Department of Computer Science & Applications

A

Revised Syllabus of

Ph. D. Course Work

in

Computer Science

Session 2020-2021 and onwards

DR. HARISINGH GOUR UNIVERSITY, SAGAR (M.P)

(A Central University)

1. Name of the program : **Ph. D. in Computer Science**
2. Duration of the program : as per University ordinance 23A
   a. Minimum duration : as per University ordinance 23A
   b. Maximum duration : as per University ordinance 23A
3. Structure of the program:

Ph D. in Compuer Science Sem. I Credit Distribution

Semester	Core Course (CC) Credits	Elective Course (EC) Credits	Language Course (LN) Credits	Skill Based Course (SE) Credits	Total Credits
I	14	04	-	-	**18**
other Semester	**Synopsis approval and Thesis Work**				

4. **Medium of Instruction & Examination:** Medium of instruction as well as examination will be English only.
5. **Attendance:** Students must secure minimum 75% attendance in each course to appear in the End Semester Examination. If a student fails to secure 75% attendance in a course the he or she will not be allowed to appear in End Semester Examination of the respective course. Relaxation may be granted as per University Ordinance.
6. **Scheme of Examination:**
   (a) Mid Semester Examination (ME) : 20 Marks
   (b) Internal Assessment (IA) : 20 Marks
   (c) End Semester Examination (ESE) : 60 Marks

a. Mid Semester Examination: 20 Marks

Syllabus and pattern of examination will be decided by the corresponding course instructor(s).

b. Internal Assessment : 20 Marks

15 marks of internal assessment will be evaluated on any one or more than one methods of the following:

i. Classroom activities.
ii. Presentation
iii. Assignment
iv. Quizzes
v. Practical based Test

Remaining 05 marks will be assigned for attendance. The marks for attendance shall be awarded as follows:

i. 75% and below : 00 Mark
ii. >75% and upto 80% : 01 Mark
iii. > 80% and upto 85% : 02 Marks
iv. > 85% and upto 90% : 03 Marks
v. > 90% and upto 95% : 04 Marks
vi. > 95% : 05 Marks

c. End Semester Examination : 60 Marks

The END SEMESTER Paper shall be of 60 marks and of 3 hours duration. The pattern of Questions asked shall be as per University Ordinance.

Note: A student shall be eligible to appear in End Semester Examination of course if he/she appeared in Mid Semester Examination and Internal Assessment and fulfils the requirement of attendance, failing which he/she will not be permitted to appear in the End Semester Examination of respective course.

Summary of Ph.D. Course Work (One Semester) in Computer Science

Semester 1									
Course Code	Course Title	Credit	L	T	P	Sessional		ESE	Total
						ME	IA		
CSA-CC-141	Research Methodology	4	4	-	-	20	20	60	100
CSA-CC-142	Data Structure and Algorithms	4	3	-	1	20	20	60	100
CSA-CC-143	Review of Published research work	4	-	-	-	20	20	60	100
CSA-CC-144	Research and Publication & Ethics	2	2	-	-	20	20	60	100
Elective 1 (Opt Any One of Following)									
CSA-EC-141	Data Mining	4	4	-	-	20	20	60	100
CSA-EC-142	Parallel Computing	4	4	-	-	20	20	60	100
CSA-EC-143	Machine Learning	4	4	-	-	20	20	60	100
CSA-EC-144	Cloud Computing	4	4	-	-				
CSA-EC-145	Image Processing and Computer Vision	4	4	-	-	20	20	60	100
CSA-EC-146	Advanced Pattern Recognition	4	4	-	-	20	20	60	100
CSA-EC-147	Simulation & Modeling	4	4	-	-	20	20	60	100
CSA-EC-148	Applied Cryptography	4	4	-	-	20	20	60	100

Ph. D. Coursework I Semester

Course Code	Course Title	Credit	L	T	P	Sessional		ESE	Total
						ME	IA		
CSA-CC-141	Research Methodology	4	4	-	-	20	20	60	100

Course Objective:

1. Study and understand the research issues & challenges, research goals, and scientific methods.
2. Study Sampling, External Validity, Levels of Measurement, Scaling and Qualitative Measures. Data Preparation, Descriptive Statistics and Correlation; and Inferential Statistics
3. Reviewing Literature and Research Papers; Writing Research Papers, Thesis, Reports and Project Proposals Plagiarism and Copyrights.

Course Contents:

Unit	Topic	Proposed Lectures
I	**Research Foundations:** Research, Research Goals and Quality Research, Types of Research, Variables, Hypotheses and Data; Structure, Positivism and Post-Positivism; Scientific Methods, Reasoning and Arguments; Mathematical Methods of Proof and Research Fallacies.	12
II	**CS Research Context:** Nature of Computer Science, Scientific Methods in Computer science, Types of Research in CS, Research Methods in Computer Science, Research Paradigms in CS, Grand Challenges for CS Research.	12
III	**Measurements:** Sampling, External Validity, Levels of Measurement, Scaling and Qualitative Measures. Research Design: Internal Validity, Types of Designs, Experimental Design, Probabilistic Equivalence, Hybrid Experimental Designs and Quasi-Experimental Design.	12
IV	**Statistical Inference:** Conclusion Validity, Threats to Conclusion Validity, Improving Conclusion Validity, and Statistical Power; Data Preparation, Descriptive Statistics and Correlation; and Inferential Statistics.	12
V	**Research Skills:** Reviewing Literature and Research Papers; Writing Research Papers, Thesis, Reports and Project Proposals; Formatting, Appendices, Citation Formats and Style; General Conventions, Issues, Plagiarism and Copyrights.	12

Suggested Reading:

1. Research Methodology: a step-by-step guide for beginners, Kumar, Pearson Education.
2. Practical Research Methods, Dawson, C., UBSPD Pvt. Ltd.
3. Montgomary, Douglas C. & Runger, George C. (2007) 3/e, Applied Statistics & probability for Engineers (Wiley India).
4. Kothari C.K. (2004) 2/e, Research Methodoloy – Methods and Techniques (New Age International, New Delhi).
5. Krishnswamy, K.N., 'Shivkumar, Appa Iyer and Mathiranjan M. (2006) Management Research Methodology; Integration of Principles, Methods and Techniques.
6. Researching Information System and Computing by Briony J Oates.

Course Outcome: Course student will be able to:

- The basic concepts of research and its methodologies, Identify appropriate research topics, select and define appropriate research problem and parameters
- Prepare a project proposal (to undertake a project)
- Oorganize and conduct research in a more appropriate manner, writing research report and thesis.

Ph. D. Coursework I Semester

Course Code	Course Title	Credit	L	T	P	Sessional		ESE	Total
						ME	IA		
CSA-CC-142	Data Structure and Algorithms	4	4	-	-	20	20	60	100

Course Objective: Students will learn

1. To be able to analyze correctness and the running time of the algorithms in various domains and to be able to apply the algorithms and design techniques to advanced data structures.
2. To be able to analyze the running time complexity of different searching and sorting algorithms.
3. The student learns to implement basic data structures like stacks, queues, linked lists, trees, and graphs.

Unit	Topic	Proposed Lectures
I	**Complexity Analysis:** Time and Space complexity of algorithms, asymptotic analysis, average and worst case analysis, asymptotic notation, importance of efficient algorithms, program performance measurement, data structures and algorithms. **Data Struction**: Introduction andClassification of Data Structure, Abstract data types, Stack, Stack Operations, Applications of stack: Conversion of Infix to prefix and Postfix Expressions, Evaluation of postfix expression using stack.	12
II	Queues, Operations on Queue: Create, Add, Delete, Full and Empty, Circular queue, Deque and Priority Queue. Link List : Singly Linked Lists,Circular Linked Lists- Doubly Linked	12
III	Tree and Graph: Tree, Forest, Binary tree, types of Binary tree,Binary tree traversals,Binary Serach Tree (BST) and Its traversal. AVL tree, Graph: types of Graph, BFS, DFS, DAG, minimum spanning trees - Kruskal's and Prim's algorithms, Shortest Paths using Dijakstra Algorithm. Winograd's and Strassen's matrix multiplication algorithms.	12
IV	Searching , Sorting and Hashing: Linear and Binary Searching, Sorting methods: - Selection, Bubble, Insertion, Radix, Quick, Merge, Bucket and Count. Hashing: Different Hashing methods, Hash Function.	12
V	Different types of algorithms design with examples. Huffman coding, Knapsack Problem,Travel Salesman Problem. String searching and Pattern matching, Knuth-Morris-Pratt algorithm.	12

Suggested Reading:

1. T. H. Cormen, C.E. Leiserson and R.L.Rivest: Introduction to Algorithms, Prentice Hall of India, New Delhi.
2. E. Horowitz and S. Sahni: Fundamental of Computer Algorithms, Galgotia Pub./Pitman, New Delhi/London.
3. K. Mehlhorn: Data Structures and Algorithms, Vol. 1 and Vol. 2, Springer-Verlag, Berlin.
4. Gilles Dowek, Introduction to the theory of programming languges, Springer.
5. Bhubaneswar Mishra, Algorithmatic Algebra, Springer
6. Peter Brass, Advanced Dtas Structures (Cambridge University Press)
7. Jeff Edmonds, How to think about algorithms (Cambridge University Press)

Course Outcome: At the end of Course student will be able to:

- Explain the concept of data structure, abstract data types, algorithms and basic data organization schemes such as arrays and linked lists.
- Describe the applications of stacks and queues and implement various operations on them using arrays and linked lists.
- Study different types of asymptotic notations that are used to analyze the running time of different algorithms and solve recurrences.
- Solve a variety of problems using different algorithm design paradigms like Dynamic Programming, Greedy Method, construction of Minimum Spanning Tree, study of Shortest Path problem and Maximum Network Flow problem.

Ph. D. Coursework I Semester

Course Code	Course Title	Credit	L	T	P	Sessional		ESE	Total
						ME	IA		
CSA-CC-143	Review of Published Research Work	4	-	-	-	20	20	60	100

This paper will be covered literature survey on specific topic and candidate will write review report.

The Internet resources on a specific topic shall be used. Following are research oriented reading Material

Essential Material:

1. Roberto Cipolla, Computer Vision, springer
2. Ernesto Sanchez, Industrial Applications, of Evolutionary Algorithms, Springer.
3. Janos, J. Sarbo, Knowledge in formation : a Computational theory of Interperation, springer.
4. Liang Wang, Machine Learning for vision based motion analsysis, Springer.
5. Weisi Lin, Multimedia Analysis, processing and communicaitons, Springer.
6. Krishamurthy, Introductory theory of Computer Science(Affiliated East West).

Suggested Reading:

1. Jie Wu, Distributed System diesgn (CRC Press)
2. Radhakrishnan, Digital logic and computer organization.
3. Keyes, Securities Technology Handbook, CRC Press.
4. Gonzlez, Digital Image Processing 3E, Pearson Education.
5. Ananda S. Chowdhury, Computer Vision Guided Virtual Crraniofacial Surgery, Springer.
6. Nanda, Fuzzy Mathematical Concepts, Narosa.
7. Brain, R Hunt, A Guide to Matlab for begineers and experienced users (CUP)
8. Whitbeck, Ethics in Engineerng Practice and Research (Cambridge).

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Ph. D. Coursework I Semester

Course Code	Course Title	Credit	L	T	P	Sessional		ESE	Total
						ME	IA		
CSA-CC-144	Research and Publication & Ethics	2	2	-	-	20	20	60	100

Unit	Topic	Proposed Lectures
I	**Philosophy and Ethics:** Introduction to Philosophy: definition, nature, scope, concept, branches Ethics: definition, moral philosophy, nature of moral judgment and reactions	6
II	**Scientific Conduct:** Ethics with respect to science and research; Intellectual honesty and research integrity, copyright, Scientific misconduct: falsification, fabrication and Plagiarism (FFP); Redundant Publication: duplication and overlapping publication, salami slicing; Selective reporting and misrepresentation of data	6
III	**Publication Ethics:** definition, introduction and importance Best practice/standard setting initiative and guidelines: COPE, WAME, etc. Conflict and interest **Publication misconduct:** definition, concept, problems that leads to unethical behaviour and vice versa, type Violation of publication ethics, authorship and contributorship Identification of publication misconduct, complaint and appeals Predatory publisher and journals Avoiding Plagiarism. Preparing documents for MoUs, Confidentiality Agreements	6
IV	**Open access publishing:** Open access publication and initiatives SHERPA/RoMEO online resource to check publisher copyright and self-archiving policies Software tool to identify predatory publication developed by SPPU Journal finder/journal suggestion tools viz. JANE, Elsevier Journal finder, Springer, Journal Suggester, etc.	6
V	**Group Discussion:** Subject Specific Ethical Issues FFP, authorship Conflict interest, Complaints and appeals: examples and fraud from India and abroad. **Software tools:** Use of plagiarism software like turnitin, Urkund and other open source software tools. **Database:** Indexing database, Citation database: web of science, scopus, etc. **Research metrics:** Impact factor of Journal as per journal citation report, SNIP,SJR,IPP, Cite Score Metrics: h-index, g-index, i-10 index, altmetrics.	6

Suggested Material:

1. Nicholas H. Steneck. Introduction to the Responsible Conduct of Research. Office of Research Integrity. 2007. Available at: https://ori.hhs.gov/sites/default/files/rcrintro.pdf
2. The Student's Guide to Research Ethics By Paul Oliver Open University Press, 2003.
3. Responsible Conduct of Research By Adil E. Shamoo; David B. Resnik Oxford University Press, 2003
4. Ethics in Science Education, Research and Governance Edited by KambadurMuralidhar, Amit Ghosh Ashok Kumar Singhvi. Indian National Science Academy, 2019.
5. Anderson B.H., Dursaton, and Poole M.: Thesis and assignment writing, Wiley Eastern 1997.
6. BijornGustavii: How to write and illustrate scientific papers? Cambridge University Press.
7. Bordens K.S. and Abbott, B.b.: Research Design and Methods, Mc Graw Hill, 2008.
8. Graziano, A., M., and Raulin, M.,L.: Research Methods – A Process of Inquiry, Sixth Edition, Pearson, 2007.

Ph. D. Coursework I Semester

Course Code	Course Title	Credit	L	T	P	Sessional		ESE	Total
						ME	IA		
CSA-EC-141	Data Mining	4	4	-	-	20	20	60	100

Course Objective: Students will learn

1. To introduce students to the basic concepts and techniques of Data Mining.
2. To develop skills of using recent data mining software for solving practical problems.
3. To gain experience of doing independent study and research.

Unit	Topic	Proposed Lectures
I	**Introduction:** Data Mining, , Motivation, Application, Data Mining—On What Kind of Data?, Data Mining Functionalities, Data Mining Task Primitives, Major Issues in Data Mining. Data pre-processing: Descriptive Data Summarization, Data Cleaning, Data Integration and Transformation, Data Reduction, Data Discretization and Concept Hierarchy Generation.	12
II	Association Rule: Mining Frequent Patterns, Associations, and Correlations: Basic Concepts and a Road Map, Association Rules, the Apriori Algorithm	12
III	**Classification and Prediction:** Classification: Classification, Issues Regarding Classification, Classification by Decision Tree Induction, Bayesian Classification, Rule-Based Classification, Metrics for Evaluating Classifier Performance, Holdout Method and Random Sub sampling Prediction: Prediction, Issues Regarding Prediction, Accuracy and Error Measures, Evaluating the Accuracy of a Classifier or Predictor.	12
IV	Clustering: Cluster Analysis, Agglomerative versus Divisive Hierarchical Clustering, Distance Measures in Algorithmic, Evaluation of Clustering.	12
V	Selected topics from research papers.	12

Suggested Reading:

1. Jiawei Han, Micheline Kamber and Jian Pei (2011) Data Mining: Concepts and Techniques.
2. Matthew North (2012) Data Mining for the Masses.
3. Pang Ning Tan, M Steinbach, Vipin Kumar, Introduction to Data Mining, Addision Wesley.
4. Schalkoff, Pattern Recognition : Statisticsl Structural and Neural Approaches, Wiley India.
5. Berson, Data Warehousing, Data Mining, and Olap, TMH.
6. Toll, M. Mitchell, Machine Learning, (India Higher Education)
7. Witten, Data Mining : Practical Machine Learning Tools and Techniques.
8. Elbe Frank, Data Mining : Practical Machine Learning tools and technqiues (Elsevier India).

Course Outcome: At the end of Course student will be able to:

- Apply data mining techniques in real life.
- Implement various data mining techniques.

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Ph. D. Coursework I Semester

Course Code	Course Title	Credit	L	T	P	Sessional		ESE	Total
						ME	IA		
CSA-EC-142	Parallel Computing	4	4	-	-	20	20	60	100

Course Objective: Students will learn

1. To introduce concepts related to parallel computing systems.
2. To focus on performance and flexibility issues related to systems design decisions

Unit	Topic	Proposed Lectures
I	**Parallel Computer:** Concept, need and requirement, various concepts in pipelining, issues involved in complex pipelining, configuring a parallel computer, Parallel Architecture: Vector processor, message passing and shared memory multiprocessors, Permutation.	12
II	**Programming:** Using sequential computing elements, data flow approach. Elementary Algorithms: Matrix manipulation, Graph connectivity and traversal, Tree traversal, Sorting and searching on PRAM.	12
III	**Complexity of Parallel algorithms:** Various processor interconnection schemes: mesh, hypercube, perfect shuffle etc., High Performance Computing approach for complex problems: problems in Computational Geometry.	12
IV	Permutations and Combinations, Fourier transforms, traversing combinational spaces, Decision and Optimization.	12
V	**Task Scheduling:** DAG, Priority of task, Homogenous and heterogeneous scheduling, different scheduling algorithms.	12

Suggested Reading:

1. Ratan Ghosh, Rajat Moona, Phalguni Gupta, "Foundation of Parallel Processing" NAROSA.
2. V. Rajaraman "Elements of Parallel Computing" PHI.
3. Selim Akl, "The Design and Analysis of Parallel Algorithms", PHI

Course Outcome: At the end of Course student will be able to:

- Study software components of parallel computing systems.
- Know about the communication and interconnection architecture of multiple computer systems.
- understand basic problems in paralle computing, especially in relation to concurrency, parallelism, synchronization, deadlocks, safety and liveness properties.

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Ph. D. Coursework I Semester

Course Code	Course Title	Credit	L	T	P	Sessional		ESE	Total
						ME	IA		
CSA-EC-143	Machine Learning	4	4	-	-	20	20	60	100

Course Objective: Students will learn

1. To understand the basic building blocks and general principles that allow one to design machine learning algorithms
2. To become familiar with specific, widely used machine learning algorithms
3. To learn methodology and tools to apply machine learning algorithms to real data and evaluate their performance.

Unit	Topic	Proposed Lectures
I	**Introduction:** Defining learning systems, Goals and applications of machine learning. Aspects of developing a learning system: training data, concept representation, function approximation, supervised learning, unsupervised learning, Reinforcement learning, learning algorithms.	12
II	**Decision Tree Learning:** Representing concepts as decision trees. Recursive induction of decision trees. Picking the best splitting attribute: entropy and information gain. Searching for simple trees and computational complexity, Overfitting, noisy data, and pruning.	12
III	**Ensemble Learning:** Bagging, boosting, and Ada-Boost. Experimental Evaluation of Learning Algorithms, Measuring the accuracy of learned hypotheses. Comparing learning algorithms: cross-validation, learning curves, and statistical hypothesis testing.	12
IV	**Rule Learning:** Translating decision trees into rules. Artificial Neural Networks: Neurons and biological motivation. Linear threshold units. Perceptrons: representational limitation and gradient descent training. Multilayer networks and back propagation. Hidden layers and constructing intermediate, distributed representations. Overfitting, learning network structure, recurrent networks.	12
V	**Support Vector Machines:** Maximum margin linear separators. Kernels for learning non-linear functions. Bayesian Learning: theory and Bayes rule. Naive Bayes learning algorithm. Parameter smoothing. Generative vs. discriminative training. Logisitic regression. Bayes nets and Markov nets for representing dependencies. Instance-Based Learning: Constructing explicit generalizations versus comparing to past specific examples. k-Nearest-neighbor algorithm, Case-based learning	12

Suggested Reading:

1. "The Elements of Statistical Learning" by T. Hastie, R. Tibshirani, J. Friedman..
2. "Pattern Recognition and Machine Learning" by Christopher Bishop
3. "Introduction to Machine Learning" by Ethem Alpaydin.
4. "Machine Learning: An Algorithmic Perspective" by Stephen Marsland,.

Course Outcome: At the end of Course student will be able to:

- Develop an appreciation for what is involved in learning from data.
- How to apply a variety of learning algorithms to data.
- How to perform evaluation of learning algorithms and model selection.

Ph. D. Coursework I Semester

Course Code	Course Title	Credit	L	T	P	Sessional		ESE	Total
						ME	IA		
CSA-EC-144	Cloud Computing	4	4	-	-	20	20	60	100

Course Objective: Students will learn

1. To understand the fundamental ideas behind Cloud Computing, the evolution of the paradigm, its applicability, benefits, as well as current and future challenges.
2. To learn cloud enabling technologies and get exposure to advanced clouds.
3. To explore cloud SOA technologies, relevant Workflow framework, and Virtualization technology.
4. To understand the cloud security threats and protective mechanism for cloud computing and existing Cloud computing platforms and Technologies

Unit	Topic	Proposed Lectures
I	**Introduction of Cloud Computing:** Introduction, Information Structure of Cloud Computing , Scalable Computing over the Internet, Technologies for Network based systems, Parallel, Grid Distributed and Cloud Computing, Fog Computing, Challenges of Cloud Computing, Benefits of Cloud Computing, Cloud Computing Research Areas. Major Security Issues	12
II	**Virtual Machines and Virtualization of Clusters and Data Centers:** Implementation Levels of Virtualization, Virtualization Structures/ Tools and mechanisms, Virtualization of CPU, Memory and I/O Devices, Virtual Clusters and Resource Management, Virtualization for Data Centre Automation, Introduction of CloudSim.	12
III	**Cloud Platform Architecture:** Cloud Computing and service Models, Architectural Design of Compute and Storage Clouds, Public Cloud Platforms, Inter Cloud Resource Management, Cloud Security and Trust Management. Service Oriented Architecture, Message Oriented Middleware.	12
IV	**Workflow Graph in Cloud:** Introduction of Graph, Directed Acyclic Graph(DAG), Precedence Constraint, Communication Time, Computation Time, Attributes such as b-level, critical path, t-level, ALAP, dynamic level, static level. Uses of Gantt. Chart, System Resource Graph, Some Real Workflow Graphs.	12
V	**Resource Management and Scheduling in Cloud:** Basic terminology of scheduling: Estimation Computation Time (ECT), Average ECT, Earliest Start Time(EST), Earliest Finish Time (EFT), Minimum Execution Time(MET), Performance Metrics: Scheduling Length, Cost, Speedup, Efficiency, Load Balancing, Resource Utilization, Scheduling Length Ratio(SLR), Objective Function, Some Heuristics Algorithms: HEFT, ALAP, CPOP, PETS etc. Introduction of Load Balancing and Energy Efficiency.	12

Suggested Reading:

1. "Distributed and Cloud Computing" by Kai Hwang, Geoffry C. Fox, Jack J. Dongarra, M K Elsevier.
2. "Cloud Computing, Theory and Practice" by Dan C Marinescu, M K Elsevier.
3. "Cloud Computing, A Hands on approach" by Arshadeep Bahga, Vijay Madisetti, University Press
4. "Cloud Computing: A Practical Approach" by Anthony T.Velte. Toby J. VeFte, Robert Elsenpeter, Tata McGraw Hill.

Approved by BoS on dated 08/02/2022

5. "Enterprise Cloud Computing" by Gautam Shroif, Cambridge University.
6. "Cloud Computing: Implementation, Management and Security" by, John W. Rittinouse, James F Ransome, CRC Press.
7. "Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance" by Tim Mather, Subra Ktriaraswamy, Shahed Latif.

Course Outcome: At the end of Course student will be able to:

- Compare the strengths and limitations of cloud computing.
- Examine the economics, financial, and technological implications for selecting cloud computing for own organization

Ph. D. Coursework I Semester

Course Code	Course Title	Credit	L	T	P	Sessional		ESE	Total
						ME	IA		
CSA-EC-145	Image Processing and Computer Vision	4	4	-	-	20	20	60	100

Course Objective: Students will learn

1. analytical tools and methods which are currently used in digital image processing and computer vision as applied to image information for human viewing.
2. To apply these tools in the laboratory in image restoration, enhancement, segmentation, feature extraction, pattern recognition, compression and other computer vision related tasks.

Unit	Topic	Proposed Lectures
I	**Introduction**: Image acquisition process, Sampling & quantization, Pixel neighbourhood properties (connectivity, path), Concept of matrices (Eigen values, diagonalization etc.), Image transforms (Unitary Transform and properties, 2D Fourier Transform, 2D FFT, Discrete Fourier Transform (DFT), Properties of DFT, 2D DCT and properties, Walsh-Hadamard Transform, K-L Transform, Principal Component Analysis (PCA), Wavelet transform (Definition, Properties, Mathematical function, Mother wavelets) Selected topics from recent research papers.	12
II	**Image enhancement and restoration Image Enhancements:** Point processing functions, Piece-wise linear functions, Histogram base methods (histogram equalization, specification and modification), Bit extraction, and other topics. Restoration (in spatial domain): Image restoration and degradation model, Noise types (Gaussian, Rayleigh, Poisson, other) and their pdfs (Probability Distribution Functions), Averaging Filter (Mean Filters (Arithmetic, Geometric & Harmonic), Inverse filtering, Weiner Filter, Tikhonov Regularization, LMMSE filters, constrained least squares filters, Other related optimization problems.	12
III	**Edge Detection:** Mathematical concepts, Operators based on first order derivative (Roberts, Prewitt and Sobel), Laplacian (Second order derivative based edge detection), LOG **Image Segmentation:** Thresholding based (Local, Global, Adaptive), Region based (Region split & merge, Region growing), Cluster based (K-means, Fuzz c-means), Contour based (Snakes' method), Graph based (book/literature)	12
IV	**Feature extraction:** Spatial Features, Amplitude, Transform based features, Fourier Descriptors (FDs), Histogram based statistical features, Based on statistical moments (e.g., mean, variance, kurtosis, etc), Shape/geometry based features & moment based features(Radii, perimeter, area, compactness, max boundary rectangle, orientation etc.), Texture features (GLCM'and texture features, Gabor features), Color features **Object representation and description**: Boundary representation: Chain codes, Polygon approximations, Signatures, Boundary segments, Skeletons Boundary description: Shape numbers, FDs, Statistical moments Region representation: Data structures used for representing region (quad tree, RLE, projection) Region description: Topological description, Texture, Moments, Principal components	12
V	**Object recognition**: a. Patterns & pattern classification b. Recognition based on decision theoretic methods	12

	c. Structural methods Framework of a computer vision Selected topics from recent research papers	

Suggested Reading:

1. Fundamental of image processing by R.C. Gonzalez
2. Digital image processing by A.K. Jain
3. Image Processing and Analysis by Milan Sonka
4. Selected Research papers from international journal

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Ph. D. Coursework I Semester

Course Code	Course Title	Credit	L	T	P	Sessional		ESE	Total
						ME	IA		
CSA-EC-146	Advanced Pattern Recognition	4	4	-	-	20	20	60	100

Course Objective: This course deals with pattern recognition which has several important applications. Forexample, multimedia document recognition (MDR) and automatic medical diagnosis are two such.

Unit	Topic	Proposed Lectures
I	Pattern & Pattern classes, Pattern recognition Design Cycle, Feature Extraction: Feature processing & normalization, Learning (Supervised, Unsupervised, Reinforced). Preliminary concepts and pre-processing phases, coding, normalization, filtering, linear prediction, Feature extraction and representation thresholding, contours, regions, textures, template matching, Hidden Markov Models, Taxonomy of pattern classifiers Performance measurement metrics: Confusion matrix, Accuracy, Precision, Recall, ROC curve, Area Under Curve (AUC), Confidence intervals. Data partitioning (K-fold cross validation, Leave one out , Leave m-out)	12
II	Data structure for pattern recognition, statistical pattern recognition, clustering Technique and application. Study of pattern classifiers: Supervised and unsupervised.	12
III	Pattern Classifiers: Statistical: Bayesian theorem, Bayesian classifier: Minimum distance, Maximum likelihood), Naïve Bayes, Linear Discriminant Analysis, k- nearest neighbour (KNN), Artificial Neural Network etc. and Case studies.	12
IV	Clustering techniques and algorithms Deep learning Selected topics from research papers	12
V	Selected topics from research papers and reference books	12

Suggested Reading:

1. R.O.Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley, 2001.
2. K. Fukunaga, Statistical pattern Recognition; Academic Press, 2000.
3. Devi V.S.; Murty, M.N., Pattern Recognition: An Introduction, Universities Press,
4. S.Theodoridis and K.Koutroumbas, Pattern Recognition, 4th Ed., Academic Press,

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Ph. D. Coursework I Semester

Course Code	Course Title	Credit	L	T	P	Sessional		ESE	Total
						ME	IA		
CSA-EC-147	Simulation & Modeling	4	4	-	-	20	20	60	100

Course Objective To learn the methodologies and tools for simulation and modeling of a real time problem/ mathematical model. In this course, modeling and simulation (M&S) methodologies considering both practical and theoretical aspects – Primarily in the context of defense industry and game programming will be studied in details..

Unit	Topic	Proposed Lectures
I	Introduction To Modeling & Simulation – What is Modeling and Simulation? – Complexity Types – Model Types – Simulation Types – M&S Terms and Definitions Input Data Analysis – Simulation Input Modeling – Input Data Collection, Data Collection Problems, Practical Suggestions, Effect of Period of Time – Input Modeling Strategy, Histograms, Probability Distributions, Selecting a Probability Distribution, Evaluating Goodness of Fit	12
II	Random Variate Generation – Random Numbers – Random Number Generators – Random Variate Generation, Factors to be considered, General principles –Inverse Transform Method –AcceptanceRejection Method – Composition Method –Relocate and Rescale Method, Specific distributions Output Data Analysis – Introduction, Types of Simulation With Respect to Output Analysis, Stochastic Process and Sample Path, Sampling and Systematic Errors, Mean, Standard Deviation and Confidence Interval – Analysis of Finite-Horizon Simulations, Single Run, Independent Replications, Sequential Estimation – Analysis of Steady-State Simulations, Removal of Initialization Bias (Warm-up Interval), Replication-Deletion Approach, Batch-Means Method	12
III	Comparing Systems via Simulation – Introduction – Comparison Problems, Comparing Two Systems, Screening Problems, Selecting the Bes, Comparison with a Standard, Comparison with a Fixed Performance Discrete Event Simulations – Introduction, Next-Event Time Advance, Arithmetic and Logical Relationships, Discrete-Event Modeling Approaches – Event-Scheduling Approach – Process Interaction Approach	12
IV	Entity Modeling – Entity Body Modeling – Entity Body Visualization – Entity Body Animation – Entity Interaction Modeling – Building Modeling Distributed Simulation – High Level Architecture (HLA) – Federation Development and Execution Process (FEDEP) – SISO RPR FOM Behavior Modeling – General AI Algorithms • Decision Trees • Neural Networks, Finite State Machines, Logic Programming, Production Systems – Path Planning, Off-Line Path Planning, Incremental Path Planning, Real-Time Path Planning – Script Programming, Script Parsing, Script Execution	12
V	Optimization Algorithms – Genetic Algorithms – Simulated Annealing Examples: Sensor Systems Modeling – Human Eye Modeling – Optical Sensor Modeling – Radar Modeling.	12

Suggested Reading:

1. Jerry Banks, "Handbook of Simulation: Principles, Methodology, Advances, Applications, and Practice", John Wiley & Sons, Inc., 1998.
2. George S. Fishman, "Discrete-Event Simulation: Modeling, Programming and Analysis", Springer-Verlag .
3. Andrew F. Seila, Vlatko Ceric, Pandu Tadikamalla, "Applied Simulation Modeling", Thomson Learning Inc., 2003.

Approved by BoS on dated 08/02/2022

Ph. D. Coursework I Semester

Course Code	Course Title	Credit	L	T	P	Sessional		ESE	Total
						ME	IA		
CSA-EC-148	Applied Cryptography	4	4	-	-	20	20	60	100

Course Objective: Students will learn

1. To understand how cryptographic algorithms keys and protocols, and an appropriate hardware (software) environment can solve security problem (confidentiality, integrity, authenticity).
2. To Show how security is achieved in real life systems in areas of telecom, government/identity, buildings/transportation, payment.
3. To know real-life applications of encryption, Message Authentication Codes (MAC) and Digital Signatures in smart cards and terminals, personal identity and crypto currency systems.

Unit	Topic	Proposed Lectures
I	Basic Encryption and Decryption: introduction to Ciphers, Monoalphabetic Substitutions such as the Caesar Cipher, Cryptanalysis of Monoalphabetic Ciphers, Polyalphabetic Ciphers such as Vigenere Tableaux, Cryptanalysis of Polyalphabetic Ciphers, Perfect Substitution Cipher such as the Vernam Cipher, Stream and Block Ciphers.	12
II	Encryption; authentication; symmetric cryptography, asymmetric cryptography: public-key cryptosystems; digital signatures, message authentication codes. Steganography, One-way functions; pseudo-randomness and random number generators.	12
III	Remote user authentication, notions of security; zero knowledge/ interactive proofs, multiparty cryptographic protocols, key exchange and applications.	12
IV	Cryptanalysis of cryptographic primitives and protocols, such as by side-channel attacks, differential cryptanalysis, or replay attacks; and cryptanalytic techniques on deployed systems.	12
V	Advanced Topics - ECC, DNA cryptography, quantum cryptography, Digital Watermarking. Digital signatures: Definitions and applications, Lamport and Merkle schemes. overview of signatures based on discrete-log. certificates and trust management. , SSL/TLS and IPsec, Privacy mechanisms.	12

Suggested Reading:

1. Handbook of Applied Cryptography by A. Menezes, P. Van Oorschot, S. Vanstone.
2. Cryptography by Behrouz A. Forouzan,TMH
3. Cryptography and Network Security by Stalling, PHI
4. Cryptography & security services , Mechanism & application By Mogollon , Manuel , Cyber tech. Pub.

Course Outcome: At the end of Course student will be able to:

- Learning how security problems are solved in the industry, and understanding why specific choices are made.
- Understanding security (attacks and defenses) in complex real life systems and the role of keys, cryptographic algorithms and protocols, tamper resistant hardware and other types of countermeasures.
- Study of entity authentication and data authentication, challenge-response. Detailed Contents: