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

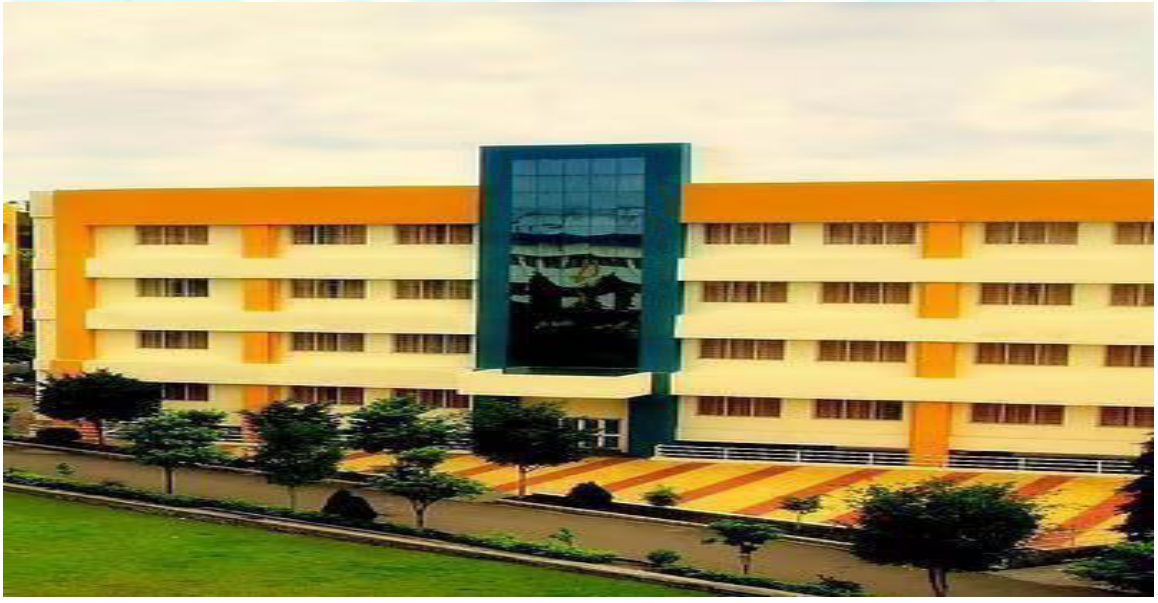
DEPARTMENT OF COMPUTER ENGINEERING

Curriculum Structure and Syllabus

of

Honors in Deep Learning

(Regulations 2023)



Effective from Academic Year 2025-26

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.

EOMS Policy

"We at PCCOE are committed to offer exemplarily Ethical, Sustainable and Value Added Quality Education to satisfy the applicable requirements, needs and expectations of the Students and Stakeholders.

We shall strive for technical development of students by creating globally competent and sensible engineers, researchers, and entrepreneurs through Quality Education.

We are committed for Institute's social responsibilities and managing Intellectual property.

We shall achieve this by establishing and strengthening state-of-the-art Engineering Institute through continual improvement in effective implementation of Educational Organizations Management Systems (EOMS)."

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 Neeworks and Deep Learning	BCE25HN01	5	Chairman BoS, Computer Engineering PCET's, Pimpri Chinchwad College of Engineering Sector No. 26, Pradhikaran, Nigdi, Pune-44
2	Deep Learning Laboratory	BCE25HN02	7	
3	Advanced Deep Learning	BCE26HN01	10	
4	Advanced Deep Learning Laboratory	BCE26HN02	12	
5	Project Stage - I	BCE27HN01	15	
6	Project Stage - II	BCE28HN01	17	

Approved by Academic Council:

Chairman
Academic Council
PCET's Pimpri Chinchwad College of Engineering
Sector No. 26, Pradhikaran, Nigdi, Pune-44

Chairman, Academic Council

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 levelcompetence 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 industriesfor higher order skill jobs.
- To provide a strong foundation to students aiming to pursue research/ higher studies in thecontemporary 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 modelsuse 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 NeuralNetworks 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 DL models with neural network and other tools to build & train models for prediction & classification tasks.
- Build & train a neural network with TensorFlow/Pytorch to perform multi-class classification, & build and deploy such models.
- Apply best practices for 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.	FA1	Formative Assessment 1
7.	FA2	Formative Assessment 2
8.	SA	Summative Assessment
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) for Scheme A, B, and C

Semester	Coursecode	Course Name	Teaching Scheme				CR	Evaluation Scheme						
			L	P	T	H		FA1	FA2	SA	TW	PR	OR	Total
V	BCE25HN01	Neural Networks and Deep Learning	3	-	-	3	3	20	20	60	-	-	-	100
V	BCE25HN02	Deep Learning Laboratory	-	4	-	4	2	-	-	-	50	-	-	50
VI	BCE26HN01	Advanced Deep Learning	3	-	-	3	3	20	20	60	-	-	-	100
VI	BCE26HN02	Advanced Deep Learning Laboratory	-	4	-	4	2	-	-	-	50	-	-	50
VII	BCE27HN01	Project Stage - I	-	10	-	10	5	-	-	-	100	-	50	150
VIII	BCE28HN01	Project Stage - II	-	10	-	10	5	-	-	-	100	-	50	150
	Total		6	28	-	34	20	40	40	120	300	-	100	600

L-Lecture, **P**-Practical, **T**-Tutorial, **H**-Hours, **Cr**-Credits, **FA**-Formative Assessment, **SA**-Summative Assessment, **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: BCE25HN01	
Credit	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
3	3	-	-	20	20	60	100

Prior knowledge of
Linear Algebra, Probability Theory, Machine Learning, Artificial Neural Network, Python programming language
is essential

Course Objectives:
This course aims at enabling students:
1. Learn fundamental concepts of artificial neural network
2. Introduce neural network architecture and its training
3. Learn fundamental concepts of convolution neural network
4. Understand the Recurrent neural network

Course Outcomes:
After learning the course, the students will be able to:
1. Illustrate fundamental concept of neural network.
2. Design neural network architecture to solve real world problem.
3. Evaluation the performance of neural network architecture.
4. Use convolution neural network to solve real world problems.
5. Develop practical solutions for real-world problems using RNNs.

Detailed Syllabus

Unit	Description	Duration (H)
I	**Neural Networks:** Introduction to Neural Network, Biological neuron, Model of Artificial Neuron, Learning rules and **activation functions:** ReLU, Sigmoid, Softmax and others, Loss, function - L1, L2 - Function approximation, classification / clustering problems – Performance parameters for classification and regression, Applications	9
II	**Neural Network Architecture**: Single layer Feed-forward networks. Multi-layer Feed-forward networks, forward propagation, Back Propagation networks, Architecture of Back-propagation (BP) Networks, Back-propagation Learning, Learning the weights, Chain rule, Stochastic gradient descent, Sigmoid units, and vanishing gradient,	9
III	**Effective training in Deep Neural Network**- early stopping, Dropout, Batch Normalization, Instance Normalization, Group Normalization, Minibatch gradient descent, Data Augmentation, Stratification, Generalization Gap –	9

	Under-fitting Vs Over-fitting, **Optimization**: Momentum, Learning rate schedules, AdaGrad, RMSProp and Adam optimization, and Batch Normalization, Initialization – weights, Bias	
IV	**Convolution Neural Network:** Basic structure of Convolutional Network, Convolutions for Images, Padding and Stride, Multiple Input and Multiple Output Channels, Pooling, FCNN, **Advanced Architectures:** VGG16/19**,** AlexNet, ResNet, and others, Transfer learning, CNN for Image Classification.	9
V	**Recurrent Neural Network**: Introduction, architecture, training in RNN, variants of RNN: LSTM, GRU, Bidirectional RNN, applications	9
Total		45

Text Books:

1. Ian Goodfellow Yoshua Bengio Aaron Courville , Deep Learning, , MIT Press, 2017
2. Michael Nielsen, Neural Networks and Deep Learning, , Determination Press
3. Aggarwal, Charu C. Neural networks and deep learning. Vol. 10. No. 978. Cham: springer, 2018.

Reference Books:

1. Jacek M. Zurada,"Introduction to artificial neural systems", West Publishing Co., 1992, ISBN: 0-3 14-93391 - 3.
2. Bishop C. M., "Pattern Recognition and Machine Learning", Springer, 2006, ISBN: 978-0-387-31073-2
3. Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks,
4. Umberto Michelucci, Apress, 2018.
5. Deep Learning with Python", Francois Chollet, Manning Publications, 2017.

Program:	B. Tech. (Computer Engineering)					Semester: V	
Course:	Deep Learning Laboratory					Code: BCE25HN02	
Credit	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	TW	OR	PR	Total
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. Design neural network layers for various learning problems.
2. Demonstrate binary as well as multi- class classification problems.
3. Interpret the model results and analyze the performance of the model.
4. 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/Term Work 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.

Detailed Syllabus

Suggested List of Assignments

Assignment No.	Assignment Title
1.	Implement a multilayer perceptron (MLP) model for prediction such as house prices.
2.	Implement logistic regression classifier in machine learning.

3.	Implement multiclass classification algorithm using feed forward neural network.
4.	Implement and evaluate a Multiclass classifier using the CNN model.
5.	Implement and evaluate a Multiclass classifier using the transfer learning.
6.	Implement and analyze performance of stock price prediction with recurrent neural network.

References:

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:	Advanced Deep Learning					Code: BCE26HN01	
Credit	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
3	3	-	-	20	20	60	100

Prior knowledge of
Linear Algebra, Probability Theory, Machine Learning, Artificial Neural Network, Python programming language
is essential

Course Objectives:
This course aims at enabling students:
1. Use deep neural network for object detection and segmentation.
2. Use Deep learning in nlp.

Course Outcomes:
After learning the course, the students will be able to:
1. Analyze the performance of task of object detection for a given image.
2. Apply segmentation techniques in real world problems.
3. Apply deep generative model to represent complex data distributions and to generate new data samples that are similar to the training data.
4. Use deep learning techniques in natural language processing.
5. Use attention model and transformer to enhance the understanding and generation of sequential data for a given real world problem.

Detailed Syllabus

Unit	Description	Duration (H)
I	**CNN for object detection**: overview, challenges in object detection, region based CNN, single shot multibox detector, YOLO, anchor box and multiscale detection, Evaluation metrics	9
II	**CNN for segmentation**: image segmentation, autoencoder, U-net, segmentation loss function, applications	9
III	**Deep Generative Models:** 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, Variational Autoencoders and Disentanglement,	9
IV	**Introduction to NLP and Deep Learning**: introduction to NLP, Word Vector representation, word2vec model, Continuous Skip-Gram model, Continuous Bag-of-Words model, Language modelling and neural network,	9

	Information Retrieval tasks using Neural Networks- Learn to Rank, Understanding Phrases, analogies.	
V	**Attention Models and Transformers**: Attention in Vision Models: An Introduction, Soft and Hard Attention: Image Captioning, Self-Attention and Transformers, Transformers to Vision Transformers, Transformers for Detection, Transformers for Segmentation, Stable diffusion model: LDM, Latent space, Text to image generation.	9
Total		45

Text Books:

1. Michael Nielsen, Neural Networks and Deep Learning, 2016
2. Zaccone, G., Karim, M. R., Menshawy, A. "Deep Learning with TensorFlow: Explore neural networks with Python", Packt Publisher, 2017.
3. Ian Goodfellow Yoshua Bengio Aaron Courville , Deep Learning, , MIT Press, 2017

Reference Books:

1. Yoav Goldberg. A Primer on Neural Network Models for Natural Language Processing
2. Jacek M. Zurada,"Introduction to artificial neural systems", West Publishing Co., 1992, ISBN: 0-3 14-93391 - 3.
3. Bishop C. M., "Pattern Recognition and Machine Learning", Springer, 2006, ISBN: 978-0-387-31073-2
4. Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks, Umberto Michelucci, Apress, 2018.
5. Deep Learning with Python", Francois Chollet, Manning Publications, 2017

e-sources:

https://web.stanford.edu/class/archive/cs/cs224n/cs224n.1184/syllabus.html

Program:	B. Tech. (Computer Engineering)					Semester: VI	
Course:	Advanced Deep Learning Laboratory					Code: BCE26HN02	
Credit	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	TW	OR	PR	Total
2	-	4	-	50	-	-	50

Prior knowledge of

Deep Learning and Python programming language, Working with an anaconda environment, Managing the python packages and multiple anaconda environments

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 object detection and segmentation models
3. implement a basic GAN model and train it on a dataset to generate
4. Design and develop deep learning models nlp.
5. Design and develop advance deep learning model using Attention Mechanisms and Transformer models.

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.
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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.

Detailed Syllabus

Suggested List of Assignments

Assignment No.	Assignment Title
1.	Implement Auto-encoders for any of the task.
2.	Implement and evaluate an object detection model using deep learning techniques.

3.	Implement and evaluate a segmentation model using deep learning techniques.
4.	Implement a Generative Adversarial Network (GAN) to generate synthetic images.
5.	Implement and evaluate deep learning model for natural language processing application.
6.	Implement modern deep learning architecture using Attention Mechanisms and Transformer models.

References:

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 Engineering)					Semester: VII	
Course:	Project Stage - I					Code: BCE27HN01	
Credit	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	TW	OR	PR	Total
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 Engineering)						Semester: VIII
Course:	Project Stage - II						Code: BCE28HN01
Credit	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	TW	OR	PR	Total
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:

1. 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.
2. 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.