SCHEME FOR ADDITIONAL 20 CREDITS FOR BTECH ECE WITH HONORS

SN	BASKET	Subject Code	LIST OF CONCENTRATION COURSES	L-T-P-C
1	**BASKET-I** *(Sem. In which course is to be offered-5th onwards)*	BECEH1-501	CMOS Design (BECED1-707)	3-0-0-3
2		BECEH1-502	Bio-Medical Electronics	3-1-0-4
3		BECEH1-503	Nano Electronics	3-1-0-4
4		BECEH1-504	Mixed Signal Design	3-1-0-4
5		BECEH1-505	Introduction to MEMS	3-1-0-4
6	**BASKET-II** *(Sem. In which course is to be offered-5th onwards)*	BECEH1-506	Neural Network & Fuzzy Logic (BECED1-705)	3-0-0-3
7		BECEH1-507	Error Correcting Codes (BECED1-803)	3-0-0-3
8		BECEH1-508	Soft Computing	3-1-0-4
9		BECEH1-509	Wireless Adhoc & Senor Networks	3-1-0-4
11	**BASKET-III** *(Sem. In which course is to be offered-6th onwards)*	BECEH1-601	Microwave Theory and Techniques (BECED1-601)	3-0-0-3
12		BECEH1-602	Fiber Optic Communications (BECED1-701)	3-0-0-3
13		BECEH1-603	Mobile Communication and Networks (BECED1-702)	3-0-0-3
14		BECEH1-604	Satellite Communication (BECED1-802)	3-0-0-3
15		BECEH1-605	Probability Theory and Stochastic Processes	3-1-0-4
16	**BASKET-IV** *(Sem. In which course is to be offered-7th & 8th)*	BECEH1-701	Machine Learning (BECED1-804)	3-0-0-3
17		BECEH1-702	Data Mining & Big Data (BECED1-805)	3-0-0-3
18		BECEH1-703	Artificial Intelligence (BECED1-806)	3-0-0-3
19		BECEH1-704	Internet of Things (BECED1-807)	3-0-0-3
20		BECEH1-705	Any open elective as offered by MRSPTU, BTI	3-0-0-3
21	**BASKET-V** *(Sem. In which course is to be offered-7th & 8th)*	BECEH1-706	Digital Image & Video Processing	3-1-0-4
22		BECEH1-707	Wavelets	3-1-0-4
23		BECEH1-708	Adaptive Signal Processing	3-1-0-4
24		BECEH1-709	Speech and Audio Processing	3-1-0-4
25	**Compulsory**	BECEH1-551	MATLAB & Simulink based lab for ECE	0-0-4-2

Select at least one subject from each basket.

Note: The students may opt one/two subjects from the MOOCs/ SWAYAM as per University Notification & as per the AICTE Model Curriculum as modified from time to time.

BASKET-I

CMOS DESIGN					
Subject Code: BECEH1-501	**L**	**T**	**P**	**C**	**Duration: 45 Hrs.**
	3	0	0	3	

Course Objectives: This course is meant to provide fundamental knowledge to students for understanding of the various concepts and techniques used in CMOS design:

1. Understand the fundamentals of IC technology components, scaling trends and limitations.
2. Design VLSI circuits and systems utilizing modern IC design methodologies and design automation tools.
3. Analyze trade-offs to optimize power, delay and area.
4. Utilize modern CAD tools for IC design, simulation, verification and automated logic synthesis and layout.
5. Explore circuit and higher-level solutions for low-power and variation-aware designs.
6. Anticipate future challenges in IC technologies and think critically about solutions..

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Understand the operation of MOS devices.
2. Design different CMOS circuits using various logic families along with their circuit layout.
3. Design different CMOS combinational and sequential circuits.

UNIT-I (11 Hrs)

MOS Devices: MOS structure, enhancement & depletion transistor, threshold voltage, MOS I-V and C-V characteristics, MOS device design equations, non-ideal behaviour of MOS; Mobility degradation, velocity saturation, Channel length modulation, threshold voltage effects, leakage temperature and geometry dependence,

The MOS Inverter: CMOS inverter and its static DC characteristics, beta ratio effects and noise margin, Dynamic behaviour of CMOS Inverter, Power consumption.

UNIT-II (12 Hrs)

CMOS Fabrication Technology: CMOS fabrication process, CMOS layout design rules, Packaging of Integrated circuits, CMOS process enhancements, fabrication issues, Interconnect parameters, Electrical wire models, transistor scaling.

Delay Models: Timing optimization, Transient response, of CMOS devices, RC delay model, linear delay model, delay in a multistage logic network

UNIT-III (11 Hrs)

Combinational Circuit Design in CMOS: CMOS logic families including static, dynamic and dual rail logic, circuit issues, combinational logic function, static complementary gate structure and layouts of different logic gates, delay and transmission times, speed power product.

UNIT-IV (11 Hrs)

Sequential Circuit Design: Sequencing of static circuits, Static and dynamic latches and registers, pulsed latches, resettable enabled latches and registers, differential flip-flops, dual edge triggered flip flops, choice of elements, sequencing dynamic circuits.

Recommended Text Books / Reference Books:

1. N.H.E. Weste and D.M. Harris, CMOS VLSI design: A Circuits and Systems Perspective, 4th Edition, Pearson Education India, 2011.
2. C.Meadand, L.Conway, Introduction to VLSI Systems, Addison Wesley, 1979.

3. J. Rabaey, Digital Integrated Circuits: A Design Perspective, Prentice Hall India, 1997.
4. P. Douglas, VHDL: Programming by Example, McGraw Hill, 2013.
5. L. Glaserand, D. Dobberpuhl, The Design and Analysis of VLSI Circuits, Addison Wesley, 1985.

BIO-MEDICAL ELECTRONICS					
Subject Code: BECEH1-502	**L**	**T**	**P**	**C**	**Duration: 60 Hrs.**
	3	1	0	4	

Course Objectives: This course is meant to provide fundamental knowledge to students for understanding of the various bio-medical instruments, circuits and their applications.

1. To explore the human body parameter measurements setups.
2. To understand medical terminology, relevant for biomedical electronics.
3. To introduce fundamentals of transducers as applicable to biomedical.

Course Outcomes: At the end of the course, students will demonstrate the ability to:

1. Understand the application of the electronic systems in biological and medical applications.
2. Understand the practical limitations on the electronic components while handling bio-substances.
3. Understand and analyze the biological processes like other electronic processes.

UNIT-I (15 Hrs)

Introduction: Brief introduction to human physiological systems, sources of biomedical signals, basic medical instrumentation system and its performance requirements.

Transducers: Introduction, classification of transducers, performance characteristics of transducers, biomedical transducers: displacement, velocity, force, acceleration, flow, temperature, potential, dissolved ions and gases.

UNIT-II (15 Hrs)

Bioelectric Electrodes: Origin of bioelectric signals, recording electrodes, electrodes for ECG, electrodes for EEG, electrodes for EMG, electrical conductivity of electrode jellies and creams.

Measurement Systems: Measurement of blood temperature, pressure and flow, basic sensors, amplifiers and signal processing, bio-potential amplifiers for ECG, EMG, EEG etc.

UNIT-III (15 Hrs)

Medical Imaging: Impedance plethysmography, Ultrasonography, X-ray and nuclear imaging, CAT, PET, MRI overview, thermography, medical use of isotopes, endoscopy.

Computer Applications and Biotelemetry: real time computer applications, data acquisition

and processing, remote data recording and management.

UNIT-IV (15 Hrs)

Prosthesis and Aids: Overview of pacemakers, defibrillators, heart-lung machine, artificial kidney, aid for the handicapped, hemodialysis and infant incubators, safety codes and standards.

Applications of Lasers to Biomedical Field: Laser, pulsed ruby laser, Nd-YAG laser, Helium-Neon laser, Argon laser, CO_2 laser, semiconductor laser, laser safety

Recommended Text Books / Reference Books:

1. W.F. Ganong, Review of Medical Physiology, 8th Asian Ed, Medical Publishers, 1977.
2. J.G. Websster, ed., Medical Instrumentation, Houghton Mifflin, 1978.
3. A.M. Cook and J.G. Webster eds., Therapeutic Medical Devices, Prentice-Halll, 1982.
4. A.K. Sawhney, A Course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai & Co., 2008.
5. R. S. Khandpur, Handbook of Biomedical Instrumentation, Second Edition, Tata McGraw-Hill Publishing House, New Delhi, 2002.

NANO ELECTRONICS

Subject Code: BECEH1-503 | **L T P C** 3 1 0 4 | **Duration: 60 Hrs.**

Course Objectives: This course is meant to provide fundamental knowledge to students for understanding of the various concepts and techniques used in nanoelectronics:

1. To create awareness about nanotechnology issues.
2. To impart knowledge about growth, fabrication and measurement techniques for nanostructures.
3. To study electronic behaviour in nanostructures.
4. To impart knowledge about nano electronic devices.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Understand various aspects of nanotechnology and the processes involved in making nanomaterials and components.
2. Leverage the advantages and appropriate use of the nanoparticles.
3. Understand significance and potential opportunities to create better materials and products.
4. Describe different nano-scale devices.

UNIT-I (15 Hrs)

Basics and Scale of Nanotechnology: Introduction to nanotechnology, scientific revolutions-time and length scale in structures, basics of quantum mechanics: Schrodinger equation, density of states, particle in a box concepts, degeneracy, band theory of solids.

Materials for Nanoelectronics: Semiconductors, crystal lattices: bonding in crystals, electron energy bands, semiconductor heterostructures, lattice-matched and pseudomorphic heterostructures, organic semiconductors, carbon nanomaterials: nanotubes and fullerenes.

UNIT-II (15 Hrs)

Fabrication and characterization Techniques for Nanostructures: Introduction, bulk crystal and heterostructure growth, nanolithography, etching, and other means for fabrication ofnanostructures and nanodevices, techniques for characterization of nanostructures, spontaneous formation and ordering of nanostructures, clusters and nanocrystals, methods of nanotube growth, chemical and biological methods for nanoscale fabrication, fabrication of nanoelectromechanical systems.

UNIT-III (15 Hrs)

Electron Transport in Semiconductors and Nanostructures: Introduction, time and length scales of the electrons in solids, statistics of the electrons in solids and nanostructures, the density of states of electrons in nanostructures, electron transport in nanostructures, electrons in quantum wells, electrons in quantum wires, electrons in quantum dots, dimensionality and size dependent phenomena, fraction of surface atoms, surface energy and surface stress.

UNIT-IV (15 Hrs)

Nanostructure Devices: Introduction, resonant-tunneling diodes, field-effect transistors, single-electron transfer devices, potential-effect transistors, light-emitting diodes and lasers, CMOS Scaling, MOSFET, FinFETs, Vertical MOSFETs, limits to scaling, 2D semiconductors and electronic devices, nanoelectromechanical system.

Recommended Text Books / Reference Books:

1. G.W. Hanson, Fundamentals of Nanoelectronics, Pearson, 2009.
2. W. Ranier, Nanoelectronics and Information Technology (Advanced Electronic Material and Novel Devices), Wiley-VCH, 2003.
3. K.E. Drexler, Nanosystems, Wiley, 1992.
4. J.H. Davies, The Physics of Low-Dimensional Semiconductors, Cambridge University Press, 1998.
5. C.P. Polle and F.J. Owens, Introduction to Nanotechnology, Willey India Pvt. Ltd.
6. Manasi Karkare, Nano Technology: Fundamentals and Applications, I.K. International Pvt. Ltd.
7. Lynn E. Foster, Nano Technology, Pearson India.

MIXED SIGNAL DESIGN					
Subject Code: BECEH1-504	**L**	**T**	**P**	**C**	**Duration: 60 Hrs.**
	3	1	0	4	

Course Objectives: This course is meant to provide fundamental knowledge to students for understanding of the various concepts and techniques used in mixed signal design:

1. To impart knowledge about mixed signal CMOS design.
2. To provide knowledge of switched-capacitor filters and their application in modern electronics.
3. To make the students understand the design of high speed and high-resolution data converters and PLLs for mixed signal design.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Understand the practical situations where mixed signal analysis is required.
2. Analyze and handle the inter-conversions between signals.
3. Design systems involving mixed signals.

UNIT-I (15 Hrs)

Introduction: Need of mixed signal design, review of analog and discrete-time signal processing and Z-transform, introduction to sampling theory, different sampling techniques and sampling circuits, basics of analog and digital filters.

UNIT-II (15 Hrs)

Switched-Capacitor Filters: Introduction, switched-resistor, basic building block, limitations, nonidealities in switched-capacitor filters, universal switched capacitor second-order filter, types of switched-capacitor filters and applications.

UNIT-III (15 Hrs)

High Speed Converters: Basics of data converters, DC and dynamic specifications of data converters, design issues in high-speed converters, converter coding schemes, interpolation and averaging, ADC architectures: flash converters, pipeline, integrating, hybrid and oversampling, DAC Architectures: resistor string, R-2R ladder network, charge scaling DAC, cyclic DAC, pipeline DAC.

High-Resolution Converters: Introduction, single and dual-slope, dual-ramp single slope, successive approximation, algorithmic, cyclic redundant signed digit, self-calibrating ADCs, PWM, integrating, MOS only R-2R, self-calibrating DACs.

UNIT-IV (15 Hrs)

Nanostructure Devices: Introduction, resonant-tunneling diodes, field-effect transistors, single-electron transfer devices, potential-effect transistors, light-emitting diodes and lasers, CMOS Scaling, MOSFET, FinFETs, Vertical MOSFETs, limits to scaling, 2D semiconductors and electronic devices, nanoelectromechanical system.

Recommended Text Books / Reference Books:

1. G.W. Hanson, Fundamentals of Nanoelectronics, Pearson, 2009.
2. W. Ranier, Nanoelectronics and Information Technology (Advanced Electronic Material and Novel Devices), Wiley-VCH, 2003.
3. K.E. Drexler, Nanosystems, Wiley, 1992.

4. J.H. Davies, The Physics of Low-Dimensional Semiconductors, Cambridge University Press, 1998.
5. C.P. Polle and F.J. Owens, Introduction to Nanotechnology, Willey India Pvt. Ltd.
6. Manasi Karkare, Nano Technology: Fundamentals and Applications, I.K. International Pvt. Ltd.
7. Lynn E. Foster, Nano Technology, Pearson India.

INTRODUCTION TO MEMS

Subject Code: BECEH1-505 | **L T P C** 3 1 0 4 | **Duration: 60 Hrs.**

Course Objectives:

1. To make aware the students about the various Micro Electro-mechanical Systems and their applications.
2. To impart knowledge of micro system fabrication technologies.
3. To provide the students detailed concepts of micro sensors.
4. To create awareness about the different types of micro actuators.

Course Outcomes: At the end of the course the students will be able to:

1. Appreciate the underlying working principles of MEMS devices and their applications.
2. Design the micro devices, micro systems using the MEMS fabrication process.
3. Understand and utilize the basic approaches for various sensor designs.
4. Gain a knowledge of basic approaches for various actuator designs

UNIT-I (15 Hrs)

Introduction: Historical background, scaling effects, Introduction to Design of Micro electromechanical Systems, Applications of Micro and Nano electro mechanical systems, Materials for MEMS: Silicon, silicon compounds, polymers, metals.

UNIT-II (15 Hrs)

Microsystem fabrication processes: Photolithography, Ion Implantation, Diffusion, Oxidation, Thin film depositions: LPCVD, Sputtering, Evaporation, Electroplating; Etching techniques: Dry and wet etching, electrochemical etching; Micromachining: Bulk Micromachining, Surface Micromachining, sacrificial layer processes, stiction; mechanics of solids in MEMS: stresses, strain, Hookes law, poisson effect, linear Thermal Expansion, bending; energy methods, overview of finite element method, modelling of coupled electromechanical systems.

UNIT-III (15 Hrs)

Micro Sensors: Design of Acoustic wave sensors, resonant sensor, Vibratory gyroscope, Capacitive and Piezo Resistive Pressure sensors- engineering mechanics behind these Microsensors. Case study: Piezo-resistive pressure sensor.

UNIT-IV (15 Hrs)

Micro Actuators: Design of Actuators: Actuation using thermal forces, Actuation using shape memory Alloys, Actuation using piezoelectric crystals, Actuation using Electrostatic forces, Micromechanical Motors and pumps. Case study: Comb drive actuators.

Recommended Text Books / Reference Books:

1. G K. Ananthasuresh, K. J. Vinoy, S. Gopalkrishnan, K. N. Bhat, V. K. Aatre, Micro and Smart Systems, Wiley India, 2012.
2. S. E. Lyshevski, Nano-and Micro-Electromechanical systems: Fundamentals of Nano-and Microengineering, CRC press, 2005.
3. S. D. Senturia, Microsystem Design, Kluwer Academic Publishers, 2001.
4. M. Madou, Fundamentals of Micro fabrication, CRC process, 1997
5. G. Kovacs. Micromachined Transducers Sourcebook, McGraw-Hill, Boston, 1998.

BASKET-II

NEURAL NETWORK & FUZZY LOGIC					
Subject Code: BECEH1-506	**L**	**T**	**P**	**C**	**Duration: 45 Hrs.**
	3	0	0	3	

Course Objectives:

1. To introduce the fundamentals of Artificial Neural Networks.
2. To Learn and apply ANN architectures, learning laws to different applications
3. To understand Fuzzy logic and design fuzzy inference systems.
4. To apply fuzzy logic and neural nets to real world problems.

Course Outcomes: At the end of the course the students will demonstrate the ability to:

1. To design different types of ANNs for variety of applications.
2. To apply ANN to various real world applications.
3. To learn Fuzzy Algebra and design fuzzy inference systems.
4. To design and apply Neuro-fuzzy and genetic algorithms for different applications.

UNIT-I (12 Hrs)

Introduction to Neural Networks: Introduction, Humans and Computers, Organization of the Brain, Biological Neuron, Biological and Artificial Neuron Models, Characteristics of ANN, McCulloch-Pitts Model, Historical Developments, Potential, Applications of ANN.

Types of Learning: Supervised, Unsupervised learning, Basic Learning laws, Hebb's rule, Delta rule, Widrow and Hoff LMS learning rule,Competitive Learning, Reinforcement Learning.

UNIT-II (12 Hrs)

Multilayer Perceptron: Perceptron, Feedforward Neural Network, Multilayer Perceptron, Error Backpropagation Learning Algorithm, MLP design issues and implementation in various applications.

Other ANNs: K-means clustering algorithm, Kohonen's feature maps. ART networks, Radial Basis Function Nets- recurrent networks, Hopfield Neural Nets, Associative and Hetro-associative memories, Applications of ANN in pattern recognition, optimization, control etc

UNIT-III (10 Hrs)

Fuzzy Algebra: Fuzzy algebra fundamental concepts, Classical sets, Fuzzy sets, Fuzzy relations, Fuzzification, Defuzzification,

Fuzzy Logic Systems: Membership functions, Fuzzy rules and Knowledge base, Fuzzy Inference System, applications of Fuzzy logic in real world problems, Fuzzy logic control and its comparison with PID control.

UNIT-IV (11 Hrs)

Neuro-fuzzy network, Genetic Algorithms, and their applications.

Recommended Text Books / Reference Books:

1. Berkin Riza C and Trubatch, "Fuzzy System design principles- Building Fuzzy IF-THEN rule bases", IEEE Press

Yegna Narayanan, "Artificial Neural Networks". 8th Printing. PHI(2003)

3. Patterson Dan W, "Introduction to artificial Intelligence and Expert systems", 3rd Ed., PHI

Simon Haykin, "Neural Networks" Pearson Education.

5. Yen and Langari, "Fuzzy Logic: Intelligence, Control and Information", Pearson Education.
6. Jacek M Zaurada, "Introduction to artificial neural Networks, Jaico Publishing Home, Fouth Impression.

ERROR CORRECTING CODES					
Subject Code: BECEH1-507	**L**	**T**	**P**	**C**	**Duration: 45 Hrs.**
	3	0	0	3	

Course Objectives:

This course is meant to provide Fundamental knowledge about:

1. Types and sources of error in digital communication
2. Various error correcting and detecting techniques
3. How to use mathematical tools to design codes and sequences for data communication.
4. Issues in achieving data rates upto Shannon's limit

Course Outcomes:

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

1. Understand fundamentals of channel coding schemes and their application areas
2. Define the sources of error in digital communication
3. Explain the fundamental limits to achieve the Shannon's Channel Capacity
4. Describe the importance and principle of ECC in data communication and storage.
5. Demonstrate an ability to compare and contrast strengths and weaknesses of various ECC
6. Develop and model different ECC for appraise of reaching data rate to Shannon limit.
7. Apply the mathematical ideas to design well known ECC
8. Demonstrate competence in analyzing and evaluating different ECC

UNIT-I (9 Hrs.)

Channel capacity and coding: Introduction; Channel Models, Channel Capacity, Need of Channel Coding, Information Capacity Theorem, Shannon Limit; Random Selection Of Codes, Hamming Distance, overview of Information Theory. Classification of error correcting codes (ECC), Linear and non-linear codes, memory-based and memory-less codes, Symmetric and asymmetric codes, perfect and quasi perfect codes, coding efficiency **; Applications of error control coding**

UNIT-II (12 Hrs.)

Block Codes : Digital Communication Channel, Introduction to Block Codes, Single Parity Check Codes, Product Codes, Repetition Codes, error detection and correction, Hamming Codes, Minimum Distance of Block Codes, bounds on the size of a block code; bounded and maximum-likelihood decoding of binary block codes, Soft - Decision Decoding, Automatic Repeat Request Schemes.

Linear Codes: Definition of Systematic Linear Codes, generator and parity check matrices,

Standard Array decoding, Parity - Check Matrices, Syndrome decoding on symmetrical channels, Shortened and Extended Linear Codes.

UNIT-III (12 Hrs.)

Cyclic codes : Introduction of Cyclic Codes, Polynomials, Generator Polynomials, Encoding Cyclic Codes, Decoding Cyclic Codes, Factors of X^n +1, Parity-Check Polynomials, Dual Cyclic Codes, Generator and Parity-Check Matrices of Cyclic Codes.

BCH Codes: Linear Algebra, Galois Field, Definition and Construction of Binary BCH Codes, Error Syndromes In Finite Fields, Decoding Single error correction (SEC) and Double Error Correction (DEC) codes, Reed- Solomen Codes.

UNIT-IV (12 Hrs.)

Convolutional Codes: Introduction to Convolution codes, Encoding, Generator Matrices, Generator Polynomials , Graphical Representation of Convolutional Codes (code tree, state diagram, trellis diagram) , Viterbi decoding algorithm. Concept of Interleaverand punctured coding

Concatenated codes: Introduction, Need and Purpose of concatenated codes, Overview of Turbo coders and decoders, LDPC coders and decoders, Recent trends in error correction coding.

Recommended Text Books / Reference Books:

1. Amitabha Bhattacharya, “Digital Communication”, Tata McGraw Hill Publishing Company Limited, 2006.
2. Hwei P. Hsu, “Analog and Digital Communications”, Schaum's Outline Series, McGraw Hill, 2nd Ed., 2003.
3. Shu Lin, Daniel J. Costello, Jr., “Error Control Coding”, Second Edition, Pearson Education, 2011.
4. Martin Tomlinson, Cen Jung Tjhai, Marcel A. Ambroze, Mohammed Ahmed, Mubarak Jibril, “Error-Correcting Coding and Decoding: Bounds, Codes, Decoders, Analysis and Applications”, Springer Nature, 2017.
5. Bose Ranjan, “Information Theory, Coding and Cryptography”, Tata McGraw-Hill, 1st Ed., 2007.
6. Sklar Bernard, “Digital Communications - Fundamentals and Applications”, Pearson Education-LPE, 2nd Ed., 2009.
7. F. J. McWilliams and N.J.A. Slone, “The Theory of Error Correcting Codes”, 1977.
8. R.E. Balahut, “Theory and Practice of Error Control Codes”, Addison Wesley, 1983.

SOFT COMPUTING					
Subject Code: BECEH1-508	**L**	**T**	**P**	**C**	**Duration: 60 Hrs.**
	3	1	0	4	

Course Objectives:

Course Outcomes: At the end of this course students will demonstrate the ability to:

UNIT-I (15 Hrs)

Soft Computing: Introduction of soft computing, soft computing vs. hard computing, various types of soft computing techniques, applications of soft computing. Fuzzy Logic: Fuzzy set versus crisp set, basic concepts of fuzzy sets, membership functions, basic operations on fuzzy sets and its properties. Fuzzy relations versus Crisp relation

Fuzzy rule base system: Fuzzy propositions, formation, decomposition & aggregation of fuzzy rules, fuzzy reasoning, Fuzzy Inference Systems (FIS) – Mamdani Fuzzy Models – Sugeno Fuzzy Models – Tsukamoto Fuzzy Models, Fuzzification and Defuzzification, fuzzy decision making & Applications of fuzzy logic.

UNIT-II (15 Hrs)

Structure and Function of a single neuron: Biological neuron, artificial neuron, definition of ANN and its applications. Neural Network architecture: Single layer and multilayer feed forward networks and recurrent networks. Course rules and equations: Perceptron, Hebb's, Delta, winner take all and out-star Course rules. Supervised Course Network: Perceptron Networks, Adaptive Linear Neuron, Multiple Adaptive Linear Neuron, Back Propagation Network, Associative memory networks, Unsupervised Course Networks: Competitive networks, Adaptive Resonance Theory, Kohnen Self Organizing Map

UNIT-III (15 Hrs)

Genetic Algorithm: Fundamentals, basic concepts, working principle, encoding, fitness function, reproduction, Genetic modelling: selection operator, cross over, mutation operator, Stopping Condition and GA flow, Constraints in GA, Applications of GA, Classification of GA

UNIT-IV (15 Hrs)

Hybrid Soft Computing Techniques: An Introduction, Neuro-Fuzzy Hybrid Systems, Genetic Neuro-Hybrid systems, Genetic fuzzy Hybrid and fuzzy genetic hybrid systems

Recommended Text Books / Reference Books:

1) Michael Negnevitsky, 'Artificial Intelligence', Pearson Education, New Delhi, 2008.
2) Timothy J. Ross, 'Fuzzy Logic with Engineering Applications', Wiley, 2010.

WIRELESS ADHOC & SENSOR NETWORKS					
Subject Code: BECEH1-509	**L**	**T**	**P**	**C**	**Duration: 60 Hrs.**
	3	1	0	4	

Course Objectives:

1. To provide knowledge of wireless adhoc& sensor networks
2. To understand wireless sensor network node architecture and network architecture
3. To become familiar with various protocols and applications of wireless sensor networks

Course Outcomes:

After the completion of the course, student/s shall demonstrate the ability/skills to:

1. Become familiar with wireless networks evolution and applications
2. Understand node and network architecture of wireless sensor networks
3. Learn various operating systems for wireless sensor network
4. Understand MAC, routing and transport protocols for wireless sensor networks
5. Learn real time applications of wireless sensor networks

UNIT-I (15 Hrs.)

Introduction to Wireless Networks: Background of wireless networks, OSI reference model, TCP/IP model, wireless technologies, wireless LAN, blue-tooth and personal area networks, adhoc networks, background of sensor networks technology, need, motivation and evolution of wireless sensor networks, advantages, applications, challenges and issues in wireless sensor networks.

Basic Wireless Sensor Network Technology: Basic sensor network architecture, motes, sensor devices, types of sensors, sensor's specifications, operating environment, wireless transmission technology and systems, hardware components and design constraints, operating systems and execution environments, sensing and communication range.

UNIT-II (15 Hrs.)

Wireless Sensor Network Architecture:

Architecture, traditional layered stack, cross-layer designs, Sensor node, commercially available sensor nodes –Imote, IRIS, Mica Mote, EYES nodes, BTnodes, TelosB, Sunspot, IEEE standards for WSNs, physical layer and transceiver design considerations in WSNs, energy usage profile, choice of modulation scheme, antenna considerations.

Operating Systems for Wireless Sensor Networks:

Introduction, operating system design issues, examples of operating systems - TinyOS, Contiki, Mate, MagnetOS, MANTIS, OSPM, EYES OS, SenOS, EMERALDS, PicOS.

UNIT-III (15 Hrs.)

Medium Access Control Protocols for Wireless Sensor Networks: Performance requirements, common protocols, MAC Protocols for WSNs - schedule-based protocols, random access-based protocols, periodic listen and sleep operations, schedule selection and coordination, schedule synchronization, adaptive listening, access control and data exchange.

Routing Protocols for Wireless Sensor Networks: Routing challenges and design issues, WSN routing techniques, flooding and its variants, GLOSSY, sensor protocols for information via negotiation, power-efficient data gathering in sensor information systems.

UNIT-IV (15 Hrs.)

Transport Control Protocols for Wireless Sensor Networks: Traditional transport control protocols – TCP and UDP, feasibility of using TCP or UDP for WSNs, transport protocol design issues, examples of existing transport control protocols for WSNs – CODA, ESRT, RMST, PSFQ, GARUDA and ATP, problems with transport control protocols, performance of transport control protocols, congestion, packet loss recovery.

Topology control, clustering, time synchronization, localization and positioning, data storage and manipulation, data aggregation, WSN applications - home control, building automation, industrial automation, medical applications, reconfigurable sensor networks, highway monitoring, military applications, civil and environmental engineering applications, wildfire Instrumentation, habitat monitoring, nanoscopic sensor applications, case study: IEEE 802.15.4 LR-WPANs standard.

Recommended Text Books / Reference Books:

1. Wireless AdHoc and Sensor Networks by Prof Sudip Misra, IIT Kharagpur (NPTEL Online Certification Course)
2. Wireless Sensor Networks: Technology, Protocols, and Applications by Kazem Sohraby/wiley.
3. Wireless Sensor Networks by Zhao Feng/ Elsevier India
4. Security in Wireless Sensor Networks by Piotr Szczechowiak/ Lap Lambert Academic Publishing
5. Wireless Sensor Networks by Raghavendra SivalingamZnati/ Springer India
6. Building Wireless Sensor Networks by Robert Faludi/ O'reilly

BASKET-III

MICROWAVE THEORY AND TECHNIQUES

Subject Code: BECEH1-601 | **L T P C** 3 0 0 3 | **Duration: 45 Hrs.**

Course Objectives:

1. To understand Waveguides and different modes.
2. To Understand various microwave components and their properties.
3. To provide knowledge on the different antenna parameters and antenna types.
4. To gain knowledge about various Microwave Systems

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Understand various microwave system components and their properties.
2. Analyze microwave circuits using scattering parameters.
3. Analyze various antenna parameters and different kinds of antennas.
4. Understand different microwave systems.

UNIT-I (12 Hrs)

Introduction to Microwaves- History of Microwaves, Microwave frequency bands, Applications of microwaves.

Waveguides: Introduction to rectangular waveguide, circular waveguide and Planar Transmission line, Comparison of Waveguide with transmission line, Propagation in TE, TM and TEM modes, characteristic impedance.

UNIT-II (12 Hrs)

Microwave Components:S-parameters, Directional coupler, E-plane Tee, H-plane Tee, magic tee and their S-parameters, attenuator, cavity resonator, Ferrite devices: Circulator, Isolator, Gyrator.

Microwave Devices: Limitations of Conventional Tubes, Construction, Operation and Properties of Two Cavity Klystron amplifier, Reflex Klystron Oscillator, Travelling Wave Tube, Magnetron. Gunn diode and PIN diode

UNIT-III (10 Hrs)

Antenna Parameters: Radiation pattern, Gain, Directive gain, Directivity, Effective Aperture, Front to Back ratio, Antenna Beam Width, Antenna Bandwidth, Antenna Beam Efficiency, Antenna Beam Area or Beam Solid Angle.

Broadband Antennas: Introduction to Aperture Antenna, Slot Antenna, Microstrip or Patch Antenna, Smart Antenna.

UNIT-IV (11 Hrs)

Microwave Measurements: Measurement of standing wave ratio, measurement of wavelength and frequency, measurement of power, radiation pattern measurement of antenna

Microwave Systems: Radar, Terrestrial and Satellite Communication, Radio aids to navigation, RFID, GPS

Recommended Text Books / Reference Books:

1. Collin, R.E., "Foundations for Microwave Engineering", 2nd Ed., John Wiley & Sons. 2000.
2. Pozar, D.M., "Microwave Engineering", 3rd Ed., John Wiley & Sons. 2004
3. Edwards, T.C. and Steer M.B., "Foundations for Interconnects and Microstrip Design", 3rd Ed., John Wiley & Sons. 2001

4. Ludwig, R. and Bretchko, P., "RF Circuit Design", Pearson Education. 2000
5. Hunter, I., "Theory and Design of Microwave Filters", IEE Press. 2001
6. Misra, D.K., "Radio-frequency and Microwave Communication Circuits", John Wiley & Sons.
7. Samuel Y Liao, "Microwave Devices and Circuits", Pearson Publication
8. M. Kulkarni, "Microwave and Radar Engineering", Umesh Publication

FIBER OPTIC COMMUNICATIONS

Subject Code: BECEH1-602 **L T P C** **Duration: 45 Hrs.**

3 0 0 3

Course Objectives:

1. To provide knowledge about various types of optical sources and detectors.
2. To impart knowledge about optical fiber link design and multiplexing techniques.
3. To provide basic understanding of optical switches and amplifiers.
4. To make aware the students about non-linear effects of fiber optic communication.

Course Outcomes: At the end of the course the students will demonstrate the ability to:

1. Understand the principles of fiber optic communication and the bandwidth advantages.
2. Understand the properties of the optical fibers and optical components.
3. Understand the operation of lasers, LEDs, and detectors.
4. Design Fiber optic link and understand non-linear effects in optical fibers.

UNIT-I (11 Hrs)

Introduction to light and optical Fiber: Introduction to vector nature of light, propagation of light, propagation of light in a cylindrical dielectric rod, ray model, wave model.

Different types of optical fibres, modal analysis of a step index fibre, Signal degradation on optical fibre due to dispersion and attenuation, fabrication of fibres and measurement techniques like OTDR

UNIT-II (12 Hrs)

Optical Sources, Detectors and Optical Link Design: LEDs and Lasers, photo-detectors- pin diodes, APDs, detector responsivity, noise, optical receivers, optical link design-BER calculation, quantum limit, power penalties.

UNIT-III (10 Hrs)

Optical switches & Amplifiers: Optical switches – coupled mode analysis of directional couplers, electro-optic switches. Optical Amplifiers - EDFA, Raman amplifier.

UNIT-IV (12 Hrs)

Optical Communication System: WDM and DWDM systems. Principles of WDM networks, Nonlinear effects in fiber optic links, Concept of self-phase modulation, group velocity dispersion and solition based communication

Recommended Text Books / Reference Books:

1. John M Senior, 'Optical Fiber Communications', PHI.
2. Gerd Keiser, 'Optical Fiber Communications', TMH.
3. G. Aggarwal, Fiber Optic Comunication systems, John wiley and sons, New York, 1997.
4. John Gowar, Optical Communication Systems, PHI Publications.

MOBILE COMMUNICATION AND NETWORKS					
Subject Code: BECEH1-603	**L**	**T**	**P**	**C**	**Duration: 45 Hrs.**
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Course Objectives: This course is meant to provide fundamental knowledge to students for understanding the basics of mobile communication and networks.

1. To make aware the students about the concept of mobile communication.
2. To provide the knowledge about the concepts of Signal Propagation.
3. To provide the knowledge about frequency selective channels and Access schemes.
4. To provide the knowledge of different receiver structures.

C**ourse Outcomes:** At the end of course, students will demonstrate the ability to: -

1. Understand the working principles of the mobile communication systems.
2. Understand the relation between the user features and underlying technology.
3. Analyze mobile communication systems for improves performance.

UNIT-I (10 Hrs)

Introduction: - Cellular Concepts-Cell structure, frequency re-use, cell splitting, channel assignment, handoff, interference, capacity, power control, Wireless Standards: - Overview of 2G, 3G and 4G cellular standards

UNIT-II (12 Hrs)

Signal Propagation- Propagation mechanism- reflection, refraction, diffraction and scattering, large scale signal propagation and lognormal shadowing. Fading channels-Multipath and small scale fading- Doppler shift, statistical multipath channel models, narrowband and wideband fading models, power delay profile, average and rms delay spread, coherence bandwidth and coherence time, flat and frequency selective fading, slow and fast fading, average fade duration and level crossing rate.

UNIT-III (11 Hrs)

Capacity of flat and frequency selective channels. Antennas- Antennas for mobile terminal- mono pole antennas, PIFA, base station antennas and arrays.

Multiple Access Schemes- FDMA, TDMA, CDMA and SDMA. Modulation schemes- BPSK, QPSK and variants, QAM, MSK and GMSK, multicarrier modulation, OFDM.

UNIT-IV (12 Hrs)

Receiver Structure- Diversity receivers- selection and MRC receivers, RAKE receiver, equalization; - Linear-ZFE and Adaptive, DFE. Transmit diversity- Altamonte scheme.

MIMO and Space time signal processing, spatial multiplexing, diversity/multiplexing tradeoff. Performance measures- Outage, average SNR, average symbol/bit error rate. System examples- GSM, EDGE, GPRS, IS-95, CDMA 2000 and WCDMA.

Recommended Text Books / Reference Books:

1. WCY Lee, Mobile Cellular Telecommunications Systems, McGraw Hill, 1990.
2. WCY Lee, Mobile Communication Design Fundamentals, Prentice Hall, 1993.
3. Raymond Steele, mobile Radio Communication, IEEE Press, New York, 1992.
4. AJ Viterbi, CDMA: Principles of Spread Spectrum Communications, Addison Wesley, 1995.
5. VK Garg & JE Wilkes, Wireless and Personal Communication Systems, Prentice Hall, 1996.

SATELLITE COMMUNICATION

Subject Code: BECEH1-604 | **L T P C** 3 0 0 3 | **Duration: 45 Hrs.**

Course Objectives:

1. To introduce various aspects in the design of systems for satellite communication.
2. To illustrate various aspects related to satellite systems such as orbital equations, sub-systems, link budget.
3. To impart knowledge about various phenomena in Satellite Communication.
4. To provide the knowledge of various multiple access techniques.

Course Outcomes: At the end of the course the students will demonstrate the ability to:

1. Visualize the architecture of satellite systems as a means of high speed, high range communication system.
2. Understand link design for satellite communication.
3. Understand and utilize the basic approaches for multiple access techniques.
4. Solve numerical problems related to orbital motion and design of link budget for the given parameters and conditions.

UNIT-I (12 Hrs)

Introduction to Satellite Communication: Principles and architecture of satellite communication, brief history of satellite systems, advantages, disadvantages, applications and frequency bands used for satellite communication.

UNIT-II (12 Hrs)

Orbital Mechanics: Orbital equations, Kepler's laws, Apogee and Perigee for an elliptical orbit, evaluation of velocity, orbital period, angular velocity of a satellite, concept of Solar day and Sidereal day.

Satellite sub-systems: Study of 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-system.

UNIT-III (10 Hrs)

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

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, C/N ratio calculations in clean air and rainy conditions

UNIT-IV (11 Hrs)

Modulation and Multiple Access Schemes: Various modulation schemes used in satellite communication, multiple access schemes: TDMA, FDMA and CDMA.

Recommended Text Books / Reference Books:

1. Timothy Pratt, 'Satellite Communication', John Wiley & Sons.
2. D.C. Aggarwal, 'Satellite Communication', Khanna Publishers.
3. Tri. T. Ha, "Digital Satellite Comunications", Tata Mcgraw Hill, 2009.
4. Dennis Roddy, Satellite Communication, Tata Mcgraw Hill, 2009

PROBABILITY THEORY AND STOCHASTIC PROCESSES					
Subject Code: BECEH1-605	**L**	**T**	**P**	**C**	**Duration: 60 Hrs.**
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Course Objectives:

1. To provide mathematical background so as to solve probabilistic problems.
2. To understand basic concepts of probability theory and various probability distributions.
3. To deal with random variables, multiple random variables, expectation, joint distribution and independence.
4. To provide knowledge of stochastic process and events.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Understand representation of random signals.
2. Investigate characteristics of random processes.
3. Make use of theorems related to random signals.
4. Understand propagation of random signals in LTI systems

UNIT-I (15 Hrs)

Probability: Sets and set operations, Sample space and events, Probability, Classical, relative frequency and axiomatic definitions of probability, addition rule and conditional probability, independence of two or more events , multiplication rule, total probability, Bayes' Theorem, combinatorial probability and sampling models

UNIT-II (15 Hrs)

Probability Distribution & Density functions :Distribution and Density functions and their Properties – Binomial, Poisson, Uniform, Gaussian, Exponential, Rayleigh and Conditional Distribution, Moments about the Origin, Central Moments, Variance and Skew, Chebychev's Inequality, Characteristic Function, Moment Generating Function.

UNIT-III (15 Hrs)

Random variables & Random Sequences: Introduction to random variable, discrete random variables, continuous random variables, probability mass function, probability density function, cumulative distribution function, Joint distribution Function, functions of one and two random variables, conditional distribution, densities and moments, Characteristic Function of a random variable, Markov, Chebyshev and Chernoff bounds. Random sequences and modes of convergence (everywhere, almost everywhere, probability distribution and mean square), Limit theorems, strong and weak laws of large numbers, central limit theorem.

UNIT-IV (15 Hrs)

Stochastic Processes: Introduction to stochastic process, classification of stochastic processes according to state space and time domain, statistical characterization, mean, correlation and covariance functions, Stationary random processes, Ergodicity, Weiner-khintchine theorem, discrete time stochastic processes, Cyclostationary processes, Gaussian, Poisson, Markov processes, transmission of random process through LTI system, Power Spectral density.

Recommended Text Books / Reference Books:

1. B. P. Lathi, "Modern Digital and Analog Communication Systems", Oxford University Press
2. H. Stark and J. Woods, "Probability and random processes with applications to Signal

Processing" Pearson
3. A. Papoulis and S. Unnikrishnan Pillai, "Probability, random variables and stochastic processes", McGraw Hill
4. K.L.Chung, "Introduction to probability theory with stochastic processes", Springer International
5. P.G. Hoel, S. C. Port and C. J. Stone, " Introduction to Probability", UBS Publishers
6. P.G. Hoel, S. C. Port and C. J. Stone, " Introduction to Stochastic Processes", UBS Publishers
7. S. Ross, "Introduction to Stochastic Models", Harcourt Asia, Academic Press