SCHEME & SYLLABUS

for

M.TECH. COURSE

in

Electronics & Communication Engineering

(w.e.f. Session 2026-2027)

DEPARTMENT OF ELECTRONICS ENGINEERING

J.C. BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA, FARIDABAD

J.C.BOSE UNIVERSITY OF SCIENCE & TECHNOLOGY, YMCA, FARIDABAD

VISION

J. C. Bose University of Science & Technology, YMCA, Faridabad (erstwhile YMCA University of Science and Technology) aspires to be a nationally and internationally acclaimed leader in technical and higher education in all spheres, which transforms the life of students through integration of teaching, research and character building.

MISSION

- To contribute to the development of science and technology by synthesizing teaching, research and creative activities.
- To provide an enviable research environment and state-of-the-art technological exposure to its scholars.
- To develop human potential to its fullest extent and make them emerge as world-class leaders in their professions and enthuse them towards their social responsibilities.

Department of Electronics Engineering

VISION

To be a Centre of Excellence for producing high-quality engineers and scientists capable of providing sustainable solutions to complex problems and promoting cost-effective indigenous technology in the area of Electronics, Communication & Control Engineering for Industry, Research Organizations, Academia and all sections of society.

MISSION

- To frame a well-balanced curriculum with an emphasis on basic theoretical knowledge as well as the requirements of the industry.
- To motivate students to develop innovative solutions to the existing problems for betterment of the society.
- Collaboration with the industry, research establishments and other academic institutions to bolster the research and development activities.
- To provide infrastructure and financial support for the culmination of novel ideas into useful prototypes.
- To promote research in emerging and interdisciplinary areas and act as a facilitator for knowledge generation and dissemination through Research, Institute - Industry and Institute-Institute interaction.

ABOUT THE DEPARTMENT

The Department of Electronics Engineering at J. C. Bose University of Science & Technology, YMCA, Faridabad (formerly YMCA University of Science & Technology, Faridabad) carries forward a distinguished legacy of technical education and industry-oriented learning. The University, established in 2009, evolved from the erstwhile YMCA Institute of Engineering, Faridabad, which was founded in 1969 as a joint venture between the Government of Haryana and the National Council of YMCA of India, with active support from overseas agencies of West Germany. The institution was established with the vision of developing highly skilled, practically oriented engineering professionals to meet the evolving technical manpower requirements of industry.

The Department of Electronics Engineering, established in 1969, has consistently contributed to academic excellence and technological advancement in electronics and allied domains. Since 1997, the Department has been offering undergraduate programmes leading to the B.Tech. degree in Electronics and Communication Engineering, Electronics Engineering (Specialization in Internet of Things), and Electronics and Computer Engineering, each of four years' duration. Admissions to the undergraduate programmes are conducted through centralized counselling as nominated by the State Government for first-year admissions, while admissions to the second year are offered through the lateral entry entrance process. In addition to undergraduate education, the Department offers postgraduate programmes leading to the M.Tech. degree in VLSI Design and Electronics & Communication Engineering. The Department also conducts Ph.D. programmes to promote advanced research and innovation in emerging areas of electronics and communication technologies.

All programmes offered by the Department are duly approved by AICTE and UGC and are designed to maintain strong academic standards while addressing contemporary industry requirements. The Department has established a strong reputation for producing competent engineering graduates with an excellent track record of student placements since its inception. To support quality teaching, learning, and research, the Department is equipped with robust academic infrastructure comprising 11 laboratories, 10 lecture halls, one conference room, and six workshops. The Department is supported by a dedicated and experienced faculty team consisting of 3 Professors, 6 Associate Professors, and 15 Assistant Professors. At present, 21 faculty members hold Ph.D. degrees across diverse areas of specialization, contributing significantly to teaching, research, consultancy, and academic development.

The curriculum of undergraduate and postgraduate programmes has been developed with active participation from industry to ensure relevance to current technological trends and professional requirements. The Department regularly organizes expert lectures and technical interactions with industry professionals each semester to strengthen the academic–industry interface. To enhance experiential learning and professional readiness, one semester of internship/training is mandatory for every B.Tech. student. Special emphasis is placed on project-based learning, laboratory practice, and workshop activities to promote innovation, problem-solving ability, and skill enhancement. The University follows a Choice Based Credit System (CBCS) and NEP, enabling students to pursue elective and audit courses according to their academic interests and career aspirations, thereby encouraging interdisciplinary learning and academic flexibility.

Program Educational Objectives (PEO):

Students of the Master of Technology programs in Electronics & Communication Engineering will demonstrate

1. Employability in the diversified sectors of the core industry, public sector or multinational corporations in the domain of semiconductor, microelectronics, wireless communication, optical and satellite communication, networking, etc., and/or pursue higher education in technologies related to communication and networking platforms at institutes of high repute.
2. To provide technical skills in software and hardware tools related to the design and implementation of Communication and Embedded Systems
3. To inculcate research culture in the learners of the program with abilities to publish at national/international level and develop prototype technologies in the related domain.
4. Attitude of lifelong learning and skills of effective interpersonal communication resulting in leading diverse teams, with ethical and social behaviour.

Program Outcomes (PO):

1. Ability to acquire and apply in-depth knowledge in the area of Electronics and Communication Engineering and contribute to the state-of-the-art.
2. An ability to independently carry out research /investigation and development work to solve practical problems
3. An ability to write and present a substantial technical report/document
4. An Ability to engage in life-long learning and learning through mistakes with/without external feedback.
5. An ability to understand the role of a leader, leadership principles and attitude conducive to effective professional practice of Electronics and Communication Engineering
6. An ability to understand the impact of research and responsibility to contribute to society.

GRADING SCHEME

Marks %	**Grade**	**Grade points**	**Category**
90-100	O	10	Outstanding
80 ≤ marks <90	A+	9	Excellent
70 ≤ marks < 80	A	8	Very good
60 ≤ marks < 70	B+	7	Good
50 ≤ marks < 60	B	6	Above average
45 ≤ marks < 50	C	5	Average
40 ≤ marks < 45	P	4	Pass
<40	F	0	Fail
	Ab	0	Absent

Percentage calculation= CGPA * 9.5

M. TECH. (Electronics & Communication Engineering)

Total Credits	**68**
Total Theory Subjects	**11+2 Audits**
Total Labs (including Projects)	**5**
Total Dissertation	**2**

SEMESTER-WISE SUMMARY OF THE PROGRAMME: M.TECH. (ECE)

S.No.	Semester	No. of Contact Hours	Marks	Credits
1	I	24	700	18
2	II	26	650	18
3	III	26	500	16
4	IV	32	500	16
5	MOOCs	-	-	6*
Total		108	2350	74

Note:

1. The scheme will be applicable from Academic Session 2019-20 onwards.
2. ***It is mandatory to pass the MOOC course(s) by all the students as per implementation of credit transfer/ mobility policy of on line courses of the University-as mentioned in Annexure-A at the end of the syllabus.**

Semester I

M. Tech. (Electronics & Communication Engineering)

Sr. No.	Category	Course Code	Course Title	Hours per week			Credits	Sessional Marks	Final Marks	Total
				L	T	P				
1	PCC	EEP-101-V1	Advanced Communication Networks	3	0	0	3	40	60	100
2	PCC	EEP-103-V1	Wireless and Mobile Communication	3	0	0	3	40	60	100
3	PEC		Program Specific Elective-I	3	0	0	3	40	60	100
4	PEC		Program Specific Elective-II	3	0	0	3	40	60	100
5	PCC	VAC-301-V1	Research Methodology and IPR	2	0	0	2	40	60	100
6	AUD		Audit course 1	2	0	0	0	40	60	100
7	PCC	EEP-105-V1	Advanced Communication Networks Lab	0	0	4	2	25	25	50
8	PCC	EEP-107-V1	Wireless and Mobile Communication Lab	0	0	4	2	25	25	50
			Total Credits				**18**	290	410	700

	Course Code	Old Code / Old Name	Course Title
Program Elective-I	EEP-109-V1	Wireless Sensor Networks (Old Name)	Advanced Wireless Sensor Networks
	EEP-111-V1		Optical Communication and Network System
	EEP-113-V1		Statistical Information Processing
Program Elective-II	EEP-115-V1		Cognitive Radio
	EEP-117-V1		RF and Microwave Circuit Design
	EEP-119-V1		DSP Architecture
	EEP-121-V1		Advanced Microprocessor and Microcontroller

AUD 1	**AEC-301-V1**	English for Research Paper Writing
	VAC-302-V1	Disaster Management
	AEC-302-V1	Sanskrit for Technical Knowledge
	VAC-303-V1	Value Education
	VAC-112-V1	Constitution of India
	VAC-304-V1	Pedagogy Studies
	AEC-317-V1	Stress Management by Yoga
	AEC-304-V1	Personality Development through Life Enlightenment Skills.
	AEC-305-V1	Swami Vivekananda's thoughts

Semester II

M. Tech. (Electronics & Communication Engineering)

Sr. No.	Category	Course Code	Course Title	Hours per week			Credits	Sessional Marks	Final Marks	Total
				L	T	P				
1	PCC	EEP-102-V1	Antennas and Radiating Systems	3	0	0	3	40	60	100
2	PCC	EEP-104-V1	Advanced Digital Signal Processing	3	0	0	3	40	60	100
3	PEC		Program Specific Elective-III	3	0	0	3	40	60	100
4	PEC		Program Specific Elective-IV	3	0	0	3	40	60	100
5	AUD		Audit course 2	2	0	0	0	40	60	100
6	PCC	EEP-106-V1	Antennas and Radiating Systems Lab	0	0	4	2	25	25	50
7	PCC	EEP-108-V1	Advanced Digital Signal Processing Lab	0	0	4	2	25	25	50
8	PCC	EEP-110-V1	Minor Project	0	0	4	2	25	25	50
			Total Credits				**18**	275	375	650

	Course Code	Old Course Code / Old Course Name	Course Title
Program Elective-III	EEP-112-V1		Satellite Communication
	EEP-114-V1	**Internet of things**	Advances in Internet of Things
	EEP-116-V1		Voice and data networks
	EEP-118-V1		Digital Image Processing
Program Elective-IV	EEP-120-V1		Markov Chain and Queuing System
	EEP-122-V1		MIMO System
	EEP-124-V1		Programmable Networks – SDN, NFV
	EEP-126-V1		Advanced Digital Communication

AUD 2 (Audit 2 should be different from audit 1)	**AEC-301-V1**	English for Research Paper Writing
	VAC-302-V1	Disaster Management
	AEC-302-V1	Sanskrit for Technical Knowledge
	VAC-303-V1	Value Education
	VAC-112-V1	Constitution of India
	VAC-304-V1	Pedagogy Studies
	AEC-317-V1	Stress Management by Yoga
	AEC-304-V1	Personality Development through Life Enlightenment Skills.
	AEC-305-V1	Swami Vivekananda's thoughts

EEP-101-V1 **Advanced Communication Network**

L T P CR			
3 0 0 3	**Theory**	**:**	**60**
	Class Work	**:**	**40**
	Total	**:**	**100**
	Duration of Exam	**:**	**3 Hrs.**

Course Objectives:

- To introduce the advanced concepts in Communication Networking.
- To introduce the designing of protocols for Communication Networks.
- To introduce the mechanisms in Quality of Service in networking.
- To introduce network design

Syllabus

Unit 1: Overview of Internet-Concepts, challenges and history, Overview of –ATM, TCP/IP Congestion and Flow Control in Internet-Throughput analysis of TCP congestion control. TCP for high bandwidth delay networks. Fairness issues in TCP.

Unit 2: Real-Time Communications over the Internet, Adaptive applications. Latency and throughput issues. Integrated Services Model (intServ). Resource reservation in the Internet. RSVP, Characterization of Traffic by Linearly Bounded Arrival Processes (LBAP). Leaky bucket algorithm and its properties.

Unit 3: Packet Scheduling Algorithms-requirements and choices, Scheduling guaranteed service connections, GPS, WFQ and rate-proportional algorithms, High speed scheduler design, Theory of Latency Rate servers and delay bound in packet switched networks for LBAP traffic.; Active Queue Management, RED, WRED and Virtual clock, Control theoretic analysis of active queue management.

Unit 4: IP address lookup-challenges, Packet classification algorithms and Flow Identification-Grid of Tries, cross-producing and controlled prefix expansion algorithms.

Unit 5: Admission control in the Internet. Concept of Effective bandwidth. Measurement-based admission control, Differentiated Services in Internet (DiffServ), DiffServ architecture and framework.

Unit 6: IPV4, IPV6, IP tunnelling, IP switching and MPLS, Overview of IP over ATM and its evolution to IP switching, MPLS architecture and framework, MPLS Protocols, Traffic engineering issues in MPLS.

Course Outcomes: On successful completion of this course, the students should be able to:

- Understand advanced concepts in Communication Networking.
- Design and develop protocols for Communication Networks.
- Understand the mechanisms in Quality of Service in networking.
- Optimise the Network Design

References:

1. Jean Wairand and Pravin Varaiya, “High Performance Communications Networks”, 2nd edition, 2000.
2. Jean Le Boudec and Patrick Thiran, “Network Calculus A Theory of Deterministic Queueing Systems for the Internet”, Springer Veriag, 2001.
3. Zhang Wang, “Internet QoS”, Morgan Kaufman, 2001.
4. Anurag Kumar, D. Manjunath and Joy Kuri, “Communication Networking: An Analytical Approach” , Morgan Kaufman Publishers, 2004.
5. George Kesidis, “ATM Network Performance”, Kluwer Academic, Research Papers, 2005

EEP-103-V1 **Wireless and Mobile Communication**

L T P CR	**Theory**	**: 60**
3 0 0 3	**Class Work**	**: 40**
	Total	**: 100**
	Duration of Exam	**: 3 Hrs.**

Course Objectives:

- To study the concepts fundaments of cellular system design and evolution of mobile communication generations.
- To study the concept of FDMA, TDMA, CDMA.
- To study the concept of large sale propagation small scale propagation, fading & multipath propagation.
- To study the concept of Equalization & diversity.
- To study the concept of 4G & 5G.

Syllabus

Unit 1: Cellular Communication Fundamentals, Cellular system design, Frequency reuse, cell splitting, handover concepts, Co channel and adjacent channel interference, interference reduction techniques and methods to improve cell coverage, Frequency management and channel assignment.GSM architecture and interfaces, GSM architecture details, GSM subsystems, GSML logical Channels, Data Encryption in GSM, Mobility Management, Call Flows in GSM.2.5 G Standards: High speed Circuit Switched Data (HSCSD), General Packet Radio Service (GPRS),2.75 G Standards: EDGE,

Unit 2: Spectral efficiency analysis based on calculations for Multiple access technologies, TDMA, FDMA and CDMA, Comparison of these technologies based on their signal separation techniques, advantages, disadvantages and application areas, Wireless network planning (Link budget and power spectrum calculations)

Unit 3: Mobile Radio Propagation: Large Scale Path Loss, Free Space Propagation Model, Reflection, Ground Reflection (Two-Ray) Model, Diffraction, Scattering, Practical Link Budget Design using Path Loss Models, Outdoor Propagation Models, Indoor Propagation Models, Signal Penetration into Buildings. Small Scale Fading and Multipath Propagation, Impulse Response Model, Multipath Measurements, Parameters of Multipath channels, Types of Small Scale Fading: Time Delay Spread; Flat, Frequency selective, Doppler Spread; Fast and Slow fading.

Unit 4: Equalization, Diversity, Equalizers in a communications receiver, Algorithms for adaptive equalization, diversity techniques, space, polarization, frequency diversity, Interleaving.

Unit 5: Code Division Multiple Access, Introduction to CDMA technology, IS 95 system Architecture, Air Interface, Physical and logical channels of IS 95, Forward Link and Reverse link operation, Physical and Logical channels of IS 95 CDMA, IS 95 CDMA Call Processing, soft Handoff, Evolution of IS 95 (CDMA One) to CDMA 2000, CDMA 2000 layering structure and channels.

Unit 6: Higher Generation Cellular Standards:3G Standards: evolved EDGE, enhancements in 4G standard, Architecture and representative protocols, call flow for LTE, VoLTE, UMTS, introduction to 5G

Course Outcomes: On successful completion of this course, the students should be able to:

- Design appropriate mobile communication systems.
- Apply frequency-reuse concept in mobile communications, and to analyze its effects on interference, system capacity, handoff techniques
- Distinguish various multiple-access techniques for mobile communications e.g. FDMA, TDMA, CDMA, and their advantages and disadvantages.
- Analyze path loss and interference for wireless telephony and their influences on a mobile communication system's performance.
- Analyze and design CDMA system functioning with knowledge of forward and reverse channel details, advantages and disadvantages of using the technology
- Understanding upcoming technologies like 3G, 4G etc.

References:

1. V.K.Garg, J.E.Wilkes, "Principle and Application of GSM", Pearson Education, 5th edition, 2008.
2. V.K.Garg, "IS-95 CDMA & CDMA 2000", Pearson Education, 4th edition, 2009.
3. T.S.Rappaport, "Wireless Communications Principles and Practice", 2nd edition, PHI,2002.
4. William C.Y.Lee, "Mobile Cellular Telecommunications Analog and Digital Systems", 2nd edition, TMH, 1995.
5. Asha Mehrotra, "A GSM system Engineering" Artech House Publishers Bosten, London,1997.

Program Elective –I

EEP-109-V1 **Advanced Wireless Sensor Networks**

Wireless Sensor Networks (old subject name)

L T P CR			
3 0 0 3	**Theory**	**:**	**60**
	Class Work	**:**	**40**
	Total	**:**	**100**
	Duration of Exam	**:**	**3 Hrs.**

Course Objectives:

- To study the concept of different wireless networks.
- To introduce basic tools used for simulation of wireless networks.
- To introduce the basic concept of security in WSM.
- To study the hardware of various wireless networks with a brief overview of protocols for sensor networks.

Syllabus

Unit 1: Introduction and overview of sensor network architecture and its applications, sensor network comparison with Ad Hoc Networks, Sensor node architecture with hardware and software details.

Unit 2: Hardware, Examples like mica2, micaZ, telosB, cricket, Imote2, tmote, btnode, and Sun SPOT; software (Operating Systems): tinyOS, MANTIS, Contiki, and RetOS.

Unit 3: Programming tools, C, nesC. Performance comparison of wireless sensor networks simulation and experimental platforms like open source (ns-2) and commercial (QualNet, Opnet)

Unit 4: Overview of sensor network protocols (details of atleast 2 important protocol per layer), Physical, MAC and routing/ Network layer protocols, node discovery protocols, multi hop and cluster-based protocols, Fundamentals of 802.15.4, Bluetooth, BLE (Bluetooth low energy), UWB.

Unit 5: Data dissemination and processing, differences compared with other database management systems, data storage; query processing.

Unit 6: Specialized features, Energy preservation and efficiency, security challenges; fault tolerance, Issues related to Localization, connectivity and topology, Sensor deployment mechanisms, coverage issues, sensor Web; sensor Grid, Open issues for future research, and enabling technologies in wireless sensor network.

Course Outcomes: On successful completion of this course, the students should be able to:

- Design wireless sensor network systems for different applications under consideration.
- Understand the hardware details of different types of sensors and select the right type of sensor for various applications.
- Understand radio standards and communication protocols to be used for wireless sensor network-based systems and application.
- Use operating systems and programming languages for wireless sensor nodes, performance of wireless sensor network systems and platforms.
- Handle special issues related to sensors like energy conservation and security challenges.

References:

1. H. Karl and A. Willig, “Protocols and Architectures for Wireless Sensor Networks”, John Wiley & Sons, India, 2012.
2. C. S. Raghavendra, K. M. Sivalingam, and T. Znati, Editors, “Wireless Sensor Networks”, Springer Verlag, 1st Indian reprint, 2010.
3. F. Zhao and L. Guibas, “Wireless Sensor Networks: An Information Processing Approach”, Morgan Kaufmann, 1st Indian reprint, 2013.
4. Yingshu Li, MyT. Thai, Weili Wu, “Wireless Sensor Network and Applications”, Springer series on signals and communication technology, 2008.

EEP-111-V1 **Optical Communication and Network System**

L T P CR		
3 0 0 3	**Theory**	**: 60**
	Class Work	**: 40**
	Total	**: 100**
	Duration of Exam	**: 3 Hrs.**

Course Objectives:

1. To introduce the students about Basic of optical communication systems and elements of fibre communication links
2. To introduce the students to the basic theory of optics, ray theory and electromagnetic mode theory for optical propagation
3. To introduce the students to the transmission characteristics of optical fibres, attenuation and their types, Dispersion and mathematical expressions
4. To introduce the students to the basic principles of optical sources like LED and LASER and their characteristics and applications.
5. To introduce the students to the basic principles of optical detectors, characteristics of p-n photodiode and p-i-n photodiode & APD.
6. To introduce the students to driver circuits for LED and LASER operation, Optical receiver, Link power budget, Rise time budget.

Syllabus

Unit 1 – Overview of Optical Fibre Communication

Electromagnetic Spectrum, Optical spectral bands, Elements of an optical fibre transmission link, Transmission windows, Advantage of optical fibre link over conventional copper system, Applications of fibre optic transmission systems

Unit 2 – Optical Fibre Structure, Waveguide and Fabrications

Optical laws and definitions, Total internal reflection, Acceptance angle, Numerical aperture, Ray optics, Optical fibre modes and configurations, Mode theory, Step index and graded index fibres, Single mode and multimode fibres, V number, Modes supported by step index and graded index fibre, Fibre materials, Fibre fabrication techniques

Unit 3 – Signal Degradation in Optical Fibres

Attenuation – Absorption losses, Scattering losses, Bending losses, Core and Cladding losses; Dispersion – Intermodal and Intramodal dispersion, Overall fibre dispersion, Dispersion optimization of single mode fibre, dispersion shifted fibres, dispersion flattened fibres.

Unit 4 – Optical Sources and Coupling

Direct and indirect band gap semiconductor, LED structures, Light source materials, Quantum efficiency, LED power, Spectral width, Modulation bandwidth, LED to fibre coupling, LASER diode, Modes and threshold condition, External quantum efficiency, Temperature effects, Light source linearity, LASER to fibre coupling

Unit 5 – Photodetectors

Principle for optical detection, Photocurrent and absorption coefficient, Quantum efficiency, Responsivity, Long wavelength cut-off, P-N photodiode, P-I-N photodiode, Avalanche photodiode (APD), APD noise, Comparison of photodetectors

Unit 6 – Optical Transmitter & Receiver Systems

Consideration for optical transmitter circuits, Drive circuits for LED operation, Drive circuits for LASER operation, Point-to-point link system considerations, Link power budget and rise time budget, Methods for design of optical link, Optical receiver, Pre-amplifier, Coherent detection, Heterodyne detection, Homodyne detection.

Unit 7 – Optical Networks

Basic Networks - SONET/SDH- Broadcast, WDM network elements, Optical line terminals and connectors, Operation principle of WDM, Performance of WDM, Nonlinear effects on network performance, Optical time division multiplexing, Synchronization.

COURSE OUTCOMES:

On successful completion of this course, the students should be able to:

1. Understand basic of optical communication systems and their advantages over conventional communication systems. Application and limitations of optical communication.
2. Understand the basic theory of optics and different types of optical fibres.
3. Understand basic transmission characteristics of optical fibre like attenuation and dispersion.
4. Understand the basic principle of optical sources like LED and LASER, their characteristics.
5. Understand principal of optical detectors like p-n photodiode p-i-n photodiode and APD.
6. Understand basic driver circuits for LED and LASER operation, concept of Optical receiver, Link power budget and rise time budget calculation,

TEXTBOOKS:

1. John Gowar, "Optical Communication Systems", PHI.
2.Gerd Keiser, "Optical Fiber Communication", TMH

REFERENCE BOOKS:

1. Franz JH & Jain VK, "Optical Communication", Narosa Pub Ins
2. John M. Senior, "Optical Communication", PHI

EEP-113-V1 **Statistical Information Processing**

L T P CR

3 0 0 3

Theory : 60

Class Work : 40

Total : 100

Duration of Exam : 3 Hrs.

Course Objectives:

- To introduce the random variable and random process.
- To study random signal modelling.
- To introduce statistical decision theory.
- To study spectral analysis.
- To introduce information theory and source coding and their application.

Syllabus

Unit 1: Review of random variables: Probability Concepts, distribution and density functions, moments, independent, uncorrelated and orthogonal random variables; Vector-space representation of Random variables, Vector quantization, Tchebaychef inequality theorem, Central Limit theorem, Discrete &Continuous Random Variables. Random process: Expectations, Moments, Ergodicity, Discrete-Time Random Processes, Stationary process, autocorrelation and autocovariance functions, Spectral representation of random signals, Properties of power spectral density, Gaussian Process and White noise process.

Unit 2: Random signal modelling: MA(q), AR(p), ARMA(p,q) models, Hidden Markov Model & its applications, Linear System with random input, Forward and Backward Predictions, Levinson-Durbin Algorithm.

Unit 3: Statistical Decision Theory: Bayes' Criterion, Binary Hypothesis Testing, M-ary Hypothesis Testing, Minimax Criterion, Neyman-Pearson Criterion, Composite Hypothesis Testing. Parameter Estimation Theory: Maximum Likelihood Estimation, Generalized Likelihood Ratio Test ,Some Criteria for Good Estimators, Bayes' Estimation Minimum Mean-Square Error Estimate, Minimum, Mean Absolute Value of Error Estimate Maximum A Posteriori Estimate , Multiple Parameter Estimation Best Linear Unbiased Estimator ,Least-Square Estimation Recursive Least-Square Estimator.

Unit 4: Spectral analysis: Estimated autocorrelation function, Periodogram, Averaging the periodogram (Bartlett Method), Welch modification, Parametric method, AR(p) spectral estimation and detection of Harmonic signals.

Unit 5:Information Theory and Source Coding: Introduction, Uncertainty, Information and Entropy, Source coding theorem, Huffman, Shanon Fano, Arithmetic , Adaptive coding , RLE, LZW Data compaction, LZ-77, LZ-78. Discrete Memory less channels, Mutual information, channel capacity, Channel coding theorem, Differential entropy and mutual information for continuous ensembles.

Unit 6:Application of Information Theory: Group, Ring & Field, Vector, GF addition, multiplication rules. Introduction to BCH codes, Primitive elements ,Minimal polynomials, Generator polynomials in terms of Minimal polynomials, Some examples of BCH codes,& Decoder, Reed- Solomon codes & Decoder, Implementation of Reed Solomon encoders and decoders

Course Outcomes: On successful completion of this course, the students should be able to:

- Characterize and apply probabilistic techniques in modern decision systems, such as information systems, receivers, filtering and statistical operations.
- Demonstrate mathematical modelling and problem solving using such models.
- Comparatively evolve key results developed in this course for applications to signal processing, communications systems.
- Develop frameworks based in probabilistic and stochastic themes for modelling and analysis of various systems involving functionalities in decision making, statistical inference, estimation and detection.

References:

1. Papoulis and S.U. Pillai, "Probability, Random Variables and Stochastic Processes",4th Edition, McGraw-Hill, 2002.
2. D.G. Manolakis, V.K. Ingle and S.M. Kogon, "Statistical and Adaptive Signal Processing", McGraw Hill, 2000.
3. Mourad Barkat , "Signal Detection and Estimation", Artech House, 2nd Edition, 2005.
4. R G. Gallager, "Information theory and reliable communication", Wiley, 1st edition, 1968.
5. F. J. MacWilliams and N. J. A. Sloane, "The Theory of Error-Correcting Codes", New York, North-Holland, 1977.
6. Rosen K.H, "Elementary Number Theory", Addison-Wesley, 6th edition, 2010.

Program Elective –II

EEP-115-V1 **Cognitive Radio**

L T P CR

3 0 0 3

Theory	**:**	**60**
Class Work	**:**	**40**
Total	**:**	**100**
Duration of Exam	**:**	**3 Hrs.**

Course Objective:

- To introduce the student about fundament concepts & applications of cognitive radio networks.
- To design and make the students understand technologies to allow an efficient use of TVWS for radio communication based on two spectrum sharing business models/ policies.
- To introduce the students to designing cognitive radio techniques as well as some optimisation techniques
- To introduce the students to the fundamentals of dynamic spectrum access, radio resource management & trading issues.

Syllabus

Unit 1: Introduction to Cognitive Radios: Digital dividend, cognitive radio (CR) architecture, functions of cognitive radio, dynamic spectrum access (DSA), components of cognitive radio, spectrum sensing, spectrum analysis and decision, potential applications of cognitive radio.

Unit 2: Spectrum Sensing: Spectrum sensing, detection of spectrum holes (TVWS), collaborative sensing, geo-location database and spectrum sharing business models (spectrum of commons, real-time secondary spectrum market).

Unit 3: Optimization Techniques of Dynamic Spectrum Allocation: Linear programming, convex programming, non-linear programming, integer programming, dynamic programming, stochastic programming.

Unit 4: Dynamic Spectrum Access and Management: Spectrum broker, cognitive radio architectures, centralized dynamic spectrum access, distributed dynamic spectrum access, learning algorithms and protocols.

Unit 5: Spectrum Trading: Introduction to spectrum trading, classification of spectrum trading, radio resource pricing, brief discussion on economic theories in DSA (utility, auction theory), classification of auctions (single auctions, double auctions, concurrent, sequential).

Unit 6: Research Challenges in Cognitive Radio: Network layer and transport layer issues, cross-layer design for cognitive radio networks.

Course Outcomes: On successful completion of this course, the students should be able to:

- Understand the fundamental concepts of cognitive radio networks.
- Develop cognitive radio, as well as techniques for spectrum hole detection that cognitive radio takes advantage of to exploit it.
- Understand technologies to allow an efficient use of TVWS for radio communications based on two spectrum sharing business models/policies.
- Understand fundamental issues regarding dynamic spectrum access, radio-resource management and trading, as well as several optimisation techniques for better spectrum exploitation.

References:

1. Ekram Hossain, Dusit Niyato, Zhu Han, "Dynamic Spectrum Access and Management in Cognitive Radio Networks", Cambridge University Press, 2009.
2. Kwang-Cheng Chen, Ramjee Prasad, "Cognitive radio networks", John Wiley & Sons Ltd., 2009.
3. Bruce Fette, "Cognitive radio technology", Elsevier, 2nd edition, 2009.
4. Huseyin Arslan, "Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems", Springer, 2007.
5. Francisco Rodrigo Porto Cavalcanti, Soren Andersson, "Optimizing Wireless Communication Systems" Springer, 2009.
6. Linda Doyle, "Essentials of Cognitive Radio", Cambridge University Press, 2009.

EEP-117-V1 **RF and Microwave Circuit Design**

L T P CR **Theory : 60**

3 0 0 3 **Class Work : 40**

Total : 100

Duration of Exam : 3 Hrs.

Course Outcomes:

- To study the concept of transmission line theory.
- To familiarize with microwave network analysis.
- To study microwave components and semiconductor devices.
- To study the concept of amplifier design.

Syllabus

Unit 1: Transmission Line Theory: Lumped element circuit model for transmission line, field analysis, Smith chart, quarter wave transformer, generator and load mismatch, impedance matching and tuning.

Unit 2: Microwave Network Analysis: Impedance and equivalent voltage and current, Impedance and admittance matrix, the scattering matrix, transmission matrix, Signal flow graph.

Unit 3: Microwave Components: Microwave resonators, Microwave filters, power dividers and directional couplers, Ferromagnetic devices and components.

Unit 4: Nonlinearity and Time Variance Inter: symbol interference, random process & noise, definition of sensitivity and dynamic range, conversion gain and distortion.

Unit 5: Microwave Semiconductor Devices and Modeling: PIN diode, Tunnel diodes, Varactor diode, Schottky diode, IMPATT and TRAPATT devices, transferred electron devices, Microwave BJTs, GaAs FETs, low-noise and power GaAs FETs, MESFET, MOSFET, HEMT.

Unit 6: Amplifier Design: Power gain equations, stability, impedance matching, constant gain and noise figure circles, small signal, low noise, high power and broadband amplifier, oscillators, mixer design.

Course Outcomes: On successful completion of this course, the students should be able to:

- Understand the behaviour of RF passive components and model active components and perform transmission line analysis.
- Demonstrate use of Smith Chart for high frequency circuit design.
- Justify the choice/selection of components from the design aspects.
- Contribute in the areas of RF circuit design.

References:

1. Matthew M. Radmanesh, “Advanced RF & Microwave Circuit Design: The Ultimate Guide to Superior Design”, AuthorHouse, 2009.
2. D.M.Pozar, “ Microwave engineering” ,Wiley, 4th edition, 2011.
3. R.Ludwig and P.Bretchko, “R. F. Circuit Design”, Pearson Education Inc, 2009.
4. G.D. Vendelin, A.M. Pavoi, U. L. Rohde, “Microwave Circuit Design Using Linear And Non Linear Techniques”, John Wiley 1990.
5. S.Y. Liao, “Microwave circuit Analysis and Amplifier Design”, Prentice Hall 1987.
6. Radmanesh, “RF and Microwave Electronics Illustrated” , Pearson Education, 2004.

EEP-119-V1 **DSP Architecture**

L T P CR
3 0 0 3

Theory : 60
Class Work : 40
Total : 100
Duration of Exam : 3 Hrs.

Course Outcomes:

- To introduce programmable DSP Hardware & special architecture modules.
- To familiarize with DSP processors, structural & architectural considerations.
- To study Multicourse DSPs, HPC, MPI, Multicourse DSP as HPC.
- To familiarize with FPGA based DSP systems & VLIW Architecture.

Syllabus

Unit 1 : Programmable DSP Hardware: Processing Architectures (von Neumann, Harvard), DSP core algorithms (FIR, IIR, Convolution, Correlation, FFT), IEEE standard for Fixed and Floating Point Computations, Special Architecture Modules used in Digital Signal Processors (like MAC unit, Barrel shifters), On-Chip peripherals, DSP benchmarking.

Unit 2: Structural and Architectural Considerations: Parallelism in DSP processing, Texas Instruments TMS320 Digital Signal Processor Families, Fixed Point TI DSP Processors: TMS320C1X and TMS320C2X Family, TMS320C25 –Internal Architecture, Arithmetic and Logic Unit, Auxiliary Registers, Addressing Modes (Immediate, Direct and Indirect, Bit reverse Addressing), Basics of TMS320C54x and C55x Families in respect of Architecture improvements and new applications fields, TMS320C5416 DSP Architecture, Memory Map, Interrupt System, Peripheral Devices, Illustrative Examples for assembly coding.

Unit 3: VLIW Architecture: Current DSP Architectures, GPUs as an alternative to DSP Processors, TMS320C6X Family, Addressing Modes, Replacement of MAC unit by ILP, Detailed study of ISA, Assembly Language Programming, Code Composer Studio, Mixed Cand Assembly Language programming, On-chip peripherals, Simple applications development as an embedded environment.

Unit 4: Multi-core DSPs: Introduction to Multi-core computing and applicability for DSP hardware, Concept of threads, introduction to P-threads, mutex and similar concepts, heterogeneous and homogeneous multi-core systems, Shared Memory parallel programming, OpenMP approach of parallel programming, PRAGMA directives, OpenMP Constructs for work sharing like for loop, sections, TI TMS320C6678 (Eight Core subsystem).

Unit 5: FPGA-based DSP Systems: Limitations of P-DSPs, Requirements of Signal processing for Cognitive Radio (SDR), FPGA-based signal processing design-case study of a complete design of a DSP processor.

Unit 6: High-Performance Computing using P-DSP: Preliminaries of HPC, MPI, OpenMP, multicore DSP as HPC infrastructure.

Course Outcomes: On successful completion of this course, the students should be able to:

- Identify and formalize architectural-level characterization of P-DSP hardware
- Ability to design, program (assembly and C), and test code using the Code Composer Studio environment

- Deployment of DSP hardware for Control, Audio and Video Signal processing applications
- Understanding of major areas and challenges in DSP based embedded systems

References:

1. M. Sasikumar, D. Shikhare, Ravi Prakash, "Introduction to Parallel Processing", 1st Edition, PHI, 2006.
2. Fayez Gebali, "Algorithms and Parallel Computing",1st Edition, John Wiley & Sons, 2011
3. Rohit Chandra, Ramesh Menon, Leo Dagum, David Kohr, DrorMaydan, Jeff McDonald,"Parallel Programming in OpenMP", 1st Edition, Morgan Kaufman,2000.
4. Ann Melnichuk,Long Talk, "Multicore Embedded systems", 1st Edition, CRC Press,2010.
5. Wayne Wolf, "High Performance Embedded Computing: Architectures, Applications and Methodologies", 1st Edition, Morgan Kaufman, 2006.
6. E.S.Gopi, "Algorithmic Collections for Digital Signal Processing Applications Using MATLAB", 1st Edition, Springer Netherlands,2007.

EEP-121-V1 ADVANCED MICROPROCESSOR & MICROCONTROLLERS

L T P CR			
3 0 0 3	**Theory**	**:**	**60**
	Class Work	**:**	**40**
	Total	**:**	**100**
	Duration of Exam	**:**	**3 Hrs.**

Course Objective:

- To introduce students to the design of basic microprocessor architectural concepts, memory addressing architectural & ALU.
- To introduce the students to various types of instruction interrupts and I/O devices.
- To introduce the students to 8051architectural, programming model & instructions.
- To introduce the students regarding architectural of advanced microprocessors, addressing models, instruction set & interrupts.
- To introduce the students regarding interfacing I/O devices, A/D converter & D/A convertors to microprocessor.
- To introduce the students to developing microprocessor-based products.

Syllabus

Unit 1 Design of basic microprocessor architectural Concepts: Microprocessor architecture, word Lengths, addressable memory, microprocessor speed, architectural characteristics, registers, instructions, memory addressing architecture, ALU, GPRs, control logic & internal data bus.

Unit 2 Microprocessor Instructions &Communication: Instruction Set, Mnemonics, Basic Instruction Types, addressing modes, Microprocessor I/O: connecting I/O port to Microprocessor, Polling and Interrupts, Interrupts and Interrupt Controllers.

Unit 3 Microcontroller: Introduction: 8051 architecture and programming model. Internal RAM and registers, I/O ports, interrupt system &Instruction sets.

Unit 4 Advanced Microprocessors: Intel x86 family of advanced microprocessors, programming model for 86 family. X86 addressing modes, instruction set, hardware of 186, 286, 386, 486 & Pentium processors. Motorola 68XXX family of microprocessor, 68XXX addressing modes, instruction set, hardware.

Unit 5 Microprocessor 110: Data Communication, parallel I/O, serial communication, Serial interface and UART, modems, I/O devices, D/A, A/D interface, special I/O devices.

Unit 6 Developing Microprocessor-Based Products: Introduction to the Design Process, Preparing the specifications, developing a design, Implementing and Testing the design, Regulatory Compliance Testing, design tool for Microprocessor Development.

Course Outcomes: On successful completion of this course, the students should be able to:

- Understand the microprocessor architecture, programming and instructions.
- Understand the concepts of 8051, instructions, addressing models and programs.
- To interface I/O devices, A/D & D/A converters with microprocessor & microcontroller.
- Understand the advanced microprocessors along with their architecture, programming model & addressing models.
- Understand the testing & design tools for microprocessor development and its based product.

Text Books:

1. C.M. Gilmore, "Microprocessors Principles and Application", MGH
2. Rajkamal, "Embedded System, Architecture & Programming", TMH

Reference Books:

1. Berry B. Berry, "Inter Series of Microprocessors", PHI
2. D. V. Hall, "Microprocessor &Interfacing", TMH
3. Peatman, "Microprocessor Based System Design", Pearson

VAC-301-V1 **Research Methodology and IPR**

L T P CR
2 0 0 2

Theory : 60
Class Work : 40
Total : 100
Duration of Exam : 2 Hrs.

Syllabus

Unit 1: Meaning of research problem, Sources of research problem, Criteria and characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentation

Unit 2: Effective literature studies approaches, analysis, plagiarism, Research ethics

Unit 3: Effective technical writing, how to write a report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Unit 4: Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development, technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property, Procedure for grants of patents, Patenting under PCT.

Unit 5: Patent Rights: Scope of Patent Rights, Licensing and transfer of technology, Patent information and databases, Geographical Indications.

Unit 6: New Developments in IPR: Administration of Patent System, New developments in IPR, IPR of Biological Systems, Computer Software etc. Traditional knowledge case studies, IPR and IITs.

Course Outcomes: On successful completion of this course, the students should be able to:

- Understand research problem formulation.
- Analyze research-related information
- Follow research ethics
- Understand that today's world is controlled by Computer, Information Technology, but tomorrow's world will be ruled by ideas, concepts, and creativity.
- Understanding that when IPR would take such an important place in the growth of individuals & nation, it is needless to emphasize the need for information about Intellectual Property Rights to be promoted among students in general & engineering in particular.
- Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about economic growth and social benefits.

References:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2 nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd,2007.
5. Mayall, "Industrial Design", McGraw Hill, 1992.
6. Niebel, "Product Design", McGraw Hill, 1974.
7. Asimov, "Introduction to Design", Prentice Hall, 1962.

8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
9. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

EEP-105-V1 **Advanced Communication Networks Laboratory**

L T P	CR		
0 0 4	2	INT.	25
		EXT.	25
		Total	50
		Duration of Exam	3 Hrs.

List of Assignments:

1. Study of Networking Commands (Ping, Tracert, TELNET, nslookup, netstat, ARP, RARP) and Network Configuration Files.
2. Linux Network Configuration.
    a. Configuring NIC's IP Address.
    b. Determining IP Address and MAC Address using if-config command.
    c. Changing IP Address using if-config.
    d. Static IP Address and Configuration by Editing.
    e. Determining IP Address using DHCP.
    f. Configuring Hostname in /etc/hosts file.
3. Design a TCP iterative Client and Server application to reverse the given input sentence.
4. Design a TCP concurrent Server to convert a given text into uppercase using the multiplexing system call "select".
5. Design a UDP client-server to transfer a file.
6. Configure a DHCP Server to serve contiguous IP addresses to a pool of four IP devices with a default gateway and a default DNS address. Integrate the DHCP server with a BOOTP daemon to automatically serve Windows and Linux OS Binaries based on client MAC address.
    a. Configure DNS: Make a caching DNS client and a DNS Proxy; implement reverse DNS and forward DNS, using TCP dump/Wireshark characterise traffic when the DNS server is up and when it is down.
7. Configure a mail server for IMAP/POP protocols and write a simple SMTP client in C/C++/Java client to send and receive mails.
8. Configure FTP Server on a Linux/Windows machine using a FTP client/SFTP client characterise file transfer rate for a cluster of small files 100k each and a video file of 700MB.Use a TFTP client and repeat the experiment.
9. Signaling and QoS of labeled paths using RSVP in MPLS.
10. Find shortest paths through provider network for RSVP and BGP.
11. Understand configuration, forwarding tables, and debugging of MPLS

Course Outcomes:

At the end of this course, students will be able to

- Identify the different types of network devices and their functions within a network.
- Understand and build the skills of subnetting and routing mechanisms.
- Understand basic protocols of computer networks, and how they can be used to assist in network design and implementation.

EEP-107-V1 **Wireless and Mobile Communication Laboratory**

L T P	CR		
0 0 4	2	INT.	25
		EXT.	25
		Total	50
		Duration of Exam	3 Hrs.

List of Assignments:

1. Understanding Cellular Fundamentals like Frequency Reuse, Interference, cell splitting, multi-path environment, Coverage and Capacity issues using communication software.
2. Knowing GSM and CDMA architecture, network concepts, call management, call setup, call release, Security and Power Control, Handoff Process and types, Rake Receiver, etc.
3. Study of GSM handset for various signalling and fault insertion techniques (Major GSM handset sections: clock, SIM card, charging, LCD module, Keyboard, User interface).
4. To study transmitters and receiver sections in mobile handset and measure frequency band signal and GMSK modulating signal.
5. To study various GSM AT Commands, their use and developing a new application using it. Understanding of 3G Communication System with features like: transmission of voice and video calls, SMS, MMS, TCP/IP, HTTP, GPS and File system by AT Commands in 3G network.
6. Study of DSSS technique for CDMA; observe the effect of variation of types of PN codes, chip rate, spreading factor, and processing gain on performance.
7. To learn and develop concepts of Software Radio in a real-time environment by studying the building blocks like Baseband and RF section, convolution encoder, Interleaver and De- Interleaver.
8. To study and analyze different modulation techniques in the time and frequency domain using an SDR kit.

Course Outcomes:

At the end of this course, students will be able to

- Understand cellular concepts, GSM and CDMA networks
- Study GSM handset by experimentation and fault insertion techniques
- Understand 3G communication systems by means of various AT commands usage in GSM
- Understanding CDMA concept using DSSS kit
- To learn, understand and develop concepts of Software Radio in a real-time environment

EEP-102-V1 **Antennas and Radiating Systems**

L T P CR

3 0 0 3

Theory : 60

Class Work : 40

Total : 100

Duration of Exam : 3 Hrs.

Course Objectives:

- To familiarize with the concept of antenna parameters and radiation mechanism.
- To study the design and analysis of linear wire antennas.
- To understand the concept of antenna arrays.
- To study the design of Aperture antenna, microstrip antenna and reflector antenna.

Syllabus

Unit 1: Types of Antennas: Wire antennas, Aperture antennas, Microstrip antennas, Array antennas, Reflector antennas, Lens antennas, Radiation Mechanism, Current distribution on thin wire antenna. Fundamental Parameters of Antennas: Radiation Pattern, Radiation Power Density, Radiation Intensity, Directivity, Gain, Antenna efficiency, Beam efficiency, Bandwidth, Polarization, Input Impedance, radiation efficiency, Antenna Vector effective length, Friis Transmission equation, Antenna Temperature.

Unit 2: Linear Wire Antennas: Infinitesimal dipole, Small dipole, Region separation, Finite length dipole, half wave dipole, Ground effects. Loop Antennas, Small Circular loop, Circular Loop of constant current, Circular loop with non-uniform current.

Unit 3: Linear Arrays: Two-element array, N-element array, Uniform Amplitude and spacing, Broadside and endfire array, Super directivity, Planar array, Design considerations.

Unit 4: Aperture Antennas: Huygens' Field Equivalence principle, radiation equations, Rectangular Aperture, Circular Aperture. Horn Antennas: E-Plane, H-plane, Sectoral horns, Pyramidal and Conical horns.

Unit 5: Microstrip Antennas: Basic Characteristics, Feeding mechanisms, Method of analysis, Rectangular Patch, Circular Patch.

Unit 6: Reflector Antennas: Plane reflector, parabolic reflector, Cassegrain reflectors, Introduction to MIMO.

Course Outcomes: On successful completion of this course, the students should be able to:

- Compute the far field distance, radiation pattern and gain of an antenna for given current distribution.
- Estimate the input impedance, efficiency and ease of match for antennas.
- Compute the array factor for an array of identical antennas.
- Design antennas and antenna arrays for various desired radiation pattern characteristics.

References:

1. Constantine A. Balanis, "Antenna Theory Analysis and Design", John Wiley & Sons, 4th edition, 2016.
2. John D Kraus, Ronald J Marhefka, Ahmad S Khan, "Antennas for All Applications", Tata McGraw-Hill, 2002.
3. R.C.Johnson and H.Jasik, "Antenna Engineering hand book", Mc-Graw Hill, 1984.
4. I.J.Bhal and P.Bhartia, "Micro-strip antennas", Artech house, 1980.

EEP-104-V1 **Advanced Digital Signal Processing**

L T P CR

3 0 0 3

Theory : 60
Class Work : 40
Total : 100
Duration of Exam : 3 Hrs.

Course Outcomes:

- To give an overview of DSP, FET along with FIR & IIR filters.
- To introduce multi-rate DSP.
- To study prediction filters, Wiener filter.
- To introduce adaptive filter, LMS algorithm, minimum mean square criterion.
- To introduce structure estimation
- To study the applications of DSP.

Syllabus

Unit 1: Overview of DSP, Characterization in time and frequency, FFT Algorithms, Digital filter design and structures, Basic FIR/IIR filter design &structures, design techniques of linear phase FIR filters, IIR filters by impulse invariance, bilinear transformation, FIR/IIR Cascaded lattice structures, parallel realization of IIR.

Unit 2: Multi-rate DSP, Decimators and Interpolators, Sampling rate conversion, multistage decimator & interpolator, polyphase filters, QMF, digital filter banks, Applications in subband coding.

Unit 3: Linear prediction & optimum linear filters, stationary random process, forward-backward linear prediction filters, solution of normal equations, AR Lattice and ARMA Lattice-Ladder Filters, Wiener Filters for Filtering and Prediction.

Unit 4: Adaptive Filters, Applications, Gradient Adaptive Lattice, Minimum Mean Square Criterion, LMS algorithm, Recursive Least Square algorithm

Unit 5: Estimation of Spectra from Finite-Duration Observations of Signals. Nonparametric Methods for Power Spectrum Estimation, Parametric Methods for Power Spectrum Estimation, Minimum-Variance Spectral Estimation, Eigenanalysis Algorithms for Spectrum Estimation.

Unit 6: Application of DSP & Multi-rate DSP, Application to Radar, Introduction to wavelets, application to image processing, design of phase shifters, DSP in speech processing & other applications

Course Outcomes: On successful completion of this course, the students should be able to:

- To understand theory of different filters and algorithms
- To understand theory of multirate DSP, solve numerical problems and write algorithms
- To understand theory of prediction and solution of normal equations
- To know applications of DSP at block level.

References:

1. J.G.Proakis and D.G.Manolakis“Digital signal processing: Principles, Algorithm and
2. Applications”, 4th Edition, Prentice Hall, 2007.
3. N. J. Fliege, “Multirate Digital Signal Processing: Multirate Systems -Filter Banks – Wavelets”, 1st Edition, John Wiley and Sons Ltd, 1999.
4. Bruce W. Suter, “Multirate and Wavelet Signal Processing”,1st Edition, Academic Press, 1997.
5. M. H. Hayes, “Statistical Digital Signal Processing and Modeling”, John Wiley & Sons Inc., 2002.
6. S.Haykin, “Adaptive Filter Theory”, 4th Edition, Prentice Hall, 2001.
7. D.G.Manolakis, V.K. Ingle and S.M.Kogon, “Statistical and Adaptive Signal Processing”, McGraw Hill, 2000

EEP-112-V1 **Satellite Communication**

L T P CR

3 0 0 3

Theory : 60

Class Work : 40

Total : 100

Duration of Exam : 3 Hrs.

Course Objective:

- To study the basics of satellite communication & laws governing the satellite motion.
- To familiarize with various satellite subsystems, satellite structure & equations
- To introduce various satellite subsystems & their applications & the effect of various atmospheric.
- To study various multiple access schemes & special-purpose satellite conditions on satellite working.

Syllabus

Unit 1: Architecture of Satellite Communication System: Principles and architecture of satellite Communication, Brief history of Satellite systems, advantages, disadvantages, applications, and frequency bands used for satellite communication and their advantages/drawbacks.

Unit 2: Orbital Analysis: Orbital equations, Kepler's laws of planetary motion, Apogee and Perigee for an elliptical orbit, evaluation of velocity, orbital period, angular velocity, etc of a satellite, concepts of Solar day and Sidereal day.

Unit 3: Satellite sub-systems: Architecture and Roles of various sub-systems of a satellite system such as Telemetry, tracking, command and monitoring (TTC & M), Attitude and orbit control system (AOCS), Communication sub-system, power sub-systems, antenna sub-system.

Unit 4: Typical Phenomena in Satellite Communication: Solar Eclipse on satellite, its effects, remedies for Eclipse, Sun Transit Outage phenomena, its effects and remedies, Doppler frequency shift phenomena and expression for Doppler shift.

Unit 5: Satellite link budget: Flux density and received signal power equations, Calculation of System noise temperature for satellite receiver, noise power calculation, Drafting of satellite link budget and C/N ratio calculations in clear air and rainy conditions, Case study of Personal Communication system (satellite telephony) using LEO.

Unit 6: Modulation and Multiple Access Schemes used in satellite communication. Typical case studies of VSAT, DBS-TV satellites and a few recent communication satellites launched by NASA/ ISRO. GPS.

Course Outcomes: On successful completion of this course, the students should be able to:

- Visualize the architecture of satellite systems as a means of high-speed, high-range communication system.
- State various aspects related to satellite systems such as orbital equations, sub-systems in a satellite, link budget, modulation and multiple access schemes.
- Solve numerical problems related to orbital motion and design of link budget for the given parameters and conditions.
- To understand multiple access schemes used in satellite communication & applications of various antennas.

References:

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

EEP-114-V1 **Advances in Internet of Things**

Internet of Things (Old name)

L T P CR			
3 0 0 3	**Theory**	**:**	**60**
	Class Work	**:**	**40**
	Total	**:**	**100**
	Duration of Exam	**:**	**3 Hrs.**

Course Objectives:

- To introduce various internet protocols & their application in designing systems.
- To understand network challenges & key scientific problems involved in IOT development.
- To describe core concepts of IOT, role & scope of smart sensors for technology convergence.
- To outline various research applications & scope for IOT legislation.

Syllabus

Unit 1: Smart cities and IoT revolution, Fractal cities, From IT to IoT, M2M and peer networking concepts, Ipv4 and IPV6.

Unit 2: Software-Defined Networks SDN, from Cloud to Fog and MIST networking for IoT communications, Principles of Edge/P2P networking, Protocols to support IoT communications, modular design and abstraction, security and privacy in fog.

Unit 3: Wireless sensor networks: introduction, IOT networks (PAN, LAN and WAN), Edge resource pooling and caching, client-side control and configuration.

Unit 4: Smart objects as building blocks for IoT, open-source hardware and embedded systems platforms for IoT, Edge/gateway, IO drivers, C Programming, multithreading concepts.

Unit 5: Operating system requirements of IoT environment, study of mbed, RIoT, and Contiki operating systems, Introductory concepts of big data for IoT applications.

Unit 6: Applications of IoT, connected cars, IoT Transportation, Smart Grid and Healthcare sectors using IoT, Security and legal considerations, IT Act 2000 and scope for IoT legislation.

Course Outcomes: On successful completion of this course, the students should be able to:

- Understand what IoT technologies are used for today, and what is required in certain scenarios.
- Understand the types of technologies that are available and in use today and can be utilized to implement IoT solutions.
- Apply these technologies to tackle scenarios in teams of using an experimental platform for implementing prototypes and testing them as running applications.

References:

1. A Bahaga, V. Madisetti, “Internet of Things- Hands on approach”, VPT publisher, 2014.
2. McEwen, H. Cassimally, “Designing the Internet of Things”, Wiley, 2013.
3. CunoPfister, “Getting started with Internet of Things”, Maker Media, 1st edition, 2011.
4. Samuel Greenguard, “Internet of things”, MIT Press, 2015.

Web resources:

1. http://www.datamation.com/open-source/35-open-source-tools-for-the-internet-of_things-1.html

2. https://developer.mbed.org/handbook/AnalogIn
3. http://www.libelium.com/50_sensor_applications/
4. M2MLabs Mainspring http://www.m2mlabs.com/framework
5. Node-RED http://nodered.org/

EEP-116-V1 **Voice and Data Networks**

L T P CR
3 0 0 3

Theory : 60
Class Work : 40
Total : 100
Duration of Exam : 3 Hrs.

Course Objectives:

- To introduce the students to data network designing & communication on designed networks.
- To introduce the students to network design issues.
- To provide the students information about various models of networks and protocols used for flow control on the data link layer.
- To introduce the students to congestion & congestion control algorithms.

Syllabus

Unit 1: Network Design Issues, Network Performance Issues, Network Terminology, centralized and distributed approaches for network design, Issues in the design of voice and data networks.

Unit 2: Layered and Layer less Communication, Cross layer design of Networks, Voice Networks (wired and wireless) and Switching, Circuit Switching and Packet Switching, Statistical Multiplexing.

Unit 3: Data Networks and their Design, Link layer design- Link adaptation, Link Layer Protocols, Retransmission. Mechanisms (ARQ), Hybrid ARQ (HARQ), Go Back N, Selective Repeat protocols and their analysis.

Unit 4: Queuing Models of Networks , Traffic Models , Little's Theorem, Markov chains, M/M/1 and other Markov systems, Multiple Access Protocols , Aloha System , Carrier Sensing , Examples of Local area networks,

Unit 5: Inter-networking, Bridging, Global Internet, IP protocol and addressing, Sub netting, Classless Inter domain Routing (CIDR), IP address lookup, Routing in Internet. End to End Protocols, TCP and UDP, Congestion Control, Additive Increase/Multiplicative Decrease, Slow Start, Fast Retransmit/ Fast Recovery,

Unit 6: Congestion avoidance, RED TCP Throughput Analysis, Quality of Service in Packet Networks. Network Calculus, Packet Scheduling Algorithms.

Course Outcomes: On successful completion of this course, the students should be able to:

- Understand protocol, algorithms, trade-offs rationale
- Understand routing, transport, DNS resolutions
- Understand queuing model and network congestion avoidance
- Understand network extensions and next generation architectures

References:

1. D. Bertsekas and R. Gallager, “Data Networks”, 2nd Edition, Prentice Hall, 1992.
2. L. Peterson and B. S. Davie, “Computer Networks: A Systems Approach”,5th Edition, Morgan Kaufman, 2011.
3. Kumar, D. Manjunath and J. Kuri, “Communication Networking: An analytical approach”, 1st Edition, Morgan Kaufman, 2004.

4. Walrand, “Communications Network: A First Course”, 2nd Edition, McGraw Hill, 2002.
5. Leonard Kleinrock, “Queuing Systems, Volume I: Theory”, 1st Edition, John Wiley and Sons, 1975.
6. Aaron Kershenbaum, “Telecommunication Network Design Algorithms”, McGraw Hill, 1993.
7. Vijay Ahuja, “Design and Analysis of Computer Communication Networks”, McGraw Hill, 1987

EEP-118-V1 **Digital Image Processing**

L T P CR

3 0 0 3

Theory : 60

Class Work : 40

Total : 100

Duration of Exam : 3 Hrs.

Course Objectives:

- To introduce the students about the Digital Image Fundamentals
- To introduce the students about Image Transform, image enhancement and image restoration.
- To introduce students about Image Segmentation, Morphological Image Processing and various coding involved in image compression.

Syllabus

Unit 1: Digital Image Fundamentals: Visual Perception, concept of uniform and non-uniform sampling & quantization, Relationships between pixels-neighbours of pixel, connectivity, labelling of connected components. Relations, equivalence and Transitive closure (Warshall's Algorithm), Distance measures, Arithmetic/ Logic operation, basic transformations.

Unit 2: Image Transforms: Discrete Fourier transform, Properties of DFT, Fast Fourier transform, Discrete Cosine transform, Hadamard transform.

Unit 3: Image Enhancement: Spatial and frequency domain methods, intensity transformation, Histogram processing and averaging, spatial filtering, low-pass and high-pass filters, Homomorphic filters, Colour image processing.

Unit 4: Image Restoration: Degradation model, digitalization of circular and block circular metrics, Algebraic approach to inverse filtering, Wiener filter, constrained least squares restoration, Interactive restoration in spatial domain.

Unit 5: Image Segmentation: Detection of Discontinuities, point detection, Line detection, Edge detection, Edge linking and boundary detection, Thresholding, Global thresholding, Adaptive Thresholding, Optimum thresholding, region-oriented segmentation.

Unit 6: Morphological Image Processing: Preliminaries, Erosion and Dilation, Opening and closing, Hit or Miss transform, Some Basic Morphological Algorithms- Boundary Extraction, Region Filling.

Unit 7: Compression: Lossy and Lossless Compression, Basic Compression Methods- Huffman Coding, Golomb Coding, Arithmetic Coding, LZW Coding, Run-Length Coding, JPEG Compression.

Course Outcomes:

On successful completion of this course, the students should be able to:

- Understand about the Digital Image Fundamentals.
- Understand about Image Transform, image enhancement and image restoration.
- Understand the principles of Image Segmentation, Morphological Image Processing and various coding involved in image compression.

Text / Reference Books:

I. Anil K Jain, "Fundamentals of Digital Image Processing", PHI Edition 1997.
II. Kenneth R Castleman, " Digital Image Processing", Pearson
III. Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing"
IV. Pearson Chanda & Majumder "Digital image processing and analysis".

EEP-120-V1 **Markov Chains and Queuing Systems**

L T P CR

3 0 0 3

Theory : 60

Class Work : 40

Total : 100

Duration of Exam : 3 Hrs.

Course Objectives:

- To introduce the students to the basics of probability theory & randomness of numbers.
- To introduce the students to Markov chains in discrete & continuous time domains and also regenerative processes used in mathematical modelling.
- To introduce students to modelling a system as a queuing system as a random process in Markov chains.

Syllabus

Unit 1: Introduction: Review of basic probability, properties of nonnegative random variables, laws of large numbers and the Central Limit Theorem.

Unit 2: Renewal Processes: Basic definitions, recurrence times, rewards and renewal reward theorem, point processes, Poisson process, Wald's equation, Blackwell's theorem.

Unit 3: Discrete-time Markov chains: definitions and properties, matrix representation, Perron-Frobenius theory.

Unit 4: Continuous-time Markov chains: basic definitions, Q-matrix, birth-death processes, quasi-birth-death processes; Embedded Markov processes, semi-Markov processes, reversible Markov chains, Random walks.

Unit 5: Fundamental queuing results: Little's theorem, invariance of the mean delay, Conservation law. Markovian queues: Jackson and BCMP networks, numerical Algorithms. M/G/1 & G/M/1 queues and G/G/1 queues.

Unit 6: Advanced queuing models: priority, vacation and retrials in queues.

Course Outcomes: On successful completion of this course, the students should be able to:

- Understand Markov Chains and regenerative processes used in modelling a wide variety of systems and phenomena.
- Model a system as a queuing system with some aspect of the queue governed by a random process.
- Understand telecommunication systems modelling using Markov chains with special emphasis on developing queuing models.

References:

1. Cliffs, “Stochastic Modelling and the Theory Queues”, Prentice Hall, 1989.
2. P.Bremaud, “Markov Chains”, Springer-Verlag, 1999.
3. E.Seneta, “Non Negative Matrices and Markov Chains”, Springer Series in Statistics, Springer,1981.
4. R.Gallager, “Discrete Stochastic Processes”, Kluwer Academic Press, 1996.
5. L.Kleinrock, “Queuing Systems”, vols I and II, John Wiley and Sons 1976.

EEP-122-V1 **MIMO System**

L T P CR

3 0 0 3

Theory : 60
Class Work : 40
Total : 100
Duration of Exam : 3 Hrs.

Course Objectives:

- To study multi-antenna systems and diversity.
- To study channel modelling and propagation.
- To study the concept of MIMO receiver & multi-antenna system.
- To study the mathematical modelling and analysis of MIMO systems

Syllabus

Unit 1: Introduction to Multi-antenna Systems, Motivation, Types of multi-antenna systems, MIMO vs. multi-antenna systems.

Unit 2: Diversity, Exploiting multipath diversity, Transmit diversity, Space-time codes, The Alamouti scheme, Delay diversity, Cyclic delay diversity, Space-frequency codes, Receive diversity, The rake receiver, Combining techniques, Spatial Multiplexing, Spectral efficiency and capacity, Transmitting independent streams in parallel, Mathematical notation

Unit 3: The generic MIMO problem, Singular Value Decomposition, Eigenvalues and eigenvectors, Equalising MIMO systems, Disadvantages of equalising MIMO systems, Pre-distortion in MIMO systems, Disadvantages of pre-distortion in MIMO systems, Pre-coding and combining in MIMO systems, Advantages of pre-coding and combining, Disadvantages of precoding and combining, Channel state information.

Unit 4: Codebooks for MIMO, Beam forming, Beam forming principles, increased spectrum efficiency, Interference cancellation, Switched beam former, Adaptive beam former, Narrowband beam former, Wideband beam former

Unit 5: Case study: MIMO in LTE, Code words to layers mapping, Pre-coding for spatial multiplexing, Pre-coding for transmit diversity, Beam forming in LTE, Cyclic delay diversity based pre-coding, Pre-coding codebooks, Propagation Channels, Time & frequency channel dispersion, AWGN and multipath propagation channels, Delay spread values and time variations, Fast and slow fading environments, Complex baseband multipath channels, Narrowband and wideband channels, MIMO channel models

Unit 6: Channel Estimation, Channel estimation techniques, Estimation and tracking, Training based channel estimation, Blind channel estimation, Channel estimation architectures, Iterative channel estimation, MMSE channel estimation, Correlative channel sounding, Channel estimation in single carrier systems, Channel estimation for CDMA, Channel estimation for OFDM.

Course Outcomes: On successful completion of this course, the students should be able to:

- Understand channel modelling and propagation, MIMO Capacity, space-time coding,

- MIMO receivers, MIMO for multi-carrier systems (e.g. MIMO-OFDM), multi-user communications, multi-user MIMO.
- Understand cooperative and coordinated multi-cell MIMO, introduction to MIMO in 4G (LTE, LTE-Advanced, WiMAX).
- Perform Mathematical modelling and analysis of MIMO systems.

References:

1. Claude Oestges, Bruno Clerckx, "MIMO Wireless Communications : From Real-world Propagation to Space-time Code Design",Academic Press, 1st edition, 2010.
2. Mohinder Janakiraman, “Space - Time Codes and MIMO Systems”, Artech House Publishers, 2004.

EEP-124-V1 **Programmable Networks - SDN, NFV**

L T P CR

3 0 0 3

Theory : 60

Class Work : 40

Total : 100

Duration of Exam : 3 Hrs.

Course Objectives:

- To introduce the students to programmable networks.
- To make the students aware of the concept & protocols of control & data plane separation.
- To introduce the students to the concept of network virtualization & control plane on SDN.
- To give the students brief knowledge on programming SDNs, Architecture & topologies of SDN.

Syllabus

Unit 1: Introduction to Programmable Networks, History and Evolution of Software Defined Networking (SDN), Fundamental Characteristics of SDN, Separation of Control Plane and Data Plane, Active Networking.

Unit 2: Control and Data Plane Separation: Concepts, Advantages and Disadvantages, the basics of OpenFlow protocol.

Unit 3: Network Virtualization: Concepts, Applications, Existing Network Virtualization Framework, Mininet: a simulation environment for SDN.

Unit 4: Control Plane: Overview, Existing SDN Controllers including Floodlight and Open Daylight projects, Customization of Control Plane, Switching and Firewall Implementation using SDN Concepts. Data Plane, Software-based and Hardware-based, Programmable Network Hardware.

Unit 5: Programming SDNs: Northbound Application Programming Interface, Current Languages and Tools, Composition of SDNs, Network Functions Virtualization (NFV) and Software Defined Networks, Concepts, Implementation and Applications.

Unit 6: Data Center Networks: Packet, Optical and Wireless Architectures, Network Topologies, Use Cases of SDNs, Data Centers, Internet Exchange Points, Backbone Networks, Home Networks, Traffic Engineering.

Course Outcomes: On successful completion of this course, the students should be able to:

- Understand advanced concepts in Programmable Networks.
- Understand Software Defined Networking, an emerging Internet architectural framework.
- Implement the main concepts, architectures, algorithms, protocols and applications in SDN and NFV.

References:

1. Thomas D. Nadeau, Ken Gray, “SDN: Software Defined Networks, An Authoritative Review of Network Programmability Technologies”, O'Reilly Media, August 2013.
2. Paul Goransson, Chuck Black, Timothy Culver. “Software Defined Networks: A Comprehensive Approach”, Morgan Kaufmann Publishers, 2016.
3. Fei Hu, “Network Innovation through OpenFlow and SDN: Principles and Design”, CRC Press, 2014.
4. Vivek Tiwari, “SDN and OpenFlow for Beginners”, Amazon Digital Services, Inc., ASIN: 2013.

5. Nick Feamster, Jennifer Rexford and Ellen Zegura, “The Road to SDN: An Intellectual History of Programmable Networks” ACM CCR April 2014.
6. Open Networking Foundation (ONF) Documents, https://www.opennetworking.org, 2015.
7. OpenFlow standards, http://www.openflow.org, 2015.

EEP-126-V1 **ADVANCED DIGITAL COMMUNICATION**

L T P CR		
3 0 0 3	**Theory**	**: 60**
	Class Work	**: 40**
	Total	**: 100**
	Duration of Exam	**: 3 Hrs.**

COURSE OBJECTIVES:

- To learn the concept of Complex baseband representation of signals Geometric representation of signals, Gram –Schmidt Orthogonalisation procedure .
- To learn the differenent types of digital modulation schemes.
- To learn the concept of Additive White Gaussian Noise(AWGN) Channel, different types of filters and detectors.
- To Learn the concept of different types of band-limited channels and their performance.
- To learn the concept of Different synchronization techniques.

SYLLABUS

UNIT 1: 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 2: 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 3: 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 4: Band-limited channels: Pulse shape design for channels with ISI: Nyquist pulse, Partial response signaling (duobinary and modified duobinary pulses), demodulation; Channel with distortion: Design of transmitting and receiving filters for a known channel and for a time-varying channel (equalization); Performance: Symbol-by-symbol detection and BER, symbol and sequence detection

UNIT5: Synchronization: Different synchronization techniques (Early-Late Gate, MMSE, ML and spectral line methods.

Course Outcomes: On successful completion of this course, the students should be able to:

- Understand the concept of Complex baseband representation of signals, geometric representation of signals, Gram –Schmidt Orthogonalisation procedure.
- Analyze different types of digital modulation schemes.
- Deduce the Additive White Gaussian Noise(AWGN) Channel, different types of filters and detectors.
- Describe the different types of band-limited channels and their performance and Different synchronization techniques.

Text Books:

1. Taub and Schilling, “Principal of Communication System”,TMH
2. S.Haykin, “Digital communication”,Willey Pub.

Reference Books:

1. WayenTomasi, “Electronic Communication System” ,Pearson pub.
2. J.Dass, S.K.Mullick& P.K. Chatterjee, “Principal of Digital Communication” , Willey Eastern Pub
3. John G. Proakis, "Digital Communication", McGraw Hill, 4th edition, 2001.
4. Bernard Sklar, "Digital Communication - Fundamental and applications", Pearson education (Asia), Pvt. Ltd., 2nd edition, 2001.

EEP-106-V1 **Antennas and Radiating Systems Laboratory**

L T P	CR		
0 0 4	2	INT.	25
		EXT.	25
		Total	50
		Duration of Exam	3 Hrs.

List of Assignments:

1. Simulation of half-wave dipole antenna.
2. Simulation of change of the radius and length of dipole wire on the frequency of resonance of antenna.
3. Simulation of quarter wave, full wave antenna and comparison of their parameters.
4. Simulation of a monopole antenna with and without a ground plane.
5. Study the effect of the height of the monopole antenna on the radiation characteristics of the antenna.
6. Simulation of a half-wave dipole antenna array.
7. Study the effect of a change in distance between elements of the array on the radiation pattern of the dipole array.
8. Study the effect of the variation of phase difference 'beta' between the elements of the array on the radiation pattern of the dipole array.
9. Case study.

Course Outcomes:

At the end of this course, students will be able to

- Determine specifications, design, construct and test antenna.
- Explore and use tools for designing, analyzing and testing antennas. These tools include Antenna design and analysis software, network analyzers, spectrum analyzers, and antenna pattern measurement techniques.

EEP-108-V1 **Advanced Digital Signal Processing Lab**

L T P	CR		
0 0 4	2	INT.	25
		EXT.	25
		Total	50
		Duration of Exam	3 Hrs.

List of Assignments:

1. Basic Signal Representation
2. Correlation: Auto And Cross
3. Stability Using Hurwitz-Routh Criteria
4. Sampling FFT of Input Sequence
5. Butterworth Lowpass and Highpass Filter Design
6. Chebyshev Type I, II Filter
7. State Space Matrix from Differential Equation
8. Normal Equation Using Levinson-Durbin
9. Decimation And Interpolation Using Rational Factors
10. Maximally Decimated Analysis DFT Filter
11. Cascade Digital IIR Filter Realization
12. Convolution and M-Fold Decimation &PSD Estimator
13. Estimation Of PSD
14. Inverse Z Transform
15. Group Delay Calculation
16. Separation of T/F
17. Parallel Realization of IIR filter

Course Outcomes:

At the end of this course, students will be able to

- Design different digital filters in software
- Apply various transforms in time and frequency
- Perform decimation and interpolation

AEC-301-V1 **ENGLISH FOR RESEARCH PAPER WRITING**

L T P CR

2 0 0 0

Theory : 60

Class Work : 40

Total : 100

Duration of Exam : 3 Hrs.

Course objectives:

- Understand that how to improve your writing skills and level of readability
- Learn about what to write in each section
- Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission

Unit 1: Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

Unit 2: Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

Unit 3: Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Unit 4: Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,

Unit 5: Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

Unit 6: Useful phrases, how to ensure the paper is as good as it could possibly be for the first- time submission

Suggested Studies:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's

Book.

1. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

VAC-302-V1 **DISASTER MANAGEMENT**

L T P CR
2 0 0 0

Theory : 60
Class Work : 40
Total : 100
Duration of Exam : 3 Hrs.

Course Objectives:

- learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

Syllabus

Unit1: Introduction: Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.

Unit 2: Repercussions Of Disasters And Hazards: Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

Unit 3: Disaster Prone Areas In India: Study Of Seismic Zones, Areas Prone To Floods And Droughts, Landslides And Avalanches, Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami, Post-Disaster Diseases And Epidemics.

Unit 4: Disaster Preparedness And Management: Preparedness, Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk, Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports, Governmental And Community Preparedness.

Unit 5: Risk Assessment: Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation, Techniques of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.

Unit 6: Disaster Mitigation: Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends in Mitigation, Structural Mitigation And Non-Structural Mitigation, Programs of Disaster Mitigation In India.

SUGGESTED READINGS:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, Pardeep Et.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi.

AEC-302-V1 **SANSKRIT FOR TECHNICAL KNOWLEDGE**

L T P CR	**Theory**	**: 60**
2 0 0 0	**Class Work**	**: 40**
	Total	**: 100**
	Duration of Exam	**: 3 Hrs.**

Course Objectives

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world
- Learning of Sanskrit to improve brain functioning
- Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
- The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

Syllabus

Unit 1: Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences

Unit 2: Order, Introduction of roots, Technical information about Sanskrit Literature

Unit 3: Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

Suggested reading

1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

Course Output

1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood
3. Being a logical language will help to develop logic in students

VAC-303-V1 **VALUE EDUCATION**

L T P CR
2 0 0 0

Theory : 60
Class Work : 40
Total : 100
Duration of Exam : 3 Hrs.

Course Objectives

- Understand the value of education and self- development
- Imbibe good values in students
- Let them know about the importance of character

Unit 1: Values and self-development, social values and individual attitudes, Work ethics, Indian vision of humanism, Moral and non-moral valuation. Standards and principles, Value judgements

Unit 2: Importance of cultivation of values, Sense of duty. Devotion, Self-reliance. Confidence, Concentration, Truthfulness, Cleanliness, Honesty, Humanity. Power of faith, National Unity, Patriotism. Love for nature, Discipline

Unit 3: Personality and Behavior Development, Soul and Science, attitude, positive thinking, integrity and discipline, Punctuality, Love and Kindness, Avoid fault Thinking, Free from anger, Dignity of labour, Universal brotherhood and religious tolerance, True friendship, Happiness Vs suffering, love for truth, Aware of self-destructive habits, Association and Cooperation, Doing best for saving nature

Unit 4: Character and Competence, Holy books vs Blind faith, Self-management and Good health, Science of reincarnation, Equality, Nonviolence, Humility, Role of Women, All religions and same message, Mind your Mind, Self-control, Honesty, Studying effectively

Suggested reading

1. Chakroborty, S.K. “Values and Ethics for organizations: Theory and practice”, Oxford University Press, New Delhi

Course outcomes

- Knowledge of self-development
- Learn the importance of Human values
- Developing the overall personality

VAC-112-V1 **CONSTITUTION OF INDIA**

L T P CR

2 0 0 0

Theory : 60

Class Work : 40

Total : 100

Duration of Exam : 3 Hrs.

Course Objectives:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Syllabus

Unit 1: History of Making of the Indian Constitution: History**,** Drafting Committee, (Composition & Working)

Unit 2: Philosophy of the Indian Constitution: Preamble, Salient Features.

Unit 3: Contours of Constitutional Rights & Duties: Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

Unit 4: Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions

Unit 5: Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, Panchayati raj, Introduction, PRI: Zila Panchayat, Elected officials and their roles, CEO Zila Pachayat, Position and role, Block level, Organizational Hierarchy (Different departments), Village level, Role of Elected and Appointed officials, Importance of grass root democracy

Unit 6: Election Commission: Election Commission, Role and Functioning, Chief Election Commissioner and Election Commissioners, State Election Commission, Role and Functioning, Institutions and Bodies for the welfare of SC/ST/OBC and women.

Course Outcomes:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

Suggested reading

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

VAC-304-V1 **PEDAGOGY STUDIES**

L T P CR

2 0 0 0

Theory : 60

Class Work : 40

Total : 100

Duration of Exam : 3 Hrs.

Course Objectives:

1. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
2. Identify critical evidence gaps to guide the development.

Unit 1: Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education, Conceptual framework, Research questions**,** Overview of methodology and Searching.

Unit 2: Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education.

Unit 3: Evidence on the effectiveness of pedagogical practices, Methodology for the in-depth stage: quality assessment of included studies, How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change, Strength and nature of the body of evidence for effective pedagogical practices, Pedagogic theory and pedagogical approaches, Teachers' attitudes and beliefs and Pedagogic strategies.

Unit 4: Professional development: alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community, Curriculum and assessment, Barriers to learning: limited resources and large class sizes

Unit 5: Research gaps and future directions: Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.

Course Outcomes:

Students will be able to understand:

- What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?
-

Suggested reading

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal, Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

AEC-317-V1 **STRESS MANAGEMENT BY YOGA**

L T P CR

2 0 0 0

Theory : 60

Class Work : 40

Total : 100

Duration of Exam : 3 Hrs.

Course Objectives

- To achieve overall health of body and mind
- To overcome stress

Syllabus

Unit 1: Definitions of the eight parts of yog. (Ashtanga)

Unit 2: Yam and Niyam, Do's and Don'ts in life, i) Ahinsa, Satya, Aastheya, Bramhacharya and Aparigraha, ii) Shaucha, Santosh, Tapa, Swadhyay, Ishwarpranidhan.

Unit 3: Asan and Pranayam, i) Various yog poses and their benefits for mind & body, ii)Regularization of breathing techniques and its effects-Types of pranayam

Course Outcomes:

- Develop a healthy mind in a healthy body, thus improving social health also
- Improve efficiency

Suggested reading

1. 'Yogic Asanas for Group Training-Part-I": Janardan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

AEC-304-V1 **PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS**

L T P CR			
2 0 0 0	**Theory**	**:**	**60**
	Class Work	**:**	**40**
	Total	**:**	**100**
	Duration of Exam	**:**	**3 Hrs.**

Course Objectives:

- To learn to achieve the highest goal happily
- To become a person with a stable mind, pleasing personality and determination
- To awaken wisdom in students

Unit 1: Neetisatakam-Holistic development of personality, Verses 19,20,21,22 (wisdom), Verses 29,31,32 (pride & heroism), Verses 26,28,63,65 (virtue), Verses 52,53,59 (don'ts), Verses 71,73,75,78 (do's)

Unit 2: Approach to day-to-day work and duties, Shrimad Bhagwad Geeta, Chapter 2-Verses 41, 47,48, Chapter 3 Verses 13, 21, 27, 35, Chapter 6 Verses 5,13,17, 23, 35, Chapter 18 Verses 45, 46, 48.

Unit 3: Statements of basic knowledge, Shrimad Bhagwad Geeta: Chapter2 Verses 56, 62, 68**,** Chapter 12 Verses 13, 14, 15, 16,17, 18**,** Personality of Role model. Shrimad Bhagwad Geeta, Chapter2 Verses 17, Chapter3 Verses 36,37,42, Chapter4 Verses 18, 38,39**,** Chapter18 Verses 37,38,63

Course Outcomes:

- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and mankind to peace and prosperity
- Study of Neetishatakam will help in developing versatile personality of students.

Suggested reading

1. "Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit, Sansthanam, New Delhi.

AEC-305-V1 SWAMI VIVEKANANDA'S THOUGHTS

L T P CR			
2 0 0 0	**Theory**	**:**	**60**
	Class Work	**:**	**40**
	Total	**:**	**100**
	Duration of Exam	**:**	**3 Hrs.**

Course Objectives:

- To introduce the biography and philosophical thought of Swami Vivekananda
- To present Swami Vivekananda's views on major religions of the world and Universal Religion
- To present Swami Vivekananda's teachings and views on social issues.

Syllabus

Unit 1: Swami Vivekananda: a Brief biography, Influence of Ramakrishna on Vivekananda, Parliament of Religions, Establishment of Ramakrishna Mission.

Unit 2: Philosophy of Swami Vivekananda, Nature of Reality, Nature of Self, Nature of the universe, The doctrine of Maya, Identity of Self and God, Karma Yoga, Raj Yoga, Bhakti Yoga, Gyan Yoga.

Unit 3: Swami Vivekananda's observations on major religions of the world (a) Hinduism (b) Christianity (c) Islam

Unit 4: The concept of Universal Religion and its characteristics, Fundamental unity of all religions, acceptance and not tolerance is the principle.

Unit 5: Vivekananda and Nationalism, The message of patriotism, spirituality as the basis of patriotism, Sociological views of Vivekananda, His views on caste and untouchability, status of women, His views on Education, Swami Vivekananda's concept of Vedantic Socialism

Books: The Complete Works of Swami Vivekananda Vol. 1 to 8 Relevant Chapters

Annexure-A

J.C. Bose University of Science & Technology, YMCA, Faridabad
(A Haryana State Government University)
(Established by Haryana State Legislative Act No. 21 of 2009 & Recognized by UGC Act 1956 u/s 22 to Confer Degrees)
Accredited 'A' Grade by NAAC

Implementation of Credit Transfer/Mobility Policy of online courses

Reference: Gazette of India (Extraordinary) Part-III, Section-4 No. 295, UGC **(Credit Framework for Online Learning Courses through SWAYAM) Regulation, 2016,** dated 19/07/2016.

With reference to 12th Academic Council Meeting dated 03/05/2017 (Agenda Item No. AC/11/12), wherein MOOCs were adopted in the CBCS scheme, In continuation to that, following modalities are proposed to introduce the credit transfer policy in academic curriculum for the Massive Open Online Courses (MOOC's) offered through SWAYAM (Study Webs of Active-Learning for Young Aspiring Minds) Portal.

A. General Guidelines

1. The SWAYAM shall notify in June and November every year, the list of the online learning Courses going to be offered in the forthcoming Semester on its website https://swayam.gov.in.
2. All the UTDs/Affiliated Colleges shall, within 4 weeks from the date of notification by SWAYAM, consider through their Chairperson/Principal the online learning courses being offered through the SWAYAM platform; and keeping in view their academic requirements, decide upon the courses which it shall permit for credit transfer and keeping in view the following points:

    a) There is non-availability of suitable teaching staff for running a course in the Department.
    b) The facilities for offering the elective papers (courses), sought for by the students are not on offer/scheme in the Institution, but are available on the SWAYAM platform.
    c) The courses offered on SWAYAM would supplement the teaching-learning process in the Institution.
    d) Online courses through SWAYAM should not be more than 20% of total courses offered in a particular semester of a programme.
3. The courses offered in a particular semester will be compiled by Digital India Cell as decided and forwarded by concerned UTDs and affiliated colleges in the prescribed format to digitalindia.ymca@gmail.com and compiled set will be put up in Academic Council for approval.
4. Student can opt for 12-16 weeks course equivalent to 3-6 credits under mentorship of faculty (MHRD MOOC's guidelines 11.1(J) issued by the MHRD vide its orders dated 11/03/2016).

5. Every student being offered a particular paper (course) would be required to register for the MOOCs for that course/paper on SWAYAM through University's/Affiliated College's SWAYAM-NPTEL Local Chapter.
6. The UTD/College may designate a faculty member as course coordinator/mentor to guide the students (at least 20 students) throughout the course with 2 hours per week contribution and with mentor addition on the Local Chapter. The mentor Chairperson/Principal will ensure the provision of facilities for smooth running of the course viz. Internet facility and proper venue in the department/college.
7. Digital India Cell of the University will be the Nodal point for keeping track of MOOCs enrolments in the University and the concerned chairpersons/principals are expected to aware their students/faculty about the online courses.
8. Importance of online learning and credit transfer policy must be shared with the students at entry level by the concerned department/college. Same may be incorporated during induction program for newly admitted students.
9. The departmental/college MOOC coordinators appointed by chairpersons of concerned departments/Principals of affiliated colleges will be responsible for identification of relevant MOOCs in the UTDs/Colleges and smooth conduction during the course.

B. Credit Transfer/Mobility of MOOCs

1. The parent Institution (offering the Course) shall give the equivalent credit weightage to the students for the credits earned through online learning courses through SWAYAM platform in the credit plan of the program.
2. Following pattern will be followed for distribution of credits and will be applicable to all students from Jan 2018 onwards:

Program	**Duration**	**Minimum Credits to be earned***
B.Tech	Semester I to VIII	3
M.Tech/MBA/M.Sc./MA	Semester I to IV	3
BBA/BCA/B.Sc./BA	Semester I to VI	3

***All students of UTDs/Affiliated colleges of all courses have to mandatorily earn minimum prescribed credits.**

<u>Note:</u> From session 2019-20 onwards, for B.Tech program, a student has to earn at least 12 credits during the duration of the Degree subject to the passing of at least one MOOC course (carrying minimum 3 credits per year).

3. A student will be eligible to get Under-Graduate/Post-Graduate degree (B.Tech/M.Tech) with Honours if he/she completes additional credits through MOOC's. (AICTE Model Curriculum, Chapter1(B)). Following pattern will be followed for earning additional credits for the award of Honours degree:

Program	Duration	Credits to be earned*	Minimum CGPA
B.Tech	Semester I to VIII	12	8.0
M.Tech	Semester I to IV	6	8.0

*Inclusive of *Minimum credits to be earned* mentioned in clause B(2) above.

4. The earned credits shall be accepted and transferred to the total credits of the concerned students by the University for Completion of his/her degree. Credits earned through MOOCs will be incorporated in the mark sheet issued to the student by Controller of Examination.
5. Credits for MOOC's will be verified by the concerned department/college and will be forwarded to Controller of Examination for further processing.
6. The courses where model curriculum of AICTE is not applicable, pattern laid down as in B(2) will be followed.

NOTE:

1. These guidelines will be applicable to all Affiliating institutions under University along with all UTDs. Affiliating colleges will establish their own Local Chapter on SWAYAM and follow the same process.
2. For further clarifications, Notifications "Credit Framework for Online Learning Courses through SWAYAM" (UGC Regulations dated 19/07/2016) and "MHRD MOOC's guidelines" (MHRD guidelines dated 11/03/2016) may be referred.