List of Open Electives offered by different Departments
M Tech, Second Year, Semester III
(Last Updated: June 2019)

A. Theory							
Department	Course Number	Subject	Scheme Of Studies Per Week			Total	Credits
			L	T	P		
			3	0	0	3	3
AEIE	AEIE6121 AEIE6122	Biosignal and Biomedical Image Processing Intelligent Control					
BT	BIOT6121	Engineering Mathematics and Biostatistics					
ChE	REEN6121 REEN6122	Composite Materials Safety and Hazards in Energy Industry					
CSE	CSEN6121 CSEN6122	Business Analytics Advanced Artificial Intelligence					
ECE	ECEN6121 ECEN6122 ECEN6123 ECEN6124	AD HOC Networks and Uses Design of Embedded Systems Cognitive Radios Automation in VLSI Design					
IT	INFO6123	Information Theory and Coding					
MATH	MATH6121	Optimization Techniques					

Subject Name: Biosignal and Biomedical Image Processing					
Paper Code: AEIE6121					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

On completion of this course you should be able to:

1. Understand acquisition, general properties and clinical applications of biomedical signals such as ECG, EEG, EMG, EP and speech signal.
2. Learn the fundamentals of different modes of 2D and 3D medical imaging, including fluoroscopic, ultrasound imaging, computed tomography and magnetic resonance imaging.
3. Demonstrate advanced knowledge of filtering, transforms and spectral analysis of biomedical signal and images.
4. Apply image processing techniques for enhancement, filtering, segmentation and registration biomedical images.
5. Gain skill set to compress biomedical signals and images using loss less and lossy compression techniques as well as modern compressed sensing technique.
6. Perform signal analysis and classification using PCA, ICA, LDA, Bay's classifier, KNN and k-means clustering algorithm.

Module I – [9L]

Acquisition, General Properties and Clinical Applications of Biomedical Signals and their signal processing aspects:

Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Evoked Potential (EP)and Speech Signals.

Physics, Signal Processing and Clinical Applications of major modalities for medical imaging:

Ultrasound, X-ray, CT, MRI, PET, and SPECT.

Module II – [11L]

Fundamentals of Biomedical Signal and Image Processing Techniques:

Signal acquisition- Sampling in time, aliasing, quantization, interpolation and noise; Convolution, Correlation and Covariance of signals.

Signal Transform: Discrete Fourier transform (DFT) and its properties, the fast Fourier transform (FFT), Short Time Fourier Transform (STFT), Time-Frequency analysis- Continuous wavelet transform and discrete wavelet transform, Discrete Cosine Transform (DCT)- Application of these transforms and examples with MATLAB.

Digital Filters: FIR and IIR digital filters design criteria, signal averaging, MATLAB implementation.

Spectral Analysis: Nonparametric Estimators of PSD and Parametric Estimators.

Module III – [8L]

Medical Image Processing Techniques:

Extension of filtering and Transforms methods to 2-D signals and systems.

Image enhancement, Image Registration, Image Segmentation-pixel based, region based, edge based and morphological methods of segmentation with example in MATLAB.

Module IV – [8L]

Emerging topics:

Biomedical Data Compression- Need for data compression, Lossless and lossy compression, Compressive Sensing Algorithms– Sampling, representation and reconstruction for Signal and Image Processing Applications.

Multivariate Analyses: Principal Component Analysis (PCA) and Independent Component Analysis (ICA).

Classification: Bayes' rule, detection, statistical classification, Linear Discriminant Analysis (LDA), Cluster Analysis- K-means clustering, K-nearest neighbour (KNN) classifier; Evaluation of classifier performance.

References:

1. J. L. Semmlow and B. Griffel, Biosignal and Medical Image Processing, 3rd Eds., 2014.
2. J. L. Semmlow, Biosignal and Medical Image Processing: MATLAB based Applications, Marcel Dekker, Inc., Yew York, USA, 2004.
3. Amine Naït-Ali (Ed.), Advanced Biosignal Processing, Springer, 2009.
4. H. Liang, J. D. Bronzino and D. R. Peterson (Eds.), Biosignal Processing- Principle and Practices, CRC Press, 2013.
5. K. J. Blinowska, J. Zygierewicz, Practical Biomedical Signal Analysis Using MATLAB, CRC Press, 2012.

Subject Name: Intelligent Control					
Paper Code: AEIE6122					
Contact hrs per week:	L	T	P	Total	Credit points
	3	0	0	3	3

Course Outcomes:

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

1. Explain the concept of intelligent control and their applications.
2. Learn basics of Neural Network and control systems based on it.
3. Gain knowledge about fuzzy set theory and control scheme based on it.
4. Apply Genetic Algorithm to solve optimization problems in different control systems.
5. Provide detailed theoretical and practical aspects of intelligent modeling, optimization and control of non-linear systems.
6. Design Neural Network based predictor of nonlinear system.

Module I – [10L]

Introduction to Intelligent Systems and Neural Networks:
Introduction and motivation, Approaches to intelligent control, Architecture for intelligent control, Expert systems.
Artificial Neural Networks: Concept of ANN and its basic mathematical model, McCulloch-Pitts neuron model, simple perceptron, Adaline and Madaline, Feedforward multilayer perceptron. Learning and training of the neural network, Adaptive learning rate, weight update rule, Radial basis function networks.

Module II - [10L]
Fuzzy Logic and Model Based Fuzzy Control:
Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control. Fuzzification, inferencing and defuzzification. Fuzzy knowledge and rule bases. Fuzzy modeling and control schemes for nonlinear systems. Self organizing fuzzy logic control. Fuzzy logic control for nonlinear time-delay system.

Module III - [8L]

Evolutionary Computation Techniques:
Genetic Algorithm: Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters, Evolutionary design of controllers. Solution of typical control problems using genetic algorithm. Concept on some other search techniques like tabu search and ant-colony search and simulated annealing techniques for solving optimization problems.

Module IV - [8L]

Hybrid Computing Technique:
Neuro-Fuzzy Hybrid System, Adaptive Neuro-Fuzzy Inference System, Genetic Neuro Hybrid System, Genetic Fuzzy hybrid and Fuzzy Genetic hybrid system, Applications in system identification and control.
Introduction to Quantum Computation: Quantum neural network for fuzzy classifier, Quantum Neuro-Fuzzy classifier.

References:

1. Y.C. Shin and C. Xu, Intelligent Systems: Modeling, Optimization and Control, CRC Press, 2008.
2. Kazumi Nakamatsu and Roumen Kountchev Eds., "New Approaches in Intelligent Control- Techniques, Methodologies and Applications", Springer, 2015.
3. Michael Negnevitsky, "Artificial Intelligence : a Guide to Intelligent Systems", Addison Wesley, 2005.
4. Robert E. King, "Computational Intelligence in Control Engineering", Control Engineering Series.
5. Marzuki Khalid, "Artificial Intelligence : Fuzzy Logic Module", University Technology Malaysia.
6. Marzuki Khalid, "Artificial Intelligence : Artificial Neural Networks Module", Universiti Teknologi Malaysia

Subject Name: Engineering Mathematics and Biostatistics					
Paper Code: BIOT6121					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

After completion of this course, students will be able to:

1. Understand and apply the basic principles of engineering mathematics.
2. Estimate men, median, mode and other parameters of central tendency in biological samples.
3. Evaluate the probability of occurrence by different methods in an experimental set-up.
4. Solve problems regarding differences in parameters between experimental and control groups by testing hypothesis.
5. Analyze the relationship between experimental groups in biological samples with the help of correlation and regression.
6. Estimate the difference between and within biological parameters in same or different groups by analysis of variance.

Module-I [9L] Introduction to Engineering Mathematics

Linear Algebra: Matrices and Determinants, Eigen values and Eigen vectors; Definite integration with Applications; Differential equations with applications; Numerical solution of ODEs: different methods.

Module-II [9L] Central tendency and theoretical distribution

Statistics of dispersion: Variability, Central tendency, Mean deviation, Standard Deviation, Variance; Probability Distribution for discrete random variables and continuous random variables; Skewness, Kurtosis, theoretical probability distributions: binomial, poisson, normal.

Module-III [9L] Testing of hypothesis

Testing Hypothesis: Concepts and importance in experimental research, type of errors; testing means, Significance of difference between means using Z score; Large sample tests based on normal distribution – Test based on t and F distributions, Chi square test for goodness of fit, independence of attribute, homogeneity, and variance of a normal population.

Module-IV [9L] Correlation, Regression & Anova

Correlation and Regression analysis; Analysis of Variance: One way and two way classifications of Anova – Applications in Biological Sciences.

Text books:

1. Introduction to Biostatistics. Pranab K Banerjee. (2nd edition). S. Chand & Co.
2. P.N. Arora, P.K. Malhan, Biostatistics, Himalaya Publishing House.
3. B.K. Pal and K. Das. Engineering Mathematics. Vol. 1 and 2. U.N. Dhur & Sons Pvt. Ltd.

Reference books:

1. Debajyoti Das and Arati Das. Statistics in Biology and Psychology, Academic Publishers.
2. P. Kandasamy, K. Thilakavthy and K. Gunavathy. Numerical Methods. S. Chand and Co., New Delhi, 1999.
3. B.S. Grewal, J.S. Grewal. Numerical Methods in Engineering and Science. Khanna Publishers, New Delhi, 1999.
4. M.K. Jain, S.R.K. Iyengar and R.K. Jain. Numerical Methods for Engineering and Scientific Computation (3rd Edition). New Age International (P) Ltd., New Delhi, 1995.
5. C.F. Gerald, P.O. Wheatley. Applied Numerical Analysis (5th Edition), Addison – Wesley, Singapore, 1998.
6. S. Narayanan, K. Manickavachakam Pillai and G. Ramanaiah. Advanced Mathematics for Engineering Students-Vol.-III. S. Viswanathan Pvt. Ltd., Chennai, 1993.

Subject Name: Composite Materials					
Paper Code: REEN 6121					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcome:

By the end of the course the students will be able to

1. Impart updated knowledge and provide strong foundation to the M. Tech. students on the preparation, structure, fabrication, properties and applications of different advanced composite materials.
2. Acquire vast ideas and strong confidence in applications of high tech materials in modern devices used in both renewable and non-renewable energy sector.
3. Carry out R & D activities for developing newer advanced materials for use in renewable energy sector.
4. Solve stringent industrial problems and needs wherever applicable more economically.
5. Pursue higher studies & carry out research works effectively in the field of materials science & engineering.
6. Acquire sound employability in different eminent academic, R & D institutes and industries.

Module–I: 9 L

Learning objective; Introduction: Definition; Classification and characteristics of Composite materials; Advantages and application of composites for both general engineering & renewable energy engineering purpose; Functional requirements of reinforcement and matrix; Effect of reinforcement (size, shape, distribution, volume fraction, and orientation of particles and fibres/whiskers) on overall composite performance;

Module II: **9 L**

Applications of composites/nano-composites in renewable energy engineering: Wind turbine, Gas turbine; hydro-turbine; electrical double layer capacitors used in storage devices (conducting polymer carbon nano-tube composites), tandem & hot carrier solar cells: transition metal- chalcogenides; perovskite-based solar cells, nano-diamond based solar energy converter, graphene-silicon batteries; black phosphorous-based solar photo voltaic; Nickel sulphide anchored graphene composites for high performance super capacitors electrode materials for fuel cell applications; Chromium-doped poly-aniline –CNT nano-composites as super capacitors electrode materials.

Module III: 9 L

Reinforcements: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers, Silicon carbide fibres & Alumina whiskers. Properties and applications of whiskers, particle reinforcements. Mechanical behaviour of composites: Rule of mixtures, Inverse rule of mixtures. Iso-strain and Iso-stress conditions. Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

Module IV: 9 L

Preparation of Metal Matrix Composites: Casting– Solid State diffusion technique, Cladding – Hot iso-static pressing; Properties and applications; Preparation of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering; Preparation of Carbon–Carbon composites: Knitting, Braiding, Weaving, Properties and applications; Preparation of Polymer Matrix Composites: Preparation of Moulding compounds and pre-pregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding; Properties and applications.

TEXT BOOKS:

1. Material Science and Technology – Vol 13 – Composites by R.W. Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction; W D Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007

References:

1. Hand Book of Composite Materials by Lubin George(Ed)
2. Composite Materials – K. K. Chawla.
3. Composite Materials Science and Applications – Deborah D.L. Chung.
4. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

Subject Name: Safety and Hazards in Energy Industry					
Paper Code: REEN 6122					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcome:

By the end of the course the students will be able to

1. Analyze the effect of release of toxic substances
2. Understand the industrial laws, regulations and source models.
3. Apply the methods of prevention of fire and explosions.
4. Understand the advantages of preventive maintenance.
5. Understand the relief and its sizing methods.
6. Understand the methods of hazard identification and preventive measures.

Module I: 9L

Definition of safety, Hazard and Risk, Safety program, Inherent safety, Safety regulations, OSHA, Process safety management, mechanical and electrical hazards, types, causes and preventive steps/procedure, Hazards due to fire, Distinction between fire and explosion, Upper Flammability limit and Lower Flammability Limit, Fire Triangle, Fire prevention and firefighting, equipment and methods, Safety color codes..

Module II: 9L

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Service life of equipment. Tools for hazards identification: HAZOP, Fault Tree, Event Tree, FMEA, Wear and Corrosion and their prevention, Application of lubrication and different methods of lubrication, Types of corrosion, corrosion prevention methods.

Module III: 9L

Risk analysis concept and methodology: Risk concept and measure of risk, Risk acceptance criteria, Quantitative risk analysis, decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, i. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

Module IV: 9L

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

Reference:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.
5. Chemical Process Safety: Fundamentals with Applications: D. A. Crowl and J.F.Louvar, Prentice Hall, 1990

Subject Name: Business Analytics					
Course Code : CSEN6121					
Contact hours per week	L	T	P	Total	Credit Points
	3	0	0	3	

Course Outcomes:

1. Students will demonstrate knowledge of data analytics.
2. Understand and critically apply the concepts and methods of business analytics
3. Students will demonstrate the ability to use various techniques to support data driven business decision-making.
4. Student will demonstrate how to recognize trends, detect outliers, summarize data sets and analyze relationships between variables
5. Able to develop and test hypotheses
6. Initiate interest to learn various tools used in this area on his/her own.

Module I [8 L]

Introduction: Overview of Business analytics, Business analytics vs Business Analysis vs Data Science, Scope of Business analytics, Business Analytics Process, Organization structure needed for effective Analytics, Competitive advantages of Business Analytics, Data and models for Business analytics

Data Visualization : Summarizing Data (Mean, Mode, Variance, Standard Deviation, Skewness), Tools for Single variable (histogram), Tools for Pairs of variables (box plot, scatter plot, contour plot), Tools for Multiple variables.

Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modeling, sampling and estimation methods overview.

Module II [10 L]

Types of Statistical Analysis: Descriptive type of statistical Analysis, Inferential Type of Statistical Analysis, Predictive Analytics, Perspective Analytics and its step in the business analytics Process, Causal Analysis, nonlinear Optimization.

Trendiness and Regression Analysis: Modeling Relationships and Trends in Data, simple Linear Regression.

Data Mining techniques: Classification, clustering, Association rules, Outer detection, Sequential Patterns used in business analytics.

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.

Module III [10 L]

Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, News vendor Model, Overbooking Model, Cash Budget Model.

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

Module IV [8 L]

Recent Trends in Business Analytics: Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

Business Analytics Tool – R: Overview of R, Some basic coding syntax of R, Discuss some Modeling Techniques in Business Analytics with R for simple problems.

Reference:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

Subject Name: Advanced Artificial Intelligence					
Paper Code: CSEN6122					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

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

1. Understand the building blocks of artificial intelligence, knowledge representation, reasoning, and machine learning techniques to real-world problems.
2. Formulate and solve problems with uncertain information using Bayesian approaches.
3. Learn supervised and unsupervised learning techniques and criteria of their performance assessment.
4. Employ fuzzy logic for development of artificial intelligent systems.
5. Familiar with AI search algorithms like genetic algorithms.
6. Develop artificial neural network model for different classification problems as well as understand basic of some of the more advanced topics of AI such as deep learning and convolutional neural network.

Module I – [9L]

Introduction to AI: Logic foundations of Artificial Intelligence, Constraint reasoning, Qualitative reasoning, Probabilistic reasoning- Bayesian probability, Steps of Bayesian problem solving, Naïve Bayesian Learning Model, Boosting of naïve Bayesian model-AdaBoost Algorithm.

Module II - [9L]

*Learning:*Supervised, Unsupervised and Reinforcement learning; Learning decision trees; Generalization and over fitting, Cross validation, Loss function, Regularization, Complexity versus goodness of fit.

Regression and classification with linear Models- Univariate linear regression, Multivariate linear regression, Linear classification with logistic regression; Perceptron Learning Algorithm (linear model), Adaline and Madaline; K-nearest neighbor model.

Module III - [9L]

*Emergent Intelligence:*Fuzzy expert systems- Fundamentals of Fuzzy sets, membership functions, Linguistic variables and hedges, operations on fuzzy sets, fuzzy rules, fuzzy inference, examples of building fuzzy expert system, fundamental issues with Fuzzy systems;

Evolutionary computation- Formal model of evolution system theory, Darwin's evolutionary algorithm, Classifier system; Genetic algorithm - basic principles of genetic algorithm, genetic operators, simple illustration of genetic algorithm with examples.

Module IV - [9L]

Neural Networks & Deep Learning: Introduction- Basic models of artificial neurons, activation functions, Simple perceptron, multilayer perceptron, Backpropagation learning algorithm, Applications of neural networks in classification and estimation.

Deep learning – Concepts of deep learning, deep networks, training of deep networks, applications of deep learning; Convolutional neural network, recurrent neural network

References:

1. Stuart J. Russell and Peter Norvig, *Artificial Intelligence A Modern Approach*, 3rd Edition, Pearson, 2016.
2. Toshinory Munakata, *Fundamentals of the New Artificial Intelligence- Neural, Evolutionary, Fuzzy and More*, Second Edition, Springer, 2008.
3. Richard E. Neapolitan, Xia Jiang, *Artificial Intelligence- With an Introduction to Machine Learning*, Second Edition, CRC Press, 2018.
4. Michael Negnevitsky, *Artificial Intelligence- A Guide to Intelligent Systems*, Addison-Wesley.
5. Neural Networks and Learning Machines, Simon Haykin, Third Edition, PHI Learning, 2009.
6. Y. S. Abu-Mostafa, M. Magdon-Ismail, H. T. Lin, Learning from Data A short Course, AMLbook.com.
7. J. Han and M. Kamber, Data Mining Concepts and Techniques, 3rd, Edition, Morgan Kaufmann Publishers, July 2011.

Subject Name: AD HOC Networks and Uses					
Paper Code : ECEN6121					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course outcomes:

1. Students will develop the ability to apply knowledge of mathematics, science and engineering in the areas of communication engineering.
2. They will be able to analyze a situation and interpret a data in ad hoc networks.
3. Students will acquire knowledge to learn and apply modeling based approach through the extensive use of simulator tools.
4. Students will be able to compare and decide about different routes.
5. They will analyse the performance of routes.
6. Students will be able to understand and develop ability to participate in research work.

Module I: [10 L]

Ad hoc Network: Introduction, Basic concept on ad hoc network, static and mobile ad hoc network, transmitter-receiver constraints, Applications.

MAC protocol: Hidden terminal, Exposed terminal, IEEE802.11 in ad hoc mode.

Routing protocols: Proactive, Reactive and hybrid routing protocol, DSDV algorithm, Dynamic source routing, Ad hoc on-demand routing, Location aided routing, Link reversal routing.

Module II: [10L]

Analysis of TCP performance in wireless ad hoc network: TCP window management and problems, different solution schemes, QoS in wireless ad hoc network – analysis of degradation of receiver SNR, practical solutions.

Achieving energy efficiency in wireless ad hoc network: Different schemes to increase the lifetime of the node in ad hoc network – MAC layer protocol, Routing protocol.

Module III: [8 L]

Localization Management: Location acquisition technique, location sensing technique, location aware routing protocol. Primary and secondary source , Different principles like weighted centriod algorithm to locate sources. Security for wireless ad hoc network: Security goals, threats and challenges, Different schemes of security in ad hoc network, routing security. Spectrum utilization – Generic Access Network (GAN) and other methods, Hotspots and uses.

Module IV: [6 L]

Sensors- sensor networking, WSN, hardware and software platforms, OS for WSN, distributed sensor network, healthcare monitoring, environmental sensing, industrial monitoring, smart city concept.

References

1. ”Ad Hoc Wireless Networks – Architectures and Protocols” - C.Siva Ram Murthy and B.S. Manoj – Pearson Education
2. Mobile Ad Hoc Networking – Stefano Basagni, Marco Conti, Silvia Giardano, Ivan Stojmenovic – Wiley India
3. Security and Quality of Service in Ad Hoc Wireless Networks – Amitabh Misra – Cambridge University Press

Subject Name: Design of Embedded Systems					
Paper Code: ECEN 6122					
Contact Hrs per week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

1. Students will learn Embedded System Design Methodology
2. Students will learn Embedded Processor Design
3. Students will learn 8051 Micro-Controller
4. Students will learn Embedded Memory and I/O Device interface
5. Students will learn Real time OS
6. Students will learn ARM Micro-Controller and PIC Micro-Controller

Module I: Introduction to embedded systems: [8L]

Embedded systems overview with various type of examples in different domains such as in communication systems, robotics application and in control application, Design challenge – optimizing design metrics, embedded processor technology, Difference between embedded computer systems and general purpose computer Systems, Design methodology.

Module II: Embedded system processor design: [10L]

Custom single-purpose processors design: using finite state machine model and RTL model. Standard single-purpose processors design: Timers, and watchdog timers, LCD controller. Interfacing of Embedded Processors: Hardware protocol basics, interfacing with a generalpurpose processor, RS232, I2C, CAN protocol.

Module III: Introduction to 8051 microcontroller: [10L]

8051 architecture, pin configuration, I/O ports and Memory organization. Instruction set and basic assembly language programming. Interrupts, Timer/Counter and Serial Communication in 8051, Introduction to PIC and ARM micro-controllers.

Module IV: Interfacing with Memory and I/O Devices: [8L]

Different types of embedded memory devices and interfacing: SRAM, DRAM, EEPROM, FLASH, CACHE memory. Different types of I/O devices and interfacing: Keypad, LCD, VGA. Square wave and pulse wave generation, LED, A/D converter and D/A Converter interfacing to 8051.

Text Books:

1. Embedded System Design: A Unified Hardware/Software Approach – 2nd Ed. by Ed Frank Vahid and Tony Givargis
2. Embedded Systems: A Contemporary Design Tool by James K. Peckol
3. Embedded / Real-Time Systems: Concepts, Design and Programming by K.V.K. Prasad
4. Embedded Systems by Raj Kamal

Reference Book:

1. Computers as Components: Principles of Embedded Computing System Design – 2nd Ed. by Wayne Wolf.

Subject Name: Cognitive Radios					
Paper Code : ECEN6123					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

The following outcomes are expected from the students after completion of the course –

1. An ability to apply knowledge of mathematics, science and engineering in the emerging areas of RF communication.
2. An ability to analyze a situation.
3. An ability to learn and apply modular approach.
4. An ability to understand research work in new areas of cognitive radios and spectrum hole sensing.
5. Development of a passion to pursue next generation wireless communication.
6. An ability to design intelligent radios for future.

Module I: [9 L] INTRODUCTION TO SOFTWARE DEFINED RADIO
Definitions and potential benefits, software radio architecture evolution, technology tradeoffs and architecture implications. Differences between software enable radio and software defined radio. Essential functions of the software radio, basic SDR, hardware architecture, Computational processing resources, software architecture, top level component interfaces, interface topologies among plug and play modules.

Module II: [9 L] COGNITIVE RADIO TECHNOLOGY
Introduction – Radio flexibility and capability – Aware – Adaptive – Comparison of Radio capabilities and Properties – Available Technologies – IEEE 802 Cognitive Radio related activities – Application, position awareness in cognitive radios, optimization of radio resources, Artificial Intelligence Techniques.

Module III: [10 L] COGNITIVE RADIO DESIGN AND CHALLENGES
Cognitive Radio – functions, components and design rules, Cognition cycle – orient, plan, decide and act phases, Inference Hierarchy, Architecture maps, Building the Cognitive Radio Architecture on Software defined Radio Architecture. Design Challenges associated with CR – Hardware requirements – Hidden primary user problem – detecting spread spectrum primary users – sensing duration and frequency – security

Module IV: [8 L] SPECTRUM SENSING
Spectrum sensing, spectrum management, spectrum mobility, spectrum sharing, upper layer issues, cross – layer design, applications of cognitive radios to optimize spectrum utilization, to reduce transmit power reduction and to improve data rate even in noisy conditions. Matched filter – waveform based sensing – cyclostationary based sensing – Energy detector based sensing – Radio Identifier – Cooperative sensing- other sensing methods.

References:

1. Joseph Mitola III, "Software Radio Architecture: Object-Oriented Approaches to wireless system Engineering", John Wiley & Sons Ltd. 2000
2. Thomas W. Rondeau, Charles W. Bostain, "Artificial Intelligence in Wireless communication", ARTECH HOUSE. 2009.
3. Bruce A. Fette, "Cognitive Radio Technology", Elsevier, 2009.
4. Ian F. Akyildiz, Won- Yeol Lee, Mehmet C. Vuran, Shantidev Mohanty, "Next generation / dynamic spectrum access / cognitive radio wireless networks: A Survey" Elsevier Computer Networks, May 2006
5. Simon Haykin, "Cognitive Radio: Brain-Empowered Wireless Communication", IEEE Journal on selected areas in communications, Feb 2005.

Subject Name: Automation in VLSI Design					
Paper Code : ECEN6124					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcome:

1. Students will understand MOS Transistor Based Digital VLSI Circuits
2. Students will understand Physical Layout Design of Digital VLSI Design
3. Students will understand VLSI Design Cycle
4. Students will learn Verilog HDL (Hardware Description Language)
5. Students will learn High level and Logic level Synthesis Algorithm
6. Students will learn Floorplan, Placement and Routing Algorithm

Module I: VLSI Circuits and Physical Layout: [10L]

Unit 1: MOS Transistor Characteristics, MOS as Digital Switch, NMOS Logic Family, CMOS Logic Family, CMOS Inverter Characteristics (VTC), Inverter Delay, CMOS Gates like NAND and NOR gates, Pass Transistor Logic and Transmission Gate, CMOS Sequential Circuits, CMOS D-Latch and D-Flip-Flop

Unit 2: CMOS Cross Section, Layout and Mask layers, Inverter Layout, Lambda Rule vs Micron Rule, Std Cell Layout Topology, Stick Diagram, Euler Path Algorithm, Layout Legging.

Module II: VLSI Design Methodology: [6L]

Unit1: Moore's Law, Scale of Integration (SSI, MSI, LSI, VLSI, ULSI, GSI), Technology growth and process Node,

Unit2: Full Custom Design, Std Cell based Semi Custom Design, VLSI Design Cycle, Y-Chart.

Module III: EDA Tools: High level Synthesis and HDL: [8L]

Unit 1: High level Synthesis EDA Flow, Control and Data Flow Graph, Scheduling, Allocation, Binding, RTL

Unit 2: Why HDL ? Frontend Design Flow using HDL (Behavioral, RTL and Gate Level), Verilog Modeling: Behavioral, Data-Flow, Structural and Mixed, Test Bench, FSM Example: Mealy Machine and Moore Machine. Pipeline Example.

Module IV: EDA Tools: Logical Synthesis and Physical Design Automation: [12L]

Unit 1: Combinational Logic Optimization: BDD: Binary Decision Diagram, OBDD, ROBDD, Technology Mapping: Pattern DAG, Subject DAG, Sequential Logic Optimization

Unit 2: Physical Layout Automation EDA Flow, Partitioning: KL Algorithm, Floor-planning cost function, Placement, Detailed Routing: Channel Routing, Horizontal Constraint Graph, Vertical Constraint Graph, Cyclic Constraint, Left-edge Algorithm, Global Routing: Steiner Tree, Maze Routing.

Text Book:

1. Principles of CMOS VLSI Design, A Systems Perspective, Author: Neil Weste, Kamran Eshraghian, Addison Wesley, 2nd Edition, 2000
2. Algorithms for VLSI Physical Design Automation, Author: N. Sherwani, KLUWER ACADEMIC PUBLISHERS (3rd edition)

Reference Book:

1. CMOS Digital Integrated Circuits, Analysis and Design, Author: Sung-Mo Kang, Yusuf Leblebici, Tata McGraw Hill (3rd Edition), 2006
2. CMOS VLSI Design, A Circuits and Systems Perspective (3rd Edition) Author: Neil Weste, David Harris, Ayan Banerjee. Pearson, 2011
3. Digital Integrated Circuit, Design Perspective, Author: .M. Rabaey, Prentice-Hall
4. VLSI Design and EDA TOOLS, Author: Angsuman Sarkar, Swapnadip De, Chandan Kumar Sarkar, SCITECH PUBLICATIONS (India) Pvt. Ltd., 2011
5. Algorithms for VLSI Design Automation, Author: Gerez, Wiley, 2011

Subject Name: Information Theory and Coding					
Paper Code: INFO6123					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:
Students who complete the course will demonstrate the ability to do the followings.

1. Derive equations for entropy, mutual information and channel capacity for all types of channels.
2. Compare among different types of error correcting codes.
3. Evaluate the channel performance using Information theory.
4. Formulate the basic equations of linear block codes.
5. Apply convolution codes for performance analysis .
6. Design BCH code for Channel performance improvement.

Detailed Syllabus:

Module I: (9 L)

Entropy and Mutual Information: Entropy, Joint and Conditional Entropy, Relative Entropy and Mutual Information, Chain Rules, Fano's Inequality, Information measures for continuous random variables, Markov chains.

Source coding: Huffman coding, Kraft Inequality, Shannon-Fano Coding, Shannon-Fano-Elias Coding, Arithmetic Coding and Run length coding.

Channel Capacity: Channel models, Discrete memoryless channels, Shannon's noisy coding theorem, The Shannon limit.

Module II: (11 L)

Linear Block Codes: Design of linear block codes, introduction of linear block codes, Matrix description of linear block codes, parity check matrix, syndrome and error detection, minimum distance of a block code, error detecting and error correcting capability of a block code, design of encoder and syndrome decoder for linear block codes. Hamming codes.

Cyclic Codes: Polynomials, division algorithm for polynomials, a method for generating cyclic codes, matrix description of cyclic codes, generator and parity check polynomials, syndrome and error detection.

Module III : (8 L)

BCH Codes: Primitive elements, minimal polynomials, generator polynomials in terms of minimal polynomials, Error Syndrome,Error location polynomial,examples of BCH codes, Reed-Solomon Codes, Interleaved and Concatenated Codes.

Module IV : (8 L)

Convolutional Codes: Tree codes, trellis codes, polynomial description of convolutional codes, distance notions for convolutional codes, the generating function, matrix representation of convolutional codes, decoding of convolutional codes – Viterbi Algorithm, distance and performance bounds for convolutional codes, Turbo codes, Turbo decoding.

References:

1. Information theory, coding and cryptography - Ranjan Bose; TMH.
2. Information and Coding - N Abramson; McGraw Hill.
3. Elements of Information Theory - T. M. Cover and J. A. Thomas, John Wiley, New York.
4. Information Theory - R B Ash; Prentice Hall.

Subject Name: Optimization Techniques					
Paper Code: MATH6121					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

Students who complete the course will demonstrate the ability to do the followings.

1. Describe the way of writing mathematical model for real-world optimization problems.
2. Identify Linear Programming Problems and their solution techniques
3. Categorize Transportation and Assignment problems
4. Apply the way in which Game Theoretic Models can be useful to a variety of real-world scenarios in economics and in other areas.
5. Convert practical situations into non-linear programming problems.
6. Solve unconstrained and constrained programming problems using analytical techniques.

MODULE I: Linear Programming Problem (LPP)-I (9L)

Formulation of an LPP; Graphical Method of solution of an LPP; Convex Combination and Convex Set; Convex Hull and Convex Polyhedron; Canonical and Standard form of an LPP; Basic Solution of a system of linear equations; Simplex Method; Big-M Method; Concept of Duality; Mathematical formulation of duals.

MODULE II: Linear Programming Problem (LPP)-II (9L)

Transportation Problems (TP) ; Representation of Transportation Problems as LPP; Methods of finding initial basic feasible solution of TP: North-West Corner Rule, Matrix Minima Method, Vogel's Approximation Method; Optimality test of the basic feasible solution; Assignment Problems; Hungarian Method.

MODULE III: Game Theory (9L)

Introduction; Strategies; The Minimax and Maximin Criterion; Existence of Saddle Point; Two person zero some Games; Games with saddle Point – Pure Strategies; Games without a Saddle Point – Mixed Strategies; Symmetric Games; Dominance Principle; Graphical Method of Solution; Algebraic Method of Solution.

MODULE IV: Non-Linear Programming Problem (NLPP) (9L)

Single-variable Optimization; Multivariate Optimization with no constraints: Semidefinite Case, Saddle Point; Multivariate Optimization with Equality Constraints: Method of Lagrange Multipliers; Multivariable Optimization with inequality constraints: Kuhn-Tucker Conditions.

Suggested Readings:

1. *Linear Programming and Game Theory* by J. G. Chakraborty and P. R. Ghosh, Moulik Library.
2. *Operations Research* by Kanti Swarup, P. K. Gupta and Man Mohan, S. Chand and Sons.
3. *Engineering Optimization* by S. S. Rao, New Age Techno Press.
4. *Operations Research by J K Sharma, Macmillan India Ltd*