GURU KASHI UNIVERSITY

B. Voc.in – Artificial Intelligence & Machine Learning

Session: 2024-25

Department of Computer Science & Engineering

Semester: V						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credits**
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
BMA599	**xxx**	**MOOC**	0	0	0	3
Elective-III(Any one of the following)						
BMA507	Soft Computing	Discipline Elective-II	**3**	**0**	**0**	**3**
BMA508	Speech and Language Processing					
Total			**19**	**0**	**8**	**26**

Semester: V

Course Title:	**FORMAL LANGUAGE & AUTOMATA THEORY**	L	T	P	Credits
Course Code: BMA501		4	0	0	4

Total Hours: 60

Learning 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 `

Course Content

UNIT I   **15 Hours**

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

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

UNIT II   **15 Hours**

Theory of Computation: 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.

UNIT III   **15 Hours**

Context Free Language: 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

UNIT IV   **15 Hours**

Push down Automata: Description and Definition, acceptance by Push down Automata, Equivalence of Push down Automata and context free grammars and languages.

Turing Machine: 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.

Transaction Modes

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

Teaching, Self-Learning, Collaborative Learning and Cooperative Learning **Suggested Readings**

- *Harry R. Lewis and Christos H. Papadimitriou. (1998). Elements of the Theory of Computation.*
- *Pearson Education Asia.*
- *Dexter C. Kozen. (1997). Automata and Computability. Undergraduate Texts in Computer*
- *Science, Springer.*
- *Michael Sipser. (1997). Introduction to the Theory of Computation.PWS Publishing.*
- *John Martin. (2007). Introduction to Languages and The Theory of Computation. Tata McGrawHill.*
- *Hopcroft J.E., Ullman J.D. (2006). Introduction to Automata Theory, Languages, and Computation (3rd Edn). Reading, MA: Addison-Wesley.*
- *Lewis F.D. (2007). Essentials of Theoretical Computer Science.*

   Web Links
- *https://stackoverflow.com/questions/17252374/what-are-the-best-sites-to-learn- about- Formal Language & Automata Theory*
- *https://www.udemy.com/course/formal-languages-and-automata-theory-e/- Formal Language & Automata Theory*
- * https://eecs.wsu.edu/~ananth/CptS317- Formal Language & Automata Theory*

Course Title: COMPUTER NETWORKS	L	T	P	Credits
Course Code: BMA502	4	0	0	4

Total Hours - 60

Learning 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.

Course Content

UNIT I 12 Hours

Data Communication Components: 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. **Techniques for Bandwidth utilization:** Multiplexing - Frequency division, Time division and Wave division, Concepts on spread spectrum.

UNIT II 18 Hours

Data Link Layer and Medium Access Sub Layer: 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 Access, Multiple access protocols -Pure ALOHA, Slotted ALOHA, CSMA/CDCDMA/CA

Network Layer: Switching, Logical addressing – IPV4, IPV6; Address mapping – ARP, RARP, BOOTP and DHCP–Delivery, Forwarding and Unicast Routing protocols.

UNIT III 15 Hours

Transport Layer: 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.

UNIT IV 15 Hours

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

Transaction Modes

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

• *Andrew S. Tanenbaum, Pearson New International Edition. (2013). Computer Networks. 8th Edition.*

- *Prentice Hall of India. (2015). Internetworking with TCP/IP Volume 1.   6th Edition Douglas Comer.*
- *W. Richard Stevens, Addison-Wesley, United States of America. (2005). TCP/I Illustrated. Volume1.*
- *Kurose, J.F. and K.W. Ross (2003) Computer Networking: A Top Down Approach Featuring the Internet, Addison Wesley.*
- *Mir, N.F. (2006) Computer and Communication Networks, Prentice Hall*

Course Title: Deep Learning	L	T	P	Credits
Course Code: BMA503	4	0	0	4

Total Hours-60

Learning Outcomes: After completion of this course, the learner will be able to:
To introduce the fundamentals of deep learning and the main research activities in this field. To learn architectures and optimization methods for deep neural network training **Course Contents:**

UNIT I   **12 Hours**

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

UNIT II   **12 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 **UNIT III**   **18 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 **UNIT IV**   **18 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

Suggested Readings

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

2. Neural Networks and Deep Learning, Michael Nielsen,, Determination Press

Reference Books

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

Course Title:	Deep Learning LAB	**L**	**T**	**P**	**Credits**
Course Code: BMA504		0	0	4	2

Total Hours: 30

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

Course Content List

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

Course Title: PROJECT -I

Course Code: BMA505

L	T	P	Credits
0	0	4	2

Total Hours: 30

 Learning 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.

Course 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

Course Title: Optimization Techniques in Machine Learning	L	T	P	Credits
Course Code: BMA506	4	0	0	4

Total Hours: 60

Learning 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.

Course Contents:

UNIT I   **18 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.

UNIT II   **10 Hours**
Machine Learning Strategy : ML readiness, Risk mitigation, Experimental mindset, Build/buy/partner, setting up a team,Understanding and communicating change.

UNIT III   **12 Hours**
Responsible Machine Learning :
AI for good and all, Positive feedback loops and negative feedback loops, Metric design and observing behaviours, Secondary effects of optimization, Regulatory concerns.

UNIT IV   **20 Hours**
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.

Text 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.

Course Title: SOFT COMPUTING	L	T	P	Credits
Course Code: BMA507	3	0	0	3

Total   Hours-45

Learning 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

Course Content

UNIT– I   **10 Hours**

Working of a simple Genetic Algorithm and the related definitions: 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.

UNIT– II   **10 Hours**

Genetic Algorithm Variations: 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.

UNIT– III   **15 Hours**

Neural Networks: 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.

UNIT– IV   **10 Hours**

Fuzzy Sets: 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 reasoning and compositional rule of inference.

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

Transaction Modes

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

- *Ordinal 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 Processing)" by L Fortuna and G Rizzotto.*
- *"Soft Computing for Control of Non-Linear Dynamical Systems (Studies in Fuzziness and Soft Computing)" by Oscar Castillo and Patricia Melin.*

Course Title: Speech and Language Processing

Course Code: BMA508

L	T	P	Credits
3	0	0	3

Total Hours-45

Learning 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

Course 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

UNIT I   **15 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.

UNIT II   **10 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.

UNIT III   **10 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 cepstral coefficients (LPCC), Gammatone Frequency Cepstral Coefficients (GFCC), i-vector.

UNIT IV   **10 hours**

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.