VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination – 2018-19 M.Tech in Artificial Intelligence and Machine Learning (SAM) Choice Based Credit System (CBCS)

I SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/Fieldwork/Assignment	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	18SAM11	Mathematical Foundation of Computer Science	04	--	03	40	60	100	4
2	PCC	18SAM12	Artificial Intelligence	04	--	03	40	60	100	4
3	PCC	18SAM13	Computational Intelligence	04	--	03	40	60	100	4
4	PCC	18SAM14	Data Mining & Analytics	04	--	03	40	60	100	4
5	PCC	18SAM15	Cognitive Science	04	--	03	40	60	100	4
6	PCC	18SAML16	Data Mining &Analytics Lab	-	04	03	40	60	100	2
7	PCC	18RMI17	Research Methodology and IPR	02	--	03	40	60	100	2
			TOTAL	**22**	**04**	**21**	**280**	**420**	**700**	**24**

Note: PCC: Professional core

Internship: All the students have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed credit shall be counted forthe same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as failed and have to complete during the subsequent University examination after satisfying the internship requirements.

MATHEMATICAL FOUNDATION OF COMPUTER SCIENCE
[As per Choice Based Credit System (CBCS) scheme]
(Effective from the academic year 2018 -2019)
SEMESTER – I

Course Code	18SFC11 / 18LNI11 / 18SCE11 / 18SCS11 / 18SCN11 / 18SSE11 / 18SIT11/**18SAM11**	CIE Marks	40
Number of Contact Hours/Week	04	SEE Marks	60
Total Number of Contact Hours	50	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

- To acquaint the students with mathematical/logical fundamentals including numerical techniques,
- To understand probability, sampling and graph theory that serve as an essential tool for applications of computer and information sciences.

Module 1	**Contact Hours**
Numerical Methods: Significant figures, Error definitions, Approximations and round off errors, accuracy and precision. Roots of Equations: Bairstow-Lin's Method, Graeffe's Root Squaring Method. Computation of eigen values of real symmetric matrices: Jacobi and Givens method. **RBT: L1, L2, L3**	**10 Hours**
Module 2	
Statistical Inference: Introduction to multivariate statistical models: Correlation and Regression analysis, Curve fitting (Linear and Non linear) **RBT: L1, L2, L3**	**10 Hours**
Module 3	
Probability Theory: Probability mass function (p.m.f), density function (p.d.f), Random variable: discrete and continuous, Mathematical expectation, Sampling theory: testing of hypothesis by t-test and chi - square distribution. **RBT: L1, L2, L3**	**10 Hours**
Module 4	
Graph Theory: Isomorphism, Planar graphs, graph coloring, Hamilton circuits and Euler cycle. Specialized techniques to solve combinatorial enumeration problems. **RBT: L1, L2, L3**	**10 Hours**
Module 5	
Vector Spaces: Vector spaces; subspaces; Linearly independent and dependent vectors ; Bases and dimension; coordinate vectors-Illustrative examples. Linear transformations; Representation of transformations by matrices; linear functional; Non singular Linear transformations; inverse of a linear transformation- Problems. **RBT: L1, L2, L3**	**10 Hours**

Course Outcomes

- Understand the numerical methods to solve and find the roots of the equations.
- Utilize the statistical tools in multi variable distributions.
- Use probability formulations for new predictions with discrete and continuous RV's.
- To understand various graphs in different geometries related to edges.
- Understand vector spaces and related topics arising in magnification and rotation of images.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full

questions, each of 20 marks.

- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

1. Steven C. Chapra and Raymond P Canale: " Numerical Methods for Engineers, 7th Edition, McGraw-Hill Publishers, 2015.
2. T.Veerarajan: "Probability, Statistics and Random Process",3 rdEdition,TataMc-Graw Hill Co.,2016.
3. David C.Lay, Steven R.Lay and J.J.McDonald: Linear Algebra and its Applications, 5th Edition, Pearson Education Ltd., 2015.

Reference Books:

1. **B.S. Grewal**: Higher Engineering Mathematics, Khanna Publishers, 44th Ed., 2017.
2. **John Vince :** "Foundation Mathematics for Computer Science", Spr inger International Publishing, Switzerland, 2015
3. **M.K.Jain, S.R.K.Iyengar and R.K.Jain:** Numerical Methods for Scientific and Engineering Computation. 6thEd.,New Age Int.Publishers.2012.
4. **Norman L.Biggs**: Discrete Mathematics, 2nd Ed., Oxford University Press, 2017.

Web links and Video Contacts:

1. *http://nptel.ac.in/courses.php?disciplineId=111*
2. *http://www.class-central.com/subject/math(MOOCs)*
3. *http://ocw.mit.edu/courses/mathematics/*

ARTIFICIAL INTELLIGENCE

[AsperChoiceBasedCreditSystem(CBCS)scheme]

(Effectivefromtheacademicyear2018-2019)

SEMESTER-I

Course Code	**18SAM12**	CIE Marks	40
NumberofContactHours/Week	**04**	SEE Marks	60
TotalNumberofContactHours	**50**	ExamHours	03

CREDITS– 04

Courseobjectives:This course will enable students to

ApplyAI techniquesto solve the given problems.

Implement trivialAItechniqueson relativelylarge system

Explain uncertaintyand Problemsolvingtechniques.

Comparevariouslearningtechniques.

Module-1 Introduction	**Contact Hours**
What Is AI? Thinking humanly: The cognitive modeling approach. Thinking rationally: The ``laws of thought'' approach. Acting rationally: The rational agent approach. The Foundations of Artificial Intelligence, Mathematics, Economics, Neuroscience, Computer engineering, The History of Artificial Intelligence. AI becomes an industry (1980--present). Agents and Environments. Good Behavior: The Concept of Rationality. The Nature of Environments. The Structure of Agents. **RBT: L1, L2**	**10Hours**
Module-2Search Techniques	
Problem-Solving Agents, Well-defined problems and solutions, Formulating problems, Real-world problems. Uninformed Search Strategies, Breadth-first search, Uniform-cost search, Depth-first search, Depth-limited search, Iterative deepening depth-first search, Bidirectional search, Informed (Heuristic) Search Strategies, Greedy best-first search, A* search: Minimizing the total estimated solution cost, Heuristic Functions. The effect of heuristic accuracy on performance. Beyond Classical Search, Local Search Algorithms and Optimization Problems, Local Search in Continuous Spaces. **RBT: L1, L2, L3**	**10Hours**
Module-3 Game Playing	
Games, Optimal Decisions in Games,The minimax algorithm,Optimal decisions in multiplayer games, Alpha Beta Pruning, Move ordering, Imperfect Real-Time Decisions,Cutting off search, Forward pruning.Stochastic Games,Evaluation functions for games of chance, Partially Observable Games, Krieg spiel: Partially observable chess,Card games, State-of-the-Art Game Programs, Alternative Approaches **RBT: L1, L2, L3**	**10Hours**
Module-4Logic and inference	

Defining Constraint Satisfaction Problems, Constraint Propagation: Inference in CSPs, Backtracking Search for CSPs, Local Search for CSPs, The Structure of Problems,Knowledge-Based Agents, The WumpusWorld,Logic , Propositional Logic: A Very Simple Logic, Propositional Theorem Proving,Effective Propositional Model Checking, Agents Based on Propositional Logic. Forward Chaining.Backward Chaining. Definition of Classical Planning. Algorithms for Planning as State-Space Search. Planning Graphs. **RBT: L1, L2, L3**	**10Hours**
Module-5Learning	
Forms of Learning, Supervised Learning, Learning Decision Trees, Evaluating and Choosing the Best Hypothesis, Model selection: Complexity versus goodness of fit, From error rates to loss, Regularization, The Theory of Learning, Regression and Classification with Linear Models, Artificial Neural Networks, Nonparametric Models, Ensemble Learning, Online Learning, Practical Machine Learning, A Logical Formulation of Learning. Knowledge in Learning. Explanation-Based Learning. Learning Using Relevance Information. Inductive Logic Programming. Statistical Learning. Learning with Complete Data.Learning with Hidden Variables: The EM Algorithm. **RBT: L1, L2, L3**	**10Hours**

Courseoutcomes:This course will enable students to

· Identify the AI based problems

· Apply techniques to solve the AI problems

· Define learning and explain various logic inference.

· Discuss different learning techniques.

Questionpaperpattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

1. Stuart Russell and Peter Norvig. Artificial Intelligence: A Modern Approach.III Edition

ReferenceBooks:

1. E. Rich , K. Knight & S. B. Nair - Artificial Intelligence, 3/e, McGraw Hill.
2. Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, Prentice Hal of India.
3. G. Luger, “Artificial Intelligence: Structures and Strategies for complex problemSolving”, Fourth Edition, Pearson Education, 2002.
4. N.P. Padhy “Artificial Intelligence and Intelligent Systems” , Oxford UniversityPress-2015

COMPUTATIONAL INTELLIGENCE
[As per Choice Based Credit System (CBCS) scheme]
(Effective from the academic year 2018 -2019)
SEMESTER – I

Course Code	18SAM13	CIE Marks	40
Number of Contact Hours/Week	04	SEE Marks	60
Total Number of Contact Hours	50	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

1. To understand the fundamental theory and concepts of neural networks, neuro-modeling, several neural network paradigms and its applications.
2. To comprehend the concepts of fuzzy sets, knowledge representation using fuzzy rules, approximate reasoning, fuzzy inference systems, and fuzzy logic control and other machine intelligence applications of fuzzy logic.
3. To interpret the basics of an evolutionary computing paradigm known as genetic algorithms and its application to engineering optimization problems.

Module 1	Contact Hours
Computational Intelligence and Knowledge : What Is Computational Intelligence? , Agents in the World , Representation and Reasoning Applications, Overview , A Representation and Reasoning System :Introduction , Representation and Reasoning Systems ,Simplifying Assumptions of the Initial RRS , Data log, Semantics , Questions and Answers , Proofs , Extending the Language with Function Symbols **RBT: L1, L2, L3**	10 Hours
Module 2	
Using Definite Knowledge :Introduction, Case Study: House Wiring , Databases and Recursion, Verification and Limitations, Case Study: Representing Abstract Concepts, Case Study: Representing Regulatory Knowledge, Applications in Natural Language Processing ; Representing Knowledge : Introduction, Defining a Solution, Choosing a Representation Language, Mapping from Problem to Representation, Choosing an Inference Procedure **RBT: L1, L2, L3**	10 Hours
Module 3	
Knowledge Engineering , Introduction, Knowledge-Based System Architecture, Meta-Interpreters, Querying the User, Explanation, Debugging Knowledge Bases, A Meta-Interpreter with Search, Unification, Beyond Definite Knowledge :Introduction, Equality ,Integrity Constraints ,Complete Knowledge Assumption , Disjunctive Knowledge, Explicit Quantification , First-Order Predicate Calculus, Modal Logic,**RBT: L1, L2, L3**	12 Hours
Module 4	
Using Uncertain Knowledge Introduction , Probability , Independence Assumptions , Making Decisions Under Uncertainty **RBT: L1, L2, L3**	10 Hours
Module 5	
Learning Introduction , Learning as Choosing the Best Representation , Case-Based Reasoning , Learning as Refining the Hypothesis Space , Learning Under Uncertainty , Explanation-Based Learning **RBT: L1, L2, L3**	08 Hours

Course Outcomes

CO-1: Identify different types of AI agents
CO-2: Apply various AI search algorithms (uninformed, informed, heuristic, constraint satisfaction, genetic algorithms)
CO-3: Exhibit the fundamental usage of knowledge representation (logic-based, frame-based, semantic nets), inference and theorem proving
CO-4: Build simple knowledge-based systems

CO-5: Express working knowledge of reasoning in the presence of incomplete and/or uncertain information
CO-6: Apply knowledge representation, reasoning, and machine learning techniques to real-world problems

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

1. David Poole, Alan MAckworth, Randy Goebel: Computational Intelligence – a logical approach, Oxford University Press,

Reference Books:

1. Fundamentals of Computational Intelligence: Neural Networks, Fuzzy Systems, and Evolutionary Computation,by James M. Keller, Derong Liu, David B. Fogel ISBN: 978-1-119-21434-2

DATA MINING & ANALYTICS [As per Choice Based Credit System (CBCS) scheme] (Effective from the academic year 2018 -2019) SEMESTER – I

Course Code	18SAM14	CIE Marks	40
Number of Lecture Hours/Week	4	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	3

Credit – 04

Course objectives: This course will enable students to

- Explain data mining and data analytics principles and techniques
- Deduce association rule mining for handling large data
- Apply classification for the retrieval purposes
- Explain clustering techniques in details for better organization and retrieval of data

Module-1	**Teaching Hours**
Introduction and Data Pre-processing :wholeness of Data Analytics,Buisness Intelligence,pattern recognition,types of pattern,finding pattern,uses of pattern, data processing chain,data,database,data warehouse,data mining,data visualization.**RBT:L1,L2**	**10Hours**
Module-2	
Mining Frequent Patterns, Associations and correlations : Basic concepts and a Road Map, Efficient and scalable Frequent item set Mining methods, Mining various kinds of association Rules, From association mining to cluster analysis, constraint based association mining.**RBT:L1,L2,L3**	**10 Hours**
Module-3	
Classification and Prediction: Basic Concepts, Decision tree induction, Bayesian Classification, Rule-Based classification, Classification by Back propagation, Support Vector machines, Associative classification: classification by association rule analysis, Lazy learners, other classification methods. Prediction, accuracy and error measures, evaluating the accuracy of classifier or predictor.**RBT:L1,L2,L3**	**10Hours**
Module-4	
Cluster Analysis: Basic concepts and methods, Partitioning methods, Hierarchical Methods, Density-based methods, Grid-Based Methods, Evaluation of clustering. **RBT:L1,L2,L3**	**10Hours**
Module -5	
Data mining trends and research frontiers: Mining complex data types, other methodologies of data mining, Data mining applications, Data Mining and society. **RBT:L1,L2,L3**	**10Hours**

Course outcomes:

At the end of this course the students will be able to:

1. Compare the different concepts of Data Mining
2. Design and deploy appropriate classification techniques
3. Cluster the high dimensional data for better organization of the data
4. Evaluate mathematical methods underlying the effective application of data mining.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

1. Jiawei Han, MichelineKamber, Jian Pei: Data Mining Concepts and Techniques,ELSEVIER(MK) 3rd

edition 2012.

2. Dr. Anil Maheshwari, Data Analytics Made Accessible,2018 Edition.

Reference Books:

1. Alex Berson and Stephen J. Smith “Data Warehousi ng, Data Mining & OLAP”, Tata McGraw – Hill Edition, Tenth Reprint 2007.
2. K.P. Soman, ShyamDiwakar and V. Ajay “Insight in to Data mining Theory and Practice”, Easter Economy Edition, Prentice Hall of India, 2006.
3. G. K. Gupta “Introduction to Data Mining with Ca se Studies”, Easter Economy Edition, Prentice Hall of India, 2006.
4. Pang-Ning Tan, Michael Steinbach and Vipin Kumar “Introduction to Data Mining”, Pearson Education, 2007.

COGNITIVE SCIENCE
[As per Choice Based Credit System (CBCS) scheme]
(Effective from the academic year 2018 -2019)
SEMESTER – I

Course Code	18SAM15	CIE Marks	40
Number of Contact Hours/Week	04	SEE Marks	60
Total Number of Contact Hours	50	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

- Demonstrate knowledge and understanding of well established theories in cognitive psychology, as well as an appreciation for the complexity of cognitive processes.
- Appreciate research and theories of cognition from diverse fields of study, including neuroscience, neuropsychology, evolutionary psychology, and behavioral economics.
- Acquire an understanding of research methods in cognitive psychology and the ability to critically evaluate research in this area.

Module 1	**Contact Hours**
The prehistory of cognitive science, The reaction against behaviorism in psychology, The theory of computation and the idea of an algorithm, Linguistics and the formal analysis of language, Information-processing models in psychology, The discipline matures: Three milestones: Language and micro-worlds, How do mental images represent?, An interdisciplinary model of vision**RBT: L1, L2**	**10 Hours**
Module 2	
The turn to the brain : Cognitive systems as functional systems , The anatomy of the brain and the primary visual pathway , Extending computational modeling to the brain , Mapping the stages of lexical processing ,; THE INTEGRATION CHALLENGE, Cognitive science and the integration challenge; Cognitive science: An interdisciplinary endeavor, Levels of explanation: The contrast between psychology and neuroscience, The integration challenge, Local integration I: Evolutionary psychology and the psychology of reasoning, Local integration II: Neural activity and the BOLD signal **RBT: L1, L2, L3**	**10 Hours**
Module 3	
I N FO R MA TIO N - P RO C ES SI N G MODE LS OFTHEMIND **,** Physicalsymbolsystemsandthelanguageofthought **;** Thephysicalsymbolsystemhypothesis **,** Fromphysicalsymbolsystemstothelanguageofthought **,**The Chinese room argument **,** Applying thesymbolicparadigm **;** Expertsystems,machinelearning,andtheheuristicsearchhypothesis **,** ID3: An algorithm formachinelearning **,** WHISPER:Predictingstabilityinablockworld **,** **RBT: L1, L2, L3**	**10 Hours**
Module 4	
Neuralnetworksanddistributedinformationprocessing **;** Neurally inspired models of information processing , Single-layernetworksandBooleanfunctions **,** Multilayer networks, Informationprocessinginneuralnetworks:Keyfeatures, Neuralnetworkmodelsofcognitiveprocesses; Languageandrules:Thechallengeforinformation-processingmodels, Language learning inneuralnetworks, Objectpermanenceandphysicalreasoningininfancy, Neuralnetworkmodelsofchildren'sphysicalreasoning **RBT: L1, L2, L3**	**10 Hours**
Module 5	

THE O RGAN I ZA TI O NOF THEMIND , Howarecognitivesystemsorganized?; Architectures forintelligentagents , Fodoronthemodularityofmind , Themassivemodularityhypothesis , Strategies forbrainmapping ; Structure and function inthebrain , , Studying cognitive functioning: Techniques from neuroscience , Combining resources I: The locus of selection problem , Combining resources II: Networks for attention , Fromdatatomaps:Problemsandpitfalls**RBT: L1, L2, L3**	**10 Hours**

Course Outcomes

1. Synthesize and analyze information from a variety of sources concerning foundational concepts and arguments in cognitive science and philosophy.
2. Engage in philosophical discussion and debate on the various philosophical issues relating to cognitive science.
3. Critically assess arguments about the nature of cognition, the methodology of cognitive science and the role of cognitive sciences in society.
4. Clearly articulate their own position with respect to contemporary real world debates about philosophy and cognitive science.
5. Critically evaluate evidence from a broad range of disciplines including cognitive science, psychology and neuroscience.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Books:

1. **Jose Luis Bermudez, Cognitive Science – An Introduc tion to the Science of the Mind, Second Edition, Cambridge University Press**

Reference Books:

1. **Reisberg, D. (2005). Cognition (3rd ed.). W. W. Norton & Co. price**
2. **Kurzban, R. (2012). Why Everyone (Else) Is a Hypocrite. Princeton University Press; ISBN: 978-0-691-15439-8.**

Data Mining & Analytics Lab [As per Choice Based Credit System (CBCS) scheme] (Effective from the academic year 2018 -2019) SEMESTER – I

Course Code	18SAML16	CIE Marks	40
Number of Lecture Hours/Week	4	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	3

Credit – 02

Course objectives: This course will enable students to

- Implement Data mining algorithms using real world data
- Implement concepts of data analytics.

Instructions: 1) Use 50% of course duration for Part A and 50% course duration for Part-B

2) Programs can be implemented using any of frame works like Weka, Orange, R, Hadoop etc.

Part –A : Laboratory Work

List of experiments

1. **Write a program to implement decision trees using any data sets (Ex: Heart disease data set).**
2. **Write a program to demonstrate association analysis.**
3. **Implement any clustering technique.**
4. **Implement linear and logistic regression.**
5. **Implement a Map reduce program that processes a weather data set.**
6. **Data Analytics: Write a program that transposes the original data set, find all pairs products reviewed together and writes on the output folder all the pairs of products that appear more than once and their frequencies. The pairs of products must be sorted by frequency.**

PART –B: Mini Project

Design and Develop a mini project using any data mining/analytics technique.

Course outcomes:

At the end of this course the students will be able to:

1. Design and deploy appropriate data mining techniques
2. Apply data mining and analytics techniques for large data sets.
3. Create application using data mining /analytics techniques.

Question paper pattern:

Part-A (50% of maximum marks)

All laboratory experiments aretobeincludedforpracticalexamination.
Studentsare allowed to pick one experiment and execute.
Strictlyfollow theinstructions as printed on the cover page of answer script for breakup of marks.
Change of experiment is allowed only once and marks allotted to the procedure part to be made zero.

Part-B(50% of Maximum marks)

Follow theinstructions as printed on the cover page of answer script for breakup of marks for the Mini project.

MACHINE LEARNING TECHINIQUES
[As per Choice Based Credit System(CBCS)scheme]
(Effectivefromtheacademicyear2018-2019)
SEMESTER-II

Subject Code	**18SAM21**	IA Marks	40
Number of Contact Hours/Week	**04**	Exam Marks	60
Total Number of Contact Hours	**50**	Exam Hours	03

CREDITS–04

Course objectives:

- To understand the basic concepts of learning and decision trees.
- To understand the neural networks and genetic algorithms
- To understand the Bayesian techniques
- To understand the instant based learning
- To understand the analytical learning and reinforced learning

Module-1	**Contact Hours**
INTRODUCTION, CONCEPT LEARNING AND DECISION TREES Learning Problems – Designing Learning systems, Perspectives and Issues – Concept Learning – Version Spaces and Candidate Elimination Algorithm – Inductive bias – Decision Tree learning – Representation – Algorithm – Heuristic Space Search	**10Hours**
Module-2	
NEURAL NETWORKS AND GENETIC ALGORITHMS: Neural Network Representation – Problems – Perceptrons – Multilayer Networks and Back Propagation Algorithms – Advanced Topics – Genetic Algorithms – Hypothesis Space Search – Genetic Programming – Models of Evolution and Learning.	**10Hours**
Module-3	
BAYESIAN AND COMPUTATIONAL LEARNINGL Bayes Theorem – Concept Learning – Maximum Likelihood – Minimum Description Length Principle – Bayes Optimal Classifier – Gibbs Algorithm – Naïve Bayes Classifier– Bayesian Belief Network – EM Algorithm – Probably Learning – Sample Complexity for Finite and Infinite Hypothesis Spaces – Mistake Bound Model.	**10Hours**
Module-4	
INSTANT BASED LEARNING AND LEARNING SET OF RULES: K- Nearest Neighbor Learning – Locally Weighted Regression – Radial Basis Functions – Case-Based Reasoning – Sequential Covering Algorithms – Learning Rule Sets – Learning First Order Rules – Learning Sets of First Order Rules – Induction as	**10Hours**
Module-5	

ANALYTICAL LEARNING AND REINFORCED LEARNING: Perfect Domain Theories – Explanation Based Learning – Inductive-Analytical Approaches - FOCL Algorithm – Reinforcement Learning – Task – Q-Learning – Temporal Difference Learning	**10Hours**

Courseoutcomes:

On Completion of the course, the students will be able to

– Choose the learning techniques with this basic knowledge.

– Apply effectively neural networks and genetic algorithms for appropriate applications.

- Apply bayesian techniques and derive effectively learning rules.

- Choose and differentiate reinforcement and analytical learning techniques

Question paper pattern:

The question paper will have ten questions.

There will be 2 questions from each module.

Each question will have questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Tom M. Mitchell, "Machine Learning", McGraw-Hill Education (INDIAN EDITION), 2013.

ReferenceBook:

1. EthemAlpaydin, "Introduction to Machine Learning", 2nd Ed., PHI Learning Pvt. Ltd., 2013.

2. T. Hastie, R. Tibshirani, J. H. Friedman, "The Elements of Statistical Learning", Springer; 1st edition, 2001.

COMPUTER VISON AND GRAPHICS
[As per Choice Based Credit System (CBCS) scheme]
(Effective from the academic year 2018 -2019)
SEMESTER – II

Subject Code	18SAM22	IA Marks	40
Number of Lecture Hours/Week	4	Exam Marks	60
Total Number of Lecture Hours	50	Exam Hours	3

Credit – 04

Course objectives: This course will enable students to

- Review image processing techniques for computer vision
- Discuss shape and region analysis
- Discuss 3D viewing, transformations and perspective geometry
- Analyze Hough Transform and its applications to detect lines, circles, ellipses
- Analyze three-dimensional image analysis techniques
- Illustrate motion analysis
- Discuss some applications of computer vision algorithms

Module-1	**Contact Hours**
CAMERAS, LIGHT AND COLOR MODELS: Pinhole Cameras, Radiometry Measuring Light: Light in Space, Light Surfaces, Important Special Cases, Sources, Shadows, And Shading: Qualitative Radiometry, Sources and Their Effects, Local Shading Models, Application: Photometric Stereo, Interreflections: Global Shading Models, Color: The Physics of Color, Human Color Perception, Representing Color, A Model for Image Color, Surface Color from Image Color. **RBT:L1,L2**	**10Hours**
Module-2	
FILTERS, EDGE DETECTION AND TEXTURES : Linear Filters: Linear Filters and Convolution, Shift Invariant Linear Systems, Spatial Frequency and Fourier Transforms, Sampling and Aliasing, Filters as Templates, Edge Detection: Noise, Estimating derivatives, Detecting Edges, Texture: Representing Texture, Analysis (and Synthesis) Using Oriented Pyramids, Application: Synthesis by Sampling Local Models, Shape from Texture **RBT:L1,L2,L3**	**10Hours**
Module-3	
3D VIEWING AND HUMAN VISION: The Geometry of Multiple Views: 3D viewing, 3D Transformations, Composition of 3D Transformations, Two Views, Stereopsis: Reconstruction, HumanStereposis, Binocular Fusion, Using More Cameras, Segmentation by Clustering: What Is Segmentation?, Human Vision: Grouping and Getstalt, Applications: Shot Boundary Detection and Background Subtraction, Image Segmentation by Clustering Pixels, Segmentation by Graph-Theoretic Clustering **RBT:L1,L2,L3**	**10Hours**
Module-4	
SEGMENTATION: Segmentation by Fitting a Model: The Hough Transform, Fitting Lines, Fitting Curves,Fitting as a Probabilistic Inference Problem, Robustness, Segmentation and Fitting UsingProbabilistic Methods: Missing Data Problems, Fitting, and Segmentation, The EMAlgorithm in Practice, Tracking With Linear Dynamic Models: Tracking as an AbstractInference Problem, Linear Dynamic Models, Kalman Filtering, Data Association,Applications and Examples. **RBT:L1,L2,L3**	**10Hours**
Module-5	
GEOMETRIC CAMERA MODELS AND CALIBARTION: Perspective transformations, Perspective Views, the Perspective Geometry and camera models, Elements of Analytical Euclidean Geometry, Geometric Camera Calibration: Least-Squares Parameter Estimation, A Linear Approach to Camera Calibration, Taking Radial Distortion into Account, An Application: Mobile Robot Localization, Model-	**10Hours**

Based Vision: Initial Assumptions, Obtaining Hypotheses by Pose Consistency, Obtaining Hypothesesby pose Clustering, Application:Registration In Medical Imaging Systems, Curved Surfaces and Alignment. **RBT:L1,L2,L3**	

Course outcomes:

Upon completion of the course, the students will be able to

- Implement fundamental image processing techniques required for computer vision
- Perform shape analysis and implement boundary tracking techniques
- Apply chain codes and other region descriptors
- Apply Hough Transform for line, circle, and ellipse detections.
- Represent and implement images and objects using 3D representation
- Apply 3D vision techniques.
- Develop applications using computer vision techniques

Question paper pattern:

The question paper will have ten questions.
There will be 2 questions from each module.
Each question will have questions covering all the topics under a module.
The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. David A. Forsyth and Jean Ponce: Computer Vision – A Modern Approach, PHI Learning (Indian Edition), 2009
2. D. Hearn and M. Pauline Baker, Computer Graphics (C Version), Pearson Education, 2nd Edition, 2004

Reference Books:

1. E. R. Davies: Computer and Machine Vision – Theory, Algorithms and Practicalities,Elsevier (Academic Press), 4th edition, 2013
2. J. D. Foley, A. Van Dam, S. K. Feiner and J. F. Hughes, Computer Graphics – Principles and Practice, Second Edition in C, Pearson Education, 2003.

SOFT COMPUTING
[AsperChoiceBasedCreditSystem(CBCS)scheme]
(Effectivefromtheacademicyear2018-2019)
SEMESTER-II

SubjectCode	**18SAM23**	IAMarks	40
NumberofContactHours/Week	**04**	ExamMarks	60
TotalNumberofContactHours	**50**	ExamHours	03

CREDITS–04

Courseobjectives:

- To learn the key aspects of Soft computing
- To know about the components and building block hypothesis of Genetic algorithm.
- To gain insight onto Neuro Fuzzy modeling and control.
- To gain knowledge in machine learning through GA and Fuzzy.

Module-1	**Contact Hours**
Introduction to Soft Computing - Introduction to Fuzzy logic – Genetic algorithms - Hybrid systems and its applications - Fundamental concept of ANN – Evolution - basic Model of ANN - Terminologies used in ANN	**10Hours**
Module-2	
Classical Sets and Fuzzy Sets – Fuzzy Relations - Properties of Fuzzification and Defuzzification	**10Hours**
Module-3	
Logic and Fuzzy Systems – Fuzzy Control Systems - Fuzzy Classification	**10Hours**
Module-4	
Genetic algorithms: Introduction - Basic operations - Traditional algorithms - Simple GA -General genetic algorithms - The schema theorem - Genetic programming - applicationsInverted Deduction – Inverting Resolution	**10Hours**
Module-5	
Perceptron Network - Adaptive linear neuron - Multiple adaptive linear neurons - Back propagation Network (Theory, Architecture, Algorithm for training, learning factors, testing and applications of all the above NN models)	**10Hours**

Courseoutcomes:

The student shall be able to

- Implement machine learning through neural networks.
- Design Genetic Algorithm to solve the optimization problem
- Develop a Fuzzy expert system.
- Model Neuro Fuzzy system for clustering and classification.

Question paper pattern:

The question paper will have ten questions.

There will be 2 questions from each module.

Each question will have questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", Third Edition

3. Principles of Soft computing, Shivanandam, Deepa S. N Wiley India, Jun-2007

ReferenceBook:

3. Neuro-fuzzy and soft computing, J.S.R. JANG, C.T. SUN, E. MIZUTANI, Phi (EEE edition), 2012.

NATURAL LANGUAGE PROCESSING
[AsperChoiceBasedCreditSystem(CBCS)scheme]
(Effectivefromtheacademicyear2018-2019)
SEMESTER-II

SubjectCode	**18SAM241**	IAMarks	40
NumberofContactHours/Week	**04**	ExamMarks	60
TotalNumberofContactHours	**50**	ExamHours	03

CREDITS–04

Courseobjectives:This course will enable students to

- To introduce the fundamentals of Natural language processing from algorithm view point.
- To understand different issues which Natural language processing a complicated task
- To understand various application of Natural language processing [NLP].
- Analyzing text processing and retrieval techniques.

Module-1	**Contact**
Introduction, Morphology: Knowledge in Speech & Lang Processing, Ambiguity, Models & Algorithms, Language, Thought & Understanding, Some Brief History, The State of the Art & Near-Term Future, Summary Morphology and Finite State Transducers: Survey of English Morphology, Finite state Morphological Parsing, Lexicon-Free FST: The Porter Stemmer, Human Morphological Parsing, Summary, Combining FST Lexicon and Rules.	**10Hours**
Module-2	
N-Grams: Counting Words in Corpora, Simple N-Grams, Smoothing, Back off, Deleted Interpolation, N-Grams for Spelling and Pronunciation, Entropy, Summary. Word Classes and Part-of- Speech Tagging: English Word Classes, Tag sets for English, Part-of-Speech Tagging,	**10Hours**
Module-3	
Context-Free Grammars and Predicate Calculus for English: Constituency, Context-Free Rules and Trees, Sentence Level Constructions, Coordination, Agreement, The Verb Phrase Sub Categorization, Auxiliaries, Spoken Language Syntax, Grammar Equivalence and Normal Form, Finite –State and Context- Free Grammars, Grammars and Human Processing, The Early Algorithm, Finite-State Parsing Method, Summary Representing Meaning:	**10Hours**
Module-4	
Semantic Analysis: Syntax-Driven Semantic Analysis, Attachments for a Fragment of English, Integrating Semantic Analysis into the Earley Parser, Idioms and Compositionality, Robust Semantic Analysis, Summary. Lexical Semantics: Relations Among Lexemes and Their Senses, WordNet: A Database of Lexical Relations, The Internal Structure of Words, Creativity and the Lexicon, Summary Word Sense Disambiguation and Information.	**10Hours**
Module-5	
Retrieval: Selection Restriction Based Disambiguation, Robust Word Sense Disambiguation, Information Retrieval, Other Retrieval Tasks, and Summary. Case Study of Simple Text Recognition or Content Based Text Extraction System. Evolving Explanatory Novel Patterns for Semantically-Based Text Mining: Related Work, A Semantically Guided Model for Effective Text Mining.	**10Hours**

Courseoutcomes:The students shall be able to

- Explain the fundamentals of Natural language processing from algorithm view point.
- Understand different issues which Natural language processing a complicated task
- Understand various application of Natural language processing [NLP].
- Analyze text processing and retrieval techniques.

Question paper pattern:

The question paper will have ten questions.
There will be 2 questions from each module.
Each question will have questions covering all the topics under a module.
The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Daniel Jurafsky and James H Martin, "Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", 2nd Edition, Prentice Hall, 2009.

ReferenceBook:

1. Christopher D.Manning and HinrichSchutze, "Foundations of Statistical Natural LanguageProcessing", MIT Press, 1999.
2. TanveerSiddiqui, U.S. Tiwary, "Natural Language Processing and Information Retrieval", Oxford University Press, 2008.
3. Anne Kao and Stephen R. Poteet (Eds), "Natural LanguageProcessingand Text Mining",SpringerVerlag London Limited 2007.

Biometric Systems
[AsperChoiceBasedCreditSystem(CBCS)scheme]
(Effectivefromtheacademicyear2018-2019)
SEMESTER-II

SubjectCode	**18SAM242**	IAMarks	40
NumberofContactHours/Week	**04**	ExamMarks	60
TotalNumberofContactHours	**50**	ExamHours	03

CREDITS–04

Courseobjectives:This course will enable students to

- effectively assemble a framework that can be used to understand the issues and progress being made in multi biometrics while identifying the challenge s and potential research directions in this field

Module-1	**Contact**
BIOMETRICS: WHEN IDENTITY MATTERS ,Introduction , Operation of a biometric system , Verification versus identification , Performance of a biometric system , Applications of biometrics , Biometric characteristics, Limitations of biometric systems , Biometric standards , Multibiometric systems	**10Hours**
Module-2	
INFORMATION FUSION IN BIOMETRICS ; Introduction , Fusion in biometrics , Issues in designing a multibiometric system ,Sources of multiple evidence ,Acquisition and processing architecture, Levels of fusion	**10Hours**
Module-3	
LEVELS OF FUSION IN BIOMETRICS , Introduction , Sensor level fusion, Feature level fusion, Rank level fusion, Decision level fusion	**10Hours**
Module-4	
SCORE LEVEL FUSION Introduction, Classifier combination rules , Score fusion techniques , Density-based score fusion, Transformation-based score fusion, Classifier-based score fusion, Comparison of score fusion techniques, User-specific score fusion	**10Hours**
Module-5	
FUSION INCORPORATING ANCILLARY INFORMATION, Introduction, Quality-based fusion, Soft biometrics	**10Hours**

Course outcomes: The students shall be able to

- identify the sources of multiple biometric information
- determine the type of information t o b e fused
- design optima l fusion methodologies
- evaluate and comparing different fusion methodologies
- build robust multimodal interface s that facilitate the efficient acquisition of multi biometric data

Question paper pattern:

The question paper will have ten questions.

There will be 2 questions from each module.

Each question will have questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Handbook of Multibiometrics, byArun A, Ross, Karthik Nandakumar and Anil K. Jain , © 2006 Springer Science+Business Media

ReferenceBook:

Probabilistic Graphical Models
[AsperChoiceBasedCreditSystem(CBCS)scheme]
(Effectivefromtheacademicyear2018-2019)
SEMESTER-II

SubjectCode	**18SAM243**	IAMarks	40
NumberofContactHours/Week	**04**	ExamMarks	60
TotalNumberofContactHours	**50**	ExamHours	03

CREDITS–04

Course objectives: This course will enable students to

- Give a systematic and timely overview of the most important PGMs with their applications in various research areas
- Introduce the state-of-the-art and open problems of PGMs.

Module-1	Contact
• Intro and Refresher of Probabilities, Bayesian Networks (directed graphical models)	10Hours
Module-2	
• Excurse Causality , Markov Networks (undirected graphical models) Factor graphs, Parameter Estimation	10Hours
Module-3	
Maximum-A-Posteriori Estimation, Bayesian Inference, EM, Inference and Learning in Hidden Markov Models Maximum Entropy Models, (Loopy) Belief Propagation	10Hours
Module-4	
Approximate Inference Conditional Random Field Learning , Energy Minimization, Structured Loss Functions	10Hours
Module-5	
• Structured Support Vector Machines , Graph cuts	10Hours

Courseoutcomes:The students shall be able to

1. Link the PGM techniques with the real applications in various research areas and show students how such techniques can lead to the state-of-the-art methods.
2. Deepen students understanding by research paper reading and presentation, in-class discussion, quiz, and assignments.
3. Provide students an opportunity to explore how to link PGMs with their own research through the semester-long course project. “Toy” projects are not acceptable.

Question paper pattern:

The question paper will have ten questions.
There will be 2 questions from each module.
Each question will have questions covering all the topics under a module.
The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

2. “Probabilistic graphical models – Principles and techniques” by Daphne Koller and Nir Friedman, the MIT press.

ReferenceBook:

Robotics and Automation
[AsperChoiceBasedCreditSystem(CBCS)scheme]
(Effectivefromtheacademicyear2018-2019)
SEMESTER-II

SubjectCode	**18SAM251**	IAMarks	40
NumberofContactHours/Week	**04**	ExamMarks	60
TotalNumberofContactHours	**50**	ExamHours	03

CREDITS–04

Courseobjectives:This course will enable students to

- To develop knowledge in various robot structures and their workspace.
- Perform spatial transformations associated with rigid body motions
- handle singularity issues associated with the operation of robotic systems

Module-1	**Contact**
Automation History of Automation, Reasons for automation, Disadvantages of automation, Automation systems, Types of automation – Fixed, Programmable and Flexible automation, Automation strategies	**10Hours**
Module-2	
Robotics: Definition of Robot, History of robotics, Robotics market and the future prospects, Robot Anatomy, Robot configurations: Polar, Cartesian, cylindrical and Jointed-arm configuration. Robot motions, Joints, Work volume, Robot drive systems, Precision of movement – Spatial resolution, Accuracy, Repeatability, End effectors – Tools and grippers.	**10Hours**
Module-3	
Controllers and Actuators: Basic Control System concepts and Models, Transfer functions, Block diagrams, characteristic equation, Types of Controllers: on-off, Proportional, Integral, Differential, P-I, P-D, P-I-D controllers. Control system and analysis. **Robot actuation and feedback components:** Position sensors – Potentiometers, resolvers, encoders, velocity sensors. Actuators - Pneumatic and Hydraulic Actuators, Electric Motors, Stepper motors, Servomotors, Power Transmission systems.	**10Hours**
Module-4	
Robot Sensors and Machine vision system: Sensors in Robotics - Tactile sensors, Proximity and Range sensors, use of sensors in robotics. Machine Vision System: Introduction to Machine vision, the sensing and digitizing function in Machine vision, Image processing and analysis, Training and Vision systems.	**10Hours**
Module-5	

Robots Technology of the future: Robot Intelligence, Advanced Sensor capabilities, Telepresence and related technologies, Mechanical design features, Mobility, locomotion and navigation, the universal hand, system integration and networking. **Artificial Intelligence:** Goals of AI research, AI techniques – Knowledge representation, Problem representation and problem solving, LISP programming, AI and Robotics, LISP in the factory.	**10Hours**

Course outcomes: The students shall be able to

- demonstrate knowledge of the relationship between mechanical structures of industrial robots and their operational workspace characteristics
- apply spatial transformation to obtain forward kinematics equation of robot manipulators.
- solve inverse kinematics of simple robot manipulator
- obtain the Jacobian matrix and use it to identify singularities

Question paper pattern:

The question paper will have ten questions.
There will be 2 questions from each module.
Each question will have questions covering all the topics under a module.
The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. John J. Craig, Introduction to Robotics: Mechanics and Control, 3rd Ed., Prentice-Hall, 2005.

ReferenceBook:

Human Computer Interaction
[AsperChoiceBasedCreditSystem(CBCS)scheme]
(Effectivefromtheacademicyear2018-2019)
SEMESTER-II

SubjectCode	**18SAM252**	IAMarks	40
NumberofContactHours/Week	**04**	ExamMarks	60
TotalNumberofContactHours	**50**	ExamHours	03

CREDITS–04

Courseobjectives:This course will enable students to

- focus on a few theoretical blocks and a few practical assignments.
- Emphasize to complement knowledge on practical systems development with knowledge on how one can and should design and construct good user interfaces.

Module-1	**Contact**
- Psychology and human computer interaction A walkthrough of theories within cognitive and perceptual psychology.	**10Hours**
Module-2	
Human decision making and actions in computer supported situations. Description, analysis, design and construction of interaction between humans and computerised technical systems.	**10Hours**
Module-3	
- User interface design as a part of practical systems development Analysis of different (functioning and non-functional) development processes.	**10Hours**
Module-4	
Development in large projects, iterative systems development, user centred development. User interface design as a part of the systems development process.	**10Hours**
Module-5	
Design and construction Methods, techniques and heuristics for design of the user interface. Standards, style guides and guidelines. Methods for evaluation of usability. Methods and techniques for user interface construction.	**10Hours**

Courseoutcomes:The students shall be able to

- Demonstrate basic knowledge on theories of psychology and on how the human being interacts with (computer) systems.
- Give insight on how knowledge of the human capabilities can influence the way in which we construct technical systems.
- Apply Methods and techniques for design and construction of user interfaces.

Question paper pattern:

The question paper will have ten questions.

There will be 2 questions from each module.

Each question will have questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Fundamentals of Human-Computer Interaction, 1st Edition, Andrew Monk

ReferenceBook:

Pattern Recognition
[AsperChoiceBasedCreditSystem(CBCS)scheme]
(Effectivefromtheacademicyear2018-2019)
SEMESTER-II

SubjectCode	**18SAM253**	IAMarks	40
NumberofContactHours/Week	**04**	ExamMarks	60
TotalNumberofContactHours	**50**	ExamHours	03

CREDITS–04

Courseobjectives:This course will enable students to

Co u rse Objec t ives: The objectives of t his cou r se are to:

- In trod u ce m a t hem a tical tools needed for Pattern Recognition
- Im part k nowledge abou t t he fu n da men t als of Patter n Recognition.
- Provide k nowledge of recognition, decision m aking an d statistical lear ning problem s

Module-1	**Contact**
Introdu c tion: Importa nce of patter n recognition, Feat ures, Feat ure Vectors, a n d Classifiers, S u pervised, Un su pervised, a n d Semi- su pervised lear ning, In trod u ction to Bayes Decision Theory, Discrimin an t F u nction s an d Decision S urfaces, Ga u ssia n PDF a n d Bayesia n Classification for Norm al Distrib u tion s.	**10Hours**
Module-2	
Da t a Tra nsform a tio n and Di m ensionali t y Reduc t io n: In trod u ction, Basis Vectors, The Kar h u nen Loeve (KL) Tra n sformation, Singular Valu e Decom position, In dependen t Com ponen t An alysis (In troduc tion only).	**10Hours**
Module-3	
Esti m ation of Unk nown Pr obabili t y Den s ity F unc t ions: Maximum Likelihood Parameter Estimation, Maximum a Posteriori Probability estimation, Bayesia n In terference, Maximum En tropy Estimation, Mixt u re Models, Naive-Bayes Classifier, The Nearest Neigh bor Rule.	**10Hours**
Module-4	
Li n ear Classifiers: In trodu ction, Linear Discrimin ant F unction s a nd Decision Hyperpla nes, The Perceptron Algorit hm, Mea n Sq u are Error Estim a te, Stoch astic Approximation of LMS Algorit hm, S um of Error Estim a te.	**10Hours**
Module-5	
No nli n ear Classifiers: The XOR Problem , The two Layer Perceptron, Th ree Layer Perceptron, Back propagation Algorithm, Basic Concepts of Clu stering, In trod u ction to Clu s tering , Proximity Meas ures.	**10Hours**

Courseoutcomes:The students shall be able to

- •Iden tify areas where Patter n Recognition a n d Machine Lear ning ca n offer a solu tion.
- Describe t he strengt h an d limitation s of some techniques used in comp u t a tional Machine Lear ning for classification, regression and den sity estim a tion problems
- Describe genetic algorithm s, validation methods a n d sa mpling techniq ues
- Describe a n d model data to solve problem s in regression a n d classification

Implemen t learning algorit hm s for su pervised tasks

Question paper pattern:

The question paper will have ten questions.

There will be 2 questions from each module.

Each question will have questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Boo k:

1. Pa tt ern Recog n i tion : Sergios Theodoridis, Kon sta n tinos Kou troum bas, Elsevier In dia Pvt. Ltd (Paper Back), 4t h edition.

R efere n ce Boo k s:

1. T h e Ele m e nts of S tatistical Lear n ing: Trevor Hastie, Springer-Verlag New York, LLC (Paper Back), 2009 .
2. Patt ern Classifica tion: Rich ard O. Du da, Peter E. Hart, David G. Stork. J ohn Wiley & Son s, 2012 .
3. Patt er n Recogn itio n a n d Im age Analysis Earl Gose: Rich ard

Deep Learning
[AsperChoiceBasedCreditSystem(CBCS)scheme]
(Effectivefromtheacademicyear2018-2019)
SEMESTER-II

SubjectCode	**18SAM31**	IAMarks	40
NumberofContactHours/Week	**04**	ExamMarks	60
TotalNumberofContactHours	**50**	ExamHours	03

CREDITS–04

Courseobjectives:This course will enable students to

- To present the mathematical, statistical and computational challenges of building neural networks To study the concepts of deep learning
- To introduce dimensionality reduction techniques
- To enable the students to know deep learning techniques to support real-time applications
- To examine the case studies of deep learning techniques

Module-1	**Contact**
INTRODUCTION 1 Introduction to machine learning- Linear models (SVMs and Perceptrons, logistic regression)- Intro to Neural Nets: What a shallow network computes- Training a network: loss functions, back propagation and stochastic gradient descent- Neural networks as universal function approximates	**10Hours**
Module-2	
DEEP NETWORKS : History of Deep Learning- A Probabilistic Theory of Deep Learning- Backpropagation and regularization, batch normalization- VC Dimension and Neural Nets-Deep Vs Shallow NetworksConvolutional Networks- Generative Adversarial Networks (GAN), Semi-supervised Learning	1
Module-3	
DIMENTIONALITY REDUCTION : Linear (PCA, LDA) and manifolds, metric learning - Auto encoders and dimensionality reduction in networks - Introduction to Convnet - Architectures – AlexNet, VGG, Inception, ResNet - Training a Convnet: weights initialization, batch normalization, hyperparameter optimization	**10Hours**
Module-4	
OPTIMIZATION AND GENERALIZATION Optimization in deep learning– Non-convex optimization for deep networks- Stochastic Optimization Generalization in neural networks- Spatial Transformer Networks- Recurrent networks, LSTM - Recurrent Neural Network Language Models- Word-Level RNNs & Deep Reinforcement Learning - Computational & Artificial Neuroscience	**10Hours**
Module-5	
CASE STUDY AND APPLICATIONS Imagenet- Detection-Audio Wave Net-Natural Language Processing Word2Vec - Joint Detection BioInformatics- Face Recognition- Scene Understanding- Gathering Image Captions	**10Hours**
Courseoutcomes:The students shall be able to	

- Understand basics of deep learning Implement various deep learning models
- Realign high dimensional data using reduction techniques
- Analyze optimization and generalization in deep learning
- Explore the deep learning applications

Question paper pattern:

The question paper will have ten questions.
There will be 2 questions from each module.
Each question will have questions covering all the topics under a module.
The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Cosma Rohilla Shalizi, Advanced Data Analysis from an Elementary Point of View, 2015.

ReferenceBook:

1. Deng & Yu, Deep Learning: Methods and Applications, Now Publishers, 2013.
2. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press, 2016.
3. Michael Nielsen, Neural Networks and Deep Learning, Determination Press, 2015.

Virtual Reality & Augmented Reality
[AsperChoiceBasedCreditSystem(CBCS)scheme]
(Effectivefromtheacademicyear2018-2019)
SEMESTER-II

SubjectCode	**18SAM321**	IAMarks	40
NumberofContactHours/Week	**04**	ExamMarks	60
TotalNumberofContactHours	**50**	ExamHours	03

CREDITS–04

Course objectives:
This course primarily contributes to Computer Science program outcomes that develop student abilities to: (a) An ability to apply knowledge of computing and mathematics to solve complex computing problems in computer science discipline. (j) An ability to use current techniques, skills, and tools necessary for computing practice with an understanding of the limitations.

Module-1	**Contact**
Introduction to Virtual Reality Fundamental Concept and Components of Virtual Reality, Primary Features and Present Development on Virtual Reality, Multiple Modals of Input and Output Interface in Virtual Reality, Input -- Tracker, Sensor, Digital Glove, Movement Capture, Video-based 3D Menus & 3DScanner etc; Output -- Visual / Auditory / Haptic Devices	**10Hours**
Module-2	
Visual Computation in Virtual Reality (1) Fundamentals of Computer Graphics; Real time rendering technology; Principles of Stereoscopic Display; Software and Hardware Technology on Stereoscopic Display	**10Hours**
Module-3	
Environment Modeling in Virtual Reality Geometric Modeling; Behavior Simulation; Physically Based Simulation, Haptic & Force Interaction in Virtual Reality Concept of haptic interaction; Principles of touch feedback and force feedback; Typical structure and principles of touch/force feedback facilities in applications.	**10Hours**
Module-4	
Augmented Reality System Structure of Augmented Reality; Key Technology in AR; General solution for calculating geometric & illumination consistency in the augmented environment.	**10Hours**
Module-5	
VR Development Tools Frameworks of Software Development Tools in VR; Modeling Tools for VR; X3D Standard; Vega, MultiGen, Virtools etc	**10Hours**

Courseoutcomes:The students shall be able to

- Describe the basic concept and framework of virtual reality.
- Interpret the principles and multidisciplinary features of virtual reality.
- Use the technology for multimodal user interaction and perception in VR, in particular the visual, audial and haptic interface and behavior.
- Use the technology for managing large scale VR environment in real time.
- Work with the VR system framework and development tools.

Question paper pattern:

The question paper will have ten questions.

There will be 2 questions from each module.

Each question will have questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Textbook(s) and other required material: Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition. Wiley-IEEE• Press, 2003/2006.

ReferenceBook:

2. . Sherman, William R. and Alan B. Craig. Understanding Virtual Reality – Interface, Application, and Design, Morgan Kaufmann, 2002.

3. Fei GAO. Design and Development of Virtual Reality Application System, Tsinghua Press, March 2012. (高飞. 虚拟现实应用系统设计与开发, 清华大学出版社, 2012 年3 月).

4. Guangran LIU. Virtual Reality Technology, Tsinghua Press, Jan. 2011. …(刘光然 虚拟现实技术, 清华大学出版社, 2011 年1 月).

AGILE TECHNOLOGIES

[As per Choice Based Credit System (CBCS) scheme]
(Effective from the academic year 2018 -2019)
SEMESTER – II

Subject Code	18SCE324 / 18SCS242 / 18SIT331 / 18SSE323/**18SAM322**	IA Marks	40
Number of Contact Hours/Week	04	Exam Marks	60
Total Number of Contact Hours	50	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

- Explain iterative, incremental development process leads to faster delivery of more useful software
- Evaluate essence of agile development methods
- Illustrate the principles and practices of extreme programming
- Show the roles of prototyping in the software process
- Explain the Mastering Agility

Module -1	**Contact Hours**
Why Agile?: Understanding Success, Beyond Deadlines, The Importance of Organizational Success, Enter Agility, **How to Be Agile?:** Agile Methods, Don't Make Your Own Method, The Road to Mastery, Find a Mentor **RBT: L1, L2**	**10 Hours**
Module -2	
Understanding XP: The XP Lifecycle, The XP Team, XP Concepts, **Adopting XP:** Is XP Right for Us?, Go!, Assess Your Agility **RBT: L1, L2**	**10 Hours**
Module – 3	
Practicing XP: Thinking: Pair Programming, Energized Work, Informative Workspace, Root-Cause Analysis, Retrospectives, **Collaborating:** Trust, Sit Together, Real Customer Involvement, Ubiquitous Language, Stand-Up Meetings, Coding Standards, Iteration Demo, Reporting, **Releasing:**"Done Done", No Bugs, Version Control, Ten-Minute Build, Continuous Integration, Collective Code Ownership, Documentation. **Planning:** Vision, Release Planning, The Planning Game, Risk Management, Iteration Planning, Slack, Stories, Estimating. **Developing:** Incremental requirements, Customer Tests, Test-Driven Development, Refactoring, Simple Design ,Incremental Design and Architecture, Spike Solutions, Performance Optimization, Exploratory Testing **RBT: L1, L2, L3**	**10 Hours**
Module-4	
Mastering Agility: Values and Principles: Commonalities, About Values, Principles, and Practices, Further Reading, **Improve the Process:** Understand Your Project, Tune and Adapt, Break the Rules, **Rely on People :**Build Effective Relationships, Let the Right People Do the Right Things, Build the Process for the People, **Eliminate Waste :**Work in Small, Reversible Steps, Fail Fast, Maximize Work Not Done, Pursue Throughput **RBT: L1, L2, L3**	**10 Hours**
Module-5	
)eliver Value: Exploit Your Agility, Only Releasable Code Has Value, Deliver Business Results, Deliver requently, **Seek Technical Excellence :**Software Doesn't Exist, Design Is for Understanding, Design Trade-ffs, Quality with a Name, Great Design, Universal Design Principles, Principles in Practice, Pursue Mastery **RBT: L1, L2, L3**	**10 Hours**

Course outcomes:

tudents should be able to

- Define XP Lifecycle, XP Concepts, Adopting XP
- Evaluate on Pair Programming, Root-Cause Analysis, Retrospectives, Planning, Incremental

Requirements, Customer Tests

- Demonstrate concepts to Eliminate Waste

Question paper pattern:

The question paper will have ten questions.
There will be 2 questions from each module.
Each question will have questions covering all the topics under a module.
The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. **The Art of Agile Development** (Pragmatic guide to agile software development), James shore, Chromatic, O'Reilly Media, Shroff Publishers & Distributors, 2007.

Reference Books:

1. Agile Software Development, Principles, Patterns, and Practices,Robert C. Martin, Prentice Hall; 1st edition, 2002.
2. Agile and Iterative Development A Manger's Guide", Craig Larman Pearson Education, First Edition, India, 2004.

INTERNET OF THINGS
[As per Choice Based Credit System (CBCS) scheme]
(Effective from the academic year 2018 -2019)
SEMESTER – I

Subject Code	18LNI22 / 18SCE23 / 18SCN14 / 18SCS14 / 18SSE321/**18SAM323**	IA Marks	40
Number of Contact Hours/Week	04	Exam Marks	60
Total Number of Contact Hours	50	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

- Define and explain basic issues, policy and challenges in the IoT
- Illustrate Mechanism and Key Technologies in IoT
- Explain the Standard of the IoT
- Explain resources in the IoT and deploy of resources into business
- Demonstrate data analytics for IoT

Module -1	**Contact Hours**
What is The Internet of Things? Overview and Motivations, Examples of Apllications, IPV6 Role, Areas of Development and Standardization, Scope of the Present Investigation.Internet of Things Definitions and frameworks-IoT Definitions, IoT Frameworks, Basic Nodal Capabilities. Internet of Things Apjplication Examples-Overview, Smart Metering/Advanced Metering Infrastructure-Health/Body Area Networks, City Automation, Automotive Applications, Home Automation, Smart Cards, Tracking, Over-The-Air-Passive Surveillance/Ring of Steel, Control Application Examples, Myriad Other Applications. **RBT: L1, L2, L3**	**10 Hours**
Module -2	
Fundamental IoT Mechanism and Key Technologies-Identification of IoT Object and Services, Structural Aspects of the IoT, Key IoT Technologies. Evolving IoT Standards-Overview and Approaches, IETF IPV6 Routing Protocol for RPL Roll, Constrained Application Protocol, Representational State Transfer, ETSI M2M,Third Generation Partnership Project Service Requirements for Machine-Type Communications, CENELEC, IETF IPv6 Over Low power WPAN, Zigbee IP(ZIP),IPSO **RBT: L1, L2, L3**	**10 Hours**
Module – 3	
Layer ½ Connectivity: Wireless Technologies for the IoT-WPAN Technologies for IoT/M2M, Cellular and Mobile Network Technologies for IoT/M2M,Layer 3 Connectivity :IPv6 Technologies for the IoT: Overview and Motivations. Address Capabilities,IPv6 Protocol Overview, IPv6 Tunneling, IPsec in IPv6,Header Compression Schemes, Quality of Service in IPv6, Migration Strategies to IPv6. **RBT: L1, L2, L3**	**10 Hours**
Module-4	
Case Studies illustrating IoT Design-Introduction, Home Automation, Cities, Environment, Agriculture, Productivity Applications. **RBT: L1, L2, L3**	**10 Hours**
Module-5	
Data Analytics for IoT – Introduction, Apache Hadoop, Using Hadoop MapReduce for Batch Data Analysis, Apache Oozie, Apache Spark, Apache Storm, Using Apache Storm for Real-time Data Analysis, Structural Health Monitoring Case Study. **RBT: L1, L2, L3**	**10 Hours**

Course outcomes:

At the end of this course the students will be able to:

- Develop schemes for the applications of IOT in real time scenarios
- Manage the Internet resources
- Model the Internet of things to business
- Understand the practical knowledge through different case studies
- Understand data sets received through IoT devices and tools used for analysis

Question paper pattern:

The question paper will have ten questions.

There will be 2 questions from each module.

Each question will have questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Daniel Minoli, ”Building the Internet of Things with IPv6 and MIPv6:The Evolving World of M2M Communications”, Wiley, 2013.
2. ArshdeepBahga, Vijay Madisetti, ”Internet of Things: A Hands on Approach” Universities Press., 2015

Reference Books:

1. Michael Miller,” The Internet of Things”, First Edition, Pearson, 2015.
2. Claire Rowland,Elizabeth Goodman et.al.,” Designing Connected Products”, First Edition,O’Reilly, 2015.

Game Theory
[AsperChoiceBasedCreditSystem(CBCS)scheme]
(Effectivefromtheacademicyear2018-2019)
SEMESTER-II

SubjectCode	**18SAM331**	IAMarks	40
NumberofContactHours/Week	**04**	ExamMarks	60
TotalNumberofContactHours	**50**	ExamHours	03

CREDITS–04

Courseobjectives:This course will enable students to

- To familiarize with the process of game design and development To learn the processes, mechanics, issues in game design• To understand the architecture of game programming• To know about game engine development, modeling, techniques and frameworks•

Module-1	**Contact**
INTRODUCTION 9 Elements of Game Play – Artificial Intelligence – Getting Input from the Player - Sprite Programming – Sprite Animation - Multithreading – Importance of Game Design – Game Loop.	**10Hours**
Module-2	
3D GRAPHICS FOR GAME PROGRAMMING 9 Coordinate Systems, Ray Tracing, Modeling in Game Production, Vertex Processing, Rasterization, Fragment Processing and Output Merging, Illumination and Shaders, Parametric Curves and Surfaces.	**10Hours**
Module-3	
GAME DESIGN PRINCIPLES 9 Character Development, Story Telling, Narration, Game Balancing, Core mechanics, Principles of level design, Genres of Games, Collision Detection, Game Logic, Game AI, Path Finding, Case study : Tetris.	**10Hours**
Module-4	
GAMING ENGINE DESIGN 9 Renderers, Software Rendering, Hardware Rendering, and Controller Based Animation, Spatial Sorting, Level of Detail, Collision Detection, Standard Objects, and Physics, Case study : The Sims	**10Hours**
Module-5	
GAME DEVELOPMENT 9 Developing 2D and 3D Interactive Games Using OpenGL, DirectX – Isometric and Tile Based Games, Puzzle Games, Single Player Games, Multi-Player Games. Case study: Mine craft.	**10Hours**

Courseoutcomes:The students shall be able to

- Develop game programming skills and create interactive games.

Question paper pattern:

The question paper will have ten questions.

There will be 2 questions from each module.

Each question will have questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. David H. Eberly, ―3D Game Engine Design: A Practical Approach to Real-Time Computer Graphics‖, Second Edition, Morgan Kaufmann, 2010.

2. Jung Hyun Han, ―3D Graphics for Game Programming‖, First Edition, Chapman and Hall/CRC, 2011.

ReferenceBook:

1. Jonathan S. Harbour, ―Beginning Game Programming‖, Course Technology, Third Edition PTR, 2009.

2. Ernest Adams and Andrew Rollings, ―Fundamentals of Game Design‖, Third Edition, Pearson Education, 2014.

3. Scott Rogers, ―Level Up: The Guide to Great Video Game Design‖, First Edition, Wiley, 2010. 4. Jim Thompson, Barnaby Berbank-Green, and Nic Cusworth, ―Game Design: Principles, Practice, and Techniques - The Ultimate Guide for the Aspiring Game Designer‖, First Edition, Wiley, 2008.

Distributed Computing
[AsperChoiceBasedCreditSystem(CBCS)scheme]
(Effectivefromtheacademicyear2018-2019)
SEMESTER-II

SubjectCode	**18SAM332**	IAMarks	40
NumberofContactHours/Week	**04**	ExamMarks	60
TotalNumberofContactHours	**50**	ExamHours	03

CREDITS–04

Course objectives:

Understand the general introductory concepts in the design and implementation of parallel and distributed systems, covering all the major branches such as Cloud Computing, Grid Computing, Cluster Computing, Supercomputing, and Many-core Computing.

Module-1	**Contact**
Distributed System Models High-Performance Computing, Grid Computing, Cloud Computing	**10Hours**
Module-2	
Many-core Computing Many-Task Computing, Programming Systems and Models, Processes and threads	**10Hours**
Module-3	
Map Reduce , Workflow Systems, Virtualization, Distributed Storage & File systems	**10Hours**
Module-4	
Data-Intensive Computing, Distributed Hash Tables, Consistency Models, Fault Tolerance, Performance analysis and tuning	**10Hours**
Module-5	
Parallel architectures, Multithreaded programming, GPU architecture and programming, Message passing interface	**10Hours**

Courseoutcomes:The students shall be able to

1. Explain the range of requirements that modern parallel/distributed systems have to address.
2. Define the functionality that parallel/distributed systems must deliver to meet some need.
3. Articulate design tradeoffs inherent in large-scale parallel and distributed system design.
4. Describe how the resources in a parallel and distributed system are managed by software.
5. Justify the presence of concurrency within the framework of a parallel and distributed system.

Question paper pattern:

The question paper will have ten questions.
There will be 2 questions from each module.
Each question will have questions covering all the topics under a module.
The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Distributed and Cloud Computing: Clusters, Grids, Clouds, and the Future Internet (DCC) by Kai Hwang, Jack Dongarra & Geoffrey C. Fox

ReferenceBook:

2. Andrew S. Tanenbaum and Maarten van Steen. “Distributed Systems: Principles and Paradigms” (DSPD), Prentice Hall, 2nd Edition, 2007

Multidisciplinary Design Optimization
[Asper Choice Based Credit System(CBCS)scheme]
(Effectivefromtheacademicyear2018-2019)
SEMESTER-II

Subject Code	**18SAM333**	IA Marks	40
Number of Contact Hours/Week	**04**	Exam Marks	60
Total Number of Contact Hours	**50**	Exam Hours	03

CREDITS–04

Course objectives: This course will enable students to

- acquire basic knowledge about engineering design optimization techniques and newer techniques for multidisciplinary optimization;
- develop proper engineering design optimization problem statements;
- select which optimization method(s) is/are appropriate for a given application;

Module-1	**Contact**
Basic Concepts: Optimal Design Problem Formulation, Solution Existence and Uniqueness, Functions of One Variable: Concepts and Newton's Method, Polynomial Fit and Golden Section Search	**10Hours**
Module-2	
Unconstrained Functions in N Variables: Zero-Order Methods, First-Order Methods, Scaling and Convergence, Conjugate Direction and Variable Metrics (DFP and BFGS), Newton's Method, Variable Scaling Issues, Constrained Functions in N Variables - Sequential Unconstrained Minimization Techniques: Exterior Penalty Methods, Interior and Extended Interior Penalty Methods,	**10Hours**
Module-3	
Variable Penalty Function, Comparison of Penalty Methods, Constraint Scaling, Augmented Lagrange Method (ALM) for Equality Constraints, ALM for Inequality Constraints and Generalized ALM ; Linear Programming: Simplex Method; Constrained Functions in N Variables - Direct Methods: Overview, Zero-Order Methods, Feasible Directions,	**10Hours**
Module-4	
Zoutendjik's Feasible Directions, Reduced Gradient, Sequential Quadratic Programming, Sequential Quadratic Programming , Global Optimization: Simulated Annealing, Nelder-Mead Simplex, Genetic Algorithm	**10Hours**
Module-5	
Multiobjective Optimization: Pareto Optimality, Global Function /Weighted Sum, Epsilon-Constraint or Gaming Approach , Min-Max, Goal Attainmen, Recent MDO Techniques: Approximations and Response Surface Methodology in MDO, problem decomposition strategies	**10Hours**

Course outcomes:The students shall be able to

- Use relevant engineering optimization concepts,
- Implement gradient-based and derivative free algorithms,
- Describe appropriate surrogate optimization frameworks,
- Formulate MDO problem and Architectures
- Describe non-hierarchical and hierarchical coordination methods.

Question paper pattern:

The question paper will have ten questions.

There will be 2 questions from each module.

Each question will have questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Multidiscipline Design Optimization, Vanderplaats, G. N., VR&D, 2007. (ISBN: 0-944956-04-1)
2. Introduction to Optimum Design, Arora, J. S., Fourth Edition, Elsevier Academic Press, San Diego, CA, 2016. (ISBN: 9780-12-800806-5)

Reference Book: