M.S. in Artificial Intelligence

Non-Credit courses

Course Code	Course Title	Credit Hours
CS-408	Introduction to Artificial Intelligence	----

Compulsory Courses

Course Code	Course Title	Credit Hours
CS-5101	Advanced Artificial Intelligence	3 + 0
CS-5102	Machine Learning	3 + 0
CS-5103	Mathematics for Artificial Intelligence	3 + 0
CS-5104	Intelligent Systems Design	3 + 0
CS-5105	Deep Learning	3 + 0

Elective Courses

Course Code	Course Title	Credit Hours
CS-5106	Natural Language Processing	3 + 0
CS-5107	Computer Vision	
CS-5108	Embedded Intelligence	3 + 0
CS-5109	Heuristics and Optimization	3 + 0
CS-5110	Sentiment Analysis	3 + 0
CS-5111	Augmented and Virtual Reality	3 + 0
CS-5112	Automatic Speech Recognition	3 + 0
CS-5113	Visual Computing	3 + 0
CS-5114	Neuro-computation	3 + 0
CS-5115	Advanced Image Processing	3 + 0
CS-5116	Human-Robot Interaction	3 + 0
CS-5117	Artificial Intelligence in Cybersecurity	3 + 0
CS-5118	Advanced Tools and Frameworks for Artificial Intelligence	3 + 0
CS-5119	Ethics in Artificial Intelligence	3 + 0
CS-552	Data Analytics	3 + 0
CS-562	Big Data Computing	3 + 0

			CS-563	Business Intelligence	3 + 0
			CS-566	Data Mining	3 + 0
			CS-5120	Deep Reinforcement Learning	3 + 0
			CS-5121	Computational Creativity	3 + 0
			CS-5122	Probabilistic Graphical Models	3 + 0
			CS-5123	Multi-agent and Complex Adaptive Systems	3 + 0
			CS-5124	Pattern Recognition	3 + 0
			CS-5125	Knowledge Representation and Reasoning	3 + 0
			CS-5126	Semantic Web	3 + 0
			CS-5127	Information Retrieval	3 + 0
			CS-5128	Artificial Neural Networks	3 + 0
			CS-5129	Internet of Things	3 + 0
			CS-5130	Serious Games	3 + 0
			CS-5002	Thesis	6 + 0

CS-408 Introduction to Artificial Intelligence

	Cr. Hrs.	Contact Hrs.	Exam Marks
Th.	-	3	100
Pr.	-	-	-

Intelligence, Computational Intelligence, Intelligent Agents, Solving Problem by searching, Searching Strategies, Local search Algorithms and Optimization Problems, Knowledge Representation, Reasoning with Imperfect Knowledge, Rule-Based Systems, Modeling Reasoning Strategies, Learning with Complete Data, Regression and Classification, Decision Trees, Artificial Neural Networks, Evolutionary Computing, Genetic Algorithms.

Recommended book(s) for the approved course

Text book:

1. Russell & Norvig, "Artificial Intelligence – A Modern Approach", 3rd edition, Pearson, 2016
2. Mariusz Flasinkski, "Introduction to Artificial Intelligence", Springer 2016

CS-5101 Advanced Artificial Intelligence

	Cr. Hrs.	Contact Hrs.	Exam Marks
Th.	3	3	100
Pr.	-	-	-

Intelligent Agents, Adversarial Search, Constraint Satisfaction Problem, Logical Agent, First-Order Logic, Inference in First Order Logic, Quantifying Uncertainty, Probabilistic "Reasoning, Probabilistic Reasoning over Time, Utility Theory, Making Complex Decisions, Game Theory, Learning from Examples, Artificial Neural Networks, Support Vector machines, Decision Trees, Learning Probabilistic Models, Learning with Hidden Variables, Deep Learning, Natural Language Processing, Computer Vision, Robotics, Case Studies.

Recommended book(s) for the approved course

Text book:

1. Stuart J. Russell, Peter Norvig, "Artificial Intelligence – A Modern Approach", 3rd Edition, Pearson, 2016.
2. Daphne Koller and Nir Friedman, "Probabilistic Graphical Models", MIT Press, 2009

CS-5102 Machine Learning

	Cr. Hrs.	Contact Hrs.	Exam Marks
Th.	3	3	100
Pr.	-	-	

The Learning Problem, Components of Learning, Types of Learning, Learning Feasibility, Linear Models, Linear Classification and Regression, Logistic Regression, Non-Linear Transformation; Error and Noise, Error Measures and Noisy Targets, Training vs. Testing, Theory of Generalization, The Vapnik-Chervonenkis (VC) Dimension, Definition, VC Dimension of Perceptrons, Interpreting VC Dimension, Generalization Bounds; Bias-Variance Tradeoff, Neural Networks: Stochastic Gradient Descent, Backpropagation Algorithm, Overfitting, Regularization, Validation, Model Selection and Cross Validation.

Recommended book(s) for the approved course

Text book:

1. Miroslav Kubat, "An Introduction to Machine Learning", 2nd edition, Springer, 2018
2. Yaser S. Abu-Mostafa, Malik Magdon-Ismail, Hsuan-Tien Lin, "Learning from Data", AML Book, 2012
3. Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, "Foundations of Machine Learning", MIT Press, 2012

CS-5103 Mathematics for Artificial Intelligence

	Cr. Hrs.	Contact Hrs.	Exam Marks
Th.	3	3	100
Pr.	-	-	

Applied Linear Algebra for Artificial Intelligence, Linearly dependency, Matrices, Eigen Values & Eigen Vectors, Computational Geometry, Hyperplane, Convolution in Image Processing, Multi-variate Calculus, Functions, Scalar Derivatives, Gradient, Gradient Algorithms, Probabilistic and Bayesian Reasoning, Bayes Rule, Random Variables, Dimensionality Reduction, Principle Components Analysis & Singular Value Decomposition, Maximum A-Posteriori (MAP) & Maximum Likelihood Estimation (MLE) and Distributions, Empirical Risk Minimization, Parameter Estimation, Density Estimation, Linear Regression and Classification Methods, Optimization Theory.

Recommended book(s) for the approved course

Text book:

1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, "Mathematics for Machine Learning", 1st edition, Cambridge University Press, 2019
2. Edward A. Bender, "Mathematical Methods in Artificial Intelligence", 1st edition, Wiley, 1996

CS-5104 Intelligent Systems Design

	Cr. Hrs.	Contact Hrs.	Exam Marks
Th.	3	3	100
Pr.	-	-	

Intelligent Systems, Types of Intelligent Systems and Design Methodology, Intelligent Agents, Rule-based Expert Systems, Neural Networks and Deep Learning, Genetic Algorithms, Fuzzy Logic, Emerging Artificial Intelligence Technologies and Computing Hardware, GPGPUs and Hardware Accelerators, Soft Computing, Web Technologies, Cloud Computing and Fog Computing in Intelligent Systems, Role of IoT in Intelligent Systems Design. Chat Bots, Intelligent Human Machine Interface, Ethics, Case Studies (Autonomous Cars, Robots, Humanoids, Smart Agriculture).

Recommended book(s) for the approved course

Text book:

1. Stuart Russell, "Artificial Intelligence – A Modern Approach", 3rd Edition, Pearson Education, 2015.
2. Management Association, Information Reso (Editor), "Artificial Intelligence: Concepts, Methodologies, Tools, and Applications", 4 Volume Set edition, Information Science Reference, 2016

CS-5105 Deep Learning

	Cr. Hrs.	Contact Hrs.	Exam Marks
Th.	3	3	100
Pr.	-	-	-

Deep Learning (DL), success of DL models, Gradient descent, logistic regression, cost functions, hypotheses and tasks, training data, maximum likelihood based cost, cross entropy, Mean Square Error (MSE) cost, feed-forward networks, Multi-layer Perceptron (MLP), sigmoid units, neuroscience inspiration, Graphics Processing Unit (GPU) training, regularization, Rectified Linear Units (RLUs), dropout, Convolutional neural networks (CNNs), probabilistic methods, Recurrent neural networks (RNNs), attention memory networks, auto encoders, deep generative models, Generative adversarial networks (GANs), Boltzmann Learning.

Recommended book(s) for the approved course

Text book:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", Massachusetts Institute of Technology, 2016
2. Andrew W. Trask, "Grokking Deep Learning", Manning Publishing Co., 2019

CS-5106 Natural Language Processing

	Cr. Hrs.	Contact Hrs.	Exam Marks

Th.	3	3	100
Pr.	-	-	-

Natural Language Processing (NLP), Information Extraction Techniques in NLP, Word, Morphology & Lexicons, Language Model & Smoothing, Regular Expression, String Edit Distance Alignment & Noisy Channel, Part of Speech Tag, Content Free Grammar & Hidden Markov Model, Parsing, Probabilistic & Non-probabilistic Model, Parsing Algorithms, Lexical Semantics, Word Embedding/Vector Semantics, Compositional Semantics, Semantic Parsing, Introducing to Different Applications of Natural Language Processing, Deep Learning for NLP components.

Recommended book(s) for the approved course

Text book:

1. Li Deng, Yang Liu, "Deep Learning in Natural Language Processing", 1st edition, Springer-Verlag London, 2018.
2. D. Jurafsky, J.Martin, "Speech & Language Processing", 2nd edition, Pearson Education, 2009.

CS-5107 Computer Vision

	Cr. Hrs.	Contact Hrs.	Exam Marks
Th.	3	3	100
Pr.	-	-	-

Fundamentals of Computer Vision, Geometrical and Optical Image Formation, Vision Systems Design, Basics of Image Processing, Filtering, Edge Detection, Features Detection, Contours, Segmentation, Morphological Operators, Motion Detection, Optical Flow, Object Tracking, Motion Capture, Recognition, Large-Scale Instance Recognition and Retrieval, Category Recognition and Advanced Feature Encoding, Applications (Optical Character Recognition, Facial Recognition, Quality Control, Visual Feedback, Mapping and Robot Guidance, Activity Monitoring, Motion Estimation, Autonomous Systems).

Recommended book(s) for the approved course

Text book:

1. E.R. Davies, "Computer Vision", 5th edition, Academic Press, 2017.
2. Synder & Qi, "Fundamentals of Computer Vision", Cambridge University Press, 2017.

3. Gustavo Olague, “Evolutionary Computer Vision”, Springer, 2016.

CS-5108 Embedded Intelligence

	Cr. Hrs.	Contact Hrs.	Exam Marks
Th.	3	3	100
Pr.	-	-	-

Cyber Physical Systems, Sensing Techniques, Wired and Wireless Sensor Networks, Internet of Things, Internet of Cameras, Development of Embedded Systems with Intelligence, Intelligent Sensor-actuator Systems, Internet of Intelligent Things. Algorithms for Systems with Limited Processing and Communication Resources, Case Studies.

Recommended book(s) for the approved course

Text book:

1. Houbing Song, Danda Rawat, Sabina Jeschke, Christian Brecher, “Cyber-Physical Systems Foundations, Principles and Applications”, Elsevier Academic Press, 2017/
2. Danda B. Rawat, Joel J.P.C. Rodrigues, Ivan Stojmenovic, “Cyber-Physical Systems: From Theory to Practice”, CRC Press, 2015

CS-5109 Heuristics and Optimizations

	Cr. Hrs.	Contact Hrs.	Exam Marks
Th.	3	3	100

Pr.	-	-	-

Meta-heuristics, Gradient-based Optimization, M Single-State Methods (Hill-Climbing, Simulated Annealing, Tabu Search, Iterated Local Search) M Population-based Methods (The Genetic Algorithm, Particle Swarm Optimization), Representation of an Individual (Vectors, Direct Encoded Graphs, Trees and Genetic Programming, Lists, Rule sets, Bloat), Parallel Methods; Coevolution; Combinatorial Optimization (Greedy Randomized Adaptive Search Procedures, Ant Colony Optimization, Guided Local Search), Optimization by Model Fitting; Policy Optimization; Relevant Case Studies.

Recommended book(s) for the approved course

Text book:

1. Sean Luke, "Essentials of Metaheuristics", 2nd edition, 2014
2. A.E. Eiben J.E. Smith, "Introduction to Evolutionary Computing", Springer, 2008
3. Mitchell Melanie, "An Introduction to Genetic Algorithms", the MIT Press, 1998.
4. Carlos Coello, Gary B. Lamont, "Evolutionary Algorithms for Solving Multi-Objective Problems (Genetic and Evolutionary Computation)", 2nd edition, Springer, 2007

CS-5110 Sentiment Analysis

	Cr. Hrs.	Contact Hrs.	Exam Marks
Th.	3	3	100
Pr.	-	-	-

Subjectivity Analysis, Text Categorization Concept, Computational Linguistic Concept and Subjectivity Analysis, Sentiment Extraction, Topic Extraction, Product Review, Sentiment Analysis of Comparative Words & Applications, Opinion Retrieval and Spam, Searching for Opinion, Opinion Summarization, Opinion Spam, Document Representation, Text Clustering & Topic Modeling, Social Media and Network Analysis, Characteristics of Social Network, Interconnectivity, Text Visualization, Mathematical and Programming Tools for Visualization of Large Collection of Text Documents.

Recommended book(s) for the approved course

Text book:

1. Charu C. Aggarwal, C.Zhai, "Mining Text Data", 1st edition, Springer-Verlag, 2012

2. D.Jurafsky, J. Martin, “Speech & Language Processing”, 2nd Edition, Pearson Education, 2009
3. Christoppher D. Manning, Prabhakar Raghavan, Hinrich Schutze, “Introduction to Information Retrieval”, 1st Edition, Cambridge University Press, 2007

CS-5111 Augmented and Virtual Reality

	Cr. Hrs.	Contact Hrs.	Exam Marks
Th.	3	3	100
Pr.	-	-	-

Augmented Reality (AR) / Virtual Reality (VR) / Mixed Reality (MR), Design and Art across Digital Realities, Spatial Computing, Modalitites for Spatial Computing Devices, Designing for Senses, Sensory Technology, Sensory Design, AR Design Tools and Techniques, Mathematical Modeling 3D and 7D Technologies, Hologram Effect, AR Mappings, Cross Platform Augmented and Virtual Reality Applications. Data Visualization and Artificial Intelligence in Spatial Computing.

Recommended book(s) for the approved course

Text book:

1. Erin Pangilinan, Steve Lukas, Vasanth Mohan, “Creating Augmented and Virtual Realities: Theory and Practice for Next-Generation Spatial Computing”, 1st edition, 2019
2. Tom Dieck, MM. Claudia, Jung, Timothy, “Augmented Reality and Virtual Reality”, Springer, 2019

CS-5112 Automatic Speech Recognition

	Cr. Hrs.	Contact Hrs.	Exam Marks
Th.	3	3	100

Pr.	-	-	-

History of Automatic Speech Recognition, Speech Signal, Speech Production Process, Approaches to Automatic Speech Recognition, Signal Processing Methods for Speech Recognition, Filter Banks, Linear Predictive Coding (LPC), Vector Quantization and Audio Based Spectral Analysis, Discriminative and Generative Methods in Speech Recognition, Conventional Acoustic Modeling, Gaussian Mixture Model (GMM) and Hidden Markov Model (HMM), Deep Neural Networks Methods in Speech Recognition, Model Initialization Techniques, Training and Decoding Methods, Feature Representation & Discriminative Learning.

Recommended book(s) for the approved course

Text book:

1. L. Rabiner, B.H.Juang, "Fundamentals of Speech recognition", 2nd edition, Pearson Education, 2009.
2. Dong Yu, Li Deng, "Automatic Speech Recognition: A Deep Learning Approach", 1st Edition, Springer-Verlag London, 2015

CS-5113 Visual Computing

	Cr. Hrs.	Contact Hrs.	Exam Marks
Th.	3	3	100
Pr.	-	-	-

Handling with Images and 3D Models, Computer Graphics, Image Processing, Visualization, Computer Vision, Virtual and Augmented Reality, Video Processing, Pattern Recognition, Human Computer Interaction, Machine Learning and Digital Libraries, Acquisition, Processing, Analysis and Rendering of Visual Information (mainly Images and Video), Industrial Quality Control, Medical Image Processing and Visualization, Surveying, Robotics, Multimedia Systems, Virtual Heritage, Special Effects in Movies and Television, and Computer Games.

Recommended book(s) for the approved course

Text book:

1. Aditi Majumder and M. Gopi, "Introduction to Visual Computing: Core Concepts in Computer Vision, Graphics, and Image Processing", 1st edition, A Chapman and Hall Book, 2018.
2. Rafael C. Gonzalez Richard E Woods, "Digital Image Processing", 4th edition, Pearson, 2017

CS-5114 Neurocomputation

	Cr. Hrs.	Contact Hrs.	Exam Marks
Th.	3	3	100
Pr.	-	-	-

Dynamical Systems, Phase Portraits, Hodgkin Classification, Bifurcations, Neuro-computational properties, Building Models, Electrophysiology of Neurons, The Hodgkin-Huxley Model, Hodgkin-Huxley Equations, Action Potential, Propagation of the Action potentials, Dendritic Compartments, Simple Models, Integrate-and-Fire, Resonate-and-Fire, Quadratic Integrate – and – Fire, Canonical Models Dendrites Multiple Compartments, The Cable Equation, Branching and Equivalent Cylinders, Isolated Junction, Dendrites with Active Processes.

Recommended book(s) for the approved course

Text book:

1. Eugene M. Izhikevich, “Dynamical Systems in Neuroscience: The Geometry of Excitability and Bursting”, The MIT Press, 2007
2. G. Bard Ermentrout, David H. Terman, “Mathematical Foundations of Neuroscience – Interdisciplinary applied mathematics”, Springer, 2010.

CS-5115 Advanced Image Processing

	Cr. Hrs.	Contact Hrs.	Exam Marks
Th.	3	3	100
Pr.	-	-	-

Overview of Image and Video Processing, Applications of Image and Video Processing, Color Image Capture and Representation, Color Coordinate Conversion, Spatial Domain Filtering (Linear Convolution, Median and Morphological Filtering), 2D and 3D Discrete-Fourier Transform, Motion Estimation and its Applications, Image and Video Enhancement, Edge Detection, Noise Filtering, Histogram Equalization, Image Recovery Restoration and Super-resolution, Lossless Compression, Image Compression Techniques and Standards, Video Compression Techniques and Standards.

Recommended book(s) for the approved course

Text book:

1. Y. Wang, J. Ostermann, Y.Q.Zhang, "Video Processing and Communications", Prentice Hall, 2002.
2. J.W. Woods, "Multidimensional signal image and video processing and coding," 2nd edition, Academic Press/Elsevier, 2012
3. Rafael C. Gonzalez, Richard Eugene Woods, "Digital Image Processing", Prentice Hall, 2008

CS-5116 Human-Robot Interaction

	Cr. Hrs.	Contact Hrs.	Exam Marks
Th.	3	3	100
Pr.	-	-	-

Designing Computer Interfaces, Cognitivist User Models, Post-cognitivist Perspective, Perceptual Principles, Mental Model Principles, Principles based on Attention, Memory Principles, User Customization, Embedded Computation, Augmented Reality, Social Computing, Knowledge-driven Human-computer Interaction, Emotions and Human-computer Interaction, Brain-computer Interfaces, Activity Theory or Ethnomethodological Accounts of Human Computer Use, Computer Use and HCI Research Practice.

Recommended book(s) for the approved course

Text book:

1. Takayuki Kanda, Hiroshi Ishiguro, "Human-Robot Interaction in Social Robotics", 1st edition, CRC Press, 2013
2. K. Dautenhahn, J. Saunders, "New Frontiers in Human-Robot Interaction", John Benjamins Publishing Company, 2011

CS-5117 Artificial Intelligence in Cyber Security

	Cr. Hrs.	Contact Hrs.	Exam Marks
Th.	3	3	100
Pr.	-	-	-

Cyber Security Concepts, Web Application Security, Advanced Machine Learning Concepts in Cyber Security, Research Methods, Priniciples and Advanced Technologies, Intelligent Risk Management, Intelligent Techniques for Malware Detection, Statistical Learning for Intrusion Detection Systems (IDS), Intelligent Spam Detection, Intelligent Firewalls, Digital Investigation, Security Events and Information Managements (SEIM), User Behavior Modeling, Case Studies, Neural Computing and Deep Learning for Cyber Security.

Recommended book(s) for the approved course

Text book:

1. Clarence Chio, David Freeman, "Machine Learning and Security: Protecting Systems with Data and Algorithms", 1st edition, O'Reilly Media, 2018
2. Leslie F. Sikos, "AI in Cyber Security", 1st edition, Springer, 2019

CS-5118 Advanced Tools and Frameworks for Artificial Intelligence

	Cr. Hrs.	Contact Hrs.	Exam Marks
Th.	3	3	100
Pr.	-	-	-

Implementation Aspects of Artificial Intelligence Models, Algorithmic Designs, Machine Learning Algorithm Designs, Tools for Data Visualization, Data Preprocessing, Machine Learning, Neural Networks, Deep Learning, Data Mining, Network Analysis, Statistical Learning.

Recommended book(s) for the approved course

Text book:

1. S.N. Sivanandam, S. N Deepa, “Introduction to Neural Networks using MATLAB 6.0”, Tata McGraw-Hill /Education, 2006
2. Wei-Meng Lee, “Python Machine Learning”, Wiley, 2019

CS-5119 Ethics in Artificial Intelligence

	Cr. Hrs.	Contact Hrs.	Exam Marks
Th.	3	3	100
Pr.	-	-	-

Ethics in Artificial Intelligence (AI), Current Initiative in AI and Ethics, Ethics and Empirical Evidence, Normative Ethical Theories, Four Domains of Ethics, Ethical Issues in AI, Methodology for AI Implication, Thinking Procedure for AI in Ethics, Codes for Professional Ethics, Relation, Autonomy

Recommended book(s) for the approved course

Text book:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, Massachusetts Institute of Technology, 2016
2. Andrew W. Trask, “Grokking Deep Learning”, Manning Publishing Co., 2019