Department of Computer Science

Learning Outcomes-based Curriculum Framework (LOCF)

M. Tech. Computer Science

(With Specialization in Digital Image Computing)

(Syllabus effective from 2020 Admission Onwards)

UNIVERSITY OF KERALA

2020

UNIVERSITY OF KERALA

Department ofComputer Science

2020

Syllabus for M. Tech Programme in Computer Science
(With Specialization Digital Image Computing)

Programme Outcomes (PO)for M. Tech Computer Science (with specialization Digital Image Computing)	
PO1	Develop the graduates to be successful professionals in industry, academia, research, entrepreneurship.
PO2	Develop the thinking skills and hence promoting innovation and research.
PO3	Provide support to the post graduates who can pursue life-long learning to chase their dreams.
PO4	Acquire skill set to solve the real life problems using team work
PO5	Enhance the presentation and communication skills
PO6	Gain self confidence by solving and implementing real life projects
PO7	Mould the graduates to develop a sense of social responsibility and social awareness
PO8	Understand the significance of academic integrity and research ethics

Programme Specific Outcomesfor M.Tech Computer Science (with specialization Digital Image Computing)	
PSO1	Provide the graduates flair of research by making them to do research-oriented projects.
PSO2	Possess the skill set to develop and implement the algorithms in computer science and the interdisciplinary areas.
PSO3	Provide advanced technical skills in the area of Image Processing and Machine Intelligence to graduates who can perform better as an individual or in a team; through their critical analytical and research skills.
PSO4	Develop the ability to apply mathematical and engineering skills in a pragmatic manner to solve problems.
PSO5	Develop an ability to identify, critically analyze, formulate and solve research problems in Digital Image Processing, Medical Image Processing.
PSO6	Develop the skills for writing technical and scientific research publications.
PSO7	Able to solve the real life problems with machine learning and deep learning techniques.
PSO8	Possess the ability to specialize in Image Processing, Intelligent systems
PSO9	Exposure to learn new tools and programming languages including MATLAB, Python, OpenCV, LaTeX, OpenGL

Department of Computer Science

University of Kerala

Programme structure of **M. Tech. in Computer Science**
(withSpecialization in **Digital Image Computing)**

Semester	Course Code	Name of the course	Credits
I	**Core Courses (CC)**		
	CSM-CC-611	Mathematics for Image Processing	4
	CSM-CC-612	Digital Image Processing	4
	CSM-CC-613	Machine Learning Techniques	4
	CSM-CC-614	Image Processing Laboratory	3
	Discipline-Specific Elective (DE)		
	CSM-DE-615(i)	High-Performance Computing	4
	CSM-DE-615(ii)	Computational Cognitive Neuroscience	4
	CSM-DE-615(iii)	Advanced Natural Language Processing	4
	CSM-DE-615(iv)	Cyber Security and Cyber law	4
	CSM-DE-615(v)	Digital Video Processing	4
	CSM-DE-615(vi)	Computational Geometry	4
	Generic Courses (GC)		
	CSM-GC-601	Basics of Digital Image Processing	2
	CSM-GC-602	Introduction to Scilab	2
II	**Core Courses (CC)**		
	CSM-CC-621	Advanced Computation Models	4
	CSM- CC -622	Data and Image Compression	4
	CSM- CC -623	Image Analysis and Computer Vision	4
	CSM- CC -624	Computer Vision Laboratory	3
	Discipline-Specific Elective (DE)		
	CSM-DE-625(i)	Robotics and Intelligent System Design	4
	CSM-DE-625(ii)	Biomedical Image Processing	4
	CSM-DE-625(iii)	Visual Cryptography	4
	CSM-DE-625(iv)	Nature Inspired Computing and Optimization	4
	CSM-DE-625(v)	Reinforcement Learning Techniques	4
III	**Core Courses (CC)**		
	CSM-CC-631	Research Methodology	4
	CSM-CC-632	Dissertation(Part-I)	10
	Skill Enhancement Elective (SE)		
	CSM-SE-601	Entrepreneurial Skills and Scientific Writing	2
	Generic Courses (GC)		
	CSM-GC-602	Artificial Intelligence and Applications	2
IV	**Core Courses (CC)**		
	CSM-CC-641	Dissertation(Part-II)	16

SEMESTER I	Course Code:CSM-CC-611	Credits: 4

MATHEMATICS FOR IMAGE PROCESSING

	COURSE OUTCOMES
CO1	Solve linear algebra problems
CO2	Compute eigen values and eigen vectors of a matrix
CO3	Analyse the significance of linear algebra in computational problems
CO4	Solve the problems based on linear equations
CO5	Identify the relevance of probability distributions in solving real life problems
CO6	Apply dimensionality reduction techniques
CO7	Apply statistical parameters in image processing problems and write the inference
CO8	Use linear algebra to solve the image processing and computer vision applications

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Solve linear algebra problems	PSO 4 PSO7	U,A	C,P
CO2	Compute eigen values and eigen vectors of a matrix	PSO4	U,A	C,P
CO3	Analyse the significance of linear algebra in computation problems	PSO2	An	C,P
CO4	Solve the problems based on linear equations	PSO4	A	P
CO5	Identify the relevance of probability distributions in solving real life problems	PSO4	A	P,C
CO6	Apply dimensionality reduction techniques	PSO7	A	C,P
CO7	Apply statistical parameters in image processing problems and write the inference	PSO4	A	P, C
CO8	Use linear algebra to solve the image processing and computer vision applications	PSO3	A	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create, KC- Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

Module-1: Linear Algebra: Solving Linear Equations, Vectors and Linear Equations, Idea of Elimination, Elimination Using Matrices, Rules for Matrix Operations, Inverse Matrices

Module -2: Eigenvalues and Eigenvectors:Introduction to Eigenvalues, Diagonalizing a Matrix, Systems of Differential Equations, Symmetric Matrices, Positive Definite Matrices

Module -3 : Linear Algebra in Probability & Statistics: Mean, Variance, and Probability, Covariance Matrices and Joint Probabilities, Multivariate Gaussian and Weighted Least Squares

Module -4 : Probability and Random Process: Probability Distributions, Random Signals , Stationary Process, Markov Process, Markov Chain

Module -5 : Singular Value Decomposition (SVD)- Image Processing by Linear Algebra, Bases and Matrices in the SVD, Principal Component Analysis (PCA by the SVD), Geometry of the SVD

Module -6 : Applications – Image Processing, Computer Vision, Graphs and Networks, , Matrices in Engineering, Computer Graphics

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

- Assignments
- Poster Presentation
- Solve mathematical problems

LEARNING RESOURCES

References

- Gilbert Strang, Linear Algebra and Its Applications, Academic Press (1976) Fourth Edition : Brooks/Cole/Cengage (2006).
- Gilbert Strang, Introduction to Linear Algebra, Indian edition, Wellesley Publishers, May 2016
- Erwin Kreyszig; Herbert Kreyszig; E J Norminton, Advanced Engineering Mathematics. New York John Wiley 2011.
- Higher Engineering Mathematics, by B S Grewal, Khanna Publishers

SEMESTER I	Course Code:CSM-CC-612	Credits: 4

DIGITAL IMAGE PROCESSING

	COURSE OUTCOMES
CO1	Explain the elements of image processing
CO2	Analyse how 2D image signals are processed
CO3	Provide Hands-on experience in using computers to process digital images
CO4	Perform histogram equalization on an image
CO5	Illustrate the process of smoothening and sharpening in gray scale and color images
CO6	Compare Otsu thresholding and Binary Thresholding techniques
CO7	Explain the restoration filters in image processing
CO8	Implement an algorithm for noise removal in spatial and in frequency domain
CO9	Implement three Edge detection filters including Canny, Prewitt, Sobel
CO10	Analyse the significance of region based segmentation algorithm in processing images.
CO11	Discuss about the current technologies and issues specific to Digital Image Processing.

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Explain the elements of image processing	PSO 2 PSO7	U	C
CO2	Analyse how 2D image signals are processed	PSO2	An	C,P
CO3	Provide Hands-on experience in using computers to process digital images	PSO3 PSO2	A, E	P
CO4	Perform histogram equalization on an image	PSO4	A	P
CO5	Illustratethe process of smoothening and sharpening in gray scale and color images	PSO4	A	P,C
CO6	Compare Otsu thresholding and Binary Thresholding techniques	PSO7	An	C
CO7	Explain the restoration filters in image processing	PSO2	U	C
CO8	Implement an algorithm for noise removal in spatial and in frequency domain	PSO3 PSO8	A	P
CO9	Implement three Edge detection filters including Canny, Prewitt, Sobel	PSO2	A	P
CO10	Analyse the significance of region based segmentation algorithm in processing images.	PSO2	An	C,P
CO11	Discuss about the current technologies and issues specific to Digital Image Processing.	PO8	U	C

COURSE CONTENT

Module 1 : Signals and System: Signals, Impulse Sequence, Exponential Sequence, Periodic Sequence, Linear Systems, Shift-Invariant systems, Linear Shift Invariant (LSI) systems

Module 2 : Convolution and Correlation, Inverse Convolution or Deconvolution, Finite Impulse Response System, Infinite Impulse Response System, Transforms- Fourier Transform, Z Transform, DST, DCT, KL Transform

Module 3 : Steps in Digital Image Processing Sampling and Quantization- Applications of Image Processing, Intensity Transformation and Spatial Filtering, Intensity Transformation Functions, Piecewise Linear Transformation Functions, Histogram Processing, Histogram Equalization, Histogram Matching, Local Enhancement, Enhancement using Arithmetic and Logic operations, Image Subtraction, Image Averaging

Module 4: Spatial Filtering, Smoothening Spatial Filters, Sharpening Spatial Filters, Laplacian Filter, Unsharp masking and High Boost Filter, Gradient operators – Edge detection filters, Filtering in Frequency domain, Frequency Domain Smoothening Filters: Ideal Filter, Butterworth Filter, Gaussian Filter, Frequency Domain Sharpening Filters, Laplacian in Frequency domain, Homomorphic Filtering.

Module 5 : Image degradation/Restoration process model, Noise probability density functions, Spatial Filtering: Mean Filters, Order-statistics filter, Adaptive Filters, Periodic Noise Reduction – Frequency domain filters: Band-reject filters, Band-pass filters, Notch filters. Estimating the degradation function, Inverse filtering, Wiener filtering, Performance measures.

Module 6 : Color image processing: Color fundamentals, Color models – RGB, CMYK, HSI, YCbCr, La*b* color spaces. Full color image processing, Color image smoothening and sharpening, color edge detection. Point and line detection. Image segmentation: Fundamentals, Thresholding, Optimum global thresholding – Otsu's method. Region based segmentation

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

- Assignments
- Poster Presentation
- Implementation of image processing programs

LEARNING RESOURCES

References

● Anil K. Jain, "Fundamentals of Digital Image Processing", Pearson, 1st Ed., 1988.

● AzrielRosenfield, Avinash C. Kak, "Digital Picture Processing", Morgan Kaufmann, 2nd Ed., 1982.

● Bernd Jahne, "Digital Image Processing", Springer, 6th Ed., 2005.

● Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing", 4th Ed., Pearson, March 2017.

● William K. Pratt, "Digital Image Processing: PIKS Scientific Inside", John Wiley & Sons, 4th Ed., 2007.

SEMESTER 1	CSM-CC-613	Credits: 4

MACHINE LEARNING TECHNIQUES

	COURSE OUTCOMES:
CO1	Demonstrate the capability to articulate the basic concepts of Machine learning
CO2	Compare and contrast different supervised machine learning algorithms
CO3	Evaluate unsupervised machine learning algorithms with examples
CO4	Explain the elements in Reinforcement learning techniques
CO5	Apply machine learning algorithms to solve real world problems
CO6	Illustrate the dimensionality reduction techniques with practical aspects
CO7	Compare the statistical Machine learning Techniques.
CO8	Identify the techniques to evaluate the performance of a classifier

TAGGING COURSE OUTCOMES

	Course Outcomes:	PO/PSO	CL	KC
CO1	Demonstrate the capability to articulate the basic concepts of Machine learning	PSO1	A	C,P
CO2	Compare and contrast different supervised machine learning algorithms	PSO5	E	C.P
CO3	Evaluate unsupervised machine learning algorithms with examples	PSO2	E	P
CO4	Explain the elements in Reinforcement learning techniques	PSO2	An	C
CO5	Apply machine learning algorithms to solve real world problems	PSO7	A	P
CO6	Illustrate the dimensionality reduction techniques with practical aspects	PSO9	A	C,P
CO7	Compare the statistical Machine learning Techniques.	PSO4	E	C,P
CO8	Identify the techniques to evaluate the performance of a classifier	PSO5	U,A	C

COURSE CONTENT

Module 1: Introduction to Machine Learning, Applications: Learning Associations, Classification ,Regression, Unsupervised Learning, Reinforcement Learning , Batch learning and online learning, Instance based learning Versus Model Based learning, Challenges of Machine Learning.

Module 2 : Supervised Learning algorithms-Classification: Linear Discriminant Classifier, Decision Trees, Random Forest, Support Vector Machines, kernel Functions, linear SVM, Non-linear SVM, ,KNN algorithm-Distance measures, Naïve Bayes classifier, Regression : Linear Regression, Logistic Regression

Module 3 : Unsupervised Learning algorithms**:** Clustering: Similarity measures, Clustering criteria, Distance functions, Hierarchical clustering, Single Linkage, Average Linkage and Complete Linkage algorithms, Ward's Method. Partitional Clustering, Forgy's Algorithm, K-means algorithm, Fuzzy C means algorithm,

Module 4 : Reinforcement Learning: Introduction, Elements of Reinforcement Learning, Limitations and scope, Markov Decision Process, Temporal Difference learning, Q-learning, On-policy TD control, Off-policy TD control.

Module 5 : Dimensionality Reduction: Problems of dimensionality, Need, The Curse of Dimensionality, Main approaches of Dimensionality reduction, Subset selection, Principle Component Analysis, Factor Analysis, Linear Discriminant Analysis

Module 6 : Statistical Learning- stochastic process, Markov process, HMM, Cross-Validation and Resampling Methods- *K*-Fold Cross-Validation, 5×2 Cross-Validation, Bootstrapping, Measuring Classifier Performance :Accuracy, Precision, Recall, F1 Score, Sensitivity, Specificity, ROC, AUC, Confusion matrix

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

- Assignments
- Poster Presentation
- Implementation of machine learning programs

LEARNING RESOURCES

References

- Aurélien Géron "Hands-On Machine Learning with Scikt-Learn &TensorFlow", O'Reilly Media, Inc.,2019
- Bishop, C. M. "Neural Networks for Pattern Recognition". New York: Oxford University Press (1995).
- Duda, R., Hart, P., and Stork, D. (2001). "Pattern Classification". New York: Wiley.
- EthemAlpaydın "Introduction to Machine Learning Second Edition" , The MIT Press Cambridge, Massachusetts, London, England
- LaureneFauseett: "Fundamentals of Neural Networks", Prentice Hall India, New Delhi,1994.
- Mitchell, T. (1997). "Machine Learning". New York: Mc Graw-Hill.

SEMESTER I	CSM-CC-614	Credits:4

IMAGE PROCESSING LABORATORY

	COURSE OUTCOMES
CO1	Implement basic image processing and machine learning algorithms
CO2	Perform image restoration using wiener filtering
CO3	Implement a mini project in image processing using machine learning techniques
CO4	Perform convolution and correlation on images
CO5	Implement filtering algorithms in spatial and frequency domain
CO6	Solve real life problems using image processing and machine learning
CO7	Apply and evaluate the feature extraction and dimensionality techniques on images.

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Implement basic image processing and machine learning algorithms	PSO2, PSO4	A	P
CO2	Perform image restoration using wiener filtering	PSO2	A	P
CO3	Implement a mini project in image processing research area	PSO1 PSO2, PSO4	A	P
CO4	Compare the working of convolution and correlation	PSO2 PSO9	An	P
CO5	Implement filtering algorithms in spatial and frequency domain	PSO2	A	P
CO6	Solve real life problems using image processing algorithms	PSO2, PSO7, PSO8	A	P
CO7	Apply and evaluate the feature extraction and dimensionality reduction techniques on images	PSO2, PSO8 PSO9	A, E	P

Students should undertake a research-oriented mini project to get an exposure to the recent research developments in the domain of Digital Image Processing. A detailed project report should be submitted and its evaluation should be conducted at the end of the semester.

List of Experiments

Implement the following algorithms and methods

- Hough Transform,
- Feature Extraction: Entropy, GLCM
- Dimensionality Reduction: PCA, LDA

- Classifiers:
- FCM, SVM, Perceptron, MLP, K-NN,
- Bayes Classifiers, Random Forest
- Adaboost, Decision Tree
- Histogram Equalization
- Color Image processing
- Image Deblurring using Wiener Filter
- Homomorphic filtering
- Contrast Stretching
- Unsharp masking
- Image Subtraction
- Local Enhancement and Global Enhancement
- Edge Detection – Laplacian and Canny

ELECTIVE- I

SEMESTER 1	CSM-DE-615(i)	Credits:4

HIGH PERFORMANCE COMPUTING

	COURSE OUTCOMES
CO1	Illustrate the computational complexity of modern problem methodology
CO2	Demonstrate the working of parallel computing
CO3	Discuss the nature and working of parallel algorithms
CO4	Explain the randomization techniques in parallel programming
CO5	Illustrate the use SPMD Programming
CO6	Assess the performance of the parallel programming

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Illustrate the computational complexity of modern problem methodology	PSO9	A	C
CO2	Demonstrate the working of parallel computing	PSO2	A	P
CO3	Discuss the nature and working of parallel algorithms	PSO4	U	C
CO4	Explain the randomization techniques in parallel programming	PSO2	A	P
CO5	Illustrate the use SPMD Programming	PSO2	U	C
CO6	Assess the performance of the parallel programming	PSO2	E	C,P

COURSE CONTENT

Module 1: Review of Computational Complexity, Granularity and Partitioning, Locality: temporal, spatial, stream, kernel, Basic methods for parallel programming, Real-world case studies (drawn from multiscale, multi-discipline applications)

Module 2 : High-End Computer Systems: Memory Hierarchies, Multi-core Processors: Homogeneous and Heterogeneous, Shared-memory Symmetric Multiprocessors, Vector Computers, Distributed Memory Computers, Supercomputers and Petascale Systems, Application Accelerators / Reconfigurable Computing, Novel computers: Stream, multithreaded, and purpose-built

Module 3 : Parallel Algorithms: Parallel models: ideal and real frameworks, Basic Techniques: Balanced Trees, Pointer Jumping, Divide and Conquer, Partitioning, Regular Algorithms: Matrix operations and Linear Algebra, Irregular Algorithms: Lists, Trees, Graphs.

Module 4 : Randomization: Parallel Pseudo-Random Number Generators, Sorting, Monte Carlo techniques. Parallel Programming: Revealing concurrency in applications, Task and Functional Parallelism, Task Scheduling, Synchronization Methods, Parallel Primitives (collective operations).

Module 5 :SPMD Programming (threads, OpenMP, MPI), I/O and File Systems, Parallel Matlabs (Parallel Matlab, Star-P, Matlab MPI), Partitioning Global Address Space (PGAS) languages (UPC, Titanium, Global Arrays)

Module 6 : Achieving Performance: Measuring performance, Identifying performance bottlenecks, Restructuring applications for deep memory hierarchies, Partitioning applications for heterogeneous resources, using existing libraries, tools, and frameworks.

SUGGESTED CLASS ROOM ACTIVITIES

- Assignments each module will be made available in between the lectures.
- Presentation (Video) of different robots and its working.
- Model Your Idea Context – Illustrate and model a robot for your own idea.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

- Assignments
- Implementation of programs

LEARNING RESOURCES

References

● Bader, David A. Petascale Computing. CRC Press, 2007

● David Culler Jaswinder Pal Singh,"Parallel Computer Architecture: A hardware/Software Approach", Morgan Kaufmann, 1999.

● G.E. Karniadakis, R.M. Kirby II, Parallel Scientific Computing in C++ and MPI: A Seamless Approach to Parallel Algorithms and their Implementation, Cambridge University Press,2003.

● G.S. Almasi and A. Gottlieb, Highly Parallel Computing, 2/E, Addison-Wesley, 1994.

● Kai Hwang, "Scalable Parallel Computing", McGraw Hill 1998

● M.J. Quinn, Parallel Programming in C with MPI and OpenMP, McGraw-Hill, 2004

● Wilkinson and M. Allen, Parallel Programming: Techniques and Applications Using Networked Workstations and Parallel Computers, 2/E, Prentice Hall, 2005

SEMESTER 1	CSM-DE-615(ii)	Credits:4

COMPUTATIONAL COGNITIVE NEUROSCIENCE

	COURSE OUTCOMES
CO1	Correlate machine learning and human learning in the context of computational cognitive neuroscience
CO2	Ability to identify the important issues in cognitive scienceand comprehend the empirical data
CO3	Articulate the basics of psychological ideas and translate psychological theories to computational or mathematical models.
CO4	Apply computational models and algorithms to cognitive science data
CO5	Illustrate how computational and mathematical theories can be applied to real-world problems, and effectively find solutions.
CO6	Categorize the characteristics of neurological brain disorders including Epilepsy, Alzheimer disease and Dementia
CO7	Compare fMRI and MRI

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Correlate machine learning and human learning in the context of computational cognitive neuroscience	PSO2	U	C
CO2	Ability to identify the important issues in cognitive science and comprehend the empirical data	PSO2, PSO7	U, A	C, P
CO3	Articulate the basics of psychological ideas and translate psychological theories to computational or mathematical models.	PSO4	U	C,F
CO4	Apply computational models and algorithms to cognitive science data	PSO4, PSO7	A	P
CO5	Illustrate how computational and mathematical theories can be applied to real-world problems, and effectively find solutions.	PSO7, PSO2	A	C,P
CO6	Categorize the characteristics of neurological brain disorders including Epilepsy, Alzheimer disease and Dementia	PSO7	An	P
CO7	Compare fMRI and MRI	PSO5	An	P

COURSE CONTENT

Module 1 : Introduction to Neuroscience - Computational Neuroscience: Descriptive Models- Computational Neuroscience: Mechanistic and Interpretive Models- The Electrical Personality of Neurons- Making Connections: Synapses- Time to Network: Brain Areas and their Function

Module 2 : Structural Neuroanatomy of the Human Brain- Structure and Anatomy- Development and Vascular Organization of the Brain- Terminology of Brain Organization-

Module 3 : Functional Anatomy of the Brain- Methods of Communication in the Brain Organization of Cognitive Domains- Neuropsychological Assessment of Cognition -Principles and Methods of Neuroimaging

Module 4 : Approaches to Neuroimaging- Basics of MRI - Basics of fMRI- Structural MRI Studies- Functional MRI Studies- Experimental design and special applications in neuroimaging- Experimental Design- Functional Connectivity MRI Studies- Diffusion Tensor Imaging

Module 5 : Brain Imaging and Spectroscopy- Structural Brain Imaging – MRI (T1 and FLAIR) and CT- – MRI T1 processing- Structural MRI - Diffusion Weighted Imaging- – Functional MRI – BOLD – Block and Event-related design- – fMRI Processing -

Module 6 : Magnetic Resonance Spectroscopy –overview- How does MR Spectroscopy work? Positron Emission Tomography (PET)- overview- How does PET work ? - Neurological Brain Disorders : Epilepsy, Alzheimer disease and Dementia

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

- Assignments
- Poster Presentation
- Implementation of programs

References

O'Reilly, R. C., Munakata, Y., Frank, M.J., Hazy, T.E. and Contributors (2014). Computational Cognitive Neuroscience. Wiki Book, 2nd Edition,

Online Source : Computational Neuroscience by University of Washington offered by Coursera

Online source :Fundamental Neuroscience for Neuroimaging by Johns Hopkins University by offered by Coursera

SEMESTER 1	CSM-DE-615(iii)	Credits:4

ADVANCED NATURAL LANGUAGE PROCESSING

	COURSE OUTCOMES
CO1	Demonstrate the NLP- Text & Speech understanding system
CO2	Generalize the knowledge representation system in Language processing
CO3	Differentiate: Active & Passive constructions in lexical analysis
CO4	Constitute the wh-movements and its evaluation
CO5	Illustrate the process of morphological analysis in NLP
CO6	Implement the Finite State Model for morphological processing
CO7	Differentiate between top-down parsing& bottom-up parsing
CO8	Recall the Phonetics & Phonology in speech forms
CO9	Examine the place and manner of articulation in speech processing
CO10	Apply the probability model for speech processing
CO11	Identify the different types of Parts-of- speech tagging
CO12	Develop a Baum Welch Algorithm for speech processing

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Demonstrate the NLP- Text & Speech understanding system	PSO2	A	P, C
CO2	Generalize the knowledge representation system in Language processing	PSO4	C	P
CO3	Differentiate: Active & Passive constructions in lexical analysis	PSO2	An	C
CO4	Constitute the wh-movements and its evaluation	PSO9	U	C
CO5	llustrate the process of morphological analysis in NLP	PSO2	U, A	C, P
CO6	Implement the Finite State Model for morphological processing	PSO8	A	P
CO7	Differentiate between top-down parsing& bottom-up parsing	PSO8	An	P
CO8	Recall the Phonetics & Phonology in speech forms	PSO2	U	C
CO9	Examine the place and manner of articulation in speech processing	PSO2	U	C
CO10	Apply the probability model for speech processing	PSO2, PSO9	A	P
CO11	Identify the different types of Parts-of- speech tagging	PSO2, PSO9	U, A	P
CO12	Develop a Baum Welch Algorithm for speech processing	PSO7,PSO8,PSO9	A	P

COURSE CONTENT

Module 1 : Introduction - Machine Learning and NLP, ArgMax Computation; Tree Adjoining Grammars: Dependency Grammars-Statistical Parsing; Introduction to Semantic Processing, Semantic Knowledge Representation, Deep Structure and Logical Form-Compositional Semantic Interpretation-Semantic Grammars-Case Frames and Case Frame based Parsing; Problems in NL Generation-Basic Generation Techniques Hard Problems in NLP-Speech Understanding and Translation-Discourse Processing.

Module 2 : Lexical Functional Grammar: Active-Passive and Dative Constructions-Wh-movement in Questions. Overview of LFG - LFG Formalism-Well-formedness Conditions-Handling Wh movement in Questions Computational Aspects.

Module 3 : Morphology and Finite State Transducers: Root and Stem, affixes - Inflectional Morphology-Derivational Morphology-Finite State Morphological Parsing-The Lexicon and Morphotactics Morphological Parsing with Finite State Transducers-Orthographic Rules and Finite-State Transducers-Combining an FST Lexicon and Rules-Lexicon-Free FSTs.

Module 4 : Word Sense Disambiguation: WordNet – Lexicography, Corpus. Wordnet; Application in Query Expansion, Measures of WordNet Similarity, Resnick's work on WordNet Similarity, Parsing Algorithms, Evidence for Deeper Structure; Top Down Parsing Algorithms, Noun Structure: Noun, verb, adjective and adverb structure. Top Down Parsing Algorithms, Non-noun Structure and Parsing Algorithms; Probabilistic parsing: Sequence labelling, PCFG; Probabilistic parsing: Training issues, Arguments and Adjuncts, Probabilistic parsing; inside-outside probabilities.

Module 5 : Speech : Phonetics, Hidden Markov Model, Graphical Models for Sequence Labelling in NLP, Consonants (place and manner of articulation) and Vowels; Forward Backward probability: Viterbi Algorithm, Phonology, Sentiment Analysis and Opinions on the Web, Machine Translation and MT Tools - GIZA++ and Moses, NLTK, Textblob – Python, Regular expression. Text Alignment, POS Tagging.

Module 6 : Phonology: ASR, Speech Synthesis, Hidden Markov Model and Viterbi, Precision, Recall , F-score, Map, Semantic Relations; UNL; Universal Networking Language: Introduction, Semantic Role Extraction, Baum Welch Algorithm; HMM training.

References:

1. Dash, NiladriSekhar (2005) Corpus Linguistics and Language Technology, New Delhi : Mittal Publications.
2. Introduction to Natural Language Processing, Jacob Eisenstein. 2019
3. Natural Language Processing with Python. Steven Bird, Ewan Klein and Edward Loper. 2016
4. Natural Language Understanding (2nd Edition) 2nd Edition- 2017. James Allen
5. RuslanMitkov, (2003), The Oxford Handbook of Computational Linguistics, Oxford University Press.
6. Speech and Language Processing (3rd ed. draft), Dan Jurafsky and James H. Martin. Draft chapters in progress, October 16, 2019
7. Statistical Machine Translation. Philipp Koehn. 2016

8. The Handbook of Computational Linguistics and Natural Language Processing (Blackwell Handbooks in Linguistics) 1st Edition, Kindle Edition by Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin (Editor),

SEMESTER 1	CSM-DE-615(iv)	Credits:4

CYBER SECURITY AND CYBER LAW

	COURSE OUTCOMES
CO1	Identify the issues and challenges in Networking
CO2	Explain the concepts of Information security, Threats, Vulnerabilities, Impact and control measures.
CO3	Analyze the efficiency of algorithms in cryptography.
CO4	Discuss network security issues and Virtual Private Networks.
CO5	Relate Cyber laws with security incidents**.**
CO6	Analyze Cyber Law in the context of breach of cyber security.
CO7	Discuss IT Act & its Amendments

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Identify the issues and challenges in Networking	PSO1	U, A	C
CO2	Explain the concepts of Information security, Threats, Vulnerabilities, Impact and control measures.	PSO2	U	C, P
CO3	Analyze the efficiency of algorithms in cryptography.	PSO4	E	C
CO4	Discuss network security issues and Virtual Private Networks.	PSO2	U	C, P
CO5	Relate Cyber laws with security incidents**.**	PSO5, PSO7	A	C
CO6	Analyze Cyber Lawin the context of breach of cyber security.	PSO2	An	F, C
CO7	Discuss IT Act & its Amendments	PSO2	U	F, C

COURSE CONTENT

Module 1 : Information System Threats and attacks, Classification of Threats and Assessing Damages, Security in Mobile and Wireless Computing- Security Challenges in Mobile Devices, authentication Service Security, Security Implication for organizations, Laptops Security, confidentiality, Integrity Availability, Access Control- Biometrics.

Module 2 : Model of Cryptographic Systems, Issues in Documents Security, System of Keys, Public Key Cryptography, Digital Signature, Requirement of Digital Signature System, Finger Prints, Firewalls, Design and Implementation Issues, Policies Network Security- Basic Concepts, Dimensions, Perimeter for Network.

Module 3 : Network Perimeter Security Fundamentals**:** Introduction, layers of Network Security, Security by Router – Firewall: Basics, Types - Network Address Translation Issues. - Virtual Private

Networks**:** VPN Basics, Types of VPN, IPSecTunneling& Protocols. - VLAN: introduction, Links, Tagging, VLAN Trunk Protocol (VTP).

Module 4 : Constitutional & Human Rights Issues in Cyberspace Freedom of Speech and Expression in Cyberspace - Right to Access Cyberspace – Access to Internet- Right to Privacy - Right to Data Protection.
Module 5 : Cyber Crimes & Legal Framework Cyber Crimes against Individuals - Institution and State - Hacking - Digital Forgery - Cyber Stalking/Harassment - Cyber Pornography - Identity Theft & Fraud Cyber terrorism - Cyber Defamation - Different offences under IT Act, 2000.
Module 6 :` Intellectual Property Issues in Cyber Space Interface with Copyright Law - Interface with Patent Law- trademarks & Domain Names Related issues. Indian Context of Jurisdiction and IT-Act, 2000. , International Law and Jurisdictional Issues in Cyberspace.

REFERENCES

- Forouzan, B.A., Cryptography & Network Security. Tata McGraw-Hill Education, 2010.
- Godbole,“ Information Systems Security”, Willey.
- IT Act 2000 Jeffrey M. Bradshaw, Software Agents (Editor). MIT Press.
- Kahate, A. Cryptography and Network Security. McGraw-Hill Higher Ed., 2009.
- Luger., Artificial Intelligence. 4 ed.- Pearson Education.
- Merkov, Breithaupt,“ Information Security”, Pearson Education
- Schou, Shoemaker, “Information Assurance for the Enterprise”, Tata McGraw Hill,“Cyber Laws Simplified”, Mc GrawHillFurnell, “Computer Insecurity”, Springer.
- Yadav, “Foundations of Information Technology”, New Age, Delhi.

SEMESTER 1	CSM-DE-615(v)	Credits:4

DIGITAL VIDEO PROCESSING

	COURSE OUTCOMES
CO1	Develop the capability of representing, analyzing, compressing and processing video
CO2	Apply the appropriate motion estimation technique for video processing applications
CO3	Illustrate the steps for processing of compressed video
CO4	Identify the steps for performing video summarization
CO5	Describe the video sampling mechanism
CO6	Evaluate the metrics for analyzing the efficiency of video processing algorithms
CO7	Describe the fundamentals of image and video processing and their applications
CO8	Develop familiarity and implement basic image and video processing algorithms.
CO9	Select and apply appropriate technique to real problems in image and video analysis.

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Develop the capability of representing, analyzing, compressing and processing video	PSO3	U, A	C,P
CO2	Apply the appropriate motion estimation technique for a given video processing applications	PSO2	A	P
CO3	Illustrate the steps for processing of compressed video	PSO1	A	C, P
CO4	Identify the steps for processing video summarization	PSO2	U, A	C, P
CO5	Describe the video sampling mechanism	PSO8	U	C
CO6	Evaluate the metrics for analyzing the efficiency of video processing algorithms	PSO8	E	P
CO7	Describe the fundamentals of image and video processing and their applications	PSO2	U	C
CO8	Implement basic image and video processing algorithms.	PSO9	A	P
CO9	Apply appropriate technique to real problems in image and video analysis.	PSO7	A	P

COURSE CONTENT

Module 1 : Analog video and NTSC television- Spatio-temporal sampling; Sampling structure conversion (without using motion) - Motion Analysis- Real versus apparent motion- Spatial-temporal constraint methods (optical flow equation) –

Module 2 : Block-matching methods- Mesh-based methods - Region-based (parametric) motion modeling - Motion segmentation and layered video representations

Module 3 : Video Processing- Motion-compensated (MC) filtering- Noise reduction - Signal recovery and general inverse problems - Restoration (deblurring) - Superresolution, Mosaicing - Deinterlacing - Frame-rate conversion (MC-Interpolation)

Module 4 : Video Compression - Frame-based compression (principles behind MPEG-1, MPEG-2) Scalable or layered frame-based compression- Object-based compression (principles behind MPEG-4)

Module 5 : Video communication- Video streaming and error-resilience- Efficient processing of compressed video- Digital TV

Module 6 : Advanced Video Processing : Video indexing, summarization, and retrieval.-Video meta-data extraction and representation.- video semantic analysis - video quality evaluation techniques

REFERENCES

- Digital Video Processing" by M. Tekalp (Prentice Hall, 1995, ISBN 0-13-190075-7).
- H.264 and MPEG-4 Video Compression: Video Coding for Next Generation Multimedia – Iain E.G. Richardson, Wiley, 2003
- Handbook of Image and Video processing – Al Bovik (Alan C Bovik), Academic Press, Second Edition, 2005.
- Video Processing and Communications" by Yao Wang, JoernOstermann, and Ya-Qin Zhang, Prentice Hall, 2002, ISBN 0-13-017547-1.

SEMESTER 1	CSM-DE-615(vi)	Credits:4

COMPUTATIONAL GEOMETRY

	COURSE OUTCOMES
CO1	Explain fundamental geometry representations
CO2	Explain and apply basic concepts from Polygons and Triangulations
CO3	Analyze the 3D graphics programming and understand its limitations
CO4	Implement and evaluate basic geometry processing algorithms, such as smoothing, remeshing, deformation, and constructive solid geometry
CO5	Perform PCA based shape synthesis
CO6	Discuss surface reconstruction techniques
CO7	Explain the deformation types including Volume-based Deformation, Multi-Scale Deformation, Free-Form Deformation

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Explain fundamental geometry representations	PSO2	U	C
CO2	Apply basic concepts of Polygons and Triangulations for geometry processing	PSO4	U,A	P
CO3	Analyze the 3D graphics programming	PSO3	An	P
CO4	Describe basic geometry processing algorithms, such as smoothing, remeshing, deformation, and constructive solid geometry	PSO4, PSO9	A	P
CO5	Perform PCA based shape synthesis	PSO4	A	P
CO6	Discuss surface reconstruction techniques	PSO2	U	C
CO7	Explain the deformation types including Volume-based Deformation, Multi-Scale Deformation, Free-Form Deformation	PSO2	U	F

COURSE CONTENTS

Module 1 : Introduction- Digital Models- Geometry representation - Polygons and Triangulations - polygonal Jordan Curve - Art Gallery problem- Point Sets- Convex hull construction-Voronoi Diagrams

Module 2 : Mesh Data Structures- Face-Based Data Structures- Edge-Based Data Structures - Halfedge-Based Data Structure Directed-Edge Data Structure- 3D Graphics Programming- Introduction to open inventor tool- Mesh Comparison- Distance- Geodesic distance- Diffusion distance- Shape descriptors- Sampling - Shape correspondence

Module 3 :Surface reconstruction- Explicit representation- Implicit representation- Implicit function- Implicit reconstruction- Marching Squares algorithm- Marching cubes algorithm- Signed distance function- KD tree for NN- Scientific visualization - Direct scalar field visualization- Vector field visualization- Information visualization

Module 4 :Mesh Generation - Shape Synthesis- Part based shape synthesis- PCA based shape synthesis- PCA Computation - PCA application- eigen vector decomposition -Active shape model - Shape from Silhouette- Mesh Processing- Mesh smoothing- Remeshing- Subdivision surfaces- Subdivision curves

Module 5 :Mesh parameterization- Texture Mapping - Parameterization types- Linear Parameterization Methods- Disk Parameterization - Fixed-Boundary Parameterization - Free-Boundary Parameterization - MDS-based Parameterization - Parameterization Refinement- Parameterization of Closed Meshes - Spherical Parameterization- Sphere Generation Method - Parameterization Distortion

Module 6 :Shape Registration - Rigid vs. Non-rigid- Rigid Alignment via PCA- Eigen decomposition of Covariance Matrix- Rigid Alignment Transformations- Rigid Alignment via ICP- Rigid Alignment via RANSAC - Mesh Deformation- Deformation Types- Volume-based Deformation- Multi-Scale Deformation- Free-Form Deformation (FFD)- Interpolation- Skinning- Shell-based Deformation- Physically based deformation

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

- Assignments
- Poster Presentation
- Implementation of programs

REFERENCES:

- Polygon Mesh Processing, Mario Botsch, Leif Kobbelt, Mark Pauly, Pierre Alliez, Bruno Lévy , 2010

On-line Sources

- Computer Graphics: Geometric Modeling, course by L. Guibas (Stanford)
- Digital Geometry Processing, course by Hao Li
- Digital Geometry Processing, course by Mirela Ben-Chen
- Geometric Modeling course by TamalDey and the associated course notes (Ohio State University).
- http://staff.ustc.edu.cn/~fuxm/course/2017_Spring_DGP/index.html
- http://user.ceng.metu.edu.tr/~ys/ceng789-dgp/
- https://www.cs.ubc.ca/~sheffa/dgp/
- https://www.cse.iitb.ac.in/~cs749/spr2017/

SEMESTER 1	CSM-GC-601	Credits:2

BASICS OF DIGITAL IMAGE PROCESSING

	COURSE OUTCOMES
CO1	Explain the different tasks in digital image processing.
CO2	Illustrate the process of sampling and quantization in digtal images
CO3	Analyse the steps for removing the blur in an image
CO4	Explain various spatial and frequency domain filtering techniques.
CO5	Explore the image segmentation techniques

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Explain the different tasks in digital image processing.	PSO1	U	C, P
CO2	Illustrate the process of sampling and quantization in digtal images	PSO5	A	C,P
CO3	Analyse the steps for removing the blur in an image	PSO5	An	P
CO4	Explain various spatial and frequency domain filtering techniques.	PSO3	U	C
CO5	Explore the image segmentation techniques	PSO9	U	P

COURSE CONTENT

Module 1 : Images and Pictures- Image Processing- Image Acquisition and Sampling- Aspects of Image Processing- Types of digital images- Quantization and dithering- Histograms

Module 2 : Filtering- Low and High Pass filters- Guassian Filters- Edge Sharpening- Non linear filters- region of interest processing- Image Interpolation- Enhancement by Spatial Filtering

Module 3 : Fourier transforms of Images- Filtering in frequency domain- Ideal Filtering- Butterworth Filtering- Homomorphic filtering.

Module 4 : Image Restoration- Degradation model- Types of Noises- Median Filtering- Average Filtering- Adaptive Filtering- Wiener Filter.

Module 5 : Image Segmentation- Thresholding- Otsu's Thresholding- Adaptive Thresholding- Edge detection- Watershed algorithm- Hough Transform.

Module 6 : Mathematical Morphology- basic ideas- Dilation - Erosion- Opening- Closing- Hit or miss transforms- Gray Scale morphology- Processing of color images

LEARNING RESOURCES

REFERENCES

- Alasdair McAndrew , Introduction to Digital Image Processing with Matlab, Cengage Learning, 2004
- Anil K. Jain, “Fundamentals of Digital image Processing”, Prentice Hall, US Ed., 1989.
- Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing", 3rd Ed., PHI, 2007.
- William K. Pratt, “Digital Image Processing: PIKS Scientific Inside”, Wiley Interscience, 4th Ed., 2007

SEMESTER 1	CSM-GC-602	Credits:2

INTRODUCTION TO SCILAB

	COURSE OUTCOMES
CO1	Identify the significance of Scilab over other programming tools.
CO2	Demonstrate the procedures in downloading and accessing Scilab software.
CO3	Compare built-in operators and functions in scilab.
CO4	Discuss the working of arrays, matrices and other vectors in scilab programming.
CO5	Solve basic mathematical and relational problems using scilab programming.
CO6	Illustrate basic polynomial arithmetic using scilab programming.
CO7	Demonstrate 2D and 3D plotting using Scilab programming.
CO8	Create user defined functions in Scilab programming.
CO9	Apply statistical functions in Scilab programming.

TAGGING COURSE OUTCOMES

	Course Outcome	PSO	CL	KC
CO1	Identify the significance of Scilab over other programming tools.	PSO1	K	F
CO2	Demonstrate the procedures in downloading and accessing Scilab software.	PSO2	A	P
CO3	Compare built-in operators and functions in scilab.	PSO4	An	C,P
CO4	Discuss the working of arrays, matrices and other vectors in scilab programming.	PSO9	U	P
CO5	Solve basic mathematical and relational problems using scilab programming.	PSO4	A	P
CO6	Illustrate basic polynomial arithmetic using scilab programming.	PSO9	A	P
CO7	Demonstrate 2D and 3D plotting using Scilab programming.	PSO2	A	P
CO8	Create user defined functions in Scilab programming.	PSO7	C	P
CO9	Apply statistical functions in Scilab programming.	PSO4	A	P

COURSE CONTENT

Module 1 : Introduction to Scilab – Why Scilab, downloading & installing scilab, Scilab Environment – manipulating the command line, working directory, comments, variables in memory, the scilab menu bar, demos.

Module 2 :Scalars & Vectors - initializing vectors in scilab, mathematical operations on vectors, relational operations, logical operations on vectors, built-in logical functions- conditional statements, Mathematical functions on scalars, complex numbers, trigonometric functions

Module 3 :Matrices – introduction, arithmetic operators for matrices, basic matrix processing- Accessing and Addressing Matrix- Mathematical Operations with Matrix

Module 4 :Polynomials – introduction, creating polynomials, basic polynomial commands, finding roots of polynomial, polynomial arithmetic

Module 5 :Plotting- Plotting 2D graphs - Plotting 3D graphs- Functions in Scilab- Applications - Numerical Linear Algebra(Solving linear equations, Eigen values)
Module 6 :Statistics – basic statistical functions, applying statistical functions on matrices, distributions, frequency of values of a matrix or vector, centre, weighted centre, central moment, correlation, covariance, variance matrix, frequencies, cumulative sum, fisher test.

REFERENCES

- Vinu V. Das, Programming in Scilab 4.1, New Age Publishers,2008
- Ramachandran Hema, Achuthsankar S Nair, Scilab (A Free Software to Matlab), S Chand 2011
- Dr. M. Affouf, Scilab by Example, CreateSpace Independent Publishing 2012

SEMESTER 2	CSM-CC-621	Credits:4

ADVANCED COMPUTATION MODELS

	COURSE OUTCOME
CO1	Explain the basic theory and concepts of neural networks
CO2	Identify different neural network architectures, algorithms and applications.
CO3	Solve the neural network problems based on different learning rules.
CO4	Compare the crisp logic, the concept of fuzzy logic involved in various systems and fuzzy set theory.
CO5	Describe the fuzzy logic concepts including the use of fuzzy inference systems and approximate reasoning in solving complex tasks.
CO6	Implement, train, and evaluate neural networks
CO7	Different deep network architectures and how these are used in current applications
CO8	Design different type of classification methods suitable for the problems to be addressed.

TAGGING COURSE OUTCOMES

	Course Outcome	PSO	CL	KC
CO1	Explain the basic theory and concepts of neural networks	PSO2	U	C
CO2	Identify different neural network architectures, algorithms and applications.	PSO2	U	C
CO3	Solve the problems based on different learning rules.	PSO3	Ap	P
CO4	Compare the crisp logic, the concept of fuzzy logic involved in various systems and fuzzy set theory.	PSO3	U,A	P
CO5	Describe the fuzzy logic concepts including the use of fuzzy inference systems and approximate reasoning in solving complex tasks.	PSO3	U	C
CO6	Implement, train, and evaluate neural networks using existing software libraries	PSO3	U	C
CO7	Different deep network architectures and how these are used in current applications	PSO4	E	p
CO8	Design different type of classification methods suitable for the problems to be addressed.	PSO1, PSO5, PSO6 PSO7	C	P

COURSE CONTENT

Module 1 : Introduction to Fuzzy logic.Fuzzy sets and membership functions. Operations on Fuzzy sets. Fuzzy relations, rules, propositions, implications and inferences. Defuzzification techniques. Fuzzy logic controller design, Neuro Fuzzy systems, ANFIS, Applications of Fuzzy systems.

Module 2 :ANN Basics, Biological neuron,Models of neuron, Types of Neural network, learning, Activation Functions, The perceptron model, Backpropagation, stochastic gradient descent, Multi-layer Perceptrons.

Module 3 : Convolutional neural network :Architecture , Working of Convolutional Neural Network, ConvNet Layers, Convolutional Layer, Pooling Layer , Normalization Layer, Fully-Connected Layer, Converting Fully-Connected Layers to Convolutional Layers, ConvNet Architectures- Layer Patterns, Layer Sizing Patterns, AlexNet, VGGNet

Module 4 : Deep Learning Hardware and Software: CPUs, GPUs, TPUs, PyTorch, TensorFlow Dynamic vs Static computation graphs, Activation functions, data processing Batch Normalization, Transfer learning, Update rules, hyperparameter tuning, Learning rate scheduling, data augmentation.

Module 5 : Unsupervised Learning: Non-probabilistic Models: sparse coding, Autoencoders, stacked auto encoders, denoising auto encoders, deep auto encoders, Deep Belief Networks (DBNs), Generative Adversarial Networks (GANs).

Module 6 : Reurrent and Recursive networks, Bidirectional RNNS, Deep recurrent networks, Recursive Neural networks, The long short term memory,Deep Reinforcement Learning. Implementing object detection and classification using CNN with the help of any deep libraries like Tensorflow, Keras, Caffe.

LEARNING RESOURCES

References

- Michael Nielsen, Neural Networks and Deep Learning, Determination Press, 2015.
- CosmaRohillaShalizi, Advanced Data Analysis from an Elementary Point of View, 2015.
- Deng & Yu, Deep Learning: Methods and Applications, Now Publishers, 2013.
- Ian Goodfellow, YoshuaBengio, Aaron Courville, Deep Learning, MIT Press, 2016
- Kalchbrenner, Nal, Edward Grefenstette, and Phil Blunsom. "A convolutional neural network for modelling sentences." ACL (2014).

On line sources

http://www.cs.toronto.edu/~hinton/deeprefs.html

SEMESTER 2	CSM-CC-621	Credits:4

DATA AND IMAGE COMPRESSION

	COURSE OUTCOMES
CO1	Model and code the redundancy in a data
CO2	Design a Huffman and Adaptive huffman codes for the data
CO3	Check whether a code is uniquely decidable or not.
CO4	Encode the data using adaptive dictionary based algorithms including LZ77, LZ78, LZW
CO5	Analyse the CALIC algorithm to do the image compression
CO6	Encode the data using BWT algorithm
CO7	Analyse the working of JPEG compression algorithm
CO8	Compare Static quantization and Adaptive quantization techniques
CO9	Discuss LBG algorithm
C10	Explain Vector Quantization Technique

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Model and code the redundancy in a data	PSO2	An	C
CO2	Design a Huffman and Adaptive huffman codes for the data	PSO3, PSO4	E	P
CO3	Check whether a code is uniquely decidable or not.	PO4	An	P
CO4	Encode the data using adaptive dictionary based algorithms including LZ77, LZ78, LZW	PSO2 PSO3	A	C, P
CO5	Analyse the CALIC algorithm to do the image compression	PSO2	An	C
CO6	Encode the data using BWT algorithm	PSO3	A	C, P
CO7	Analyse the working of JPEG compression algorithm	PSO2 PSO3	An	C
CO8	Compare Static quantization and Adaptive quantization techniques	PO5	An	C
CO9	Discuss LBG algorithm	PSO2	U	C
C10	Explain Vector Quantization Technique	PSO2	U	C

COURSE CONTENT

Module 1 : Introduction: Compression Techniques, Modeling and Coding, Mathematical Preliminaries for Lossless compression: Information Theory, Uniquely decodable codes, Prefix codes, Kraft-McMillan Inequality.
Module 2 : Huffman Coding, Adaptive Huffman Coding, Arithmetic Coding: Coding a sequence, Generating a binary code, Dictionary Techniques: Static Dictionary, Digram coding, Adaptive Dictionary, LZ77, LZ78, LZW algorithms
Module 3 : Context-based Compression: Prediction with partial match (ppm), Burrows-Wheeler Transform (BWT), CALIC, JPEG standard, JPEG-LS, Run-Length Coding
Module 4 : Scalar and Vector Quantization: Quantization: Quantization problem, Uniform Quantizer, Lloyd- Max Quantizer, LBG Algorithm, Tree Structured and Structured Vector Quantizers

Module 5 : Image data properties- Discrete image transforms in image data compression - Predictive compression methods - Vector quantization- Compression in transform domain- JPEG, Wavelets compression
Module 6 :
Hierarchical and progressive compression methods- Comparison of compression methods - Other techniques - Coding - JPEG and MPEG image compression.

REFERENCES

- Alistair Moffat, Andrew Turpin, "Compression and Coding Algorithms", Kluwer Academic Publishers, 1st Ed., 2002.
- David Salomon, "Data Compression – The Complete Reference", Springer, 4th Ed., 2006.
- John Miano, "Compressed Image File Formats", Addison Wesley Professional, 1st Ed., 1999.
- Khalid Sayood, "Introduction to Data Compression", Morgan Kaufmann Publishers, 4th Ed., 2012.
- Mark Nelson, Jean-Loup Gailly, "The Data Compression Book", John Wiley & Sons, 2nd Ed., 1995.
- Peter Wayner, "Compression Algorithms for Real Programmers", Morgan Kaufmann, 1st Ed., 1999.
- VasudevBhaskaran, Konstantinos Konstantinides, "Image and Video Compression Standards", Kluwer Academic Publishers, 2nd Ed., 2003.

SEMESTER 2	CSM- CC -623	Credits:4

IMAGE ANALYSIS AND COMPUTER VISION

	COURSE OUTCOME
CO1	Explain the fundamental theories and techniques of human vision with computer vision.
CO2	Explain the process of image formation in the camera.
CO3	Explore the significance of morphological operations
CO4	Apply different region properties in an image
CO5	Summarize different texture, color-based feature extraction methods used for computer vision
CO6	Illustrate the working of Camera calibration system
CO7	Explain different methods to compute the motion of an object from 2D image sequences
CO8	Explain the process of the depth information from stereo images
CO9	Apply different types of morphological operations to an image
CO10	Develop a computer-based system with vision capabilities

TAGGING COURSE OUTCOMES

	Course Outcome	PSO	CL	KC
CO1	Explain the fundamental theories and techniques of human vision with computer vision.	PSO2	U	C
CO2	Explain the process of image formation in the camera.	PSO2	U	C
CO3	Explore the significance of morphological operations and apply different type of morphological operations in order to get the perfect object from the given image	PSO3	AP	P
CO4	Apply different region properties in an image	PSO3	AP	C,P
CO5	Summarize different texture, color-based feature extraction methods used for computer vision	PSO4	U	C,P
CO6	Illustrate the working of Camera calibration system	PSO2	U	C
CO7	Explain different methods to compute the motion of an object from 2D image sequences	PSO2, PSO6	U	C
CO8	Explain the process of the depth information from stereo images	PSO2	U	C
CO9	Apply different types of morphological operations to an image	PSO3	AP	C,P
CO10	Develop a computer-based system with vision capabilities	PSO1, PSO5, PSO7	Cr	P

COURSE CONTENT

Module 1 : Imaging and Image Representation: Imaging Devices, 3D structure from 2D images, Five frames of reference. Binary Image Analysis: Pixels and Neighborhoods, Applying masks to images, Counting the objects in an image, Connected components labeling. Binary image morphology, Region properties, Region adjacency graphs,

Module 2 : Feature detection and matching: Points and patches, SIFT, Edges-Edge detection and linking, Lines-Hough transforms. Color and Shading: Color bases, Color histograms, Color segmentation, Shading. Texture: Texture, Texels and Statistics, Texel based Texture Descriptions, Quantitative Texture Measures, Texture Segmentation.

Module 3 : Content based image retrieval: Image distance measures: Colorsimilarity,Texture similarity, Shape similarity, Database organization. Motion from 2D image sequences: Computing Motion Vectors, Computing paths of moving points, Detecting significant changes in video.

Module 4 : Matching in 2D: Registration of 2D data, Representation of points, Affine mapping functions, 2D object recognition via Affine Mapping: Local Feature Focus method, Pose clustering, Geometric hashing, 2D object recognition via Relational Matching.

Module 5 : Perceiving 3D from 2D images: Labeling of line drawings from blocks world, 3D cues available in 2D images, Perspective imaging model, Depth perception from Stereo- Establishing correspondences.

Module 6 :3D sensing and Object pose Computation: 3D Affine transformations, Camera Model, Affine calibration matrix, Improved Camera calibration method, Pose estimation, 3D object reconstruction.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

- Assignments
- Quiz
- Demonstration of simple experiments

LEARNING RESOURCES

References

- Linda G. Shapiro, George C. Stockman, “Computer Vision”, Prentice Hall, 1st Ed., 2001.
- Richard Szeliski, “Computer Vision: Algorithms and Applications”, Springer, 1st Ed., 2010.
- David A. Forsyth, Jean Ponce, “Computer Vision: A Modern Approach”, 2nd Ed., 2011.
- Simon J. D. Prince, “Computer Vision: Models, Learning, and Inference”, Cambridge University Press, 1st Ed., 2012.
- Ramesh Jain, RangacharKasturi, Brian G. Schunck, “Machine Vision”, McGraw-Hill, 1st Ed., 1995
- Ranjay Krishna “Computer Vision :Foundatons and Applications “Stanford University

SEMESTER 2	CSM- CC -624	Credits:3

COMPUTER VISION LABORATORY

	COURSE OUTCOMES
CO1	Implement basic data compression algorithms including Huffman Coding and adaptive huffman coding
CO2	Implement dictionary based data compression algorithms including JPEG.
CO3	Implement a mini project in image compression domain.
CO4	Implement the programs for Testing Uniquely Decodable Codes and check whether the code word is prefix code or not
CO5	Implement image compression using JPEG and LBG
CO6	Implement the programs for Texture classification
CO7	Implement Object detection using computer vision algorithms

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO/PO	CL	KC
CO1	Implement basic data compression algorithms including Huffman Coding, Golumb Coding	PO4 PO5	A	C,P
CO2	Implement advanced data compression algorithms including JPEG, .	PO4 PO5	A	P
CO3	Implement a mini project in image compression domain.	PO4 PO5	A	P
CO4	Implement the programs for Testing Uniquely Decodable Codes and check whether the code word is prefix code or not	PO4 PO5	A	P
CO5	Analyse the JPEG compression algorithm	PO4 PO5	An	C,P
CO6	Implement LBG algorithm	PO5 PO4	A	P

COURSE CONTENT

Following experiments, related to Data Compression and Computer Vision need to be implemented:

Data Compression

- Entropy, Testing Uniquely Decodable Codes
- Huffman algorithm, Adaptive Huffman algorithm
- LZ77 , LZ78, LZW
- Image compression using LBG, JPEG and Vector Quantization

Computer Vision

- Connected Component Labelling
- Morphological Operations
- Region based Segmentation
- Texture Classification
- Object detection
- Object Tracking
- Stereo imaging

Students should undertake a research-oriented mini project to get an exposure to the recent research developments in the domain of Image -Video processing or Computer Vision. A detailed project report should be submitted and its evaluation should be conducted at the end of the semester.

SEMESTER 2	CSM-DE-625(i)	Credits: 4

ROBOTICS AND INTELLIGENT SYSTEM DESIGN

	COURSE OUTCOMES
CO1	Demonstrate the skillset to program and control a robotics system
CO2	Explain the management and analysis of robotics systems
CO3	Illustrate the working of a robot understanding the concepts of electronics, programming and robotics
CO4	Acquire basic Knowledge on Robots
CO5	Ability to process end effectors and robotic controls.
CO6	Analyze Robot Transformations and Sensors
CO7	Able to understand Robot cell design and applications

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Demonstrate the skillset to program and control a robotics system	PSO1	A	P
CO2	Explain the management and analysis of robotics systems	PSO2	U	C
CO3	Illustrate the working of a robot understanding the concepts of electronics, programming and robotics	PSO3	A	P
CO4	Acquire basic Knowledge on Robots	PSO1	U	C
CO5	Ability to process end effectors and robotic controls.	PSO7	A	P
CO6	Analyze Robot Transformations and Sensors	PSO2	An	P
CO7	Able to understand Robot cell design and applications	PSO2, PSO8	A	P

COURSE CONTENTS

Module 1 : Introduction - What is robotics? - Robotics and AI - Embedded Systems -Agent-Task-Environment model - Embodied Systems - Synthetic approaches to science

Module 2 : Mobile Robots, Position, and Orientation -Translational and Dynamics - lying and Swimming Robots - Articulated Robots - Transformations, Path Planning, and Trajectories

Module 3 :Sensors and signal processing- Common sensors and their properties- 1D signal processing-VisionPlanning approaches to robot control- STRIPS and SHAKEY - Robot manipulator kinematicsLimitations of planning approaches

Module 4 :Control Theory - Feedback, feedforward and open loop control- Linear first order lag processesLimitations of control theory -Probability Based Approaches -Markov Decision Processes (MDPs) Navigation

Module 5 :Behaviour-Based Control -The subsumption architecture- Hybrid architectures Formalising behaviour based control (SMDPs)- Adaptive approaches to robot control - Reinforcement learning for control

Module 6 :Model Based learning approaches to control -Learning maps - Evolutionary approaches - Parameter Estimation and Adaptive Control - Task Planning and Multi-Agent Systems

LEARNING RESOURCES

References

- Albus, J. I., and Meystel, A. M., *Engineering of Mind*, J. Wiley & Sons, 2001.
- C. Asfahl, *Robots and Manufacturing Automation*, J. Wiley & Sons, 1992.
- D. Auslander, J. Ridgely, and J. Ringgenberg, *Control Software for Mechanical Systems*, Prentice-Hall, 2002.
- G. Bekey, *Autonomous Robots*, MIT Press, 2005.
- H. Asada and J.-J. Slotine, *Robot Analysis and Control*, J. Wiley & Sons, 1986.
- H. Choset, *Principles of Robot Motion*, MIT Press, 2005.
- M. Brady, J. Hollerbach, T. Johnson, T. Lozano-Perez, and M. Mason, *Robot Motion: Planning and Control*, MIT Press, 1984.
- P. Antsaklis and K. Passino, *An Introduction to Intelligent and Autonomous Control*, Kluwer, 1993.
- R. Arkin, *Behavior-Based Robotics*, Bradford, 1998.

Online sources
http://www.stengel.mycpanel.princeton.edu/MAE345Lectures.html

SEMESTER 2	CSM-DE-625(ii)	Credits:4

BIOMEDICAL IMAGE PROCESSING

	COURSE OUTCOME
CO1	Explain the use of the biological signals in diagnosis, patient monitoring and physiological investigation.
CO2	Describe the physical basis and engineering principles underlying common approaches in acquiring 2D and 3D images for biomedical applications, including x-ray imaging, tomographic techniques.
CO3	Analyse the performance used to automatically process and analyze these images, including different image representations, image enhancement, restoration, edge detection, automatic image segmentation and registration.
CO4	Explain the biomedical applications including Image Guided Surgery, Image Guided Therapy, Computer Aided Diagnosis/Diagnostic Support Systems.
CO5	Analyze the various methods of face recognition system.
CO6	Explain the Iris recognition methods
CO7	Summarise the different steps in Fingerprint recognition
CO8	Design and implement an application based on image processing and some pattern recognition techniques

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Explain the use of the biological signals in diagnosis, patient monitoring and physiological investigation.	PSO2	U	C
CO2	Describe the physical basis and engineering principles underlying common approaches in acquiring 2D and 3D images for biomedical applications, including x-ray imaging, tomographic techniques.	PSO2	U,An	P
CO3	Analyse the performance used to automatically process and analyze these images, including different image representations, image enhancement, restoration, edge detection, automatic image segmentation and registration.	PSO3	An	P
CO4	Explain the biomedical applications including Image Guided Surgery, Image Guided Therapy, Computer Aided Diagnosis/Diagnostic Support Systems.	PSO2	U	C
CO5	Analyze the various methods of face recognition system.	PSO4	U,An	C,P
CO6	Explain the Iris recognition methods	PSO3	U	C
CO7	Summarise the different steps in Fingerprint recognition	PSO4	U	P
CO8	Design and implement an application based on image processing and some pattern recognition techniques	PSO1 PSO5	C	P

		PSO6 PSO7		

COURSE CONTENT

Module 1 : Medical Image Processing: Introduction to medical imaging, brief history, importance, applications, trends, challenges; Medical Image Formation Principles: X-Ray and Computed Tomography(CT) imaging , Basic principles of CT, 2D Image reconstructionFourier space and filtered backprojection methods, Iterative reconstruction.

Module 2 : Imaging Modalities: Magnetic Resonance Imaging (MRI) Mathematics of MR, spin physics, NMR spectroscopy, imaging principles, Nuclear Imaging- positron emission tomography (PET) , single photon emission Tomography (SPECT)

Module 3 : Ultrasound Imaging , Overview, Generation and Detection of Ultrasound Waves, Physical and Physiological Principles of Ultrasound, Fundamental Ultrasound Concepts Wave Equation, Attenuation, Reflection, Ultrasound Imaging Modalities, Applications of Ultrasound Imaging, Microscope, The simple Microscope- principles, The compound Microscope, Optics, Image Formation.

Module 4 : Edge Detection and Segmentation of Images: Edge Detection-Sobel Edge detection, Laplacian of Gaussian edge Detection, Canny Edge Detection. Image Segmentation: Region Segmentation using Luminance Thresholding, Region Growing, Quad-Trees.

Module 5 : Analysis of Shape: Representation of shapes and contours-Signatures of contours, chain coding, segmentation of contours, Thinning and skeletenoization, Shape Factors- Compactness, moments, chord length statistics, Fourier descriptors, Fractional concavity, Analysis of spicularity, Application: Shape Analysis of Calcifications.

Module 6 : Texture in Biomedical Images : Models for the Generation of Texture: Random texture, Ordered texture , Oriented texture , Statistical Analysis of Texture: GLCM measures of texture, Laws_ Measures of Texture Energy.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Quiz
- Demonstration of simple experiments

LEARNING RESOURCES

References

- Bankman I.N. “Hand book of Medical Imaging-Processing and Analysis” , Academic Press
- Bovik A.I. “Handbook of Image and Video processing”, Academic Press.
- Jiri Jan, “Medical Image Processing, Reconstruction and Restoration- Concepts and
- KayyanNaarian, Robert Splinter, “Biomedical Signal and Image Processing” CRC Tayler & Francis,2012
- L. Landini, V. Positano, M.L. Santarelli, “Advanced Image Processing in Magnetic Methods”, CRC Tayler & Francis, 2006.
- Paul Suetens, “Fundamentals of Medical Imaging”, Cambridge University Press, Second Edition
- Rangaraj M. Rangayyan, *“*Biomedical Image Analysis”, CRC Tayler & Francis, 2004 Resonance Imaging”, CRC Tayler & Francis, 2005.

Online sources

https://www.britannica.com/technology/microscope/Stereoscopic-microscopes

SEMESTER 2	CSM-DE-625(iii)	Credits:4

VISUAL CRYPTOGRAPHY

	COURSE OUTCOME
CO1	Explain the network security problems and cryptographic techniques.
CO2	Identify the need and importance of visual cryptography.
CO3	Demonstrate steganography and digital watermarking.
CO4	Demonstrate basic visual cryptographic models using halftone techniques.
CO5	Discuss the procedures for constructing visual secret shares.
CO6	Discuss about visual cryptography and share generation using color images.
CO7	Compare Basic Visual Secret Sharing schemes (Naor and Shamir's, Wu and Chen's scheme, Wu and Chang's scheme, etc.)
CO8	Compare Multiple secret sharing schemes in Visual Cryptography (Shyuet.al's scheme and Fenget.al's scheme).
CO9	Design ideas on visual cryptography and secret sharing methods.

TAGGING COURSE OUTCOMES

No.	Course Outcome	PSO	CL	KC
CO1	Explain the network security problems and cryptographic techniques.	PSO8	U	C
CO2	Identify the need and importance of visual cryptography.	PSO8	U	C
CO3	Illustrate steganography and digital watermarking algorithms.	PSO9	A	C,P
CO4	Demonstrate basic visual cryptographic models using halftone techniques.	PSO9	A	C,P
CO5	Discuss the procedures for constructing visual secret shares.	PSO9	U	C
CO6	Discuss about visual cryptography and share generation using color images.	PSO9	U	P
CO7	Compare Basic Visual Secret Sharing schemes (Naor and Shamir's, Wu and Chen's scheme, Wu and Chang's scheme, etc.)	PSO9	An	C,P
CO8	Compare Multiple secret sharing schemes in Visual Cryptography(Shyuet.al's scheme and Fenget.al's scheme).	PSO9	E	C,P
CO9	Design ideas on visual cryptography and secret sharing methods.	PSO3	C	M

COURSE CONTENTS

Module 1 :Basics of cryptography - Images for secure communication - Steganography: introduction, LSB Steganography - Digital Watermarking: Reversible Data Hiding technique, significant share generation.

Module 2 : Visual cryptography: introduction, history, visual cryptography Vs traditional cryptography, common issues in Visual Cryptography - Visual Secret Sharing scheme: Construction of Visual Secret Shares, Halftone VSS Construction Using Error Diffusion, Share structure. - Distribution of SIP and ABP: Generation of Halftone shares via Error Diffusion.

Module 3 : Schemes for general model - Naor and Shamir's Basic Visual Secret Sharing Scheme - (n, n) threshold schemes - (k, n) threshold schemes, Moiré Cryptography scheme, Size-adjustable visual secret sharing schemes.

Module 4 : Visual Cryptography for Color Images - Color Superposition and Darkening Problem - Formal Models for Colored VCS - Models for B&W VC and Color VC - Visual Cryptography Schemes for SC model.

Module 5 : Visual Cryptography Schemes for ND model - General schemes for Colored VC - (2, 2) threshold schemes - (t, n) threshold AS models. - Probabilistic Visual Cryptography Schemes: Probabilistic Schemes with No Pixel Expansion, Probabilistic Schemes with Pixel Expansion.

Module 6 : Visual Cryptography for Multiple Secrets- Introduction - Visual Two-Secret Sharing Schemes: Wu and Chen's scheme, Wu and Chang's scheme - Visual Multiple Secret Sharing Schemes: Shyu et al.'s scheme, Feng et al.'s scheme.

LEARNING RESOURCES

REFERENCES

- BorkoFurht, EdinMuharemagic and Daniel Socek, Multimedia Encryption and Watermarking, Springer, 2005 , 978-0-387-24425-9.
- Jen- Shyang Pan, Hsiang- Cheh Huang and Lakhi C. Jain, Intelligent Watermarking Techniques, World Scientific., 2004, 978-981-238-757-8 (hardcover).
- Josef Pieprzyk, Thomas hardjino and Jennifer Sebberry, Fundamentals of computer security, Springer International Edition 2003, 978-3-540-43101-5.
- Naor, Moni, and Adi Shamir. "Visual cryptography." In Workshop on the Theory and Application of of Cryptographic Techniques, pp. 1-12. Springer Berlin Heidelberg, 1994.
- Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, Pearson Education, Fourth Edition, 978-0133356724, 2017.
- Shen Ying," Visual Cryptography based Multiparty Copyright Protect Scheme", 978-1-4244-5848-6/10/ ©2010 IEEE.
- Shruti M. Rakhunde, Archana A. Nikose," New Approach for Reversible Data Hiding Using Visual Cryptography", 2014 Sixth International Conference on Computational Intelligence and Communication Networks.
- StelvioCimato, "Visual Cryptography and Secret Image Sharing", CRC Press 2017, 9781138076044.

- T. Hofmeister, M. Krause, and H.U.Simon. Contrast-optimal k out of n secret sharing schemes in visual cryptography. In COCCON ’97, Lecture Notes in Computer Science, volume 1276, pages 176–185, Berlin, 1997. Springer.
- Zhi Zhou, Member,Gonzalo R. Arce, Giovanni Di Crescenzo, “Halftone Visual Cryptography”, IEEE Transactions On Image Processing, Vol. 15, No. 8, August 2006.

SEMESTER 2	CSM-DE-625(iv)	Credits:4

NATURE INSPIRED COMPUTING AND OPTIMIZATION

	COURSE OUTCOMES
CO1	Algorithms that can be used for autonomous design and adaptation of intelligent systems.
CO2	Insight in biologically inspired as well as traditional machine learning methods for search, optimization and classification.
CO3	Analyse the benefits and drawbacks of the nature inspired computing techniques
CO4	Apply bioinspired algorithms for solving real life problems
CO5	Illustrate the working of Ant Colony Algorithms
CO6	Compare firefly algorithm with Cuckoo search algorithm

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Algorithms that can be used for autonomous design and adaptation of intelligent systems.	PSO1	C	P
CO2	Insight in biologically inspired as well as traditional machine learning methods for search, optimization and classification.	PSO2	U	C
CO3	Analyse the benefits and drawbacks of the nature inspired computing techniques	PSO2	An	P
CO4	Apply bioinspired algorithms for solving real life problems	PSO7	A	P
CO5	Illustrate the working of Ant Colony Algorithms	PSO8	A	P
CO6	Compare firefly algorithm with Cuckoo search algorithm	PSO3, PSO9	An	P

COURSE CONTENT

Module 1 : Models of Life and Intelligence - Fundamentals of bio-inspired models and bio-inspired computing. Evolutionary models and techniques, Swarm models and its self-organisation, swarm and evolutionary algorithms. Optimisation problems – single and multi-objective optimisation, heuristic, meta-heuristic and hyper heuristic functions.

Module 2 : Genetic algorithms - Mathematical foundation, Genetic problem solving, cross over and mutation. genetic algorithms and Markov process, applications of genetic algorithms

Module 3 : Ant Colony Algorithms - Ant colony basics, hybrid ant system, ACO in combinatorial optimisation, variations of ACO, case studies. Particle Swam algorithms - particles moves, particle swarm optimisation, variable length PSO, applications of PSO, case studies.

Module 4 :
Artificial Bee Colony algorithms - ABC basics, ABC in optimisation, Multi-dimensional bee colony algorithms, applications of bee algorithms, Selected nature inspired techniques - Hill climbing, simulated annealing, Gaussian adaptation, Cuckoo search, Fire fly algorithm, SDA algorithm, bat algorithm, case studies.

Module 5 : Other nature inspired techniques - Social spider algorithm, Cultural algorithms, Harmony search algorithm, Intelligent water drops algorithm, Artificial immune system, Flower pollination algorithm, case studies.

Module 6 : Selected nature inspired optimization techniques - Bacterial colony optimization, Glow-worm Swarm optimization, Plant growth adaptation in optimization, Termite colony optimization, African Buffalo optimization, case studies.

LEARNING RESOURCES

REFERENCES

- Albert Y.Zomaya - "Handbook of Nature-Inspired and Innovative Computing", Springer, 2006
- Floreano, D. and C. Mattiussi -"Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies", MIT Press, 2008
- Leandro Nunes de Castro - " Fundamentals of Natural Computing, Basic Concepts, Algorithms and Applications", Chapman & Hall/ CRC, Taylor and Francis Group, 2007
- Marco Dorrigo, Thomas Stutzle -" Ant Colony Optimization", Prentice Hall of India, New Delhi, 2005
- Vinod Chandra S S, Anand H S - "Machine Learning: A Practitioners Approach", Prentice Hall of India, New Delhi, 2020

SEMESTER 2	CSM-DE-625(v)	Credits:4

REINFORCEMENT LEARNING TECHNIQUES

	COURSE OUTCOMES
CO1	Describe the key features of reinforcement learning that distinguishes it from AI and non-interactive machine learning
CO2	Exemplify an application problem (e.g. from computer vision, robotics, etc), decide if it should be formulated as a RL problem
CO3	Implement in code common RL algorithms
CO4	Explain the multiple criteria for analyzing RL algorithms and evaluate algorithms on these metrics
CO5	Illustrate the working of policy gradients in Reinforcement Learning
CO6	Identify the significance of importance sampling in Monte Carlo Methods

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Describe the key features of reinforcement learning that distinguishes it from AI and non-interactive machine learning	PSO1	K	C
CO2	Exemplify an application problem (e.g. from computer vision, robotics, etc), decide if it should be formulated as a RL problem	PSO3	A	P
CO3	Implement in code common RL algorithms	PSO9	A	P
CO4	Explain the multiple criteria for analyzing RL algorithms and evaluate algorithms on these metrics	PSO7	U	C
CO5	Illustrate the working of policy gradients in Reinforcement Learning	PSO4	A	P
CO6	Identify the significance of importance sampling in Monte Carlo Methods	PSO4	K	C

COURSE CONTENT

Module 1 : Origin and history of Reinforcement Learning research. : Reinforcement learning framework- Its connections with other related fields and with different branches of machine learning. Applications of Reinforcement learning.

Module 2 : Brush up of Probability concepts - Axioms of probability, concepts of random variables, PMF, PDFs, CDFs, Expectation. Concepts of joint and multiple random variables, joint, conditional and marginal distributions. Correlation and independence.

Module 3 : Markov Decision Process -Introduction to RL terminology, Markov property, Markov chains, Markov reward process (MRP). Introduction to Markov decision process (MDP), state and action value functions, Bellman expectation equations, optimality of value functions and policies, Bellman optimality equations

Module 4 : Overiew of dynamic programing for MDP, definition and formulation of planning in MDPs, principle of optimality, iterative policy evaluation, policy iteration, value iteration,

Module 5 : Monte Carlo Methods for Model Free Prediction and Control-Overiew of Monte Carlo methods for model free RL, First visit and every visit Monte Carlo, Monte Carlo control, On policy and off policy learning, Importance sampling.

Module 6 : Policy Gradients -Getting started with policy gradient methods, Log-derivative trick, Naive REINFORCE algorithm, bias and variance in Reinforcement Learning, Reducing variance in policy gradient estimates, baselines, advantage function, actor-critic methods.

LEARNING RESOURCES

References

- "Reinforcement Learning: An Introduction", Richard S. Sutton and Andrew G. Barto, 2nd Edition
- "Probability, Statistics, and Random Processes for Electrical Engineering", 3rd Edition, Alberto Leon-Garcia
- MLAPP "Machine Learning: A Probabilistic Perspective", Kevin P. Murphy

SEMESTER 2	CSM-GC-602	Credits:2

ARTIFICIAL INTELLIGENCE AND APPLICATIONS

	COURSE OUTCOMES
CO1	Demonstrate fundamental understanding of the history of artificial intelligence (AI) and its foundations.
CO2	Demonstrate awareness and a fundamental understanding of various applications of AI techniques in intelligent agents, expert systems, Natural language Processing - machine learning models.
CO3	Demonstrate an ability to share in discussions applications of AI, its current scope and limitations
CO4	Apply basic principles of AI in solving daily life

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Demonstrate fundamental understanding of the history of artificial intelligence (AI) and its foundations.	PSO1	A	P
CO2	Demonstrate awareness and a fundamental understanding of various applications of AI techniques in intelligent agents, expert systems, Natural language Processing - machine learning models.	PSO2	A	P
CO3	Demonstrate an ability to share in discussions applications of AI, its current scope and limitations	PSO5	A	P
CO4	Apply basic principles of AI in solving daily life	PSO4, PSO7	A	P

COURSE CONTENT

Module 1 : Introduction to Artificial Intelligence- History of AI- Advantages and Disadvantages of AI- Applications- AI domains

Module 2 : Search and Control Strategies- State- Space representation- Problem Solving - Heuristic Techniques – Hill Climbing – Simulated Annealing – Generate and Test, Problem reduction- Constraint Satisfaction- Means End Analysis

Module 3 : Machine Learning- Supervised and Unsupervised Algorithms- Neural Networks- Classification and Predictions model – Applications

Module 4 : Natural Language Processing - Natural Language Processing Tasks - NLP Applications- Recommender System - Sentimental Analysis

Module 5 : Introduction to Game Theory- Two player game - Mini- Max Procedure- Alpha Beta Cut off .

Module 6 :AI in real life , Expert system - Expert system development- Modern expert systems.

LEARNING RESOURCES

References

- Artifcial Intelligence: A Modern Approach Third Edition Stuart Russell and Peter Norvig, 2010. Pearson Education, Inc. ISBN: 978-0-13-604259-4
- Artificial Intelligence, Dan W Patterson, Prentice Hall of India (1999)
- Artificial Intelligence, Nils J.Nilsson, ELSEVIER.
- E.Rich and K.Knight, Artificial Intelligence, - TMH

Online Sources
https://www.tutorialspoint.com/artificial_intelligence/artificial_intelligence_overview.htm

SEMESTER 3	CSM-CC-631	Credits:4

RESEARCH METHODOLOGY

	COURSE OUTCOMES
CO1	Demonstrate the capability to prepare M. Tech dissertation with a research bias.
CO2	Formulate a viable research problems.
CO3	Critically Analyse the research articles and reports.
CO4	Illustrate the categories of research methodologies with examples.
CO5	Develop the skill to write a technical paper based on research findings.
CO6	Analyze the benefits and drawbacks of
CO7	Illustrate the basic outline of research process with an example.
CO8	Critically analyze and prepare a literature review.
CO9	Develop professional ethics and code of ethics in research. .
CO10	Develop a skill to prepare and execute a research project.
CO11	Prepare technical report and research papers
CO12	Assess the research performance using the metric including impact factor, H-index, i-index

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Demonstrate the capability to prepare M. Tech dissertation with a research bias.	PSO1	A	C,P
CO2	Formulate a viable research problems.	PSO1	A	C
CO3	Critically Analyse the research articles and reports.	PSO5, PO8	An	C
CO4	Illustrate the categories of research methodologies with examples.	PO2	A	P
CO5	Develop the skill to write a technical paper based on research findings.	PO8	A	P
CO6	Analyze the benefits and drawbacks of	PO1	E	C, P
CO7	Illustrate the basic outline of research process with an example.	PO6	C	M
CO8	Critically analyze and prepare a literature review.	PSO1	An	C,P
CO9	Develop professional ethics and code of ethics in research. .	PO8	C	C,P
CO10	Develop a skill to prepare and execute a research project.	PO4, PO6	A	C,P
CO11	Prepare technical report and research papers	PO5, PO8	A	C,P
CO12	Assess the research performance using the metric including impact factor, H-index, i-index	PO8	A,E	C,P

COURSE CONTENT

Module 1 : Introduction to Research Methodology: Motivation towards research. Types of research: Quantitative research approach and Qualitative research approach. Steps in research process - Problem definition, setting out a plan, literature review, analysis and hypothesis formulation, presentation and interpretation, decision making. Criteria of good research.

Module 2 : Professional ethics in research - Ethical issues-ethical committees. Copy right - royalty - Intellectual property rights and patent law - Copy left- Open access-reproduction of published material - Plagiarism - Citation and acknowledgement. Creative commons license. Impact factor, H-index, Identifying major conferences and important journals in the concerned area. Collection of at least 4 papers in the area.
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Module 3 : Research formulation and literature review - Problem definition and formulation, literature review, characteristics of a good research question, literature review process. Analyze the chosen papers and understand how the authors have undertaken literature review, identified the research gaps, arrived at their objectives, formulated their problem and developed a hypothesis.
Data Collection - Primary and secondary data primary and secondary data sources, data collection methods data processing, types of data processing, data processing stages classification of data.

Module 4 : Data analysis - Regression analysis, Correlation analysis, PCA, sampling. Analyse the chosen papers and study the methods of data collection used. - Data processing and analysis strategies used– Study the tools used for analysing the data.

Module 5 : Research design - Need for research design, Features of a good design, Types of research designs, induction and deduction. Hypothesis formulation and testing - Hypothesis, important terms, Types of research hypothesis, hypothesis testing, Z-test, t-test, f-test, making a decision, types of errors, ROC graphics.

Module 6 : Presentation of the Research Work - technical writing, structure and components, contents of a typical technical paper, business report, technical report, research report, general tips for writing report. Presentation of data- oral presentation. Identification of a simple research problem – Literature survey- research design- methodology –paper writing based on a hypothetical result.

REFERENCES

- C. R. Kothari – " Research Methodology", New Age International, 2004
- J. W. Bames – "Statistical Analysis for Engineers and Scientists", Tata McGraw-Hill, New York, 1994
- R. Panneerselvam - "Research Methodology", Prentice Hall India, New Delhi, 2014
- Vinod Chandra S S, Anand H S - "Research Methodology", Pearson Education, Chennai, 2017

SEMESTER 3	CSM-SE-601	Credits:2

ENTREPRENEURIAL SKILLS AND SCIENTIFIC WRITING

	COURSE OUTCOMES (CO)
CO1	**Demonstrate the ability to plan, organize, and execute a project or new venture with the goal of bringing new products and service**
CO2	**Develop skillset to carry out scientific research in the field of entrepreneurship**
CO3	**Prepare scientific reports and communicate the results in journal/conferences**
CO4	Analyse and Prepare research papers and literature review
CO5	**Assess the commercial viability of new technologies, business opportunities**

TAGGING COURSE OUTCOMES

	Course Outcomes (CO)	PSO/PO	CL	KC
CO1	**Demonstrate the ability to plan, organize, and execute a project or new venture with the goal of bringing new products and service**	**PO1**	**A**	**P**
CO2	**Develop skillset to carry out scientific research in the field of entrepreneurship**	**PO2**	**C**	**P**
CO3	**Prepare scientific reports and communicate the results in journal/conferences**	**PO8**	**C**	**P,M**
CO4	Analyse and Prepare research papers and literature review	**P08, PO5**	An	P
CO5	**Assess the commercial viability of new technologies, business opportunities**	**PO1, PO7**	**E**	**P**

COURSE CONTENT

Module 1 : Introduction to entrepreneurship- Idea generation and business opportunity – Who is an entrepreneur –Traits-Qualities-competence of an entrepreneur Factors affecting entrepreneurship development- Creativity and entrepreneurship -

Module 2 : Steps in Creativity - Innovation and invention- Legal Protection of innovation - Skills of an entrepreneur - Decision making and Problem Solving (steps indecision making) -Procedures for initiation of the Startup-

Module 3 : Introduction to Soft Skills- Communication Skills - Presentation Skills -Time Management Skills- Group Discussion & Interview Skills - Emotional Intelligence Skills –

Module 4 : Life Skills - Self awareness- Identifying one's strengths and weakness Planning & Goal setting- Leadership skills- Stress Management Skills

Module 5 : How to read a research paper ? Structure and Components of Research Report, Data Presentation , Types of Report, Layout of Research Report, Mechanism of writing a research Thesis, Formats of a research paper, IMRAD format,

Module 6 : Google Scholar, Web of Science, Scopus, Impact Factor, h-Index, g- index, Copyrights andPatents, IPR Laws. Citation, Plagiarism, Creative commons licenses

Learning Resources

REFERENCES

- C. R. Kothari – " Research Methodology", New Age International, 2004
- Cecile Niewwenhuizen, Entrepreneurial Skills: Second Edition,Isbn-13: 978-0702176937
- J. W. Bames – "Statistical Analysis for Engineers and Scientists", Tata McGraw-Hill, New York, 1994
- R. Panneerselvam - "Research Methodology", Prentice Hall India, New Delhi, 2014
- Vinod Chandra S S, Anand H S - "Research Methodology", Pearson Education, Chennai, 2017

SEMESTER 3	CSM-CC-632	Credits:10

DISSERTATION – PART – 1

	COURSE OUTCOMES
CO1	Identify a specific topic for dissertation in the area of Digital Image Processing.
CO2	Prepare Preliminary study on the topic and give a presentation on it.
CO3	Implement the initial phase of the work as the first part of the dissertation.
CO4	Present the progress of the research work based on the results and analysis.
CO5	Prepare and submit a well written report in the department.
CO6	Analyse and a thorough understanding of problem solving in a research project.

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Identify a specific topic for dissertation in the area of Digital Image Processing.	PSO1	A	C
CO2	Prepare Preliminary study on the topic and give a presentation on it.	PO4	A, An	P
CO3	Implement the initial phase of the work as the first part of the dissertation.	PO5	A	P
CO4	Present the progress of the research work based on the results and analysis.	PO5	A	C
CO5	Prepare and submit a well written report in the department.	PO6	C, An	C,P
CO6	Analyse and a thorough understanding of problem solving in a research project.	PO6	An	C, P

COURSE CONTENT

The dissertation work shall be carried out in the department under the guidance of an internal guide. However any specific request from the student to work in a National Level Institute/ R&D company in the industry can also be considered with specific conditions.

SEMESTER 4	CSM-CC-641	Credits:16

DISSERTATION(PART-II)

	COURSE OUTCOMES
CO1	Investigate the related and recent works in the area of dissertation.
CO2	Apply critical thinking and design new strategies for the work
CO3	Implement and analyse the performance of the new method.
CO4	Propose a new algorithm in the area of study.
CO5	Prepare a dissertation on the work done in the prescribed format.
CO6	Presentation on the entire work done as part of the course.

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Investigate the related and recent works in the area of dissertation.	PO4	A	P
CO2	Apply critical thinking and design new strategies for the work.	PO5	An	C
CO3	Implement and analyse the performance of the new method.	PSO3	A	C, P
CO4	Propose a new algorithm in the area of study.	PSO1 PSO2	C	M
CO5	Prepare a dissertation on the work done in the prescribed format.	PO6	An	C
CO6	Presentation on the entire work done as part of the course.	PO7	A, E	

COURSE CONTENT

The second phase of the dissertation work shall be carried out as the extension of the first work. At the end of the course, all the students should submit a dissertation with the details of the work done, findings and suggestions. There will be internal and external evaluations of the work. Student should have atleast one research publication (communicated / accepted) or presentation in International Conference / Seminar for the final submission of dissertation. The publication should be in reputed International Journals (UGC –CARE List) or International Conferences. The conference proceedings should be recognized by Department Council.