ಬಿ.ಎಂ.ಎಸ್. ತಾಂತ್ರಿಕ ಮತ್ತು ವ್ಯವಸ್ಥಾಪನಾ ಮಹಾವಿದ್ಯಾಲಯ

BMS INSTITUTE OF TECHNOLOGY & MANAGEMENT

(Autonomous Institution Under VTU)

Yelahanka, Bengaluru -560064

Bachelor of Engineering

Department of Artificial Intelligence & Machine Learning

VI Semester Scheme and Syllabus
2022 Scheme
Effective from the AY 2023-24

Approved in the BoS meeting held on 3rd March 2025

Vision and Mission of the Department

Vision:

To develop professionals equipped to build sustainable and intelligent solutions that effectively interact with natural intelligence towards creating a digitally empowered environment for future generations, safeguarding social ethics.

Mission:

- To enable students with the spirit and power of interdisciplinary acumen by integrating a world of knowledge into a world of intelligent systems and subsystems.
- Boost academic outcome through place-based education and collaborations with established research labs and industries.
- Encourage entrepreneurship efforts among students and develop them into great leaders.

Program Educational Objectives (PEOs)

PEO'S	
PEO1	Possess essential professional engineering skills that make them confident to develop high-quality AI solutions for various application domains under realistic constraints.
PEO2	Demonstrate the importance of life-long learning through professional development, computing practices, and specialized certifications
PEO3	Engage and succeed in their professional careers through teamwork, ethical behaviour, proactive involvement, and effective communication.

Program Specific Outcomes (PSOs)

PSO'S	
PSO-1	Ability to apply acquired skills to build optimized solutions adhering to principles and practices of Computational Intelligence.
PSO-2	Employ ethical strategies and policies in project and product development.

BMS INSTITUTE OF TECHNOLOGY & MANAGEMENT

(Autonomous Institution Affiliated to VTU, Belagavi)

B. E. in Artificial Intelligence & Machine Learning

Scheme of Teaching and Examinations – 2022 Scheme

Outcome-Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2022-23 onwards)

VI Semester

Sl. No.	Course Category	Course Code	Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Credits Distribution				Examination				Contact Hours/week
					L	T	P	Total	CIE Marks	SEE Marks	Total Marks	SEE Duration (H)	
1	IPCC	BAI601	**Natural Language Processing**	TD: AI & ML PSB: AI & ML	3	0	1	4	50	50	100	3	3 + 2 = 5
2	PCC	BAI602	**Deep Learning**		4	0	0	4	50	50	100	3	4
3	PCC	BAI603	**Theory of Computation**		3	0	0	3	50	50	100	3	3
4	PEC	BAI604X	**Professional Elective Course II**		3	0	0	3	50	50	100	3	3
5	OEC	BAI605X	**Open Elective Course I**		3	0	0	3	50	50	100	3	3
6	PW	BAI606	**Major Project Phase I**		0	0	3	3	100	-	100	-	6
7	PCCL	BAIL607	**Deep Learning Lab**		0	0	1	1	50	50	100	3	2
8	AEC	BAI608X	**Ability Enhancement Course / Skill Enhancement Course**		For Theory course				50	50	100	1	1
					1	0	0	1					
					For Practical course							2	2
					0	0	1	1					
9	NCMC	BNSK609	**National Service Scheme (NSS)**	NSS Coordinator	0	0	0	0	100	-	100	-	2
		BPEK609	**Physical Education (Sports and Athletics)**	PED									
		BYOK609	**Yoga**	Yoga Teacher									
		BNCK609	**National Cadet Corps (NCC)**	NCC officer									
		BMUK609	**Music**	Music Teacher									
10	NCMC	BIKS610	**Indian Knowledge System**	Any Department	0	0	0	0	100	-	100	-	1
TOTAL					**17**	**0**	**6**	**22**	**650**	**350**	**1000**	**-**	**32**

IPCC: Integrated Professional Core Course, **PCC**: Professional Core Courses, **PEC**: Professional Elective Course, **OEC**: Open Elective Course, **PCCL**: Professional Core Course laboratory, **NCMC**: Non-Credit Mandatory Course, **ESC**: Engineering Science Course, **AEC**: Ability Enhancement Course, **L:** Lecture, **T**: Tutorial, **P**: Practical, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation.

Professional Elective Course II		Open Elective Course I		Ability Enhancement Course	
Course Code	**Course Name**	**Course Code**	**Course Name**	**Course Code**	**Course Name**
BAI604A	Cloud Computing & Virtualization	BAI605A	Fundamentals of Artificial Intelligence	BAI608A	Generative AI Lab
BAI604B	Robotics Process Automation	BAI605B	Data Analytics	BAI608B	Business Intelligence Lab Using Power BI
BAI604C	Human Computer Interface	BAI605C	Fundamentals of DBMS	BAI608C	Web Programming Lab
BAI604D	Big Data Analytics	BAI605D	Fundamentals of Algorithms	BAI608D	Haskell Programming Lab

Integrated Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practical's of the same course. Credit for IPCC can be 04 and its Teaching– Learning hours (L: T: P) can be considered as (3: 0: 2) or (2: 2: 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper.

National Service Scheme /Physical Education/Yoga/NCC/Music: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE) (Sports and Athletics), Yoga (YOG), National Cadet Corps (NCC) and Music with the concerned coordinator of the course during the beginning of each semester starting from III semester to VII semester. In every semester, students should choose any one mandatory course among the available 5 courses without repeating the course again. Activities shall be carried out in each of the semesters from III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of degree.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering a professional elective is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

Open Elective Courses (OEC): Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they can opt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor.

Selection of an open elective shall not be allowed if,

- The candidate has studied the same course during the previous semesters of the program.
- The syllabus content of open electives is similar to that of the Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters of the program.
- The minimum students' strength for offering open electives is 10. However, this condition shall not be applicable to cases where the admission to the program is less than 10.

Project Phase-I: Students have to discuss with the mentor /guide and with their help he/she has to complete the literature survey and prepare the report and finally define the problem statement for the project work.

VI semester (2022 Scheme) Open Elective Courses offered to AIML, CSE and ISE Students - Group I			
Sl. No.	**Course Code**	**Course Title**	**Teaching Department and QP settin Department**
1.	22CV65A	Water Conservation and Rainwater Harvesting	CV
2.	22CV65B	Geographic Information Systems	CV
3.	22CV65D	Sustainable Development Goals	CV
4.	22ME65A	Digital Transformation in Industry	ME
5.	22ME65B	Intellectual Property Management	ME
6.	22ME65C	Supply Chain Management	ME
7.	22EC65A	Sensors and Applications	ECE/ETE
8.	22EC65B	Digital Coding Techniques	ECE/ETE
9.	22EC65C	Microcontrollers	ECE/ETE
10.	22EC65D	Automotive Electronics	ECE/ETE
11.	22EE65A	Renewable Energy Systems	EEE
12.	22EE65B	Energy Audit & Demand Side Management	EEE
13.	22EE65C	Battery Management Systems	EEE

Syllabus of VI Semester

DEPARTMENT OF ARTIFICAL INTELLIGENCE AND MACHINE LEARNING
Choice Based Credit System (CBCS)
SEMESTER – VI

Natural Language Processing (3:0:1:0) 4
(Effective from the academic year 2024 -25)

Course Code	**BAI601**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	3:0:1:0	SEE Marks	50
Total Number of Contact Hours	40(T) + 12(P)	Exam Hours	3 Hours

Course Objectives:

This course will enable students to:

1. Will be able to understand the wide spectrum of problem statements, tasks, and solution approaches within NLP.
2. Will be able to implement and evaluate different NLP applications and apply machine learning and deep learning methods for this process.
3. Evaluate various algorithms and approaches for the given task, dataset, and stage of the NLP product.

Preamble: This course introduces the fundamental concepts and techniques of Natural Language Processing (NLP). Students will gain an in-depth understanding of the computational properties of natural languages and the commonly used algorithms for processing linguistic information. The course examines NLP models and algorithms using both the traditional symbolic and the more recent statistical approaches.

Module – I

Overview and language modelling: Overview: Origins and challenges of NLP-Language and Grammar-Processing Indian Languages- NLP Applications-Information Retrieval. Language Modelling: Various Grammar- based Language Models-Statistical Language Model.

Textbook 1: Ch. 1,2 **(08 Hours)**

Module – II

Word level and syntactic analysis: Word Level Analysis: Regular Expressions-Finite-State Automata-Morphological Parsing-Spelling Error Detection and Correction-Words and Word Classes-Part-of Speech Tagging. Syntactic Analysis: Context-free Grammar-Constituency- Parsing-Probabilistic Parsing.

Textbook 1: Ch. 3,4 **(08 Hours)**

Module – III

Information Retrieval and Lexical Resources: Information Retrieval: Design features of Information Retrieval Systems-Classical, Non classical, Alternative Models of Information Retrieval – valuation Lexical Resources: World Net-Frame Net- Stemmers-POS Tagger-Research Corpora.

Textbook 1: Ch. 9,12 **(08 Hours)**

Module – IV

Annotating Linguistic Structure: Context-Free Grammars and Constituency Parsing, Dependency Parsing.

Textbook 2: Ch. 17, 18 **(08 Hours)**

Module – V

NLP Applications:
Case Study: Machine Translation, Question Answering and Information Retrieval.
Textbook 2: Ch. 13, 14 **(08 Hours)**

Lab Components:

1. Develop a python program to perform the following:
   a. To read a word file and extract the email ids present in the file using Regular expressions.
   b. Develop a python program to read a text data, convert the text to lower case, remove punctuations and stop words.
2. Develop a python program to illustrate text standardization and spell correction.
3. Develop a python program to illustrate Tokenizing, Stemming and Lemmatization.
4. Develop a python program for Text to feature conversion using
   - One-hot encoding
   - Count Vectorizer
   - TF – IDF
5. Develop a python program for Generating N-grams.

Course Outcomes:

CO1: Understand the fundamental concepts and techniques of natural Language Processing.
CO2: Apply appropriate natural language generation, probabilistic classification and sematic techniques to solve the real-world problem.
CO3: Apply information retrieval techniques for real world problems.
CO4: Discover the usage of Context-Free Grammars and parsing.
CO5: Develop real time applications for the given NLP problem.

Text Books:

1. Tanveer Siddiqui, U.S. Tiwary, "**Natural Language Processing and Information Retrieval**", Oxford University Press, 2008.
2. **Speech and Language Processing**: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition by Daniel Jurafsky and James H Martin, 3rd Edition, Prentice Hall, 2019.

Reference Books:

1. Anne Kao and Stephen R. Poteet (Eds), "Natural Language Processing and Text Mining", Springer-Verlag London Limited 2007.
2. James Allen, "Natural Language Understanding", 2nd edition, Benjamin/Cummingspublishing company, 1995.
3. Gerald J. Kowalski and Mark.T. Maybury, "Information Storage and Retrieval systems", Kluwer academic Publishers, 2000.

Alternate Assessment Tools (AATs) suggested:

- Experiential Learning/ MOOC/Certification Courses (Infosys Springboard, Geek for Geeks, IBM, Hacker earth, Math works)
- Model presentation
- Video

Web links / e – resources:

1. **https://nptel.ac.in/courses/106105158**
2. **https://archive.nptel.ac.in/courses/106/106/106106211/**

DEPARTMENT OF ARTIFICAL INTELLIGENCE AND MACHINE LEARNING
Choice Based Credit System (CBCS)
SEMESTER – VI

Deep Learning (3:0:0:0) 3
(Effective from the academic year 2024 -25)

Course Code	**BAI602**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	3:0:0:0	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3 Hours

Course Objectives:
This course will enable students to:

- Build Foundational Knowledge: Understand the basic concepts and terminologies of deep learning, including neural networks, layers, activation functions, and optimization techniques.
- Hands-on Practice: Gain practical experience by building, training, and evaluating deep learning models using popular frameworks like TensorFlow and PyTorch.
- Explore Advanced Topics: Dive into advanced architectures such as convolutional neural networks (CNNs), recurrent neural networks (RNNs).
- Real-world Applications: Learn how deep learning is applied in various industries and solve real-world problems through project-based learning.
- Ethics and Future Directions: Discuss the ethical implications of deep learning and explore the future trends and research directions in this rapidly evolving field.

Preamble:
This course is designed to provide you with a comprehensive understanding of deep learning, a subfield of artificial intelligence that is driving advancements in numerous areas such as computer vision, natural language processing, speech recognition, and autonomous systems. Deep learning models, inspired by the structure and function of the human brain, have the capability to learn and make intelligent decisions from large amounts of data.

Module – I

Introduction to Deep Learning
Why Deep Learning: What is AI and deep learning? The history and rise of deep learning, why deep learning, the motivation of deep architecture, Applications, Future potential and challenges Getting Yourself Ready for Deep Learning: Basics of linear algebra, Deep learning with GPU, Deep learning software frameworks, Setting up deep learning on AWS.
Chapter 1, 2 **(08 Hours)**

Module – II

Getting Started with Neural Networks: Multilayer perceptron, how a network learns, Deep learning models, Deep learning models, Deep learning models, Recurrent neural networks (RNN/LSTM), Recurrent neural networks (RNN/LSTM). Deep Learning in Computer Vision: Origins of CNNs, Fine-tuning CNNs, Popular CNN architectures.
Chapter: 3, 4 **(08 Hours)**

Module – III

Recurrent Neural Networks (RNN) & LSTM:
Deep learning for text, Limitations of neural networks, Recurrent neural networks, RNN architectures, Basic RNN model, Training RNN is tough, Long short-term memory network, LSTM implementation with TensorFlow, Applications, Language Modelling, Sequence tagging, Machine translation, Seq2Seq inference, Chatbots.
Chapter: 6 **(08 Hours)**

Module – IV

Multimodality: What is multimodality learning? Challenges of multimodality learning, Image captioning, Visual question answering, multi-source based self-driving.
Deep Reinforcement Learning: What is reinforcement learning (RL)? Deep reinforcement learning, Implementing reinforcement learning.
Chapter:7, 8 **(08 Hours)**

Module – V

Deep Learning Hacks: Massaging your data, Tricks in training, Fine-tuning, Model compression.
Deep Learning Trends: Recent models for deep learning, Novel applications, Genomics, Predictive medicine, Clinical imaging, Lip reading, Visual reasoning, Code synthesis.
Chapter:9, 10 **(08 Hours)**

Course Outcomes:
The students will be able to:

- CO1: Understand and explain the principles and architectures of deep learning models.
- CO2: Implement and train deep learning models using modern frameworks.
- CO3: Understand the basic architecture and functioning of RNNs & LSTM.
- CO4: Recognize the challenges and advantages of working with multimodal data.
- CO5: Implement and experiment with deep learning solutions in emerging areas like genomics, predictive medicine, clinical imaging, lip reading, visual reasoning, and code synthesis.

Textbook:

1. Wei Di, Anurag Bhardwaj, Jianing Wei, "**Deep Learning Essentials**", Packt publishers, 2018.

Reference Books

1. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition, O'Reilly Media, Inc. 2019.
2. Neural Networks and Deep Learning, Charu C. Aggarwal, Springer International Publishing, 2018

Alternate Assessment Tools (AATs) suggested:

- Experiential Learning/ MOOC/Certification Courses (Infosys Springboard, Geek for Geeks, IBM, Hacker earth, Math works)
- Model presentation
- Video

Web links / e – resources:

- https://archive.nptel.ac.in/courses/106/106/106106184/
- http://neuralnetworksanddeeplearning.com/index.html
- https://stanford.edu/~shervine/teaching/cs-230/cheatsheet-convolutional-neural-networks

DEPARTMENT OF ARTIFICAL INTELLIGENCE AND MACHINE LEARNING
Choice Based Credit System (CBCS)
SEMESTER – VI

Theory of Computation (3:0:0:0) 3
(Effective from the academic year 2024 -25)

Course Code	**BAI603**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	3:0:0:0	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3 Hours

Course Objectives:

This course will enable students to:

- Demonstrate the understanding of key notions, such as algorithm, computability, decidability, and complexity through problem solving.
- Develop formal mathematical methods to prove properties of languages, grammars and automata.
- Design Turing machines for any language & illustrate the decidability or undecidability of various problems.
- Analyze and evaluate computational problems using time and space complexity measures, classify problems into different complexity classes.

Preamble:

This course is an introduction to the theory of computation. This is the branch of computer science that aims to understand which problems can be solved using computational devices and how efficiently those problems can be solved. To be able to make precise statements and rigorous arguments, computational devices are modeled using abstract mathematical "models of computation." This can be applied in designing compilers and pattern recognition system, AI, parsing and formal verification and considered as one of the central areas of computer science. It is used for modeling of complex and real world, interactive systems, and model security requirements of real- world applications and enforces the security policies.

Module – I

FINITE AUTOMATA

Introduction to formal proof – Additional forms of Proof – Inductive Proofs –Finite Automata – Deterministic Finite Automata – Non-deterministic Finite Automata – Finite Automata with Epsilon Transitions

Textbook 1: Chapter 1 & 2 **(08 Hours)**

Module – II

REGULAR LANGUAGES

Regular Expressions – FA and Regular Expressions –Applications of Regular expressions- Proving Languages not to be regular – Closure Properties of Regular Languages – Equivalence and Minimization of Automata.

Textbook 1: Chapter 3 & 4 **(08 Hours)**

Module – III

CONTEXT FREE GRAMMAR AND PUSHDOWN AUTOMATA

CFG – Parse Trees – Applications of context free Grammar-Ambiguity in Grammars and Languages – Definition of the Pushdown Automata – Languages of a Pushdown Automata – Equivalence of Pushdown Automata and CFG, Deterministic Pushdown Automata-Pumping lemma for CFG.

Textbook 1: Chapter 5, 6 & 7 **(08 Hours)**

Module – IV

COMPUTABILITY THEORY

The Church – Turing Thesis: Turing Machines, Variants of Turing Machines, The Definition of Algorithm, Decidability, Reducibility

Textbook 2: Chapters 3, 4 & 5 **(08 Hours)**

Module – V

COMPLEXITY THEORY

Time and space measures of complexity, complexity classes P, NP, L, NL, PSPACE, BPP and IP

Textbook 2: Chapters 7 & 8 **(08 Hours)**

Course Outcomes:

At the end of the course the student will be able to:

CO1: Recall the basic concepts of formal proof techniques and identify the characteristics and functions of finite automata models.

CO2: Develop formal mathematical methods to prove properties of languages, grammars, and automata.

CO3: Apply the principles of context-free grammars (CFG) and pushdown automata (PDA) to analyze and solve problems in formal language theory.

CO4: Design Turing machines for any language & illustrate the decidability or undecidability of various problems.

CO5: Analyze and evaluate computational problems using time and space complexity measures, classify problems into different complexity classes.

Textbooks

1. J.E.Hopcroft, R.Motwani and J.D Ullman, "**Introduction to Automata Theory, Languages and Computations"**, Third Edition, Pearson Education, 2016.
2. Michael Sipser, "**Introduction to the Theory of Computation",** 3rd Edn. Cengage Learning, 2012. ISBN: 9781133187790.

Reference Books

1. J. Martin, —**Introduction to Languages and the Theory of Computation**, Third Edition, TMH, 2007.

Alternate Assessment Tools (AATs) suggested:

- Experiential Learning/ MOOC/Certification Courses (Infosys Springboard, Geek for Geeks, IBM, Hacker earth, Math works)
- Model presentation
- Video

Web links / e – resources:

1. https://nptel.ac.in/courses/106104148
2. **https://www.udemy.com/course/the-complete-theory-of-computation/**

DEPARTMENT OF ARTIFICAL INTELLIGENCE AND MACHINE LEARNING
Choice Based Credit System (CBCS)
SEMESTER – VI

CLOUD COMPUTING AND VIRTUALIZATION (3:0:0:0) 3
(Effective from the academic year 2024 -25)

Course Code	**BAI604A**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	3:0:0:0	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3 Hours

Course Objectives:
This course will enable students to:

- Discuss the concepts, characteristics, delivery models and benefits of cloud computing.
- Explore the key technical, organisational and compliance challenges of cloud computing.
- Grasp the concepts of virtualization efficiently.
- Understand the Cloud Resource Management and Scheduling
- Explore the security issues that arise from cloud computing architectures intended for delivering Cloud based enterprise IT services.

Preamble: Cloud computing gives your business more flexibility. You can quickly scale resources and storage up to meet business demands without having to invest in physical infrastructure. Companies don't need to pay for or build the infrastructure needed to support their highest load levels. Cloud computing is the on-demand availability of computing resources (such as storage and infrastructure), as services over the internet. It eliminates the need for individuals and businesses to self-manage physical resources themselves, and only pay for what they use. virtualization creates simulated versions of a machine's software or hardware components, while cloud computing is a model that enables users to access a shared pool of resources conveniently.

Module – I

Introduction, Cloud Infrastructure: Cloud computing, Cloud computing delivery models and services, Ethical issues, Cloud vulnerabilities, Cloud computing at Amazon, Cloud computing the Google perspective, Microsoft Windows Azure and online services, Open-source software platforms for private clouds, Cloud storage diversity and vendor lock-in, Energy use and ecological impact, Service level agreements, Exercises and problems.

Textbook 1: Chapter 1 (1.3-1.6), Chapter 3 (3.1-3.5, 3.7,3.8) (08 Hours)

Module – II

Cloud Computing: Application Paradigms.: Challenges of cloud computing, Architectural styles of cloud computing, Workflows: Coordination of multiple activities, Coordination based on a state machine model: The Zookeeper, The Map Reduce programming model, A case study: The GreThe Web application, Cloud for science and engineering, High-performance computing on a cloud, Cloud computing for Biology research, Social computing, digital content and cloud computing.

Textbook 1: Chapter 4 (4.1-4.11) (08 Hours)

Module – III

Cloud Resource Virtualization: Virtualization, Layering and virtualization, Virtual machine monitors, Virtual Machines, Performance and Security Isolation, Full virtualization and paravirtualization, Hardware support for virtualization, Case Study: Xen a VMM based paravirtualization, Optimization of network virtualization, vBlades, Performance comparison of virtual machines, The dark side of

virtualization, Exercises and problems

Textbook 1: Chapter 5 (5.1-5.9, 5.11,5.12,5.16) (08 Hours)

Module – IV

Cloud Resource Management and Scheduling: Policies and mechanisms for resource management, Application of control theory to task scheduling on a cloud, Stability of a two-level resource allocation architecture, Feedback control based on dynamic thresholds, Coordination of specialized autonomic performance managers, A utility- based model for cloud-based Web services, Resourcing bundling: Combinatorial auctions for cloud resources, Scheduling algorithms for computing clouds, Fair queuing, Start-time fair queuing, Borrowed virtual time, Cloud scheduling subject to deadlines, Scheduling MapReduce applications subject to deadlines, Resource management and dynamic scaling, Exercises and problems.

Textbook1: Chapter 6 (6.1-6.14, 6.16) (08 Hours)

Module – V

Cloud Security, Cloud Application Development: Cloud security risks, Security: The top concern for cloud users, Privacy and privacy impact assessment, Trust, Operating system security, Virtual machine Security, Security of virtualization, Security risks posed by shared images, Security risks posed by a management OS, A trusted virtual machine monitor, Amazon web services: EC2 instances, Connecting clients to cloud instances through firewalls, Security rules for application and transport layer protocols in EC2, How to launch an EC2 Linux instance and connect to it, How to useS3 in java

Textbook1: Chapter 9 (9.1-9.9, 11.1-11.5) (08 Hours)

Course outcomes :

At the end of the course the student will be able to:

CO1 : Understand the Cloud Infrastructure models and services

CO2: Can able to Identify the Challenges of cloud computing and use for research.

CO3: Demonstrate the working of VM and VMM on any cloud platforms(public/private), and run a software service on that..

CO4: Exhibit the Cloud Resource Management and Scheduling with solve the real time problems.

CO5: Identify the known threats, risks, vulnerabilities and privacy issues associated with Cloud based IT services.

Textbooks

5. **Cloud Computing Theory and Practice**, Dan C. Marinescu, Morgan Kaufmann, Morgan Kaufmann Publishers In Elsevier 2013

Reference Books

1. Mastering Cloud Computing Rajkumar Buyya, Christian Vecchiola, and ThamaraiSelvi McGraw Hill Education
2. Computing Principles and Paradigms, RajkumarBuyya , James Broberg, Andrzej Goscinsk,i Willey, 2014.

Alternate Assessment Tools (AATs) suggested:

- Experiential Learning/ MOOC/Certification Courses (Infosys Springboard, Geek for Geeks, IBM, Hacker earth, Math works)
- Model presentation
- Video

Web links / e – resources:

3. **https://nptel.ac.in/courses/106105167**
4. **https://archive.nptel.ac.in/courses/106/104/106104182/**

DEPARTMENT OF ARTIFICAL INTELLIGENCE AND MACHINE LEARNING
Choice Based Credit System (CBCS)
SEMESTER – VI

ROBOTIC PROCESS AUTOMATION (3:0:0:0) 3
(Effective from the academic year 2024 -25)

Course Code	**BAI604B**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	3:0:0:0	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3 Hours

Course Objectives:
This course will enable students to:

- Identify and recall the key concepts, history, and benefits of RPA, including its flavours and comparison with BPO, BPM, and BPA.
- Explain the technologies and components involved in RPA, and their role in automation.
- Apply UiPath Studio to create, record, and execute basic automation tasks, demonstrating proficiency in task recording and workflow sequencing.
- Analyze different workflow processes using control flow mechanisms, decision-making loops, and data manipulation techniques to identify optimization strategies.

Preamble: Robotic process automation (RPA) is a software technology that makes it easy to build, deploy,
and manage software robots that emulate human's actions interacting with digital systems and software. RPA can automate a wide range of tasks, such as data entry, invoice processing, customer service responses, report generation, and even email management. In particular, it excels at executing manual and repetitive tasks (e.g. billing, coding invoices, and sending reminders).

Module – I

RPA Foundations- What is RPA - flavors of RPA- History of RPA- The Benefits of RPA- The downsides of RPA- RPA Compared to BPO, BPM and BPA - Consumer Willingness for Automation- The Workforce of the Future- RPA Skills-On-Premise Vs. the Cloud- Web Technology- Programming Languages and Low Code- 0CR-Databases-APls- Al-Cognitive Automation-Agile, Scrum, Kanban and Waterfall, Devops-Flowcharts.
Record and Play - Downloading and installing UiPath Studio - Learning Ui Path Studio- - Task recorder - Step-by-step examples using the recorder
Textbook 1: Chapter 1 and 2
Textbook2: Chapter 2 **(08 Hours)**

Module – II

Sequence, Flowchart, and Control Flow-sequencing the workflow- Activities-Control flow, various types of loops, and decision Making-Step-by-step example using Sequence and Flowchart-Step-by-step example using Sequence and Control flow

Data Manipulation-Variables and Scope Collections-Arguments - Purpose and Use-Data table usage with examples Clipboard Management-File operation with step-by-step example-CSV/Excel to data table and vice versa with a step-by-step example.

Textbook2: Chapter 3 and 4 **(08 Hours)**

Module – III

Taking Control of the Controls- Finding and attaching windows- Finding the control- Techniques for waiting for a control- Act on controls - mouse and keyboard activities- Working with UiExplorer.

Handling events- Revisit recorder- Screen Scraping- When to use OCR- Types of OCR available, How to use OCR- Avoiding typical failure point

Textbook2: Chapter 5 **(08 Hours)**

Module – IV

Tame that Application with Plugins and Extensions: Terminal plugin- SAP automation, Java plugin Citrix automation- Mail plugin- PDF Plugin-Web integration, Excel and Word Plugins, Credentia management, Extensions – Java, Chrome, Firefox, and Silverlight

Handling User Events and Assistant Bots: What are assistant bots? - Monitoring system event triggers Monitoring image and element Triggers-Launching an assistant bot on a keyboard event

Textbook: Chapter 6 and 7 **(08 Hours)**

Module – V

Exception Handling, Debugging, and Logging- Exception handling- Common exceptions and ways to handle them- Logging and taking screenshots- Debugging techniques- Collecting crash dumps- Error reporting

Textbook: Chapter 8 **(08 Hours)**

Course outcomes:

At the end of the course the student will be able to:

CO1: Understand the key concepts, history, and benefits of RPA, including its flavours and comparison with BPO, BPM, and BPA.

CO2: Explain the technologies and components involved in RPA, and their role in automation.

CO3: Apply UiPath Studio to create, record, and execute basic automation tasks, demonstrating proficiency in task recording and workflow sequencing.

CO4: Analyze different workflow processes using control flow mechanisms, decision-making loops, and data manipulation techniques to identify optimization strategies.

CO5: Examine the RPA applications and handle user events.

Textbooks:

1. Tom I'aulli, **The Robotic Process Automation llandbook**:A Guide to Implementing RPA Systems,2020,lSBN-13 (electronic):978-7-4842-5729-6

2.Alok Mani Tripathi, **Learning Robotic Process Automation**, Packt Publishing, 2018, ISBN: 9781788470940.

Reference Books:

1.Frank Casale , Rebecca Dilla, Heidi Jaynes , Lauren Livingston, "Introduction to Robotic Proces Automation: a Primer", Institute of Robotic Process Automation,1st Edition 2015.

2. Richard Murdoch, Robotic Process Automation: Guide To Building Software Robots, Automate Repetitive Tasks & Become An RPA Consultant", Independently Published, 1st Edition 2018.

3. Srikanth Merianda,"Robotic Process Automation Tools, Process Automation and their benefits Understanding RPA and Intelligent Automation", Consulting Opportunity Holdings LLC, 1st Edition 2018

4. Lim Mei Ying, "Robotic Process Automation with Blue Prism Quick Start Guide: Create software robots and automate business processes", Packt Publishing, 1st Edition 2018.

Alternate Assessment Tools (AATs) suggested:

- Experiential Learning/ MOOC/Certification Courses (Infosys Springboard, Geek for Geeks, IBM, Hacker earth, Math works)
- Model presentation
- Video

Web links / e – resources:

1. https://www.javatpoint.com/cloud-computing-tutorial
2. https://www.tutorialspoint.com/cloud_computing/index.htm
3. https://www.digimat.in/nptel/courses/video/106105167/L01.html

DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING
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SEMESTER – VI

Human Computer Interface (3:0:0:0) 3
(Effective from the academic year 2024 -25)

Course Code	**BAI604C**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	3:0:0:0	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3 Hours

Course Objectives:
This course will enable students to:

- To equip students with the skills necessary to design and evaluate user-friendly interfaces.
- To emphasize the importance of user-centered design processes.
- To explore innovative interaction techniques and their applications.
- To address accessibility and ensure technology is inclusive for all users.
- To discuss the social and ethical considerations of technology use.

Preamble: Human-Computer Interaction (HCI) is a multidisciplinary field focused on the design, evaluation, and implementation of interactive computing systems for human use and the study of major phenomena surrounding them. It aims to improve the interactions between users (humans) and computers by making computers more user-friendly and receptive to the user's needs.

Module – I

Introduction: The User Interface: Introduction, Importance of the User Interface, Importance and benefits of Good Design History of Human Computer Interface.
Characteristics of Graphical and Web User Interface: Graphical User Interface, popularity of graphics, concepts of Direct Manipulation, Graphical System advantage and disadvantage, Characteristics of GUI. Web User Interface, popularity of web, Characteristics of Web Interface, Merging of Graphical Business systems & the Web, Principles of User Interface Design
Textbook 2: Chapter 1 and 2 **(08 Hours)**

Module – II

Design Process: Interaction design basics: Introduction, What is design?, The process of design, User focus, Scenarios, Navigation design, Screen design and layout.
HCI in the software: Introduction, The software life cycle, Usability engineering, Iterative design and prototyping, Design Rationale.
Textbook 1: Chapter 5 and 6 **(08 Hours)**

Module – III

Design rules: Introduction, Principles to support usability, Standards, guidelines, Golden rules and heuristics, HCI patterns.
Implementation support: Introduction, Elements of windowing systems, Programming theapplication, Using toolkits, User interface management systems.
Textbook 1: Chapter 7 and 8 **(08 Hours)**

Module – IV

Models and Theories: Cognitive Models: Introduction, Goal and task hierarchies, Linguistic models, The challenge of display-based systems, Physical and device models, cognitive architectures.

Communication and collaboration models: Introduction, Face-to-Face communication, Conversation, Text-based communication, Group working.
Textbook 1: Chapter 12 and 14 **(08 Hours)**

Module – V

Advanced Topics in HCI: Groupware: Introduction, Groupware systems, computer-mediated communication, meeting and decision support systems, shared applications and artifacts. frameworks for groupware.

Ubiquitous Computing and Augmented Reality: Introduction, Ubiquitous computing applications research, virtual and augmented reality, information and data visualization.

Textbook 1: Chapter 19 and 20 **(08 Hours)**

Course outcomes :

At the end of the course the student will be able to:

CO1: Design user interfaces that enhance user experience and usability.
CO2: Apply cognitive psychology principles to improve user interaction with systems.CO3: Apply design processes and usability testing.
CO4: Develop accessible and inclusive technology solutions.
CO5: Critically analyze the social and ethical implications of HCI.

Textbooks

1. Alan Dix, Janet Finlay, Gregory D. Abowd, Russell Beale - **Human - Computer Interaction**, Pearson Education, Third Edition, 2009.
2. Wilbert O. Galitz ,Wiley - **The Essential Guide to User Interface Design** , Indian Edition.

Reference Books

1. Ben Shneiderman, Designing the User Interface: Strategies for Effective Human-Computer Interaction, Pearson, 5th Edition.
2. Donald A. Norman, The Design of Everyday Things, Basic Books, Revised Edition.
3. The Encyclopaedia of Human-Computer Interaction, 2nd Ed. https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed

Alternate Assessment Tools (AATs) suggested:

- Experiential Learning/ MOOC/Certification Courses (Infosys Springboard, Geek for Geeks, IBM, Hacker earth, Math works)
- Model presentation
- Video

Web links / e – resources:

1. https://archive.nptel.ac.in/courses/106/103/106103115/
2. https://archive.nptel.ac.in/courses/106/106/106106177/

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BIGDATA ANALYTICS (3:0:0:0) 3
(Effective from the academic year 2024 -25)

Course Code	**BAI604D**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	3:0:0:0	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3 Hours

Course Objectives:
This course will enable students to:

- Identify the tools required to manage and analyze big data
- Implement Techniques and Principles in achieving big data analytics with scalability and streaming capability.
- Analyze web graph and social network.

Preamble: This course will introduce the characteristics of Big Data and its application in Big Data Analytics. Big data analytics describes the process of uncovering trends, patterns, and correlations in large amounts of raw data to help make data-informed decisions. The features, benefits, limitations and applications of Hadoop will be discussed. You will explore the components of Hadoop ecosystem, map reduce and learn how to use Hive, HBase and Pig to process Big Data. In this course, you will also learn how to leverage MongoDB to deliver insights into Big Data.

Module – I

Introduction to Big Data Analytics: Big Data, Scalability and Parallel Processing, Designing Data Architecture, Data Sources, Quality, Pre-Processing and Storing, Data Storage and Analysis, Big Data Analytics Applications and Case Studies.

Text book 1 : Chapter 1 (1.1 to 1.7) (08 Hours)

Module – II

Introduction to Hadoop: Hadoop Distributed File System Basics, Running Example Programs and Benchmarks, Hadoop MapReduce Framework, MapReduce, Essential Hadoop Tools - Using Apache Pig, Hive.

Text book 2 : Chapter 3 (3.1 to 3.2), Chapter 4 (4.1 to 4.2), Chapter 5 (5.1 to 5.2), Chapter 7 (7.1 to 7.2) (08 Hours)

Module – III

NoSQL Big Data Management, MongoDB and Cassandra: Introduction, NoSQL Data Store, NoSQL Data Architecture Patterns, NoSQL to Manage Big Data, Shared-Nothing Architecture for Big Data Tasks, MongoDB, Databases, Cassandra Databases.
Text book 1 : Chapter 3 (3.1 to 3.7) (08 Hours)

Module – IV

MapReduce, Hive and Pig: Introduction, MapReduce Map Tasks, Reduce Tasks and MapReduce Execution, Composing MapReduce for Calculations and Algorithms, Hive, HiveQL, Pig.
Textbook 1: Chapter 4 (4.1 to 4.6) **(08 Hours)**

Module – V

Text, Web Content, Link, and Social Network Analytics: Introduction, Text mining, Web Mining Web Content and Web Usage Analytics, Page Rank, Structure of Web and analyzing a Web Graph, Social

Network as Graphs and Social Network Analytics:
Text book 1: Chapter 9 (9.1 to 9.5) (08 Hours)

Course outcomes :

At the end of the course the student will be able to:

CO1: Describe fundamentals of Big Data analytics.
CO2: Investigate Hadoop framework and Hadoop Distributed File system.
CO3: Demonstrate the concepts of NoSQL using MongoDB and Cassandra for Big Data.
CO4: Demonstrate the MapReduce programming model to process the big data along with Hadoop tools.
CO5: Analyze web contents and Social Networks to provide analytics with relevant visualization tools.

Textbooks

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", 1st Edition, Pearson Education, 2016. ISBN-13: 978-9332570351.

Reference Books

1. Tom White, "Hadoop: The Definitive Guide", 4th Edition, O"Reilly Media, 2015.ISBN-13: 978-9352130672.
2. Boris Lublinsky, Kevin T Smith, Alexey Yakubovich, "Professional Hadoop Solutions", 1stEdition, Wrox Press, 2014ISBN-13: 978-8126551071.

Alternate Assessment Tools (AATs) suggested:

- Experiential Learning/ MOOC/Certification Courses (Infosys Springboard, Geek for Geeks, IBM, Hacker earth, Math works)
- Model presentation
- Video

Web links / e – resources:

1. **https://onlinecourses.nptel.ac.in/noc22_cs65/preview**
2. **https://data-flair.training/blogs/hadoop-tutorial/**

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Fundamentals of Artificial Intelligence (3:0:0:0) 3
(Effective from the academic year 2024 -25)

Course Code	**BAI605A**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	3:0:0:0	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3 Hours

Course Objectives:
This course will enable students to:

- Become familiar with basic principles of AI toward problem solving
- know approaches of inference, perception, knowledge representation, and learning.
- Know the difference between supervised and unsupervised algorithms
- Gain a deep understanding of reinforcement learning (RL) concepts

Preamble: Artificial Intelligence (AI) and Machine Learning (ML) are transforming industries, reshaping how we work, live, and interact with technology. This course serves as a gateway into the dynamic and rapidly evolving fields of AI and ML, where the students can delve into the theories, algorithms, and applications that are driving innovation across the globe. Throughout this course, the foundational concepts of AI were explored, including machine learning techniques such as supervised and unsupervised learning, reinforcement learning, and neural networks. students can gain practical experience implementing these algorithms to solve real-world problems, from predictive analytics to natural language processing and computer vision.

Module – I

Introduction: What is AI? Foundations and History of AI
Intelligent Agents: Agents and environment, Good Behaviour: The Concept of Rationality, The nature of environment, The structure of agents**.**

Text book 1: **Chapter 1 & 2** **(08 Hours)**

Module – II

Problem-solving: Problem-solving agents, Example problems, Searching for Solutions
Uninformed Search Strategies: Breadth First search, Depth First Search, Iterative deepening depth first search;
Informed Search Strategies: Heuristic functions, Greedy best first search, A*search. Heuristic Functions

Text book 1: **Chapter 3** **(08 Hours)**

Module – III

Logical Agents: Knowledge–based agents, The Wumpus world, Logic, Propositional logic: A Very Simple Logic
First Order Logic: Representation Revisited, Syntax and Semantics of First Order logic, Using First Order logic.
Textbook 1: Chapter 7, 8 **(08 Hours)**

Module – IV

Inference in First Order Logic: Propositional Versus First Order Inference, Unification, Forward Chaining, Backward Chaining, Resolution.
Textbook 1: Chapter 9 **(08 Hours)**

Module – V

Uncertain Knowledge and Reasoning: Quantifying Uncertainty: Acting under Uncertainty, Basic Probability Notation, Inference using Full Joint Distributions, Independence, Baye's Rule, and its use.

Text book 1: Chapter 12 **(08 Hours)**

Course outcomes:

At the end of the course the student will be able to:

CO1: Identify the modern view of Artificial Intelligence and its applications based on agent philosophy.

CO2: Understand the concept of Intelligent agents to solve problems using uninformed and informed search strategies.

CO3: Develop knowledge base sentences using propositional logic and first order logic.

CO4: Implement inference algorithms to efficiently solve problems by reasoning from goals to known facts.

CO5: Describe the concepts of quantifying uncertainty and understand uncertainty handling using probability theory.

Textbooks

1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence – A Modern Approach" , 4th Edition, Pearson Education, 2021.

Reference Books

1. Saroj Kaushik, "Artificial Intelligence", 2nd Edition, Cengage Learning India Pvt. Ltd. 2023.
2. Deepak Khemani, "A First Course in Artificial Intelligence", McGraw Hill Education (India) Pvt. Ltd. 2016.

Alternate Assessment Tools (AATs) suggested:

- Experiential Learning/ MOOC/Certification Courses (Infosys Springboard, Geek for Geeks, IBM, Hacker earth, Math works)
- Model presentation
- Video

Web links / e – resources:

1. **https://nptel.ac.in/courses/106102220**
2. **https://nptel.ac.in/courses/106105077**

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DATA ANALYTICS (3:0:0) 3
(Effective from the academic year 2024-25)

Course Code	**BAI605B**	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3

Course Objectives:
This course will enable students to: (List as per the requirement of your course)

- Understand different techniques of Data Analysis.
- Be familiar with concepts of data streams.
- Be exposed to data analytics algorithms.
- Derive the performance measures of Regression and Classification algorithms.
- Examine the applications of data analytics for real time applications.

Preamble:
To provide strong foundation for data analytics and application area related to it and understand the underlying core concepts and emerging technologies in data analytics. This course provides a understanding and framework for basic analytics tasks, including data extraction, cleaning, manipulation, and analysis. This course also guides in decision making and examine real-world examples to improve decision-making.

Module – 1

What Can We Do with Data? -Big Data and Data Science, Big Data Architectures, Small Data, what is Data? A Short Taxonomy of Data Analytics, Examples of Data Use, A Project on Data Analytics.
Descriptive Statistics, Scale Types, Descriptive Univariate Analysis, Descriptive Bivariate Analysis Final Remarks.
Textbook 1: Chapter 1.1- 1.7, 2.1 - 2.5 (8 Hours)

Module – 2

Descriptive Multivariate Analysis: Multivariate Frequencies, Multivariate Data Visualization, Multivariate Statistics, Infographics and Word Clouds, Final Remarks,
Data Quality and Preprocessing, -Data Quality, converting to a Different Scale Type, Converting to a Different Scale, Data Transformation, Dimensionality Reduction.
Textbook 1: Chapter 3,4 (8 Hours)

Module – 3

Clustering: Distance Measures, Clustering Validation, Clustering Techniques.
Frequent Pattern Mining- Frequent Itemset, Association Rules, Behind Support and Confidence, Other Types of Patterns
Textbook 1: Chapter 5,6 (8 Hours)

Module – 4

Regression -Predictive Performance Estimation, Finding the Parameters of the Model, Technique and Model Selection.
Classification -Binary Classification, Predictive Performance Measures for Classification, Distance-based Learning Algorithm
Textbook 1: Chapter 8,9 (8 Hours)

Module – 5

Applications for Text, Web and Social Media-Working with Texts, Recommender Systems, Social Network Analysis.

Textbook 1: Chapter 13 **(8 Hours)**

Course Outcomes:

The students will be able to:

CO1: Explore the fundamental concepts of data analytics
CO2: Understand data analysis techniques for applications handling large data
CO3: Understand various algorithms used in data analytics process
CO4: Apply and present the inference of Regression and Classification algorithms
CO5: Analyze the applications of a data analytics for real time applications.

Textbooks:

1. "A general introduction to data analytics " Jõao Mendes Moreira, André de Carvalho, Tomás Horváth., |a Hoboken, Wiley, 2019.

References:

1. Data Analytics Made Accessible by Dr. Anil Maheshwari
2. Principles of Data Wrangling, by Joseph M. Hellerstein, Tye Rattenbury, Jeffrey Heer, Sean Kandel, Connor Carreras, Released July 2017
3. Visual Analytics with Tableau by Alexander Loth , Nate Vogel, et al.

Alternate Assessment Tools (AATs) suggested:

- Experiential Learning/ MOOC/Certification Courses (Infosys Springboard, Geek for Geeks, IBM, Hacker earth, Math works)
- Model presentation
- Video

Web links / e – resources:

1. http://www.cse.iitm.ac.in/~ravi/nptel-courses/intro-to-data-analytics/
2. https://www.youtube.com/watch?v=CaqJ65CIoMw

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Fundamentals of Database Management System (3:0:0) 3
(Effective from the academic year 2024-25)

Course Code	**BAI605C**	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3

Course Objectives:
This course will enable students :

1. To Provide a strong foundation in database concepts, technology, and practice.
2. To Practice SQL programming through a variety of database problems.
3. To Understand the relational database design principles.
4. Demonstrate the use of concurrency and transactions in database.

Preamble: Database Management Systems course is intended to deliver students the elementary concepts of a database management system and equips them to design and implement a database application built over those concepts. It also introduces advanced level areas like transaction processing, concurrency control and recovery management.

Module – 1

Introduction to Databases: Introduction, Characteristics of database approach, Advantages of using the DBMS approach, History of database applications.
Overview of Database Languages and Architectures: Data Models, Schemas, and Instances. Three schema architecture and data independence, database languages, and interfaces, The Database System environment.
Conceptual Data Modelling using Entities and Relationships: Entity types, Entity sets and structural constraints, Weak entity types, ER diagrams .
Text Book : Chapter 1.1 to 1.8, 2.1 to 2.6, 3.1 to 3.10 **08 Hours**

Module – 2

Relational Model: Relational Model Concepts, Relational Model Constraints and relational database schemas, Update operations, transactions, and dealing with constraint violations.
SQL: SQL data definition and data types, Schema change statements in SQL, specifying constraints in SQL, retrieval queries in SQL, INSERT, DELETE, and UPDATE statements in SQL, Additional features of SQL.
Text Book : Chapter 5.1 to 5.3, Chapter 6.1 to 6.5 **08 Hours**

Module – 3

SQL: Advanced Queries: More complex SQL retrieval queries, Specifying constraints as assertions and action triggers, Views in SQL, Schema Change Statements in SQL.
Text Book : Chapter 7.1 to 7.5 **08 Hours**

Module – 4

Introduction to Normalization using Functional and Multivalued Dependencies: Informal design guidelines for relation schema, Functional Dependencies, Normal Forms based on Primary Keys, Second and Third Normal Forms, Boyce- Codd Normal Form, Multivalued Dependency and Fourth Normal Form, Join Dependencies and Fifth Normal Form.
Text Book : Chapter 14.1 to 14.7 **08 Hours**

Module – 5

Transaction Processing: Introduction to Transaction Processing, Transaction and System concepts, Desirable properties of Transactions

Concurrency Control in Databases: Two-phase locking techniques for Concurrency control, Concurrency control based on Timestamp ordering

Text Book : Chapter 20.1 to 20.3, Chapter 21.1 to 21.2 **08 Hours**

Course Outcomes:

The students will be able to

CO1: Describe the basic elements of a relational database management system .

CO2: Design entity relationship for the given scenario**.**

CO3: Apply SQL to find solutions to a broad range of queries

CO4: Analyze various normalization forms for the given application.

CO5: Analyze and implement transaction processing, concurrency control protocols in databases**.**

Text Books:

1. Fundamentals of Database Systems, Ramez Elmasri and Shamkant B. Navathe, 7th Edition, 2017, Pearson

Reference Books:

1. Database management systems, Ramakrishnan, and Gehrke, 3rd Edition, 2014, McGraw Hill

Alternate Assessment Tools (AATs) suggested:

- **Online Certification Course on DBMS**

Web links / e – resources:

1. https://nptel.ac.in/courses/106/105/106105175/
2. https://onlinecourses.nptel.ac.in/noc21_cs04/
3. https://nptel.ac.in/courses/106/106/106106093/

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Fundamentals of Algorithms (3:0:0:0) 3
(Effective from the academic year 2024 -25)

Course Code	**BAI605D**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	3:0:0:0	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3 Hours

Course Objectives:
This course will enable students to:

- Describes basic data structure and its application
- Explain the methods of analyzing the algorithms and to analyze performance of Algorithms.
- Solve problems using algorithm design methods such as the greedy method, divide and conquer, decrease and conquer, transform and conquer, Dynamic programming
- Choose the appropriate data structure and algorithm design method for a specified Application.
- Introduce P and NP classes.

Preamble: The advancement in science and technology enhances the performance of processor, which proportionally affect the characteristics of computer system, such as security, scalability and reusability. Important problems such as sorting, searching, string processing, graph problems, Combinational problems, numerical problems are basic motivations for designing algorithm and analyzing it. Since algorithm design techniques are growing at a fast pace, it has become important for IT professionals to upgrade their knowledge in order to meet growing industry demand.

Module – I

Introduction to Data Structure: Structures and pointers revisited. Introduction to data structures - Basic terminology, Classification, Operations.
The Stack - Definition, Operations, Array Representation of stacks in C, Application of Stack Recursion - finding GCD, Fibonacci Series, Recursion Types, and Recursion versus iteration.

Queues - Definition, Array representation of Queues, Operations on Queues, Types of Queues- Linear Queue and its implementation in C, Applications of Queues

Textbook-1- Chapter 1.11, Chapter 7,8 (08 Hours)

Module – II

Introduction: Notion of Algorithm, Fundamentals of Algorithmic Problem Solving, Fundamentals of the Analysis of Algorithm Efficiency: Analysis Framework, Asymptotic Notations and Basic efficiency classes, Mathematical analysis of Recursive and Non-recursive algorithms, Examples. Brute Force: Selection Sort and Sequential Search.

Textbook-2- Chapter 1, 2 (08 Hours)

Module – III

Divide-and-Conquer: Merge sort, Quick sort. Decrease-and-Conquer: Insertion Sort, Depth First and Breadth First Search, Topological Sorting using DFS and Source Removal Method.

Textbook-2- Chapter 5 (08 Hours)

Module – IV

Transform-and—Conquer: Introduction, Heaps and Heapsort. Dynamic Programming: Warshall's Algorithm, Floyd's Algorithm, The knapsack Problem (fractional Knapsack only)

Textbook-2- Chapter 6 **(08 Hours)**

Module – V

Greedy Technique: Prim's Algorithm, Kruskal's Algorithm, Dijkstra's Algorithm, Huffman Trees. Introduction to P, NP and NP-Complete Problems.

Textbook-2- Chapter 9 **(08 Hours)**

Course outcomes:

At the end of the course the student will be able to:

CO1: Describe the basic concept of data structures and identify the data structures required to solve a given problem.

CO2: Describe basic knowledge of algorithm analysis, algorithm design strategies, various algorithms.

CO3: Apply algorithms to solve a given computational problem

CO4: Analyze algorithms with respect to time & space complexity

CO5: Design algorithm for a given problem using suitable algorithm design strategy

Textbooks

1. **Data Structures Using C**, Second edition, Reema Thereja, Oxford Press, 2017.
2. Anany Levitin, **Introduction to The Design and Analysis of Algorithms**, 3 rd Edition, Pearson Education, 2012.
3. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran, **Fundamentals of Computer Algorithms**, 2 nd Edition, Press 2014.

Reference Books

1. Coremen T.H., Leiserson C. E., and Rivest R. L., Introduction to Algorithms, 3rd edition, PHI, 2015.
2. R.C.T. Lee, S.S. Tseng, R.C. Chang and Y.T.Tsai, Introduction to the Design and Analysis of Algorithms A Strategic Approach, 1st Edition, Tata McGraw Hill, 2005.
3. Debasis Samanta: Classic Data Structures, 2nd Edition, PHI, 2009. 4. Balagurusamy E, Programming in ANSI C, 7th Edition, Tata McGraw Hill, 2017.

Alternate Assessment Tools (AATs) suggested:

- Experiential Learning/ MOOC/Certification Courses (Infosys Springboard, Geek for Geeks, IBM, Hacker earth, Math works)
- Model presentation
- Video

Web links / e – resources:

1. **https://nptel.ac.in/courses/106105164**
2. **https://archive.nptel.ac.in/courses/106/106/106106131/**

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Deep Learning Lab (0:0:2:0) 1
(Effective from the academic year 2024 -25)

Course Code	**BAIL607**	CIE Marks	**50**
Teaching Hours/Week (L:T:P:S)	**0:0:2:0**	SEE Marks	**50**
Total Number of Contact Hours	**15**	Exam Hours	**3 Hours**

Course Objectives:
This course will enable students to:

- **Understand the Basics:** Gain a solid understanding of the fundamental concepts of neural networks and deep learning.
- **Hands-On Experience:** Develop practical skills through hands-on lab exercises using popular deep learning frameworks such as TensorFlow/Keras and PyTorch.
- **Model Implementation:** Learn to implement, train, and evaluate various types of neural networks, including feedforward neural networks, convolutional neural networks (CNNs), and recurrent neural networks (RNNs).
- **Real-World Applications:** Understand the applications of deep learning in solving real-world problems and gain experience in building models for tasks such as image classification, text classification, and data generation.

Preamble: This course introduces deep learning, a subset of machine learning that focuses on neural networks with many layers. Deep learning has revolutionized various fields, including computer vision, natural language processing, and speech recognition. This course aims to equip students with the foundational knowledge and practical skills necessary to understand, implement, and apply deep learning techniques.

Sl. No.	Laboratory Programs
1	Implement a simple neural network from scratch. • Implement a perceptron. • Train the perceptron on a simple dataset (e.g., AND, OR logic gates). • Visualize the decision boundary.
2	Build a feedforward neural network using a deep learning framework. • Create a simple feedforward neural network using TensorFlow/Keras or PyTorch. • Train the network on the MNIST dataset. • Evaluate the model's accuracy and visualize some predictions.
3	Explore different activation functions and their effects on training. • Implement different activation functions (e.g., Sigmoid, ReLU, Tanh). • Train a neural network on the MNIST dataset using each activation function. • Compare and visualize the training performance and accuracy.
4	Understand the impact of different optimizers on the training process. • Implement various optimizers (e.g., SGD, Adam, RMSprop). • Train a neural network on the CIFAR-10 dataset using each optimizer. • Compare the convergence speed and final accuracy of each optimizer.
5	Learn how regularization techniques can improve model generalization. • Implement L2 regularization and dropout. • Train a neural network on the Fashion MNIST dataset with and without regularization. • Visualize the effect of regularization on training and validation loss.

6	Implement a simple CNN and understand its applications in image recognition. • Build a simple CNN using TensorFlow/Keras or PyTorch. • Train the CNN on the MNIST dataset. • Evaluate the model's performance and visualize the learned filters.
7	Explore RNNs and their applications in sequence data. • Implement a simple RNN for text classification. • Train the RNN on a dataset of your choice (e.g., sentiment analysis dataset). • Evaluate the model's accuracy and visualize some predictions.
8	Understand how to use pre-trained models for transfer learning. • Load a pre-trained model (e.g., VGG16, ResNet) using TensorFlow/Keras or PyTorch. • Fine-tune the model on a custom dataset (e.g., flower classification). • Evaluate the model's performance and visualize some predictions.

Course Outcomes:

At the end of the course the student will be able to:

CO1: Explain the functioning of different types of neural networks, including feedforward, convolutional, and recurrent neural networks.

CO2: Implement basic neural network models using deep learning frameworks such as TensorFlow/Keras and PyTorch.

CO3: Compare the performance of different neural network architectures and optimization techniques.

Textbooks:

1. Wei Di, Anurag Bhardwaj, Jianing Wei, "**Deep Learning Essentials**", Packt publishers, 2018.
2. Seth Weidman, "**Deep Learning from Scratch"**, O'REILLY, January – 2021, ISBN:978-93-5213-902-6.

Web links / e – resources:

1. https://archive.nptel.ac.in/courses/106/106/106106184/
2. http://neuralnetworksanddeeplearning.com/index.html
3. https://stanford.edu/~shervine/teaching/cs-230/cheatsheet-convolutional-neural-networks

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Generative AI Lab (0:0:2:0) 1
(Effective from the academic year 2024 -25)

Course Code	**BAI608A**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	0:0:2:0	SEE Marks	50
Total Number of Contact Hours	15	Exam Hours	3 Hours

Course Objectives:
This course will enable students to:

- Understand the principles and concepts behind generative AI models, including architecture of ChatGPT
- Explain the knowledge gained to implement generative models using Prompt design frameworks.
- Apply various Generative AI applications for increasing productivity.
- Develop and Operationalizing Large Language Modes-based Apps.

Preamble:
The advancement of artificial intelligence (AI) has resulted in the emergence of a remarkable field known as generative AI. Generative AI is a type of AI technology that allows machines to generate new content, data, or outputs that are like human-created content. It uses large datasets to learn the underlying structure and characteristics of the data, enabling it to produce original and contextually relevant outputs. Generative AI can generate various data types, including text, images, sounds, animations, and 3D models, and it can create entirely new data based on the patterns it has learned.

Descriptions

Design, develop, and implement the specified programs as given in the list given below using python Language under LINUX /Windows environment.

SL. No.	Program List
1.	Text Generation with GPT-2: Experiment with OpenAI's GPT-2 model for generating diverse and coherent text based on prompts.
2.	Image Synthesis using DALL-E: Dive into image generation with OpenAI's DALL-E, creating unique and imaginative visuals based on textual descriptions.
3.	Music Composition with Magenta: Explore Magenta, a project by Google, to generate music compositions using machine learning techniques.
4.	Code Generation with OpenAI Codex: Try your hand at code generation using OpenAI Codex, which is proficient in understanding and generating programming code.
5.	Artistic Creations with StyleGAN: Use StyleGAN for artistic projects, generating visually striking images with control over specific visual attributes.
6.	Story Writing with ChatGPT: Engage in creative writing by utilizing ChatGPT for generating dialogues, narratives, and even collaborative storytelling.
7.	Facial Image Generation with StyleGAN: Experiment with StyleGAN for creating realistic and diverse facial images, exploring the nuances of facial feature synthesis.
8.	Language Translation with Marian MT: Implement language translation using Marian MT, a multilingual transformer model, for translating text between different languages.

Course outcomes:
At the end of the course the student will be able to:

CO1: Understand the foundations and principles behind generative models.
CO2: Apply prompt engineering skills to real-world scenarios, such as information retrieval, question-answering, or text generation.
CO3: Apply the learned skills and techniques through the models that involve the future with ChatGPT.
CO4: Apply different architectures used in large language models, such as transformers, and understand their advantages and limitations.

Textbooks

1. **Modern Generative AI with ChatGPT and OpenAI Models:**Leverage the Capabilities of OpenAI's LLM for Productivity and Innovation with GPT3 and GPT4, by Valentina Alto, Packt Publishing Ltd, 2023.
2. **Generative AI for Cloud Solutions:** Architect modern AI LLMs in secure, scalable, and ethical cloud environments, by Paul Singh, Anurag Karuparti ,Packt Publishing Ltd, 2024.

Reference Books

1. The Artificial Intelligence and Generative AI Bible: [5 in 1] The Most Updated and Complete Guide | From Understanding the Basics to Delving into GANs, NLP, Prompts, Deep Learning, and Ethics of AI ,Kindle Edition by Alger Fraley .
2. "Ripples of Generative AI: How Generative AI Impacts, Informs and Transforms Our Lives" by Jacob Emerson, ISBN-10: 1088221610 Publisher: Artificial Intelligence, 2023
3. "Demystifying Prompt Engineering: AI Prompts at Your Fingertips (A Step-By-Step Guide)" ,Kindle Edition ,by Harish Bhat

Alternate Assessment Tools (AATs) suggested:

- Experiential Learning/ MOOC/Certification Courses (Infosys Springboard, Geek for Geeks, IBM, Hacker earth, Math works)
- Model presentation
- Video

Web links / e – resources:

- https://onlinecourses.swayam2.ac.in/imb24_mg116/preview
- https://www.cloudskillsboost.google/paths/118

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BUSINESS INTELLIGENCE LAB USING POWER BI (0:0:2:0) 1
(Effective from the academic year 2024-2025)

Course Code	**BAI608B**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	02
Examination type (SEE)	Practical		

Course objectives:

- Gain hands-on experience with Power BI tools and techniques for data analysis and visualization.
- Develop skills in data integration, data modeling, and report/dashboard creation.
- Apply excel tools like pivot table and pivot chart for data analysis and visualization.
- Integrate machine learning models with Power BI and visualize predictions.

Preamble: Power BI is a technology-driven business intelligence tool provided by Microsoft for analyzing and visualizing raw data to present actionable information. It combines business analytics, data visualization, and best practices that help an organization to make data-driven decisions.

Sl. No.	Experiments
1	Import the legacy data from different sources such as (Excel , SqlServer etc.) and load in the target system. (Sample database such as Adventureworks, Northwind, foodmart etc.)
2	Design and implement an Extraction Transformation and Loading (ETL) process to construct the database in the Sqlserver/ Power BI.
3	a. Create the Data staging area for the selected database. b. Create the cube with suitable dimension and fact tables based on OLAP models for multidimensional analysis.
4	a. Create the ETL map and setup the schedule for execution. b. Execute the MDX(multidimensional expressions) queries to extract the data from the data warehouse.
5	a. Import the data from data warehouse in Microsoft Excel and create the Pivot table and Pivot Chart. b. Import the cube in Microsoft Excel and create the Pivot table and Pivot Chart to perform data analysis.
6	Apply the what – if Analysis for data visualization. Design and generate necessary reports based on the data warehouse data.
7	Calculate metrics such as average, sum, and percentage using DAX (Data Analysis Expressions) formulas in Power BI.
8	Use Power BI tool to integrate machine learning models and visualize predictions alongside historical data.
9	Create custom visuals using Tree map and sunburst chart in Power BI marketplace for given employee dataset.
10	Build relationships between different tables like one-to-one and one-to-many and configure cardinality and cross-filtering directions in Power BI.

Course outcomes:

At the end of the course the student will be able to:

CO1: Get familiar with the Power BI tool for data import from sources like: excel, Sqlsever etc.

CO2: Develop dashboard, Treemap etc for interactive data visualisation in Power BI.

CO3: Develop visual representations for data analysis using Excel.

CO4: Integrate machine learning models to visualise predictions.

Suggested Learning Resources:

1. "Learn Power BI: A comprehensive, step-by-step guide for beginners to learn real-world business intelligence", 2022, Second Edition, By Greg Deckler.
2. "Business Intelligence, A Comprehensive Approach to Information Needs, Technologies and Culture", 2021, by Rimvydas Skyrius.
3. https://www.packtpub.com/en-us/product/business-intelligence-with-microsoft-power-bi-with-material-9781801078580

Alternate Assessment Tools (AATs) suggested:

- Experiential Learning/ MOOC/Certification Courses (Infosys Springboard, Geek for Geeks, IBM, Hacker earth, Math works)
- Model presentation
- Video

Web links / e – resources:

1. **https://onlinecourses.nptel.ac.in/noc24_cs65/preview**
2. **https://www.youtube.com/watch?v=glA5eG8s0Pw**

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WEB PROGRAMMING LAB (0:0:2:0)1
(Effective from the academic year 2024 -25)

Course Code	**BAI608C**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	0:0:1:0	SEE Marks	50
Total Number of Contact Hours	15	Exam Hours	3 Hours

Course Objectives:
This course will enable students to:
- Describe the hierarchy of objects in HTML and XML.
- Design dynamic and interactive web pages by embedding Java Script code in HTML.
- Illustrate the advantages and use of different types of CSS.
- Examine the HTML. Know how to use Dynamic HTML.
- Familiarize server side scripting language like Perl &PHP.

Preamble: In today's digital age, advanced web technologies and user-friendly graphical interfaces have revolutionized how businesses and individuals interact with computers and databases. From dynamic web content design to intuitive user interfaces, innovations like PHP, Perl, XML, CSS, and XSLT enable seamless tasks such as online shopping, data management, and interactive web applications. These tools efficiently handle tasks from executing UNIX commands to managing personal data in databases, enhancing productivity and user engagement across diverse computing environments.

Descriptions

The basics of Web application tools such as HTML, XHTML and CSS are introduced. The course also provides knowledge about advanced research topics such as XML, Perland PHP.

Sl. No.	Experiments
1.	Design and develop static web pages for an online bookstore, resembling www.amazon.com, including Home Page, Registration & Login, User Profile Page, Books Catalogue, Shopping Cart, Payment by Credit Card, and Order Confirmation.
2.	Design a web page that collects student details (Name, Branch, Semester, University, Date of Admission, Mobile Number, Email ID) and uses JavaScript to validate the inputs, ensuring correctness and reducing server resource wastage from invalid requests.
3.	Design a web page using JavaScript and XHTML to collect SRN (format: any letter, two digits, two letters, three digits). Implement event handlers to validate input and display error messages via alert windows when incorrect data is entered.
4.	Create and save an XML document for student information and display it using a cascaded style sheet (CSS) to efficiently retrieve and present dynamic web content.
5.	Design a document using CSS and XSLT to create an organized item catalog (by name, price, and manufacturer) for an online electronic shopping site to enhance its look and feel.
6.	Develop a PHP web page to accept and store book information (ISBN, title, authors, edition, publisher) in a MySQL database. Design another PHP web page to search for a book by title and display the results with proper headings.
7.	a) Design an HTML page to take a UNIX command as input and submit it to a Perl program that executes the command and displays the output. b) Write a Perl program to track and display the number of visitors to a web page with proper headings.

8.	Write a Perl program to: a) Store personal information (first name, last name, age, permanent address, pin code) entered by the user into a MySQL table. b) Retrieve and display this information from the MySQL database on the front end.

Course outcomes:

At the end of the course the student will be able to:

CO1: Define the CSS with its types and use them to provide the styles to the web pages at various levels.

CO2: Develop the modern web pages using the HTML and CSS features with different layouts as per need of applications.

CO3: Apply Java Script to develop the dynamic web pages and use server side Scripting with PHP to generate the web pages dynamically using the database connectivity.

CO4: Examine the HTML. Know how to use Dynamic HTML.

Textbooks

1. "**PHP and MySQL Web Development**" by Luke Welling and Laura Thomson (Publisher: Sams Publishing)
2. "**Perl by Example**" by Ellie Quigley (Publisher: Prentice Hall)

eference Books

1. "Learning PHP, MySQL & JavaScript: With jQuery, CSS & HTML5" by Robin Nixon (Publisher: O'Reilly Media)
2. "Programming Perl" by Larry Wall, Tom Christiansen, and Jon Orwant (Publisher: O'Reilly Media)
3. "XML in a Nutshell" by Elliotte Rusty Harold and W. Scott Means (Publisher: O'Reilly Media)

Alternate Assessment Tools (AATs) suggested:

- Experiential Learning/ MOOC/Certification Courses (Infosys Springboard, Geek for Geeks, IBM, Hacker earth, Math works)
- Model presentation
- Video

Web links / e – resources:

1. **https://archive.nptel.ac.in/courses/106/106/106106222/**
2. **https://www.youtube.com/watch?v=ZxKM3DCV2kE**

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Haskell Programming Lab (0:0:2) 1
(Effective from the academic year 2024-2025)

Course Code	**BAI608D**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	02
Examination type (SEE)	Practical		

Course objectives:

- To introduce students to functional programming using Haskell.
- To provide hands-on experience with Haskell programming concepts.
- To develop problem-solving skills using functional programming techniques.
- To prepare students for advanced courses in artificial intelligence and machine learning.

Preamble: Haskell is a modern, standard, purely functional programming and non-strict language. It is Specially designed to handle a wide range of applications, from numerical through to symbolic. It has an expressive syntax and very rich inbuilt architecture.
Haskell is a purely Functional, non-strict Programming Language. It is Specially designed to cope with large-scale industrial production applications. It is known for its rich built architecture. Haskell programs are written as Mathematical functions.

Sl. No.	Experiments
Overview of Haskell and Install and set up GHC (Glasgow Haskell Compiler).	
1	a. Implement the function factorial:: Int -> Int that takes a non-negative integer and returns its factorial. The factorial of 0 is 1, and the factorial of any other number n is n * factorial(n-1). b. Implement the function Fibonacci:: Int -> Int that takes a non-negative integer n and returns the nth Fibonacci number. The sequence starts with 0 and 1, and each subsequent number is the sum of the previous two.
2	a. Write a function to filter even numbers from a list. b. Write a function to generate a list of prime numbers up to a given limit.
3	Implement the function sumNatural:: Int -> Int that takes a non-negative integer N and returns the sum of the first N natural numbers. Using recursion Implement the function power :: Int -> Int -> Int that takes two integers X and N and returns X raised to the power N (X^N).
4	a. Write a higher-order function to apply a given function to each element in a list. b. Write a higher-order function to filter elements of a list based on a predicate function.
5	a. Define an algebraic data type to represent a binary tree and write functions to manipulate it. b. Define a data type to represent shapes and write functions to calculate their properties.
6	Define a data type with multiple constructors and write functions using pattern matching.
7	Create a module Shapes.hs and define the following: • A data type Shape to represent a circle and a rectangle. • Functions area :: Shape -> Float and perimeter :: Shape -> Float to calculate the area and perimeter of a shape. Create a main program Main.hs that imports the Shapes module and uses these functions.

8	Create a module Geometry.hs and define the following functions: • areaCircle:: Float -> Float - Calculates the area of a circle. • areaRectangle:: Float -> Float -> Float - Calculates the area of a rectangle.

Course outcomes (Course Skill Set):

At the end of the course, the student will be able to:

CO1: Outline the fundamental concepts of Haskell programming.
CO2: Apply Haskell programming techniques to solve problems.
CO3: Develop programs involving data structures to handle multi-valued data items.
CO4: Integrate Haskell code with AI and ML.

Suggested Learning Resources:

- "Programming in Haskell" by Graham Hutton
- "Learn You a Haskell for Great Good A Beginners Guide" by Miran Lipovaca.

Alternate Assessment Tools (AATs) suggested:

- Experiential Learning/ MOOC/Certification Courses (Infosys Springboard, Geek for Geeks, IBM, Hacker earth, Math works)
- Model presentation
- Video

Web links / e – resources:

1. **https://nptel.ac.in/courses/106106137**
2. **https://www.youtube.com/watch?v=TklkNLihQ_A**