

ಡಾ. ಮನಮೋಹನ ಸಿಂಗ್
ಬೆಂಗಳೂರು ನಗರ ವಿಶ್ವವಿದ್ಯಾನಿಲಯ



Dr. MANMOHAN SINGH
BENGALURU CITY UNIVERSITY

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No.MSBCU/BoS/BCA-UG/ /2026-27

Date:07.07.2026

NOTIFICATION

Sub: V & VI Semesters Syllabus of Dr. Manmohan Singh
Bengaluru City University-reg.

Ref: 1. Recommendations of Board of Studies in the Computer
Science and Applications [PG & UG]
2. Academic Council resolution No.05 dated.08.06.2026
3. Approval of the Vice-Chancellor dated.07.07.2026

In pursuance of the recommendation in the BoS in Computer Science and Applications (PG & UG) and as per the resolution of the Academic Council cited at ref (2) above and after consultation with Dean of Science Faculty & Chairperson of BoS, the Syllabus of following courses are hereby notified for information of the concerned, effective from the academic year 2026-27.

1.	B.Sc. Computer Science V & VI Semester
2.	BCA – V & VI Semester
3.	BCA- AI & ML – V & VI Semester
4.	BCA- Data Science– V & VI Semester
5.	B.Voc (IT) – V & VI Semester

The copy of the Syllabus is notified in the University Website: www.bcu.ac.in for information of the concerned.

REGISTRAR

To:

The Registrar (Evaluation), Dr. Manmohan Singh Bengaluru City University, Bengaluru.

Copy to;

1. The Dean, Faculty of Science, MSBCU.
2. The Chairman & Members of BoS in Computer Science and Applications (PG &UG), MSBCU.
3. Principals of all affiliated Colleges of MSBCU.
4. The P.S. to Vice-Chancellor/Registrar/Registrar (Evaluation), MSBCU.
5. Office copy / Guard file / University Website: www.bcu.ac.in



Dr. MANMOHAN SINGH
BENGALURU CITY UNIVERSITY

CHOICE BASED CREDIT SYSTEM
[As per SEP]

Syllabus for BCA [AI & ML]

2026-27 onwards

Board of Studies in Computer Science for UG

No : BCU/BoS/Comp.Sci. & Appln.(PG & UG)/361/2025-26 dated 05-01-2026

1	Dr. Ashok S B Director, School of Computer Science Maharani Cluster University Bengaluru-560001	Chairperson
2	Prof. Guru D S Department of Studies in Computer Science University of Mysore, Mysore-570006	Member
3	Prof. Aziz Makandar Department of Computer Science Karnataka State Akkamahadevi Women University, Jnanashakti Campus, Vijayapura-586109	Member
4	Prof. Suneetha Department of Computer Science, Karnataka State Open University, Muktha Gangothri, Mysuru-570006	Member
5	Prof. Veena R Department of MCA, Seshadripuram College, Seshadripuram, Bengaluru-560020	Member
6	Prof. Kiran Kumar M N Department of Computer Applications, BMS College of Commerce and Management, Bengaluru-560004	Member
7	Prof. Latha B Department of Computer Science Vijaya College, R V Road, Basavanagudi, Bengaluru- 560004	Member
8	Prof. R Shanthi Krishna Department of Computer Applications, SSMRV College, Jayanagar, Bengaluru-560041	Member
9	Prof. Roopa H R Department of Computer Applications, Seshadripuram Institute of Commerce and Management, Seshadripuram, Bengaluru-560020	Member
10	Sri Seby Kallarakkal CEO-Nabler Web Solutions, Bengaluru-560052	Member

Name of the Degree Program : **Bachelor of Computer Applications (AI & ML)**
Discipline Course : **Computer Science**
Starting Year of Implementation: **2024-25 (I & II Semesters)**
2025-26 (III & IV Semesters)
2026-27 (V & VI Semesters)

Programme Outcome (PO):

PO 1	Apply knowledge of computing fundamentals, programming principles, and mathematical foundations to solve problems related to computer applications and AI & ML.
PO 2	Identify, analyze, and define problems related to data processing, algorithms, and machine learning, and apply appropriate computing techniques to solve them.
PO 3	Design and implement solutions for AI and ML-based problems using suitable algorithms, data structures, and models while considering performance and accuracy.
PO 4	Use data analysis, exploratory data visualization, and feature engineering to draw conclusions from structured and unstructured data.
PO 5	Apply appropriate software tools and new age technologies and cloud platforms for solving computational and AI & ML related problems.
PO 6	Understand ethical issues and responsibilities in AI and data usage, and adhere to legal, societal and cyber security norms in professional practices.
PO 7	Effectively communicate AI and ML solutions, system designs, and findings with stakeholders through reports, documentation and visualizations.
PO 8	Function effectively as an individual or as a team member in software development and AI & ML projects, both in academic and professional environments.
PO 9	Recognize the need for and engage in continuous learning to keep pace with rapidly evolving technologies in AI, machine learning, and data science.
PO 10	Apply AI and ML knowledge to develop innovative applications and solutions, fostering entrepreneurship and the ability to create tech-based startups.

ASSESSMENT

Weightage for the Assessments (in percentage)

Type of Course	Formative Assessment	Summative Assessment
Theory	20%	80 %
Practical	20%	80 %

Detailed Structure for BCA- AI&ML Programme

Semester	Course Code	Paper Title	Teaching Hours / Week	Marks		Duration of Exam in Hours	Credits
				Exam	IA		
I	24BCA11	Discrete Structure	03	80	20	03	03
	24BCA12	Problem Solving Technique	03	80	20	03	03
	24BCA13	Computer Architecture	03	80	20	03	03
	24BCA12P	Problem Solving Technique Lab	04	40	10	03	02
	24BCA13P	Computer Architecture Lab	04	40	10	03	02
	24BCA1P	Office Automation Tools	04	40	10	03	02
	24BCAL11	Language-I	04	80	20	03	03
	24BCAL12	Language-II	04	80	20	03	03
	24BCACC1	Constitutional Values- I	02	40	10	1.5	02
		Total Credits					23
II	24BCA21	Data Structures	03	80	20	03	03
	24BCA22	Object Oriented Programming Using Java	03	80	20	03	03
	24BCA23	Operating System	03	80	20	03	03
	24BCA21P	Data Structures Lab	04	40	10	03	02
	24BCA22P	Java Programming Lab	04	40	10	03	02
	24BCA23P	Unix & Shell Programming Lab	04	40	10	03	02
	24BCAL21	Language - I	04	80	20	03	03
	24BCAL22	Language - II	04	80	20	03	03
	24BCACC2	Constitutional Values - II	02	40	10	1.5	02
	24BCACC3	Environmental Studies	02	40	10	1.5	02
		Total Credits					25

Semester	Course Code	Paper Title	Teaching Hours / Week	Marks		Duration of Exam in Hours	Credits
				Exam	IA		
III	24BCA31	Database Management System	04	80	20	03	03
	24BCA32	Python Programming	04	80	20	03	03
	24BCA33	Design and Analysis of Algorithms	04	80	20	03	03
	24BCA34	Feature Engineering	02	40	10	1.5	02
	24BCA31P	Database Management System Lab	03	40	10	03	02
	24BCA32P	Python Programming Lab	03	40	10	03	02
	24BCA33P	Design and Analysis of Algorithms Lab	03	40	10	03	02
	24BCAL31	Language –I	04	80	20	03	03
	24BCAL32	Language –II	04	80	20	03	03
Total Credits							23
IV	24BCA41	Artificial Intelligence	04	80	20	03	03
	24BCA42	Data Analytics	04	80	20	03	03
	24BCA43	Internet of Things	04	80	20	03	03
	24BCA44	Data Visualization	02	40	10	1.5	02
	24BCA41P	Artificial Intelligence Lab	03	40	10	03	02
	24BCA42P	Data Analytics Lab	03	40	10	03	02
	24BCA43P	Internet of Things Lab	03	40	10	03	02
	24BCASE1	Probability and Statistics	02	40	10	1.5	02
	24BCAL41	Language - I	04	80	20	03	03
	24BCAL42	Language - II	04	80	20	03	03
Total Credits							25

Semester	Course Code	Paper Title	Teaching Hours / Week	Marks		Duration of Exam in Hours	Credits
				Exam	IA		
V	24BCA51	Machine Learning & Neural Networks	04	80	20	03	03
	24BCA52	Digital Image Processing	04	80	20	03	03
	24BCA53	Software Engineering	04	80	20	03	03
	24BCA54	Natural Language Processing	04	80	20	03	03
	24BCA51P	Machine Learning & Neural Networks Lab	03	40	10	03	02
	24BCA52P	Digital Image Processing Lab	03	40	10	03	02
	24BCASE2	Quantitative Techniques	02	40	10	1.5	02
	24BCAPJ	Project	08	120	30	03	06
Total Credits							24
VI	24BCA61	Deep Learning	04	80	20	03	03
	24BCA62	Predictive Analysis	04	80	20	03	03
	24BCA63	Introduction to Robotics in AI	04	80	20	03	03
	24BCA64	DevOps	04	80	20	03	03
	24BCA61P	Deep Learning Lab	03	40	10	03	02
	24BCAIS	Internship	03*	80	20	03	06
Total Credits							20
Overall Total Credits: 140							

***This is only for guidance, supervision and monitoring of internship and its report. The same is to be considered on par with the workload.**

SEMESTER – V

Theory	24BCA51: Machine Learning & Neural Networks	
Teaching Hours : 04 Hours/Week		Credits : 03
Duration of Exam : 03 Hours		Maximum Marks : 100 (Exam 80 + IA 20)

Course Outcomes

COs	Description
CO1	Understand fundamental concepts of Machine Learning, types of learning, and data preprocessing techniques.
CO2	Apply supervised and unsupervised learning algorithms for solving real-world problems.
CO3	Analyze and implement neural network models and learning algorithms.
CO4	Evaluate machine learning models and use appropriate performance metrics and tools.

UNIT – I: Foundations of Machine Learning

14 Hours

Introduction to Artificial Intelligence and Machine Learning, Types of Machine Learning: Supervised, Unsupervised, Reinforcement Learning, Applications of ML, ML Workflow: Data Collection, Preprocessing, Training and Testing, Data Preprocessing: Handling missing data, Data normalization and scaling, Feature selection and extraction, Model Evaluation Basics: Accuracy, Precision, Recall, F1-score.

UNIT – II: Supervised Learning Techniques

14 Hours

Regression: Linear Regression, Multiple Linear Regression; Classification: Logistic Regression, K-Nearest Neighbours (KNN), Decision Trees, Random Forest; Concepts of Overfitting and Underfitting, Cross-validation Techniques.

UNIT – III: Unsupervised Learning & Dimensionality Reduction

14 Hours

Clustering: K-Means Clustering, Hierarchical Clustering; Association Rule Learning: Apriori Algorithm (basics); Dimensionality Reduction: Principal Component Analysis (PCA); Applications of Unsupervised Learning.

UNIT – IV: Neural Networks and Advanced ML Tools

14 Hours

Biological vs Artificial Neuron, Perceptron Model, Activation Functions (Sigmoid, ReLU, Tanh), Neural Network Architecture, Feedforward Neural Networks, Backpropagation Algorithm, Gradient Descent (basic idea), Introduction to Deep Learning (overview), Model Evaluation Techniques: Confusion Matrix, ROC Curve (basic idea), Introduction to ML Libraries: NumPy, Pandas, Scikit-learn.

TEXT BOOKS:

1. Machine Learning and Artificial Intelligence by Ameet V. Joshi, published by Springer, 1st Edition, 2020.
2. Machine Learning by Kamalkant Hiran, Ruchi Doshi, Ritesh Kumar Jain, and Kamlesh Lakhwani, published by BPB Publications, 1st Edition, 2021.

REFERENCE BOOKS:

1. Machine Learning by Tom M. Mitchell, published by McGraw-Hill, 1st Edition, 1997.
2. Introduction to Machine Learning by Ethem Alpaydın, published by MIT Press, 4th Edition, 2020.
3. Deep Learning by Ian Goodfellow, Yoshua Bengio, and Aaron Courville, published by MIT Press, 1st Edition, 2016.
4. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow by Aurélien Géron, published by O'Reilly Media, 2nd Edition, 2019.

Theory	24BCA52: Digital Image Processing	
Teaching Hours : 04 Hours/Week		Credits: 03
Duration of Exam: 03 Hours		Maximum Marks: 100 (Exam 80 + IA 20)

Course Outcomes

COs	Description
CO1	Understand the fundamentals of digital images, image representation and processing techniques.
CO2	Apply image enhancement and filtering techniques in spatial and frequency domains.
CO3	Analyze image segmentation and feature extraction methods.
CO4	Implement image processing algorithms using modern tools and libraries.

UNIT – I: Fundamentals of Digital Image Processing

14 Hours

Introduction to Digital Image Processing, Applications, Image Representation (Pixels, Resolution, Intensity Levels), Types of Images (Binary, Grayscale, Color), Components of Image Processing System, Image Acquisition, Sampling and Quantization, Human Visual System Basics, Color Models (RGB, CMY, HSV).

UNIT – II: Image Enhancement Techniques

14 Hours

Spatial Domain: Gray Level Transformations (Negative, Log, Power Law), Contrast Stretching, Histogram Processing (Equalization, Specification), Smoothing Filters (Mean, Median), Sharpening Filters (Laplacian, Sobel, Prewitt);
Frequency Domain: Fourier Transform Basics, Frequency Representation, Low Pass and High Pass Filters, Ideal, Butterworth and Gaussian Filters, Image Restoration Basics, Noise Models and Filtering.

UNIT – III: Image Segmentation

14 Hours

Fundamentals of Image Segmentation, Edge Detection (Sobel, Prewitt, Canny), Thresholding Techniques, Region-Based Segmentation, Morphological Operations (Dilation, Erosion, Opening, Closing).

UNIT – IV: Feature Extraction and Applications

14 Hours

Feature Extraction Basics, Shape and Texture Features, Object Recognition Basics, Image Classification Basics, Applications of Digital Image Processing: Face Detection, Medical Imaging, Computer Vision

TEXT BOOKS

1. Digital Image Processing by Rafael C. Gonzalez and Richard E. Woods, published by Pearson, 4th Edition, 2018.
2. Fundamentals of Digital Image Processing by Anil K. Jain, published by Prentice Hall, 1st Edition, 1989.
3. Digital Image Processing by S. Sridhar, published by Oxford University Press, 2nd Edition, 2016.

REFERENCE BOOKS

1. Digital Image Processing Using MATLAB by Rafael C. Gonzalez, Richard E. Woods, and Steven L. Eddins, published by Pearson, 2nd Edition, 2009.
2. Fundamentals of Digital Image Processing by Anil K. Jain, published by Prentice Hall, **1st** Edition, 1989.
3. Digital Image Processing and Analysis by Bhabatosh Chanda and Dwijesh Dutta Majumder, published by Prentice Hall of India, 2nd Edition, 2011.
4. Computer Vision: Algorithms and Applications by Richard Szeliski, published by Springer, **1st** Edition, 2010.

Theory	24BCA53: Software Engineering	
Teaching Hours : 04 Hours/Week		Credits: 03
Duration of Exam: 03 Hours		Maximum Marks: 100 (Exam 80 + IA 20)

Course Outcome

COs	Description
CO1	Ability to understand software engineering concepts and SDLC models.
CO2	Analyze software requirements and prepare design models.
CO3	Apply testing, maintenance, and project management techniques.
CO4	Understand modern software engineering trends and tools

UNIT – I Introduction to Software Engineering

14 Hours

Introduction to Software and Software Engineering, Software Products and Software process, Characteristics of Software, Software Crisis and Need for Software Engineering, Software Development Life Cycle (SDLC), Role of Software Engineer, Software Process Framework, Ethics in Software Engineering, Software Process Models: Waterfall Model, Prototype Model, Spiral Model, Incremental Model, Agile Model (Basics), Emerging Trends in Software Development.

UNIT - II Requirements Engineering and Software Design

14 Hours

Requirement Engineering Process, Feasibility Study, Requirement Gathering Techniques, Software Requirement Specification (SRS), Functional and Non-Functional Requirements, Introduction to Software Design, Design Principles, Modular Design, Structured Design Tools, Introduction to UML Diagrams, Coding Standards and Documentation

UNIT – III Testing Strategies and Product Metrics

14 Hours

Software Testing Basics, Unit Testing, Integration Testing, System Testing and Validation, Test strategies for conventional software, Black-box and White-box testing, Software Quality, Metrics for Analysis Model, Metrics for Design Model, Metrics for source code, Metrics for testing, Metrics for maintenance, Software Measurement, Metrics for software quality. Clean room software development.

UNIT - IV Software Maintenance and Project Management

14 Hours

Software Maintenance Concepts, Types of Maintenance, Reverse Engineering and Re-engineering, Software Reliability, Software Quality Assurance, Software Project Planning, Cost Estimation Basics, Scheduling and Risk Management, Team Management, Introduction to CASE Tools.

TEXT BOOKS

1. Software Engineering, A practitioner's Approach- Roger S. Pressman, 6th edition, Mc Graw Hill International Edition.
2. Software Engineering- Sommerville, 7th edition, Pearson Education.
3. The unified modeling language user guide Grady Booch, James Rumbaugh, Ivar Jacobson, Pearson Education.

REFERENCE BOOKS

1. Software Engineering, an Engineering approach- James F. Peters, Witold Pedrycz, John Wiley.
2. Software Engineering principles and practice- Waman S Jawadekar, The Mc Graw-Hill Companies.
3. Fundamentals of object-oriented design using UML Meiler page-Jones: Pearson Education.

Theory	24BCA54: Natural Language Processing	
Teaching Hours : 04 Hours/Week		Credits : 03
Duration of Exam : 3 Hours		Maximum Marks : 100 (Exam 80 + IA 20)

Course Outcomes

COs	Description
CO1	Understand NLP concepts, challenges and linguistic fundamentals.
CO2	Apply text preprocessing, lexical analysis and language modeling techniques.
CO3	Analyze syntactic and semantic structures using parsing and tagging methods.
CO4	Evaluate NLP models and implement applications such as sentiment analysis and NER.

UNIT – I: Introduction and Linguistic Foundations

14 Hours

Introduction to Natural Language Processing, History and Applications, Challenges in NLP (ambiguity, sparsity, context), NLP Pipeline and Components, Levels of Language Analysis (Phonology, Morphology, Lexical, Syntax, Semantics, Pragmatics), Basics of Corpus Linguistics, Text Corpora, Annotation, Language Resources and Datasets.

UNIT – II: Text Preprocessing and Language Modeling

14 Hours

Text Preprocessing: Sentence Segmentation, Tokenization, Stop Word Removal, Normalization, Stemming and Lemmatization, Handling Noise and Special Characters, Regular Expressions, Vocabulary Creation, N-grams and Probabilistic Language Models, Smoothing Techniques (Laplace), Bag of Words, TF-IDF and Feature Extraction.

UNIT – III: Syntax and Semantic Processing

14 Hours

POS Tagging (Rule-Based, Stochastic, Transformation-Based), Hidden Markov Models (conceptual), Context-Free Grammar (CFG), Constituency and Dependency Parsing, Parsing Algorithms (Top-Down, Bottom-Up, Chart Parsing), Lexical Semantics, Word Sense Disambiguation, Semantic Relationships, Named Entity Recognition (NER), Semantic Role Labeling (basic idea).

UNIT – IV: Discourse, Applications and Modern NLP

14 Hours

Pragmatics and Discourse Analysis, Coreference Resolution, Context Handling, Text Classification, Sentiment Analysis, Information Retrieval, Question Answering, Chatbots and Conversational Agents, Machine Translation (Rule-Based, Statistical, Neural – overview), Word Embeddings (Word2Vec, GloVe), Overview of Deep Learning in NLP, NLP Libraries and Tools (NLTK, SpaCy, Transformers).

TEXT BOOKS:

1. Speech and Language Processing by Daniel Jurafsky and James H. Martin, published by Pearson, 3rd Edition (Draft), 2023.
2. Natural Language Processing with Python by Steven Bird, Ewan Klein, and Edward Loper, published by O'Reilly Media, 1st Edition, 2009.
3. Introduction to Natural Language Processing by Jacob Eisenstein, published by MIT Press, 1st Edition, 2019.

REFERENCE BOOKS:

1. Speech and Language Processing by Daniel Jurafsky and James H. Martin, published by Pearson, 3rd Edition (Draft), 2023.
2. Natural Language Processing with Python by Steven Bird, Ewan Klein, and Edward Loper, published by O'Reilly Media, 1st Edition, 2009.
3. Introduction to Natural Language Processing by Jacob Eisenstein, published by MIT Press, 1st Edition, 2019.

Theory	24BCA54: Quantitative Techniques
Teaching Hours : 2 Hours/Week	Credits : 02
Duration of Exam : 1.5 Hours	Maximum Marks : 50 (Exam 40 + IA 10)

Course Outcomes

COs	Description
CO1	Understand fundamental quantitative concepts such as number systems, percentages, ratios, and algebra required for solving aptitude problems.
CO2	Apply arithmetic and algebraic techniques to solve problems related to time, speed, distance, work, and real-life business scenarios.
CO3	Analyze data using tables, charts, and graphs to interpret and solve data interpretation and data sufficiency problems.
CO4	Evaluate different problem-solving approaches and select appropriate strategies such as approximation, elimination, and shortcut methods to improve speed and accuracy.

UNIT – I Core Arithmetic and Algebra

14 Hours

Number System - Divisibility rules; LCM & HCF; Remainders (basic concepts). Percentages and Applications - Percentage calculations; Profit and Loss; Discount problems. Ratio and Proportion - Direct & inverse proportion; Partnership problems. Averages - Simple and weighted averages. Time, Speed and Distance - Basic concepts; Relative speed; Problems on trains. Time and Work - Work efficiency; Pipes and cisterns. Algebra Basics - Linear equations; Quadratic equations (basic problems).

UNIT – II Data Interpretation and Advanced Aptitude

14 Hours

Data Interpretation – Tables; Bar charts; Pie charts; Line graphs. Permutations and Combinations - Basic counting principles. Probability - Basic probability concepts; Simple applications. Logarithms (Basics) - Rules and applications. Sequences and Series - Arithmetic Progression (AP); Geometric Progression (GP). Geometry (Basics) - Areas and volumes. Problem-Solving Strategies - Approximation techniques; Time-saving tricks; Elimination methods.

Text Books

1. Aggarwal, R. S., Quantitative Aptitude for Competitive Examinations, S. Chand Publishing, 2025 Revised Edition.
2. Sharma, Arun, Quantitative Aptitude for CAT, McGraw Hill Education, 2026 Edition.

Reference Books

1. Guha, Abhijit, Quantitative Aptitude for Competitive Examinations, McGraw Hill Education, 2023 Edition.
2. Verma, Sarvesh K., Quantum CAT: Quantitative Aptitude, Arihant Publications, 2024 Edition.

3. Tyra, Nishit K., Magical Book on Quicker Maths, BSC Publishing, 2023 Edition.
4. Verma, Rajesh, Fast Track Objective Arithmetic, Arihant Publications, 2023 Edition.
5. Singh, Ajay, Objective Arithmetic, Arihant Publications, 2023 Edition.

Lab	24BCA51P: Machine Learning & Neural Networks Lab	
Teaching Hours : 03 Hours/Week		Credits : 02
Duration of Exam : 3 Hours		Maximum Marks : 50 (Exam 40 + IA 10)

Lab Programs

1. Study and implementation of NumPy and Pandas for data handling.
2. Data preprocessing: handling missing values, encoding and feature scaling.
3. Implementation of Simple Linear Regression.
4. Implementation of Multiple Linear Regression.
5. Implementation of Logistic Regression.
6. Implementation of K-Nearest Neighbors (KNN).
7. Implementation of Decision Tree Classifier.
8. Implementation of Random Forest Algorithm.
9. Implementation of Support Vector Machine (SVM).
10. Implementation of K-Means Clustering.
11. Implementation of Hierarchical Clustering.
12. Implementation of Principal Component Analysis (PCA).
13. Implementation of Perceptron Model.
14. Implementation of Artificial Neural Network (ANN).

Lab	24BCA52P: Digital Image Processing Lab	
Teaching Hours : 03 Hours/Week		Credits : 02
Duration of Exam : 3 Hours		Maximum Marks : 50 (Exam 40 + IA 10)

Lab Programs

1. Study of image representation and basic operations using Python/OpenCV.
2. Read, display and save images using image processing libraries.
3. Implementation of image conversion: RGB to Grayscale and vice versa.
4. Image resizing, cropping and rotation operations.
5. Implementation of image negative and basic gray level transformations.
6. Contrast stretching and intensity transformations.
7. Histogram plotting and Histogram Equalization.
8. Image smoothing using filters: Mean Filter and Median Filter.
9. Image sharpening using Laplacian filter.
10. Edge detection using Sobel and Prewitt operators.
11. Edge detection using Canny algorithm.
12. Implementation of frequency domain filtering using Fourier Transform.
13. Low-pass and High-pass filtering of images.
14. Image segmentation using thresholding techniques.

Project Work	24BCAPJ: Project
Teaching Hours : 08 Hours/Week	Credits : 06
Duration of Exam : 3 Hours	Maximum Marks : 150 (Exam 120 + IA 30)

- a. The project shall be either research-oriented or application-based in the emerging areas of Computer Technology.
- b. Project work may be carried out individually or in a group consisting of a maximum of three students.
- c. A hardbound project report must be submitted as part of the project work.
- d. The use of open-source or licensed software tools is encouraged, and all such tools utilized must be properly acknowledged and cited in the report.

Summative Assessment Criteria	
Writing	20
Demonstratiom	60
Vivavoce	20
Report	20
Total	120

Formative Assessment Criteria	
Review Meeting-1	10
Review Meeting-2	10
Review Meeting-3	10
Total	30

SEMESTER – VI

Theory	24BCA61: Deep Learning	
Teaching Hours : 04 Hours/Week		Credits : 03
Duration of Exam : 03 Hours		Maximum Marks : 100 (Exam 80 + IA 20)

Course Outcomes (COs)

COs	Description
CO1	Understand deep learning concepts and neural network architectures.
CO2	Apply CNN and RNN models for solving complex problems.
CO3	Analyze training techniques and optimization methods.
CO4	Implement deep learning solutions using modern frameworks.

UNIT – I: Foundations and Training of Deep Learning

14 Hours

Introduction to Deep Learning, Evolution from Machine Learning to Deep Learning, Limitations of Traditional Machine Learning, Review of Artificial Neural Networks, Perceptron and Multi-Layer Perceptron, Activation Functions: Sigmoid, Tanh, ReLU and Softmax, Loss Functions: Mean Squared Error and Cross Entropy, Gradient Descent and its Variants: Batch, Stochastic and Mini-Batch Gradient Descent, Backpropagation Algorithm, Computational Graphs (basic idea), Weight Initialization Techniques, Vanishing and Exploding Gradient Problems, Regularization Techniques: L1, L2, Dropout and Early Stopping, Optimization Algorithms: Momentum, RMSProp and Adam, Hyperparameter Tuning.

UNIT – II: Convolutional Neural Networks (CNN)

14 Hours

Introduction to CNN, Convolution Operation, Kernels and Feature Maps, Stride and Padding, Pooling Layers: Max Pooling and Average Pooling, CNN Architectures: LeNet and AlexNet (overview), Image Classification using CNN, Transfer Learning and Fine-Tuning, Applications in Computer Vision.

UNIT – III: Recurrent Neural Networks (RNN)

14 Hours

Sequential Data and Sequence Modeling, Recurrent Neural Networks, Backpropagation Through Time (BPTT), Vanishing Gradient Problem in RNN, Long Short-Term Memory (LSTM), Gated Recurrent Units (GRU), Applications in Natural Language Processing and Time Series Forecasting.

UNIT – IV: Advanced Deep Learning and Applications

14 Hours

Autoencoders, Generative Models: Introduction to GANs (basic idea), Attention Mechanism (basic idea), Introduction to Transformers (overview), Deep Learning Applications: Image Processing, Speech Recognition, NLP and Recommendation Systems, Overview of Frameworks: TensorFlow, Keras and PyTorch.

TEXT BOOKS:

1. Deep Learning by Ian Goodfellow, Yoshua Bengio, and Aaron Courville, published by MIT Press, 1st Edition, 2016.
2. Deep Learning with Python by François Chollet, published by Manning Publications, 2nd Edition, 2021.
3. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow by Aurélien Géron, published by O'Reilly Media, 2nd Edition, 2019.

REFERENCE BOOKS:

1. Neural Networks and Deep Learning by Michael Nielsen, published by Determination Press, **1st Edition, 2015**.
2. Pattern Recognition and Machine Learning by Christopher M. Bishop, published by Springer, **1st Edition, 2006**.
3. Machine Learning: A Probabilistic Perspective by Kevin P. Murphy, published by MIT Press, **1st Edition, 2012**.

Theory	24BCA62: Predictive Analytics
Teaching Hours : 04 Hours/Week	Credits : 03
Duration of Exam : 03 Hours	Maximum Marks : 100 (Exam 80 + IA 20)

Course Outcome

COs	Description
CO1	Understand predictive analytics concepts and data preparation techniques.
CO2	Apply regression and classification models for prediction tasks.
CO3	Analyze time series data and forecasting techniques.
CO4	Evaluate predictive models and apply them in real-world scenarios.

UNIT – I: Data Preparation and Exploration

14 Hours

Introduction to Predictive Analytics, Types of Data and Data Sources, Data Collection Methods, Data Cleaning and Preprocessing, Handling Missing Values and Outliers, Data Transformation and Normalization, Feature Engineering Techniques, Exploratory Data Analysis (EDA), Data Visualization Techniques, Correlation Analysis.

UNIT – II: Predictive Modeling Techniques

14 Hours

Regression Models: Simple Linear Regression and Multiple Linear Regression, Classification Models: Logistic Regression, Decision Trees and Random Forest, Bias-Variance Tradeoff, Overfitting and Underfitting, Model Training and Validation Techniques, Cross Validation Methods.

UNIT – III: Time Series and Forecasting

14 Hours

Introduction to Time Series Data, Components of Time Series: Trend, Seasonality and Noise, Moving Averages, Smoothing Techniques, Forecasting Methods, Introduction to ARIMA Models (basic concept), Applications in Business and Finance Forecasting.

UNIT – IV: Model Evaluation and Applications

14 Hours

Model Evaluation Metrics: Accuracy, Precision, Recall, F1 Score, Confusion Matrix, ROC Curve (basic idea), Model Selection and Comparison, Deployment Concepts (basic idea), Applications of Predictive Analytics: Business Intelligence, Healthcare Analytics, Financial Forecasting, Customer Behavior Analysis, Tools and Libraries: Python, Pandas, NumPy and Scikit-learn.

Text Books:

1. Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die by Eric Siegel, published by Wiley, 1st Edition, 2013.
2. The Elements of Statistical Learning: Data Mining, Inference, and Prediction by Trevor Hastie and Robert Tibshirani, published by Springer, 2nd Edition, 2009.
3. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow by Aurélien Géron, published by O'Reilly Media, 2nd Edition, 2019.

Reference Books:

1. Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die by Eric Siegel, published by Wiley, 1st Edition, 2013.
2. The Elements of Statistical Learning: Data Mining, Inference, and Prediction by Trevor Hastie and Robert Tibshirani, published by Springer, 2nd Edition, 2009.
3. Pattern Recognition and Machine Learning by Christopher M. Bishop, published by Springer, 1st Edition, 2006.

Theory	24BCA63: Introduction to Robotics in AI	
Teaching Hours : 04 Hours/Week		Credits : 03
Duration of Exam : 03 Hours		Maximum Marks : 100 (Exam 80 + IA 20)

Course Outcome

COs	Description
CO1	Understand the basic concepts, components and classifications of robots.
CO2	Analyze sensing, perception and control techniques used in robotics.
CO3	Apply AI methods for robot navigation, planning and decision making.
CO4	Evaluate applications of robotics in real-world scenarios.

UNIT – I: Fundamentals of Robotics

14 Hours

Introduction to Robotics, History and Evolution of Robots, Components of a Robotic System: Mechanical Structure, Sensors, Actuators and Controllers, Classification of Robots: Industrial Robots, Service Robots and Mobile Robots, Degrees of Freedom, Robot Configuration and Workspace, Basics of Robot Kinematics: Forward and Inverse Kinematics (conceptual), Introduction to Robot Dynamics (basic idea).

UNIT – II: Sensors, Actuators and Control Systems

14 Hours

Types of Sensors: Proximity Sensors, Vision Sensors, Force Sensors and Tactile Sensors, Sensor Characteristics and Data Processing, Actuators: Electric, Hydraulic and Pneumatic Actuators, Motor Types: DC Motors, Servo Motors and Stepper Motors, Control Systems: Open Loop and Closed Loop Control, Feedback Mechanisms, Introduction to Embedded Systems in Robotics.

UNIT – III: Robot Perception and AI Techniques

14 Hours

Robot Perception, Image Processing and Computer Vision Basics for Robotics, Object Detection and Recognition, Feature Extraction, Sensor Fusion Concepts, Localization and Mapping (basic idea), Path Planning Algorithms, Search Techniques: Breadth First Search (BFS), Depth First Search (DFS) and A* Algorithm (basic idea), Introduction to Machine Learning and Reinforcement Learning in Robotics.

UNIT – IV: Applications of Robotics in AI

14 Hours

Industrial Automation and Manufacturing Robots, Autonomous Vehicles and Self-Driving Systems, Healthcare and Medical Robotics, Service Robots and Humanoid Robots, Drones and Unmanned Aerial Vehicles (UAVs), Human-Robot Interaction, Ethical, Social and Safety Issues in Robotics, Future Trends in Robotics and AI.

TEXT BOOKS:

1. Industrial Robotics: Technology, Programming and Applications by Mikell P. Groover, published by McGraw-Hill, 1st Edition, 1986.
2. Introduction to Robotics: Mechanics and Control by John J. Craig, published by Pearson, 3rd Edition, 2004.
3. Probabilistic Robotics by Sebastian Thrun, Wolfram Burgard, and Dieter Fox, published by MIT Press, 1st Edition, 2005.

REFERENCE BOOKS:

1. Robotics: Modelling, Planning and Control by Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, and Giuseppe Oriolo, published by Springer, 1st Edition, 2009.
2. Introduction to Autonomous Robots by Nikolaus Correll, Bradley Hayes, Adam Johnson, and Sebastian Thrun, published by MIT Press, 1st Edition, 2016.
3. Robot Modeling and Control by Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, published by Wiley, 1st Edition, 2005.

Theory	24BCA64: DevOps	
Teaching Hours : 04 Hours/Week		Credits : 03
Duration of Exam : 3 Hours		Maximum Marks : 100 (Exam 80 + IA 20)

Course outcomes

COs	Description
CO1	Understand DevOps concepts, lifecycle and cultural practices.
CO2	Apply CI/CD pipelines using modern DevOps tools.
CO3	Analyze containerization and cloud-based deployment techniques.
CO4	Evaluate monitoring, automation and security practices in DevOps.

UNIT – I: Introduction to DevOps and Version Control 14 Hours

Introduction to DevOps, Evolution from Traditional Software Development to DevOps, DevOps Lifecycle, Principles of DevOps: Collaboration, Automation, Continuous Integration, Continuous Delivery and Continuous Feedback, DevOps Culture and Practices, Agile and DevOps Integration, Version Control Systems, Distributed Version Control, Introduction to Git, Git Commands and Workflows, Branching and Merging Strategies.

UNIT – II: Continuous Integration and Continuous Deployment (CI/CD) 14 Hours

Continuous Integration (CI), Continuous Delivery (CD) and Continuous Deployment, CI/CD Pipeline Architecture, Build Automation Tools, Introduction to Jenkins, Automated Testing in CI/CD, Source Code Integration, Pipeline as Code (basic idea), Artifact Management, Deployment Strategies: Blue-Green Deployment and Rolling Deployment.

UNIT – III: Containerization and Cloud Computing 14 Hours

Virtualization Concepts, Introduction to Containers, Docker Architecture, Docker Images, Containers and Dockerfile, Container Lifecycle Management, Introduction to Container Orchestration, Basics of Kubernetes, Microservices Architecture, Cloud Computing Basics, Service Models: IaaS, PaaS and SaaS, Deployment on Cloud Platforms (basic idea).

UNIT – IV: Monitoring, Security and DevOps Practices 14 Hours

System Monitoring and Logging, Performance Monitoring, Introduction to Monitoring Tools (basic overview), Log Management, Infrastructure as Code (basic idea), Configuration Management, Security in DevOps (DevSecOps), Continuous Monitoring, Backup and Recovery Strategies, Best Practices in DevOps, Challenges and Future Trends.

TEXT BOOKS:

1. The Phoenix Project: A Novel About IT, DevOps, and Helping Your Business Win by Gene Kim, Kevin Behr, and George Spafford, published by IT Revolution Press, 1st Edition, 2013.
2. Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation by Jez Humble and David Farley, published by Addison-Wesley, 1st Edition, 2010.
3. Kubernetes: Up and Running by Kelsey Hightower, Brendan Burns, and Joe Beda, published by O'Reilly Media, 3rd Edition, 2022.

REFERENCE BOOKS:

1. The DevOps Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations by Gene Kim, Jez Humble, Patrick Debois, and John Willis, published by IT Revolution Press, 1st Edition, 2016.
2. Accelerate: The Science of Lean Software and DevOps: Building and Scaling High Performing Technology Organizations by Nicole Forsgren, Jez Humble, and Gene Kim, published by IT Revolution Press, 1st Edition, 2018.
3. Site Reliability Engineering: How Google Runs Production Systems by Google, edited by Betsy Beyer, Chris Jones, Jennifer Petoff, and Niall Richard Murphy, published by O'Reilly Media, 1st Edition, 2016.

Lab	24BCA61P: Deep Learning Lab	
Teaching Hours : 03 Hours/Week		Credits : 02
Duration of Exam : 3 Hours		Maximum Marks : 50 (Exam 40 + IA 10)

Lab Programs

1. Introduction to Python libraries for deep learning: NumPy, Pandas, Matplotlib.
2. Implementation of a simple Artificial Neural Network (ANN) using Keras/TensorFlow.
3. Implementation of activation functions and loss functions.
4. Training a neural network using gradient descent optimization.
5. Implementation of Multi-Layer Perceptron (MLP) for classification.
6. Hyperparameter tuning of neural networks.
7. Implementation of Convolutional Neural Network (CNN).
8. Image classification using CNN on a standard dataset.
9. Implementation of pooling and convolution operations.
10. Transfer learning using pre-trained models.
11. Implementation of Recurrent Neural Network (RNN).
12. Sequence prediction using RNN/LSTM.
13. Implementation of LSTM for time series or text data.
14. Performance evaluation of deep learning models.

Internship	24BCAIS: Internship
Teaching Hours : 02 Hours/Week	Credits : 06
Duration of Exam : 3 Hours	Maximum Marks : 100 (Exam 80 + IA 20)

Guidelines

- Students in the VI Semester must undertake an internship, which will be supervised and monitored by both internal and external mentors.
- Internships can be carried out in organizations of any scale, including small, medium, or large enterprises, which includes online/offline mode.
- Student attendance must comply with university regulations, requiring a minimum of 75%.
- Students are required to complete at least 30 hours of internship work during the semester.
- The internship report should include details such as the company profile, functions and operations, nature of the work undertaken, learning outcomes.
- The report should be approximately 30–50 pages long and must include the internship certificate and a log sheet issued by the company. It should be submitted before the end of the semester for evaluation and viva-voce.
- All reports must be authenticated with the official seal and signed by the Head of the Department (HOD).
- The internship evaluation will be carried out externally by the university.

Summative Assessment Criteria	
Report	30
Log Book Maintenance	20
Viva Voce	30
Total	80

Formative Assessment Criteria	
Review Meeting-1	10
Review Meeting-2	10
Total	20

BLUEPRINT FOR QUESTION PAPER						
FOR 03 CREDITS						
Marks	Unit I	Unit II	Unit III	Unit IV	Number of questions to be answered	Total
2	3	3	3	3	10	20
6	2	2	2	2	5	30
10	1	1	1	1	3	30
Total						80
FOR 02 CREDITS						
Marks	Unit I	Unit II	Number of questions to be answered		Total	
2	3	3	5		10	
5	3	3	4		20	
10	1	1	1		10	
Total						40

Formative Assessment - 03 Credits

Category	Marks Allotted
Tests	10
Assignments	10
Total Marks	20

Formative Assessment - 02 Credits

Category	Marks Allotted
Tests	5
Assignments	5
Total Marks	10

