M. TECH IN COMPUTATIONAL ENGINEERING AND NETWORKING

CENTRE FOR EXCELLENCE IN COMPUTATIONAL ENGINEERING & NETWORKING

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.

CURRICULUM

First Semester

Course Code	Type	Course	L T P	Credits
16MA603	FC	Computational Linear Algebra for Data Sciences	2 0 1	3
16CN602	FC	Fundamentals of Embedded Computing	2 0 1	3
16CN603	FC	Fundamentals of Image Processing	2 0 1	3
16CN604	FC	Computational Methods for Optimization	2 0 1	3
16CN605	FC	Algorithms and Structures for Data Science	2 0 1	3
16CN606	FC	Digital Logic Design	1 0 1	2
	HU	Cultural Education*		P/F
		Credits	**17**	

*****Non Credit Course

Second Semester

Course Code	Type	Course	L T P	Credits
16CN611	SC	Advanced Signal Processing and Pattern Classification	2 0 1	3
16CN612	SC	High Performance Computing for Data Science	2 0 1	3
16CN613	SC	Deep Learning and Probabilistic Graphical Models	2 0 1	3
16CN614	SC	Scientific Computing	2 0 1	3
16CN607	FC	Real Time Operating System for Embedded Computing	2 0 1	3
16CN615	SC	Computer Networks and IOT	2 0 1	3
16EN600	E	Technical Writing*		P/F
		Credits	**18**	

*****Non Credit Course

Third Semester

	Type	Course	L T P	Credits
	E	Elective 1	2 0 1	3
	E	Elective II	2 0 1	3
	E	Elective III	2 0 1	3
16CN798	P	Dissertation		6
		Credits	**15**	

Fourth Semester

Course Code	Type	Course	L T P	Credits
16CN799	P	Dissertation		16
		Credits	**16**	

Total Credits:66

List of Courses

Foundation Core

Course Code	Course	L T P	Credits
16MA603	Computational Linear Algebra for Data Sciences	2 0 1	3
16CN602	Fundamentals of Embedded Computing	2 0 1	3
16CN603	Fundamentals of Image Processing	2 0 1	3
16CN604	Computational Methods for Optimization	2 0 1	3
16CN605	Algorithms and Structures for Data Science	2 0 1	3
16CN606	Digital Logic Design	1 0 1	2
16CN607	Real Time Operating System for Embedded Computing	1 0 1	2

Subject Core

Course Code	Course	L T P	Credits
16CN611	Advanced Signal Processing and Pattern Classification	2 0 1	3
16CN612	High Performance Computing for Data Science	2 0 1	3
16CN613	Deep Learning and Probabilistic Graphical Models	2 0 1	3
16CN614	Scientific Computing	2 0 1	3
16CN615	Computer Networks and IOT	2 0 1	3

Electives

Recommended for CSE/IT Branch

Course Code	Course	L T P	Credits
16CN701	Computational Methods for Cryptography	2 0 1	3
16CN702	Deep Learning for Speech Recognition	2 0 1	3
16CN703	Deep Learning for Visual Recognition	2 0 1	3
16CN704	Deep Learning for NLP	2 0 1	3
16CN705	Introduction to Cloud Computing	2 0 1	3

Recommended for ECE/EEE Branch

Course Code	Course	L T P	Credits
16CN711	Statistical and Adaptive Signal Processing	2 0 1	3
16CN712	Digital Control System	2 0 1	3
16CN713	Advanced Communication System Design	2 0 1	3
16CN714	Data Communications & Computer Networks	2 0 1	3
16CN715	Hardware Software Co-Design	2 0 1	3

16CN716	DSP Processors and Architecture	2 0 1	3
16CN717	Software Defined Radio	2 0 1	3

Recommended for Chemical and Bio-informatics

Course Code	Course	L T P	Credits
16CN721	Molecular Modeling of Materials	2 0 1	3
16CN722	Understanding Molecular Simulation	2 0 1	3
16CN723	Bio-Molecular Modeling and Simulation	2 0 1	3
16CN724	Computational Drug Designing and Delivery Systems	2 0 1	3
16CN725	Computational Bio-Nanotechnology	2 0 1	3

Recommended for Mechanical Branch

Course Code	Course	L T P	Credits
16CN731	Introduction to Additive Manufacturing	2 0 1	3
16CN732	Introduction to Manufacturing Process	2 0 1	3
16CN733	3D Computer Aided Design - Solid Works	2 0 1	3
16CN734	Silicone and Urethane Mold Making	2 0 1	3
16CN735	Resin and Foam Casting	2 0 1	3
16CN736	Finite Element Analysis	2 0 1	3
16CN737	Applied Computational Fluid Dynamics	2 0 1	3

Common for all Branches:

Course Code	Course	L T P	Credits
16CN738	Computational Electromagnetics	2 0 1	3
16CN739	Complex Systems in Engineering, Finance and Biology: Modelling and Analysis	2 0 1	3

16MA603 COMPUTATIONAL LINEAR ALGEBRA FOR DATA SCIENCES 2-0-1-3

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.

TEXTBOOKS/ 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.

16CN602 FUNDAMENTALS OF EMBEDDED COMPUTING 2-0-1-3

Introduction to Embedded systems, hardware/software co-design, Embedded micro controller cores, embedded memories, 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. Interfacing and Integration of microcontroller based systems. Examples of Industrial process automation.

TEXTBOOKS/ 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.

16CN603 FUNDAMENTALS FOR IMAGE PROCESSING 2-0-1-3

Partial differential equation-Basic concepts and definitions, applications-conduction of heat in a rod, Boundary conditions, Vibration of a rectangular membrane, Helmholtz equation, vibrating circular membrane, Calculus of variation-Euler Lagrange equation-Definition of a functional, First variation, Essential and natural boundary conditions, Second variation, Functional derivative,- Solution of Euler Lagrange-Discretizing schemes, Application in signal image processing - Denoising, Deblurring, Inpainting, Non linear Diffusion, Segmentation. Convex Optimization based methods for Image processing that uses sparsity and different kinds of penalty functions.

TEXTBOOKS/ REFERENCES:

1. Keonwook Kang, Chris Weinberger and Wei Cai, "*A Short Essay on Variational Calculus*", Available from: http://micro.stanford.edu/~caiwei/Forum/2006-05-03-VarCalc/vari_calculus_v04.pdf, 2006.
2. K.P Soman and Ramanathan , "*Digital Signal and Image Processing-The Sparse Way*",

Wiley Publishers, 2011.

16CN604 COMPUTATIONAL METHODS FOR OPTIMIZATION 2-0-1-3

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, and 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.

TEXTBOOKS/ REFERENCES:

1. Stephen P. Boyd and Lieven Vandenberghe D, "*Convex Optimization"*, Cambridge University Press, 2004.
2. Kalyanmoy Deb, "*Optimization for Engineering Design Algorithms and Examples*", Prentice Hall of India, New Delhi, 2004.
3. Edwin K.P. Chong and Stanislaw H. Zak, "*An Introduction to Optimization*" Second Edition, Wiley-Interscience Series in Discrete Mathematics and Optimization, 2004.
4. M. Asghar Bhatti, "*Practical Optimization Methods: With Mathematica Applications*", Springer VerlagPublishers, 2000.

16CN605 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. Fundamental Techniques - 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.

TEXTBOOKS/ 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.

16CN606 DIGITAL LOGIC DESIGN 1-0-1-2

Review of Boolean logic; Combinatorial circuits; Sequential circuits; Design considerations – Meta-stability, Noise margins, Power, Fan out, Design Rules, Skew, Timing Analysis; State Machines; Verilog HDL - Data types, Types of modeling, Tasks and functions, Verification and test bench, Timing modeling.

TEXTBOOKS/ REFERENCES:

1. Palnitkar, Samir. "*Verilog HDL: A Guide to Digital Design and Synthesis*", Vol. 1. Prentice Hall Professional, 2003.
2. Wakerly, John F, "*Digital Design*", Vol. 3. Prentice Hall, 2000.
3. Tocci and Ronald J, "*Digital Systems: Principles and Applications*",. Pearson Education India, 1991.

16CN611 ADVANCED SIGNAL PROCESSING AND PATTERN CLASSIFICATION 2-0-1-3

Fourier based signal processing, Discrete-Time Bases and Filter Banks , Continuous-Time Bases and Wavelets, Orthogonal wavelets, bi-orthogonal wavelets, m-band wavelets, wavelet packet analysis, lifting schemes, second generation wavelets, Classification: Naïve Bayes, Decision trees, Deep learning neural network and kernel methods for Classification.Applications: Speech, audio, image, and video compression, Signal Denoising, Feature extraction, Inverse problems.

TEXTBOOKS/ REFERENCES:

1. M. Vetterli, J. Kovacevic and V. K. Goyal, "*The World of Fourier and Wavelets: Theory, Algorithms and Applications*", 2015.
2. Ian Goodfellow, Yoshua Bengio and Aaron Courville," *Deep Learning*", MIT Press 2016

16CN612 HIGH PERFORMANCE COMPUTING FOR DATA SCIENCE 2-0-1-3

Introduction - Top500 supercomputers, HPC terminology: Flops, Benchmarks, Inter Process Communication; Performance metrics and Laws - Speedup , Efficiency, Redundancy, Utilisation and Quality, Scalability, Amdahl's Law, Gustafson-Barsis Law, Karp-Flatt Matric, Iso-efficiency Metric, Parallelising overheads and solutions; Parallel Architectures-Flynn's Taxonomy, More on SIMD based processing, Process & Program & Instruction level parallelism, Shared memory : Threading and Synchronisation, Cache coherence methods, Serial Multi processors, Multi core and Pipeline architecture, Distributed memory: Message passing models, Inter process communication; Message Passing Interface - MPI-3 standard introduction, MPI programming models, Linux Clustering and MPI implementations, Open-MPI: configure, make and install, Point-to-Point IPC and personal threads, Collective IPC and common threads, Synchronization methods, Data Definition methods, Status and monitoring methods, Cluster management utility methods, Parallel Algorithms using MPI, GPGPUs - GPU architecture, GP-GPUs and Kernels, The CUDA Programming API: The CUDA programming model, Major functions and kernels, IDEs and other CUDA Libraries, OpenCL devices and API, AMD SDK, Sample kernel functions; Computing examples - Pi computation -Monte Carlo and integration methods; Mandelbrot Set, Matrix Multiplication, FFT computation; Functional Programming and in-memory Map-Reduce - Scala based functional map reduce, Apache Spark framework: Clustering, Deploying map reduce jobs

TEXTBOOKS/ REFERENCES:

1. Peter S. Pacheco and Morgan Kaufmann ,*"Parallel Programming with MPI"*, 1997.
2. Nicholas Wilt,*"The CUDA Handbook: A Comprehensive Guide to GPU Programming",* Reference Books.
3. William Gropp, Ewing Lusk, Anthony Skjellum, *"Using MPI: Portable Parallel Programming with the Message-Passing Interface"*, Scientific and Engineering Computation, Third Edition.
4. Sanders, Jason, and Edward Kandrot. "*CUDA by Example: An Introduction to General-Purpose GPU Programming",* Portable Documents. Addison-Wesley Professional, 2010.
5. Andy Konwinski, Holden Karau and Patrick Wendell, *"Learning Spark: Lightning-Fast Big Data Analysis"*, O'Reilly Media, Inc., 2015.

16CN613 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. .

TEXTBOOKS/ REFERENCES:

1. Koller Daphne and Nir Friedman, *"Probabilistic Graphical Models: Principles and Techniques"*. MIT press, 2009.
2. Ian Goodfellow, Yoshua Bengio and Aaron Courville, "Deep Learning", MIT press 2016.

16CN614 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.

TEXTBOOKS/ REFERENCES:

1. Kutz J. Nathan, *"Data-Driven Modeling & Scientific Computation: Methods for Complex Systems & Big Data"*, Oxford University Press, 2013.
2. Arfken G.B., and Weber, H.J., *"Mathematical Methods for Physicists"*, Sixth Edition, Academic Press, 2005.

16CN607 REAL TIME OPERATING SYSTEM FOR EMBEDDED COMPUTING 2-0-1-3

Introduction to UNIX/LINUX, Real Time Operating Systems and Brief History of OS,Objects, Services and I/O Pipes, Event Registers, Signals, Other Building Blocks , Exceptions, Interrupts and Timers Exceptions, Interrupts, Case Studies of RTOS

TEXTBOOKS/ REFERENCES:

1. Rajib Mall, *"Real-Time Systems: Theory and Practice"*, Pearson, 2008.
2. Jane W. Liu, *"Real-Time Systems"*, Pearson Education, 2001.
3. Krishna and Shin, *"Real-Time Systems"*, Tata McGraw Hill. 1999.

16CN615 COMPUTER NETWORKS AND IOT 2-0-1-3

Network software tools –Wireshark, TCP Dump, Packet Sniffer, mininet, linux OS Application Server configuration – Webserver, application server, Database server,Introduction to IOT,IOT frame work,Programming IOT devices.

TEXTBOOKS/ REFERENCES:

1. CISCO Semester 1 and 2, "*Networking Course*", Reference Material.
2. Andrew S. Tanenbaum, "*Computer Networks*", Fourth Edition, Prentice Hall PTR, 2002.
3. Adrian McEwen,HakimCassimally, "*Designing the Internet of Things*", John Wiley and Sons, 2013.

16EN600 TECHNICAL WRITING P/F
(Non-credit Course)

Technical terms – Definitions – extended definitions – grammar checks – error detection – punctuation – spelling and number rules – tone and style – pre-writing techniques – Online and offline library resources – citing references – plagiarism – Graphical representation – documentation styles – instruction manuals – information brochures – research papers – proposals – reports (dissertation, project reports etc.)

TEXTBOOKS/REFERENCES:

1. H.L. Hirsch, "*Essential Communication Strategies for Scientists, Engineers and Technology Professionals"*, Second Edition, New York: IEEE Press, 2002.
2. P.V. Anderson, "*Technical Communication: A Reader-Centered Approach"*, Sixth Edition, Cengage Learning India Pvt. Ltd., New Delhi, 2008, (Reprint 2010).
3. W.Jr. Strunk and E.B.White, "*The Elements of Style"*, New York. Alliyan & Bacon, 1999.

16CN701 COMPUTATIONAL METHODS FOR CRYPTOGRAPHY 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.

TEXTBOOKS/ REFERENCES:

1. Kaufman, C., Perlman, R. and Speciner, M., "*Network Security: Private Communication in a Public World*", Second Edition, Prentice Hall 2002.
2. W. Stallings: "*Cryptography and Network Security: Principles and Practices*", Fourth Edition, Prentice Hall, 2000.
3. D. R. Stinson: "*Cryptography: Theory and Practice*", Third Ed., CRC Press, 2005.

16CN702 DEEP LEARNING FOR SPEECH RECOGNITION 2-0-1-3

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

TEXTBOOKS/ 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. Geoffrey Hinton, Li Deng, Dong Yu, George Dahl, Abdel-Rahman Mohamed, Navdeep Jaitly, 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.
4. Li Deng and Douglas O'Shaughnessy, *" Speech Processing: A Dynamic and Optimization-Oriented Approach"*, CRC Press, 2003.
5. Li Deng and Dong Yu, *"Deep Convex Net: A Scalable Architecture for Speech Pattern Classification"*, in proceedings of INTERSPEECH 2011.
6. Li Deng and Dong Yu, *"Deep Convex Networks for Image and Speech Classification"*, in International Conference on Machine Learning, June 2011.
7. Li Deng, Dong Yu and John Platt, *"Scalable Stacking and Learning for Building Deep Architectures"*, in proceedings ICASSP 2012.
8. Abdel-Rahman Mohammad, G. E. Hinton and Gerald Penn, *"Understanding how Deep Belief Networks Perform Acoustic Modeling"*, in proc. ICASP 2012.
9. 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.

16CN703 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 – Back propagation – 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..

TEXTBOOKS/ REFERENCES:

1. Domingos and Pedro. *"A Few Useful Things to Know about Machine Learning."* Communications of the ACM 55.10, pp:78-87, 2012.
2. Li Fei-Fei (Stanford), Rob Fergus (NYU) and 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 Andreyevich Radul, "*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, pp-437-478, 2012.
5. LeCun and Yann A., et al. *"Efficient Backprop "*, Neural networks: Tricks of the trade, Springer Berlin Heidelberg, pp:9-48, 2012.
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, pp: 818-833, 2014.
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 pp: 211-252, 2015.
10. Mahendran, Aravind and Andrea Vedaldi, *"Understanding Deep Image Representations by Inverting Them."* Computer Vision and Pattern Recognition (CVPR), 2015 IEEE Conference on. IEEE, 2015.

16CN704 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 backpropagation -- for named entity recognition, Recurrent neural networks -- for language modeling and other tasks, GRUs and LSTMs -- for machine translation, Recursive neural networks -- for parsing, Convolutional neural networks -- for sentence classification.

TEXTBOOKS/ REFERENCES:

1. Mikolov, Tomas, et al, *"Distributed Representations of Words and Phrases and their Compositionality"* Advances in neural information processing systems, 2013.
2. Mikolov, Tomas, et al, *"Efficient Estimation of Word Representations in Vector Space"*, arXiv preprint arXiv: 1301.3781, 2013.
3. Pennington, Jeffrey, Richard Socher, and Christopher D. Manning, *"Glove: Global Vectors for Word Representation"*, *EMNLP*, Vol. 14, 2014.
4. Huang, Eric H., et al. *"Improving Word Representations via Global Context and Multiple Word Prototypes"*, Proceedings of the 50th Annual Meeting of the Association for Computational Linguistics: Long Papers-Volume 1. Association for Computational Linguistics, 2012.
5. Rumelhart, David E., Geoffrey E. Hinton, and Ronald J. Williams. *"Learning Representations by Back-Propagating Errors."* Cognitive modeling 5.3, 1988.
6. *"*Backpropagation_Algorithm*",* http://ufldl.stanford.edu/wiki/index.php.
7. Collobert, Ronan, et al. *"Natural Language Processing (almost) from Scratch"*, The Journal of Machine Learning Research 12, pp: 2493-2537, 2011.
8. Socher, Richard, et al. *"Recursive Deep Models for Semantic Compositionality over a Sentiment Treeban." Proceedings* of the conference on empirical methods in natural language processing (EMNLP),Vol. 1631, 2013.

9. Bengio, Yoshua. *"Practical Recommendations for Gradient-Based Training of Deep Architectures."*, Neural Networks: Tricks of the Trade. Springer Berlin Heidelberg, pp:437-478, 2012
10. Mikolov, Tomáš, et al. *"Extensions of Recurrent Neural Network Language Model."* Acoustics, Speech and Signal Processing (ICASSP), 2011 IEEE International Conference on. IEEE, 2011.
11. Irsoy, Ozan, and Claire Cardie. *"Opinion Mining with Deep Recurrent Neural Networks." EMNLP*. 2014.
12. Chung, Junyoung, et al. *"Empirical Evaluation of Gated Recurrent Neural Networks on Sequence Modeling."* arXiv preprint arXiv: 1412.3555, 2014.
13. Hochreiter, Sepp, and Jürgen Schmidhuber. *"Long Short-Term Memory."* Neural Computation 9.8, pp: 1735-1780, 1997.
14. Socher, Richard, et al. *"Parsing Natural Scenes and Natural Language with Recursive Neural Networks."* Proceedings of the 28th International Conference on Machine Learning (ICML-11). 2011.
15. Socher, Richard, et al. *"Parsing with Compositional Vector Grammars." ACL (1)*. 2013.
16. Kalchbrenner, Nal, Edward Grefenstette, and Phil Blunsom. "*A Convolutional Neural Network for Modelling Sentences."* arXiv preprint arXiv: 1404.2188, 2014.

16CN705 INTRODUCTION TO CLOUD COMPUTING 2-0-1-3

Context: Taxonomy of parallel and distributed computing - shared/distributed memory - and data/task parallel computing - Role of Cloud computing. Technology: Cloud Virtualization - Elastic computing - Infrastructure/Platform/Software as a Service (IaaS/PaaS/SaaS) - Public/Private Clouds - Service oriented architectures. Design Patterns: Design of task/data parallel distributed algorithms - Cloud applications - Task graphs and Map-Reduce model - Amdahl's law, data locality, speed up of Cloud applications. Execution Models: Synchronous/asynchronous execution patterns - Scale up/Scale out on VMs - Data marshalling/unmarshalling - Asynchronous coordination of concurrent tasks on VMs - NoSQL Cloud storage. Evaluation: Load balancing of stateful/stateless applications - Performance metrics for evaluating Cloud applications - Consistency, Availability and Partitioning (CAP theorem). Programming project using public Cloud infrastructure e.g. Amazon AWS, Microsoft Azure Cloud resources provided.

TEXTBOOKS/ REFERENCES:

1. Tom White, *"Hadoop: The Definitive Guide"*, O'Reilly Media, 2009.
2. Kai Hwang, Jack Dongarra and Geoffrey Fox, Morgan Kaufmann, *"Distributed and Cloud Computing"*, Parallel Processing to the Internet of Things, Tata Book House, 2011.
3. Tanenbaum and Van Steen, *"Distributed Systems: Principles and Paradigms*", Pearson, 2007.
4. Jean Dollimore, Tim Kindberg and George Coulouris, *"Distributed Systems: Concepts and Design"*, Fourth Edition, Addison Wesley, 2005.
5. Randal E. Bryant and David R, "*Computer Systems: A Programmer's Perspective"*, O'Hallaron, Prentice Hall, 2003.

6. Patterson and Hennessy, *"Computer Organization and Design: The Hardware/Software Interface"*, Fourth Edition, Morgan Kaufmann/Elseiver, 2013.
7. Jason Venner, *"Pro Hadoop"*, A Press, 2009.

PAPER REFERNCES:

1. "Understanding Full Virtualization, Paravirtualization and hardware Assist", VMWare, Tech Report WP-028-PRD-01-01, 2007.
2. "Formal Requirements for virtualization 3rd Generation Architectures", Popek and Goldberg, CACM, 1974.
3. "Performance overhead among three Hypervisors: An experimental study using Hadoop Benchmarks", Jack Li, Qingyang Wang, DeepalJayasinghe, Junhee Park, Tao Zhu, CaltonPu,IEEE Big Data Congress,2013.
4. "On the performance variability of production cloud services", Iosup A, Yigitbasi N, and Epeme D, IEEE/ACM international symposium on cluster, cloud and grid computing(CCgrid),2011.
5. "Scheduling workflows with budget constraints", RizosSakellariou and Henan Zhao, Integrated Research in GRID computing, 2007.
6. A low-cost rescheduling policy for efficient mapping of workflows on grid systems, RizosSakellariou and Henan Zhao, Scientific programming 12(2004) 253-262.
7. "The Definitive Guide To The Xen Hypervisor", Series - Prentice Hall Open Source Software Development, David Chisnall
8. "Running Xen: A Hands-on Guide To The Art Of Virtualization", by Jeanna Matthews, Eli M. Dow, Todd Deshane. Prentice Hall.

16CN711 STATISTICAL AND ADAPTIVE SIGNAL PROCESSING 2-0-1-3

Review of random variables, Parameter Estimation Theory, Estimation of signal in presence of white Gaussian Noise, Adaptive Filtering.

TEXTBOOKS/ REFERENCES:

1. M. Hays,*"Statistical Digital Signal Processing and Modelling"*, John Wiley and Sons, 1996.
2. M.D. Srinath, P.K. Rajasekaran and R. Viswanathan, "*Statistical Signal Processing with Applications*", PHI, 1996.
3. Simon Haykin, "*Adaptive Filter Theory*", Prentice Hall, 1996.
4. D.G. Manolakis, V.K. Ingle and S.M. Kogon, "*Statistical and Adaptive Signal Processing",* McGraw Hill, 2000.
5. S. M. Kay, "*Modern Spectral Estimation*", Prentice Hall, 1987.

16CN712 DIGITAL CONTROL SYSTEM 2-0-1-3

Concept & Representation of Discrete time System, State Space Analysis, Controllability, Observability& Stability tests, Design of discrete time Controllers and observers, State Observers.

TEXTBOOKS/ REFERENCES:

1. B. C. Kuo, *"Digital Control Systems*", Oxford University Press, Second Edition, Indian Edition, 2007.
2. K. Ogata, *"Discrete Time Control Systems*", Second Edition, Prentice Hall, 1995.
3. M. Gopal, *"Digital Control and State Variable Methods"*, Tata Mcgraw Hill, Second Edition, 2003.
4. G. F. Franklin, J. D. Powell and M. L. Workman, *"Digital Control of Dynamic Systems"*, Third Edition, Addison Wesley, 1998, Pearson Education, Asia, 2000.
5. K. J. Astroms and B. Wittenmark, *"Computer Controlled Systems - Theory and Design"*, Prentice Hall, Third Edition, 1997.

16CN713 ADVANCED COMMUNICATION SYSTEM DESIGN 2-0-1-3

Multiple Access and Multiplexing Techniques; Spread spectrum and Code division multiple access (CDMA) techniques: Direct sequence, Frequency hopping; Multicarrier techniques: Orthogonal frequency division (OFDM) and Multicarrier CDMA (MC-CDMA).

TEXTBOOKS/ REFERENCES:

1. Simon Haykin, *"Digital Communications*", John Wiley and sons, 1998.
2. Wayne Tomasi, *"Advanced Electronic Communication Systems"*, Fourth Edition Pearson Education Asia, 1998.
3. B.P.Lathi, *"Modern Digital and Analog Communication Systems"*, Third Edition, Oxford University Press, 1998.
4. Ravindranathan, *"Communication Systems Modeling Using Matlab and Simulink"* Universities Press, 1996.

16CN714 DATA COMMUNICATIONS AND COMPUTER NETWORKS 2-0-1-3

Introduction, Bandwidth utilization, Connecting LANs, Backbone Networks, and Virtual LANs, Connecting Devices,Network Layer, Transport Layer, Application Layer, WWW and HTTP.

TEXTBOOKS/ REFERENCES:

1. Behrouza A. Forouzan, *"Data Communications and Networking*", Fourth Edition, TMH, 2006.
2. A.S.Tanenbaum, "*Computer Networks"*, Fourth Edition, Pearson Education, 2013.

16CN715 HARDWARE SOFTWARE CO-DESIGN 2-0-1-3

Codesign overview, Models and methodologies of system design, Hardware software partitioning and scheduling, Cosimulation, synthesis and verifications, Architecture mapping, HW-SW Interfaces and Reconfigurable computing, System on Chip (SoC) and IP cores, Low-

Power Techniques in RT Embedded Systems, On-chip Networking, Sensor Networks, Software for Embedded Systems, Introduction to Xilinx Zynq and Vivado, Dataflow modelling.

TEXTBOOKS/ REFERENCES:

1. J.Staunstrup and W.Wolf , *"Hardware/Software Co-Design Principles and Practice*", Springer Science and Business Media, 2013.
2. Patrick Schaumont, *"A Practical Introduction to Hardware Software Co-design,* Springer Science and Buisness Media, 2013.

16CN716 DSP PROCESSORS AND ARCHITECTURE 2-0-1-3

Introduction to Digital Signal Processing, Computational Accuracy In DSP Implementations, Architectures For Programmable DSP Devices, Execution Control And Pipelining, Programmable Digital Signal Processors, Implementations Of Basic DSP Algorithms, Implementation Of FFT Algorithms, Interfacing Memory and I/O Peripherals to programmable DSP Devices.

TEXTBOOKS/ REFERENCES:

1. Avtar Singh and S. Srinivasan, *"Digital Signal Processing"*, Thomson Publications, 2004.
2. Lapsley et al, *"DSP Processor Fundamentals, Architectures & Features"*, S. Chand & Co, 2002.

16CN717 SOFTWARE DEFINED RADIO 2-0-1-3

Introduction to Software Defined Radios, SDR Architecture, Analog to Digital and Digital toAnalog conversion, Digital frequency up and down convertors, Digital Hardware for SDR, Introduction to USRP, UHD, GNU Radio and RTL- SDR, Multiple Access and Multiplexing Techniques, Spread spectrum and Code division multiple access (CDMA) techniques: Direct sequence, Frequency hopping; Multicarrier techniques: Orthogonal frequency division (OFDM) and Multicarrier CDMA (MC-CDMA).

TEXT BOOK/REFERENCES:

1. Robert W. Stewart , Kenneth W. Barlee , Dale S. W. Atkinson , Louise H., Crockett, *"Software Defined Radio using MATLAB & Simulink and the RTL-SDR"*, First Edition, Strathclyde Academic Media, Sep 2015.

16CN721 MOLECULAR MODELING OF MATERIALS 2-0-1-3

Introduction-models, computational chemistry methods.Structure-property relationship. Symmetry and point group-irreducible representation-Labeling of electronic terms. Quantum mechanics-The time-independent Scrodingerequation.HÜckel MO theory-expectation energy-HÜckel MO and symmetry-molecules containing hetero atoms-the extended HÜckel MO theory.Hatree-Fock Theory-Bosons and Fermions-Koopmann'stheorem.Basis sets-

Classification. Semi-Empirical methods-NDO,16CNDO, MNDO, PM3, ZDO, Hamiltonian in SEM. Ab-initio method-Correlation energy-CI, MBPT, MP-perturbation. Density functional theory-Electron density, pair density, Functional, Hohenberg and Kohn theorems, Kohn Sham method.Reduced density matrix-N-representabilityconditions.Molecular mechanics- MM-triads, Forcefields.Modeling of molecules- PES, transition state, SPE, solvation, population analysis, electric multipoles and multipole moments, thermodynamic properties.

TEXT BOOKS/REFERENCES:

1. K.I. Ramachandran. G. Deepa and Krishnan Namboori P. K., "*Computational Chemistry and Molecular Modeling-Principles and Applications*", Springer-Verlag Berlin Heidelberg, 2008.
2. Tamar Schlick, "*Molecular Modeling and Simulation-An Interdisciplinary Guide*", Springer Verlag, 2002.
3. Donald W Rogers, "*Computational Chemistry using PC*", Wiley-Interscience, 2003.

16CN722 UNDERSTANDING MOLECULAR SIMULATION 2-0-1-3

Introduction- Basics, Statistical thermodynamics, ergodicity. Molecular dynamics-Strategy, force calculation, integrating equations of motion, Verlet algorithm, Common other algorithms. Pair-wise potential-two-body potential, directional bonding in semi conductors, interatomic potentials for molecular materials, electrostatics, periodic boundary conditions. Shielding, atom types in force fields, capturing many body effects in metals.Molecular materials-reactive force fields, EAM potentials.MD at constant temperature, Andersen, Berendsen approach, Noose-Hoover approach, isothermal/isobaric MD. Monte-Carlo Simulation- Metropolis method, translational moves, orientaional moves, MC in different ensembles. Free energy and Phase Equilibria-Thermodynamic integration, Gibb's ensemble, Free energy of solids, free energy of chain molecules.Molecular simulation of complex systems-Long-range interactions, biased MC schemes, tackling time scale problems, dissipative particle dynamics, spin modeling and magnetic character. Case studies-Application of simulation studies in the areas of material simulation, biosynthesis, computational nanotechnology and computational drug designing.

TEXTBOOKS/ REFERENCES:

1. DaanFrenkel and BerendSmith,*"Understanding Molecular Simulation- from Algorithms to Applications"*, Academic Press, California, 2002.
2. W.D. CallisterJr., *"Material Science and Engineering: An Introduction*", John Wiley and Sons, 2003.
3. T. Saito, "*Computational Material Design*", Springer-Verlag Berlin and Heidelberg GmbH, 1998.

16CN723 BIO-MOLECULAR MODELING AND SIMULATION 2-0-1-3

Potential Energy Functions, Energy Minimization, and Molecular Dynamics, PEFs, EM and MD (II), Introduction to Protein Structure Prediction, Fatty Acid Binding Protein (FABP), Validation of Protein Structure, homology model and compare to x-ray structure. Potential Energy Functions- Energy Minimization.Molecular Dynamics, Protein Structure, Biomolecular Interactions and Thermodynamics.Nonbonded computations- cutoff schemes, shift functions, Ewald sum, finite dielectric corrections, multipole methods, continuum solvation. Multivariate minimization- independent variables, Greedy Descent, Line searches, Trust region method, Convergence criteria. Solvate and energy minimize homology model (AMBER), Protein-Ligand Complexes, Perform docking of ligand to FABP homology model structure, Nucleic acid structure- Theoretical and computational approaches to biomolecular structure force fields- Monte Carlo techniques in biomolecular modeling-Molecular dynamic simulation for biomolecular modeling - similarity and diversity in chemical design-Effect of Sequence Identity on Model Accuracy.

TEXT BOOKS/REFERENCES:

1. Tamar Schlick, "*Molecular Modeling and Simulation- an Interdisciplinary Guide*", Springer-Verlag Heidelberg, 2002.
2. Haian Fu, "*Protein-Protein Interactions: Methods and Applications"*, Methods in Molecular Biology, Humana Press-Totowa, New Jersey, 2008.
3. Werner Ebeling, Lutz Schimansky-Geier, Yuri M. Romanovsky, "*Stochastic Dynamics of Reacting Biomolecules*", World Scientific Publishing, London, 2004.

16CN724 COMPUTATIONAL DRUG DESIGNING AND DELIVERY SYSTEMS 2-0-1-3

Drugs-classification, designing filters, pharmacophore and pharmacophoricgraphs,SAR, molecular descriptors. Energetics of drug designing-Free enrgy, steric interactions, solvation effect, ligand target interaction. Target characterization-protein, sequence analysis, secondaystructure analysis, protein scanning, nucleic acids, enzymes as target, hormones as targets, homology modeling. Modeling for drug design-Computation of weak interaction, niormal mode analysis, bondstrain energy. Docking-searching and pose, solvation based scoring, Consensus scoring, MD simulation based docking, multiple active site correction. Pharmacokinetics-1,2 and 3 compartment models, ADME, multiple doses, bioavailability, clinical casestudies. Pharmacodynamics-agonists, antagonists, spare receptors, therapeutic index. Mechanism based designing-cellular processing, disease based analysis. Structure based design- ID to 5 D screening, combinatorial library. Pharmacogenomics-SNPs, gene-gene and gene-environment interactions, Drug delivery-drug carriers, acoustic targeted drug delivery, familiarization with tools and software, case studies.

TEXT BOOKS/REFERENCES:

1. David C Young, "*Computational Drug Design*", John Wiley &Sons. Inc, New Jersey, 2009.
2. Kenneth M. Merz, Dagmar Ringe and Charles H. Reynolds, "*Drug Design: Structure- and Ligand-Based Approaches*", Cambridge University Press, 2010.

3. *Robert M. Stroud, Janet Finer-Moore, "Computational and Structural Approaches to Drug Discovery: Ligand-Protein Interactions",* Royal Society of Chemistry-Biomolecular Sciences, UK, 2008.

16CN725 COMPUTATIONAL BIO-NANOTECHNOLOGY 2-0-1-3

Building up of nano-structures that incorporate biological molecules as components of the system.Use of biological design strategies as removable scaffolds and templates for the bottom-up assembly of nanomaterials.Applications of nanotechnology in biotechnology-killing cancer cells, providing oxygen and artificial mitochondria.Bionanomachines in action-Biomolecules; Structure and function of Proteins, Polysaccharides, Lipids, Nucleic acids; DNA and RNA.Biomolecular design and Biotechnology- Recombinant DNA technology, Biomolecular structure determination, Molecular Modeling. Structural principles of Bionanotechnology- The raw materials; biomolecular structure and stability, Protein folding, Self assembly, Self-organization, Molecular recognition, Flexibility Functional principles of Bionanotechnology- Information driven nano-assembly, Energetics, Chemical transformation, Regulation, Biomaterials, Biomolecular motors, Traffic across membranes, Biomolecular sensing, Self replication, Machine-Phase bionanotechnology. Bionanotechnology today: Basic capabilities, Nanomedicine, Molecular design using biological selection, Harnessing molecular motors, Artificial life, Hybrid materials, Biosensors. The future of Bionanotechnology- Ethical considerations, Case studies.

TEXT BOOKS/REFERENCES:

1. Tuan Vo-Dinh, "*Nanotechnology in Biology and Medicine, Methods, Devices and Applications*", CRC Press-Taylor & Francis, London, 2006.
2. Mary Mehrnoosh and Eshaghian-Wilner, "*Bio-Inspired and Nanoscale Integrated Computing"*, John Wiley & Sons, 2009.

16CN731 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.

TEXTBOOKS/ REFERENCES:

1. Ian Gibson, David W. Rosen and Brent Stucker , *"Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing",* Springer, 2009.
2. Ali K. Kamrani and Emad Abouel Nasr , *"Engineering Design and Rapid Prototyping",* Springer, 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.

16CN732 INTRODUCTION TO MANUFACTURING PROCESS 2-0-1-3

History of manufacturing (manufacturing processes overview), Powder metallurgy, Welding, brazing and soldering, Electroforming and coating processes, Forging and hot working of metal, Cold working of metal, Presswork and sheet metal, Inspection, measuring instruments, gages and quality control, Metal cutting and plastics machining, Plastic forming process, Turret and automatic lathes, Threads and thread cutting, Shapers and planers, Drilling and boring machines, Milling machines and cutters, Gears and gear cutting machines, Metal sawing: broaching and filing, Abrasives: grinding wheels and grinding machines, Finishing: lapping and super finishing, Automation and computer numerical control (16CNC), Metal cleaning and protective surface treatment, Mass production, Jigs, fixtures & dies, Introduction to geometric dimensioning and tolerancing

TEXTBOOKS/ REFERENCES:

1. John A.Schey , *"Introduction to Manufacturing",* McGraw-Hill Science,1999.
2. Robert creese , *"Introduction to Manufacturing Processes and Materials",* Marcel Dekker, 1999.

16CN733 3D COMPUTER AIDED DESIGN – SOLID WORKS 2-0-1-3

Data management and CAD operator responsibilities, Basic system operations, Networks, CAD task outline, File management and security, Areas of drafting and design project responsibility), Documentation in the CAD environment, Symbols library usage, Parts lists and bill of materials , Work orders and change orders, Production and working drawing projects), Two dimensional drawing generation, Advanced CAD terminology, menus, and commands, Input methods and set-up procedures , Editing and viewing display commands d. Advanced dimensioning commands, Output methods and plotting procedures), Three dimensional drawing generation, Procedures, in conjunction with 2D data base, to create 3D models, View and display alternatives of 3D models, Modeling, shading and rendering, Generation of 2D views, paper space layouts from 3D models)

TEXTBOOKS/ REFERENCES:

1. Matt Lombard, *"Solid Works 2013 Bible",* John Wiley& Sons, 2013.
2. David Planchard, *"Engineering Graphics with Solid Works 2014 and Video Instruction",* Schroff Development Corp., 2014.
3. https://www.solidworks.com/

16CN734 SILICONE AND URETHANE MOLD MAKING 2-0-1-3

Overview of mold making and casting, Mold-making materials: silicone and urethane, Advantages of various types, Disadvantages of various types, Qualities of 2-component rubbers, Fundamental steps in silicone and urethane mold-making, Terminology and main varieties of equipment technologies, Terminology related to materials and mold-making, Guidelines for safe operation of mold-making equipment, Guidelines for safe handling of materials, including hazardous chemicals, Key operational concepts in mold-making with silicone and urethane, Role of viscosity, Effects of temperature, Multiple part molds, Related topics, Types of mold releases, Advantages of various types, Disadvantages of various types, Urethane mold-making materials, Advantages of various types, Disadvantages of various types,(Clean up, finishing, surface coatings, and quality assurance methods) in mold-making with silicone and urethane, General uses, benefits and industry specific applications for, Case studies of silicone and urethane mold-making in specific industry sectors, Theater, Art, Rapid manufacturing, Jewelry making, Part design, Engineering, Technical drawing interpretation (print reading), materials specification standards and production plans used in industry

TEXTBOOKS/ REFERENCES:

1. Kurt C. Frisch, Daniel Klempner, *"Advances in Urethane: Science & Technology"*, Volume XIV, CRC Press,1998.
2. Michael J. Owen and Petar R. Dvornic, *"Silicone Surface Science"*, Springer, 2012.

16CN735 RESIN AND FOAM CASTING 2-0-1-3

Overview of mold making and casting, Casting materials: resins and foams, Advantages of various types, Disadvantages of various types, Qualities of 2-component rubbers, Fundamental steps in resin and foam casting, Terminology and main varieties of equipment technologies, Terminology related to materials and casting, Guidelines for safe operation of equipment, Guidelines for safe handling of materials, including hazardous, chemicals, Key operational concepts in casting with resins and foams including, Role of viscosity, Effects of temperature, Multiple part molds, Related topics, Types of mold releases, Advantages of various types, Disadvantages of various types, Casting materials, Advantages of various types, Disadvantages of various types, Clean up, finishing, surface coatings, and quality assurance methods, in casting with resins and foams, General uses, benefits and industry specific applications for casting, Case studies of resin and foam casting in specific industry sectors, Theater, Art, Rapid manufacturing, Jewelry making, Part design, Engineering, Technical drawing interpretation (print reading), materials, specification standards and production plans used in industry, Lab Activities : Use basic machine operations and safety procedures for all, laboratory machine/devices, Interpret Materials Safety Data Sheets (MSDS) for all casting and, finishing materials used in lab activities, Apply specific equipment operational settings, variables and, monitoring procedures, Solve machine specific problems. Apply troubleshooting techniques, operator intervention and problem resolution methods, Complete a pressure casting, Extract the above, Use clean-up methods for the above, Finish and surface coat a completed mold, Apply advanced post-production options and methods, Tooling creation with emphasis on casting, Technical drawing interpretation (print reading), national materials, specification standards, and mold/casting production plans used in industry, Conduct measurement verification, geometry analysis, quality assurance

TEXTBOOKS/ REFERENCES:

1. Andrew J. Martin, *"The Essential Guide to Mold Making & Slip Casting"*, Lark Crafts, 2007.

16CN736 FINITE ELEMENT ANALYSIS 2-0-1-3

Basic concept of Finite Element Method, Historical background, FEMApplications, General Description of FEM, Commercial FEM softwarepackages. Spring element-stiffness matrix, boundary conditions, solvingequations.Variational formulation approach- Rayleigh-Ritz method,Principle of minimum Potential Energy, Weighted residual methods, Bar and Beam elements, local and global coordinate system, transformationof coordinate systems, element stress. Analysis of truss. Natural coordinatesystem, Interpolation polynomial, Isoparametric elements and Numericalintegration -Gaussian quadrature approach-simple problems in 1-D, Review of the basic theory in 2-D elasticity, plane stress, 2-D problems usingConstant 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.

TEXTBOOKS/ REFERENCES:

1. Chandrupatla and 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 Engineering Science*", McGraw-Hill, London, 1977.
6. Cook, Robert Davis et al, *"Concepts and Applications of Finite Element Analysis",* John Wiley & Sons, 1999.

16CN737 APPLIED 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.

TEXTBOOKS/ REFERENCES:

1. *T*.J Chung, *"Computational Fluid Dynamics"*, Cambridge University Press, 2002.
2. H.K. Versteeg and 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.

16CN738 COMPUTATIONAL ELECTROMAGNETICS 2-0-1-3

Review of electromagnetic theory, Review of basic numerical methods. Advanced Numerical methods forElectromagnetics :- Finite-Difference Method (FDM), Finite-Difference Time-Domain (FDTD) methods,Method of Moments (MoM), Method of Lines, transmission-line-matrix methods, Finite Element Method(FEM) , Admittance Method (AM) and Impedance Method (IM). Applications.

TEXTBOOKS/ REFERENCES:

1. Matthew N.O. Sadiku, *"Numerical Techniques in Electromagnetics , with MATLAB,"* Third Edition, CRC Press, 2011.
2. A. F. Peterson, S. L. Ray and R. Mittra, *"Computational Methods for Electromagnetics "*, IEEE Press, New York, 1998.

16CN739 COMPLEX SYSTEMS IN ENGINEERING, FINANCE AND BIOLOGY: MODELLING AND 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.

TEXTBOOKS/ REFERENCES:

1. N. Boccora, "*Modelling of Complex Systems"*, Second Edition, Springer 2010.
2. S. Strogatz, "*Nonlinear Dynamics and Chaos with Applications to Physics, Biology, Chemistry & Engineering"*, Second 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”*, Third 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.