Annexure-V

Curriculum and Rules and Regulations

for

# B.Tech. Minor Degree

(in addition to existing Major Degree)

in

# Computer Science and Engineering

Computer Science and Engineering Department

**NATIONAL INSTITUTE OF TECHNOLOGY DELHI**

(An autonomous Institute under the aegis of Ministry of Education, Govt. of India.)

**Department of Computer Science and Engineering**
**National Institute of Technology Delhi**

## About the Department

The Computer Science and Engineering Department was started in 2010 along with the foundation of NIT Delhi. Initially, only the Bachelor of Technology Programme was offered with the intake 30 which presently has been increased to 60. Now, apart from B. Tech., the department also offers Master of Technology (CSE & Analytics), and Ph.D. program which cover a number of important areas of Computer Science and Engineering. The department provides the students with a broad undergraduate and graduate curriculum, based on the application and theoretical foundations of computer science. The departmental faculties and students participate in interdisciplinary research. The department envisions producing quality graduates, capable of leading the world in the technical realm. The department is equipped with the latest configuration and high computing system with hi-speed Internet facilities. The Computer Science Program at this institute are dedicated to educate students and to advance research in computer and information technology. The department has all the facilities to carry out the related teaching and research work.

## VISION

To communicate quality Computer Science Education for producing globally identifiable skilled technocrats and entrepreneurs upholding sound ethics, profound knowledge, and innovative ideas to meet industrial and societal expectations.

## MISSION

- **M1** To impart value-based **technical knowledge** and skill relevant to Computer Science and Engineering through effective pedagogies and hands-on experience on the latest tools and technologies to **maximize employability**.
- **M2** To strengthen **multifaceted competence**, nurture **creativity, and innovation,** and create **entrepreneurial environment** for an ever-changing technological scenario requiring communally cognizant solutions.
- **M3** To create an appetite for **research, and higher education** in contemporary, and emerging areas of Computer Science.
- **M4** To inculcate the **moral, ethical, and social ideals** essential for prosperous nation-building.

## PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

- **PEO1** Graduates are prepared to be employed in IT industries and be engaged in continuous learning, understanding, and applying innovative ideas while maintaining strong ethical standards.
- **PEO2** Graduates are prepared to pursue higher studies and continue to develop their professional knowledge.
- **PEO3** Graduates are equipped to do research in areas of specialization and the allied fields.

**PEO4** Graduates are prepared to meet the changing needs of society through knowledge-based service, exhibit leadership qualities with demonstrable attributes in lifelong learning and become successful entrepreneurs.

## PROGRAM SPECIFIC OUTCOMES (PSOs)

**PSO1** Ability to analyze, develop and design new tools and approaches to create cutting-edge solutions for Industry.

**PSO2** Ability to carry out research and education in trans-disciplinary fields to solve the problems of national as well as international significance.

## Rules and Regulations for the Proposed Minor Degree Programme

1. B. Tech students may opt for the minor degree in the CSE department as per their interest.
2. CSE department is providing minor degree through two different specializations.
    a. *Artificial Intelligence and Machine Learning*
    b. *Data Science*

    The detailed curriculum is attached herewith in the Annexures.
3. Students have to opt for a minimum of **4 courses (16 credits) and one project (2 credits)**, then only will be awarded the **minor degree in Computer Science and Engineering with the respective specialization.** The project should be approved by the department of CSE. Hence, in a minor degree a student should complete **18 credits other than the desired credits** of his/her major degree
4. The SGPA and CGPA calculation will also be completely different for a major and minor degree, with no mapping or no correlation.
5. Separate grade sheets for the minor degrees will be issued like the existing major degree.
6. To commence with the provision of Major and Minor Degrees will be applicable for the students studying in the 5th Semester only from the Academic Year 2022-23.
7. Upcoming 3dr year/ 5th semester Students, while registering for the 5th semester can choose this option.
8. Students studying in the 7th Semester in the Academic Year 2022-23 are not eligible for Minor Degrees.
9. Minor Degree is not mandatory for the students. It is optional for only those students who are willing to do it.
10. The students can opt for the courses for Minor Degree from the 5th semester to the 8th semester with not more than 2 courses in a semester.
11. For a Minor degree, the students can opt for a maximum of two courses through online modes such as MOOC/ NPTEL, etc.
12. In case, the student opts for online courses (as mentioned in the previous point), the Department as per the academic calendar and prevailing norms will do the evaluation.
13. Subjects listed in the 8th semester will be purely online modes such as MOOC/ NPTEL, etc. However, the Department as per the academic calendar and prevailing norms will do the evaluation.

## Credit Requirement

**Semester wise Credit Structure for Minor Degree**

| Sl. No. | Courses | Credits | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1st Year | | 2nd Year | | 3rd Year | | 4th Year | | |
| | | 1st Sem | 2nd Sem | 3rd Sem | 4th Sem | 5th Sem | 6th Sem | 7th Sem | 8th Sem | |
| 1 | Programme Core | — | — | — | — | — | — | — | — | — |
| 2 | Programme Electives | — | — | — | — | 08 | 04 | 04 | — | 16 |
| 3 | Open Electives | — | — | — | — | — | — | — | — | — |
| 4 | Applied Sciences | — | — | — | — | — | — | — | — | — |
| 5 | Humanities | — | — | — | — | — | — | — | — | — |
| 6 | Summer Training, Independent Study & Project | — | — | — | — | — | — | — | 02 | 02 |
| 7 | Allied Engineering | — | — | — | — | — | — | — | — | — |
| **Total** | | — | — | — | — | **08** | **04** | **04** | **02** | **18** |

# Course Scheme

| Year | Fifth Semester | | | | | | Sixth Semester | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Sub Code** | **Subject Name** | **L** | **T** | **P** | **C** | **Sub Code** | **Subject Name** | **L** | **T** | **P** | **C** |
| **Ist** | CSBB XXX | Elective-I [Select from Specialization-I/ Specialization-II/ Specialization-III] | 3 | 0 | 2 | 4 | CSBB XXX | Elective-III [Select from Specialization-I/ Specialization-II/ Specialization-III] | 3 | 0 | 2 | 4 |
| | CSBB XXX | Elective-II [Select from Specialization-I/ Specialization-II/ Specialization-III] | 3 | 0 | 2 | 4 | | | | | | |
| | **Total** | | | | | **08** | **Total** | | | | | **04** |
| **IInd** | **Seventh Semester** | | | | | | **Eight Semester** | | | | | |
| | CSBB XXX | Specialization-I/ Specialization-II/ Specialization-III | 3 | 0 | 2 | 4 | CSPB XXX | Project II | 0 | 0 | 4 | 2 |
| | **Total** | | | | | **04** | **Total** | | | | | **02** |

| Specialization in Artificial Intelligence and Machine Learning | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Set-1** | | | | | | | | | | | | |
| | **Sub Code** | **Subject Name** | **L** | **T** | **P** | **C** | **Sub Code** | **Subject Name** | **L** | **T** | **P** | **C** |
| | CSBB 311 | Machine Learning | 3 | 0 | 2 | 4 | CSBB 312 | Pattern Recognition | 3 | 0 | 2 | 4 |
| | CSBB 313 | Digital Image Processing | 3 | 0 | 2 | 4 | CSBB 314 | Computer Vision | 3 | 0 | 2 | 4 |
| | CSLB 315 | Optimization Techniques | 3 | 1 | 0 | 4 | CSBB 405 | Fuzzy Logic and Applications | 3 | 0 | 2 | 4 |
| | CSBB 406 | Cloud Computing | 3 | 0 | 2 | 4 | | | | | | |
| **Set-2** | | | | | | | | | | | | |
| | **Sub Code** | **Subject Name** | **L** | **T** | **P** | **C** | **Sub Code** | **Subject Name** | **L** | **T** | **P** | **C** |
| | CSBB 314 | Computer Vision | 3 | 0 | 2 | 4 | CSLB 315 | Optimization Techniques | 3 | 1 | 0 | 4 |
| | CSBB 316 | Information Storage & Retrieval | 3 | 0 | 2 | 4 | CSBB 317 | Soft Computing | 3 | 0 | 2 | 4 |
| | CSBB 405 | Fuzzy Logic and Applications | 3 | 0 | 2 | 4 | CSBB 407 | Natural Language Processing | 3 | 0 | 2 | 4 |
| | CSBB 408 | Reinforcement Learning and Applications | 3 | 0 | 2 | 4 | CSBB 409 | Social Network Analysis | 3 | 0 | 2 | 4 |
| | CSBB 412 | Motion Analytics | 3 | 0 | 2 | 4 | CSBB 415 | Motion Planning for Robotics | 3 | 0 | 2 | 4 |
| | CSBB 424 | Deep Learning and Applications | 3 | 0 | 2 | 4 | | | | | | |
| **Set-3** | | | | | | | | | | | | |
| | **Sub Code** | **Subject Name** | **L** | **T** | **P** | **C** | **Sub Code** | **Subject Name** | **L** | **T** | **P** | **C** |
| | CSBB 405 | Fuzzy Logic and Applications | 3 | 0 | 2 | 4 | CSBB 406 | Cloud Computing | 3 | 0 | 2 | 4 |
| | CSBB 407 | Natural Language Processing | 3 | 0 | 2 | 4 | CSBB 408 | Reinforcement Learning and Applications | 3 | 0 | 2 | 4 |
| | CSBB 409 | Social Network Analysis | 3 | 0 | 2 | 4 | CSBB 412 | Motion Analytics | 3 | 0 | 2 | 4 |
| | CSBB 413 | Introduction to Cognitive Computing | 3 | 0 | 2 | 4 | CSLB 414 | Game Theory | 3 | 1 | 0 | 4 |
| | CSBB 415 | Motion Planning for Robotics | 3 | 0 | 2 | 4 | CSBB 424 | Deep Learning and Applications | 3 | 0 | 2 | 4 |

| Specialization in Data Science | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Set-1** | | | | | | | | | | | | |
| | **Sub Code** | **Subject Name** | **L** | **T** | **P** | **C** | **Sub Code** | **Subject Name** | **L** | **T** | **P** | **C** |
| | CSBB 311 | Machine Learning | 3 | 0 | 2 | 4 | CSLB 315 | Optimization Techniques | 3 | 1 | 0 | 4 |
| | CSLB 321 | Mathematical Foundation of Data Science | 3 | 1 | 0 | 4 | | | | | | |
| **Set-2** | | | | | | | | | | | | |
| | **Sub Code** | **Subject Name** | **L** | **T** | **P** | **C** | **Sub Code** | **Subject Name** | **L** | **T** | **P** | **C** |
| | CSBB 314 | Computer Vision | 3 | 0 | 2 | 4 | CSLB 315 | Optimization Techniques | 3 | 1 | 0 | 4 |
| | CSBB 323 | Data Handling & Visualization | 3 | 0 | 2 | 4 | CSBB 325 | Time Series Analysis | 3 | 0 | 2 | 4 |
| | CSBB 326 | Distributed System | 3 | 0 | 2 | 4 | CSBB 406 | Cloud Computing | 3 | 0 | 2 | 4 |
| | CSBB 409 | Social Network Analysis | 3 | 0 | 2 | 4 | CSBB 421 | Internet of Things | 3 | 0 | 2 | 4 |
| | CSBB 422 | Big Data Analytics | 3 | 0 | 2 | 4 | CSBB 424 | Deep Learning and Applications | 3 | 0 | 2 | 4 |
| **Set-3** | | | | | | | | | | | | |
| | **Sub Code** | **Subject Name** | **L** | **T** | **P** | **C** | **Sub Code** | **Subject Name** | **L** | **T** | **P** | **C** |
| | CSBB 314 | Computer Vision | 3 | 0 | 2 | 4 | CSBB 406 | Cloud Computing | 3 | 0 | 2 | 4 |
| | CSBB 409 | Social Network Analysis | 3 | 0 | 2 | 4 | CSLB 414 | Game Theory | 3 | 1 | 0 | 4 |
| | CSBB 421 | Internet of Things | 3 | 0 | 2 | 4 | CSBB 422 | Big Data Analytics | 3 | 0 | 2 | 4 |
| | CSBB 424 | Deep Learning and Applications | 3 | 0 | 2 | 4 | CSBB 425 | Information Security and Privacy | 3 | 0 | 2 | 4 |
| | CSBB 426 | Business Intelligence and Analytics | 3 | 0 | 2 | 4 | CSBB 427 | Advanced Databases | 3 | 0 | 2 | 4 |

**COURSE CONTENT**

**Department: Computer Science and Engineering**

| **Course Code: CSBB 311** | **Open course (YES/NO)** | **HM Course (YES/NO)** | **DC (YES/NO)** | **DE (YES/NO)** |
|---|---|---|---|---|
| | NO | NO | NO | YES |
| **Type of course** | Elective | | | |
| **Course Title** | **MACHINE LEARNING** | | | |
| **Course Objectives:** | This course aims to provide students with the knowledge of key concepts of machine learning from a mathematically well motivated perspective. The course aims to familiarize the students with the two broad categories of machine learning algorithms supervised and unsupervised. | | | |
| **Course Outcomes** | **CO1:** Learn the basics and mathematical background of Machine learning | | | **L1, L2** |
| | **CO2:** Data exploratory analysis before applying machine learning | | | **L2, L3** |
| | **CO3:** Compare machine learning techniques | | | **L2, L3, L4** |
| | **CO4:** Apply Machine learning in real life applications. | | | **L4, L5, L6** |

| **Semester** | **Autumn:** | | **Spring: YES** | | |
|---|---|---|---|---|---|
| **III** | **Lecture** | **Tutorial** | **Practical** | **Credits** | **Total teaching hours** |
| Contact Hours | 3 | 0 | 2 | 4 | 36 |
| Prerequisite course code as per proposed course numbers | NIL | | | | |
| Prerequisite credits | NIL | | | | |
| Equivalent course codes as per proposed course and old course | NIL | | | | |
| Overlap course codes as per proposed course numbers | NIL | | | | |

| **Text Books:** | | |
|---|---|---|
| 1 | Title | Introduction to Machine Learning |
| | Author | Ethem Alpaydin |
| | Publisher | MIT Press |
| | Edition | 2004 |

| | | |
|---|---|---|
| 2 | Title | Pattern recognition and machine learning |
| | Author | C. M. Bishop |
| | Publisher | Springer |
| | Edition | 2007 |
| **Reference Book:** | | |
| 1 | Title | Machine Learning |
| | Author | Tom Mitchel |
| | Publisher | McGraw Hill |
| | Edition | 2017 |
| 2 | Title | Machine Learning in Action |
| | Author | Peter Harrington |
| | Publisher | Manning Publications Co. |
| | Edition | 2002 |

| | |
|---|---|
| **Content** | **UNIT 1: Supervised Learning**<br>Machine learning basics, Artificial Neural Network, Classifying with k Nearest Neighbors, Splitting datasets one feature at a time: decision trees, Classifying with probability theory: naive Bayes, Support vector machines, Improving classification with the AdaBoost meta algorithm.<br><br>**UNIT 2: Unsupervised Learning**<br>Grouping unlabeled items using k means clustering, Association analysis with the Apriori algorithm, Efficiently finding frequent itemsets with FP growth.<br><br>**UNIT 3: Reinforcement Learning**<br>Markov decision process (MDP), Bellman equations, Value iteration and policy iteration, Linear quadratic regulation (LQR), Linear Quadratic Gaussian (LQG), Q learning, Value function approximation, Policy search, POMDPs.<br><br>**UNIT 4: Forecasting and Learning Theory**<br>Predicting numeric values: regression, Logistic regression, Tree based regression. Bias/variance tradeoff, Union and Chernoff/Hoeffding bounds, Vapnik– Chervonenkis (VC) dimension, Worst case (online) learning, Practical advice on how to use learning algorithms.<br><br>**UNIT 5: Additional Tools**<br>Dimensionality reduction: Feature Extraction Principal component analysis to simplify data, Simplifying data with the singular value decomposition, Feature Selection – Ranking methods, subset selection – forward and backward. Big Data and MapReduce. |
| **Course Assessment** | Continuous Evaluation 25% |
| | Mid Semester 25% |
| | End Semester 50% |

Lab Experiments:

| Exp. No. | List of Experiments |
|---|---|
| 1 | Python Frameworks Tutorial (with Jupyter and Colab) and it's Data Structures |
| 2 | Introduction to Python libraries for Data Analysis (Pandas, NumPy, Matplotlib) |
| 3 | Data Collection & Creation Using Web Scraping- Static and Dynamic Webpages |
| 4 | Exploratory Data Analytics and Feature Engineering |
| 5 | Regression Techniques: Linear and Logistic |
| 6 | Traditional Computational Techniques (Decision Tree, KNN) |
| 7 | Implementing Classifier with Probability Theory( naïve Bayes and Bayesian Networks) |
| 8 | Implementation of Perceptron for logic gates (AND, OR, NOT) |
| 9 | Implementing Support Vector Machine Classifier from scratch |
| 10 | Neural networks for Binary Classification |
| 11 | Introduction to Reinforcement Learning: Path finding bot problem |

| Course Code: CSBB 313 | Open course (YES/NO) | HM Course (YES/NO) | DC (YES/NO) | DE (YES/NO) |
|---|---|---|---|---|
| | NO | NO | NO | YES |
| **Type of course** | Elective | | | |
| **Course Title** | **DIGITAL IMAGE PROCESSING** | | | |
| **Course Objectives:** | The course aims to cover techniques and tools for digital image processing, image transformation in spatial and frequency domains. It introduces image analysis techniques in the form of image segmentation. The course also aims to cover the processing of colored images. The course also aims to cover techniques and tools for digital image processing and to provide hands-on experience in applying these tools to process images. The students would be encouraged to develop the image processing tools from scratch, rather than using any image processing library functions. Students will also get an opportunity to familiarize with image processing platforms such as Open CV, MATLAB, etc. | | | |

| **Course Outcomes** | | |
|---|---|---|
| | **CO1:** Learn the basics and mathematical background of Image Processing | **L1, L3** |
| | **CO2:**Analysis and study of methods used for image sampling and quantization, image transforms, image enhancement and restoration, image encoding, image analysis and pattern recognition | **L2, L4** |
| | **CO3:** Utility of image compression techniques for storage and transmission purpose. | **L3, L5** |
| | **CO4:** To learn about color imaging, color models, and color image processing. | **L4** |

| **Semester** | **Autumn:** | | **Spring: YES** | | |
|---|---|---|---|---|---|
| **III** | **Lecture** | **Tutorial** | **Practical** | **Credits** | **Total teaching hours** |
| Contact Hours | 3 | 0 | 2 | 4 | 36 |
| Prerequisite course code as per proposed course numbers | NIL | | | | |
| Prerequisite credits | NIL | | | | |
| Equivalent course codes as per proposed course and old course | NIL | | | | |
| Overlap course codes as per proposed course numbers | NIL | | | | |
| **Text Books:** | | | | | |

| | | |
|---|---|---|
| 1 | Title | Digital Image Processing |
| | Author | R.C. Gonzalez, R.E Woods |
| | Publisher | Pearson Education |
| | Edition | 2008 |
| **Reference Book:** | | |
| 1 | Title | Digital Image Processing Using MATLAB |
| | Author | R.C. Gonzalez, R.E Woods, S. L. Eddins |
| | Publisher | PHI |
| | Edition | 2003 |
| 2 | Title | Image Processing, Analysis, and Machine Vision |
| | Author | M. Sonka, V. Hlavac, R. Boyle |
| | Publisher | Brooks/Cole |
| | Edition | 2007 |
| 3 | Title | Digital Image Processing |
| | Author | W.K. Pratt |
| | Publisher | Wiley-Interscience |
| | Edition | 2007 |

| | |
|---|---|
| **Content** | **UNIT 1**<br>Introduction: Digital image representation, Fundamental steps in image processing, Components of Digital Image processing systems, Elements of visual perception, Image Formation model, Image Sampling and quantization, Relationship between pixels – neighborhood, adjacency connectivity, regions, boundaries and distance measures.<br><br>**UNIT 2**<br>Image Enhancement: Enhancement by point processing, Sample intensity transformation, Histogram processing, Image subtraction, Image averaging, Spatial filtering- Smoothing Spatial filters, Sharpening Spatial filters, Frequency domain- Fourier Transform, Low-Pass, High-Pass, Laplacian, Homomorphic filtering.<br><br>**UNIT 3**<br>Image Segmentation: Detection of discontinuities – point, line and edge detection, Edge linking and boundary detection, Thresholding, Region-based segmentation – region growing, region splitting and merging, Use of motion in segmentation- Spatial techniques and Frequency domain techniques<br><br>**UNIT 4**<br>Image Compression: Coding redundancy, Interpixel redundancy, fidelity criteria, Image compression models, Error-free compression, Variable length coding, Bit-plane coding, Lossless predictive coding, Lossy compression, Image compression standards, Real-Time image transmission, JPEG and MPEG.<br><br>**UNIT 5: Additional Tools**<br>Color Image Processing: Color Models, Pseudo color Image Processing, Color Transformations, Smoothing and sharpening, Image Segmentation based on color. |
| **Course Assessment** | Continuous Evaluation 25% |
| | Mid Semester 25% |
| | End Semester 50% |

Lab Experiments:

| **Exp. No.** | **List of Experiments** |
|---|---|
| 1 | Simulation and Display of an Image, Negative of an Image(Binary & Gray Scale). |
| 2 | Implementation of transformations namely, translation, rotation, scale and shear. |
| 3 | Implementation of Histogram, and Histogram Equalization. |
| 4 | Implementation of FFT(1-D & 2-D) of an image. |
| 5 | Implementation of Image Compression by DCT. |
| 6 | Implementation of Image Smoothening Filters(Mean and Median filtering of an Image). |
| 7 | Implementation of image sharpening filters and Edge Detection using Gradient Filters. |
| 8 | Implementation of image restoring techniques. |
| 9 | Implementation of image segmentation techniques. |
| 10 | Program for morphological operation: erosion and dilation |

| **Course Code: CSLB 315** | **Open course (YES/NO)** | **HM Course (YES/NO)** | **DC (YES/NO)** | **DE (YES/NO)** |
|---|---|---|---|---|
| | NO | NO | NO | YES |
| **Type of course** | Elective | | | |
| **Course Title** | **OPTIMIZING TECHNIQUES** | | | |
| **Course Objectives:** | ● This course aims to cover the concepts of optimization methods and algorithms developed for solving various types of optimization Problems.<br>● To apply the mathematical results and numerical techniques of Optimization theory to various Engineering and Analytics problems.<br>● Explain the theoretical workings of the graphical, simplex, and analytical methods for making effective decision on variables so as to optimize the objective function. | | | |
| **Course Outcomes** | **CO1:** Understand the fundamentals of Linear Programming and Dynamic Programming | | | **L1, L3** |
| | **CO2:** Enumerate the fundamentals of Integer programming technique and apply different techniques to solve various optimization problems arising from engineering areas. | | | **L1, L2** |
| | **CO3:** Identify appropriate optimization methods to solve complex problems involved in various industries. | | | **L1, L2, L4** |
| | **CO4:** To understand the graphical, simplex, and analytical methods for making effective decisions. | | | **L2, L5** |

| **Semester** | **Autumn:** | | **Spring: YES** | | |
|---|---|---|---|---|---|
| **III** | **Lecture** | **Tutorial** | **Practical** | **Credits** | **Total teaching hours** |
| Contact Hours | 3 | 1 | 0 | 4 | 36 |
| Prerequisite course code as per proposed course numbers | NIL | | | | |
| Prerequisite credits | NIL | | | | |
| Equivalent course codes as per proposed course and old course | NIL | | | | |
| Overlap course codes as per proposed course numbers | NIL | | | | |

| **Text Books:** | | |
|---|---|---|
| 1 | Title | An Introduction to Optimization |
| | Author | Edwin K.P. Chong, Stanislaw H. Zak |

| | | |
|---|---|---|
| | Publisher | Wiley |
| | Edition | 2017 |
| **Reference Book:** | | |
| 1 | Title | Convex Optimization |
| | Author | Stephen Boyd |
| | Publisher | LievenVandenberghe |
| | Edition | 2004 |
| 2 | Title | Modern Optimization with R (Use R) |
| | Author | Paulo Cortez |
| | Publisher | Springer |
| | Edition | 2014 |
| **Content** | **UNIT 1**<br>Preliminaries: Proofs, Vector Spaces and Matrices, Linear Transformations, Eigenvalues and Eigenvectors, Orthogonal Projections, Quadratic Forms, Matrix Norms, Concepts from Geometry, Elements of Calculus.<br><br>**UNIT 2**<br>Unconstrained Optimization: Basics of Set Constrained and Unconstrained Optimization, One Dimensional Search Methods, Golden Section Search, Fibonacci Search, Newton's Method, Secant Method, Solving Ax = b.<br><br>**UNIT 3**<br>Linear Programming: Introduction to Linear Programming, Simplex Method, Duality.<br><br>**UNIT 4**<br>Nonlinear Constrained Optimization: Problems with Equality Constraints, Problems with Inequality Constraints, Karush Kuhn Tucker Condition, Convex Optimization Problems.<br><br>**UNIT 5: Additional Tools**<br>Algorithms for Constrained Optimization: Projections, Project gradient methods, Penalty methods. | |
| **Course Assessment** | Continuous Evaluation 25% | |
| | Mid Semester 25% | |
| | End Semester 50% | |

| **Course Code: CSBB 424** | **Open course (YES/NO)** | **HM Course (YES/NO)** | **DC (YES/NO)** | **DE (YES/NO)** |
|---|---|---|---|---|
| | NO | NO | NO | YES |
| **Type of course** | Elective | | | |
| **Course Title** | **DEEP LEARNING AND APPLICATIONS** | | | |
| **Course Objectives:** | The purpose of this course is to provide the students with the advance knowledge of Machine learning. It aims to enable the students to understand the design of various Deep Learning models and applications. | | | |
| **Course Outcomes** | **CO1:** Solve problems in linear algebra, probability, optimization, and machine learning. | | | **L1, L2, L3** |
| | **CO2:** Implement deep learning models in Python using the PyTorch library and train them with real-world datasets. | | | **L4, L5, L6** |
| | **CO3:** Design convolutional networks for handwriting and object classification from images or video. | | | **L4, L5, L6** |
| | **CO4:** Design recurrent neural networks with attention mechanisms for natural language classification, generation, and translation. | | | **L4, L5, L6** |

| **Semester** | **Autumn:** | | **Spring: YES** | | |
|---|---|---|---|---|---|
| **III** | **Lecture** | **Tutorial** | **Practical** | **Credits** | **Total teaching hours** |
| Contact Hours | 3 | 0 | 2 | 4 | 36 |
| Prerequisite course code as per proposed course numbers | Machine Learning Course | | | | |
| Prerequisite credits | NIL | | | | |
| Equivalent course codes as per proposed course and old course | NIL | | | | |
| Overlap course codes as per proposed course numbers | NIL | | | | |

| **Text Books:** | | |
|---|---|---|
| 1 | Title | Deep Learning |
| | Author | Ian Goodfellow and Yoshua Bengio and Aaron Courville |
| | Publisher | MIT Press |
| | Edition | 2016 |
| **Reference Book:** | | |
| 1 | Title | Machine Learning: An Algorithmic Perspective |

| | | |
|---|---|---|
| | Author | Stephen Marsland |
| | Publisher | Chapman and Hall/CRC |
| | Edition | 2014 |
| 2 | Title | Introduction to Probability for Data Science |
| | Author | Stanley H. Chan |
| | Publisher | Michigan Publishing |
| | Edition | 2021 |

| | |
|---|---|
| **Content** | **UNIT 1: Introduction**<br>Well posed learning problem, Types of Machine Learning, Applications, Linear Algebra, Probability and Information Theory, Numerical Computation.<br><br>**UNIT 2: Learning Models**<br>Traditional Machine Learning Basics: Linear Regression, Logistic, Regression, kNearest Neighbors, Classifier with Probability Theory, Decision Trees, Random Forest, Support Vector Machine,<br>Artificial Neural Network: Artificial Neuron, Perceptron, Stochastic Gradient Descent, and Back Propagation Neural Network, Neural Network Architecture, NN with One Hidden Layer, NN with One Hidden Layer and Multiple Outputs, Neural Network Hyper-parameters.<br><br>**UNIT 3: Deep Learning**<br>Deep Architure: Need, applications, Hyper-parameters in Deep Neural Networks (Encoding, Layers, Loss function, Learning Rate, Momentum and Optimization, Regularization and dropout, Batch Norms) , vanishing gradient problem, and ways to mitigate it.<br>Convolution Neural Network: from Dense Layers to Convolutions, pooling layers, CNN Architectures ( AlexNet, VGG, NiN, GoogLeNet, ResNet, DensNet), Application in Image segmentation, Automated Object Detection models.<br><br>**UNIT 4: Deep Sequence Models**<br>Sequence Modeling Problems, Motivation and Applications, Traditional Models: Recurrent Neural Networks, Back-propagation through time; Modern Recurrent Neural Networks: Gated Recurrent Units, Long Short Term Memory (LSTM), Deep Recurrent Neural Networks, automatic image captioning, video to text with LSTM models.<br><br>**UNIT 5: Deep Learning**<br>Latent variable models, Autoencoders, Deep Generative Modeling: Variational Autoencoders, Generative Adversarial Networks (GANs), Recent Advance, Image generation with Generative adversarial networks.<br>Transfer Learning: Need and motivation, Transfer Learning Process, Data Augmentation, Applications.<br>Deep Reinforcement Learning: Components of an RL - (Agent, Policy, Value function, Model), MDP, DP, TDL, Q-Learning. SARSA Learning, Deep-Reinforcement Learning Need and Applications, Types of Deep-RL : Deep Q-Network (DQN) , Policy Gradient [ Advantage Actor-Critic (A2C/A3C), DDPG, PPO] , Alpha zero Future Trends in Deep Leaning, Attention models for computer vision tasks. |
| **Course Assessment** | Continuous Evaluation 25% |
| | Mid Semester 25% |
| | End Semester 50% |

Lab Experiments:

| Exp. No. | List of Experiments |
|---|---|
| 1 | Implement vector addition in TensorFlow. |
| 2 | Implement regression models. |
| 3 | Implement Feed Forward Networks. |
| 4 | Improve Deep Learning models by fine tuning hyper parameters. |
| 5 | Use a pre-trained model to implement transfer learning. |
| 6 | Performa sentiment analysis using deep learning models. |
| 7 | Implement sequence models for prediction. |
| 8 | Implement financial planning via Deep Reinforcement Learning. |

| Course Code: CSBB 406 | Open course (YES/NO) | HM Course (YES/NO) | DC (YES/NO) | DE (YES/NO) |
|---|---|---|---|---|
| | NO | NO | NO | YES |
| **Type of course** | Elective | | | |
| **Course Title** | **CLOUD COMPUTING** | | | |
| **Course Objectives:** | ● To learn the fundamentals of cloud computing<br>● To study different cloud computing technologies.<br>● To learn the functionality of cloud storage and standards.<br>● To study various case studies.<br>● To design an efficient and reliable cloud environment. | | | |

| **Course Outcomes** | | |
|---|---|---|
| | **CO1:** Explain the fundamentals of Cloud Computing. | **L2** |
| | **CO2:** Examine the functionality of different cloud technologies. | **L4** |
| | **CO3:** Analyze the role and functioning of various cloud environments. | **L5** |
| | **CO4:** Examine the working of different cloud environments and deploy it. | **L6** |

| **Semester** | **Autumn:** | | **Autumn: YES** | | |
|---|---|---|---|---|---|
| **III** | **Lecture** | **Tutorial** | **Practical** | **Credits** | **Total teaching hours** |
| Contact Hours | 3 | 0 | 2 | 4 | 36 |
| Prerequisite course code as per proposed course numbers | Machine Learning Course | | | | |
| Prerequisite credits | NIL | | | | |
| Equivalent course codes as per proposed course and old course | NIL | | | | |
| Overlap course codes as per proposed course numbers | NIL | | | | |

**Text Books:**

| | | |
|---|---|---|
| 1 | Title | Cloud Computing: Bible |
| | Author | Barrie Sosinsky |
| | Publisher | Wiley Publication |
| | Edition | 2018 |
| 2 | Title | Cloud Computing: A Practical Approach |
| | Author | Anthony Velte and Robert C. Elsenpete |
| | Publisher | McGraw Hill |
| | Edition | 2018 |

| **Reference Book:** | | |
|---|---|---|
| 1 | Title | Cloud Computing: Principles and Paradigms |
| | Author | Rajkumar Buyya, James Broberg, Andrzej Goscinski |
| | Publisher | Wiley Publication |
| | Edition | 2011 |
| **Content** | **Unit 1: Cloud Computing Basics**<br>Cloud Computing overview, Applications, Internets and the Cloud, First moves in the Cloud, Benefits, Limitations and Security Concerns in the Cloud.<br><br>**Unit 2: Cloud Computing Technology**<br>Hardware and Infrastructure: Clients, Security, Network, Services. Accessing the Cloud: Platforms, Web Applications, Web APIs, Web Browsers.<br><br>**Unit 3: Cloud Storage and Standards**<br>Cloud Storage Overview, Cloud Storage Providers. Standards: Application, Client, Infrastructure, Service.<br><br>**Unit 4: Cloud Computing at Work**<br>Software as a Service: Overview, Driving Forces, Company Offerings, Industries. Developing Applications: Google, Microsoft, Intuit Quick Base, Cast Iron Cloud, Bungee Connect, Development.<br><br>**Unit 5: Organizations and Cloud Computing**<br>Cloud Computing with the Titans: Google, EMC, NetApp, Microsoft, Amazon, IBM, Partnerships, The Business case for going to the Cloud. | |
| **Course Assessment** | Continuous Evaluation 25% | |
| | Mid Semester 25% | |
| | End Semester 50% | |

Lab Experiments:

| **Exp. No.** | **List of Experiments** |
|---|---|
| 1 | Install hypervisor with different flavors of linux or windows OS on top of host OS and bare-metal system. |
| 2 | Set up CloudSim environment, create and run Virtual Machine (VM). |
| 3 | Create Data Centers, and allocate VMs on Data Centers. |
| 4 | Install Google App Engine (GAE). Create web applications using python/java. |
| 5 | Assigning cloudlets and analyzing the scheduling parameters for various scenarios. |
| 6 | Implement a procedure to transfer the files from one virtual machine to another virtual machine. |
| 7 | Install Hadoop node cluster and run basic applications. |
| 8 | Run various Cloud-based web services and evaluate their performances. |