Pimpri Chinchwad Education Trust's

PIMPRI CHINCHWAD COLLEGE OF ENGINEERING

SECTOR NO. 26, PRADHIKARAN, NIGDI, PUNE 411044

An Autonomous Institute Approved by AICTE and Affiliated to SPPU, Pune

DEPARTMENT OF COMPUTER ENGINEERING

Curriculum Structure and Syllabus

of

Honors in Deep Learning

(Course 2020)

Effective from Academic Year 2023-24

(Updated with minor changes)

Institute Vision

To be one of the top 100 Engineering Institutes of India in coming five years by offering exemplarily Ethical, Sustainable and Value Added Quality Education through a matching ecosystem for building successful careers.

Institute Mission

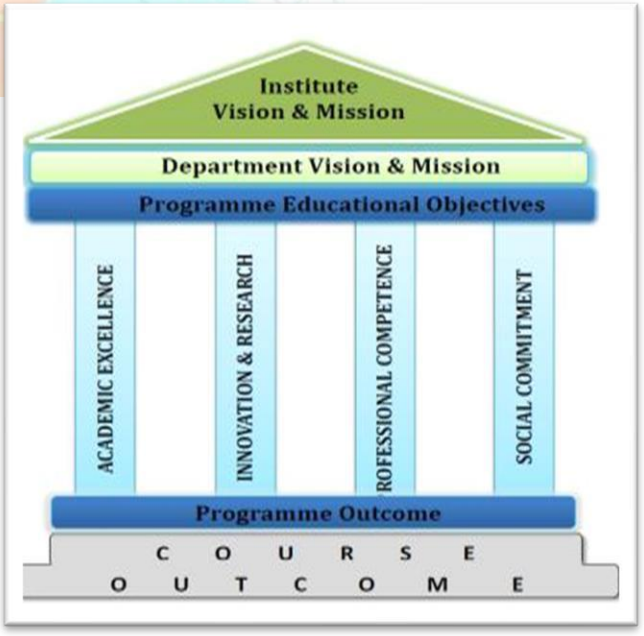
1. Serving the needs of the society at large through establishment of a state-of-art Engineering Institute

2. Imparting right Attitude, Skills, Knowledge for self-sustenance through Quality Education

3. Creating globally competent and Sensible engineers, researchers and entrepreneurs with an ability to think and act independently in demanding situations

Quality Policy

We at PCCOE are committed to impart Value Added Quality Education to satisfy the applicable requirements, needs and expectations of the Students and Stakeholders. We shall strive for academic excellence, professional competence and social commitment in fine blend with innovation and research. We shall achieve this by establishing and strengthening state-of- the-art Engineering and Management Institute through continual improvement in effective implementation of Quality Management System.



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	Pimpri Chinchwad Education Trust's **Pimpri Chinchwad College of Engineering**	
Course Approval Summary		

A) Board of study - Department of Computer Engineering

Sr. No.	Name of the Course	Course Code	Page number	Signature and stamp of BoS
1	Neural Networks and Deep Learning	HCE5981	5	
2	Deep Learning Laboratory	HCE5982	7	
3	Deep Learning and Applications	HCE6981	11	
4	Deep Learning Modelling Laboratory	HCE6982	13	
5	Project Stage - I	HCE7981	16	
6	Project Stage - II	HCE8981	18	

Approved by Academic Council:

Chairman, Academic Council
Pimpri Chinchwad College of Engineering

Approved by Board of Governors:

Chairman, Board of Governors
Pimpri Chinchwad College of Engineering

Preface

Looking at Global Scenario to enhance the employability skills and impart deep knowledge in emerging/ multidisciplinary areas, an additional avenue is provided to passionate learners through the Minors and Honours Degree Scheme in academic structure.

For **Honors degree** program, student has to earn additional 20 credits in emerging area of one's own domain.

Objectives of Honors Degree

- To enable students to pursue allied academic interest in contemporary areas.
- To provide effective yet flexible options for students to achieve basic to intermediate level competence in the contemporary area.
- To enhance the employability skills with different combinations of competencies and flavors.
- To provide an academic mechanism for fulfilling demand of specialized areas from industries for higher order skill jobs.
- To provide a strong foundation to students aiming to pursue research/ higher studies in the contemporary field of study.

Preface of Honors in Deep Learning

The growth in AI is owed to the fact that quintillions of data is generated each day, which makes these technologies more relevant, stronger and beneficial in today's age. Virtual assistants, translators, chatbots, driverless vehicles, and many more applications are the result of these futuristic technologies. The Deep Learning approach of AI provides a foundation for problem solving that impacts virtually all areas of the economy, including science, engineering, medicine, banking, finance, sports and the arts. Deep learning is an interdisciplinary field that mimics the functioning of the human brain to find correlations and patterns by processing data with a specified logical structure. Deep learning models use multiple hidden layers in the neural network as opposed to traditional neural networks that only contain a handful of hidden layers. Deep learning algorithms map inputs to already learned data to deliver an accurate output. The concept underpinning this technology is very similar to how our brain functions (biological neural networks). Deep learning models are trained by using large sets of labeled data and neural network architectures that automate feature learning without the need for manual extraction.

Learning Objective

Honors courses in Deep Learning will enable learners to build expertise in Deep Learning, starting from essential theoretical foundations to learning how to apply them in the real world effectively. The programme creates a practical understanding of how Deep learning algorithms can be developed and optimized for hardware. Such systems can be used in cutting edge research where power and performance are the major constraints. The start of course will cover the foundation of Neural networks and Deep learning. Each unit will cover different models starting off with fundamentals such as Linear Regression, and logistic/softmax regression. Followed by Feedforward deep neural networks, the role of different activation functions, normalization and dropout layers. Then Convolutional Neural Networks and Transfer learning will be covered. Finally, several other Deep learning methods will be covered. The laboratory sessions will cover fundamentals of deep learning and its applications including speech, text, image, and video processing. The advanced stage of course will cover the practice of essential tools such as Tensorflow, Keras, PyTorch etc. It also includes project work for learners to implement and develop problem solving abilities for real problems.

What you will learn

- Build ML models with NumPy & scikit-learn, build & train supervised models for prediction & binary classification tasks (linear, logistic regression)
- Build & train a neural network with TensorFlow to perform multi-class classification, & build & use decision trees & tree ensemble methods
- Apply best practices for ML development & use unsupervised learning techniques for unsupervised learning including clustering & anomaly detection
- Build recommender systems with a collaborative filtering approach & a content-based deep learning method & build a deep reinforcement learning model

Learning Outcome

The course will teach you how to develop deep learning models using recent frameworks. The course will start with introduction to the DL framework. Then each section will cover different models starting off with fundamentals such as Linear Regression, and logistic/softmax regression. Followed by Feedforward deep neural networks, the role of different activation functions, normalization and dropout layers. Then Convolutional Neural Networks and Transfer learning will be covered. Finally, several other Deep learning methods will be covered.

After completing this course, learners will be able to:

- Apply and Demonstrate the knowledge of Deep Neural Networks and related machine learning methods
- Use the Python libraries for Deep Learning applications
- Build Deep Neural Networks using recent DL frameworks
- Evaluate the performance of DL models on bench mark and real world datasets

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LIST OF ABBREVIATIONS IN CURRICULUM STRUCTURE

Sr. No.	Abbreviation	Expansion
1.	L	Lecture
2.	P	Practical
3.	T	Tutorial
4.	H	Hours
5.	CR	Credits
6.	IE1	Internal Evaluation 1
7.	IE1	Internal Evaluation 2
8.	ETE	End Term Evaluation
9.	TW	Term Work
10.	OR	Oral
11.	PR	Practical
12.	PROJ	Project

Curriculum Structure

Honors in Deep Learning

CURRICULUM STRUCTURE

Structure for Honors in Deep Learning (Computer Engineering)

Semester	Course code	Course Name	Teaching Scheme				CR	Evaluation Scheme						
			L	P	T	H		IE1	IE2	ETE	TW	PR	OR	Total
V	HCE5981	Neural Networks and Deep Learning	3	-	-	3	3	20	30	50	-	-	-	100
V	HCE5982	Deep Learning Laboratory	-	4	-	4	2	-	-	-	50	-	-	50
VI	HCE6981	Deep Learning and Applications	3	-	-	3	3	20	30	50	-	-	-	100
VI	HCE6982	Deep Learning Modelling Laboratory	-	4	-	4	2	-	-	-	50	-	-	50
VII	HCE7981	Project Stage - I	-	10	-	10	5	-	-	-	100	-	50	150
VIII	HCE8981	Project Stage - II	-	10	-	10	5	-	-	-	100	-	50	150
	Total		**6**	**28**	**0**	**34**	**20**							**600**

L-Lecture, **P**-Practical, **T**-Tutorial, **H**-Hours, **Cr**-Credits, **IE** Internal Evaluation, **ETE**-End Term Evaluation, **TW**-Term Work, **OR**-Oral, **PR**-Practical

Course Syllabus

Semester – V

Honors in Deep Learning

Program:	B. Tech. (Computer) - Honors in Deep Learning			Semester: V			
Course:	Neural Networks and Deep Learning			Code: HCE5981			
Teaching Scheme				Evaluation Scheme			
Lecture	**Tutorial**	**Credit**	**Hours**	**IE1**	**IE2**	**ETE**	**Total**
03	-	03	03	20	30	50	100

Prior knowledge of
Linear Algebra and Univariate Calculus, Machine Learning, Programming and problem solving **is essential.**

Course Objectives:

1. To introduce basics of AI, Machine learning and Deep Learning
2. To introduce the fundamental techniques and principles of Neural Networks
3. To familiarize different models in Neural Networks(CNN,ANN,RNN) and their applications
4. To explain functioning of deep neural networks

Course Outcomes:

After learning the course, the students will be able to:

1. Distinguish different types of NN architectures.
2. Design Feed Forward Neural Network architecture for research problems.
3. Apply deep learning techniques to practical problems.
4. Evaluate model performance and interpret results.

Detailed Syllabus

Unit	Description	Duration (H)
I	**Introduction to Deep Learning** Evolution of AI, Machine Learning vs Deep Learning, Deep Learning types, Stages in ML/DL project, Applications of Deep Learning,	**07**
II	**Fundamentals of Neural Networks**: Introduction to Neural Network, Model of Artificial Neuron, Learning rules and various activation functions.	**07**
III	**Neural Network Architecture**: Single layer Feed-forward networks. Multi-layer Feed-forward networks. Recurrent Networks.	**08**
IV	**Back propagation Networks**: Back Propagation networks, Architecture of Back-propagation (BP) Networks, Back-propagation Learning, Variation of Standard Back propagation algorithms.	**07**

V	**Deep Neural Networks:** Introduction to Deep Neural Networks, training deep models, Training Deep Neural Networks using Back Propagation-Setup and initialization issues, Gradient- Descent Strategies, vanishing and exploding Gradient problems, regularizations, dropouts.	**08**
VI	**Convolutional Neural Networks**: Basic structure of Convolutional Network, Convolutions for Images, Padding and Stride, Multiple Input and Multiple Output Channels, Pooling, FCNN Case study: Image classification using CNN.	**08**
	Total	**45**

Text Books:

1. S.Rajasekaran and G.A. Vijayalakshmi Pai, "Neural Networks,Fuzzy Logic and Genetic Algorithms", PHI Learning Pvt. Ltd., 2003, ISBN:978-81-203-2186-1.
2. Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, "Dive into Deep Learning", Amazon Science, 2021.

Reference Books:

1. Jacek M. Zurada,"Introduction to artificial neural systems", West Publishing Co., 1992, ISBN: 0-3 14-93391 - 3.
2. Goodfellow I., BengioY., and Courville A., "Deep Learning", MIT Press, 2016, ISBN: 978-0262035613.
3. Bishop C. M., "Pattern Recognition and Machine Learning", Springer, 2006, ISBN: 978-0-387-31073-2.

Program:	B. Tech. (Computer) - Honors in Deep Learning					Semester: V	
Course:	Deep Learning Laboratory					Code: HCE5982	
Teaching Scheme				Evaluation Scheme			
Practical	Tutorial	Credit	Hours	TW	PR	OR	Total
4	-	2	4	50	-	-	50

Prior knowledge of

Machine learning algorithms and Python programming language, Working with an anaconda environment, Managing the python packages and multiple anaconda environments.

is essential.

Course Objectives:

1. To illustrate simple neural networks and deep neural networks.
2. To interpret the model results and analyze the accuracy of the model.
3. To explain different preprocessing operations on structured data or on unstructured data.
4. To explain how to predict the results using a trained model.

Course Outcomes:

After learning the course, the students will be able to:

1. Perform different pre-processing operations on structured or unstructured data
2. Design neural network layers for various learning problems.
3. Demonstrate binary as well as multi- class classification problems.
4. Interpret the model results and analyze the performance of the model.
5. Apply statistical concepts and perform Exploratory Data Analysis.
6. Implement, train, and validate their own neural network.

Guidelines for Students:

1. The laboratory assignments are to be submitted by students in the form of a journal. Journal consists of prologue, Certificate, table of contents, and handwritten write-up of each assignment.
2. Each assignment write-up should have Title, Objectives, Outcomes, Theory- Concept in brief, dataset used, data description, Conclusion, Assessment grade/marks and assessor's sign.
3. Program codes with sample output of all performed assignments are to be submitted as softcopy.

Guidelines for Laboratory /TW Assessment:

1. Continuous assessment of laboratory work is done based on overall performance and Laboratory performance of students.
2. Each Laboratory assignment assessment should assign grade/marks based on parameters with appropriate weightage.
3. Suggested parameters for overall assessment as well as each Laboratory assignment assessment include- timely completion, performance, innovation, efficiency, punctuality, and neatness.

Guidelines for Laboratory Conduction

1. Operating System recommended: - 64-bit Open-source Linux or its derivative
2. Programming tools recommended: - Python, OpenCV
3. Use of Anaconda platform is encouraged.

Suggested List of Assignments

Assignment No.	Assignment Title
1.	Write a program to build a logistic regression classifier with a Neural Network mindset . Consider following guidelines. a. Consider any convenient dataset (Cats dataset etc.) and pre-process the dataset. b. Define the appropriate model structure. c. Evaluate the model performance. d. Analyse the obtained results
2.	Implement a multilayer perceptron (MLP) model for prediction such as house prices. a. Perform Exploratory Data Analysis b. Prepare dataset c. Build MLP model d. Evaluate Model performance e. Predict for test data
3.	Build a Multiclass classifier using the CNN model. Use MNIST or any other suitable dataset. a. Perform Data Pre-processing b. Define Model and perform training c. Evaluate Results using confusion matrix (OR) Design an object detection model using deep neural networks for simple objects. a. Select appropriate dataset and perform data pre-processing b. Define architecture in terms of layers c. Evaluate Model performance Label the object with appropriate text.
4.	Install OpenCv package on your system and perform following operations on images. a. Image Sharpening b. Edge Detection & Image Gradients c. Cropping d. Blurring Background Subtraction Method

Reference Books:

1. Jacek M. Zurada,"Introduction to artificial neural systems", West Publishing Co., 1992, ISBN: 0-3 14-93391 -3
2. Goodfellow I., BengioY., and Courville A., "Deep Learning", MIT Press, 2016, ISBN: 978-0262035613.
3. Bishop C. M., "Pattern Recognition and Machine Learning", Springer, 2006, ISBN: 978-0-387-31073-2

Web references:

1. https://www.youtube.com/watch?v=oXlwWbU8l2o
2. https://www.datacamp.com/community/tutorials/exploratory-data-analysis-python
3. https://www.analyticsvidhya.com/blog/2020/02/learn-image-classification-cnn-convolutional-neural-networks-3-datasets/

Course Syllabus
Semester – VI
Honors in Deep Learning

Program:	B. Tech. (Computer) - Honors in Deep Learning			Semester: VI			
Course:	Deep Learning and Applications			Code: HCE6981			
Teaching Scheme				Evaluation Scheme			
Lecture	Tutorial	Credit	Hours	IE1	IE2	ETE	Total
03	-	03	03	20	30	50	100

Prior knowledge of

Linear Algebra, Probability Theory, Machine Learning, Artificial Neural Network, Python programming language

is essential.

Course Objectives:

1. To familiarize the theoretical foundations, algorithms, and methodologies of deep Learning.
2. To design and develop an application-specific deep learning model.
3. To elaborate various deep unsupervised techniques available in the field of deep learning.

Course Outcomes:

After learning the course, the students will be able to:

1. Identify the methodologies to create application-specific deep learning models
2. Understand the working of different transfer learning models
3. Apply appropriate deep learning algorithms for analyzing the data for a variety of problems.
4. Use the unsupervised deep learning models and analyze the performance

Detailed Syllabus

Unit	Description	Duration (H)
I	**Deep Computer Vision using Convolutional Neural Networks:** Image Classification, Image Augmentation, Object Detection or localization and segmentation, Similarity learning, Image captioning, Generative models, Video analysis **Application**: Image Classification/Object Detection	**07**
II	**Transfer Learning:** Popular CNN Architectures and Transfer learning Techniques: LeNet, ResNet, VGGNet, AlexNet, DenseNet, PixelNet.	**07**
III	**Recurrent Neural Networks:** Architectural Overview, Bidirectional RNNs – Encoder-decoder sequence to sequence architectures – Back-propagation Through Time for training RNN, Vanishing and Exploding Gradients, Long Short-Term Memory Networks, Gated recurrent Unit. **Application:** video to text	**08**
IV	**Deep Unsupervised Learning:** Auto-encoders, De-noising auto-encoders, Sparse auto-encoders, Variational Auto-encoder. **Applications:** Image generation	**08**

V	**Generative Adversarial Networks(GANs)** Introduction of GANs(Generative Modeling) , Different Types of GANs, Components of GANs, Training and Prediction of GANs, Brief on GAN Loss Function, Challenges Faced by GANs, Application of GANs	**07**
VI	**Natural Language Processing:** Introduction to NLP, Word Vector representation, word2vec model, Continuous Skip-Gram model, Continuous Bag-of-Words model **Application:** Sentiment analysis	**08**
	Total	**45**

Reference Books:

1. Murphy, K. P., "Machine Learning: A Probabilistic Perspective", The MIT Press, 2012.
2. Alpaydin, E.,"Introduction to Machine Learning", MIT Press, Prentice Hall of India, 3rd Edition 2014.
3. Zaccone, G., Karim, M. R., Menshawy, A. "Deep Learning with TensorFlow: Explore neural networks with Python", Packt Publisher, 2017.

Web references:

1. NPTEL:: Computer Science and Engineering – NOC : Deep Learning- Part 1
2. Deep Learning - Course (nptel.ac.in)

Program:	B. Tech. (Computer) - Honors in Deep Learning	Semester: VI
Course:	Deep Learning Modelling Laboratory	Code: HCE6982

Teaching Scheme				Evaluation Scheme			
Practical	**Tutorial**	**Credit**	**Hours**	**TW**	**PR**	**OR**	**Total**
4	-	2	4	50	-	-	50

Prior knowledge of

Linear Algebra, Probability Theory, Machine Learning, Artificial Neural Network, Python programming language.

is essential.

Course Objectives:

1. To demonstrate various tools and techniques available in the field of deep Learning.
2. To apply an appropriate deep learning model for a given real world problem.
3. To implement various deep unsupervised techniques available in the field of deep learning.

Course Outcomes:

After learning the course, the students will be able to:

1. Apply the recent tools and techniques to implement deep learning algorithms
2. Experiment and evaluate the performance of different transfer learning models
3. Implement appropriate algorithms for analyzing different types of datasets available in various domains.
4. Develop deep learning models to encode and reconstruct the original data.

Guidelines for Students:

1. Students are expected to complete a minimum of five assignments out of the seven assignments listed below.
2. The laboratory assignments are to be submitted by students in the form of a journal.

Guidelines for Laboratory /TW Assessment

1. Continuous assessment of laboratory work is done based on the overall performance and Laboratory performance of the students.
2. Each Laboratory assignment assessment should assign grade/marks based on parameters with appropriate weightage.
3. Suggested parameters for overall assessment as well as each Laboratory assignment assessment include- timely completion, performance, innovation, efficiency, punctuality, and neatness.

Guidelines for Laboratory Conduction

1. Recommended Tools for the implementation of above assignments: Python, TensorFlow, Pytorch, MATLAB, etc.
2. Use of the Anaconda platform is encouraged.

Suggested List of Assignments

Assignment No.	Assignment Title

1.	Apply a pre-trained network and apply it to a new task using transfer learning a) Use any three pre-trained models including AlexNet, GoogleNet, VGGNet, MobileNet, ResNet, DenseNet, etc. b) Fine-tune the hyper-parameters and compare their performance for a suitable application.
2.	Design RNN or its variant including LSTM or GRU a) Select a suitable time series dataset. Example – predict sentiments based on product reviews b) Apply for prediction
3.	Implement Auto-encoders for any of the task including: a) Data Compression b) Image de-noising c) Dimensionality reduction
4.	Design and implement Deep Convolutional GAN to generate images of faces/digits from a set of given images.

Reference Books:

1. Murphy, K. P., "Machine Learning: A Probabilistic Perspective", The MIT Press, 2012.
2. Alpaydin, E.,"Introduction to Machine Learning", MIT Press, Prentice Hall of India, 3rd Edition 2014.
3. Zaccone, G., Karim, M. R., Menshawy, A. "Deep Learning with TensorFlow: Explore neural networks with Python", Packt Publisher, 2017.

Web references:

1. NPTEL :: Computer Science and Engineering - NOC:Deep Learning- Part 1
2. Deep Learning - Course (nptel.ac.in)

Course Syllabus
Semester – VII
Honors in Deep Learning

Program:	B. Tech. (Computer) - Honors in Deep Learning	Semester: VII
Course:	Project Stage - I	Code: HCE7981

Teaching Scheme				Evaluation Scheme			
Practical	**Tutorial**	**Credit**	**Hours**	**TW**	**PR**	**OR**	**Total**
10	-	5	10	100	-	50	150

Course Objectives:

1. To apply the knowledge for solving real world problems.
2. To develop problem solving abilities.
3. To search information for project work from appropriate sources such as manuals, books, research journals and from other sources, and in turn increase analytical skills.
4. To formulate and analyze the problems to be solved in the existing literature.
5. To work in a team and learn professionalism.

Course Outcomes:

After learning the course, the students will be able to:

1. Identify the realistic problem of societal, industry or research relevance.
2. Summarize case studies based on the literature and prepare literature reviews relevant to problem statements.
3. Identify the gap to define the problem statement of a project.
4. Design and analyze a problem by applying domain knowledge.
5. Demonstrate knowledge and coordinate effectively in a team.

Project work guidelines:

- The student is expected to initiate the project work in semester VII, and complete the project work up to the design phase. So in this semester, the student shall complete the partial work of the Project which will consist of problem statement, literature review, SRS, Model and Design.
- In Project Stage -I the student shall complete the project work which consists of a presentation on the advancement in technology pertaining to the selected project topic.
- The student shall prepare and submit the progress report of Project work stage -I in standard format for satisfactory completion of the work that is the duly certified by the concerned guide (Internal External (in case of sponsored project)/ Co-Guide (in case of interdisciplinary project)) and head of the Department/Institute.

Course Syllabus
Semester – VIII
Honors in Deep Learning

Program:	B. Tech. (Computer) - Honors in Deep Learning					Semester: VIII	
Course:	Project Stage - II					Code: HCE8981	
Teaching Scheme				Evaluation Scheme			
Practical	Tutorial	Credit	Hours	TW	PR	OR	Total
10	-	5	10	100	-	50	150

Course Objectives:

1. To follow SDLC meticulously and meet the objectives of proposed work.
2. To apply recent tools and techniques.
3. To develop the solutions and conduct experimentations.
4. To validate and evaluate the work undertaken.
5. To consolidate the work as a furnished report.
6. To present project management skills in a team.

Course Outcomes:

After learning the course, the students will be able to:

1. Identify technical ideas and its relevance in recent tools and technologies.
2. Implement the methods relevant to the problem statement.
3. Critically analyze the results and their interpretation.
4. Demonstrate working models and prepare good quality technical reports.
5. Present knowledge of team work.

Guidelines for Project Stage -II:

- In Project Work Phase–II, the student shall complete the remaining project work which consists of Selection of Technology and Tools, Installations, UML implementations, testing, results, performance discussions using data tables per parameter considered for the improvement with existing/known algorithms/systems and comparative analysis and validation of results and conclusions.
- The student shall prepare and submit the report of Project work in standard format for satisfactory completion of the work that is duly certified by the concerned guide and head of the Department/Institute.

Vision and Mission of Computer Department

Department Vision

To be a premier Computer Engineering program by achieving excellence in Academics and Research for creating globally competent and ethical professionals.

Department Mission

M1: To develop technologically competent and self-sustained professionals through contemporary curriculum.

M2: To nurture innovative thinking and collaborative research, making a positive impact on society.

M3: To provide state-of-the art computing environment and learning opportunities through Center of Excellence.

M4: To foster leadership skills and ethics with holistic development.