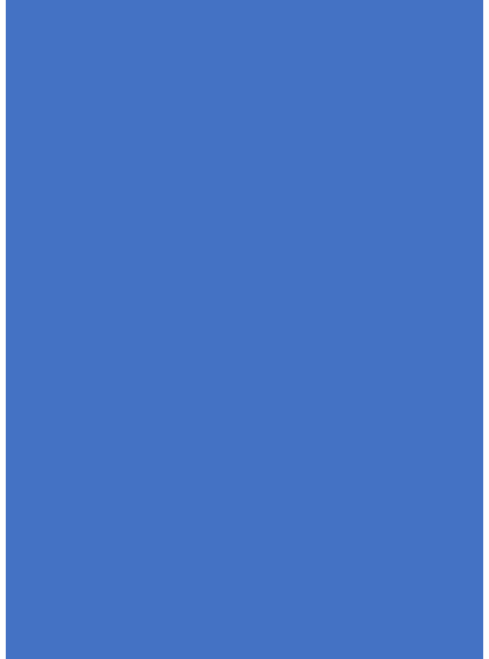
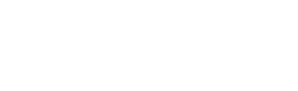
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**Curriculum for** 

**Third Year B. Tech.**

**Computer Science and Engineering**

**(Artificial Intelligence)**

**2020R1 Pattern**

**Department of Computer Science and Engineering (Artificial Intelligence)** 

Bansilal Ramnath Agarwal Charitable Trust’s 

**Vishwakarma Institute of Information Technology, Pune-48** (An Autonomous Institute affiliated to Savitribai Phule Pune University) **Department of Computer Science and Engineering (Artificial Intelligence)**

**Vision:**

“Excellence in Computer Science and Engineering providing AI-driven solutions with holistic development.”

**Mission:**

∙ To equip aspiring engineers for industry, academia, research, and entrepreneurship by offering excellent education in emerging AI techniques.

∙ To impart value-added technical and research-oriented education by inculcating life skills with an emphasis on human values.

∙ To educate and empower Learners with professional integrity for research and higher studies.

**Program Specific Outcomes (PSOs):**

At the end of the program, students should be able to

**PSO1:** Apply problem solving skills through programming techniques for addressing real life problems using suitable AI Techniques to provide innovative computing solutions. **PSO2:** Solve industrial and societal problems using innovative AI techniques with ethical considerations.

**Programme Educational Objectives (PEOs):**

1. Develop graduates who possess applied knowledge and skills in artificial intelligence, enabling them to effectively analyze complex problems and devise innovative solutions in diverse domains

2. Provide students with holistic and multidisciplinary expertise in computing, with a focus on artificial intelligence, to foster innovation throughout their careers.

3. Impart the importance of good ethical practices, professional conduct, responsible team leadership, and societal impact among students in the AI domain.

**Program Outcomes (POs)**

At the end of program, students should be able to:

**1. Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

**Third Year B. Tech (Pattern 2020R1) CSE (Artificial Intelligence)**

Bansilal Ramnath Agarwal Charitable Trust’s 

**Vishwakarma Institute of Information Technology, Pune-48** (An Autonomous Institute affiliated to Savitribai Phule Pune University) **Department of Computer Science and Engineering (Artificial Intelligence)**

**2. Problem analysis**: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

**3. Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety and the cultural, social and environmental considerations.

**4. Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**5. Modern tool usage**: Create, select and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

**6. The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**7. Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of, and need for sustainable development.

**8. Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

**9. Individual and team work**: Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings.

**10. Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.

**11. Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**12. Life-long learning**: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Third Year B. Tech (Pattern 2020R1) CSE (Artificial Intelligence)**

Bansilal Ramnath Agarwal Charitable Trust’s 

**Vishwakarma Institute of Information Technology, Pune-48** (An Autonomous Institute affiliated to Savitribai Phule Pune University) **Department of Computer Science and Engineering (Artificial Intelligence)**

**Third Year B.Tech Pattern 2020R1 Syllabus**

**(Year 2024-25)**

**Third Year B. Tech (Pattern 2020R1) CSE (Artificial Intelligence)**

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**Vishwakarma Institute of Information Technology, Pune-48** (An Autonomous Institute affiliated to Savitribai Phule Pune University) **Department of Computer Science and Engineering (Artificial Intelligence)**

**T.Y. B.Tech. Computer Science and Engineering (Artificial Intelligence) SEMESTER V (PATTERN 2020R1)**

| **CourseCode** | **Course Name** | **Teaching**  **Scheme**  **(Hrs/Week)** | | | **Assessment Scheme (100-mark scale)** | | | | | | | | | | **Credit s** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Theory Lab Tut** |  |  | **ISA** | | | | | | **ESA** | | | **Total** |
| **HA** |  |  | **TW SCE PPT** | **GD** | **CIE** | **ESE** | **PR**  **Exam** | **OR** | **100** |
| CAUA31201 | ARTIFICIAL  INTELLIGENCE | 3 | 2 | - | - | - | 20 | - | - | 20 | 40 | 20 | - | 100 | 4 |
| CAUA31202 | DEEP LEARNING | 3 | 2 | - | - | - | 20 | - | - | 20 | 40 | 20 | - | 100 | 4 |
| CAUA31203 | BIG DATA  ANALYTICS | 3 | 2 | - | - | - | 20 | - | - | 20 | 40 | 20 | - | 100 | 4 |
| CAUA31204 | DATA  COMMUNICATIO N &  NETWORKING | 2 | 2 | - | - | 20 | - | 20 | - | 20 | 40 | - | - | 100 | 3 |
| CAUA31205 | PROFESSIONAL ELECTIVE I | 3 | 2 | - | - | - | 20 | - | - | 20 | 40 | - | 20 | 100 | 4 |
| CAUA31206 | RESEARCH  METHODOLOGY AND IPR | 2 | - | - | - | - | 50 | - | - | - | - | - | - | 50 | 2 |
| CAUA31207 | PROJECT - I | - | 4 | - | - | 30 | - | - | - | - | - | - | 20 | 50 | 2 |
|  | **Total** | **16** | **14** | **-** | **-** | **50** | **130** | **20** | **-** | **100** | **200** | **60** | **40** | **600** | **23** |

| **Professional Elective I** | |
| --- | --- |
| CAUA31205A | FULL STACK SOFTWARE DEVELOPMENT |
|  | CAUA31205B CLOUD DEVELOPMENT OPERATIONS |

**BOS Chairman Dean Academics Director**

**Third Year B. Tech (Pattern 2020R1) CSE (Artificial Intelligence)**

Bansilal Ramnath Agarwal Charitable Trust’s 

**Vishwakarma Institute of Information Technology, Pune-48** (An Autonomous Institute affiliated to Savitribai Phule Pune University) **Department of Computer Science and Engineering (Artificial Intelligence)**

**T.Y. B.Tech Computer Science and Engineering (Artificial Intelligence) SEMESTER VI (PATTERN 2020R1)**

| **Course**  **Code** | **Course Title** | **Course Type** | **Teaching**  **Scheme** | | | **Examination Scheme** | | | | | **Total** | **Credits** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **L** | **T** | **P** | **CIE** | **ISE** | **SCE** | **ESE** | **PR/**  **OR/**  **TW** |
| CAUA32201 | DESIGN AND  ANALYSIS OF  ALGORITHMS | TH | 3 | - | 2 | 20 | 20 | 20 | 40 | 25 | 125 | 4 |
| CAUA32202 | NATURAL  LANGUAGE  PROCESSING | TH | 3 | - | 2 | 20 | 20 | 20 | 40 | 25 | 125 | 4 |
| CAUA32203 | GENERATIVE AI | TH | 3 | - | 2 | 20 | 20 | 20 | 40 | 25 | 125 | 4 |
| CAUA32204 | PROFESSIONAL  ELECTIVE II | TH | 3 | - | 2 | 20 | 20 | 20 | 40 | 25 | 125 | 4 |
| CAUA32205 | OPEN ELECTIVE I | TH | 3 | - | - | 20 | 20 | 20 | 40 | - | 100 | 3 |
| CAUA32206 | PROJECT II | CE | - | - | 4 | - | - | - | - | 25 | 25 | 2 |
| M3 | MANDATORY  COURSE | AU | - | - | - | - | - | - | - | - | - | - |
|  | **TOTAL** |  | **15** | **0** | **12** | **100** | **100** | **100** | **200** | **125** | **625** | **21** |

**BOS Chairman Dean Academics Director**

**Third Year B. Tech (Pattern 2020R1) CSE (Artificial Intelligence)**

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**Vishwakarma Institute of Information Technology, Pune-48** (An Autonomous Institute affiliated to Savitribai Phule Pune University) **Department of Computer Science and Engineering (Artificial Intelligence)**

**SEMESTER- V**

**Third Year B. Tech (Pattern 2020R1) CSE (Artificial Intelligence)**

**Home**

Bansilal Ramnath Agarwal Charitable Trust’s

**Vishwakarma Institute of Information Technology, Pune-48** (An Autonomous Institute affiliated to Savitribai Phule Pune University) **Department of Computer Science and Engineering (Artificial Intelligence)**

**CAUA31201: ARTIFICIAL INTELLIGENCE**

| **Teaching Scheme** | **Examination Scheme** | | | | |
| --- | --- | --- | --- | --- | --- |
| **Credits:** 04  **Lecture (L):** 03 hrs / week  **Practical (P):** 02 hr / week | CIE | SCE | ESE | PR | Total |
| 20 | 20 | 40 | 20 | 100 |
| **Prerequisites:** Linear Algebra, Probability and Statistics, Discrete Mathematics | | | | | |
| **Course Objectives:**  1. To understand the various characteristics of intelligent agents.  2. To learn the different search strategies in AI.  3. To learn knowledge representation and working knowledge of reasoning in presence of incomplete and uncertain information.  4. To learn how to represent knowledge in solving AI problems and to introduce the concepts of Expert Systems and Machine Learning.  5. To know about the various applications of AI.  6. To know advancements of AI | | | | | |
| **Course Outcomes:**  After completion of the course, student will be able to:  1. Understand different types of AI Agents and environment.  2. Implement various AI search algorithms.  3. Understand fundamentals of knowledge representation and working knowledge of reasoning in presence of incomplete and uncertain information.  4. Apply knowledge representation, reasoning and machine learning techniques to real world problems and design the Expert Systems.  5. Apply AI techniques for real world application.  6. To understand best practices for scalability, reliability, and security in cloud-based AI and ML solutions. | | | | | |
| **Contents** | | | | | |
| **Unit I: Introduction to Artificial Intelligence& Intelligent Agents (6 Hrs)** | | | | | |
| Introduction, Definition, Future of Artificial Intelligence, Characteristics of Intelligent Agents, Typical Intelligent Agents, Environment, Environment Types, Problem Solving Approach to Typical AI problems.  Defining the problem as a State Space Search, Problem Characteristics, Problem solving Methods, Search Strategies: Uninformed - Informed - Heuristics  Constraint Satisfaction Problems, Constraint Propagation, Backtracking and look ahead strategy Search. | | | | | |
| **Unit II: Search Strategies (6 Hrs)** | | | | | |
| Uninformed Search Strategies: Breadth-first search, Depth-first search  Informed (Heuristic) Search Strategies: Greedy best first search, Optimal search: A\* search, Minimizing the total estimated solution cost | | | | | |

**Third Year B. Tech (Pattern 2020R1) CSE (Artificial Intelligence)**

Bansilal Ramnath Agarwal Charitable Trust’s 

**Vishwakarma Institute of Information Technology, Pune-48**

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

**Department of Computer Science and Engineering (Artificial Intelligence)**

| Heuristic search techniques: Heuristic Function, Generate and test, Hill Climbing, Best-First Search, Beam search, Tabu Search. |
| --- |
| **Unit III: Knowledge Representation and Inference (6 Hrs)** |
| Knowledge representation, Types of knowledge, Structured representation of knowledge, Propositional logic, Predicate logic, First order logic. Rule based expert system, Rules Inference: Backward chaining, Forward chaining, Rule value approach, Inference engine, Rules. Knowledge Representation: Conceptual Dependency, Frames, Semantic nets. |
| **Unit IV: Planning & Learning in Expert Systems (6 Hrs)** |
| Planning: Block world problem, Goal Tree, Non-linear planning, Hierarchical planning, Goal stack planning  Definition of learning, Forms of learning, learning by taking advice, Learning in problem solving, Induction learning, Explanation based learning, Formal learning theory, Ensemble learning. Expert systems - Intelligent System Vs Expert system, Architecture of expert systems, Roles of expert systems, Knowledge Acquisition, Meta Expert systems shells. |
| **Unit V: AI Applications (6 Hrs)** |
| AI in Speech Recognizer, Natural Language Processing, Chatbots, Computer Vision, Role of AI in Industry 4.0 and industry 5.0.  AI in Robotics – Robotic sensors, Agriculture robots, Domestic robots, Delivery robots, Mining robots, Space robots, Robotics in biological sensing, Unmanned Aerial Vehicle – UAV, Forestry.  AI in E-commerce, Education, Manufacturing, Navigation, Healthcare, Gaming, Social media, Security, Lifestyle |
| **Unit VI: Advancements of AI on Cloud Platforms (6 Hrs)** |
| Amazon Web Services (AWS): Amazon SageMaker, Alexa, Lex, and Polly, Conversational gents, Amazon Comprehend, natural language processing, Amazon Rekognition, image and video, Amazon Translate, Amazon Machine Learning, Amazon Transcribe, transcription, Amazon Textract, document analysis.  Microsoft Azure: Microsoft Azure Machine Learning Studio, Azure Machine Learning Service, Azure Cognitive Services Google Cloud Platform (GCP): AI Hub Google Cloud AI Building Blocks |
| **Textbooks:** |
| 1. Stuart Russell, Peter Norvig, Artificial Intelligence: A Modern Approach, Prentice Hall, Fourth edition, 2020  2. Artificial Intelligence by Elaine Rich, Kevin Knight and Nair ISBN-978-0- 07008770-5, TMH 3. Artificial Intelligence by Patrick Henry Winston, Addison-Wesley PublishingCompany,ISBN 0- 201-53377-4 |
| **Reference Books:** |

**Third Year B. Tech (Pattern 2020R1) CSE (Artificial Intelligence)**

Bansilal Ramnath Agarwal Charitable Trust’s 

**Vishwakarma Institute of Information Technology, Pune-48**

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

**Department of Computer Science and Engineering (Artificial Intelligence)**

| 1. Artificial Intelligence with Python -Second Edition-Alberto ArtasanchezPrateek Joshi-Packt Publishing Ltd  2. Artificial Intelligence by Saroj Kausik ISBN:- 978-81-315-1099-5, Cengage Learning 3. Artificial Intelligence and Intelligent Systems by Padhy, Oxforfd University Press 4. Deepak Khemani, “A First Course in Artificial Intelligence”, McGraw HillEducation(India), 2013, ISBN : 978-1-25-902998-1 |
| --- |
| **List of NPTEL Courses:** |
| 1. https://cse.iitkgp.ac.in/~pallab/artificial\_intelligence\_autumn\_2020/index.html 2. https://onlinecourses.nptel.ac.in/noc22\_cs56/preview  3. https://onlinecourses.nptel.ac.in/noc23\_ge40/preview |
| **List of Assignments:** |
| **Similar problem statements can be floated for each batch by subject in-charge. Implement any 7 of them.**  1. Implement DFS, BFS for 8-puzzle problem .  2. Implement constraint satisfaction problem.  3. Perform parsing of family tree using knowledge-base.  4. To Implement A\* Algorithm for an application.  5. Implement minmax algorithm for game playing.  6. Implement basic search strategies – 8-Queens Problem  7. Implement Forward Chaining Algorithm  8. Implement backward chaining algorithm  9. Create a Chabot application for any real-world scenario |

**Third Year B. Tech (Pattern 2020R1) CSE (Artificial Intelligence)**

**Home**

Bansilal Ramnath Agarwal Charitable Trust’s

**Vishwakarma Institute of Information Technology, Pune-48** (An Autonomous Institute affiliated to Savitribai Phule Pune University) **Department of Computer Science and Engineering (Artificial Intelligence)**

**CAUA31202: DEEP LEARNING**

| **Teaching Scheme** | **Examination Scheme** | | | | |
| --- | --- | --- | --- | --- | --- |
| **Credits:** 04  **Lecture (L):** 03 hrs / week  **Practical (P):** 02 hrs / week | CIE | SCE | ESE | PR | Total |
| 20 | 20 | 40 | 20 | 100 |
| **Prerequisites:** Probability and Statistics, Machine Learning | | | | | |
| **Course Objective(s):**  1. To explain the theoretical foundations, algorithms, and methodologies of deep learning. 2. To understand the basics of deep neural networks.  3. Comparing different deep learning architectures.  4. To characterize different architectures and parameters of deep neural networks such as CNN. 5. To explain deep generative models using autoencoders and representation Learning. 6. To describe Reinforcement Learning. | | | | | |
| **Course Outcomes:**  After completion of the course, student will be able to -  1. Analyze the different issues and needs of parameters required for the design of any deep neural network.  2. Apply convolutional neural networks-based techniques and analyze their performance. 3. Apply recurrent neural networks-based algorithms and analyze their performance. 4. To implement and apply deep generative models.  5. To apply deep generative models using autoencoders and representation learning. 6. To understand reinforcement learning process and deep learning applications. | | | | | |
| **Contents** | | | | | |
| **Unit I: Introduction of Deep Learning (8 Hrs)** | | | | | |
| **Fundamentals of Deep Learning:** Introduction to Deep Learning, Neuron, Neural Networks, Types of Deep Learning Networks, Working of Neural Network  **Perceptrons:** Single Layer Perceptron, Multilayer Perceptrons (MLPs), Representation Power of MLPs, Working of Perceptron with Weights and Bias, Sigmoid Neurons, Advantage and challenges of deep learning.  **Activation Functions:** Activation Functions for Neural Networks, RELU, LRELU, ERELU, Sigmoid, Tanh, Softmax  **Training Neural Networks:** Backpropagation and Forward propagation.  **Gradient Descent** - Gradient Descent (GD), Vanishing Gradient Problem, Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, AdaGrad, RMSProp  **Hyper parameters:** Layer size, Magnitude (momentum, learning rate) | | | | | |

**Third Year B. Tech (Pattern 2020R1) CSE (Artificial Intelligence)**

Bansilal Ramnath Agarwal Charitable Trust’s 

**Vishwakarma Institute of Information Technology, Pune-48**

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

**Department of Computer Science and Engineering (Artificial Intelligence)**

|  |
| --- |
| **Unit II: Convolutional Neural Networks (5 Hrs)** |
| **Building blocks:** Convolution blocks, Convolution Operation, Parameter Sharing, Padding, Strides, ReLU layer, Max Pooling, Fully Connected Layers, Activation functions, Basic Architecture and mathematical modelling of CNN. YOLO for object detection.  **Pretrained Models, Transfer learning techniques and popular CNN architectures:** AlexNet, VGGNet, ResNet, InceptionV3, DenseNet, EfficientNet, DarkNet, TFLite, ImageNet  **Case study:** Image classification using CNN. |
| **Unit III: Recurrent Neural Networks (6 Hrs)** |
| **RNN:** Architectural Overview, Types of Recurrent Neural Networks, Feed-Forward Neural Networks vs Recurrent Neural Networks  **Bidirectional RNNs:** Encoder-decoder sequence to sequence architectures, Back-propagation through time for training RNN, Long Short-Term Memory (LSTM) Recurrent Neural Networks, Gated Recurrent Unit Networks |
| **Unit IV: Autoencoders and Transformers (6 Hrs)** |
| **Autoencoders and Decoders:** Types of Autoencoders: Undercomplete Autoencoders, Regularized Autoencoders, Sparse Autoencoders, Stochastic Encoders and Decoders, Denoising Autoencoders, Contractive Autoencoders, Applications of Autoencoders  **Transformers:** Introduction, Architecture, Self-Attention in Transformers, Multi-head attention in Transformers, Applications |
| **Unit V: Deep Generative Models (5 Hrs)** |
| **Deep generative model:** Introduction, Generative adversarial network (GAN), discriminator network, generator network, types of GAN, Deep Convolutional Adversarial Network, Applications of GAN networks  **Case Study:** GAN for detection of real or fake images |
| **Unit VI: Reinforcement Learning and Deep Learning Applications (6 Hrs)** |
| **Reinforcement Learning:** Introduction of reinforcement learning, Elements of Reinforcement Learning, Agent Environment Interaction Cycle, Markov Decision Process, basic framework of reinforcement learning, challenges of reinforcement learning, Simple reinforcement learning for Tic Tac-Toe.  **Deep Learning Applications:** Image Classification, Social Network analysis, Speech Recognition, Recommender system, Natural Language Processing, Chatbots |
| **Text Books:** |

**Third Year B. Tech (Pattern 2020R1) CSE (Artificial Intelligence)**

Bansilal Ramnath Agarwal Charitable Trust’s 

**Vishwakarma Institute of Information Technology, Pune-48**

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

**Department of Computer Science and Engineering (Artificial Intelligence)**

| 1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, ISBN: 978- 0262035613, 2017.  2. Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, ISBN-13:978-1491914250, 2017.  3. Charu C. Aggarwal, “Neural Networks and Deep Learning: A Textbook”, Springer, ISBN: 978- 3-319-94463-0, 2019.  4. Nikhil Buduma, "Fundamentals of Deep Learning Designing Next-Generation Machine Intelligence Algorithms" O'Reilly |
| --- |
| **Reference Books:** |
| 1. Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, “Dive into Deep Learning”, 2021.  2. Giancarlo Zaccone, Md. Rezaul Karim, Ahmed Menshawy "Deep Learning with TensorFlow: Explore neuralnetworks with Python", Packt Publisher, 2017.  3. Umberto Michelucci “Applied Deep Learning. A Case-based Approach to Understanding. Deep Neural Networks” Apress, 2018.  4. Antonio Gulli, Sujit Pal "Deep Learning with Keras", Packt Publishers, 2017. 5. Francois Chollet "Deep Learning with Python", Manning Publications, 2017. |
| **List of MOOC / NPTEL and e-Learning Courses:** |
| 1. https://www.my-mooc.com/en/categorie/deep-learning  2. https://onlinecourses.nptel.ac.in/noc19\_cs58  3. https://onlinecourses.nptel.ac.in/noc21\_ee23  4. https://onlinecourses.nptel.ac.in/noc23\_cs24/  5. https://onlinecourses.nptel.ac.in/noc23\_cs56  6. https://www.analyticsvidhya.com/blog/2021/07/in-depth-explanation-of-recurrent-neural-network 7. https://www.automl.org/automl/  8. Deep Learning for Visual Computing https://onlinecourses.nptel.ac.in/noc22\_ee54 9. Deep Learning - IIT Kharagpur https://onlinecourses.nptel.ac.in/noc22\_cs22 10. Deep Learning - IIT Ropar https://onlinecourses.nptel.ac.in/noc22\_cs35/ |
| **List of Assignments:** |
| **Similar problem statements can be floated for each batch by subject in-charge.** 1. Implementing Feedforward neural networks in Python using Keras and TensorFlow 2. Facial recognition using OpenCV and deep learning for binary classification. 3. Implement Image classification using convolutional neural networks (CNNs) for multiclass classification.  4. Time series prediction using RNN – stock market analysis or weather forecasting 5. Text identification using OpenCV, Tesseract (OCR) and deep neural network 6. Sentiment analysis using LSTM network or GRU.  7. Object detection using YOLO and Pretrained Model  **Mini project is to be performed in a group of 2 to 4 students.**  Develop a mini project in a group using different predictive models techniques to solve any real life problem. |

**Third Year B. Tech (Pattern 2020R1) CSE (Artificial Intelligence)**

**Home**

Bansilal Ramnath Agarwal Charitable Trust’s

**Vishwakarma Institute of Information Technology, Pune-48** (An Autonomous Institute affiliated to Savitribai Phule Pune University) **Department of Computer Science and Engineering (Artificial Intelligence)**

**CAUA31203: BIG DATA ANALYTICS**

| **Teaching Scheme** | **Examination Scheme** | | | | |
| --- | --- | --- | --- | --- | --- |
| **Credits:** 04  **Lecture (L):** 03 hrs / week  **Practical (P):** 02 hr / week | CIE | SCE | ESE | PR | Total |
| 20 | 20 | 40 | 20 | 100 |
| **Prerequisites:** Programming and Problem solving, Data Structures & Algorithms, Operating Systems, DBMS, Machine Learning | | | | | |
| 1. To comprehend Big data and its features.  2. To develop various applications based on distributed computing frameworks. 3. To apply various operations on distributed storage.  4. To learn and analyze how to handle large data sets in main memory.  5. To learn spark streaming and programming.  6. To learn the various machine learning techniques for Big Data Analytics. | | | | | |
| **Course Outcomes:**  After completion of the course, student will be able to -  1. Comprehend Big data and its features.  2. Develop various applications based on distributed computing frameworks. 3. Apply various operations on distributed storage.  4. Explore and analyze large data sets in main memory.  5. Make Use of Spark framework and perform streaming and programming.  6. Demonstrate various machine learning techniques for Big Data Analytics. | | | | | |
| **Contents** | | | | | |
| **Unit I: Understanding Big Data (6 Hrs)** | | | | | |
| **Overview:** Classification of Digital Data, Structured and Unstructured Data, Big Data & Big data Computing, Role of Distributed System in Big Data **Characteristics of Big Data**: 3 Vs and more, Big data Evolution – Definition - Challenges with Big Data.  **Big Data Applications & Use cases**: Web search, Marketing and advertising, Information retrieval, Patterns for Big Data Deployment, IT for IT Log Analytics, The Fraud Detection Pattern | | | | | |
| **Unit II: Hadoop Map-Reduce Framework (6 Hrs)** | | | | | |
| Basics of functional programming, Map reduce fundamentals, Data flow (Architecture), Architecture of Hadoop, Requirements of Hadoop Framework, Design principle of Hadoop, Comparison with other system, Hadoop Components – Hadoop 1 vs Hadoop 2 – Hadoop Daemon’s, Map Reduce Programming: I/O formats, Map side join, Reduce Side Join, Secondary sorting, Pipelining MapReduce jobs, Hadoop Ecosystem overview | | | | | |
| **Unit III: Hadoop Distributed File System (6 Hrs)** | | | | | |
| Distributed System Overview, Distributed File System with NFS, Basic HDFS Architecture: NameNode, Secondary NameNode, DataNode, checkpoint Node. Features of HDFS, HDFS Assumption and Goals: Hardware failure, Streaming data access, Large datasets, coherency model. HDFS Read and Write Operations. | | | | | |

**Third Year B. Tech (Pattern 2020R1) CSE (Artificial Intelligence)**

Bansilal Ramnath Agarwal Charitable Trust’s 

**Vishwakarma Institute of Information Technology, Pune-48**

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

**Department of Computer Science and Engineering (Artificial Intelligence)**

| **Unit IV: Spark Programming (6 Hrs)** |
| --- |
| Spark Basics: Introduction to Spark, Spark components, Spark Architecture: Spark client, driver, Spark context, Master and Executers, Spark execution: Job, Stage and Task, Spark Application developments, Spark Streaming: Batch processing and Real time processing, Concepts of Spark streaming, Stream sources, Architecture of Spark streaming, Stateless transformation, Stateful transformation. Spark Programming in Python/Java - Application Execution. |
| **Unit V: High Performance Data Analytics with CUDA (6 Hrs)** |
| Introduction to GPU Computing, CUDA Programming Model, CUDA API, Simple Matrix Multiplication in CUDA, CUDA Memory Model, Shared Memory Matrix Multiplication, Additional CUDA API Features. Data Analysis with Spark Shell. |
| **Unit VI: Machine Learning Algorithms for Big Data Analytics (6 Hrs)** |
| Introduction, Estimating the relationships, Outliers, Variances, Probability Distributions, and Correlations, Regression analysis, Finding Similar Items, Similarity of Sets and Collaborative Filtering, Publicly Available Datasets: UCR STAR [https://star.cs.ucr.edu], Twitter Streaming API, Big-data Libraries: MLlib (Machine Learning), GraphX |
| **Text Books:** |
| 1. Raj Kamal and Preeti Saxena, “Big Data Analytics Introduction to Hadoop, Spark, and Machine Learning”, McGraw Hill Education, 2018 ISBN: 9789353164966, 9353164966 2. Douglas Eadline, "Hadoop 2 Quick-Start Guide: Learn the Essentials of Big Data Computing in the Apache Hadoop 2 Ecosystem", 1 stEdition, Pearson Education, 2016. ISBN13: 978- 9332570351  3. Data Analytics: The Ultimate Beginner's Guide to Data Analytics Paperback – 12 November 2017by Edward Mize. |
| **Reference Books:** |
| 1. Hadoop: The Definitive Guide, Tom White, THIRD EDITION, OREILLY 2. Hadoop in Action, Chuck Lam, Manning  3. Professional Hadoop, Benoy Antony et al, July 2016, Wiley  4. Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Michael Minelli et al Wiley, 2013.  5. Professional CUDA® C Programming, John Cheng, John Wiley & Sons, Inc. |
| **List of Assignments:** |
| 1. Installation and Configuration of Single Node Hadoop System.  2. Configuration of Multi-node Hadoop System.  3. HDFS commands such as Adding files and directories, retrieving files and Deleting files 4. Develop a MapReduce program to calculate the frequency of a given word in a given file. (word count)  5. Develop a MapReduce program to implement Matrix Multiplication.  6. Develop a MapReduce to analyze weather data set and print whether the day is shinny or cool day. |

**Third Year B. Tech (Pattern 2020R1) CSE (Artificial Intelligence)**

Bansilal Ramnath Agarwal Charitable Trust’s 

**Vishwakarma Institute of Information Technology, Pune-48**

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

**Department of Computer Science and Engineering (Artificial Intelligence)**

| 7. Develop a MapReduce program to find the frequency of books published eachyear and find in which year maximum number of books were published usingthe following data. Title Author Published-year Author-country Language No of pages  8. Develop a MapReduce program to analyze Uber data set to find the days on which each basement has more trips using the following dataset.  The Uber dataset consists of four columns they are:  dispatching\_base\_number date active\_vehicles trips  9. Implement applications using SPARK. |
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**Third Year B. Tech (Pattern 2020R1) CSE (Artificial Intelligence)**

**Home**

Bansilal Ramnath Agarwal Charitable Trust’s

**Vishwakarma Institute of Information Technology, Pune-48**

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

**Department of Computer Science and Engineering (Artificial Intelligence) CAUA31204: Data Communication and Networking**

| **Teaching Scheme** | **Examination Scheme** | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Credits:3**  Lecture (L): 02  Practical (P): 02 hrs/Week | CIE | PPT | SCE | ESE | OR | Total |
| 20 | 20 | - | 40 | 20 | 100 |
| **Prerequisites:**  Digital Electronics and Computer Architecture  **Course objectives:**  1. To understand the fundamental concepts of Data Communication.  2. To classify the transmission media and switching Techniques.  3. To Design and Develop the LAN Topologies.  4. To illustrate the functions of OSI and TCP/IP Protocol.  5. To understand the functionality of Data link layer | | | | | | |
| **Course Outcomes:**  Upon completion of the course, students will be able to  1. Elaborate the concepts of Data Communication.  2. Discriminate various Transmission Media, Connecting devices and Switching Techniques for digital data communication.  3. Demonstrate the functions of OSI layers & TCP/IP protocol stack.  4. Comprehensive functions of Error Control and Data Link Control | | | | | | |
| **Contents** | | | | | | |
| **Unit I – Introduction to Data Communications (6 Hrs)** | | | | | | |
| Process of Data Communication and its components: Transmitter, Receiver, Medium, Message, Protocol. Analog and Digital: Analog and Digital Data, Analog and Digital Signals, Periodic and Non-periodic Signal.  Transmission Impairment: Attenuation, Distortion, Noise  Data Rate Limits: Noiseless Channel: Nyquist Bit Rate, Noisy Channel: Shannon Capacity, Using Both Limits  Performance: Bandwidth, Throughput, Latency (delay), Bandwidth-delay Product, Jitter. Modes of Communication (Simplex, Half Duplex, Full Duplex). | | | | | | |
| **Unit II – Transmission Media and Switching (6 Hrs)** | | | | | | |
| Guided Media: Twisted-Pair, Coaxial and Fiber-Optic Cable Unguided Media: Radio Waves, Microwaves, Infrared  Connecting devices: Hubs, Repeaters, Active hubs, Bridges, Switches, Routers, Gateways Switching: Circuit-switched Networks: Three Phases, Efficiency, Delay. Packet switching: Datagram networks, Virtual circuit networks. | | | | | | |
| **Unit III – Layered Model and Topologies (6 Hrs)** | | | | | | |

**Third Year B. Tech (Pattern 2020R1) CSE (Artificial Intelligence)**

Bansilal Ramnath Agarwal Charitable Trust’s 

**Vishwakarma Institute of Information Technology, Pune-48**

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

**Department of Computer Science and Engineering (Artificial Intelligence)**

| The OSI Model: Layered Architecture, peer-to-peer Processes, Encapsulation of Layers in the OSI Model, TCP/IP Protocol Suite, LAN, MAN, WAN, Topologies- star, mesh, bus, hybrid etc. Addressing: Physical &logical Addresses, Port Addresses, Specific Addresses |
| --- |
| **Unit IV– Error Control and Data Link Control (6 Hrs)** |
| Types of errors: Single bit error and burst error, Redundancy, detection versus correction, forward error correction versus retransmission,  Block coding: error detection, error correction, CRC, polynomial, checksum, hamming code, hamming Distance, DLC Services: Framing, Flow and error control DLL Protocols: Simple protocol, Stop n wait, Go back to N, Selective repeat Point-to-point Protocol (PPP) : Framing, Transition Phases, Multiplexing, Multilink PPP. |
| **Textbooks:**  1. Fourauzan B., "Data Communications and Networking", 5th edition, McGraw-Hill Publications 2. Stallings William., "Data and Computer Communications", Sixth Edition, Prentice Hall of India. |
| **Reference books:**  1. Andrew S. Tenenbaum ,”Computer Networks”, Pearson  2. Douglas E. Comer, “Computer Networks and Internets”, Pearson Education  3. Godbole Achyut, “Data Communication and Networks”, Tata McGraw Hill Publication. |
| **List of Assignments:**  1. Exploring different Analog and Digital Data conversion techniques.  2. Network Representation on Network Simulator tool  3. Study of DCE, DTE, straight and cross cables  4. Identify MAC and IP addresses (physically as well as using packet tracer tool). 5. Demonstrate the use of Wireshark tool for network analysis  6. Setup a wired LAN using Layer 2 Switch. It includes preparation of cable, testing of cable using line tester, configuration machine using IP addresses, testing using PING utility and demonstrating the PING packets captured traces using Wireshark Packet Analyzer Tool.  7. Demonstrate the different types of topologies and types of transmission media by using a packet tracer tool.  8. Test with basic network tools. Read the man pages of ifconfig, ping, traceroute, arp, dig and nslookup. Write the solution of the following problems into the report and also paste the screenshots of Terminal into the report.  (a) Find the IP address of your machine using ‘ifconfig’ command.  (b) Use ‘ping ’ command and find out ( i.) the average RTT(round trip time). (ii.) the %packet loss. (iii.) size of packet that is sent to www.iitk.ac.in server. (iv.) size of packet that is received by your machine.  (c) Use ‘dig www.iitk.ac.in’ command and find out i. the ip address of iitk.ac.in. ii. the ip addresses of local DNS servers of your institute |

**Third Year B. Tech (Pattern 2020R1) CSE (Artificial Intelligence)**

Bansilal Ramnath Agarwal Charitable Trust’s 

**Vishwakarma Institute of Information Technology, Pune-48**

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

**Department of Computer Science and Engineering (Artificial Intelligence)**

| (d) Use ‘traceroute www.iitk.ac.in’ and find out i. number of hops in between your machine and iitk.ac.in server. ii. the ip address of your network gateway of your subnet.  (e) Use ‘arp -an’ command to find out the MAC address of the device that is performing as your network gateway.  9. Write a program for hamming code error control method.  10. Write a program for checksum stop-n-wait flow control method.  11. Write a program for checksum Go-back-N flow control method.  **NPTEL / MOOC course:**  1. “Data Communication”, IIT Kharagpur Prof. Ajit Pal  https://nptel.ac.in/courses/106105082 |
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**Third Year B. Tech (Pattern 2020R1) CSE (Artificial Intelligence)**

**Home**

Bansilal Ramnath Agarwal Charitable Trust’s

**Vishwakarma Institute of Information Technology, Pune-48**

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

**Department of Computer Science and Engineering (Artificial Intelligence) CAUA31205: PROFESSIONAL ELECTIVE I**

| **Teaching Scheme** | | **Examination Scheme** |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Credits:3**  Lecture (L): 02  Practical (P): 02 hrs/Week | | CIE | SCE | | ESE | OR | Total |
| 20 | 20 | | 40 | 20 | 100 |
| **Course Name** | **Application Developer** | | |  | **IBM Full Stack Software Developer** |  |  |
| Full Stack  Software  Development  (CAUA31205A) | IBM Full Stack Software Developer | | | Introduction to Cloud Computing | | | |
| IBM Full Stack Software Developer | | | Introduction to Web Development with HTML, CSS, JavaScript | | | |
| IBM Full Stack Software Developer | | | Getting Started with Git and GitHub | | | |
| IBM Full Stack Software Developer | | | Developing Cloud Native Applications | | | |
| IBM Full Stack Software Developer | | | Developing Cloud Apps with Node.js and React | | | |
| IBM Full Stack Software Developer | | | Introduction to Containers w/ Docker, Kubernetes & OpenShift | | | |
| IBM Full Stack Software Developer | | | Python for Data Science, AI &  Development | | | |
| IBM Full Stack Software Developer | | | Application Development using  Microservices and Serverless | | | |
| IBM Full Stack Software Developer | | | Full Stack Cloud Development Capstone Project | | | |
| IBM Full Stack Software Developer | | | Full Stack Software Developer  Assessment | | | |
| **2** | **DevOps Engineer** | | | **IBM DevOps and Software**  **Engineering** | | | |
| Cloud  Development  Operations  (CAUA31205B) | IBM DevOps and Software  Engineering | | | Introduction to DevOps | | | |
| IBM DevOps and Software  Engineering | | | Introduction to Cloud Computing | | | |
| IBM DevOps and Software  Engineering | | | Introduction to Agile Development and Scrum | | | |
| IBM DevOps and Software  Engineering | | | Hands-on Introduction to Linux  Commands and Shell Scripting | | | |
| IBM DevOps and Software  Engineering | | | Getting Started with Git and GitHub | | | |
| IBM DevOps and Software  Engineering | | | Python for Data Science, AI &  Development | | | |
| IBM DevOps and Software  Engineering | | | Introduction to Containers w/ Docker, Kubernetes & OpenShift | | | |
| IBM DevOps and Software  Engineering | | | Application Development using  Microservices and Serverless | | | |

**Third Year B. Tech (Pattern 2020R1) CSE (Artificial Intelligence)**

Bansilal Ramnath Agarwal Charitable Trust’s 

**Vishwakarma Institute of Information Technology, Pune-48**

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

**Department of Computer Science and Engineering (Artificial Intelligence)**

|  | IBM DevOps and Software  Engineering | Introduction to Test Driven  Development (TDD) |
| --- | --- | --- |
| IBM DevOps and Software  Engineering | Continuous Integration and Continuous Delivery (CI/CD) |
| IBM DevOps and Software  Engineering | Application Security and Monitoring |
| IBM DevOps and Software  Engineering | DevOps Capstone Project |

**Third Year B. Tech (Pattern 2020R1) CSE (Artificial Intelligence)**

**Home**

Bansilal Ramnath Agarwal Charitable Trust’s

**Vishwakarma Institute of Information Technology, Pune-48**

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

**Department of Computer Science and Engineering (Artificial Intelligence)**

**CAUA31206: RESEARCH METHODOLOGY AND IPR**

| **Teaching Scheme** | **Examination Scheme** | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Credits:** 02  **Lecture (L):** 02 hrs / week | CIE | ISE | SCE | ESE | TW | Total |
| **--** | **--** | 50 | **--** | -- | 50 |
| **Prerequisites: Nil** | | | | | | |
| **Course Objective(s):**  1. Explain the formulation of Research Problem  2. Explain the importance of ideas, concept and creativity  3. Transfer the knowledge about the IPR required for Engineer’s  4. Describe how IPR creates National wealth  5. Teach National and International IP System | | | | | | |
| **Course Outcomes:**  Upon completion of course, students will be able to:  1. Formulate the research problem with appropriate objectives  2. Understand the right of ownership, scope of protection as well as the ways to create and to extract value from IP.  3. Identify different types of Intellectual Properties (IPs)  4. Discover how IPR are regarded as a source of national wealth and mark of an economic leadership in context of global market scenario  5. Analyze national & International IP system. | | | | | | |
| **Contents** | | | | | | |
| **Unit I: Introduction to Research Problem (6 Hrs)** | | | | | | |
| Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations, Effective literature studies approaches, analysis Plagiarism, Research ethics. | | | | | | |
| **Unit II: Introduction to Intellectual Property (6 Hrs)** | | | | | | |
| Introduction to the concepts Property and Intellectual Property, Nature and Importance of Intellectual Property Rights Understanding the types of Intellectual Property Rights: - Patents, Designs, Trademarks (Registered and unregistered trademarks), Copyright, Traditional Knowledge, Geographical Indications, Trade Secrets, Idea Patenting, (Case Studies) | | | | | | |
| **Unit III: Patent Formulation (6 Hrs)** | | | | | | |
| New Developments in IPR, Process of Patenting and Development: technological research, innovation, patenting, development, International Scenario: WIPO, TRIPs, Indian Patent Office and its Administration. | | | | | | |

**Third Year B. Tech (Pattern 2020R1) CSE (Artificial Intelligence)**

Bansilal Ramnath Agarwal Charitable Trust’s 

**Vishwakarma Institute of Information Technology, Pune-48** (An Autonomous Institute affiliated to Savitribai Phule Pune University) **Department of Computer Science and Engineering (Artificial Intelligence)**

| **Unit IV: Patent Act and Licensing (6 Hrs)** |
| --- |
| Administration of Patent System–Patenting under Indian Patent Act, Patenting under PCT, Patent Rights and its Scope, Licensing and transfer of technology, Patent information and database. Provisional and Non-Provisional Patent Application and Specification |
| **Text Books:** |
| 1.Resisting Intellectual Property by Halbert, Taylor&FrancisLtd,2007  2. Industrial Design by Mayall, Mc GrawHill  3. Intellectual Property in New Technological Age by Robert P. Merges, Peter S. Menell, Mark A. Lemley |
| **Reference Books:** |
| 1.Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction” 2. Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guide for beginners” 3. Intellectual Property Rights under WTO by T. Ramappa, S. Chand 4. Introduction to Design by Asimov, Prentice Hall |

**Third Year B. Tech (Pattern 2020R1) CSE (Artificial Intelligence)**

**Home**

Bansilal Ramnath Agarwal Charitable Trust’s

**Vishwakarma Institute of Information Technology, Pune-48**

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

**Department of Computer Science and Engineering (Artificial Intelligence)**

**CAUA31207: PROJECT STAGE - I**

| **Teaching Scheme** | **Examination Scheme** | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Credits:** 02  **Practical (P):** 04 hrs / week | CIE | ISE | SCE | OR | TW | Total |
| **--** | **--** | **--** | 20 | 30 | 50 |
| **Prerequisites:** | | | | | | |
| **Course Objective(s):**  1. To apply the learnt skill sets required to solve an engineering related problem. 2. To expose students to product development cycle using industrial experience, use of state of art technologies.  3. To provide the students with the opportunity to design or conduct independent research related to IT courses.  4. To encourage and expose students for participation in research paper presentation activities and IPR.  5. To learn the importance of teamwork, documentation and ethics. | | | | | | |
| **Course Outcomes:**  Upon completion of course, students will be able to:  1. Identify the problem that needs technological solution and define scope. 2. Demonstrate a sound literature review and design the solution.  3. Implement the solution and test by applying knowledge and various tools. 4. Track the progress of the project with the help of a project management tool. 5. Perform effectively as an individual and a team member in multi-disciplinary teams. 6. Communicate with engineers and the community at large in written and oral forms. | | | | | | |
| **Contents** | | | | | | |
| **Unit I: - Title and scope finalization (6 Hrs)** | | | | | | |
| **Problem statement:** a concise statement of the problems which initiate the industrial problem or research questions or design ideas. Answering questions: What is the issue that we want to address (problem or question)?Why need to address the issues? How can the project solve the issues?, d. Who will benefit from the project? Setting a clear goal of what needs to be accomplished by doing the work. Students should  **Objectives:** only state the technical objective of the project (e.g. to evaluate the performance of the design, to test a hypothesis, to study the relationship between variable x and variable y etc.). Use measurable action verbs when defining an objective (e.g. define, design, identify, describe, analyze, evaluate etc).  **Scope:** Scope sets a clear boundary (time, geography, environment, function etc.) of our work to provide a common understanding of the project among stakeholders (in FYP the stakeholders are students, lecturer, panels etc.). Scope makes our project achievable and realistic by defining the limits and constrains of the study.  **Formal technical review-0 (FTR-0)** | | | | | | |

**Third Year B. Tech (Pattern 2020R1) CSE (Artificial Intelligence)**

Bansilal Ramnath Agarwal Charitable Trust’s 

**Vishwakarma Institute of Information Technology, Pune-48** (An Autonomous Institute affiliated to Savitribai Phule Pune University) **Department of Computer Science and Engineering (Artificial Intelligence)**

| **Unit II: Literature review and design (6 Hrs)** |
| --- |
| **Literature review:** To summarize and synthesize the ideas of others (Similar systems and research work) Discuss the techniques or different design decisions; make comparisons and give technical comments; Summarize the comparison with tables or graphs to clarify the differences. **Design:** SRS; Use of the designing tools; discussion on the tradeoff of a particular design decision; Selection of Technology and Tools, UI/UX design, database design, design of test cases and performance metrics Installations; Use of various tools  **Formal technical review-1 (FTR-1)** |
| **Unit III: Implementation and Testing (6 Hrs)** |
| Implementation of algorithms, databases and modules as per design; Testing: Analysis of results and performance; comparative analysis (comparison with existing/ known algorithms/ systems) and validation of results; discussions and conclusions.  **Formal technical review-2 (FTR-2)** |
| **Unit IV: Report writing and Project outcome generation (6 Hrs)** |
| Documentation and presentation: Project report writing and demo video creation. 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. **Project outcome:** Submit the research paper based on the work done to a reputed conference/ journal or IPR or participation in hackathon or participation in project competition as per the suggestions of the guide. For industry sponsored projects, the work must be submitted/ deployed as per industry requirement and obtain the completion certificate from the industry. **Project Oral exam:** The assessment will be broadly based on work undergone, content delivery, presentation skills, documentation, question-answers and report. |

**Third Year B. Tech (Pattern 2020R1) CSE (Artificial Intelligence)**