M. TECH - COMPUTATIONAL ENGINEERING AND NETWORKING

CENTRE FOR EXCELLENCE IN COMPUTATIONAL ENGINEERING & NETWORKING

SCOPE:

This course aims at preparing students in the area of computational sciences especially in data driven modeling and scientific computation. Recent advances in computing-hardware platforms (NVIDIA CPU-GPUs, and Intel-Altera CPU-FPGA) , Artificial Intelligence software platforms (like Torch, Theano and Tensor-flow) and sensor technology (camera, lidar, ultrasonic sensors) has resulted rapid progress in machine -cognition tasks and is expected that machines will soon surpass the humans in visual and audio perception capabilities. This M.Tech course is tuned to cater to the demands in terms of skills required of the new scenario.

Note: Curriculum take into account the fact that, Modern AI, data science and Scientific computing requires strong foundation in Mathematics and statistics. So the strategy used in the choice and schedule of the subjects is that "give strong foundation in common core and foundational subjects in the first two semesters and allow the student to master an area of his/her choice through four electives, one minor and major project. So 50% of the weightage is for building foundation and remaining 50 % for specialization.

CURRICULUM

First Semester

Course Code	Type	Course	L T P	Credits
18MA607	FC	Computational Linear Algebra and Optimization for Data Sciences	3 0 1	4
18CN621	SC	Introduction to Machine Learning	2 0 1	3
18CN601	FC	Algorithms and Structures for Data Science	2 0 1	3
18CN622	SC	Real Time Operating System for Embedded Computing	2 0 1	3
18CN623	SC	Embedding Computing for Data Science	2 0 1	3
18RM600	SC	Research Methodology	2 0 0	2
18HU601	HU	Amrita Values Program*		P/F
18HU602	HU	Career Competency-I*		P/F
		Credits	**18**	

*****Non Credit Course

Second Semester

Course Code	Type	Course	L T P	Credits
18CN624	SC	Machine Learning for Signal Processing and Pattern Classification	2 0 1	3
18CN602	FC	Deep Learning and Probabilistic Graphical Models	2 0 1	3
18CN625	SC	Scientific Computing	2 0 1	3
18CN626	SC	Computer Networks and IoT	2 0 1	3
	E	Elective-I	2 0 1	3
	E	Elective-II	2 0 1	3
18HU603	HU	Career Competency-II	0 0 2	1
		Credits	**19**	

Third Semester

	Type	Course	L T P	Credits
18CN627	SC	Big Data Framework for Data Science	2 0 1	3
	E	Elective-III	2 0 1	3
	E	Elective-IV	2 0 1	3
18CN798	P	Dissertation		8
		Credits	**17**	

Fourth Semester

Course Code	Type	Course	L T P	Credits
18CN799	P	Dissertation		12
		Credits	**12**	

Total Credits: 66

LIST OF COURSES

Foundation Core

Course Code	Course	L T P	Credits
18MA607	Computational Linear Algebra and Optimization for Data Sciences	3 0 1	4
18CN601	Algorithms and Structures for Data Science	2 0 1	3
18CN602	Deep Learning and Probabilistic Graphical Models	2 0 1	3

Subject Core

Course Code	Course	L T P	Credits
18CN621	Introduction to Machine Learning	2 0 1	3
18CN622	Real Time Operating System for Embedded Computing	2 0 1	3
18CN623	Embedding Computing for Data Science	2 0 1	3
18CN624	Machine Learning for Signal Processing and Pattern Classification	2 0 1	3
18CN625	Scientific Computing	2 0 1	3
18CN626	Computer Networks and IoT	2 0 1	3
18CN627	Big Data Framework for Data Science	2 0 1	3
18RM600	Research Methodology	2 0 0	2

Electives

Students are allowed to choose the electives offered under M.Tech RSW.

AUTOMATION AND CONTROL

Course Code	Course	L T P	Credits
18CN701	Feedback Control Systems	2 0 1	3
18CN702	Digital Control Systems	2 0 1	3
18CN703	Multivariable Control Systems	2 0 1	3
18CN704	Applied Kalman Filtering	2 0 1	3
18CN705	System Identification	2 0 1	3
18CN706	Modelling, Simulation and Identification of Battery Dynamics	2 0 1	3
18CN707	Battery Management and Control	2 0 1	3

Electives

VEHICLE POWER ELECTRONICS

All the Electives given under the specialization in “Automation and Control” are also applicable to the specialization in “Vehicle Power Electronics”

Course Code	Course	L T P	Credits
18CN708	Modelling and Control of Power Electronics Systems	2 0 1	3
18CN709	Model Predictive Control	2 0 1	3

HEALTHCARE

Course Code	Course	L T P	Credits
18CN710	Deep Learning in Genomics and Biomedicine	2 0 1	3
18CN711	Deep Learning for Biomedical Data Analysis	2 0 1	3

AI and DATASCIENCE

Course Code	Course	L T P	Credits
18CN712	Introduction to Natural Language Processing	2 0 1	3
18CN713	Speech Processing	2 0 1	3
18CN714	Social Media Analytics	2 0 1	3
18CN715	Deep Learning for NLP	2 0 1	3
18CN716	Deep Learning for Visual Recognition	2 0 1	3
18CN717	Deep learning for Cybersecurity	2 0 1	3

Mechanical/Civil/Aerospace Electives

Course Code	Course	L T P	Credits
18CN718	Computational Fluid Mechanics	2 0 1	3
18CN719	Finite Element Analysis	2 0 1	3

18CN720	Deep Learning Essentials for Self-Driving Car	2 0 1	3
18CN721	Introduction to Additive Manufacturing	2 0 1	3
18CN722	Unmanned Aerial Vehicles and Essential Control	2 0 1	3
18CN723	Computational Robotics and Robotic Operating System	2 0 1	3
18CN724	Complex Systems in Engineering, Finance & Biology: Modelling & Analysis	2 0 1	3
18CN725	IoT for Disaster Management Systems	2 0 1	3

General Electives

Course Code	Course	L T P	Credits
18CN726	Introduction to Data Analysis	2 0 1	3
18CN727	Live-in-Lab	2 0 1	3

18MA607 COMPUTATIONAL LINEAR ALGEBRA AND OPTIMIZATION FOR DATA SCIENCES 3-0-1-4

Matrices and Gaussian Elimination – Introduction, Geometry of Linear Equations, Gaussian Elimination, Matrix multiplication, Inverses and Transposes, Special matrices and applications. Vector spaces and Linear equations– Vector spaces and subspaces, linear independence, basis and dimension, the four fundamental subspaces. Orthogonality - Perpendicular vectors and orthogonal subspaces, inner products and projections onto lines, projections and least square applications, orthogonal basis, orthogonal spaces, orthogonal matrices, Gram Schmidt orthogonalization, FFT. Eigenvalues and Eigenvectors – Introduction, diagonal form of a matrix, difference equations and the powers of A^k, Positive Definite Matrices - Minima, Maxima and saddle points, tests for positive definiteness, semi-definite and indefinite matrices, Singular Value Decomposition, iterative methods for Ax = b, applications in sparse signal and image processing.Introduction - mathematical optimization, least-squares and linear programming, convex and nonlinear optimization. Convex sets, Convex optimization problems - optimization problem in standard form, convex optimization problems, quasi-convex optimization, linear optimization, quadratic optimization, generalized inequality constraints, semi definite programming, vector optimization. Duality, Approximation and fitting, Statistical estimation, Geometric problems, Unconstrained minimization- gradient descent method, steepest descent method, Newton's method. Equality constrained minimization - equality constrained minimization, eliminating equality constraints,

Newton's method with equality constraints, infeasible start Newton method, implementation. Interior-point methods -inequality constrained minimization, logarithmic barrier function and central path, barrier method, L1 Norm Optimization methods,

Alternating direction method of multipliers (ADMM), Applications in Signal and Image Processing.

TEXT BOOKS/ REFERENCES:

1. Gilbert Strang, "*Linear Algebra and its Applications*", Third Edition, Harcourt College Publishers, 1988.
2. Gene H. Golub and V. Van Loan, "*Matrix Computations*", Third Edition, John Hopkins University Press, Baltimore, 1996.
3. David C. Lay, "*Linear Algebra and Its Applications*", Pearson Addison Wesley, 2002.
4. Stephen P. Boyd and LievenVandenberghe d, Convex Optimization, Cambridge University press, 2004
5. Kalyanmoy Deb, "*Optimization for Engineering Design Algorithms and Examples*", Prentice Hall of India, New Delhi, 2004.
6. Edwin K.P. Chong and Stanislaw H. Zak, "*An Introduction to Optimization*" Second Edition, Wiley-Interscience Series in Discrete Mathematics and Optimization, 2004.
7. M. AsgharBhatti, "*Practical Optimization Methods: With Mathematica Applications*", Springer VerlagPublishers, 2000.

18CN621 INTRODUCTION TO MACHINE LEARNING 2-0-1-3

The need for Machine Learning – Supervised learning – Unsupervised Learning – Linear regression and Feature selection – Linear Classification – Support Vector Machines – Clustering – Dimensionality Reduction – Graphical – Artificial Neural Networks – Dimensionality Reduction - Combining classifiers - regularization, clustering - Spectral clustering, Reinforcement Learning - Markov models - Large Scale Machine Learning -Applications - Introduction to Deep Learning – Deep Learning Architectures – LSTM – CNN – RNN – Hyper parameter tuning – Decision Trees – Machine Learning applied to medical data – ECG – EEG – Deep Learning applications in medical data – EEG – ECG.

TEXT BOOKS/REFERENCES:

1. Pattern Recognition and Machine Learning. Bishop, C. M. Springer (2010).
2. Introduction to Machine Learning with Python. Mueller, A. C. & Guido, S. O'REILLY' Publishers (2016).
3. Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms. Buduma, N. &Locascio, N. O'REILLY' Publishers (2017).
4. Introduction to Machine Learning, 2nd Edition. Alpaydin, E. MIT Press (2009).

5. Soman, K. P., Loganathan, R., & Ajay, V. (2009). *Machine learning with SVM and other kernel methods*. PHI Learning Pvt. Ltd.
6. EthemAlpaydin, ―Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series)‖, Third Edition, MIT Press, 2014
7. Stephen Marsland, ―Machine Learning – An Algorithmic Perspective‖, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
8. Tom M Mitchell, ―Machine Learning‖, First Edition, McGraw Hill Education, 2013.

18CN601 ALGORITHMS AND STRUCTURES FOR DATA SCIENCE 2-0-1-3

Algorithm Analysis - Methodologies for Analyzing Algorithms, Asymptotic Notation, A Quick Mathematical Review, Case Studies in Algorithm Analysis, Amortization, Experimentation .Basic Data Structures - Stacks and Queues, Vectors, Lists, and Sequences, Trees, Priority, Queues and Heaps, Dictionaries and Hash Tables.

Search Trees and Skip Lists - Ordered Dictionaries and Binary Search Trees, AVL Trees. Bounded-Depth Search Trees, Splay Trees, Skip Lists. Sorting, Sets, and Selection - Merge-Sort, Abstract Data Type, Quick-Sort, A Lower Bound on Comparison-Based Sorting, Bucket-Sort and Radix-Sort, Comparison of Sorting Algorithms, Selection. FundamentalTechniques - The Greedy Method, Divide-and-Conquer, Dynamic Programming.Graphs - Abstract Data Type Data Structures for Graphs, Graph Traversal. Directed Graphs , Weighted Graphs, Single-Source Shortest Paths, All-Pairs Shortest Paths, Minimum Spanning Trees, Network Flow and Matching, Flows and Cuts. Additional Topics-Computational Geometry, Range Trees, Priority Search Trees, Quadtrees and *k*-D Trees, the Plane Sweep Technique, Convex Hulls. NP-Completeness - P and NP, NP-Completeness, Important NP-Complete Problems.

TEXT BOOKS/ REFERENCES:

1. Michael T. Goodrich and Roberto Tamassia, "*Algorithm Design Foundations, Analysis and Internet Examples*", John Wiley and Sons, 2003.
2. Michael T. Goodrich and Roberto Tamassia, "*Data Structures and Algorithms in C++*", John Wiley and Sons, 2003.
3. Michael T. Goodrich and Roberto Tamassia, "*Data Structures and Algorithms in Java*", Fourth Edition, John Wiley and Sons, 2004.

18CN622 REAL TIME OPERATING SYSTEM FOR EMBEDDED COMPUTING 2-0-1-3

Programming languages intended for real time systems, Introduction to Real time operating system (RTOS), System support: scheduling, resource handling, Design and analysis of real time system software, Modelling and verification of real time systems, Reliability and fault tolerance, Interrupts, Fault recovery, Distributed real time systems, Real time communication, Real time systems for multiprocessor systems

TEXT BOOKS/ REFERENCES:

1. Liu, Jane W. S., Real-time systemsUpper Saddle River, N.J.: Prentice Hall, cop. 2000
2. Rajib Mall, "Real-Time Systems: Theory and Practice," Pearson, 2008.
3. Jane W. Liu, "Real-Time Systems" Pearson Education, 2001.
4. Krishna and Shin, "Real-TIme Systems," Tata McGraw Hill. 1999.

18CN623 EMBEDDED COMPUTING FOR DATA SCIENCE 2-0-1-3

Introduction to Embedded systems, hardware/software code sign, Embedded micro controller cores, embedded memories,Basic electronics using arduino and raspberry pi, Examples of embedded systems, sensors and interfacing techniques, Real-time concepts, real-time operating systems, Required RTOS services/capabilities (in contrast with traditional OS). Digital Systems- Design of P, PI, and PID controllers. State space and filtering systems. Motor Controls. Communication systems- System design and simulation on simulink. Signal processing systems- Hardware based on DSP Chips and Microcontrollers, Development environments of microcontrollers and DSP processors. Software development for data acquisition, fundamentals of wireless networks for embedded system, Interfacing and Integration of microcontroller based systems. Examples of Industrial process automation, software development using python, introduction to data streams and analytics. Data visualization using python tools,Machine learning techniques on sensor data streams

TEXT BOOKS/ REFERENCES:

1. D. Gajski, F. Vahid, S. Narayan, and J. Gong.“Specification and Design of Embedded Systems”, PEARSON Education, 1994

2. Syaunstrup and W. Wolf. “Hardware Software Co-design: Principles and Practice”, Kluwer, Academic Publishers, 1997
3. Python Programming with Raspberry Pi Paperback – Import, 28 Apr 2017
   by Sai Yamanoor and Srihari Yamanoor

18CN624 MACHINE LEARNING FOR SIGNAL PROCESSING AND PATTERN CLASSIFICATION 2-0-1-3

Introduction to real world signals - speech, image. Feature extraction and front-end signal processing - information rich representations, robustness to noise and artifacts, signal enhancement, bio inspired feature extraction. Basics of pattern recognition, Discriminative modeling - support vector machines, neural networks and back propagation. Introduction to deep learning - convolutional and recurrent networks, pre-training and practical considerations in deep learning, understanding deep networks.Clustering methods and decision trees.Applications in computer vision and speech recognition.

TEXT BOOKS/REFERENCES:

1. "Pattern Recognition and Machine Learning", C.M. Bishop, 2nd Edition, Springer, 2011.
2. "Deep Learning", I. Goodfellow, Y, Bengio, A. Courville, MIT Press, 2016.
3. "Digital Image Processing", R. C. Gonzalez, R. E. Woods, 3rd Edition, Prentice Hall, 2008. d. "Fundamentals of speech recognition", L. Rabiner and H. Juang, Prentice Hall, 1993.
4. "Deep Learning: Methods and Applications", Li Deng, Microsoft Technical Report.
5. "Automatic Speech Recognition - Deep learning approach" - D. Yu, L. Deng, Springer, 2014. "Computer Vision: Algorithms and Applications", R. Szeliski, Springer, 2010

18CN602 DEEP LEARNING AND PROBABILISTIC GRAPHICAL MODELS 2-0-1-3

Samples, Events, Event space, Probability Space , Random Variables, Independence and Conditional Independence, Conditional Probability, Joint Probability, Bayes' theorem Joint and Marginal Probability, Estimation Theory - Maximum Likelihood Estimators. Probabilistic Graphical Models: Direct and undirected model, Inference from Direct and undirected graphical model, Structured and Unstructured graphical models, Partition Function, D-Separation, Energy based models, Factor Graphs, Sampling from Graphical Models. Montecarlo Methods: Markov Chain and Montecarlo methods, Gibbs Sampling, Approximate Inference – Expectation Maximization, MAP Inference. Special cases: HMM, CRF, Kalman Filter, Deep Learning and graphical Models. .

TEXT BOOKS/ REFERENCES:

1. Koller, Daphne, and Nir Friedman. Probabilistic graphical models: principles and techniques. MIT press, 2009.
2. Ian Goodfellow, YoshuaBengio and Aaron Courville, Deep Learning, MIT press 2016

18CN625 SCIENTIFIC COMPUTING 2-0-1-3

Root finding: Functions and polynomials, zeros of a function, roots of a nonlinear equation, bracketing, bisection, secant, and Newton-Raphson methods. Interpolation, splines, polynomial fits, Chebyshev

approximation. Numerical Integration and Differentiation: Evaluation of integrals, elementary analytical methods, trapezoidal and Simpson's rules, Romberg integration, Gaussian quadrature and orthogonal polynomials, multidimensional integrals, summation of series, Euler-Maclaurin summation formula, numerical differentiation and estimation of errors. Ordinary differential equations: Lipschitz condition, solutions in closed form, power series method. Numerical methods: error analysis, stability and convergence, Euler and Runge-Kutta methods, multistep methods, Adams-Bashforth and Adams-Moulton methods, Gear's open and closed methods, predictor-corrector methods.

Numerical solution of PDEs: relaxation methods for elliptic PDEs, Crank-Nicholson method for parabolic PDEs, Lax-Wendroff method for hyperbolic PDEs. Calculus of variations and variational techniques for PDEs, integral equations. Finite element method and finite difference time domain method, method of weighted residuals, weak and Galerkin forms, ordinary and weighted/general least squares. Fitting models to data, parameter estimation using PDEs.Iterative methods for Solution of linear matrix equations.

TEXT BOOKS/ REFERENCES:

1. Kutz, J. Nathan, Data-Driven Modeling & Scientific Computation: Methods for Complex Systems & Big Data, Oxford University press,
2. Arfken, G.B., and Weber, H.J., Mathematical Methods for Physicists, Sixth Edition, Academic Press, 2005.

18CN626 COMPUTER NETWORKS AND IOT 2-0-1-3

This course starts with the basics of computer networks and basic requirements to setup a network .The course take through discussion of current problems faced in networking and how to resolve it. The remaining portion covers the OSI Layers, Protocols, Web technologies, IOT Architectures, Introducing IOT frameworks and cloud platforms for IOT. The practical aspects of the subject will be covered through a specially made embedded board called ESP32 development board for IOT along with open source cloud platforms for data management and visualization

Introduction to computer Networks, Building a Network, Network Architecture, Implementing Network Software, Introduction to web technologies for IOT, Introduction to cloud services and platforms for IOT, Building IOT Application using ESP32 development board, Web programming and Database management, IOT application development using Arduino, Raspbery-PI and ESP32

TEXT BOOKS/ REFERENCES:

1. CISCO Semester 1 and 2,"Networking Course" Reference Material.
2. Computer networks a Systems Approach By Larry .L.Peterson and Bruce.S.Davie
3. Raspberry PI Networking Cookbook

4. An Introduction to Computer Networks By Peter L Dordal
5. Fiction Programming the Raspberry Pi- Getting Started with Python - Simon Monk
6. Andrew S. Tanenbaum, “Computer Networks”, Fourth Edition, Prentice Hall PTR, 2002.
7. Designing the Internet of Things (Paperback)by Adrian McEwen,HakimCassimally
8. Stan Openshaw and Ian Turton, “High-Performance Computing and the Art of Parallel Programming”, O’Rielly Press, 2000.

18CN627 BIGDATA FRAMEWORK FOR DATASCIENCE 2-0-1-3

New generation Big data using Functional Programming in Scala: Basic Syntax- type inference and static types- function types and value types, closures. Immutability and immutable types-generic type Parameters-Recursive arbitrary collections-cons list- Iterative arbitrary collections-Arrays-Tail recursion-factorial example-functional abstractions with examples-square root, fixed point, sequence summations. Higher order functions- MapReduce Template-Pattern Matching syntax. Similar higher order (Cons) List operations on arbitrary Collections-filter, fold, partition, span. Basic entity classes and object in Scala. Apache Spark: - Resilient Distributed Data Sets- Creating RDDs, Lineage and Fault tolerance, DAGs, Immutability, task division and partitions, transformations and actions, lazy evolutions and optimization - Formatting and housing data from spark RDDs-Distributed File systemsHDFS and Tachyon-Persistance. Setting up a standalone Spark cluster-: spark-shell, basic API, ModulesCore-Key/Value pairs and other RDD features, MLlib-examples for bi-class SVM and logistic regression, Streaming and stream context, GraphX- streaming work count and page rank example. Data Frames and Datasets. Creating data frames from RDDs. Using Spark SQL to query data frames. NoSQL aggregate data bases. Graph data bases and querying them. Some analytics case studies: - Server Log data, Wikipedia dump text, Financial data, image data (using Cifar and Mnist), Matrix/ Vector multiplication and factorization using MapReduce.

TEXT BOOKS/REFERENCES:

1. Learning Spark: Lightning-Fast Big Data Analysis 1st Edition by Holden Karau , Andy Konwinski, Patrick Wendell, MateiZaharia
2. Programming in Scala: A Comprehensive Step-by-Step Guide Third Edition by Martin Odersky, Lex Spoon, Bill Venners.
3. High Performance Spark: Best Practices for Scaling and Optimizing Apache Spark 1st Edition, by Holden Karau, Rachel Warren
4. Scala for the Impatient 2nd Edition, by Cay S. Horstmann
5. Spark: The Definitive Guide: Big Data Processing Made Simple 1st Edition, Kindle Edition by Bill Chambers, MateiZaharia

18RM600 RESEARCH METHODOLOGY 2-0-0-2

Unit I:
Meaning of Research, Types of Research, Research Process, Problem definition, Objectives of Research, Research Questions, Research design, Approaches to Research, Quantitative vs. Qualitative Approach, Understanding Theory, Building and Validating Theoretical Models, Exploratory vs. Confirmatory Research, Experimental vs Theoretical Research, Importance of reasoning in research.

Unit II:
Problem Formulation, Understanding Modeling & Simulation, Conducting Literature Review, Referencing, Information Sources, Information Retrieval, Role of libraries in Information Retrieval, Tools for identifying literatures, Indexing and abstracting services, Citation indexes

Unit III:
Experimental Research: Cause effect relationship, Development of Hypothesis, Measurement Systems Analysis, Error Propagation, Validity of experiments, Statistical Design of Experiments, Field Experiments, Data/Variable Types & Classification, Data collection, Numerical and Graphical Data Analysis: Sampling, Observation, Surveys, Inferential Statistics, and Interpretation of Results

Unit IV:
Preparation of Dissertation and Research Papers, Tables and illustrations, Guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript. References, Citation and listing system of documents

Unit V:
Intellectual property rights (IPR) - patents-copyrights-Trademarks-Industrial design geographical indication. Ethics of Research- Scientific Misconduct- Forms of Scientific Misconduct. Plagiarism, Unscientific practices in thesis work, Ethics in science

TEXT BOOKS/ REFERENCES:

1. Bordens, K. S. and Abbott, B. B., "Research Design and Methods – A Process Approach", 8th Edition, McGraw-Hill, 2011
2. C. R. Kothari, "Research Methodology – Methods and Techniques", 2nd Edition, New Age International Publishers
3. Davis, M., Davis K., and Dunagan M., "Scientific Papers and Presentations", 3rd Edition, Elsevier Inc.
4. Michael P. Marder," Research Methods for Science", Cambridge University Press, 2011
5. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age". Aspen Law & Business; 6 edition July 2012

ELECTIVES

AUTOMATION AND CONTROL

18CN701 FEEDBACK CONTROL SYSTEMS 2-0-1-3

Introduction to feedback control - System modeling in the time domain - Dynamic response- Basic properties of feedback - Stability analysis - Root-locus analysis - Root-locus controller design - Frequency-response analysis - Frequency-response design - Digital controller implementation.

TEXT BOOKS/REFERENCES:

Joao P. Hespanha, Linear Systems Theory, Princeton University Press, 2009.

Course web-page: http://mocha-java.uccs.edu/ECE4510/index.html

18CN702 DIGITAL CONTROL SYSTEMS 2-0-1-3

Introduction to digital control - Emulation of analog controllers - Sampling and reconstruction.- Stability analysis techniques - Digital controller design - Digital filter structures and quantization effects - Adaptive inverse control.

TEXT BOOKS/REFERENCES:

1. Joao P. Hespanha, Linear Systems Theory, Princeton University Press, 2009.
2. Course web-page: http://mocha-java.uccs.edu/ECE5540/index.html

18CN703 MULTIVARIABLE CONTROL SYSTEMS 2-0-1-3

Continuous-time state-space systems - Discrete-time state-space systems – Stability - Observability and controllability - State-feedback control - Output-feedback control - Linear quadratic regulation.

Course web-page: http://mocha-java.uccs.edu/ECE5520/index.html

TEXT BOOKS/REFERENCES:

Joao P. Hespanha, Linear Systems Theory, Princeton University Press, 2009.

18CN704 APPLIED KALMAN FILTERING 2-0-1-3

Introduction to Kalman filters - State-space dynamic systems - Dynamic systems with noisy inputs - The linear Kalman filter - Kalman filter generalizations - Nonlinear Kalman filters - Particle filters - IMM/multitarget tracking - Simultaneous state and parameter estimation - Kalman filter applications.

Course web-page: http://mocha-java.uccs.edu/ECE5550/index.html

TEXT BOOKS/REFERENCES:

Simon, D.,Optimal State Estimation: Kalman,H8 and Nonlinear Approaches ,Wiley Interscience, 2006

18CN705 SYSTEM IDENTIFICATION 2-0-1-3

Introduction to system identification - LTI systems, time-domain nonparametric system ID - Frequency-domain nonparametric system ID - Transfer function models and parametric system ID - Deterministic state-space models and system ID - Stochastic state-space models and system ID - Feedback and real-time system ID.

Course web-page: http://mocha-java.uccs.edu/ECE5560/index.html

TEXT BOOKS/REFERENCES:

Ljung, L., "System Identification: Theory for the User," 2d, Prentice Hall PTR, 1999.

18CN706 MODELLING, SIMULATION AND IDENTIFICATION OF BATTERY DYNAMICS 2-0-1-3

Battery boot camp - Equivalent-circuit cell models - Microscale cell models - Continuum (porous electrode) cell models - State-space models and the dynamic realization algorithm. - Reduced-order models of cell dynamics - Thermal models.

Course web-page: http://mocha-java.uccs.edu/ECE5710/index.html

TEXT BOOKS/REFERENCES:

Gregory L. Plett, Battery Management Systems, Volume 1: Battery Modeling, ARTECH House, Boston, USA

18CN707 BATTERY MANAGEMENT AND CONTROL 2-0-1-3

Functions of a battery management system - Battery models and simulation of battery packs - Battery state estimation - Battery health estimation - Cell balancing - Voltage-based power limit estimation - Physics-based optimal control

Course web-page: http://mocha-java.uccs.edu/ECE5720/index.html

TEXT BOOKS/REFERENCES:

Gregory L. Plett, Battery Management Systems, Volume II: Equivalent-Circuit Methods, ARTECH House, Boston, USA

VEHICLE POWER ELECTRONICS

All the Electives given under the specialization in "Automation and Control" are also applicable to the specialization in "Vehicle Power Electronics"

18CN708 MODELLING AND CONTROL OF POWER ELECTRONICS SYSTEMS

Averaged switch modeling and simulation - Techniques of design-oriented analysis - Dynamic modeling and simulation of converters operating in discontinuous conduction mode - Introduction to sampled-data modeling - Current programmed control - Introduction to digital control of switching converters - Modern rectifiers

TEXT BOOKS/REFERENCES:

Erickson and Maksimovic, Fundamentals of Power Electronics, 2nd edition, Springer Science+Business (2000), ISBN 0-7923-7270-0.

18CN709 MODEL PREDICTIVE CONTROL 2-0-1-3

Review of mathematical fundamentals - Dynamic systems - Discrete-time systems - Model predictive control formulation - Discrete-time model predictive control with constraints – Stability - Robust model predictive control - Case study examples and applications of model predictive control.

TEXT BOOKS/REFERENCES:

Erickson and Maksimovic, Fundamentals of Power Electronics, 2nd edition, Springer Science+Business (2000), ISBN 0-7923-7270-0.

HEALTHCARE

18CN710 DEEP LEARNING IN GENOMICS AND BIOMEDICINE 2-0-1-3

Introduction to Machine Learning - Genomics – DenseNets and Convolutional Nets for Genomics - Recurrent NN –Autoencoders and representation learning - Generative Models –Drug Discovery and protein structure: MoleculeNet – One shot Learning drug discovery - Case Studies

TEXT BOOKS/REFERENCES:

Based on latest research papers

18CN711 DEEP LEARNING FOR BIOMEDICAL DATA ANALSIS 2-0-1-3

Introduction to Deep Learning - Convolutional Neural Networks - Convolutional Neural Networks: Architectures – Convolution / pooling layers – Understanding and Visualizing Convolutional Neural Networks . Lenet, Alexnet, Googlenet for visual perception tasks- Point of care disease diagnosis using CNN – Case Studies based on latest research papers.

TEXT BOOKS/REFERENCES:

1. Simonyan, Karen, Andrea Vedaldi, and Andrew Zisserman. "Deep inside convolutional networks: Visualising image classification models and saliency maps." *arXiv preprint arXiv:1312.6034* (2013).

2.Zeiler, Matthew D., and Rob Fergus. "Visualizing and understanding convolutional networks."*Computer vision–ECCV 2014*.Springer International Publishing, 2014.818-833.

3.Domingos, Pedro. "A few useful things to know about machine learning." *Communications of the ACM* 55.10 (2012): 78-87.

AI & DATASCIENCE

18CN712 INTRODUCTION TO NATURAL LANGUAGE PROCESSING 2-0-1-3

Introduction - Words - Regular Expressions - N-grams - Python for NLP - Part-of-Speech Tagging - Hidden Markov and Maximum Entropy Models - Morphological analyzer using machine learning- Syntactic Parsing - Statistical Parsing -Dependency Parsing- Features and Unification - Language and Complexity. The Representation of Meaning - Computational Semantics - Lexical Semantics - Vector space models - Question Answering and Summarization - Dialogue and Conversational Agents - Machine Translation-

TEXT BOOKS/REFERENCES:

1. Jurafsky D, Martin JH. Speech and Language Processing. 2nd edn Englewood Cliffs, NJ: Prentice-Hall, 2008.
2. Manning C, Schuetze H. Foundations of Statistical Natural Language Processing. Cambridge, MA: MIT Press, 1999.
3. Sandra Kübler, Ryan McDonaldandJoakimNivre,“Dependency Parsing Synthesis Lectures on Human Language Technologies”, Morgan and Claypool Publishers, 2009.

18CN713 SPEECH PROCESSING 2-0-1-3

Overview of Speech Processing, Spectral, TemporalandSpectro-Temporal Analysis of Speech, Source Filter Theory of Speech Production, Cepstral Analysis of Speech, Linear Prediction Analysis, Speech Coding. Development of Speech Systems.

Neurons, Combining Neurons, Feed Forward Networks , Deep Neural Networks for Acoustic Modeling in Speech recognition. Context Dependent Deep Neural Nets, Output representation of speech deep nets, Linear output representation in deep stacking network. Kernal Deep Networks.Recurrent NN.Comparing the relative performance of Speaker Independent GMM-HMM system and DNN on TIMIT Database.Glottal activity detection. Glottal Activity detection using Deep belief networks

TEXT BOOKS/REFERENCES:

1. Li Deng, " Deep Learning: Methods and Applications", Foundations and Trends® in Signal Processing: Vol. 7: No. 3–4, pp 197-387, 2014
2. Dong Yu and Li Deng " Automatic Speech Recognition- A deep learning approach", Springer, 2015
3. Rabiner, Juang and B. Yegnanarayana, " Fundamentals of Speech Recognition", Pearson Ed.,2009
4. Geoffrey Hinton, Li Deng, Dong Yu, George Dahl, Abdel-rahman Mohamed, NavdeepJaitly, Andrew Senior, Vincent Vanhoucke, Patrick Nguyen, Tara Sainath, and Brian Kingsbury, " Deep Neural Networks for Acoustic Modeling in Speech recognition" , IEEE Signal Process. Magazine, Nov. 2012
5. Li Deng, Douglas O'Shaughnessy, " Speech Processing: A Dynamic and Optimization-Oriented Approach", CRC Press, 2003
6. Li Deng and Dong Yu, "Deep Convex Net: A Scalable Architecture for Speech Pattern Classification", in proceedings of INTERSPEECH 2011
7. Li Deng and Dong Yu, "Deep Convex Networks for image and speech classification", in international conference on machine learning, June 2011
8. Li Deng, Dong Yu and John Platt, "Scalable stacking and learning for building deep architectures", in proceedings ICASSP 2012
9. Abdel-rahman Mohammad, G. E. Hinton, Gerald Penn, " Understanding how Deep Belief Networks perform acoustic Modeling", in proc. ICASP 2012
10. Brian Hutchinson, Li Deng and Dong Yu, "Tensor deep stacking Networks", IEEE Trans. on Pattern Analysis and Machine Intelligence, Vol. 35, No. 8, Aug. 2013

18CN714 SOCIAL MEDIA DATA ANALYTICS 2-0-1-3

Introduction to Text Analytics- Text Analytics in Social Media - Python and R- Collecting and Extracting Social Media Data - Vector Space Models of Semantics - Data Analysis, Visualization, and Exploration -Sentiment Analysis with Social media data Data - Author profiling in Social media data- Network Analysis with R . - Code-mixed data analytics -**Topic modelling - Influence and Centrality in Social Networks -Geospatial social data mining -** Shingling of Documents -Mining Data Streams, The Stream Data Model, Sampling Data in Stream, Filtering Streams, Link Analysis, Page Rank, Topic-Sensitive Page Rank, Link Spam, hubs and Authorities, Frequent Itemsets- Mining Social network Graphs

TEXT BOOKS/REFERENCES:

1. Jure Leskovec, AnandRajaraman, Jeffrey D Ullman, "Mining of Massive Datasets", 2014.

2. Charu C. Aggarwal, “Social Networking Analytics”, Kluwer Academic Publishers, 2011.
3. Charu C. Aggarwal, Cheng Xiang Zhai, “Mining Text Data”, Springer, 2012.
4. Cheng, Zhiyuan, James Caverlee, and Kyumin Lee. "You are where you tweet: a content-based approach to geo-locating twitter users." Proceedings of the 19th ACM international conference on Information and knowledge management.ACM, 2010.

18CN715 DEEP LEARNING FOR NLP 2-0-1-3

Introduction to NLP and Deep Learning -Simple Word Vector representations: word2vec, GloVe - Advanced word vector representations: language models, softmax, single layer networks -Neural Networks and back propagation for named entity recognition- Introduction to Tensorflow -Recurrent neural networks for language modelling and other tasks - GRUs and LSTMs for machine translation - Recursive neural networks for parsing - Recursive neural networks for different NLP tasks - Convolutional neural networks for sentence classification - The future of Deep Learning for NLP: Dynamic Memory Networks.

TEXT BOOKS/REFERENCES:

1. Turney, Peter D., and Patrick Pantel. "From frequency to meaning: Vector space models of semantics." *Journal of artificial intelligence research* 37 (2010): 141-188.
2. Mikolov, Tomas, et al. "Efficient estimation of word representations in vector space." *arXiv preprint arXiv:1301.3781* (2013).
3. Mikolov, Tomas, et al. "Distributed representations of words and phrases and their compositionality." *Advances in neural information processing systems*. 2013.
4. Pennington, J., Socher, R., & Manning, C. (2014). Glove: Global vectors for word representation. In *Proceedings of the 2014 conference on empirical methods in natural language processing (EMNLP)* (pp. 1532-1543).
5. Collobert, R., Weston, J., Bottou, L., Karlen, M., Kavukcuoglu, K., &Kuksa, P. (2011).Natural language processing (almost) from scratch.*Journal of Machine Learning Research*, *12*(Aug), 2493-2537.
6. Abadi, Martín, Paul Barham, Jianmin Chen, Zhifeng Chen, Andy Davis, Jeffrey Dean, Matthieu Devin et al. "TensorFlow: A System for Large-Scale Machine Learning." In *OSDI*, vol. 16, pp. 265-283. 2016
7. Kumar, A., Irsoy, O., Ondruska, P., Iyyer, M., Bradbury, J., Gulrajani, I., Zhong, V., Paulus, R. and Socher, R., 2016, June. Ask me anything: Dynamic memory networks for natural language processing. In *International Conference on Machine Learning* (pp. 1378-1387).
8. Liu, W., Wang, Z., Liu, X., Zeng, N., Liu, Y., &Alsaadi, F. E. (2017).A survey of deep neural network architectures and their applications.*Neurocomputing*, *234*, 11-26.

18CN716 DEEP LEARNING FOR VISUAL RECOGNITION 2-0-1-3

Image Classification: Data driven approach – k- Nearest Neighbor - Linear Classification: Support Vector Machine – softmax – Optimization: Stochastic Gradient Descent – Backpropagation – Neural Network Architecture: model of a biological neuron – activation functions – neural net architecture – preprocessing – weight initialization - batch normalization – regularization – loss functions- Learning and Evaluation – Convolutional Neural Networks: Architectures – Convolution / pooling layers – Understanding and Visualizing Convolutional Neural Networks . Lenet, Alexnet, Googlenet for visual perception tasks..

TEXT BOOKS/ REFERENCES:

1. Domingos, Pedro. "A few useful things to know about machine learning." *Communications of the ACM* 55.10 (2012): 78-87.
2. Li Fei-Fei (Stanford), Rob Fergus (NYU), Antonio Torralba (MIT), “Recognizing and Learning Object Categories” (Awarded the Best Short Course Prize at ICCV 2005).
3. Baydin, AtilimGunes, Barak A. Pearlmutter, and Alexey AndreyevichRadul. "Automatic differentiation in machine learning: a survey." *arXiv preprint arXiv:1502.05767* (2015).
4. Bengio, Yoshua. "Practical recommendations for gradient-based training of deep architectures." *Neural Networks: Tricks of the Trade*. Springer Berlin Heidelberg, 2012. 437-478.
5. LeCun, Yann A., et al. "Efficient backprop." *Neural networks: Tricks of the trade*. Springer Berlin Heidelberg, 2012. 9-48.
6. Simonyan, Karen, Andrea Vedaldi, and Andrew Zisserman. "Deep inside convolutional networks: Visualising image classification models and saliency maps." *arXiv preprint arXiv:1312.6034* (2013).
7. Zeiler, Matthew D., and Rob Fergus. "Visualizing and understanding convolutional networks." *Computer vision–ECCV 2014*. Springer International Publishing, 2014. 818-833.
8. Springenberg, Jost Tobias, et al. "Striving for simplicity: The all convolutional net." *arXiv preprint arXiv:1412.6806* (2014).
9. Russakovsky, Olga, et al. "Imagenet large scale visual recognition challenge." *International Journal of Computer Vision* 115.3 (2015): 211-252.
10. Mahendran, Aravindh, and Andrea Vedaldi. "Understanding deep image representations by inverting them." *Computer Vision and Pattern Recognition (CVPR), 2015 IEEE Conference on*. IEEE, 2015.

18CN717 DEEP LEARNING FOR CYBERSECURITY 2-0-1-3

Introduction – Vocabulary- Concepts: History , Crash Course in Number Theory -Properties of Mod- Calculator algorithms- Simple cryptosystems- Modern stream ciphers- Running time of algorithms- AES- Public key cryptography- RSA- Signatures-Hash functions- Finite fields- Discrete log cryptosystems - Diffie Hellman key exchange- ElGamal message exchange- Massey Omura message exchange- ElGamal signature system- Elliptic curves- Elliptic curve cryptosystems.

TEXT BOOKS/ REFERENCES:

1. Kaufman, C., Perlman, R. and Speciner, M., "*Network Security: Private Communication in a Public World* ", 2nd edition, Prentice Hall 2002.
2. W. Stallings: "*Cryptography and Network Security: Principles and Practices*", 4th edition, Prentice Hall, 2000.
3. D. R. Stinson: "*Cryptography: Theory and Practice*", third ed., CRC Press, 2005.

MECHANICAL/CIVIL/AEROSPACE ELECTIVES

18CN718 COMPUTATIONAL FLUID DYNAMICS 2-0-1-3

Introduction to CFD and principles of conservation, continuity equation, Navier stokes equation, energy equation and general structure of conservation equations. Numerical Solution of ODEs, methods for parabolic equations, methods for elliptic equations, methods for hyperbolic equations, systems of equations, Aerodynamics-Hydrodynamics with Python, Application in unmanned aerial vehicles, Autonomous cars.

TEXT BOOKS/ REFERENCES:

1. *T*.J Chung, Computational fluid dynamics, Cambridge university press, 2002
2. H.K. Versteeg&W.Malalasekera, An introduction to Computational fluid dynamics, Longman scientific and Technical, 1995
3. Leona Barbara, CFD Python:12 steps to Navier-Stokes, Online course material
4. Leona Barbara, Aero Python: Aerodynamics-Hydrodynamics with Python, online course material

18CN719 FINITE ELEMENT ANALYSIS 2-0-1-3

Basic concept of Finite Element Method, Historical background, FEM Applications, General Description of FEM, Commercial FEM software packages. Spring element-stiffness matrix, boundary conditions, solving equations.Variational formulation approach- Rayleigh-Ritz method,Principle of minimum

Potential Energy, Weighted residual methods, Bar and Beam elements, local and global coordinate system, transformation of coordinate systems, element stress. Analysis of truss. Natural coordinate system, Interpolation polynomial, Isoparametric elements and Numerical integration -Gaussian quadrature approach-simple problems in 1-D, Review of the basic theory in 2-D elasticity, plane stress, 2-D problems using Constant Strain Triangles (CST), isoparametric representation, element matrices, stress calculations. Finite element modeling and simulation techniques-symmetry, Nature of FE solutions, error, convergence, adaptivity, substructures (super elements) in FEA, Review of basic dynamic equations, Hamilton's principle, element massmatrices, free vibration (normal mode) analysis, Eigen values and Eigen vectors. Introduction to transient response analysis, Review of basic equations of heat transfer, steady state one dimensional heatconduction, governing equations, boundary conditions, element characteristics-Simple problems in 1-D, 2-D, 3-D problems, introduction to transient heat transfer, simple problems using ANSYS.

TEXT BOOKS/ REFERENCES:

1. Chandrupatla&Belagundu, "*Finite elements in Engineering*", Prentice Hall of India Private Ltd., 1997.
2. Rao S.S. "*Finite Element Method in Engineering*", Pregamon Press, 1989.
3. Krishnamoorthy. C.S., "*Finite Element Analysis- Theory and Programming"*, Tata McGraw-Hill Publishing Co., 1987.
4. Reddy, J.N. "*An introduction to the Finite Element Method*", McGraw Hill Book Company New York; 1984.
5. Zienkiewicz. O.C. "*The Finite Element Method in Engg. Science*", McGraw-Hill, London, 1977.
6. Cook, Robert Davis et all, "Concepts and Applications of Finite Element Analysis", Willy, John & Sons, 1999.

18CN720 DEEP LEARNING ESSENTIALS FOR SELF-DRIVING CAR 2-0-1-3

Introduction to self driving technology, fundamentals of deep learning, introduction and overview of Python, Machine Learning with Python, Neural Networks with Python, Introduction to tensorflow and kerasdeeplearning platforms, Fundamentals of building a driverless vehicles from a conventional car, introduction to embedded platforms for self driving car software development, Integration of various sensors to self driving cars, Navigation and obstacle avoidance using deep learning

TEXT BOOKS/ REFERENCES:

1. Driverless: Intelligent Cars and the Road Ahead (MIT Press) Hardcover– September 23, 2016 by HodLipson , Melba Kurman
2. Deep Learning An MIT Press book, by Ian Goodfellow and YoshuaBengio and Aaron Courvill
3. http://cs231n.github.io/
4. Stanley: The Robot that Won the DARPA Grand Challenge
5. http://karpathy.github.io/2016/05/31/rl/

18CN721 INTRODUCTION TO ADDITIVE MANUFACTURING 2-0-1-3

Historical evolution of rapid prototyping technology in the CAD/ CAM hierarchy, Fundamental steps in rapid prototype, ASTM F42 standard terminolgy and main varieties of machine technologies used internationally, Advantages and disadvantages of main RP technologies, Guidelines for safe operation of RP machines and handling of associated RP materials, Stereolithography apparatus (SLA), Fused deposition modeling (FDM), Multi-jet modeling (MJM), Selective laser sintering (SLS), Three-dimensional printing (3DP), Additive Manufacturing data file formats and manipulation, Stereo lithography (STL) file export and import procedures/ translation to RP machines driven with varied proprietary software , STL file problems and repair techniques, Clean-up, finishing, surface coatings and quality assurance methods in RP technologies, Secondary applications ,Metal Casting processes, Silicone mold making and resin casting process, Rapid tooling for manufacturing, General uses, benefits and industry specific applications for Additive Manufacturing

TEXT BOOKS/ REFERENCES:

1. Ian Gibson, David W. Rosen, Brent Stucker , *"Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing"*, Springer,2009
2. Ali K. Kamrani, Emad Abouel Nasr , *"Engineering Design and Rapid Prototyping"*, Sringer, 2010
3. Brian Evans, *"Practical 3D Printers: The Science and Art of 3D Printing"*,Apress,2012
4. Hod Lipson, Melba Kurman, *" Fabricated: The New World of 3D Printing"*, John Wiley & Sons, 2013

18CN722 UNMANNED AERIAL VEHICLES AND ESSENTIAL CONTROL 2-0-1-3

This course includes UAV components, command and control (C2) communication systems, basics of flight, regulatory and regulations, safety and societal considerations. Laboratory activities provide opportunity for students to gain hands-on experience in working with UAVs, Design aspects of drone, Drone control experiments using MATLAB and parrot drones, PID control for drones, State space controls for drone

TEXT BOOKS/ REFERENCES:

1. ASA Test Prep. Remote Pilot Test Prep — UAS: Study & Prepare. Wellfleet Press, 2016. 978-1577151326

2. Austin, Unmanned Aircraft Systems: UAVS Design, Development and Deployment. Wiley, 2010. 978-0- 470-05819-0

3. Baichtal, Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs. Que Publishing, 2016. 978-0789755988

4. Beard & McLain, Small Unmanned Aircraft: Theory and Practice. Princeton University Press, 2012. 978- 0691149219

5. Cares &Dickmann, Operations Research for Unmanned Systems. Wiley, 2016. 978-1-118-91894-4

6. UAS110 Syllabus - Page 3 Chao & Chen, Remote Sensing and Actuation Using Unmanned Vehicles. Wiley, 2012. 978-1-118- 12276-1

7. Cheng, Aerial Photography and Videography Using Drones. Peachpit Press, 2015. 978-0-13-412277-9

18CN723 COMPUTATIONAL ROBOTICS AND ROBOTIC OPERATING SYSTEM 2-0-1-3

Anintroductory course presenting foundational material in the design of robots. Topics include basic properties of sensors, motors, gears, drive mechanisms, control schemes, and processors to guide and control robots. This course provides a general introduction to robotics from a computational perspective with a focus on mobile robots. This includes the use of popular software for interacting with and simulating robots, such as the Robot Operation System (ROS). It will provide a view of robots as autonomous agents with a mechanical embodiment, which must observe and act upon their surroundings through the iterative execution of a sensing-planning-actuation loop. On the sensing and perception side, the course will cover state estimation challenges, such as robot localization, simultaneous localization and mapping (SLAM), as well as Bayesian solutions to these problems, such as Kalman and particle filters. For planning and decision making purposes, the course will introduce basic planning and re-planning methods, such as A* and D*-like algorithms, the configuration space abstraction, sampling-based planners, and a toolbox of algorithms that solve problems by utilizing these principles.

Extensions to multi-robot systems, online planning and handling uncertainty will be touched upon as well. On the control side, the course will offer an introductory coverage of robot kinematics and

dynamics, as well as foundational algorithms for trajectory following (e.g., PID).The lab activities will be done using Arduino, Raspberry Pi hardware for building the mobile robots.

TEXT BOOKS/ REFERENCES:

1. Robotics, Vision and Control: Fundamental Algorithms In MATLAB® Second, Completely Revised, Extended And Updated Edition (Springer Tracts in Advanced Robotics) Paperback – 23 May 2017 by Peter Corke
2. Programming Robots with ROS A Practical Introduction to the Robot Operating System By Brian Gerkey, William Smart, Morgan Quigley
3. Mastering ROS for Robotics Programming Paperback – Import, 21 Dec 2015 by Lentin Joseph
4. Advances in Automation, Robotics and Measurement Techniques Series: Advances in Intelligent Systems and Computing, Vol. 743 Szewczyk, Roman, Zieliński, Cezary, Kaliczyńska, Małgorzata (Eds.)2018

18CN724 COMPLEX SYSTEMS IN ENGINEERING, FINANCE & BIOLOGY: MODELLING & ANALYSIS 2-0-1-3

Definition of a complex system- Complex systems in engineering- Complex systems in nature & society- Modelling of complex systems-Introduction to dynamical system theory- standard models in dynamical systems-transitions in dynamical systems-bifurcations- Maps and flows- Chaos- Routes to chaos.

Analysis of chaotic data from experiments-basics of time series analysis-standard models in time series analysis-nonlinear time series analysis- phase space reconstruction- precursors to predict transitions in complex systems- critical slowing down- precursors based on recurrence-precursors based on multifractal formalism.

Emergence of order in complex systems-transitions as pattern formation-spatial early warning signals-complex networks-network properties as early warning measures-Networks in natural and engineering systems-Networks in biology-Networks in finance.

Applications in remote sensing- Applications in cyber security- Applications in physiology- Applications in finance-future of complex system theory.

TEXT BOOKS/ REFERENCES:

1. N. Boccora, *Modelling of Complex Systems*, 2nd Edition, Springer 2010.
2. S. Strogatz, *Nonlinear Dynamics and Chaos with applications to Physics, Biology, Chemistry & Engineering,* 2nd Edition, Westview Press 2014.
3. H. D. I. Abarbanel, *Analysis of Observed Chaotic Data*, Springer 1997.

4. R. C. Hilborn, *Chaos and Nonlinear Dynamics: An Introduction for Scientists and Engineers*, Oxford University Press 1994.
5. R. H. Shumway and D. S. Stoffer, *Time Series Analysis and Its Applications*, 3rd Edition, Springer 2011.
6. D. Sornette, *Critical Phenomena in Natural Sciences*, Springer 2000.
7. M. Cross and H. Greenside, *Pattern Formation and Dynamics in Non-equilibrium Systems*, Cambridge University Press 2009.
8. R. P. Sattoras, M. Rubi and A. D. Guilera (Eds), *Statistical Mechanics of Complex Networks*, Springer 2003.

18CN725 IOT FOR DISASTER MANAGEMENT SYSTEMS 2-0-1-3

The explosive growth of the "Internet of Things" is changing our world and the rapid drop in price for typical IoT components is allowing people to innovate new designs and products at home. In this first class in the specialization you will learn the importance of IoT in society, the current components of typical IoT devices and trends for the future. IoT design considerations, constraints and interfacing between the physical world and your device will also be covered. You will also learn how to make design trade-offs between hardware and software. We'll also cover key components of networking to ensure that students understand how to connect their device to the Internet. Please note that this course does not include discussion forums. The special focus will be on using IOT for disaster management applications, IOT hardware and software development for disaster management.

. Introduction to IOT and disaster management, State the technological trends which have led to IoT , The impact of IoT on society, Define what an embedded system is in terms of its interface, IOT components of an embedded system, Describe the interactions of embedded systems with the physical world, The core hardware components most commonly used in IoT devices , Describe the interaction between software and hardware in an IoT device, Describe the role of an operating system to support software in an IoT device, Explain the use of networking and basic networking hardware, Describe the structure of the Internet, Describe the meaning of a network protocol

TEXT BOOKS/ REFERENCES:

1. Vijay Madisetti, ArshdeepBahga, "Internet of Things: A Hands-On Approach"
2. WaltenegusDargie,ChristianPoellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice"
3. http://www.mait.com/assets/final-iot-report-revised-v4-(29_06_16).pdf

4. Disaster Management Paperback – 2003 by Harsh K. Gupta

GENERAL ELECTIVES

18CN726 INTRODUCTION TO DATA ANALYSIS 2-0-1-3

The need for data analysis – variables and data – graphs and distributions – measures of center and spread – normal distribution – z-scores – correlation – functions –hypothesis testing – confidence interval and errors – t-test – chi-square test – goodness of fit – test for independence – ANOVA – introduction to design of experiments - random samples – sample statistics and population statistics – regression analysis – regression models – method of least squares –data reduction – Time Series Analysis – AR models – ARMA models – ARIMA models – Basics of nonlinear TSA.

TEXT BOOKS/REFERENCES:

1. Basic skills in Statistics: A Guide for Healthcare Professionals. Cook, A., Netuveli, G. and Sheikh, A.Class Publishing (London) (2004).
2. Basic Statistics: Understanding conventional methods and modern insights. Wilcox, R. R. Oxford University Press (2009).
3. Basic Statistics for the behavioural sciences. 6th edition. Heiman, G. W. Wadsworth (2011).
4. Introduction to Time Series and Forecasting (Springer Texts in Statistics) 2nd Edition. Brockwell, P. J. & Richard, A. D (1991).
5. Introduction to Engineering Statistics and Six Sigma. Allen, T. T. Springer – Verlag (London) (2006).
6. Statistical Design and Analysis of Experiments: With Applications to Engineering and Science. 2nd Edition.Mason, R. L., Gunst, R. F. and Hess, J. L. Wiley-Interscience (2003).
7. Time Series: Theory and Methods (Springer Series in Statistics) 2nd edition. Brockwell, P. J. & Richard, A. D (1991).