Industry Partner

SINCE : 2011

NEXCORE ALLIANCE

Bachelors(B.Voc) - Artificial Intelligence & Machine Learning

2025-26

Session:

Department of Computer Science & Engineering

Sem: 5

S emester: V						
C ourse Code	**C ourse Title**	**T ype of Course**	**L**	**T**	**P**	**C redit s**
BMA501	Formal Language & Automata Theory	Core	4	0	0	4
BMA502	Computer Networks	Core	4	0	0	4
BMA503	Deep learning	Core	4	0	0	4
BMA504	Deep Learning Lab	Skill based	0	0	4	2
BMA505	Project-1	Skill based	0	0	4	2
BMA506	Optimization Techniques in Machine Learning	Core	4	0	0	4
B MA599	**x xx**	**M OOC**				
	E lective-III(Any one of the following)		0	0	0	3
			3	**0**	**0**	**3**
BMA507	Soft Computing	Discipline Elective-II				
BMA508	Speech and Language Processing					
T otal			**1 9**	**0**	**8**	**2 6**

S emester: V

C ourse Title: F ORMAL LANGUAGE & AUTOMATA THEORY

C ourse Code: BMA501

L	T	P	C redits
4	0	0	4

T otal Hours: 60

L earning Outcomes:

After completion of this course, the learner will be able to:

1. Write a formal notation for strings, languages and machines.
2. Design finite automata to accept a set of strings of a language.
3. Formulate the context free grammars to generate strings of context free language.
4. Determine equivalence of languages accepted by Push Down Automata and languages

U NIT I **1 5 Hours**

F ormal L anguages:

C ourse Content

Basics of strings, alphabets, grammar, formal language, Chomsky classification of languages, languages and their relation, operations on languages, Closure properties of language classes.

R egular g rammar:

Regular grammars, Regular expressions, Algebraic method using Arden's theorem, Equivalence of Finite Automata and Regular expressions, Properties of regular languages, pumping lemma.

U NIT II **1 5 Hours**

T heory o f C omputation:

Deterministic Finite Automata, Acceptance by Finite Automata,
Transition systems, Non-Deterministic Finite Automata, Equivalence of DFA and NDFA, Moore and Mealy machines, Equivalence of Moore and Mealy machine, Minimization of Finite Automata, Applications and limitations of Finite Automata.

1 5 Hours

U NIT III

C ontext F ree L anguage: Derivation, ambiguity, simplification of context free grammar, normal forms- Chomsky Normal Form, Greibach Normal Form, pumping lemma. Context Sensitive Language, The model of Linear Bounded Automata, Relation between Linear Bounded Automata and Context Sensitive Language

U NIT IV **1 5 Hours**

P ush d own A utomata: Description and Definition, acceptance by Push down Automata, Equivalence of Push down Automata and context free grammars and languages.

T uring M achine: Definition and Model, Representation of Turing Machine, Design of Turing Machine, Variants of Turing Machine, Decidability and Recursively Enumerable Languages, Halting Problem, Post Correspondence Problem.

T ransaction Modes

Teaching, Self-Learning, Collaborative Learning and Cooperative Learning **S uggested Readings**
Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile

- *H arry R. Lewis and Christos H. Papadimitriou. (1998). Elements of the Theory of Computation.*
- *P earson Education Asia.*
- *D exter C. Kozen. (1997). Automata and Computability. Undergraduate Texts in Computer*
- *S cience, Springer.*
- *M ichael Sipser. (1997). Introduction to the Theory of Computation.PWS Publishing.*
- *J ohn Martin. (2007). Introduction to Languages and The Theory of Computation. Tata*
- *M cGrawHill.*
- *H opcroft J.E., Ullman J.D. (2006). Introduction to Automata Theory, Languages, and Computation (3rd Edn). Reading, MA: Addison-Wesley.*
  L ewis F.D. (2007). Essentials of Theoretical Computer Science.

W eb Links

- *h ttps://stackoverflow.com/questions/17252374/what-are-the-best-sites-to-learn- about- F ormal Language & Automata Theory*
- *h ttps://w ww.udemy.com/course/formal-languages-and-automata-theory-e/- F ormal L anguage & Automata Theory*
- *h ttps://eecs.wsu.edu/~ananth/CptS317- Formal Language & Automata Theory*

C ourse Title: COMPUTER NETWORKS

C ourse Code: BMA502

L	T	P	C redits
4	0	0	4

T otal Hours - 60

L earning Outcomes:

After completion of this course, the learner will be able to:

1. Understand the fundamentals of computer networking.
2. Learn the basic terminology of the computer networking area.
3. Analysis the various congestion control algorithms.
4. Describe the functions of the different layer of the OSI Protocol.

C ourse Content

U NIT I **1 2 Hours**

Representation of data and its flow Networks, Various Connection Topology, Protocols and Standards, OSI model, Transmission Media, LAN: Wired LAN, Wireless LANs, Connecting LAN and Virtual LAN. **T echniques for Bandwidth utilization: D ata Communication Components:**

Multiplexing - Frequency division, Time division and Wave division, Concepts on spread spectrum.

U NIT II **1 8 Hours**

D ata L ink L ayer a nd M edium A ccess S ub L ayer:

Error Detection and Error Correction -

Fundamentals, Block coding, Hamming Distance, CRC; Flow Control and Error control protocols - Stop and Wait, Go back – N ARQ, Selective Repeat ARQ, Sliding Window, Piggybacking, Random

N etwork Layer:

U NIT III Switching, Logical addressing – IPV4, IPV6; Address mapping – ARP, RARP, BOOTP, and DHCP- Delivery, forwarding and unicast routing protocols. **1 5 H ours**

T ransport L ayer:

U NIT IV Process to Process Communication, User Datagram Protocol (UDP), Transmission Control Protocol (TCP), SCTP Congestion Control; Quality of Service, QoS improving techniques: Leaky Bucket and Token Bucket algorithm. **1 5 Hours**

A pplication L ayer:

Domain Name Space (DNS), DDNS, TELNET, EMAIL, File Transfer Protocol (FTP), WWW, HTTP, SNMP, Bluetooth, Firewalls, and Basic concepts of Cryptography.

T ransaction Modes

Teaching, Self-Learning, Collaborative Learning and Cooperative Learning **S uggested Readings**
Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile

- *Andrew S. Tanenbaum, Pearson New International Edition. (2013). Computer Networks. 5th Edition.*

- *P rentice Hall of India. (2015). Internetworking with T CP/IP Volume 1. 6 th Edition D ouglas Comer.*
- *W . Richard Stevens, Addison-Wesley, United States o f America. (2005). TCP/I Illustrated. Volume1.*
- *K urose, J.F. and K.W. Ross (2003) Computer Networking: A Top Down Approach Featuring the I nternet, Addison Wesley.*
- *M ir, N.F. (2006) Computer and Communication Networks, Prentice Hall*

C ourse Title: Deep Learning

C ourse Code: BMA503

L	T	P	C redits
4	0	0	4

T otal Hours-60

L earning Outcomes:

After completion of this course, the learner will be able to:

learn architectures and optimization methods for deep neural network training **C ourse Contents:**

To introduce the fundamentals of deep learning and the main research activities in this field. To

U NIT I **1 2 Hours**

Introduction: History of Deep Learning, McCulloch Pitts Neuron, Multilayer Perceptrons (MLPs), Representation Power of MLPs, Sigmoid Neurons, Feed Forward Neural Networks, Back propagation.

U NIT II **1 2 Hours**

Module 2: Activation functions and parameters, Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, Principal Component Analysis and its interpretations,

Singular Value Decomposition, Parameters v/s Hyper-parameters **U NIT III** **1 8 Hours**

Auto-encoders & Regularization, Auto encoders and relation to PCA, Regularization in auto encoders, Denoising auto encoders, Sparse auto encoders, Regularization: Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Encoder Decoder Models,

Attention Mechanism, Attention over Images, Batch Normalization **U NIT IV** **1 8 Hours**

Deep Learning Models : Introduction to CNNs, Architecture, Convolution/pooling layers, CNN Applications, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet. Introduction to RNNs, Back propagation through time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT, GRU, LSTMs

Deep Learning Applications : Image Processing, Natural Language Processing, Speech recognition, Video Analytics

S uggested Readings

1. Deep Learning, Ian Goodfellow Yoshua Bengio Aaron Courville, MIT Press, 2017

2. Neural Networks and Deep Learning, Michael Nielsen,, Determination Press **R eference Books**

1. Deep Learning Step by Step with Python, N D Lewis, 2016

C ourse Title: D eep Learning LAB

C ourse Code: BMA504

L	T	P	C redits
0	0	4	2

T otal Hours: 30

L earning Outcomes:

After completion of this course, the learner will be able to:

1. Understand the methods and terminologies involved in deep neural network, differentiate the learning methods used in Deep-nets.
2. Identify and apply suitable deep learning approaches for given application.
3. Design and develop custom Deep-nets for human intuitive applications

C ourse Content List

4. Design of test procedures to assess the efficiency of the developed model.

of Programs:

1. Demonstration and implementation of Shallow architecture, using Python, Tensorflow and Keras.
2. Hyper parameter tuning and regularization practice -
   - Multilayer Perceptron (BPN)
   - Mini-batch gradient descent
3. Convolution Neural Network application using Tensorflow and Keras,
   - Classification of MNIST Dataset using CNN Face recognition using CNN
4. Object detection using Transfer Learning of CNN architectures
5. Image denoising (Fashion dataset) using Auto Encoders
   - Handling Color Image in Neural Network aka Stacked Auto Encoders (Denoising)
6. Text processing, Language Modeling using RNN
7. Transfer Learning models for classification problems
8. Sentiment Analysis using LSTM
9. Image generation using GAN

C ourse Title: PROJECT -I

C ourse Code: BMA505

L	T	P	C redits
0	0	4	2

T otal Hours: 30

L earning Outcomes:

After completion of this course, the learner will be able to:

1. Use latest multimedia devices and programming software.
2. Design and construct a hardware and software system, component or process to meet desired needs.
3. Understand the multidisciplinary applications Problems.
4. Examine work as professionals, with portfolio ranging from data management, network configuration, designing hardware, database and software design to management and administration of entire systems.

C ourse Content

1. Project should include following phases: System Analysis and Design
2. Coding - Implementation Testing
3. It should be a working project Must have a future perspective
4. The Domain of project can be from: Databases
5. Application software
6. System software
7. Multimedia
8. Web Applications, etc.

A complete project report must be submitted along with softcopy of project. Project report may include Requirements of Project, Flow Chart, DFD's, Coding and Test Results

C ourse Title: Optimization Techniques in Machine Learning

C ourse Code: BMA506

L	T	P	C redits
4	0	0	4

T otal Hours: 60

L earning Outcomes:

1. The students will be able to understand and analyze how to deal with changing data.
2. They will also be able to identify and interpret potential unintended effects in your project.
3. They will understand and define procedures to operationalize and maintain your applied machine learning model.

C ourse Contents:

U NIT I **1 8 Hours**

Introduction : What is optimization, Formulation of LPP, Solution of LPP: Simplex method, Basic Calculus for optimization: Limits and multivariate functions, Derivatives and linear approximations: Single variate functions and multivariate functions.

U NIT II **1 0 Hours**

Machine Learning Strategy : ML readiness, Risk mitigation, Experimental mindset, Responsibility, Team, setting up team,Understanding and communicating change.

U NIT III **1 2 Hours**

Build/buy/partner, Leading ML

U NIT IV **2 0 Hours**

AI for good and all, Positive feedback loops and negative feedback loops, Metric design and observing behaviours, Secondary effects of optimization, Regulatory concerns.

Machine Learning in production and planning :
Integrating info systems, users break things, time and space complexity in production, when to retain the model? Logging ML model versioning, Knowledge transfer, Reporting performance to stakeholders.
Care and feeding of your machine learning model :
MLPL Recap, Post deployment challenges, QUAM monitoring and logging, QUAM Testing, QUAM maintenance, QUAM updating, Separating Datastack from Production, Dashboard Essentials and Metrics monitoring.

T ext Books/Suggested References:

1. Jeeva Jose, Introduction to Machine Learning, Khanna Book Publishing 2020.
2. Rajiv Chopra, Machine Learning, Khanna Book Publishing 2021
3. Optimization for Machine Learning, Suvrit Sra, Sebastian Nowozin and Stephen J. Wright, MIT Press, 2011.
4. Optimization in Machine Learning and Applications, Suresh Chandra Satapathy, Anand J. Kulkarni, Springer, 2019.

C ourse Title: SOFT COMPUTING

C ourse Code: BMA507

L	T	P	C redits
3	0	0	3

T otal H ours-45

L earning Outcomes:

After completion of this course, the learner will be able to:

1. Determine Working of a simple Genetic Algorithm and the related definitions: Representation/Encoding Schemes, initializing a GA population
2. Analysis the concept of Neural Networks.
3. Examine the Genetic Algorithm variations: Scaling fitness, Niching and speciation, Crowding Technique for Multimodal Problems.
4. Understand the basic terminology and definitions, Model of an artificial neuron, Sigmoid function, Neural Network Architectures, Characteristics of neural networks, Learning methods, Rosenblatt's Perception

C ourse Content

U NIT – I **1 0 Hours**

W orking o f a s imple G enetic A lgorithm a nd t he r elated d efinitions:

Representation/ Encoding Schemes, initializing a GA population, evaluation function, genetic operators, study of parameters of genetic algorithms and its performance, sampling and selection mechanisms, mathematical foundations of genetic algorithms, schemata theorem and building block hypothesis, optimizing numerical functions using GA.

U NIT– II **1 0 Hours**

G enetic A lgorithm V ariations:

Scaling fitness, Niching and speciation, Crowding Technique for Multimodal Problems, Multi-Objective Genetic Algorithms, Master Slave and Distributed Genetic Algorithms, Designing GAs for numerical optimization, knapsack problem, travelling salesperson and other similar problems.

U NIT – III **1 5 Hours**

N eural N etworks:

Basic terminology and definitions, Model of an artificial neuron, Sigmoid function, Neural Network Architectures, Characteristics of neural networks, Learning methods, Rosenblatt's Perceptron, Fixed increment perceptron learning algorithm for a classification problem, Examples of learning of AND/OR gate by perception, XOR problem. Back Propagation Neural Networks Architecture of a back propagation network, Model for multi-layer perceptron, Back propagation learning, Delta or gradient descent learning rule and effect of learning rate, Back propagation learning algorithm.

U NIT– IV **1 0 Hours**

F uzzy S ets:

Basic terminology and definitions, Operations on Fuzzy sets, MF formulations and parameterization, Derivatives of parameterized MFs, Fuzzy numbers,

Extension principal and fuzzy relations, Linguistic variables, Fuzzy If-Then Rules, Fuzzy

S oftware and Tools to be learnt: MATLAB tool boxes on global optimization, neural networks and fuzzy logic, R Programming, GALIB 247 and KEEL

T ransaction Modes

reasoning and compositional rule of inference.

Teaching, Self-Learning, Collaborative Learning and Cooperative Learning **S uggested Readings**

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile

- *O rdinal Optimization: Soft Optimization for Hard Problems" by Yu-Chi Ho and Qian- Chuan Zhao.*
- *" Soft Computing: New Trends and Applications (Advanced Textbooks in Control and Signal P rocessing)" by L Fortuna and G Rizzotto.*
- *" Soft Computing for Control of Non-Linear Dynamical Systems (Studies in Fuzziness and Soft C omputing)" by Oscar Castillo and Patricia Melin.*

C ourse Title: Speech and Language Processing

C ourse Code: BMA508

L	T	P	C redits
3	0	0	3

T otal Hours-45

L earning Outcomes:

1. Be competent with fundamental concepts for natural language processing and automatic speech recognition
2. To understand technologies involved in developing speech and language applications.
3. To demonstrate the use of deep learning for building applications in speech and natural language processing

C ourse Outcomes

At the end of this course, student will be able to:

1. Describe the importance of different NLP modules in Text processing and fundamentals of speech production
2. Describe ways to represent speech and text
3. Demonstrate the working of sequence models for text
4. Use signal processing techniques to analyze/represent the speech signal
5. Execute trials of speech/language systems

U NIT I **1 5 hours**

Introduction to Natural Language Processing :
Overview of NLP - Introduction to Levels of NLP - Morhpology: Derivational & Inflectional Morphology - POS tagging - Parsing: Shallow and Dependency Parsing, Semantics: Word Level Semantics and Thematic roles.

Text Preprocessing & Feature Representation:
Introduction to Corpora, Sentence Segmentation, Stemming: Porter Stemmer, Bag of words and Vector Space Model, Topic Modeling, N-gram Language Model, Smoothing, Word Embeddings: Word2Vec, Glove and Fasttext.

U NIT II **1 0 hours**

Applications of NLP-1
Sentiment Classification using ML & DL models, Named Entity Recognition - CRF and LSTMs, Text Summarization - Statistical and Deep Learning models.
Applications of NLP-2:
Machine Translation - Encoder & Decoder Model, Attention Models, Question Answering - Knowledge based Q&A and Deep Learning models for Q&A.

U NIT III **1 0 hours**

Introduction to Speech Processing: Fundamentals of speech production – Perception of sound – Vocal tract model – Phonetics - Short-Time analysis of the signal – Energy – Zero crossing – Autocorrelation – Short time Fourier analysis. Feature Representaion of Speech Signal: Mel Frequency Cepstral Coeffecients, Perceptual linear prediction (PLP), Linear prediction

U NIT IV **1 0 hours**

cepstral coefficients (LPCC), Gammatone Frequency Cepstral Coefficients (GFCC), i-vector.

Automatic Speech and Speaker Recognition: Automatic Speech recognition formulation: Isolated word recognition – Large vocabulary continuous speech recognition - HMM/GMM based speech recognition – DNN/HMM model -- CNN based speech recognition - RNN language Models – Evaluation metrics, Speaker Item 66/29 - Annexure - 25 Proceedings of the 66th Academic Council (16.06.2022) 664 recognition model – Alexa/Google assistant-based application development.