysis, Buy-grid framework, Strategic procurement.

UNIT II

B2B Marketing Strategy: Strategy making and strategy management process, Industrial products strategy– Managing Products for Business Markets-Managing Services for Business Markets-Managing Business Market Channels the Growth-Share Matrix, Multifactor Portfolio Matrix, The Balanced Scorecard.

B2B Marketing STP: Market Segmentation, bases for segmenting business markets, basic framework of segmentation, choosing target segments and positioning.

UNIT III

Business Marketing Communications- B2B Advertising, Digital marketing, - Trade shows, exhibitions, and business meets - Managing the sales force - Deployment analysis, direct marketing. Demand forecasting: industrial market, Forecasting- meaning, importance and relevance, issues related to forecasting, forecasting measurement models, sales force forecasting, estimating segment demand, Collaborative approach to estimate demand, qualitative and quantitative forecasting methods.

UNIT IV

Product management: (existing and new) in industrial market, role of product in the industrial market, new product development, industrial product life cycle, product evaluation matrix, techniques for identifying new products QFD, perceptual mapping, reverse engineering, fish bone diagram, role of service and maintenance in industrial markets, customer experience life cycle, service quality.

Pricing: Pricing strategies; the pricing policy; Price on the Internet; Financial marketing, competitive bidding, commercial terms and conditions, role of leasing.

UNIT V

Buyer seller relationship, types of relationships, transactional and collaborative relationships, influencing industrial customers, role of service in industrial markets. CRM.

B2B marketing research, challenges in B2B research, developing a marketing information system, role of qualitative research techniques in B2B research.

UNIT VI

Business marketing channels and participants - Channel design and management decisions - B2B logistics management, types of industrial middlemen and intermediaries, marketing logistics and physical distribution.

Strategic decision making in industrial markets, strategic planning at corporate levels, allocation of resources, portfolio analysis, developing SBU'S objectives and goals, implementing and controlling marketing plan. Marketing through electronic commerce.

Textbooks / References:

1. Business Market Management Understanding, Creating and Delivering Value by James C. Anderson, Das Narayandas, James A. Narus and D.V.R. Seshadri Pearson, 2010 3rd edition
2. Business Marketing Management b2b By Hutt and Speh South-Western CENGAGE Learning www.cengagebrain.com 2013
3. B2B Brand Management by Kotler and Pfoertsch Springer www.springer.com 2006
4. Business Marketing: Text and Cases by Krishna K Havaldar, McGrawhill Publications, 2014 4th edition.

NPTEL Platform:

NPTEL Course	Name of Instructor	Host Institute	Link
Business To Business Marketing (B2B)	Prof. J. K. Nayak	IIT Roorkee	Business To Business Marketing (B2B) – Course (nptel.ac.in)

MULTIDISCIPLINARY MINOR

DESIGN OF MECHATRONICS SYSTEMS

Weekly Teaching Hours	**TH: 03**	**Tu: 1**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Course Objectives:

1. Introduce students to the interdisciplinary nature of mechatronics, emphasizing the integration of mechanical engineering, electronics, control systems, and computer science.
2. Familiarize students with a variety of sensors and actuators commonly used in mechatronic systems, and explain their principles of operation and selection criteria.
3. Provide an understanding of control system theory, enabling students to design and implement closed-loop control strategies for mechatronic systems.
4. Introduce software development concepts, including programming languages, real-time operating systems, and software architecture for mechatronic applications.
5. Demonstrate techniques for integrating mechanical components, electronics, and software modules seamlessly, ensuring proper communication and synchronization.

Course Outcomes:

1. Apply knowledge to select appropriate sensors and actuators based on system requirements, considering factors such as accuracy, range, and compatibility.
2. Analyze and process sensor data using signal processing techniques, demonstrating the capability to extract meaningful information from noisy sensor measurements.
3. Proficiently program microcontrollers and embedded systems to interface with sensors, actuators, and other hardware components.
4. Integrate mechanical components and subsystems with electronics and software, ensuring seamless communication and optimal functionality.

UNIT I

Introduction: Elements of mechatronics system: Sensor, actuator, plant, and controller. Applications of mechatronics system. Systems like CDROM, scanner opened to see whats there inside and why? Integrated mechanical-electronics design philosophy. Examples of real-life systems. Smart sensor concept and utility of compliant mechanisms in mechatronics

UNIT II

Microprocessor building blocks, combinational and sequential logic elements, memory, timing, and instruction execution fundamentals with an example of the primitive microprocessor. Microcontrollers for mechatronics: Philosophy of programming interfaces, setting sampling time, and getting started with TIVA programming. Programming different interfaces PWM, QEI etc. Mathematical modelling of mechatronic systems.

UNIT III

Modelling friction, DC motor, and Lagrange formulation for system dynamics. Dynamics of 2R manipulator, Simulation using Matlab, Selection of sensors and actuators.

UNIT IV

Concept of feedback and closed loop control, mathematical representations of systems and control design in the linear domain. Basics of Lyapunov theory for nonlinear control, notions of stability, Lyapunov theorems and their application

UNIT V

Trajectory tracking control development based on Lyapunov theory, Basics of sampling of a signal, and signal processing.

UNIT VI

Digital systems and filters for practical mechatronic system implementation. Research example/ case studies of the development of the novel mechatronic system: 3D micro-printer, Hele-Shaw system for microfabrication.

Textbooks / References:

1. Devdas Shetty, Richard A. Kolk, ―Mechatronics System Design, PWS Publishing company.
2. Boukas K, Al-Sunni, Fouad M ―Mechatronic, Systems Analysis, Design and Implementation,‖ Springer,
3. Sabri Cetinkunt, ―Mechatronics with Experiments, 2nd Edition, Wiley.
4. Janschek, Klaus, ―Mechatronic Systems Design, Springer.

NPTEL Platform

NPTEL Course	Name of Instructor	Host Institute	Link
Design Of Mechatronic Systems	Prof. Prasanna Gandhi	IIT Bombay	Design Of Mechatronic Systems – Course (nptel.ac.in)

MULTIDISCIPLINARY MINOR

SUSTAINABLE POWER GENERATION SYSTEMS

Weekly Teaching Hours	**TH: 03**	**Tu: 1**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Course Objectives:

1. The course content is designed to provide comprehensive knowledge of various renewable energy systems. Specifically, in this course, the design and analysis of renewable energy power plants will be discussed.
2. The concepts will be illustrated with practical examples, schematics and block diagrams wherever required. Enough numerical problems with solutions will be discussed in the course.
3. This course is specifically designed for undergraduate and postgraduate students of Energy Engineering and Technology.
4. Further, the course will be very much useful for students and researchers from varied academic backgrounds for the synthesis of novel energy conversion devices and processes.

Course Outcomes:

1. Explain the principles of sustainability in the context of power generation and understand its significance in the global energy transition.
2. Identify and describe various renewable energy sources, including solar, wind, hydro, geothermal, and biomass, and explain their potential for power generation
3. Compare and contrast the advantages and limitations of different sustainable power generation technologies, considering factors such as efficiency, scalability, reliability, and intermittency.
4. Analyse the environmental, social, and economic impacts of both conventional and sustainable power generation methods, and evaluate their contributions to mitigating climate change and reducing pollution.

UNIT I

Introduction to power generation:

Global and Indian scenario, an overview of current technologies available for power

generation, Concept of the renewable energy-based power plant

Solar Thermal Power Generation:

Fundamentals of Solar thermal energy conversion, solar thermal based power plant design and analysis (flat plate and concentrator), ORC, RC, and Stirling engine.

UNIT II

Solar Photovoltaic Power Generation:

Fundamentals of Solar photovoltaic energy conversion, Solar PV power plant design, Performance analysis of standalone and grid-connected PV systems.

Wind Power Generation:

Introduction to wind turbine, classification and analysis of different components, Theory, design, and analysis of wind turbines (horizontal axis and vertical axis) and wind farms.

UNIT III

HydroPower Generation:

Introduction to hydropower plant, overview of micro, mini and small hydropower plants, hydraulic turbines, Selection and design criteria of pumps and turbines, Brief theory, design, and analysis of hydropower plants

Biomass Power Generation:

Fundamentals of bioenergy production technologies through different routes, design, and analysis of biochemical and thermochemical reactors for clean power generation and value-added products, IGCC.

UNIT IV

Hydrogen energy and fuel cells

Importance, various routes of hydrogen generation, basic principle, and design of different types of fuel cells and their applications, prospects, IGFC

Week 8: Module-8: Geothermal Energy

Fundamentals, classification, theory, design, and analysis of geothermal power plant

UNIT V

Ocean Thermal Energy

Fundamentals, classification, theory, design, and analysis of ocean thermal power plant Week 10: Module-10: Wave and Tidal Energy

Fundamentals, classification, theory, design, and analysis of wave and tidal power plant

UNIT VI

Energy Storage

Different modes of energy storage; design and analysis of different technologies for thermal, mechanical, and electrochemical energy storage systems

Week 12: Module-12: Energy Economics

Cost analysis, interest, accounting rate of return, Payback, Discounted cash flow, Net present value, internal rate of return, Inflation, and life cycle analysis of energy systems.

Textbooks / References:

1. J. Twidell, T. Weir, Renewable Energy Resources, Taylor and Francis, 4th Edition, 2021.

2. G. Boyle (Editor), Renewable Energy: Power for a Sustainable Future, Oxford University Press, 3rd Edition, 2012.

3**.** G. N. Tiwari, Solar Energy, Fundamentals, Design, Modeling and Applications, Narosa, 2002.

4**.** J. A. Duffie and W. A. Beckman, Solar Engineering of Thermal Processes, John Wiley, 4th Edition, 2013.

5. R. Gasch, J. Twele, Wind Power Plants: Fundamentals, Design, Construction and Operation, Springer, 2nd Edition, 2012.

6. P. Breeze, Hydropower, Elsevier, 1st Edition, 2018

7. S. C. Bhattacharyya, Energy Economics Concepts, Issues, Markets and Governance, Springer, 2nd Edition, 2019.

8. S.p Sukhatme and J.K. Nayak, Solar Energy: Principles of Thermal Collection and Storage, Tata Mc-Graw Hill Education Private Limited, 3rd Edition, 2010.

NPTEL Platform

NPTEL Course	Name of Instructor	Host Institute	Link
Sustainable Power Generation Systems	Dr. Pankaj Kalita	IIT Guwahati	Sustainable Power Generation Systems – Course (nptel.ac.in)

MULTIDISCIPLINARY MINOR

ETHICAL HACKING

Weekly Teaching Hours	**TH: 03**	**Tu: 1**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Course Objectives:

1. Introduce students to the concept of ethical hacking, its importance in cyber security, and the role of ethical hackers in identifying vulnerabilities.
2. Provide an overview of cyber security principles, threats, and attacks, highlighting the need for ethical hacking to strengthen defences.
3. Teach students a structured approach to hacking, including reconnaissance, scanning, gaining access, maintaining access, and covering tracks.
4. Cover essential network concepts to help students understand how networks function, including protocols, IP addressing, and network architecture.

Course Outcomes:

1. Gain a comprehensive understanding of ethical hacking concepts, methodologies, and its role in enhancing cyber security.
2. Acquire a solid grasp of cyber security principles, types of threats, and the importance of proactive defence strategies.
3. Develop proficiency in various hacking techniques, including reconnaissance, scanning, exploitation, and post-exploitation activities.
4. Perform effective vulnerability assessments on systems and networks, identifying potential security weaknesses and exposures.
5. Demonstrate the ability to conduct penetration tests, simulating real-world attacks to evaluate the strength of security measures.

UNIT I

Introduction to ethical hacking. Fundamentals of computer networking. TCP/IP protocol stack. IP addressing and routing. TCP and UDP. IP subnets. Routing protocols. IP version 6.

UNIT II

Installation of attacker and victim system. Information gathering using advanced google search,

archive.org, netcraft, whois, host, dig, dnsenum and NMAP tool.

UNIT III

Vulnerability scanning using NMAP and Nessus. Creating a secure hacking environment. System Hacking: password cracking, privilege escalation, application execution. Malware and Virus. ARP spoofing and MAC attack.

UNIT IV

Introduction to cryptography, private-key encryption, public-key encryption. Cryptographic hash functions, digital signature and certificate, applications. Steganography, biometric authentication, network-based attacks, DNS, and Email security.

UNIT V

Packet sniffing using Wireshark and Burpsuite, password attack using burp suite. Social engineering attacks and Denial of service attacks. Elements of hardware security: side-channel attacks, physical inclinable functions, hardware trojans.

UNIT VI

Different types of attacks using the Metasploit framework: password cracking, privilege escalation, remote code execution, etc. Attack on web servers: password attack, SQL injection, cross-site scripting.

Textbooks / References:

1. Data and Computer Communications -- W. Stallings.
2. Data Communication and Networking -- B. A. Forouzan
3. TCP/IP Protocol Suite -- B. A. Forouzan
4. UNIX Network Programming -- W. R. Stallings
5. Introduction to Computer Networks and Cyber security -- C-H. Wu and J. D. Irwin
6. Cryptography and Network Security: Principles and Practice -- W. Stalling

NPTEL Platform

NPTEL Course	Name of Instructor	Host Institute	Link
Ethical Hacking	Prof. Indranil Sengupta	IIT Kharagpur	Ethical Hacking – Course (nptel.ac.in)

MULTIDISCIPLINARY MINOR

ARTIFICIAL INTELLIGENCE AND MACHIN LEARNING

Weekly Teaching Hours	**TH: 03**	**Tu: 1**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Course Objectives:

1. Apply AI techniques to solve the given problems.
2. Implement trivial AI techniques on relatively large system
3. Explain uncertainty and Problem-solving techniques.
4. Compare various learning techniques.

Course Outcomes:

This course will enable students to

1. Identify the AI-based problems.
2. Apply techniques to solve AI problems.
3. Define learning and explain various logic inferences.
4. Discuss different learning techniques.

UNIT I

Introduction to AI and State space search, Introduction to unguided and guided search

UNIT II

Problems in search and solutions, Genetic algorithms, Neural Networks, BPNN, learning process in BPNN

UNIT III

Some other search methods and Admissibility, Planning, Game Playing

UNIT IV

Mini-max and other game-playing algorithms, using predicate logic for Knowledge Representation

UNIT V

Resolution and non-monotonic reasoning, Strong methods for Knowledge Representation; Fuzzy logic and CD, Scripts and Introduction to Expert systems, Developing expert systems

and Machine learning

Text/Reference Books:

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach. III Edition

2. E. Rich, K. Knight & S. B. Nair - Artificial Intelligence, 3/e, McGraw Hill.

3. Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, Prentice Hal of India.

4. G. Luger, ―Artificial Intelligence: Structures and Strategies for Complex Problem Solving‖, Fourth Edition, Pearson Education, 2002.

5. N.P. Padhy ―Artificial Intelligence and Intelligent Systems‖, Oxford University Press- 2015.

NPTEL Platform

NPTEL Course	Name of Instructor	Host Institute	Link
Artificial Intelligence and Machine Learning	By Prof. Bhushan Trivedi	GLS University	https://onlinecourses.swayam2.ac.in/cec21_cs08/preview

MULTIDISCIPLINARY MINOR

COMPONENTS AND APPLICATIONS OF INTERNET OF THINGS

Weekly Teaching Hours	**TH: 03**	**Tu: 1**		
Scheme of Marking	**TH: 60**	**Tests: 20**	**IA : 20**	**Total: 100**

Course Objectives:

1. The objective of this course is to learn about the Basics of IoT, Components of IoT including Sensors and actuators, computing, and communication systems.
2. It will also cover IoT Protocols, Security of IoT, Cloud-based design and AI/Deep learning-based analytics.

Course Outcomes:

1. Identify IoT Components: Recognize and classify key components of IoT systems, including sensors, actuators, communication protocols, and data processing units.
2. Explore IoT Communication: Understand various wireless and wired communication technologies used in IoT networks and their suitability for different application scenarios.
3. Design IoT Applications: Create IoT solutions by integrating hardware and software components, demonstrating proficiency in prototyping, programming, and data handling.
4. Analyse Data from IoT Devices: Collect, analyse, and interpret data generated by IoT devices to extract meaningful insights and support informed decision-making.

UNIT I

Basics of IoT

Introduction to the Internet of Things, various sensors, and sensing techniques. Technological trends in IoT. Impact of IoT on society. Review of various IoT application domains including agriculture, healthcare, manufacturing, device management, and vehicle-to-vehicle communication and wearable computing devices.

UNIT II

Microcontroller and Interfacing Techniques for IoT Devices

Introduction to IoT and architecture layers, IoT smart devices, Typical embedded computing

systems, Introduction to ARM architecture and programming method, Embedded system development: a case study, Introduction to interfacing techniques.

UNIT III

IoT Protocols & Security

Networking and basic networking hardware. Networking protocols, Interaction between software and hardware in an IoT device. IoT components and technologies to secure systems and devices.

Various security issues related to the IoT and security architectures. Hardware security threats and security vulnerabilities; protecting physical hardware

UNIT IV

Location Tracking

Introduction to device localization and tracking; different types of localization techniques: time-of-arrival (TOA) based, time-difference-of-arrival (TDOA) based, angle-of-arrival (AOA) based, received signal strength (RSS) based, Radio-Frequency Identification (RFID) based and fingerprinting based; Monte-Carlo tracking; Kalman filter based tracking; Cramer-Rao lower bound (CRLB) for device location estimator; Device diversity/heterogeneity issue in IoT networks.

UNIT V

Deep learning for IoT

This topic will focus on how to build a good model from past data to predict correctly when the system is provided with a data point. In this course, mostly, supervised learning will be considered. The basics of neural networks, activation functions, back-propagation, etc. will be covered. At the end, some of the challenges in the context of IoT will be mentioned.

UNIT VI

IoT Applications

Smart grid: Introduction to smart grid, Integration of IoT into smart grid, Standardization activities for IoT aided smart grid, Applications of IoT aided smart grid, Architectures for IoT sided smart grid, Prototypes, Applications of big data and cloud computing, Open Issues, and Challenges.

IoT-based Smart Home and Nano-grid Monitoring System

Sensor-Controller Coordination of a DC Microgrid in IoT Platform, Cyber-physical system, dc microgrid, DC-DC power converter, distributed energy generator, sensor control and controller design. Low-cost DC Nano-grid with Smart Remote Monitoring Unit, DC-DC converter modelling, closed-loop control, placement of IoT devices, sensors, microgrid, solar energy, and low-cost communication system design. Introduction, objective, components of the home monitoring system, control, and management, Zigbee, Wireless Sensor Network (WSN), Internet of Things (IoT).

Internet of Robotic Things (IoRT): Introduction to stationary and mobile robots; Brief introduction to localization, mapping, planning, and control of robotic systems; Introduction to cloud-enabled robotics; Applications of IoT in robotics; Architectures for IoRT; Examples and case studies; Open issues and challenges.

Textbooks / References:

It will be provided in each of the lecture sessions. (Refer NPTEL platform)

NPTEL Course	Name of Instructor	Host Institute	Link
Components And Applications of Internet of Things	Dr. Sanjoy Kumar Parida	Indian Institute of Technology Patna	https://onlinecourses.swayam2.ac.in/arp20_ap03/preview

INTERNSHIP

Weekly Teaching Hours	**TH: --**			
Scheme of Marking	**TH: --**	**IA = 50**	**OR/PR = 50**	**Total: 100**

Course Outcomes:

1. Able to develop a sound theoretical and practical knowledge of new technologies.
2. Able to develop domain-specific problem-solving and critical-thinking skills
3. Able to develop individual responsibility towards their internship goal as well as participate as an effective team member
4. Gain exposure to professional work culture & practices
5. Able to develop effective presentation & communication skills, and create proper documentation of the work

SEMINAR - II

Weekly Teaching Hours	**TH: --**			
Scheme of Marking	**TH: --**	**IA = 50**	**OR/PR = 50**	**Total: 100**

The seminar shall be on the state of the art in the area of the advanced communication of student‘s choice approved by an authority. The student shall submit the duly certified seminar report in standard format, for satisfactory completion of the work duly signed by the concerned guide and head of the Department/Institute.

PROJECT - I

Weekly Teaching Hours	**TH: --**	**PR = 4Hr**		
Scheme of Marking	**TH: --**	**IA = 50**	**OR/PR = 50**	**Total: 100**

Project I is an integral part of the final project work. In this, the student shall complete the partial work of the project which will consist of a problem statement, literature review, project overview, scheme of implementation that may include mathematical model/SRS/UML/ERD/block diagram/ PERT chart, and layout and design of the proposed system/work. As a part of the progress report of project-I work; the candidate shall deliver a presentation on the progress of the work on the selected dissertation topic.

It is desired to publish the paper on the state of the art on the chosen topic in an international conference/ journal.

The student shall submit the duly certified progress report of project -I in standard format for satisfactory completion of the work duly signed by the concerned guide and head of the department/institute.

FOURTH SEMESTER

PROJECT- II

Weekly Teaching Hours	**TH: --**	**PR = --**		
Scheme of Marking	**TH: --**	**IA = 100**	**OR/PR = 100**	**Total: 200**

In Project - II, the student shall complete the remaining part of the project which will consist of the simulation/ analysis/ synthesis/implementation/fabrication of the proposed project work, workstation, conducting experiments and taking results, analysis and validation of results and concluding.

It is mandatory to publish the paper on the state of the art on the chosen topic in an international conference/ journal.

The student shall prepare the duly certified final report of project work in standard format for satisfactory completion of the work duly signed by the concerned guide and head of the department/institute.