MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

B. Tech
COMPUTER SCIENCE AND ENGINEERING
(Artificial Intelligence)

CURRICULUM

FOR

B. TECH DEGREE PROGRAMME

IN

COMPUTER SCIENCE AND ENGINEERING
(Artificial Intelligence)

2022 SCHEME (AUTONOMOUS)

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE, Autonomous Institution Affiliated to APJ Abdul Kalam Technological University)MAR IVANIOS VIDYANAGAR, NALANCHIRA, THIRUVANANTHAPURAM – 695015, KERALA.Phone: 0471 2545866

Fax: 0471 2545869

Web: www.mbcet.ac.in

email: hodcs@mbcet.ac.in

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

B.TECH DEGREE PROGRAMME

IN

COMPUTER SCIENCE AND ENGINEERING-AI

CURRICULUM AND DETAILED SYLLABI

2020 SCHEME

Items	Board of Studies (BOS)	Academic Council (AC)
Date of Approval	24.11.2021	22.04.2022
	16.08.2022	21.11.2022
	28.02.2023	20.03.2023
	26.03.2024	19.06.2024
	29.04.2025	28.05.2025

Head of the Department
Chairman, Board of Studies

Principal
Chairman, Academic Council

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

(Autonomous)

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

B. TECH DEGREE PROGRAMME

IN

COMPUTER SCIENCE AND ENGINEERING (Artificial Intelligence)

For the students admitted from 2022-23

Scheduling of Courses

i) Knowledge Segments and Credits

Every course of B. Tech Programme is placed in one of the nine categories as listed in table below. No semester shall have more than six lecture-based courses and two laboratory courses, and/ordrawing/seminar/project courses in the curriculum.

Table 1: Credit distribution and the Knowledge Domains

Sl. No.	Category	Category Code	Total credits
1	Humanities and Social Sciences including Management Courses	HSC	5
2	Basic Science Courses	BSC	26
3	Engineering Science Courses	ESC	22
4	Programme Core Courses, Comprehensive Course Work and Viva Voce	PCC	79
5	Programme Elective Courses	PEC	15
6	Open Elective Courses	OEC	03
7	Project Work and Seminar	PWS	10
8	Mandatory Non-credit Courses (P/F) with Grade	MNC	Non-Credit
9	Mandatory Student Activities (P/F)	MSA	2
Total Mandatory Credits			**162**

ii) Semester-wise Credit Distribution

Semester	*I*	*II*	*III*	*IV*	*V*	*VI*	*VII*	*VIII*	*Total*
Credits for Courses	20	18	22	22	24	22	15	17	**160**
Activity Points (Min.)	40				60				**100**
Credits for Activities	2								**2**
Total Credits									**162**

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY
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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

B. TECH DEGREE PROGRAMME

IN

COMPUTER *SCIENCE* AND ENGINEERING (Artificial Intelligence)

2022-CURRICULUM AND DETAILED SYLLABI (S7and S8)

SEMESTER VII						
Slot	**Category Code**	**Course Number**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	PCC	CS2U40A	Foundations of Deep Learning	2-1-0	3	3
B	PEC	CS2UXXX CS1UXXX	Programme Elective II	2-1-0	3	3
C	OEC	CS0UXXX	Open Elective	2-1-0	3	3
D	MNC	NC0U40A	Industrial Safety Engineering	2-1-0	3	---
E	PCC	CS2U48A	Deep Learning Lab	0-0-3	3	2
T	PWS	CS2U49A	Seminar	0-0-3	3	2
U	PWS	CS2U49B	Project Phase I	0-0-6	6	2
R/M/H	VAC		Remedial/Minor/HonoursCourse	0-1-6/ 3-1-0	7/4	4
TOTAL					**24 (31/28)**	**15/19**

SEMESTER VIII						
Slot	**Category Code**	**Course Number**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	PCC	CS2U40B	Generative AI	2-1-0	3	3
B	PEC	CS2UXXX	Programme Elective III	2-1-0	3	3
C	PEC	CS2UXXX	Programme Elective IV	2-1-0	3	3
D	PEC	CS2UXXX	Programme Elective V	2-1-0	3	3
T	PCC	CS2U40C	Comprehensive Course Viva	1-0-0	1	1
U	PWS	CS2U49C	Project Phase II	0-0-12	12	4
R/M/H	VAC		Remedial/Minor/HonoursCourse	0-1-6	7	4
TOTAL					**25/32**	**17/21**

PROGRAMME ELECTIVE II

Slot	Category Code	Course Number	Courses	L-T-P	Hours	Credit
D	PEC	CS2U41A	Big data Analytics	2-1-0	3	3
		CS2U41B	Social Network Analysis	2-1-0	3	3
		CS2U41C	Data Mining	2-1-0	3	3
		CS2U41D	AI for Health Care	2-1-0	3	3
		CS2U41E	Game Theory in Artificial Intelligence	2-1-0	3	3
		CS1U41F	Natural Language Processing	2-1-0	3	3
		CS2U41F	Cloud Data Management	2-1-0	3	3

OPEN ELECTIVE I

Slot	Category Code	Course Number	Courses	L-T-P	Hours	Credit
C	OEC	CS0U41A	Introduction to Mobile Computing	2-1-0	3	3
		CS0U41B	Introduction to Deep Learning	2-1-0	3	3
		CS0U41C	Computer Graphics	2-1-0	3	3
		CS0U41D	Python for Engineers	2-1-0	3	3
		CS0U41E	Object Oriented Concepts	2-1-0	3	3

PROGRAMME ELECTIVE III

Slot	Category Code	Course Number	Course	L-T-P	Hours	Credit
B	PEC	CS2U42A	AI For Cyber Security	2-1-0	3	3
		CS2U42B	Web Intelligence and Big Data	2-1-0	3	3
		CS2U42C	Cognitive Modelling	2-1-0	3	3
		CS2U42D	Image and Video Analytics	2-1-0	3	3
		CS1U42G	Computer Vision	2-1-0	3	3

PROGRAMME ELECTIVE IV

Slot	Category Code	Course Number	Courses	L-T-P	Hours	Credit
B	PEC	CS2U43A	Human Computer Interaction	2-1-0	3	3
		CS2U43B	Deep Learning for Signal & Image Processing	2-1-0	3	3
		CS2U43C	Artificial Intelligence for Robotics	2-1-0	3	3
		CS2U43D	Data Pre-processing and Feature Engineering	2-1-0	3	3
		CS2U43F	Introduction to Reinforcement Learning	2-1-0	3	3
		CS2U43G	Bio-Inspired Optimization Techniques	2-1-0	3	3
		CS2U43H	Text Mining	2-1-0	3	3

PROGRAMME ELECTIVE V

Slot	Category Code	Course Number	Courses	L-T-P	Hours	Credit
C	PEC	CS1U44A	High Performance Computing	2-1-0	3	3
		CS1U44B	Block Chain Technologies	2-1-0	3	3
		CS2U44A	Knowledge Engineering and Expert Systems	2-1-0	3	3
		CS2U44B	IoT for AI	2-1-0	3	3
		CS2U44C	Big Data and Database Management	2-1-0	3	3
		CS1U44F	Bioinformatics	2-1-0	3	3
		CS1U44G	Computational Linguistics	2-1-0	3	3

Minors

Semester	BASKET I SOFTWARE ENGINEERING				BASKET II MACHINE LEARNING				BASKET III NETWORKING			
	Course Number	Course	L-T-P	Credit	Course Number	Course	L-T-P	Credit	Course Number	Course	L-T-P	Credit
S3	CS0M 20A	Object Oriented Programming	3-1-0	4	CS0M 20B	Python for Machine Learning	3-1-0	4	CS0M 20C	Data Communication	3-1-0	4
S4	CS0M 20D	Programming Methodologies	3-1-0	4	CS0M 20E	Mathematics for Machine Learning	3-1-0	4	CS0M 20F	Introduction to Computer Networks	3-1-0	4
S5	CS0M 30A	Concepts in Software Engineering	3-1-0	4	CS0M 30B	Concepts in Machine Learning	3-1-0	4	CS0M 30C	Client Server Systems	3-1-0	4
S6	CS0M 30D	Introduction to Software Testing	3-1-0	4	CS0M 30E	Concepts in DeepLearning	3-1-0	4	CS0M 30F	Wireless Networks and IoT Applications	3-1-0	4
S7	CS0M 49A	Mini Project	0-1-6	4	CS0M 49A	Mini Project	0-1-6	4	CS0M 49A	Mini Project	0-1-6	4
S8	CS0M 49B	Mini Project	0-1-6	4	CS0M 49B	Mini Project	0-1-6	4	CS0M 49B	Mini Project	0-1-6	4

Honours

Semester	BASKET I				BASKET II				BASKET III			
	SECURITY IN COMPUTING				COMPUTATIONAL BIOLOGY				COMPUTER VISION			
	Course Number	Course	L-T-P	Credit	Course Number	Course	L-T-P	Credit	Course Number	Course	L-T-P	Credit
S4	CS1H20A	Number Theory	3-1-0	4	CS2H20A	Computational Fundamentals for Bioinformatics	3-1-0	4	CS2H20B	Advanced Topics in Computer Graphics	3-1-0	4
S5	CS1H30A	Cryptographic Algorithms	3-1-0	4	CS2H30A	ComputationalBiology	3-1-0	4	CS2H30B	Advanced Concepts In Computer Vision	3-1-0	4
S6	CS1H30D	Network Security	3-1-0	4	CS2H30C	Machine Learning In Computational Biology	3-1-0	4	CS2H30D	Image AndVideo Processing	3-1-0	4
S7	CS1H40A	Cyber Forensics	3-1-0	4	CS2H40A	Computational Health Informatics	3-1-0	4	CS2H40B	Surveillance Video Analytics	3-1-0	4
S8	CS1H49A	Mini Project	0-1-6	4	CS2H49A	Mini Project	0-1-6	4	CS2H49A	Mini Project	0-1-6	4

Semester VII

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS2U40A	**Foundations of deep learning**	**PCC**	**2**	**1**	**0**	**3**	**2022**

PRE-REQUISITE: CS2U30C Introduction to Machine learning

COURSE OVERVIEW

This course provides the learners an overview of the concepts and algorithms involved in deep learning. The course covers the basic concepts in neural networks, deep learning, optimization techniques, regularization techniques, convolutional neural networks, recurrent neural networks, autoencoders, and generative models. The students will be able to implement deep learning algorithms to solve real-world problems.

COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Explain the basic concepts of deep learning.	Understand
CO 2	Explain the deep learning techniques for structured/tabular data.	Understand
CO 3	Outline the standard regularization and optimization techniques for the effective training of deep neural networks.	Understand
CO 4	Apply convolutional Neural Network (CNN) models for different use cases.	Apply
CO 5	Explain the concepts of Recurrent Neural Network (RNN), Long Short Term Memory(LSTM), Gated Recurrent Unit (GRU).	Understand
CO 6	Explain the concepts of auto encoder, generative models, Transformers	Understand

SYLLABUS

The Deep Learning course provides a comprehensive understanding of deep learning architectures, and their applications. It covers fundamental concepts, including activation functions, loss functions, backpropagation, and challenges like overfitting and hyperparameter tuning. The course explores training deep models, focusing on optimization techniques (SGD, Adam), regularization methods (dropout, batch normalization), and ensemble learning. Advanced topics include Convolutional Neural Networks (CNNs) for image processing, Recurrent Neural Networks (RNNs) for sequential data, and generative models such as Autoencoders, GANs, and transformers. The course also discusses attention mechanisms and state-of-the-art architectures used in modern deep learning applications.

TEXT BOOKS

1. **Ian Goodfellow, Yoshua Bengio, and Aaron Courville,** *Deep Learning*, MIT Press, **2016.**

2. **Charu C. Aggarwal**, *Neural Networks and Deep Learning*, Springer International Publishing, part of Springer Nature**, 2018.**
3. Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., Kaiser, Ł., and Polosukhin, I., *Attention Is All You Need*, NeurIPS, 2017

REFERENCES

1. **Nikhil Buduma and Nicholas Locascio**, *Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms*, 1st Edition, O'Reilly Media, Inc., **2017.**
2. **M. Gopal,** *Deep Learning: Core Concepts, Methods and Applications*, Pearson Education, **2022.**

COURSE PLAN

Module	Contents	Hours
I	**Introduction to Deep learning and training Deep models** Introduction to deep learning. Deep feed forward network. Setup and initialization- Weight intializations, Vanishing and exploding gradient problems, Optimization techniques - Gradient Descent (GD), Stochastic GD, GD with momentum, GD with Nesterov momentum, AdaGrad, RMSProp, Adam., Regularization Techniques—L1 and L2 regularization, Early stopping, Dataset augmentation, Parameter sharing, Ensemble methods, Dropout, Batch normalization.	**10**
II	**Deep Learning for Structured Data** Introduction to Deep Learning for Structured Data. Feedforward Neural Networks (MLPs) for Tabular Data. Preprocessing techniques: feature scaling, embeddings for categorical variables. Model optimization for tabular datasets. Evaluation metrics and overfitting in tabular models. Comparison with traditional machine learning methods (Decision Trees, Random Forest, XGBoost). Hybrid Approaches: Combining Deep Learning with Classical ML models.	**7**
III	**Convolutional Neural Network-CNN** Convolutional Neural Networks: Basic Architecture, Convolution Operation, Motivation, 3D Convolution , Padding, Stride, Pooling. Variants of convolution functions, efficient convolution algorithms, sparse connections, and weight sharing. Training CNN, Transfer learning, Applications of Convolutional Networks, Pre-trained Convolutional Architectures : Google Net, VGG, ResNet, EfficientNet. Object detection- RCNN, YOLO.	**11**
IV	**Sequential Models** Applications of sequential models, Recurrent neural networks, LSTM, GRU. Encoder-Decoder Models. Attention Mechanism. NLP-Language Modeling (GPT, BERT) Sequence-to-Sequence Learning (Transformer models). Text Classification— Named Entity Recognition (NER), Text Embedding & Representation Learning - Word2Vec, BERT Embedding. Generative Text Models	**9**
V	**Encoder decoder models and Generative models** Autoencoders, Types of autoencoders: Variational Auto-Encoder, under complete auto-encoder, stochastic encoder, denoising encoder. Image Segmentation- UNet. Generative models: generative adversarial networks (GAN). Applications of GAN.	**8**
	Total Hours	**45**

ASSESSMENT PATTERN

Continuous Assessment		
Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignment	:	15 marks
Total	:	**50 marks**
End Semester Examination	:	**100 marks**

Course Code	Course Name	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
NCOU40A	INDUSTRIAL SAFETY ENGINEERING	MNC	2	1	0	-	2020

COURSE OVERVIEW

The course is intended to give knowledge of various safety management principles, various safety systems, various machine guarding devices, hazard identification techniques, energy sources, systems & applications and the need in the present context. Learners will be able to compare different hazard identification tools and choose the most appropriate based on the nature of industry. It aims to equip students in working with projects and to take up research work in connected areas.

COURSE OUTCOME

After the completion of the course the student will be able to

Course Outcomes	Description	Level
CO1	Describe the theories of accident causation and preventive measures of industrialaccidents.	Understand
CO2	Explain about personal protective equipment, its selection, safety performance &indicators and importance of housekeeping.	Understand
CO3	Explain different issues in construction industries.	Understand
CO4	Describe various hazards associated with different machines and mechanicalmaterial handling.	Understand
CO5	Utilize different hazard identification tools in different industries with theknowledge of different types of chemical hazards.	Understand

SYLLABUS

Safety introduction: Need for safety. Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence, Reportable accidents. Safety policy. Safety Officer-responsibilities,authority. Safety committee-need, types, advantages.

Personal protection in work environment: Personal protection in the work environment, Types of PPEs, Personal protective equipment- respiratory and non-respiratory equipment. Standards related to PPEs. Housekeeping: 5 s of housekeeping. Work permit system- objectives, hot work and cold work permits. Typical industrial models and methodology. Entry into confined spaces.

Safety issues in construction: Introduction to construction industry and safety issues in construction Safety in various construction Familiarization with relevant Indian Standards and the National Building Code provisions on construction safety. Relevance of ergonomics in construction safety. Ergonomics Hazards - Musculoskeletal Disorders and Cumulative Trauma Disorders.

Safety hazards in machines: Machinery safeguard-Point-of-Operation, Principle of machine guarding -types of guards and devices. Safety in turning, and grinding. Welding and Cutting-Safety Precautions of Gas welding and Arc Welding. Maintenanceof common elements-wire rope, chains slings, hooks, clamps. Hearing Conservation Program in Production industries.

Hazard identification and analysis: Hazard and risk, Types of hazards –Classification of Fire, Types of Fire extinguishers, fire explosion and toxic gas release. Control of Chemical Hazards, Hazardous properties of chemicals, Material Safety Data Sheets (MSDS).

TEXT BOOKS:

1. R.K Jain (2000) Industrial Safety, Health and Environment management systems, Khanna Publications.
2. Paul S V (2000), Safety management System and Documentation training Programme handbook, CBS Publication.
3. Krishnan, N.V. (1997). *Safety management in Industry*. Jaico Publishing House, NewDelhi.
4. John V. Grimaldi and Rollin H.Simonds. (1989) *Safety management*. All India TravellerBook Seller, Delhi.
5. Ronald P. Blake. (1973). *Industrial safety.* Prentice Hall, New Delhi.
6. Alan Waring. (1996). *Safety management system*. Chapman & Hall, England.
7. Vaid, K.N., (1988). Construction safety management. National Institute of Construction Management and Research, Mumbai.
8. AIChE/CCPS. (1992). *Guidelines for Hazard Evaluation Proce*dures. (second edition). Centre for Chemical Process Safety, American Institute of Chemical Engineers, New York.

REFERENCES

1. Ronald P. Blake. (1973). *Industrial safety*. Prentice Hall, New Delhi.
2. Alan Waring. (1996). *Safety management system*. Chapman & Hall, England.
3. Vaid, K.N., (1988). Construction safety management. National Institute of Construction Management and Research, Mumbai.
4. AIChE/CCPS. (1992). *Guidelines for Hazard Evaluation Procedures*. (second edition). Centre for Chemical Process Safety, American Institute of Chemical Engineers, New York.

COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Industrial safety Engineering** Need for safety. Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence. Reportable accidents, Theories of accident causation. Safety organization. Role of management, supervisors, workmen, unions,government and voluntary agencies in safety. Safety officer-responsibilities, authority, Safety committee need, types, advantages.	9

II	**Personal protection in the work environment** Types of PPEs, respiratory and non-respiratory equipment, Standards related to PPEs, Monitoring Safety Performance: Frequency rate, severity rate, Monitoring Safety Performance: incidence rate, activity rate. Housekeeping: Responsibility of management and employees.Advantages of good housekeeping. 5 s of housekeeping, Work permit system-objectives, hot work and cold work permits, Typical industrial models and methodology. Entry into confinedspaces, Types of PPEs, respiratory and non-respiratory equipment.	9
III	**Introduction to construction industry and safety** Excavation and filling – Under-water works – Under-pinning &Shoring, Ladders & Scaffolds – Tunneling, Blasting –Demolition – Confined space, Familiarization with relevant Indian Standards and the NationalBuilding Code provisions on construction safety. Relevance of ergonomics in construction safety. Ergonomics Hazards, Musculoskeletal Disorders and Cumulative Trauma Disorders.	9
IV	**Machinery safeguard** Point-of-Operation, Principle of machine guarding , Types of guards and devices. Safety in Power Presses, primary & secondary operations – shearing-bending - rolling – drawing. Safety in turning, boring, milling, planning and grinding. Welding and Cutting-Safety Precautions of Gas welding and Arc Welding, Cutting and Finishing. Material Handling-Classification-safety consideration- manual and mechanical handling. Handling assessments and techniques- lifting, carrying, pulling, pushing, palletizing and stocking. Material Handling equipment-operation & maintenance. Maintenance of common elements-wire rope, chains slings,hooks, clamps	9
V	**Hazard identification** Hazard and risk, Types of hazards – Classification of Fire, Types of Fire extinguishers fire, explosion and toxic gas release. Inventory analysis, Fire and explosion hazard rating of process plants, The Dow Fire and Explosion Hazard Index. Preliminary hazard analysis, Hazard and Operability study (HAZOP). Chemical hazard- Classifications, Control of Chemical Hazards. Hazardous properties of chemicals. Material Safety Data Sheets (MSDS).	9
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS2U48A	Deep Learning Lab	PCC	0	0	3	2	2022

COURSE OVERVIEW

This course aims to introduce the learner to an overview of the concepts and algorithms involved in deep learning. Basic concepts and application areas of machine learning, deep networks, convolutional neural networks, and recurrent neural networks are covered in this course. This is a foundational program that will help students understand the capabilities, challenges, and consequences of deep learning and prepare them to participate in the development of leading-edge AI technology. They will be able to gain the knowledge needed to take a definitive step in the world of AI.

COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Implement basic neural networks and CNN on standard datasets.	Apply
CO 2	Apply the impact of optimization algorithms, weight initialization strategies, dropout, and regularization techniques on deep learning model performance	Apply
CO 3	Apply object detection techniques using YOLO and Faster R-CNN architectures.	Apply
CO 4	Implement models for sequential data processing	Apply
CO 5	Implement auto encoders and GAN on standard datasets and analyze the performance.	Apply
CO 6	Implement and fine-tune transformer-based models like BERT for natural language processing tasks,	Apply

TEXT BOOKS

1. **Ian Goodfellow, Yoshua Bengio, and Aaron Courville,** *Deep Learning*, MIT Press, **2016.**
2. **Charu C. Aggarwal**, *Neural Networks and Deep Learning*, Springer International Publishing, part of Springer Nature**, 2018.**
3. Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., Kaiser, Ł., and Polosukhin, I., *Attention Is All You Need*, NeurIPS, 2017

REFERENCES

1 **Nikhil Buduma and Nicholas Locascio**, *Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms*, 1st Edition, O'Reilly Media, Inc., **2017.**

2. **M. Gopal,** *Deep Learning: Core Concepts, Methods and Applications*, Pearson Education, **2022.**

COURSE PLAN

Module	Contents	Hours
1	Implement Feed forward neural network with three hidden layers for classification on CIFAR-10 dataset and visualize weights and activations.	3
2	Analyze the impact of optimization, weight initialization techniques, dropout and regularization techniques and visualize the change in performance.	6
3	Digit classification using CNN architecture for MNIST dataset.	3
4	Digit classification using pre-trained networks like VGGnet-19 or ResNet for MNIST dataset and analyze and visualize performance improvement.	6
5	Object detection using YOLO and Faster RCNN.	6
6	Implement a simple RNN. Analyze and visualize the performance change while using LSTM and GRU instead of simple RNN.	6
7	Implement a shallow autoencoder for image reconstruction using MNIST dataset.	6
8	Implement image generation using GAN.	6
9	Implement sentence prediction using BERT.	3
	Total Hours	45

ASSESSMENT PATTERN

Continuous Assessment

Attendance	:	15 marks
Continuous Evaluation	:	30 marks
Viva	:	15 marks
Continuous assessment Test	:	15 marks
Total	:	75 marks
End Semester Examination	:	75 marks
Total	:	150 Marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS2U49A	SEMINAR	PWS	0	0	3	2	2020

COURSE OVERVIEW:

The course 'Seminar' is intended to enable a B.Tech graduate to read, understand, present and prepare report about an academic document. The learner shall search in the literature including peer reviewed journals, conference, books, project reports etc., and identify an appropriate paper/thesis/report in her/his area of interest, in consultation with her/his seminar guide. This course can help the learner to experience how a presentation can be made about a selected academic document and also empower her/him to prepare a technical report.

COURSE OUTCOMES

After successful completion of the course, the students will be able to:

Course Outcomes	Description	Level
CO1	Identify academic documents from the literature which are related to her/his areas of interest.	Apply
CO2	Read and apprehend an academic document from the literature which is related to her/ his areas of interest	Analyze
CO3	Prepare a presentation about an academic document	Create
CO4	Give a presentation about an academic document	Apply
CO5	Prepare a technical report.	Create

General Guidelines

- The Department shall form an Internal Evaluation Committee (IEC) for the seminar with academic coordinator for that program as the Chairperson/Chairman and seminar coordinator & seminar guide as members. During the seminar presentation of a student, all members of IEC shall be present.
- Formation of IEC and guide allotment shall be completed within a week after the End Semester examination (or last working day) of the previous semester.
- Guide shall provide required input to their students regarding the selection of topic/ paper.
- Choosing a seminar topic: The topic for a UG seminar should be current and broad based rather than a very specific research work. It's advisable to choose a topic for the Seminar to be closely linked to the final year project area. Every member of the projectteam could choose or be assigned Seminar topics that covers various aspects linked to the Project area.
- A topic/paper relevant to the discipline shall be selected by the student during the semester break.
- Topic/Paper shall be finalized in the first week of the semester and shall be submittedto theIEC.

- The IEC shall approve the selected topic/paper by the second week of the semester.
- Accurate references from genuine peer reviewed published material to be given in the report and to be verified.

EVALUATION PATTERN

Total marks: 100, only CIE, minimum required to pass 50

Seminar Guide: 20 marks (Background Knowledge – 10 (The guide shall give deserving marks for a candidate based on the candidate's background knowledge about the topic selected), Relevance of the paper/topic selected – 10).

Seminar Coordinator: 20 marks (Seminar Diary – 10 (Each student shall maintain a seminar diary and the guide shall monitor the progress of the seminar work on a weekly basis and shall approve the entries in the seminar diary during the weekly meeting with the student), Attendance – 10).

Presentation: 40 marks to be awarded by the IEC (Clarity of presentation – 10, Interactions – 10 (to be based on the candidate's ability to answer questions during the interactive session of her/his presentation), Overall participation – 10 (to be given based onher/his involvement during interactive sessions of presentations by other students), Quality of the slides – 10).

Report: 20 marks to be awarded by the IEC (check for technical content, overall quality, templates followed, adequacy of references etc.).

Course Code	Course Name	Category	L	T	P	CREDIT	Year of Introduction
CS2U49B	PROJECT PHASE I	PWS	0	0	6	2	2020

COURSE OVERVIEW

The course 'Project Work' is mainly intended to evoke the innovation and invention skills in a student. The course will provide an opportunity to synthesize and apply the knowledge and analytical skills learned, to be developed as a prototype or simulation. The project extends to 2 semesters and will be evaluated in the 7th and 8th semester separately, based on the achieved objectives. One third of the project credits shall be completed in 7th semester and two third in 8th semester. It is recommended that the projects may be finalized in the thrust areas of the respective engineering stream or as interdisciplinary projects. Importance should be given to address societal problems and developing indigenous technologies.

COURSE OUTCOMES

After successful completion of the course, the students will be able to:

Course Outcomes	Description	Level
CO1	Model and solve real world problems by applying knowledge across domains	Apply
CO2	Develop products, processes or technologies for sustainable and socially relevant applications	Apply
CO3	Function effectively as an individual and as a leader in diverse teams and to comprehend and execute designated tasks .	Apply
CO4	Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms .	Apply
CO5	Identify technology/research gaps and propose innovative/creative solutions.	Analyze
CO6	Organize and communicate technical and scientific findings effectively in written and oral forms .	Apply

Phase 1 Target

- Literature study/survey of published literature on the assigned topic
- Formulation of objectives
- Formulation of hypothesis/ design/ methodology
- Formulation of work plan and task allocation.
- Block level design documentation
- Seeking project funds from various agencies
- Preliminary Analysis/Modeling/Simulation/Experiment/Design/Feasibility study
- Preparation of Phase 1 report

Evaluation Guidelines & Rubrics

Total: 100 marks (Minimum required to pass: 50 marks).

- Project progress evaluation by guide: 30 Marks.
- Interim evaluation by the Evaluation Committee: 20 Marks.
- Final Evaluation by the Evaluation Committee: 30 Marks.

Project Phase - I Report (By Evaluation Committee): 20 Marks

(The evaluation committee comprises HoD or a senior faculty member, Project coordinatorand project supervisor).

PROGRAM ELECTIVE 2

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS2U41A	Big data Analytics	PEC	2	1	0	3	2022

COURSE OVERVIEW

This course is offered to introduce fundamental algorithmic ideas in processing data. The preliminary concepts of Hadoop and Map Reduce are included as part of this course.

COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Course Outcomes	Level
CO1	Explain the key concepts of data science.	Understand
CO2	Describe big data and use cases from selected business domains.	Understand
CO3	Explain the process of big data analytics using Hadoop and related tools such as Pig and Hive.	Understand
CO4	Apply R programming to conduct basic data analysis on simple datasets.	Apply
CO5	Apply different machine learning approaches to process data and interpret the principles of supervised and unsupervised learning.	Apply

SYLLABUS

Introduces the fundamentals of data science and big data, covering key concepts such as the data science process, project stages, and big data characteristics (the five V's). It explores tools and technologies like Hadoop, HDFS, MapReduce, Pig, Hive, and offers a brief overview of NoSQL. Students will learn basic data analysis using R, including data types, descriptive statistics, visualization, and exploratory analysis. The course also introduces machine learning concepts, including regression, classification, clustering, model validation, and performance metrics.

TEXTBOOKS

1. Davy Cielen, Arno D. B. Meysman, and Mohamed Ali ,"Introducing Data Science - Big data, machine learning, and more, using Python tools" , Dreamtech Press 2016.
2. Michael Minelli, Michelle Chambers, and AmbigaDhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses",Wiley,2013.
3. EMC Education Services, "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", Wiley ,January 2015

REFERENCES

1. Tom White,"Hadoop: The Definitive Guide", Third Edition, O'Reilley,2012.
2. Eric Sammer,"Hadoop Operations",O'Reilly Media, Inc ,2012
3. E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilley, 2012.
4. "Programming Pig", Alan Gates, O'Reilley,2011.
5. Ethem Alpaydın, "Introduction to Machine Learning (Adaptive Computation and Machine Learning)", MIT Press, 2004.

COURSE PLAN

Module	Contents	Hours
I	Data science in a big data world: Benefits and uses of data science and big data Facets of data-the big data ecosystem and data science-Data science process-roles-stages in data science project- Defining research goals-Retrieving data-Cleansing, integrating, and transforming data- Data Exploration-Data modelling - Presentation and automation.	8
II	Big Data Overview–the five V's of big data-State of the Practice in Analytics Examples of Big Data Analytics-Apache Hadoop and the Hadoop Ecosystem-HDFS-Design of HDFS, HDFS Concepts-Daemons-Reading and Writing Data-Managing File system Metadata- Map Reduce-The Stages of Map Reduce - Introducing Hadoop Map Reduce Daemons-YARN	10
III	Analyzing the Data with Hadoop using Map and Reduce-Developing a Map Reduce Application-Anatomy of a Map Reduce Job- Scheduling-Shuffle and Sort - Task execution. Big data Management Tools: PIG-: Introduction to PIG, Execution Modes of Pig, Pig Latin, HIVE: Hive Architecture, HIVEQL, Introduction to NoSQL. (Introduction only)	9
IV	Review of Basic Analytic methods using R- Introduction to R -Data Import and Export -Attribute and Data Types - ordered and unordered factors-arrays and matrices lists and data frames -Descriptive Statistics-Exploratory Data Analysis-Dirty Data Visualizing a Single Variable-Examining Multiple Variables-statistical models in R-Graphical Procedures-High-level plotting commands-Low-level plotting commands.	9
V	Machine learning -Introduction to Machine Learning, Examples of Machine Learning applications-Supervised Learning- Regression – Single variable, Multi variable Classification – Logistic Regression- Unsupervised Learning - Clustering: K-means Reinforcement Learning-Model Selection and validation-k-Fold Cross Validation-Measuring classifier performance- Precision, recall.	9
	Total Hours	**45**

ASSESSMENT PATTERN

Continuous Assessment		
Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignment	:	15 marks
Total	:	**50 marks**
End Semester Examination	:	**100 marks**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS2U41B	Social network Analysis	PEC	2	1	0	3	2022

COURSE OVERVIEW

This course explores the evolution, structure, and applications of social networks in the context of the Semantic Web. It covers fundamental concepts such as social network analysis, ontology-based knowledge representation, and community detection and mining methods. The course also delves into understanding human behavior in social communities, trust and privacy issues in online networks, and various graph-theoretic approaches for analyzing and visualizing social networks. Through theoretical foundations and practical applications, students will gain insights into how social networks function and evolve in a digital environment.

COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Course Outcomes	Level
CO1	Explain the concept of semantic web and related applications.	Understand
CO2	Explain knowledge representation using ontology.	Understand
CO3	Explain the evolution, detection, and characterization of communities in social networks using various methods and tools.	Understand
CO4	Explain human behavior in the social web and related communities.	Understand
CO5	Apply graph theory for visualization of social networks.	Apply

SYLLABUS

Introduction to the Semantic Web, fundamentals of social network analysis, key measures, electronic discussion networks, blogs, and web-based networks. Role of ontologies in the Semantic Web, ontology-based knowledge representation, ontology languages (RDF, OWL).Web community evolution, detecting and evaluating social network communities, methods and tools for community detection, decentralized online social networks, and multi-relational community characterization.Human behavior in social communities, Graph theory concepts,hybrid visualizations, and applications in social and collaboration networks.

TEXTBOOKS

1. Peter Mika, ―Social Networks and the Semantic Web, First Edition, Springer 2007.
2. Borko Furht, ―Handbook of Social Network Technologies and Applications, 1st Edition, Springer, 2010.

REFERENCES

1. Guandong Xu, Yanchun Zhang, and Lin Li,-Web Mining and Social Networking –

Techniques and Applications, First Edition, Springer, 2011.
2. Dion Goh and Schubert Foo,-Social Information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively, IGI Global Snippet, 2008.
3. Max Chevalier, Christine Julien and Chantal Soulé-Dupuy, Collaborative and Social Information Retrieval and Access: Techniques for Improved user Modelling, IGI Global Snippet, 2009.
4. John G. Breslin, Alexander Passant, and Stefan Decker, -The Social Semantic Web, Springer, 2009.

COURSE PLAN

Module	Contents	Hours
I	Introduction to Semantic Web: Limitations of current Web – Development of Semantic Web – Emergence of the Social Web – Social Network analysis: Development of Social Network Analysis – Key concepts and measures in network analysis – Electronic sources for network analysis: Electronic discussion networks, Blogs and online communities – Web-based networks – Applications of Social Network Analysis.	**9**
II	Ontology and their role in the Semantic Web: Ontology-based knowledge Representation – Ontology languages for the Semantic Web: Resource Description Framework – Web Ontology Language – Modelling and aggregating social network data: State-of-the-art in network data representation – Ontological representation of social individuals – Ontological representation of social relationships – Aggregating and reasoning with social network data – Advanced representations.	**10**
III	Extracting evolution of Web Community from a Series of Web Archive – Detecting communities in social networks – Definition of community – Evaluating communities – Methods for community detection and mining – Applications of community mining algorithms – Tools for detecting communities social network infrastructures and communities – Decentralized online social networks – Multi-Relational characterization of dynamic social network communities.	**9**
IV	Understanding and predicting human behavior for social communities – User data management – Inference and Distribution – Enabling new human experiences – Reality mining – Context – Awareness – Privacy in online social networks – Trust in online environment – Trust models based on subjective logic – Trust network analysis – Trust transitivity analysis – Combining trust and reputation – Trust derivation based on trust comparisons – Attack spectrum and counter measures.	**8**
V	Graph theory – Centrality – Clustering – Node-Edge Diagrams – Matrix representation – Visualizing online social networks, visualizing social networks with matrix-based representations – Matrix and Node-Link Diagrams – Hybrid representations – Applications – Cover networks – Community welfare – Collaboration networks – Co-Citation networks.	**9**
	Total Hours	**45**

ASSESSMENT PATTERN

Continuous Assessment		
Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignment	:	15 marks
Total	:	**50 marks**
End Semester Examination	:	**100 marks**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS2U41C	DATA MINING	PEC	2	1	0	3	2022

COURSE OVERVIEW

This course helps the learner to understand the concepts of data mining and data warehousing. It covers the key processes of data mining, data preprocessing techniques, fundamentals and advanced concepts of classification, clustering, association rule mining, web mining and text mining. It enables the learners to develop new data mining algorithms and apply the existing algorithms in real-world scenarios.

COURSE OUTCOMES

After the completion of the course the student will be able to

CO1	Explain data mining and data warehousing concepts in application domains.	Understand
CO2	Make use of appropriate preprocessing techniques to convert raw data into suitable format for practical data mining tasks	Apply
CO3	Apply classification and clustering algorithms in various domains.	Apply
CO4	Make use of association rule mining techniques in various applications.	Apply
COs	Explain advanced data mining concepts and their applications in emerging domains	Understand

SYLLABUS

Introduction to Data Mining and Data Warehousing, Data Preprocessing: Data Reduction-Data cube aggregation, Attribute subset selection, Dimensionality reduction, Numerosity reduction, Discretization and concept hierarchy generation. Advanced classification and Cluster analysis: Classification- Introduction, Decision tree construction principle, Splitting indices ,Classification Accuracy-Precision, Recall. Clustering Paradigms, Partitioning Algorithm- PAM, Hierarchical Clustering-DBSCAN, Categorical Clustering-ROCK. Association Rule Analysis: Apriori(Level-wise algorithm), Partition Algorithm, Pincer Search Algorithm, Dynamic ltemset Counting Algorithm, FP-tree Growth Algorithm Web Mining. Text Mining

TEXT BOOKS

1. Dunham M H, “Data Mining: Introductory and Advanced Topics”, Pearson Education, New Delhi, 2003.Arun K Pujari, “Data Mining Techniques”, Universities Press Private Limited,2008.
2. Jaiwei Han and Micheline Kamber, “Data Mining Concepts and Techniques”, Elsevier, 2006

REFERENCES

1. M Sudeep Elayidom, “Data Mining and Warehousing”, 1st Edition, 2015, Cengage Learning India Pvt. Ltd.
2. Mehmed Kantardzic, “Data Mining Concepts, Methods and Algorithms”, John Wiley andsons, USA, 2003.
3. Pang-Ning Tan and Michael Steinbach, “Introduction to Data Mining”, Addison Wesley, 2006.

COURSE PLAN

Module	**Contents**	No. of Hours
I	**Introduction to Data Mining and Data Warehousing** Data warehouse-Differences between Operational Database Systems and Data Warehouses, Multidimensional data model- Warehouse schema, OLAP Operations, Data Warehouse Architecture, Data Warehousing to Data Mining, Datamining Concepts and Applications, Knowledge Discovery in Database Vs Data mining, Architecture of typical data mining system, Data Mining Functionalities, Data Mining Functionalities, Data Mining Issues	8
II	**Data Preprocessing** Data Preprocessing: Need of Data Preprocessing, Data Cleaning- Missing values, Noisy data, Data integration, Data transformation, Data Reduction-Data cube aggregation, Attribute subset selection, Data Reduction-Dimensionality reduction, Numerosity reduction, Discretization and concept hierarchy generation	8
III	**Advanced classification and Cluster analysis** Classification- Introduction, Decision tree construction principle, Splitting indices- Information Gain, Gini index, Decision Tree- ID3, Decision Tree- ID3, Decision tree construction with presorting- SLIQ Accuracy and error measures, evaluation, Introduction to clustering, Clustering Paradigms, Partitioning Algorithm- PAM, Hierarchical Clustering-DBSCAN, Categorical Clustering-ROCK	10
IV	**Association Rule Analysis** Association Rules: Introduction, Methods to discover association rules, A priori algorithm (Level-wise algorithm), Partition Algorithm, Pincer Search Algorithm, Pincer Search Algorithm, Dynamic ltemset Counting Algorithm, FP-tree Growth Algorithm	10
V	**Advanced Data Mining Techniques** Web Mining - Web Content Mining, Web Structure Mining- Page Rank, Web Structure Mining —Clever algorithm, Web Usage Mining- Preprocessing, Data structures, Web Usage Mining -Pattern Discovery, Pattern Analysis, Text Mining-Text Data Analysis and information Retrieval, Basic measures for Text retrieval, Text Retrieval methods, Text Indexing Techniques Query Processing Techniques	9
	Total hours	**45**

ASSESSMENT PATTERN

Continuous Assessment

Attendance : 10 marks

Continuous Assessment Tests	:	25 marks
Assignment	:	15 marks
Total	:	**50 marks**
End Semester Examination	:	**100 marks**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS2U41D	AI for Health Care	PEC	2	1	0	3	2022

COURSE OVERVIEW

The objective of this course is to help the learners to understand how AI and machine learning techniques are transforming healthcare delivery, clinical decision-making, and biomedical research. The course will cover topics such as machine learning algorithms, deep learning architectures, natural language processing, and computer vision, with a focus on their applications in medical imaging, diagnostics, patient management, and personalized medicine. This course enables the learners to explore the opportunities and challenges of integrating AI into healthcare systems.

COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Explain the principles of AI, machine learning, and deep learning in the context of healthcare applications.	Understand
CO 2	Apply Machine Learning in developing AI models for Medical Data Analysis and Predictions.	Apply
CO 3	Apply Deep Learning for medical image analysis.	Apply
CO 4	Apply natural language processing (NLP) techniques to extract insights from electronic health records (EHRs), clinical notes, and research papers.	Apply
CO 5	Explain emerging AI technologies in healthcare, their ethical implications, regulatory challenges, and future trends.	Understand

SYLLABUS

The AI in Healthcare course provides a comprehensive understanding of how Artificial Intelligence, Machine Learning, Deep Learning, and Natural Language Processing (NLP) are applied in the medical field. It covers fundamental AI concepts, predictive modelling for disease diagnosis, deep learning for medical imaging, and NLP techniques for analysing electronic health records (EHRs) and clinical notes. The course also explores emerging AI technologies, including AI-driven personalized medicine, robotic surgeries, and blockchain for secure medical data management. Ethical considerations, regulatory frameworks (HIPAA, GDPR, FDA), and future trends are discussed to ensure responsible AI implementation. Through hands-on projects, students gain practical experience in developing AI solutions for real-world healthcare challenges.

TEXT BOOKS

1. Artificial Intelligence in Healthcare – Adam Bohr, Kaveh Memarzadeh (Academic Press, 2020)
2. Machine Learning for Healthcare – John W. McGinnis (MIT Press, 2021)
3. Deep Learning for Medical Image Analysis – S. Kevin Zhou, Hayit Greenspan, Dinggang Shen (Academic Press, 2017)
4. Natural Language Processing for Healthcare – Zhiyong Lu, Hua Xu (Springer, 2021)

REFERENCES

1. Healthcare Analytics: From Data to Knowledge to Healthcare Improvement – Hui Yang, Eva Lee (Wiley, 2016)
2. "The Role of Artificial Intelligence in Healthcare: A Comprehensive Overview" – Research Paper (Nature Medicine, 2019)
3. "The Role of Artificial Intelligence in Healthcare: A Comprehensive Overview" – Research Paper (Nature Medicine, 2019)
4. "Predictive Analytics in Healthcare" – Research Paper (IEEE Transactions on Biomedical Engineering, 2020)
5. "Deep Learning in Medical Imaging: Overview and Future Trends" – Journal Article (IEEE Transactions on Medical Imaging, 2019)
6. "AI-driven NLP for Medical Text Processing" – Research Paper (Journal of Biomedical Informatics, 2021)
7. Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again – Eric Topol (Basic Books, 2019)

COURSE PLAN

Module	Contents	Hours
I	**Introduction to AI in Healthcare**- Fundamentals of Machine Learning (Supervised, Unsupervised, Reinforcement Learning), Deep Learning Basics: Neural Networks, CNNs, RNNs, Key AI Techniques in Healthcare: Predictive Analytics, Decision Support Systems, Challenges and Opportunities of AI in Healthcare.	**6**
II	**Machine Learning for Medical Data Analysis and Predictions**- Data Collection & Preprocessing in Healthcare, Feature Engineering & Selection for Medical Data, Supervised Learning Algorithms: Decision Trees, SVM, Random Forest, XGBoost, Unsupervised Learning for Clustering & Anomaly Detection, Predictive Modeling for Disease Diagnosis (Diabetes, Heart Disease, Cancer), Case study: AI Model for Patient Risk Prediction.	**10**
III	**Introduction to Deep Learning in Medical Imaging**- Convolutional Neural Networks (CNNs) for Image Recognition, AI in Radiology: X-rays, MRI, and CT Scan Interpretation, AI in Pathology: Histopathological Image Analysis, Transfer Learning & Pretrained Models (ResNet, VGG, Efficient Net), Case study: AI Model for Disease Detection in Medical Images.	**10**
IV	**Fundamentals of NLP in Medical Text Processing**- AI for Electronic Health Records (EHRs) and Clinical Documentation, Named Entity Recognition (NER) for Medical Terms, AI Chatbots & Virtual Assistants in Healthcare, NLP in Drug Discovery and Biomedical Research, Case study: AI-powered Medical Text Analysis System.	**10**
V	**Ethical Considerations and Future Trends**- AI-driven Personalized Medicine & Genomics, AI in Robotics and Surgical Assistance, Blockchain for Secure AI-driven Medical Data Management, Regulatory Frameworks (HIPAA, GDPR, FDA Guidelines), Bias, Explainability, and Ethical Challenges in AI Healthcare, Future Trends and Career Opportunities in AI & Healthcare.	**9**
	Total Hours	**45**

ASSESSMENT PATTERN

Continuous Assessment

Attendance : 10 marks

Continuous Assessment Tests	:	25 marks
Assignment	:	15 marks
Total	:	**50 marks**
End Semester Examination	:	**100 marks**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS2U41E	**Game Theory in Artificial Intelligence**	**PEC**	**2**	**1**	**0**	**3**	**2022**

COURSE OVERVIEW

This course provides a comprehensive introduction to Game Theory and its applications in Artificial Intelligence (AI). It explores fundamental game-theoretic principles such as Nash equilibrium, decision-making strategies, multi-agent interactions, and reinforcement learning in game environments. The course emphasizes both theoretical concepts and practical implementations, enabling students to apply game-theoretic approaches in AI-driven decision-making, robotics, cybersecurity, and economic model

COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO1	Explain the fundamental concepts of game theory and its relevance to AI	Understand
CO2	Explain different types of games and equilibria used in AI.	Understand
CO3	Explain the foundational concepts in mechanism design and social choice theory	Understand
CO4	Apply the principles of VCG mechanisms and optimal mechanism design to problems such as combinatorial allocations, Internet advertising, and single- and multi-agent auctions	Apply
CO5	Apply game theory concepts in AI applications such as economics, robotics, and cybersecurity.	Apply

SYLLABUS

Fundamentals of Game Theory and its applications in Artificial Intelligence (AI), focusing on strategic decision-making in multi-agent systems. Key topics include types of games, Nash equilibrium, Minimax strategies, Bayesian games, and mechanism design, VCG Mechanism and AI applications in Game theory

TEXTBOOKS

1 Martin Osborne, An Introduction to Game Theory, Cambridge University Press , Ist Edition, 2004

2 Y. Narahari, Game Theory and Mechanism Design, World Scientific and IISc Press, Ist Edition, 2013

REFERENCES

1 William Spaniel Self , Game Theory 101:The Complete Textbook , Ist Edition, 2011

2 Steven Tadelis, Game Theory - An Introduction ,Princeton University Press Ist Edition, 2013

COURSE PLAN

Module	Contents	Hours
I	Introduction to Game Theory - Competitive equilibrium, Rationality; Strategic Games - Dominance, Nash equilibrium, Maxmin strategies, elimination of dominated strategies, preservation of pure Nash equilibrium (PSNE), matrix games, relation between maxmin and PSNE in matrix games Mixed strategies, mixed strategy Nash equilibrium (MSNE), finding MSNE, MSNE characterization theorem, algorithm to find MSNE	**9**
II	Correlated equilibrium (CE) - Computing CE, extensive form games, subgame perfection, limitations of subgame perfect Nash equilibrium; Imperfect information extensive form games (IIEFG) - strategies in IIEFGs, equivalence of strategies in IIEFGs, perfect recall, Equilibrium in IIEFG; Game theory application - P2P file sharing; Bayesian games - strategy and utility in Bayesian games, equilibrium in Bayesian games.	**9**
III	Introduction to mechanism design - revelation principle, introduction and proof of Arrow's impossibility result, introduction to social choice setup; Introduction and proof of Gibbard-Satterthwaite theorem, domain restriction, median voter theorem; Task sharing domain, uniform rule, mechanism design with transfers, examples of quasi-linear preferences, Pareto optimality and Groves payments	**9**
IV	Introduction to VCG mechanism-VCG in Combinatorial allocations, applications to Internet advertising, slot allocation and payments in position auctions, pros and cons of VCG mechanism; Affine maximizers, single object allocation, Myerson's lemma, optimal mechanism design; Single and multi-agent optimal mechanism design, examples of optimal mechanisms	**9**
V	AI Applications of Game Theory: AI in Economics: Pricing, Market Equilibria, and Auctions, Game Theory for AI Security and Cybersecurity,AI for Social Good: Fairness and Ethics in AI ,Game Theory in Autonomous Vehicles and Robotics , Future Trends: AI-driven Decision Systems and Strategic Thinking	**9**
	Total Hours	**45**

ASSESSMENT PATTERN

Continuous Assessment

Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignment	:	15 marks
Total	:	**50 marks**
End Semester Examination	:	**100 marks**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U41F	**NATURAL LANGUAGE PROCESSING**	**PEC**	**2**	**1**	**0**	**3**	**2020**

COURSE OVERVIEW

This course enables the learners to understand the concepts of Natural Language Processing. The course covers basic pre-processing steps, language models, text classification using machine learning algorithms, information and relation extraction methods, Information Retrieval, Question Answer Systems and Machine Translation models. This course enables the students to apply techniques and methods to solve challenging real-world problems in NLP.

COURSE OUTCOMES

After the completion of the course the student will be able to

Course Outcomes	Description	Level
CO1	Summarize basic concepts and learning methods for NLP	Understand
CO2	Demonstrate the relevance of pre-processing methods on text data.	Apply
CO3	Compare different language modelling techniques.	Apply
CO4	Make use of NLP techniques in Text Classification and Information Retrieval	Apply
CO5	Explain Information Extraction, Relation Detection, QA Systems and Machine Translation**.**	Understand

SYLLABUS

Introduction to NLP: NLP Tasks and Applications, Language-Building Blocks, Challenges of NLP, Machine Learning for NLP – Naïve Bayes Classifier, Logistic Regression, Support Vector Machines, Approaches to NLP-- Heuristics-Based NLP, Machine Learning-based NLP.

Pre-processing and Representation Models: NLP System Pipeline--Steps--Data Acquisition, Text Extraction and Clean-up, Pre-processing, Feature Engineering, Modelling, Evaluation, Post-Modelling Phases.Text Representation--Vector Space Models--Basic Vectorization Approaches--One-Hot Encoding, Bag of Words, Bag of N-Grams TF-IDF; Distributed Representations-- Word Embeddings, Doc2Vec.

Classification and Information Extraction: Text Classification--Text classification applications – Pipeline for building text classification systems, Naïve Bayes for Sentiment Classification – Naïve Bayes Classifier Training –Optimizing for Sentiment Analysis, Logistic Regression, Support Vector Machine for Text Classification.Information Extraction(IE)—IE Applications – The General Pipeline for IE - Named Entity Recognition(NER), Ambiguity in Named Entity Recognition – NER as Sequence Labeling –Evaluation of NER.

Relation Detection and Information Retrieval: Relation Detection and Classification – Supervised Learning Approaches to Relation Analysis –Lightly Supervised Approaches to Relation Analysis – Evaluation of Relation Analysis systems.Information Retrieval – Term weighting and document scoring – Inverted Index – Evaluation of Information Retrieval Systems.

QA Systems and Machine Translation: Question-Answering Systems – Factoid Question Answering – Question Processing – Passage Retrieval – Answer Processing – Evaluation of Factoid Answers.Machine Translation – Why Machine Translation is Hard – Classical Machine Translation – Direct Translation – Transfer – Statistical Machine Translation- The Phrase based Translation model – Alignment in MT – Training Alignment Models – Symmetrizing Alignments for Phrase-based MT – Decoding for Phrase-based Statistical MT

TEXT BOOKS

1. Daniel Jurafsky, James H. Martin , “Speech and Language Processing”(2nd and 3rd editions), Pearson Prentice Hall
2. Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta, Harshit Surana,” Practical Natural Language Processing: A Comprehensive Guide to Building Real-World NLP Systems “ June 2020 Publisher(s): O'Reilly Media, Inc. ISBN: 9781492054054.

REFERENCES

1. James Allen, “Natural Language Understanding”, Second Edn , Pearson.
2. Christopher Manning and Hinrich Schutze, Statistical Natural Language Processing, MIT Press.

COURSE PLAN

Module	Contents	No.of Hours
1	**Introduction to NLP** Introduction to NLP – Tasks and Applications, Language – Building Blocks, Challenges of NLP, Approaches to NLP - Heuristics-Based NLP, Machine Learning for NLP, Machine Learning for NLP – Naïve Bayes Classifier, Logistic Regression, Support Vector Machines – Linearly Separable Data,	**9**

	Support Vector Machines – Linearly Inseparable Data	
2	**Pre-processing and Representation Models** NLP System Pipeline – Stages – Overview, Data Acquisition, NLP System Pipeline – Text Extraction and Cleanup, NLP System Pipeline – Preprocessing - Sentence segmentation, Word tokenization, Stemming and lemmatization, Feature Engineering, Model Building, Evaluation – Metrices, Post-modeling phase, Text Representation – Vector Space Model, Vectorization Approaches – One hot encoding, Bag of words, Bag of n-grams, TF-IDF, Word Embeddings – Word2Vec- CBOW, SkipGram models	9
3	**Classification and Information Extraction** Text Classification--Text classification applications -Pipeline for building text classification systems, Sentiment Analysis using Naïve Bayes Classifier, Case Studies for Text Classification using Logistic Regression and Support Vector Machines, Information Extraction (IE) and Applications, IE Tasks and the IE Pipeline, Named Entity Recognition (NER) – Ambiguity in NER, NER as Sequence Labeling, Evaluation of NER, Practical NER Systems	9
4	**Relation Detection and Information Retrieval** Relation Detection and Classification – Supervised Learning Approaches to Relation Analysis, Relation Detection and Classification – Lightly Supervised Approaches to Relation Analysis, Relation Detection and Classification -Evaluation of Relation Analysis systems, Information Retrieval – Term weighting and document scoring, Inverted Index, Evaluation of Information-Retrieval Systems	9
5	**QA Systems and Machine Translation** Question-Answering Systems – Factoid Question Answering, Question Processing, Passage Retrieval, Answer Processing, Evaluation of Factoid Answers, Machine Translation – Why Machine Translation is Hard, Classical Machine Translation , Statistical Machine Translation, The Phrase based Translation model, Alignment in Machine Translation, Decoding for Phrase-based Statistical MT	9
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS2U41F	Cloud Data Management	PEC	2	1	0	3	2022

COURSE OVERVIEW

This course covers core principles of cloud data management and examines both current and emerging systems. Topics include modern data processing paradigms, commercial platforms, and open-source NoSQL databases. Students will also explore efforts to classify and benchmark these systems.

COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Explain the fundamentals of cloud computing and data management architectures.	Understand
CO 2	Explain cloud storage technologies and distinguish between SQL and NoSQL data models in the cloud.	Understand
CO 3	Implement big data solutions integrated with cloud services.	Apply
CO 4	Explain security, privacy, and compliance issues in cloud data environments.	Understand

SYLLABUS

Evolution and characteristics of cloud computing, Cloud storage types, Big data characteristics and architecture, security concerns in cloud environments, Security concerns in cloud environments, Serverless data processing.

TEXT BOOKS

1. Thomas Erl, "Cloud Computing: Concepts, Technology & Architecture", Prentice Hall, 2013.
2. Dan C. Marinescu, "Cloud Computing: Theory and Practice", 2nd Edition, Morgan Kaufmann, 2017.
3. Martin Kleppmann, "Designing Data-Intensive Applications", O'Reilly Media, 2017.
4. Rajkumar Buyya et al., "Mastering Cloud Computing", McGraw Hill Education, 2013.
5. AWS / Azure / Google Cloud Official Documentation & Whitepapers (especially useful for hands-on labs and real-world insights)

COURSE PLAN

Module	Contents	Hours

I	Evolution and characteristics of cloud computing, Cloud service models (IaaS, PaaS, SaaS), Cloud deployment models (Public, Private, Hybrid, Community), Introduction to cloud data lifecycle, Overview of leading cloud platforms (AWS, Azure, GCP).	**8**
II	Cloud storage types: Object, Block, and File storage, Data durability, consistency, and availability, Relational databases in the cloud (Amazon RDS, Cloud SQL), Introduction to NoSQL databases (MongoDB, DynamoDB, Cassandra), Data sharding, replication, and scaling in cloud systems.	**10**
III	Big data characteristics and architecture, Map Reduce, Hadoop ecosystem and integration with cloud, Apache Spark on AWS EMR / Dataproc, Real-time data processing with Kafka, AWS Kinesis, Data lakes and data warehouses (Redshift, BigQuery, Snowflake).	**10**
IV	Security concerns in cloud environments, Data encryption: At rest and in transit, Identity and Access Management (IAM), Regulatory compliance: GDPR, HIPAA, ISO/IEC 27001, Cloud backup and disaster recovery strategies.	**9**
V	Serverless data processing (AWS Lambda, Azure Functions), Edge computing and IoT data management, Multi-cloud and hybrid-cloud strategies.	**8**
	Total Hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of introduction
CS0U41A	INTRODUCTION TO MOBILE COMPUTING	OEC	2	1	0	3	2022

COURSE OVERVIEW

The purpose of this course is to prepare learners to understand the functionalities and design considerations of mobile computing. The course content is designed to cover the mobile computing architecture, features of different communication systems and major elements of mobile security and next generation computer systems. This course enables the learners to acquire advanced concepts on mobile and ad-hoc networks.

COURSE OUTCOMES

After the completion of the course the student will be able to

Course Outcomes	Description	Level
CO1	Describe the mobile computing applications, services, design considerations and architectures	Understand
CO2	Identify the technology trends for cellular wireless networks **.**	Understand
CO3	Summarize the Short Messaging Service and General Packet Radio Service	Understand
CO4	Outline the LAN technologies used in mobile communication.	Understand
CO5	Describe the security protocols and apply suitable security algorithm to secure the communication .	Apply
CO6	Explain the fundamental concepts of next generation mobile networks**.**	Understand

SYLLABUS

Mobile Computing Architecture: Introduction to mobile computing – Functions, Devices, Middleware and gateways, Applications and services, Limitations. Mobile computing architecture – Internet: The ubiquitous network, Three-tier architecture, Design considerations for mobile computing.

Communication Systems: Mobile computing through telephony - Evolution of telephony, Multiple access procedures - Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), Code Division Multiple Access (CDMA), Space Division Multiple Access (SDMA). Satellite communication systems – Basics, Applications, Geostationary Earth Orbit (GEO), Low Earth Orbit (LEO), Medium Earth Orbit (MEO), Satellite phones. Mobile computing through telephone – Interactive Voice Response (IVR) architecture, Overview of voice software, Developing an IVR application. Global System for Mobile Communication (GSM) - Introduction, Architecture, Entities, Call routing, Mobility management, Frequency allocation, Authentication and security.

Short Messaging Service and General Packet Radio Service: Short Message Service (SMS) – Strengths, Architecture, Value added services, Accessing the SMS bearer. General Packet Radio Service (GPRS) – Architecture, Network operations, Data services, Applications, Limitations, Billing and charging.

Wireless Local Area Networks: Wireless Local Area Network (WLAN) - Advantages, Evolution, Applications, Architecture, Mobility, Security, Deploying WLAN. Wireless Local Loop (WLL) – Architecture. High Performance Radio Local Area Network (HIPERLAN). WiFi Vs 3G.

Mobile Security and Next Generation Networks: Security issues in mobile computing - Information security, Security techniques and algorithms, Security protocols. Next generation networks – The Converged Scenario, Narrowband to broadband, Orthogonal Frequency Division Multiplexing (OFDM), Multi Protocol Label Switching (MPLS), Wireless Asynchronous Transfer Mode (WATM), Multimedia broadcast services.

TEXT BOOKS

1. Asoke K. Talukder, Hasan Ahmad, Roopa R Yavagal, Mobile Computing Technology- Application and Service Creation, 2nd Edition, McGraw Hill Education.
2. Schiller J., Mobile Communications, 2/e, Pearson Education, 2009

REFERENCES

1. Andrew S. Tanenbaum, Computer Networks, 6/e, PHI.
2. Theodore S. Rappaport, Wireless Communications Principles and Practice, 2/e, PHI, New Delhi, 2004.
3. Curt M. White, Fundamentals of Networking and Communication 7/e, Cengage learning.

COURSE PLAN

Module	Contents	No.of Hours
1	**Mobile Computing Architecture** Introduction to mobile computing – Functions, Devices, Middleware and gateways, Applications, services, limitations, Internet: The ubiquitous network, Three-tier architecture (Lecture 1), Three-tier architecture (Lecture 2), Design considerations for mobile computing (Lecture 1), Design considerations for mobile computing (Lecture 2)	9

2	**Communication Systems** Evolution of telephony, Multiple access procedures –FDMA, TDMA, CDMA, SDMA, Satellite communication systems – GEO, MEO, LEO, Satellite phones, Interactive Voice Response (IVR) architecture, Overview of voice software, Developing an IVR application (Call flow diagram), Introduction to GSM,Architecture, GSM entities, Call routing, Mobility management, Frequency allocation, Authentication and security	9
3	**Short Messaging Service and General Packet Radio Service** SMS Strengths, Architecture, Short Message Mobile Terminated (SM MT) and Short Message Mobile Originated (SM MO) messages, SMS Architecture - Operator-centric pull, operator-independent push/pull, Value added services, Accessing the SMS bearer (Lecture 1), Accessing the SMS bearer (Lecture 2), GPRS architecture, Network operations Data services, Applications,Limitations, Billing and charging	9
4	**Wireless Local Area Networks** WLAN Advantages, Evolution, Applications, WLAN Architecture (Lecture 1), WLAN Architecture (Lecture 2) Mobility, Security, Deploying WLAN, WLL Architecture, HIPERLAN, WiFi Vs 3G	9
5	**Mobile Security and Next Generation Networks** Information security – Attacks, Components, Security techniques and algorithms – Stream Vs Block cipher, Symmetric Vs Asymmetric cryptography, Security techniques and algorithms – RSA, Diffie Hellman Key exchange, Security protocols – Secure Socket Layer, Transport Layer Security, Wireless Transport Layer Security, The Converged Scenario, Narrowband to broadband, Orthogonal Frequency Division Multiplexing (OFDM) and Multi Protocol Label Switching (MPLS), Wireless Asynchronous Transfer Mode (WATM) and Multimedia broadcast services	9
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS0U41B	**Introduction to deep learning**	**OEC**	**2**	**1**	**0**	**3**	**2022**

COURSE OVERVIEW

This course aims to introduce the learner to an overview of the concepts and algorithms involved in deep learning. Basic concepts and application areas of machine learning, deep networks, convolutional neural network and recurrent neural network are covered in this course. This is a foundational program that will help students understand the capabilities, challenges, and consequences of deep learning and prepare them to participate in the development of leading-edge AI technology. They will be able to gain the knowledge needed to take a definitive step in the world of AI.

COURSE OUTCOMES

After the completion of the course the student will be able to

Course Outcomes	Description	Level
CO1	Demonstrate basic concepts in machine learning.	Understand
CO2	Illustrate the validation process of machine learning models using hyper-parameters and validation sets.	Understand
CO3	Demonstrate the concept of the feed forward neural network and its training process.	Apply
CO4	Build CNN and Recurrent Neural Network (RNN) models for different use cases.	Apply
CO5	Use different neural network/deep learning models for practical applications.	Apply

SYLLABUS

Introduction: Key components - Data, models, objective functions, optimization algorithms, Learning algorithms. Supervised learning- regression, classification, tagging, web search, page ranking, recommender systems, sequence learning, Unsupervised learning, Reinforcement learning, Historical Trends in Deep Learning. Other Concepts - overfitting, underfitting , hyperparameters and validation sets, estimators, bias and variance.

Optimization and Neural Networks: Neural Networks –Perceptron, Gradient Descent solution for Perceptron, Multilayer perceptron, activation functions, architecture design, chain rule, back propagation, gradient based learning. Introduction to optimization– Gradient based optimization, linear least squares. Stochastic gradient descent, Building ML algorithms and challenges.

Convolutional Neural Network: Convolutional Neural Networks – convolution operation, motivation, pooling, Convolution and Pooling as an infinitely strong prior, variants of convolution functions, structured outputs, data types, efficient convolution algorithms.

Recurrent Neural Network: Recurrent neural networks – Computational graphs, RNN design, encoder – decoder sequence to sequence architectures, deep recurrent networks, recursive neural networks, modern RNNs LSTM and GRU, Practical use cases for RNNs.

Application Areas: Applications – computer vision, speech recognition, natural language processing. Research Areas – Autoencoders, Representation learning, Boltzmann Machines, Deep belief networks.

TEXT BOOKS

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press 2015 ed.
2. Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, Dive into Deep Learning, August 2019.
3. Neural Networks and Deep Learning: A Textbook by Charu C. Aggarwal. Springer.1st edition, 2018.

REFERENCE BOOKS

1. Neural Smithing: Supervised Learning in Feed forward Artificial Neural Networks by Russell Reed, Robert J MarksII, 1st edition, 1999, MIT Press.
2. Practical Convolutional Neural Networks by Mohit Sewak, Md. Rezaul Karim, Pradeep Pujari, 1st edition, 2018, Packt Publishing Ltd.
3. Hands-On Deep Learning Algorithms with Python by Sudharsan Ravichandran, 1st edition, 2019, Packt Publishing Ltd.
4. Deep Learning with Python by Francois Chollet, 2nd edition, 2018, Manning Publications

COURSE PLAN

Module	Contents	No.of Hours
1	**Introduction** Key components - Data, models, objective functions, optimization algorithms, Learning algorithm, Supervised learning- regression, classification, tagging, web search, page ranking ,Recommender systems, Sequence learning, Unsupervised learning, Reinforcement learning, Historical Trends in Deep Learning. Concepts: overfit, underfit, hyperparameters and validation sets., Concepts: Estimators, bias and variance., Demonstrate the concepts of supervised learning algorithms using a suitable platform, Demonstrate the concepts of unsupervised using a suitable	9

	platform.	
2	**Optimization and Neural Networks** Perceptron, Stochastic Gradient descent, Gradient descent solution for perceptron ,Multilayer perceptron, , Activation functions- Sigmoid, tanh, Softmax, ReLU, leaky ReLU Architecture design, Chain rule, back propagation,Gradient based learning, Gradient based optimization, Linear least squares using a suitable platform. Building ML Algorithms and Challenges	9
3	Convolution Neural Network Convolution operation, Motivation, pooling ,Convolution and Pooling as an infinitely strong prior ,Variants of convolution functions – multilayer convolutional network, tensors, kernel flipping, downsampling, strides and zero padding. Variants of convolution functions - unshared convolutions, tiled convolution, training different networks.,Structured outputs, data types, Efficient convolution algorithms., Case Study: AlexNet, VGG, ResNet.	9
4	Recurrent Neural Network Computational graphs, RNN ,Encoder – decoder sequence to sequence architectures. Deep recurrent networks .Recursive neural networks , Modern RNNs, LSTM and GRU, Practical use cases for RNNs, Demonstrate the concepts of RNN using a suitable platform.	9
5	**Applications and Research** Computer vision. Speech recognition, Natural language processing., Brief introduction on current research areas- Autoencoders, Representation learning. Brief introduction on current research areas- Boltzmann Machines, Deep belief networks.	9
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS0U41C	COMPUTER GRAPHICS	OEC	2	1	0	3	2020

COURSE OVERVIEW

This course helps the learners to make awareness about strong theoretical concept in computer graphics. It covers the three-dimensional environment representation in a computer, transformation of 2D/3D objects and basic mathematical techniques and algorithms used to build applications. This course enables the learners to develop the ability to create image processing frameworks for different domains and develop algorithms for emerging display technologies.

COURSE OUTCOMES

After the completion of the course the student will be able to

Course Outcomes	Description	Level
CO1	Describe the working principles of graphics devices**.**	Understand
CO2	Illustrate line drawing, circle drawing and polygon filling algorithms**.**	Apply
CO3	Demonstrate geometric representations and transformations on 2D & 3D objects	Apply
CO4	Demonstrate the working of line and polygon clipping algorithms	Apply
CO5	Summarize visible surface detection methods and illustrate projection algorithms.	Apply

SYLLABUS

Basics of Computer Graphics: Basics of Computer Graphics and its applications. Video Display devices- Refresh Cathode Ray Tubes(CRT), Random Scan Displays and systems, Raster scan displays and systems, Color CRT displays, Flat panel display and its categories.

Line drawing, Circle drawing and Filled Area Primitives: Line drawing algorithms- DDA, Bresenham's algorithm. Circle drawing algorithms- Midpoint Circle generation algorithm, Bresenham's algorithm. Filled Area Primitives- Scan line polygon filling, Boundary filling and flood filling.

Geometric transformations: Two dimensional transformations -Translation, Rotation, Scaling, Reflection and Shearing, Composite transformations, Matrix representations and homogeneous coordinates. Basic 3D transformations.

Clipping: Window to viewport transformation. Cohen Sutherland and Midpoint subdivision line clipping algorithms, Sutherland Hodgeman and Weiler Atherton Polygon clipping algorithms.

Three dimensional graphics: Three dimensional viewing pipeline. Projections- Parallel and Perspective projections. Visible surface detection algorithms- Back face detection, Depth buffer algorithm, Scan line algorithm, A buffer algorithm

TEXT BOOKS

1. Zhigang Xiang and Roy Plastock, Computer Graphics (Schaum's outline Series), McGraw Hill, 2019.
2. Donald Hearn and M. Pauline Baker, Computer Graphics, PHI, 2e, 1996

REFERENCES

1. William M. Newman and Robert F. Sproull, Principles of Interactive Computer Graphics. McGraw Hill, 2001
2. David F. Rogers , Procedural Elements for Computer Graphics, Tata McGraw Hill,2001.
3. Donald Hearn, M. Pauline Baker and Warren Carithers, Computer Graphics with OpenGL, PHI, 4e, 2013

COURSE PLAN

Module	Contents	No.of Hours
1	**Basics of Computer Graphics** Basics of Computer Graphics and applications, Refresh Cathode Ray Tubes, Random Scan Displays and systems, Raster scan displays and systems, Color CRT displays Flat panel display and its categories.	9
2	**Line drawing, Circle drawing and Filled Area Primitives** DDA Line drawing Algorithm, Bresenham's line drawing algorithm, Midpoint Circle generation algorithm, Bresenham's Circle generation algorithm, Illustration of line drawing and circle drawing algorithms, Scan line polygon filling, Boundary filling and flood filling	9
3	**Geometric transformations** Basic 2D transformations-Translation and Rotation, Basic 2D transformations-Scaling, Reflection and Shearing, Illustration of 2D Transformations, Composite transformations, Matrix representations and homogeneous coordinates, Basic 3D transformations, Illustration of basic 3D transformations	9
4	**2D Clipping** Window to viewport transformation, Cohen Sutherland Line clipping algorithm, Midpoint subdivision Line clipping algorithm Sutherland Hodgeman Polygon clipping algorithm, Weiler Atherton Polygon clipping algorithm, Practice problems on Clipping algorithms	9
5	**Three dimensional graphics** Three dimensional viewing pipeline, Projections-Parallel projections, Projections- Perspective projections, Visible surface detection algorithms-Back face detection., Depth buffer algorithm, Depth buffer algorithm, Scan line visible surface detection algorithm, Scan line visible surface detection algorithm, A buffer algorithm	9
	Total hours	**45**

ASSESSMENT PATTERN

Continuous Assessment		
Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks

Assignment	:	15 marks
Total	:	**50 marks**
End Semester Examination	:	**100 marks**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS0U41D	Python for Engineers	**OEC**	**2**	**1**	**0**	**3**	**2022**

COURSE OVERVIEW

The objective of the course is to provide learners with an insight into Python programming in a scientific computation context and develop programming skills to solve engineering problems. It covers programming environment, important instructions, data representations, intermediate level features, Object Oriented Programming and file data processing of Python. This course lays the foundation to scientific computing, develop web applications, Machine Learning, and Artificial Intelligence-based applications and tools, Data Science and Data Visualization applications.

COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Write, test and debug Python programs	**Apply**
CO 2	Illustrate uses of conditional (if, if-else, if-elif-else and switch-case) and iterative (while and for) statements in Python programs.	**Understand**
CO 3	Develop programs by utilizing the modules Lists, Tuples, Sets and Dictionaries in Python	**Apply**
CO 4	Implement Object Oriented programs with exception handling	**Apply**
CO 5	Analyze, Interpret, and Visualize data according to the target application	**Apply**
CO 6	Develop programs in Python to process data stored in files by utilizing the module Numpy.	**Apply**

SYLLABUS

Getting Started with Python Programming- Functions and Python Data Structures- Object Oriented Programming)- Visualization and File handling- Scientific Computing

TEXT BOOKS

1. Kenneth A Lambert., Fundamentals of Python : First Programs, 2/e, Cengage Publishing, 2016
2. David J. Pine, Introduction to Python for Science and Engineering, CRC Press, 2021

REFERENCES

1. Wes McKinney, Python for Data Analysis, 2/e, Shroff / O'Reilly Publishers, 2017
2. Michael Urban and Joel Murach, Python Programming, Shroff/Murach, 2016

3. Allen B. Downey, Think Python: How to Think Like a Computer Scientist, 2/e, Schroff, 2016

COURSE PLAN

Module	Contents	Hours
I	Getting Started with Python Programming - Running code in the interactive shell, Editing, Saving, and Running a script. Using editors - IDLE, Jupyter. Basic coding skills - Working with data types, Numeric data types and Character sets, Keywords, Variables and Assignment statement, Operators, Expressions, Working with numeric data, Type conversions, Comments in the program, Input Processing, and Output, Formatting output. How Python works. Detecting and correcting syntax errors. Using built in functions and modules in math module. Control statements - Selection structure - if-else, if-elif-else. Iteration structure - for, while. Testing the control statements. Lazy evaluation.	**9**
II	Functions - Hiding redundancy and complexity, Arguments and return values, Variable scopes and parameter passing, Named arguments, Main function, Working with recursion, Lambda functions. Strings - String function. Lists - Basic list Operations and functions, List of lists, Slicing, Searching and sorting list, List comprehension. Work with tuples. Sets. Dictionaries - Dictionary functions, dictionary literals, adding and removing keys, accessing and replacing values, traversing dictionaries, reverse lookup.	**9**
III	Design with classes - Objects and Classes, Methods, Instance Variables, Constructor, Accessors and Mutators. Structuring classes with Inheritance and Polymorphism. Abstract Classes. Exceptions - Handle a single exception, Handle multiple exceptions.	**9**
IV	Plotting - An Interactive Session with PyPlot, Basic Plotting, Logarithmic Plots, More Advanced Graphical Output, Plots with multiple axes, Mathematics and Greek symbols, The Structure of matplotlib, Contour and Vector Field Plots. File Processing - The os and sys modules, Introduction to file I/O, Reading and writing text files, Working with CSV files.	**9**
V	Numerical Routines. SciPy and NumPy - Basics, Creating arrays, Arithmetic, Slicing, Matrix Operations, Special Functions, Random Numbers, Linear Algebra, Solving Nonlinear Equations, Numerical Integration, Solving ODEs. Data Manipulation and Analysis – Pandas : Reading Data from Files Using Pandas, Data Structures: Series and DataFrame, Extracting Information from a DataFrame, Grouping and Aggregation.	**9**
	Total Hours	**45**

ASSESSMENT PATTERN

Continuous Assessment		
Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignment	:	15 marks
Total	:	**50 marks**
End Semester Examination	:	**100 marks**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS0U41E	Object Oriented Concepts	OEC	2	1	0	3	**2022**

COURSE OVERVIEW

The purpose of this course is to enable learners to solve problems by breaking it down to object level while designing software and to implement it using Java. This course covers Object Oriented Principles, Object Oriented Programming in Java, Exception handling, Event handling, multithreaded programming and working with window-based graphics. This course provides learners the basics to develop Mobile applications, Enterprise Applications, Scientific Applications and Web based Applications.

COURSE OUTCOMES

After the completion of the course the student will be able to

Course Outcomes	Description	Level
CO1	Develop Java programs using the object-oriented concepts - classes, objects, constructors, data hiding, inheritance and polymorphism.	Apply
CO2	Utilize data types, operators, control statements, built in packages & interfaces, Input/output Streams and Files in Java to develop programs **.**	Apply
CO3	Illustrate how robust programs can be written in Java using exception handling mechanism	Apply
CO4	Develop application programs in Java using multithreading **.**	Apply
CO5	Develop Graphical User Interface based application programs by utilizing event handling features and Swing in Java	Apply

SYLLABUS

Object Orientation and Java basics: Object Orientation Principles – Object and Class, Data abstraction and Encapsulation, Inheritance, Polymorphism, Dynamic binding, Message communication, Benefits of using Object orientation.Introduction to Java - Java programming Environment and Runtime Environment, Development Platforms -Standard, Enterprise. Java Virtual Machine (JVM), Java compiler, Bytecode, Java applet, Java Buzzwords, Java program structure, Comments, Garbage Collection, Lexical Issues.Primitive Data types - Integers, Floating Point Types, Characters, Boolean. Literals, Type Conversion and Casting, Variables, Arrays, Strings, Vector class.

Core Java Fundamentals: Operators - Arithmetic Operators, Bitwise Operators, Relational Operators, Boolean Logical Operators, Assignment Operator, Conditional (Ternary) Operator, Operator Precedence.

Control Statements - Selection Statements, Iteration Statements and Jump Statements. Object Oriented Programming in Java - Class Fundamentals, Declaring Objects, Object Reference, Introduction to Methods, Constructors, ***this*** Keyword, Method Overloading, Using Objects as Parameters, Returning Objects, Recursion, Access Control, Static Members, Command-Line Arguments, Variable Length Arguments.

More features of Java: Inheritance - Super Class, Sub Class, The Keyword ***super***, protected Members, Calling Order of Constructors, Method Overriding, the Object class, Abstract Classes and Methods, Using ***final*** with Inheritance.Packages and Interfaces - Defining Package, CLASSPATH, Access Protection, Importing Packages, Interfaces.Exception Handling - Checked Exceptions, Unchecked Exceptions, ***try*** Block and ***catch*** Clause, Multiple ***catch*** Clauses, Nested ***try*** Statements, ***throw***, ***throws*** and ***finally***.

Advanced features of Java: Input/Output - I/O Basics, Reading Console Input, Writing Console Output, PrintWriter Class, Reading and Writing Files.Java Library - String Handling – String Constructors, String Length, Special String Operations -Character Extraction, String Comparison, Searching Strings, Modifying Strings, Using valueOf(), Comparison of String Buffer and String.

GUI Programming, Event Handling and Multithreaded Programming: Multithreaded Programming - The Java Thread Model, The Main Thread, Creating Thread, Creating Multiple Threads, Suspending, Resuming and Stopping Threads.Event Handling - Event Handling Mechanisms, Delegation Event Model, Event Classes, Sources of Events, Event Listener Interfaces, Using the Delegation Model.Swing Fundamentals - Swing Key Features, Model View Controller (MVC), Swing Controls, Components and Containers, Exploring Swing - JFrame, JLabel, JButton, JTextField.

TEXT BOOKS

1. Schildt, Java: The Complete Reference, 8/e, Tata McGraw Hill, 2011.
2. Balagurusamy E., Programming JAVA a Primer, 5/e, McGraw Hill, 2014.

REFERENCES

1. Paul Deitel, Harvey Deitel, Java How to Program, Early Objects 11/e, Pearson, 2018.
2. Y. Daniel Liang, Introduction to Java Programming, 7/e, Pearson, 2013.
3. Nageswararao R., Core Java: An Integrated Approach, Dreamtech Press, 2008.

4. Flanagan D., Java in A Nutshell, 5/e, O'Reilly, 2005.
5. Sierra K., Head First Java, 2/e, O'Reilly, 2005.

COURSE PLAN

Module	Contents	No.of Hours
1	**Object Orientation and Java basics** Object Orientation Principles – Object and Class, Data abstraction and Encapsulation, Inheritance, Polymorphism, Dynamic binding, Message communication, Benefits of using Object orientation, Java programming Environment and Runtime Environment, Development Platforms -Standard, Enterprise. JVM, Java compiler, Bytecode, Java applet, Java Buzzwords, Java program structure, Comments, Garbage Collection, Lexical Issues, Primitive Data types - Integers, Floating Point Types, Characters, Boolean, Literals, Type Conversion and Casting, Variables, Arrays, Strings, Vector class	9
2	**Core Java Fundamentals** Operators - Arithmetic Operators, Bitwise Operators, Relational Operators, Boolean Logical Operators, Assignment Operator, Conditional (Ternary) Operator, Operator Precedence, Control Statements - Selection Statements, Iteration Statements and Jump Statements, Object Oriented Programming in Java - Class Fundamentals, Declaring Objects, Object Reference, Introduction to Methods, Constructors, this Keyword, Method Overloading, Using Objects as Parameters, Returning Objects, Recursion, Access Control, static Members, Command-Line Arguments, Variable Length Arguments	9
3	**More features of Java** Inheritance - Super class, Sub class, the keyword super, protected Members, Calling Order of Constructors, Method Overriding, the Object class, Abstract Classes and Methods, Using final with Inheritance, Packages and Interfaces - Defining Package, CLASSPATH, Access Protectio, Importing Packages, Interfaces, Exception Handling - Checked Exceptions, Unchecked Exceptions, try Block and catch Clause, Multiple catch Clauses, Nested try Statements, throw, throws and finally	9
4	**Advanced features of Java** Input/Output - I/O Basics, Reading Console Input, Writing Console Output, PrintWriter Class, Working with Files (Lecture-1), Working with Files (Lecture-2), Java Library - String Handling – String Constructors, String Length, Special String Operations - Character Extraction, String Comparison, Searching Strings, Modifying Strings, Using valueOf( ), Comparison of StringBuffer and String.	9
5	**GUI Programming, Event Handling and Multithreaded Programming** Multithreaded Programming - The Java Thread Model, The Main Thread, Creating Thread, Creating Multiple Threads, Suspending, Resuming and Stopping Threads, Event handling - Event Handling Mechanisms, Delegation Event Model, Event Classes,Sources of Events, Event Listener Interfaces, Using the Delegation Model, Swing fundamentals, Swing Key Features, Model View Controller (MVC), Swing Controls, Components and Containers, Exploring Swing –JFrame, JLabel, JButton, JTextField	9
	Total hours	**45**

CS0M 49A	MINI PROJECT	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PWS	0	1	6	4	2020

COURSE OVERVIEW

The objective of this course is to apply the fundamental concepts of different courses learned in respective Minor Streams: Software Engineering, Machine Learning and Networking. This course helps the learners to get an exposure to the development of application software/hardware solutions/ software simulations in the field of Computer Science and Engineering. It enables the learners to understand the different steps to be followed such as literature review and problem identification, preparation of requirement specification & design document, testing, development and deployment. Mini project enables the students to boost their skills, widen the horizon of thinking and their ability to resolve real life problems.

COURSE OUTCOMES

After the completion of the course the student will be able to

Course Outcomes	Description	Level
CO1	Identify technically and economically feasible problems	Apply
CO2	Identify and survey the relevant literature for getting exposed to related solutions.	Apply
CO3	Perform requirement analysis, identify design methodologies and develop adaptable & reusable solutions of minimal complexity by using modern tools & advanced programming techniques	Apply
CO4	Prepare technical report and deliver presentation	Apply
CO5	Apply engineering and management principles to achieve the goal of the project	Apply

COURSE PLAN

Students are expected to follow the following steps.

1. Review of Literature and Identification of a problem
2. Create an abstract with a problem statement, solution approach, technology stack, team, etc.
3. Create Requirements Specification
4. Create Design Document . This may include designs like,
    a. System Architecture Design
    b. Application Architecture Design
    c. GUI Design
    d. API Design
    e. Database Design
    f. Technology Stack
5. Deployment, Test Run & Get Results
6. Prepare Project Report

Semester VIII

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS2U40B	**Generative AI**	**PCC**	**2**	**1**	**0**	**3**	**2022**

i) COURSE OVERVIEW

The Generative AI (GenAI) syllabus covers the key concepts, models, and tools behind AI systems that create new content, such as text, images, audio, and code. It begins with foundational knowledge of classical AI and machine learning, providing context for how GenAI differs in its goal to generate rather than just predict or classify. Students explore foundational language models like GPT, BERT, and T5, learning how these models are trained and applied in real-world tasks. Retrieval-Augmented Generation (RAG), a technique that enhances GenAI outputs with up-to-date or domain-specific information from external sources. **P**rompt engineering—designing effective inputs to steer model outputs. Through hands-on practice and conceptual learning, the syllabus aims to equip students with the skills to build, evaluate, and apply GenAI systems responsibly and creatively across different domains.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Understand the principles and concepts behind generative AI models	Undersatnd
CO2	Apply different architectures used in large language models.	Apply
CO3	Develop the ability to explore and analyze word embeddings, perform vector arithmetic to investigate word relationships, visualize embeddings using dimensionality reduction techniques	Apply
CO4	Apply the fundamentals of Stable Diffusion and other generative tools to create images and videos	Apply
CO5	Apply prompt engineering skills to real-world scenarios, such as information retrieval, text generation.	Apply

iii) SYLLABUS

Overview of Classical Machine Learning and Artificial Intelligence
Difference between Gen AI and other types of AI, advantages, and disadvantages of Gen AI technologies Foundational Language Models Retrieval Augmented Generation RAG Frame work Generative Text and Speed Models Generative Image models Prompt Engineering

iv) a) 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

b) REFERENCES

1. **Foster, D.** (2023). Generative Deep Learning: Teaching Machines to Paint, Write,

Compose, and Play (2nd ed.). O'Reilly Media. ISBN: 978-1-098-13418-1.

2. **Tunstall, L., von Werra, L., & Wolf, T.** (2022). *Natural Language Processing with Transformers: Building Language Applications with Hugging Face*. O'Reilly Media. ISBN: 978-1-098-10324-8

v) COURSE PLAN

Module	Contents	No. of hours
I	**Overview of Classical Machine Learning and Artificial Intelligence** Data Types and State of the Art models Tabular Data - Gradient Boosted Models Image Data - Convolutional Neural Networks Sequential and Time Series Data - Recurrent Neural Networks Text and Speech Data - Transformers Generative AI- GPT class of Models for Text, Diffusion for Images/Video Difference between Gen AI and other types of AI, advantages, and disadvantages of Gen AI technologies	9
II	**Foundational Language Models** LLAMA3 Instruct 8B / 70B. LLAMA3 Chat, LLAMA3 code ,E5 embedding ,MIXTRAL 8X7B , SLMs (PHI3, bitNet B1.58) LLM fine tuning -Para Efficient Fine tune (LORA, P tuning, finetuning of embedding models) **Retrieval Augmented Generation** Alignment- RLHF, DPO. RPO. RAGs -Advanced ingestion, Chunking, Embedding, Search. Ranking, Generation. Evaluation, **RAG frameworks** LLANGCHAIN basics, LLAMAINDEX ,LLANGRAPH	9
III	**Generative Text and Speed Models** Tokenization Fundamentals and Byte Pair Encoding, GPT class of models to Generate Text,Training GPT Models,Speech Models,Interacting with Trained Models	9
IV	**Generative Image models** Stable Diffusion Fundamentals,Image and Video Generation,Tools for Generating Images. GenAI Use cases	9
V	**Agentic AI, Retrieval Augmented Generation, and Advanced Prompt Engineering** Vector Data Base,LangChain with RAG and LLM Agents,Advanced Prompting Strategies (e.g., CoT, ReAct, DSP) Basic Prompting to Build AI Applications, Hosting GenAI	9
	Total	**45**

ASSESSMENT PATTERN

Continuous Assessment		
Attendance	:	10 marks

Continuous Assessment Tests	:	25 marks
Assignment	:	15 marks
Total	:	**50 marks**
End Semester Examination	:	**100 marks**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS2U40C	COMPREHENSIVE COURSE VIVA	PCC	1	0	0	1	2022

COURSE OVERVIEW:

The objective of this Course viva is to ensure the basic knowledge of each student in the most fundamental core courses in the curriculum. The viva voce shall be conducted based on the core subjects studied from third to eighth semester. This course helps the learner to become competent in placement tests and other competitive examinations.

Guidelines

1. The course should be mapped with a faculty and classes shall be arranged for practicing questions based on the core courses listed in the curriculum.
2. The viva voce will be conducted by the same three member committee assigned for final project phase II evaluation. It comprises of Project coordinator, expert from Industry/research Institute and a senior faculty from a sister department.
3. The pass minimum for this course is 25.
4. The mark will be treated as internal and should be uploaded along with internal marks of other courses.
5. Comprehensive Viva should be conducted along with final project evaluation by the three member committee.

Mark Distribution

Total marks: 50, only CIE, minimum required to pass : **25**

Course Code	Course Name	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
CS2U49C	PROJECT PHASE II	PWS	0	0	12	4	2022

COURSE OVERVIEW

The course 'Project Work' is mainly intended to evoke the innovation and invention skills in a student. The course will provide an opportunity to synthesize and apply the knowledge and analytical skills learned, to be developed as a prototype or simulation. The project extends to 2 semesters and will be evaluated in the 7th and 8th semester separately, based on the achieved objectives. One third of the project credits shall be completed in 7th semester and two third in 8th semester. It is recommended that the projects may be finalized in the thrust areas of the respective engineering stream or as interdisciplinary projects. Importance should be given to address societal problems and developing indigenous technologies.

COURSE OUTCOMES

After successful completion of the course, the students will be able to:

CO1	Model and solve real world problems by applying knowledge across domains	Apply
CO2	Develop products, processes or technologies for sustainable and socially relevant applications	Apply
CO3	Function effectively as an individual and as a leader in diverse teams and to comprehend and execute designated tasks	Apply
CO4	Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms	Apply
CO5	Identify technology/research gaps and propos innovative/creative solutions	Analyze
CO6	Organize and communicate technical and scientific findings effectively in written and oral forms	Apply

Phase 2

TARGETS:

- In depth study of the topic assigned in the light of the report prepared under Phase - I;
- Review and finalization of the approach to the problem relating to the assigned topic.
- Preparing a detailed action plan for conducting the investigation, including teamwork.
- Detailed Analysis/ Modeling / Simulation/ Design/ Problem Solving/Experiment as needed.
- Final development of product/ process, testing, results, conclusions and future directions.
- Preparing a paper for Conference Presentation/ Publication in Journals, if possible.
- Presenting projects in Project Expos conducted by the University at the cluster level and/ or state level as well as others conducted in India and abroad.
- Filing Intellectual Property Rights (IPR) if applicable.
- Preparing a report in the standard format for being evaluated by the Department Assessment Board.
- Final project presentation and viva voce by the assessment board including the external expert.

Evaluation Guidelines & Rubrics

Total: 150 marks (Minimum required to pass: 75 marks).

- Project progress evaluation by guide: 30 Marks.
- Two interim evaluations by the Evaluation Committee: 50 Marks (25 marks for each evaluation).
- Final evaluation by the Final Evaluation committee: 40 Marks
- Quality of the report evaluated by the evaluation committee: 30 Marks

(The evaluation committee comprises HoD or a senior faculty member, Project coordinator and project supervisor. The final evaluation committee comprises of Project coordinator, expert from Industry/research/academic Institute and a senior faculty from a sister department)

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS2U42A	AI for Cyber Security	PEC	2	1	0	3	2022

COURSE OVERVIEW

Machine Learning (ML) is increasingly used in sensitive and time-critical systems such as autonomous driving, cyber physical systems etc. to deliver higher performance and protect the confidentiality of the systems. Though ML based systems can be used to classify various malware attacks and develop intrusion detection systems, these systems are also susceptible to several adversarial attacks. This course covers a systematic approach on developing ML based cybersecurity methodologies. It will also cover adversarial attacks which intentionally forces ML systems to behave unexpectedly. To understand AI & CS systems are being trained to identify malware, execute pattern recognition

COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Summarize the main methods used in artificial intelligence (AI) and Cyber security.	Understand
CO 2	Develop ML models to classify malwares.	Apply
CO 3	Develop Time series model and deep learning for malware detection	Apply
CO 4	Demonstrate the vulnerabilities in ML systems and state methods to address adversarial attacks.	Understand

SYLLABUS

Basics of supervised, unsupervised, and reinforcement learning. Overview on Machine Learning with use cases from cybersecurity, classification of threats, attacks, vulnerabilities, malware, trojans etc. Classification of malware using supervised/unsupervised learning based on signatures and profiling. Decision Tree and context based malicious event detection. Time Series Analysis and Ensemble modelling to detect deviation from normal behaviour, case studies in Reconnaissance detection. Efficient Network Anomaly detection; familiarize with various stages of network attack and address using deep neural networks, develop intrusion detection systems. Adversarial attacks on ML systems, model poisoning, black box attacks, white box attacks, state-of-art research paper reading on deep learning systems.

TEXT BOOKS

1. Hands-on Machine Learning for Cyber Security by Soma Halder, ISBN139781788992282
2. Cryptography and Network Security by - Principles and Practice , Stallings William,(2017), Pearson Publication

REFERENCES

1. Machine Learning and Security by David Freeman, Clarence Chio Publisher: O'Reilly Media, Inc. Release Date: February 2018 ISBN: 9781491979891

2. Malware Data Science by Joshua Saxe with Hillary Sanders, ISBN-10: 1-59327-859-4 ISBN-13: 978-1-59327-859-5 Publisher: William Pollock

COURSE PLAN

Module	Contents	Hours
I	Overview on Machine Learning (ML) - Basics of supervised, unsupervised, and reinforcement learning. Use cases from cybersecurity, classification of threats, attacks, vulnerabilities, malware, trojans etc.	**9**
II	Classification of malware using supervised/unsupervised learning based on signatures and profiling. Decision Tree and context based malicious event detection.	**9**
III	Time Series Analysis and Ensemble modelling to detect deviation from normal behaviour, case studies in Reconnaissance detection.	**9**
IV	Efficient Network Anomaly detection; familiarize with various stages of network attack and address using deep neural networks, develop intrusion detection systems.	**9**
V	Adversarial attacks on ML systems, model poisoning, black box attacks, white box attacks, state-of-art research paper reading on deep learning systems.	**9**
	Total Hours	**45**

ASSESSMENT PATTERN

Continuous Assessment		
Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignment	:	15 marks
Total	:	**50 marks**
End Semester Examination	:	**100 marks**

Course Code	Course Name	Category	L	T	P	Credit	Year of introduction
CS2U42B	**Web Intelligence and Big Data**	**PEC**	**2**	**1**	**0**	**3**	**2022**

Pre-requisite: 23CSL20A Data Structures

COURSE OVERVIEW

This course introduces the foundational and advanced concepts of Web Intelligence and Big Data Analytics. It focuses on AI techniques applied at web scale, data mining from web resources, and analysis using distributed computing tools. Learners will explore real-world applications such as sentiment analysis, natural language processing, recommendation systems, and scalable data analytics using technologies like MapReduce, NoSQL databases, and stream processing.

COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Explain the principles and architecture of Web Intelligence and Big Data platforms	Understand
CO2	Apply data mining and machine learning algorithms for web-based applications	Apply
CO3	Develop scalable data solutions using distributed systems and MapReduce.	Apply
CO4	Apply and visualize streaming data for real-time decision making.	Apply
CO5	Develop Big Data solutions for various application domains.	Apply

SYLLABUS

Web Intelligence: Concepts and Applications, Big Data characteristics – volume, variety, velocity, Evolution of Web Intelligence, Search engines and Web crawling, Inverted indexing and document retrieval, Memory-efficient indexing, Natural language understanding.

MapReduce programming model, Hadoop ecosystem, Parallelization and scalability, Data storage- HDFS, GFS. Introduction to NoSQL databases (MongoDB, Cassandra), Data locality and task scheduling, Sentiment and opinion mining from web content, Real-time processing of web streams, Stream computing engines (Apache Storm, Flink, Spark Streaming).

Classification and clustering on web-scale datasets, Logic-based reasoning and its limitations, Dealing with uncertainty- probabilistic models, Bayesian learning, Applications in recommendation and personalization.

TEXTBOOKS

1. Jure Leskovec, Anand Rajaraman, Jeff Ullman, Mining of Massive Datasets, 3rd Edition, Cambridge University Press, 2020
2. Tom White, Hadoop: The Definitive Guide, 4th Edition, O'Reilly Media, 2015

REFERENCES

1. Jimmy Lin and Chris Dyer, Data-Intensive Text Processing with MapReduce, Morgan & Claypool, 2010
2. Russell, Matthew A., Mining the Social Web, 3rd Edition,O'Reilly Media, 2019

3. Charu C. Aggarwal, Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data, 2nd Edition, Springer, 2011

COURSE PLAN

Module	Contents	No. of hours
I	Web Intelligence- Concepts and Applications, Big Data characteristics – volume, variety, velocity, Evolution of Web Intelligence, Big Data architecture, AI at web-scale, Case study-Online Advertising, NLP, Recommendation Systems.	8
.II	Search engines and Web crawling, Inverted indexing and document retrieval, Memory-efficient indexing. Natural language understanding- syntax, semantics, information extraction.	**9**
III	MapReduce programming model, Hadoop ecosystem, Parallelization and scalability, Data storage- HDFS, GFS. Introduction to NoSQL databases (MongoDB, Cassandra). Data locality and task scheduling.	**9**
IV	Sentiment and opinion mining from web content- Real-time processing of web streams, Stream computing engines (Apache Storm, Flink, Spark Streaming), Case studies- Social media analytics.	**10**
V	Web usage and content mining-Classification and clustering on web-scale datasets, Logic-based reasoning and its limitations, Dealing with uncertainty-probabilistic models, Bayesian learning, Applications in recommendation and personalization.	**9**
	Total	**45 hours**

ASSESSMENT PATTERN

Continuous Assessment

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Assignment : 15 marks

Total : 50 marks

End Semester Examination : 100 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS2U42C	COGNITIVE MODELLING	PEC	2	1	0	3	2022

COURSE OVERVIEW

The objective of this course is to explain the basic cognitive processes of perception, thinking, problem solving, decision making, and moving in the environment and how these processes interact. The course focuses on developing and testing computational models of cognitive processes. This course provides students an elementary introduction to the basic methods used to develop and test computational models of cognition. It provides a presentation of psychological, mathematical, statistical, and computational methods used in different areas of cognitive modeling. Students taking this course would understand detailed examples of these methods in a variety of modeling areas that include recognition, categorization, decision making, and learning.

COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Explain cognitive modeling principles and their practical applications.	Understand
CO 2	Develop skills to qualitatively compare different models of category learning, assessing them based on their ability to generalize, memory efficiency, learning speed, and accuracy.	Apply
CO 3	Illustrate various parameter estimation techniques**.**	Understand
CO 4	Explain cognitive models using AIC, BIC, cross-validation, and generalization.	Understand
CO 5	Describe the fundamental principles of Instance-Based Learning (IBL), and the concept of Similarity-based Learning.	Understand

SYLLABUS

Introduction to Cognitive Modeling - Cognitive models, Qualitative Model Comparison, Basic Parameter Estimation Techniques, Application to Choice and Response Time Measures (Signal detection task, Quantitative Model Comparison, Connectionist versus Rational Approaches, Case-based reasoning.

TEXT BOOKS

1. J. Busemeyer& A. Diederich. Cognitive Modeling. Sage Publications, Inc ,2009.
2. S. Farrel& S. Stephan Lewandowsky. Computational Modeling in Cognition: Principles and Practice. Sage Publications, Inc,2010.
3. Siegelbaum, Steven A., and A. J. Hudspeth. Principles of neural science. Eds
4. Eric R. Kandel, James H. Schwartz, and Thomas M. Jessell. Vol. 4. New York: McGraw-hill, 2000

REFERENCES

1. R. Sun. Cognition and Multi-Agent Interaction. Cambridge University Press,2006.

2. Konar. Artificial Intelligence and Soft Computing: Behavioral and Cognitive Modeling of the Human Brain. CRC Press; 1 edition,1999
3. T. Mitchell. Machine Learning. McGraw-Hill Science,1997.
4. B. Hahn. Essential Matlab for Engineers and Scientists(4thEdition). 2009. Academic Press, 2009.

COURSE PLAN

Module	Contents	Hours
I	**Introduction to Cognitive Modeling** - Cognitive models, Advantages of cognitive models, Practical uses of cognitive models, Steps involved in cognitive modeling. Familiarization with cognitive modeling software tools.	**9**
II	**Qualitative Model Comparison** - Category learning experiment, Two models of category learning, Qualitative comparisons of Models, Matlab Simulation of qualitative model.	**9**
III	**Basic Parameter Estimation Techniques** - Linear and Nonlinear parameter estimation, Retention Experiment and Model, Aggregate modeling versus individual modeling, Objective function and searching for optimal parameters Application to Choice and Response Time Measures (Signal detection task; Dynamic signal detection model; parameter estimation; goodness of fit; lack of fit tests)	**9**
IV	**Quantitative Model Comparison** - Maximum likelihood estimation, Bechara's Simulated Gambling Task (BSGT), Three Cognitive Models on BSGT, Parameter estimation, Quantitative model comparisons using AIC and BIC, Cross-validation, and Generalization.	**9**
V	**Connectionist versus Rational Approaches** - (Rational) Instance-based Learning (Instances; K-nearest neighbor learning; Case-based reasoning; Similarity; Activation), (Connectionist) Neural Networks(neural networks, Rescorla-wagner/delta rule, Multi-layer feed forward networks, Relative theoretical merits of either approach	**9**
	Total Hours	**45**

ASSESSMENT PATTERN

Continuous Assessment		
Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignment	:	15 marks
Total	:	**50 marks**
End Semester Examination	:	**100 marks**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS2U42D	**Image and Video Analytics**	**PEC**	**2**	**1**	**0**	**3**	**2022**

COURSE OVERVIEW

Image and Video Analytics starts with image acquisition using sensors like CCD or CMOS, with storage in formats such as JPEG or PNG using color models like RGB. Images are represented as 2D or 3D arrays of pixel values. Image transforms like Fourier or DCT highlight features and aid in compression and enhancement. Spatial domain methods adjust pixel values directly, while frequency domain techniques modify image details through transform coefficients. Segmentation divides images into regions using methods like thresholding or edge detection, and morphological processing (e.g., dilation, erosion) refines shapes. Video processing involves capturing, analyzing, and compressing frames for efficient playback

COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Summarize different methods for image acquisition, storage and representation in digital devices and computers.	Understand
CO 2	Make use of various image transforms in representing, highlighting, and modifying image features.	Apply
CO 3	Apply the mathematical principles of digital image enhancement in spatial domain and frequency domain	Apply
CO4	Outline the various methods for segmenting and morphological processing of images	Understand
CO5	Explain the fundamental concepts in video processing pipeline	Understand

SYLLABUS

Image processing techniques – enhancement – restoration – segmentation - morphological image processing and video processing.

TEXT BOOKS

1. R. C. Gonzalez, R. E. Woods, “Digital Image Processing”, Pearson Education, Second Edition, 2008

2. Bovik, “Handbook of Image & Video Processing”, Academic Press, Second Edition, 2005

REFERENCES

1. K. Jain, “Fundamentals of Digital Image Processing”, Prentice Hall Of India, First Edition, 1989.
2. M. Tekalp, “Digital Video Processing”, Prentice-Hall, First Edition, 1995.
3. W. K. Pratt, “Digital Image Processing”, Prentice Hall First Edition, 1978.

4. Rosenfeld, A. C. Kak, “Digital Image Processing”, Prentice Hall Second Edition, 1978.

COURSE PLAN

Module	Contents	Hours
I	Introduction to Digital image processing & Applications: Elements of visual perception, Components of image processing systems, sampling, quantization, Mach band effect, Basic relationship between pixels, color image fundamentals-RGB-HIS models	**8**
II	Image transforms: Two dimensional transforms, orthogonal and unitary transforms, 2D DFT, 2D DCT, Hadamard Transform, walsh transform	**7**
III	Image Enhancement in spatial and frequency domain Point operations- Clipping and Thresholding, Digital Negative. Intensity Level Slicing, Bit Extraction, Range Compression + (Work out problems), Spatial Operations-Fundamentals of spatial convolution and correlation, Spatial averaging and spatial Low pass filtering, Median Filtering, Unsharp masking Basics of Filtering in Frequency Domain, Smoothing Frequency Domain Filters: Ideal Low Pass Filter; Gaussian Low Pass Filter; Butterworth Low Pass Filter, Sharpening Frequency Domain Filters: Ideal High Pass Filter; Gaussian High Pass Filter; Butterworth High Pass filter	**11**
IV	**Image Segmentation:** Pixel based and region based methods. **Morphological image processing**: Erosion and dilation, Opening or closing, HIT or MISS transformation, Basic morphological algorithms.	**9**
V	**Introduction to video processing**: Motion Detection and Estimation, Motion estimation algorithms, Video Enhancement and Restoration. Basics of video compression standards – MPEG4.	**10**
	Total Hours	**45**

ASSESSMENT PATTERN

Continuous Assessment		
Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignment	:	15 marks
Total	:	**51 marks**
End Semester Examination	:	**100 marks**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U42G	COMPUTER VISION	PEC	2	1	0	3	2022

COURSE OVERVIEW:

Computer vision is a field of artificial intelligence (AI) that enables computers and systems to derive meaningful information from digital images, videos and other visual inputs. The curriculum covers the basics of image formation, key computer vision concepts, methods, techniques, pattern recognition, various problems in designing computer vision and object recognition systems. This course enables the learners to understand the fundamentals of computer vision and develop applications in computer vision.

COURSE OUTCOMES:

After the completion of the course, the student will be able to

CO1	Summarize basic concepts, terminology, theories, models and methods in the field of computer vision.	Understand
CO2	Explain basic methods of computer vision related to multi-scale representation, edge detection, detection of other primitives, stereo, motion and object recognition.	Understand
CO3	Describe principles of Segmentation, Motion Segmentation and Classification.	Understand
CO4	Select appropriate object Tracking and detection methods for computer vision applications	Understand
CO5	Implement a computer vision system for a specific problem	Apply

Syllabus

Module – 1 (Image Formation and Filtering)

Geometric Camera Models - Pinhole perspective, Intrinsic and Extrinsic Parameters, Geometric Camera Calibration. Linear Filters- Linear Filters and Convolution, Shift Invariant Linear Systems. Filters as Templates - Normalized Correlation and Finding Patterns.

Module - 2(Local Image Features and Stereo Vision)

Image Gradients - Computing the Image Gradient, Gradient Based Edge and Corner Detection. Stereopsis- Binocular Camera Geometry, Epipolar Constraint, Binocular Reconstruction, Local Methods for Binocular Fusion, Global Methods for Binocular Fusion.

Module - 3 (Segmentation)

Segmentation - Background subtraction, Interactive segmentation, Forming image regions. Segmentation by clustering - Watershed Algorithm. Motion Segmentation by Parameter Estimation- Optical Flow and Motion, Flow Models, Motion Segmentation with Layers.

Module- 4 (Classification and Tracking)

Classification - Classification Basics, Two-class and Multiclass classifiers, Error, Overfitting and Regularization, Cross Validation, Classifying Images of Single Objects.Tracking - Tracking Basics, Simple Tracking Strategies, Tracking by detection, Tracking Linear Dynamical models with Kalman filters.

Module - 5 (Finding Objects and other Applications)

Object detection - The Sliding Window Method. Object Recognition -Goals of Object Recognition System. Applications - Robot Navigation by stereo vision, Face detection, Face recognition, Activity

Recognition, Tracking people.

TEXT BOOKS

1. David, and Jean Ponce. Computer vision: A modern approach. Prentice hall, 2011.

REFERENCES

1. Szeliski, Richard, Computer vision: algorithms and applications. Springer Science & Business Media, 2010.
2. Medioni, Gerard, Emerging topics in computer vision. and Sing Bing Kang. Prentice Hall PTR, 2004.
3. Trucco, Emanuele, and Alessandro Verri, Introductory techniques for 3-D computer vision. Vol. 201. Englewood Cliffs: Prentice Hall, 1998.
4. Faugeras, Olivier, and Olivier Autor Faugeras, Three-dimensional computer vision: a geometric viewpoint. MIT press, 1993.

COURSE PLAN

Module	Contents	No. of Hours
1	Geometric Camera model - Pinhole perspective, Geometric Camera model - Intrinsic Parameters, Geometric Camera model - Extrinsic Parameters, Geometric Camera Calibration – Linear Approach, Linear Filters and Convolution, Shift Invariant Linear Systems - Discrete convolution, Normalized Correlation and Finding patterns	9
2	Local Image Features - Computing the Image Gradient, Gradient Based Edge Detection, Gradient Based Corner Detection, Stereopsis - Binocular Camera Geometry and Epipolar Constraint, Essential Matrix and Fundamental Matrix, Binocular Reconstruction, Local Methods for Binocular Fusion, Global Methods for Binocular Fusion	9
3	Segmentation basics, Applications - Background Subtraction, Interactive Segmentation, Forming Image Regions, Segmentation by clustering - The Watershed Algorithm, Motion Segmentation by Parameter Estimation - Optical Flow and Motion, Flow Models and Motion Segmentation with Layers	9
4	Classification Basics, Two-class and Multiclass classifier, Error, Overfitting and Regularization, Cross Validation, Classifying Images of Single Objects Tracking Basics, Simple Tracking Strategies, Tracking by detection, Linear Dynamical models, The Kalman Filter background, Kalman filter algorithm	9
5	Detecting Objects in Images- The Sliding Window Method, Object Recognition - Goals of Object Recognition System, Application of binocular stereo vision - Robot Navigation, Face detection, Face recognition, Activity recognition, Tracking people	9
	Total hours	**45**

PROGRAM ELECTIVE 4

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS2U43A	**HUMAN COMPUTER INTERACTION**	**PEC**	**2**	**1**	**0**	**3**	**2022**

COURSE OVERVIEW

This course provides an overview of Human-Computer Interaction (HCI), with an understanding of user interface design in general. The course covers topics which include user-centered design, human cognitive and physical abilities, prototyping and evaluation techniques, graphical design fundamentals and emerging areas of HCI research including mobile interaction, augmented-reality and ubiquitous computing. This course helps the learners to design and evaluate interactive systems by following the fundamental principles of human-computer interaction.

COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Demonstrate the usability based on a variety of classic universal user-centric models.	Understand
CO 2	Summarize the different interaction styles and the methodologies for designing interactive systems.	Understand
CO 3	Interpret the core and complex user experience design issues.	Understand
CO 4	Identify the evaluation methodologies of interactive system design.	Apply
CO 5	Make use of the different contexts and suggest suitable designs for applications related to web, mobile and wearable computing.	Apply

SYLLABUS

Human-Computer Interaction (HCI) focuses on designing interactive systems that enhance user experience through understanding user cognition, ergonomic principles, and user-centered approaches. It emphasizes usability goals, universal usability for diverse users—including older adults, children, and those with disabilities—and addresses cultural and personality differences. HCI integrates guidelines, principles, and design theories alongside frameworks, prototyping methods, and interaction styles like direct manipulation, immersive environments, and expressive human-command languages. It also explores models of collaboration, system response times, frustrating experiences, and information search strategies. Cognitive models such as GOMS help in understanding user behavior, while various evaluation methods, including usability testing and heuristic evaluation, ensure design effectiveness. Furthermore, HCI encompasses the development of apps and websites, considering information architecture and social media integration, and extends into collaborative environments, AI interface agents, and pervasive technologies like mobile and wearable computing, emphasizing smart materials and material design for seamless user interaction.

TEXT BOOKS

1. Ben Shneiderman, Catherine Plaisant, Maxine Cohen, Steven Jacobs, NiklasElmqvist *Designing the User Interface: Strategies for Effective HumanComputer Interaction*, Sixth Edition, Pearson Education, 2017.
2. Preece, J., Sharp, H., Rogers, Y., *Interaction Design: Beyond Human-Computer Interactio*, Fifth Edition, Wiley, 2019.
3. David Benyon, *Designing User Experience: A guide to HCI, UX and interaction design*, 4th Edition, Pearson, 2018.

REFERENCES

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, *Human Computer Interaction*, Third Edition, Prentice Hall, 2004. 2.
2. The essential guide to user interface design, Wilbert O Galitz, Wiley Dream Tech 3.
3. Jonathan Lazar Jinjuan Heidi Feng, Harry Hochheiser, *Research Methods in HumanComputer Interaction*, Wiley, 2010. 4.
4. Samit Bhattacharya, *Human-Computer Interaction: User-Centric Computing for Design*, McGraw-Hill India, 1st Edition, 2019.

COURSE PLAN

Module	Contents	Hours
I	**Introduction to HCI and Usability** Introduction- - Components of Interaction – Ergonomics Designing Interactive systems – Understanding Users cognition and cognitive frameworks, User Centered approaches, Usability goals and measures, Universal Usability-Diverse Cognitive and Perceptual abilities, Personality differences, Cultural and International diversity, Users with disabilities- Older Adult users and Children. Guidelines, Principles and Theories.	**8**
II	**Design Process and Interaction Styles** HCI patterns, Design frameworks, Design methods, Prototyping. Understanding interaction styles - Direct Manipulation and Immersive environments, Fluid navigation - Navigation by Selection, Small Displays, Content Organization, Expressive Human and Command Languages-Speech Recognition, Traditional Command Languages, Communication and Collaboration-Models of Collaboration, Design considerations.	**8**
III	**User Experience Design** Frameworks for User Centric Computing, Computational models of users, Advancing the User Experience- Display Design, View (Window) Management, Animation, Webpage Design, Color. Timely user Experience-Models of System Response Time (SRT) Impacts, Frustrating Experiences, Information Search- Five Stage Search Framework, Data Visualization-Tasks in Data Visualization, Challenges	**9**
IV	**Cognitive Systems and Evaluation of HCI** Cognitive Models- Goal and task hierarchies, GOMS Model. Introducing Evaluation Types of Evaluation, Other Issues to Consider When Doing Evaluation. Conducting Experiments. Usability testing – Heuristic evaluation and walkthroughs, Analytics and predictive models.	**10**
V	**Contexts for Designing UX** Designing apps and websites – Website and app development, The information architecture of apps and websites. Social media -Social Networking, Sharing with others. Collaborative environments- Issues for	**10**

	cooperative working, Technologies to support cooperative working, AI and Interface Agents, Ubiquitous computing -Blended Spaces. Mobile Computing – Designing for Mobiles. Wearable Computing- Smart Materials, Material Design.	
		Total Hours **45**

ASSESSMENT PATTERN

Continuous Assessment		
Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignment	:	15 marks
Total	:	**50 Marks**
End Semester Examination	:	**100 marks**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS2U43B	**Deep learning for signal and image processing**	**PEC**	**2**	**1**	**0**	**3**	**2022**

PRE-REQUISITE: CS2U30C Introduction to Machine learning

COURSE OVERVIEW

This course provides the learners an overview of the concepts and algorithms involved in deep learning and their application for signal and image processing. The course covers the basic concepts in neural networks, deep learning, image and signal processing fundamentals, convolutional neural networks, recurrent neural networks, autoencoders, and generative models. The students will be able to implement deep learning algorithms to solve real-world problems.

COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Explain the basic concepts of signal and image processing	Understand
CO 2	Apply convolutional neural networks (CNNs) for image processing tasks	Apply
CO 3	Apply 1D Convolutional Neural Networks and Recurrent Neural Networks (RNNs) for signal processing	Apply
CO 4	Explain the concepts of auto encoder, generative models, Transformers.	Understand

SYLLABUS

Deep learning for signal and image processing leverages neural network architectures—particularly convolutional neural networks (CNNs), recurrent networks (RNNs), and transformers—to automatically learn hierarchical representations from raw data, enabling advanced feature extraction, denoising, classification, and reconstruction tasks. In signal processing, deep learning enhances traditional methods by improving performance in areas like speech recognition, biomedical signal analysis, and wireless communication through end-to-end learning. In image processing, it powers state-of-the-art techniques in object detection, segmentation, super-resolution, and image synthesis. Its ability to learn from large-scale datasets without manual feature engineering makes deep learning a transformative tool across domains where signals and images are key data modalities.

TEXT BOOKS

1. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.
2. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing. Pearson, 4e, 2017.
3. Alan V. Oppenheim and Alan S. Willsky**.** Signals and Systems**,** 2e. 1997. Pearson Education.
4. Shai Shalev-Shwartz and Shai Ben-David, Understanding Machine Learning (3rd Edition), Cambridge University Press, 2015. ISBN 978-1107512825.
5. Charu C. Aggarwal, Neural Networks and Deep Learning, Springer International Publishing AG, part of Springer Nature, 2018.

6. Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., Kaiser, Ł., and Polosukhin, I., *Attention Is All You Need*, NeurIPS, 2017

REFERENCES

1. Nikhil Buduma and Nicholas Locascio, *Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms*, 1st Edition, O'Reilly Media, Inc., 2017.
2. M. Gopal**,** *Deep Learning: Core Concepts, Methods and Applications*, Pearson Education, 2022**.**

COURSE PLAN

Module	Contents	Hours
1	**Signal Processing Essentials:** Basics of Digital Signal Processing Sampling and Aliasing. Fourier Transform and Frequency Domain Analysis Short-Time Fourier Transform (STFT).Spectrograms and Time-Frequency Representations. Use of Signal Processing Techniques for Image & Video Analysis. Introduction to 1D and 2D Convolution.	**7**
2	**Image Processing Essentials**: Introduction to Image processing and applications. Image as 2D data. Grayscale, Binary, and Color Image Representation. Image Histograms and Contrast Enhancement. Histogram Equalization . Image Smoothing and Noise Reduction Techniques. Edge Detection (Sobel, Prewitt, Canny). Morphological Operations (Erosion, Dilation, Opening, Closing. Basic Spatial Filtering.	**10**
3	**Deep Learning for Image Processing**: Convolutional Neural Networks: Basic Architecture, Convolution Operation, Motivation, 3D Convolution , Variants of convolution functions, efficient convolution algorithms, sparse connections, and weight sharing. Training CNN, Transfer learning, Applications of Convolutional Networks for image and signal data, Pre-trained Convolutional Architectures : AlexNet, ZFNet, Google Net, VGGnet-19, ResNet50.	**10**
4	**Deep Learning for Signal Processing**: 1D CNNs for Signal Classification. Recurrent neural networks for sequential data. RNN design. Encoder – decoder sequence to sequence architectures. Language modeling example of RNN. Deep recurrent networks. Challenges of training Recurrent Networks. Variants of RNNs : LSTM and GRU. Casestudy: Audio classification using spectrograms.	**9**
5	**Advanced Models & Applications**: Transformers and Self-Attention. Vision Transformers (ViT), Video Vision Transformers (ViViT), Audio Transformers. Generative Models: GANs for Image and Audio generation. Encoder- Decoder Models. Auto-encoders, types of autoencoders. Autoencoders for image reconstruction.	**9**
	Total Hours	**45**

ASSESSMENT PATTERN

Continuous Assessment

Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignment	:	15 marks
Total	:	**50 Marks**

End Semester Examination : 100 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS2U43C	Artificial Intelligence for Robotics	PEC	2	1	0	3	2022

COURSE OVERVIEW

This objective of this course is to study the use of AI in robotics, focusing on intelligent agents, problem-solving, planning, reasoning under uncertainty, and machine learning. It also covers robotic perception, localization, mapping, control, and addresses ethical issues in AI-driven robotics.

COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Explain appropriate AI methods to solve a given problem	Understand
CO 2	Apply suitable AI techniques to represent and structure a given problem within relevant frameworks.	Apply
CO 3	Apply appropriate learning methods used in Artificial Intelligence to given scenarios or problems.	Apply
CO 4	Design and perform an empirical evaluation of different algorithms on a problem formalization	Apply
CO 5	Illustrate the applications of AI in Robotic Applications.	Understand

SYLLABUS

This course explores the integration of Artificial Intelligence in Robotics, covering intelligent agents, problem-solving through search, logic-based knowledge representation, and planning techniques. It includes reasoning under uncertainty using probabilistic models like HMM's and Kalman filters, and introduces learning methods such as statistical and reinforcement learning. The course also addresses robotic perception, localization, mapping, motion planning, control, and concludes with ethical considerations in AI-driven robotics.

TEXT BOOKS

1. Stuart Russell, Peter Norvig, "Artificial Intelligence: A modern approach", Pearson Education, India, 2016.
2. Govers, F. X. *Artificial Intelligence for Robotics: Build intelligent robots that perform human tasks using AI techniques*. Birmingham, UK: Packt Publishing,2018.
3. Negnevitsky, M, "Artificial Intelligence: A guide to Intelligent Systems",. Harlow: Addison Wesley, 2002

REFERENCES

1. Manocha, D., Hsieh, M. A., & Lien, J.-M.. Deep Learning for Robotics. Cambridge, UK: Cambridge University Press,2022.
2. Huimin Lu, Xing Lu, "Artificial Intelligence and Robotics", Springer, 2017.
3. Michael Brady, Gerhardt, Davidson, "Robotics and Artificial Intelligence", Springer, 2012.
4. Robin Murphy, Robin R. Murphy, Ronald C. Arkin, "Introduction to AI Robotics", MIT

Press, 2000.

COURSE PLAN

Module	Contents	Hours
I	Introduction: Need for AI in Robotics. Thinking and acting humanly, intelligent agents, structure of agents. Problem Solving : Solving problems by searching –Informed search and exploration–Constraint satisfaction problems– Adversarial search, knowledge and reasoning–knowledge representation – first order logic	**9**
II	Planning: Planning with forward and backward State space search – Partial order planning – Planning graphs– Planning with propositional logic – Planning and acting in real world.	**9**
III	Reasoning: Uncertainty – Probabilistic reasoning–Filtering and prediction–Hidden Markov models–Kalman filters– Dynamic Bayesian Networks, Speech recognition, making decisions	**9**
IV	Learning : Forms of learning – Knowledge in learning – Statistical learning methods –reinforcement learning, communication, perceiving and acting, Probabilistic language processing, and perception	**9**
V	AI In Robotics : Robotic perception, localization, mapping- configuring space, planning uncertain movements, dynamics and control of movement, Ethics and risks of artificial intelligence in robotics.	**9**
	Total Hours	**45**

ASSESSMENT PATTERN

Continuous Assessment		
Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignment	:	15 marks
Total	:	**50 marks**
End Semester Examination	:	**100 marks**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS2U43D	**DATA PRE-PROCESSING AND FEATURE ENGINEERING**	**PEC**	**2**	**1**	**0**	**3**	**2022**

COURSE OVERVIEW

This course provides a comprehensive foundation in preparing and transforming raw data into meaningful inputs for machine learning and data analysis. Starting from fundamental data cleaning to advanced feature engineering and automation techniques, learners will explore practical methods and tools used in real-world data-driven projects.

COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Identify the types and quality of data, and apply appropriate preprocessing techniques to handle missing, noisy, and inconsistent data.	Apply
CO 2	Perform data transformation, scaling, and encoding operations to prepare raw data for effective machine learning model integration.	Apply
CO 3	Evaluate and apply feature selection techniques to reduce dimensionality and improve model performance and interpretability.	Apply
CO 4	Design and implement domain-specific feature engineering strategies, including the generation of new features from structured, text, and time-based data.	Apply
CO 5	Analyze and apply current trends in automated feature engineering, deep feature synthesis, and ethical considerations in data-centric AI development.	Understand

SYLLABUS

Introduction to Data Preprocessing: Types of data: structured vs. unstructured**,** Data understanding and collection**,** Handling missing and noisy data**,** Data integration and cleaning**,** Redundancy removal and quality metrics**. Data Transformation and Scaling:** Data normalization and standardization techniques**,** Categorical encoding methods**,** Feature binning and transformations**,** Outlier detection and treatment, **Feature Selection Techniques:** Importance and types of feature selection**,** Filter, wrapper, and embedded methods**,** Model-based feature importance**,** Multicollinearity handling, **Feature Engineering Strategies:** Domain-specific feature creation**,** Interaction and polynomial features**,** Date/time and text feature extraction**,** Basic image feature concepts**,** Feature construction and preprocessing pipelines**, Recent Advances and Automation:** AutoML and automated feature generation**,** Deep Feature Synthesis**,** Feature stores and engineering for deep learning**,** Dimensionality reduction techniques**,** Data-centric AI and real-world case studies

TEXT BOOKS

1. Feature Engineering and Selection: A Practical Approach for Predictive Models, Max Kuhn and Kjell Johnson, CRC Press (2019)
2. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow (2nd or 3rd Edition), Aurélien Géron, O'Reilly Media

REFERENCES

1. Data Preparation for Data Mining Using SAS, Mamdouh Refaat, Morgan Kaufmann, 2006.
2. Feature Engineering for Machine Learning: Principles and Techniques for Data Scientists, Alice Zheng and Amanda Casari, O'Reilly Media, 2018

COURSE PLAN

Module	Contents	Hours
I	**Introduction to Data Preprocessing:** What is data preprocessing? Types of data: structured vs. unstructured, Data collection and understanding the dataset, Handling missing data, Techniques: deletion, imputation (mean, median, mode, KNN), Handling noisy data, Binning, regression, clustering, smoothing, Data integration and redundancy removal, Data cleaning and quality metrics	9
II	**Data Transformation and Scaling:** Data normalization vs. standardization, Min-max scaling, z-score scaling, robust scaling, Encoding categorical variables, Label encoding, One-Hot encoding, Target encoding, Frequency encoding, Feature binning (discretization), Log transformation, Box-Cox transformation, Dealing with outliers, IQR, Z-score, Winsorization.	9
III	**Feature Selection Techniques:** Importance of feature selection, Filter methods: Correlation, Chi-square test, ANOVA, Wrapper methods: Recursive Feature Elimination (RFE), Embedded methods: LASSO, Ridge, ElasticNet, Feature importance from tree-based models, Dealing with multicollinearity.	9
IV	**Feature Engineering Strategies:** Domain-driven feature creation, Interaction terms and polynomial features, Date/time feature extraction (day, week, hour, seasonality), Text feature extraction: Bag of Words, TF-IDF, Word Embeddings, Feature extraction from images (basic concepts): Feature construction using aggregations and groupby operations, Pipelines and automated preprocessing.	9
V	**Recent advances and Automation in data preprocessing and feature engineering**: AutoML and automated feature engineering, Deep Feature Synthesis, Feature stores (e.g., Tecton, Feast), Feature engineering for deep learning models, Handling high-dimensional data: PCA, t-SNE, UMAP), Data-centric AI and data versioning, Case studies: Kaggle competitions/industry use cases.	9
	Total Hours	**45**

ASSESSMENT PATTERN

Continuous Assessment		
Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignment	:	15 marks
Total	:	**50 marks**
End Semester Examination	:	**100 marks**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS2U43F	**Introduction to Reinforcement Learning**	**PEC**	**2**	**1**	**0**	**3**	**2022**

COURSE OVERVIEW

This course covers fundamental principles, techniques and applications in reinforcement learning. Students gain insight into key concepts and modern algorithms in reinforcement learning. This course enables the learners to apply reinforcement learning on real world applications and research problems.

COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Solve computational problems using probability and random variables.	Apply
CO 2	Explain policy iteration and value iteration reinforcement learning algorithms.	Understand
CO 3	Make use of Monte Carlo reinforcement learning algorithms to solve real world problems.	Apply
CO 4	Summarize temporal-difference based reinforcement learning algorithms.	Understand
CO 5	Explain on-policy and off-policy reinforcement learning algorithms with function approximation.	Understand

SYLLABUS

Review Of Probability Concepts, Markov Decision Process, Finite Markov Decision Processes, Prediction And Control, Temporal-Difference (TD) Methods For Model Free Prediction And Control, Sarsa, Function Approximation Method, Eligibility Traces ,Policy Gradient Methods, The Policy Gradient Theorem, REINFORCE: Monte Carlo Policy Gradient, REINFORCE with Baseline, Actor–Critic Methods.

TEXTBOOKS

1 Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An Introduction,2nd Edition, 2014

2 Alberto Leon-Garcia, Probability, Statistics, and Random Processes for Electrical Engineering, 3rd Edition, 2007

REFERENCES

1 Reinforcement Learning: State-of-the-Art, Marco Wiering and Martijn van Otterlo, 2nd Edition,2012

2 Artificial Intelligence: A Modern Approach, Stuart J. Russell and Peter Norvig,3rd Edition, 2009

COURSE PLAN

Module	Contents	Hours
I	Review of Probability Concepts Axioms of probability, concepts of random variables, Probability mass function, Probability density function, Cumulative density functions, Expectation of random variables, Joint and multiple random variables, Conditional and marginal distributions Correlation and independence	**9**
II	Markov Decision Process Introduction to Reinforcement Learning(RL) terminology - Examples of RL, Elements of RL, Limitations and Scope of RL, Finite Markov Decision Processes, The Agent Environment Interface Goals and Rewards, Returns and Episodes, Policies and Value Functions, Optimal Policies and Optimal Value Functions, Optimal Policies and Optimal Value Functions	**9**
III	Prediction And Control Policy Evaluation (Prediction), Policy Improvement, Policy Iteration, Value Iteration, Monte Carlo Prediction, Monte Carlo Estimation of Action Values, Monte Carlo Control, Monte Carlo Control without Exploring Starts, Off-policy Prediction via Importance Sampling, Incremental Implementation, Off-policy Monte Carlo Control	**9**
IV	Temporal-Difference (Td) Methods TB-1 TD Prediction, Advantages of TD Prediction Methods Optimality of TD (0), Sarsa: On-policy TD Control, Q-learning: Off-policy TD Control, Expected Sarsa, n-step TD Prediction, n-step Sarsa, n-step Off-policy Learning Off-policy Learning Without Importance Sampling: The n-step Tree Backup Algorithm	**9**
V	Function Approximation Method TB-1 Value-function Approximation, The Prediction Objective, Stochastic- gradient Methods, Linear Methods, The Lambda-return , TD(Lambda), n- step Truncated Lambda-return Methods, Sarsa(Lambda), Policy Approximation and its Advantages, The Policy Gradient Theorem, REINFORCE: Monte Carlo Policy Gradient REINFORCE with Baseline, Actor–Critic Methods	**9**
	Total Hours	**45**

ASSESSMENT PATTERN

Continuous Assessment

Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignment	:	15 marks
Total	:	**50 marks**
End Semester Examination	:	**100 marks**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS2U43G	**Bio-Inspired Optimization Technique**	**PEC**	**2**	**1**	**0**	**3**	**2022**

COURSE OVERVIEW

Bio-inspired algorithms and computation have become increasingly popular in the last two decades. The algorithms such as ant colony algorithms, firefly algorithms and particle swarm optimization have been applied in almost every area of science and engineering. This course covers novel algorithms to solve real-life, complex problems, combining well-known bio-inspired algorithms with new concepts. The objectives of this course are to learn bioinspired theorem and algorithms, to understand simulated annealing, genetic algorithm, differential evolution, swarm optimization, ant colony for feature selection.

COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Explain the working mechanisms of bio-inspired algorithms.	Understand
CO 2	Explain the characteristics of combinatorial problems and relevant bio-inspired algorithms to be applied on it.	Understand
CO 3	Apply bio-inspired algorithms to solve combinatorial problems	Apply
CO 4	Explain the working methodology of bio-inspired algorithms.	Understand
CO 5	Evaluate the performance of different bio-inspired algorithms and compare it.	Apply

SYLLABUS

I**ntroduction to Evolutionary Algorithms and Optimization Terminology:**Different Types of Optimization,Mathematical Models of Genetic Algorithms

Recent Evolutionary Algorithms-1:
Simulated Annealing, Ant Colony Optimization, Particle Swarm Optimization, Differential Evolution

Recent Evolutionary Algorithms-2
Biogeography-based Optimization, Cultural Algorithms, Opposition-based Learning, Tabu Search, The Firefly Algorithm, Bacterial Foraging Optimization.

Combinatorial Optimization: Travelling Salesman Problem, Graph Coloring Problem

Recent Trends in the Domain of Bio-inspired Algorithms

TEXT BOOKS

1.Evolutionary Optimization Algorithms, Dan Simon, Wiley,2013

REFERENCES

1. A. E. Eiben and J. E. Smith,Introduction to Evolutionary Computing ,Second Edition, Springer
2. Helio J.C. Barbosa,Ant Colony Optimization - Techniques and Applications , Intech 2013
3. Xin-She Yang, Nature Inspired Optimization Algorithm ,First Edition, Elsevier
4. Yang , Cui, XIao, Gandomi, Karamanoglu,Swarm Intelligence and Bio-Inspired Computing,First Edition,Elsevier

COURSE PLAN

Module	Contents	Hours
I	Introduction to Evolutionary Algorithms and Optimization Terminology, Different Types of Optimization, Hill Climbing, Intelligence, Genetic Algorithms, Mathematical Models of Genetic Algorithms	**8**
II	Recent Evolutionary Algorithms-1 Simulated Annealing, Ant Colony Optimization, Particle Swarm Optimization, Differential Evolution	**10**
III	Recent Evolutionary Algorithms-2 Biogeography-based Optimization, Cultural Algorithms, Opposition-based Learning, Tabu Search, The Firefly Algorithm, Bacterial Foraging Optimization	**10**
IV	Combinatorial Optimization Travelling Salesman Problem (TSP), TSP Initialization, TSP Representation and Crossover, TSP Mutation, Graph Coloring Problem	**9**
V	Recent Trends in the Domain of Bio-inspired Algorithms	**8**
	Total Hours	**45**

ASSESSMENT PATTERN

Continuous Assessment		
Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignment	:	15 marks
Total	**:**	**50 marks**
End Semester Examination	**:**	**100 marks**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS2U43H	TEXT MINING	PEC	2	1	0	3	2022

COURSE OVERVIEW

The objective of this course is to enable the learner that text mining is an essential field in data science that focuses on extracting meaningful insights from unstructured text data. This course provides an in-depth understanding of text preprocessing, representation, and analytical techniques using machine learning and natural language processing (NLP). Students will explore various methods for text classification, clustering, sentiment analysis, and information retrieval, along with real-world applications such as search engines, chatbots, and social media analytics. Hands-on experience with Python-based text mining tools and libraries will be emphasized.

COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Explain fundamental concepts of text mining and its applications.	Understand
CO 2	Explain text preprocessing techniques such as tokenization, stemming, and lemmatization.	Understand
CO 3	Apply machine learning models for text classification and clustering.	Apply
CO 4	Apply fundamental concepts of Information Retrieval and Sentiment Analysis to extract meaningful insights from textual data.	Apply
CO 5	Apply text mining techniques to develop practical solutions for real-world applications in social media and healthcare.	Apply

SYLLABUS

Fundamental concepts and techniques of text mining, including text preprocessing, feature extraction, and representation methods such as TF-IDF and word embeddings.Supervised and unsupervised learning approaches for text classification, clustering, and topic modeling. Key applications like information retrieval and sentiment analysis.

TEXTBOOKS

1. Charu C. Aggarwal, "Machine Learning for Text," Springer,2nd Edition, 2018.
2. Christopher D. Manning, Hinrich Schütze, and Prabhakar Raghavan, "Introduction to Information Retrieval," Cambridge University Press, Ist Edition, 2008

REFERENCES

1. Steven Bird, Ewan Klein, and Edward Loper, "Natural Language Processing with Python," O'Reilly Media, 2nd Edition, 2009.

2. Jurafsky & Martin, "Speech and Language Processing," Pearson, Ist Edition, 2021.

COURSE PLAN

Module	Contents	Hours
I	Overview of text mining, Definition, General Architecture,Natural Language Processing (NLP) vs. Text Mining, Challenges in Text Mining, Overview of Text Preprocessing Techniques, Basic Text Representation: Tokens, Bag-of-Words, and Word Embeddings, Tools and Libraries: NLTK, spaCy, Scikit-learn	**9**
II	Text Preprocessing and Representation :Text Preprocessing: Tokenization, Stop-word removal, Stemming, and Lemmatization,Regular Expressions and Text Cleaning Techniques, Bag of Words (BoW) and Term Frequency-Inverse Document Frequency (TF-IDF),Word Embeddings: Word2Vec, GloVe, and FastText	**9**
III	Text Classification and Clustering: Supervised Learning for Text Classification: Naïve Bayes, SVM, Decision Trees, Random Forests,Unsupervised Learning: Text Clustering using K-Means, DBSCAN, and Hierarchical Clustering,Topic Modeling: Latent Dirichlet Allocation (LDA) and Non-Negative Matrix Factorization (NMF), Evaluation Metrics: Precision, Recall, and F1-score	**9**
IV	Information Retrieval and Sentiment Analysis : Introduction to Information Retrieval and Search Engines, Vector Space Model and PageRank Algorithm, Text Similarity Measures: Cosine Similarity, Jaccard Similarity, and Euclidean Distance. Sentiment Analysis: Lexicon-based and Machine Learning-based Approaches.	**9**
V	Applications of Text Mining : Named Entity Recognition (NER) and Part-of-Speech (POS) Tagging, Text Summarization: Extractive vs. Abstractive Approaches, Question Answering Systems and Chatbot, Text Mining in Social Media and Healthcare. Case Studies and Real-world Implementations.	**9**
	Total Hours	**45**

ASSESSMENT PATTERN

Continuous Assessment

Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignment	:	15 marks
Total	:	**50 marks**
End Semester Examination	:	**100 marks**

PROGRAM ELECTIVE 5

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U44A	**High Performance Computing**	**PEC**	**2**	**1**	**0**	**3**	**2020**

COURSE OVERVIEW

This course helps the learners to understand the different architectural features of high-end processors. This course discusses the basics of high-end processors' architecture, Instruction-Level Parallelism, Data-Level Parallelism, Thread Level Parallelism, and GPU Architectures.

COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Describe different types of modern processing environments and parallel computing hardware.	Understand
CO 2	Summarize the concepts of Instruction Level Parallelism.	Understand
CO 3	Explain the idea of Data Level Parallelism.	Understand
CO 4	Demonstrate the concept of Thread Level Parallelism.	Understand
CO 5	Describe the basics of GPU architecture.	Understand

SYLLABUS

Basics of Architecture – Classes of Computers - Classes of Parallelism and Parallel Architectures – Defining Computer Architecture – Dependability – Quantitative Principles of Computer Design – Basics of Memory Hierarchies – Virtual Memory and Virtual Machines – Pipelining

Instruction-Level Parallelism - Concepts and Challenges – Basic Compiler Techniques for Exposing ILP – Reducing Branch Costs With Advanced Branch Prediction – Hardware-Based Speculation – Multithreading: Exploiting Thread-Level Parallelism to Improve Uniprocessor Throughput

Data-Level Parallelism – Vector Architecture – Graphics Processing Units – Detecting and Enhancing Loop-Level Parallelism

Thread Level Parallelism – Multiprocessor Architecture: Issues and Approach – Centralized Shared-Memory Architectures – Synchronization: The Basics – Introduction to Memory Consistency

GPU Architectures - The CPU-GPU system as an accelerated computational platform – The GPU and the thread engine – Multi-GPU platforms – Potential benefits of GPU – accelerated platforms

TEXT BOOKS

1. John L. Hennessy, David A. Patterson Computer Architecture, Sixth Edition A Quantitative Approach, Morgan Kaufman, Fifth Edition, 2012.

2. Robert Robey, Yuliana Zamora, Parallel and High-Performance Computing, Manning Publications, First Edition, 2021.

REFERENCES

1. Thomas Sterling, Matthew Anderson, and MaciejBrodowicz, High-Performance Computing – Modern Systems and Practices, First Edition, 2017.
2. Charles Severance, Kevin Dowd,High-Performance Computing, O'Reilly Media, Second Edition, 1998.
3. Kai Hwang, Faye Alaye Briggs, Computer Architecture and Parallel Processing, McGraw-Hill, 1984.

COURSE PLAN

Module	Contents	Hours
I	**Basics of Architecture:** Classes of Computers, Defining Computer Architecture, Trends in Technology, Dependability, Measuring, Reporting, and Summarizing Performance, Quantitative Principles of Computer Design, Performance, Price and Power **Memory Hierarchy Design:** Memory Technology and Optimizations, Ten Advanced Optimizations of Cache Performance, Virtual Memory and Virtual Machines, Pipelining	**10**
II	**Instruction-Level Parallelism:** Concepts and Challenges, Basic Compiler Techniques for Exposing ILP, Reducing Branch Costs With Advanced Branch Prediction, Overcoming Data Hazards With Dynamic Scheduling, Exploiting ILP Using Multiple Issue and Static Scheduling, Multithreading: Exploiting Thread-Level Parallelism to Improve Uniprocessor Throughput	**10**
III	**Data-Level Parallelism –** Introduction, Vector Architecture – SIMD Instruction Set Extensions for Multimedia – Graphics Processing Units – Detecting and Enhancing Loop-Level Parallelism	**8**
IV	**Thread Level Parallelism** – Multiprocessor Architecture: Issues and Approach – Centralized Shared-Memory Architectures – Performance of Symmetric Shared-Memory Multiprocessors– Distributed Shared-Memory and Directory-Based Coherence – Synchronization: The Basics – Introduction to Memory Consistency	**9**
V	**GPU Architectures** - The CPU-GPU system as an accelerated computational platform – The GPU and the thread engine – Characteristics of GPU memory spaces – The PCI bus: CPU to GPU data transfer overhead – Multi-GPU platforms – Potential benefits of GPU – accelerated platforms	**8**
	Total Hours	**45**

ASSESSMENT PATTERN

Continuous Assessment

Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignment	:	15 marks
Total	:	**50 marks**
End Semester Examination	:	**100 marks**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U44B	**Blockchain Technologies**	**PEC**	**2**	**1**	**0**	**3**	**2022**

COURSE OVERVIEW

The purpose of this course is to create awareness and understanding among students on the foundation of blockchain technology. The course introduces the cryptographic principles behind blockchain and helps the students understand concepts like consensus, crypto-currency, smart contracts, use cases etc. The course enables students to develop simple decentralized applications using blockchain networks such as Ethereum.

COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Illustrate the cryptographic building blocks of blockchain technology	Understand
CO 2	Explain the fundamental concepts of blockchain technology.	Understand
CO 3	Summarize the classification of consensus algorithms.	Understand
CO 4	Explain the concepts of the first decentralized cryptocurrency bitcoin.	Understand
CO 5	Explain the use of smart contracts and its use cases.	Understand
CO6	Develop simple applications using Solidity language on Ethereum platform.	Apply

SYLLABUS

Fundamentals of Cryptography: Introduction to cryptography, Digital signature algorithms, Applications of cryptographic hash functions – Merkle trees, Distributed hash tables. Fundamentals of Blockchain Technology: Elements of blockchain. Consensus. Decentralization. Consensus Algorithms and Bitcoin: Consensus Algorithms, Bitcoin, Transactions, Blockchain, Mining, Wallets. Smart Contracts and Use cases: Smart Contracts, Decentralization, Decentralized applications. Ethereum and Solidity: Ethereum – The Ethereum network, The Ethereum Virtual Machine. The Solidity language, Smart contracts Case study.

TEXT BOOKS

1. Mastering Blockchain: A deep dive into distributed ledgers, consensus protocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more, Imran Bashir, Packt Publishing, Third edition, 2020.

COURSE PLAN

Module	Contents	Hours
I	Introduction to Cryptography, Symmetric cryptography – AES. Asymmetric cryptography – RSA. Elliptic curve cryptography, Digital signatures – RSA digital signature algorithms. Secure Hash Algorithms – SHA-256. Applications of cryptographic hash functions – Merkle trees, Distributed hash tables.	**9**
II	Blockchain – Definition, architecture, elements of blockchain, benefits and limitations, types of blockchain. Consensus – definition, types, consensus in blockchain. Decentralization – Decentralization using blockchain, Methods of decentralization, Routes to decentralization, Blockchain and full ecosystem decentralization.	**9**
III	Consensus Algorithms, Crash fault-tolerance (CFT) algorithms – Paxos, Raft. Byzantine fault- tolerance (BFT) algorithms – Practical Byzantine Fault Tolerance (PBFT), Proof of work (PoW), Proof of stake (PoS), Types of PoS. Bitcoin – Definition, Cryptographic keys – Private keys, public keys, addresses. Transactions – Lifecycle, coinbase transactions, transaction validation. Blockchain – The genesis block. Mining – Tasks of miners, mining algorithm, hash rate. Wallets – Types of wallets.	**9**
IV	Smart Contracts – Definition, Smart contract templates, Oracles, Types of oracles, Deploying smart contracts. Decentralization terminology – Decentralized applications, Decentralized Autonomous Organizations. Use cases of Blockchain technology – Government, Health care, Finance, Supply chain management. Blockchain and allied technologies – Blockchain and Cloud Computing, Blockchain and Artificial Intelligence.	**9**
V	Ethereum – The Ethereum network. Components of the Ethereum ecosystem – Keys and addresses, Accounts, Transactions and messages. The Ethereum Virtual Machine, Blocks and blockchain. The Solidity language – The layout of a Solidity source code, Structure of a smart contract, variables, data types, control structures, events, inheritance, libraries, functions, error handling. Smart contracts Case study: Voting, Auction.	**9**
	Total Hours	**45**

ASSESSMENT PATTERN

Continuous Assessment

Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignment	:	15 marks
Total	:	**50marks**
End Semester Examination	:	**100 marks**

Course Code	Course Name	Category	L	T	P	Credit	Year of introduction
CS2U44A	**Knowledge Engineering and Expert Systems**	**PEC**	**2**	**1**	**0**	**3**	**2022**

COURSE OVERVIEW

This course provides an in-depth exploration of knowledge engineering principles and the construction and use of knowledge graphs. It covers how knowledge graphs can be integrated with machine learning (ML) techniques to enhance data-driven insights and reasoning capabilities. The course combines theoretical knowledge with practical skills, enabling students to develop and deploy knowledge-based systems and explore the synergy between knowledge graphs and ML.

COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Describe fundamental concepts of Knowledge engineering and its representation using semantic web technologies	Understand
CO2	Use ontologies engineering to create and manage knowledge base	Apply
CO3	Illustrate construction and querying of Knowledge Graph (KG)	Understand
CO4	Apply basic concepts of expert systems and analyze real-world applications	Apply
CO5	Develop expert systems by selecting tools, acquiring knowledge, and addressing common development challenges.	Apply

SYLLABUS

Semantic Web and Ontologies enable machines to understand and process data meaningfully using standards like URI, XML, RDF, RDFS, and OWL for defining classes, instances, and relationships. SPARQL enables querying of RDF data, and tools like Protégé assist in ontology creation. Knowledge Graphs (KGs), built from linked data, represent relationships between entities and support tasks like data integration and ML, often implemented using Neo4j. Expert Systems, like PROSPECTOR, simulate expert reasoning, handling diagnostic or advisory tasks. Their development includes knowledge acquisition, tool selection, and system building, but challenges include knowledge elicitation and managing domain complexity.

TEXTBOOKS

3. Knowledge engineering and expert systems, Rastogi, P. N, Business Promotion Bureau, New Delhi, 1994
4. Domain-Specific Knowledge Graph Construction, Mayank Kejriwal, Springer, 2019
5. Knowledge Graphs -Methodology, Tools and Selected Use Cases, Dieter Fensel, Umutcan Simsek, Springer, 2019

REFERENCES

1. Paul Groth, Frank van Harmelen, Rinke Hoekstra. A Semantic Web Primer, Third Edition, MIT press; 2012.
2. Semantic Web concepts, technologies and applications, K K Breitman, M A Casanova, W Truszkowski, Springer, 2006

COURSE PLAN

Module	Contents	No. of hours
I	Knowledge Engineering: Definition – Historical overview and significance in AI. Knowledge representation: Semantic web and Ontologies. Semantic Web Technologies: vision and goals – layered architecture – Semantic web standards: URI, XML, RDF and RDFS.	9
II	Ontology Engineering: Definition – OWL (Web Ontology Language) –	**6**

	OWL Constructs: Classes, Instances and Properties in OWL – Complex Classes – Property Restrictions. Query Language: SPARQL queries – Advanced SPARQL. Graphs Ontology creation and management using Protégé.	
III	Knowledge graphs (KG): Definition – DIKW Pyramid – Linked Data and Knowledge Graphs – Anatomy – Construction of KG: Data modelling – Integrating data – Data extraction and transformation – Embedding techniques for knowledge graphs – Building – Querying. Implementation of KG using Neo4j. Integrating KG and Machine Learning (ML) – KG feature source of ML. Case studies of knowledge graph applications.	**10**
IV	Introduction to Expert System Features of expert system, Representation and organization of knowledge, Basic characteristics, Types of problems handled by expert systems, Case study of PROSPECTOR	**10**
V	Building an Expert System Expert system development, Selection of tool, acquiring knowledge, Building process. Problems with Expert Systems Difficulties, common pitfalls in planning, Dealing with domain expert, Difficulties during development.	**10**
	Total	**45 hours**

ASSESSMENT PATTERN

Continuous Assessment

Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignment	:	15 marks
Total	:	**50 marks**
End Semester Examination	:	**100 marks**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS2U44B	**IoT for AI**	**PEC**	**2**	**1**	**0**	**3**	**2022**

COURSE OVERVIEW

The objective of this course is to give an understanding in the Internet of Things, including the components, tools, and analysis through its fundamentals and real-world applications and to enable the students to develop IoT solutions including the softwares and programming of Raspberry Pi hardware.

COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Discuss domain-specific applications and the principles of IoT, including physical and logical design and deployment templates	Understand
CO 2	Interpret the principles of IoT and M2M, their differences, and key concepts like SDN, NFV, and essential management protocols.	Understand
CO 3	Develop the IoT design methodology, utilize Python for logical system design, and leverage key Python packages through practical case studies.	Apply
CO 4	Implement using Raspberry Pi with Python to control LEDs and switches, interface with other IoT devices.	Apply

SYLLABUS

Introduction to IoT - Physical Design of IoT, Logical Design of IoT, IoT levels and Deployment templates, Domain Specific IoT. - Platforms for IoT Applications and various protocols - IoT design methodology, Case study on IoT system - Programming Raspberry Pi with Python. Data Analytics for IoT

TEXTBOOKS

1. Internet of Things - a Hands On Approach, Arshdeep Bahga and Vijay Madisetti, Universities Press, 1/e, 2016.

REFERENCES

1. Internet of Things : Architecture and Design Principles, Rajkamal, McGraw Hill, 2/e, 2022.

2. The Internet of Things –Key applications and Protocols, Olivier Hersent, David Boswarthick, Omar Elloumi, Wiley, 1/e, 2012.

3. IoT fundamentals : Networking technologies, Protocols and use cases for the Internet of things, David Hanes Gonzalo. Salgueiro, Grossetete, Robert Barton, Cisco Press, 1/e, 2017

COURSE PLAN

Module	Contents	Hours
I	Introduction to IoT - Physical Design of IoT, Logical Design of IoT, IoT levels and Deployment templates, Domain Specific IoT- Home automation, Energy,Agriculture, Health and lifestyle.	**9**
II	Platforms for IoT Applications and various protocols: IoT and M2M-M2M, Difference between IoT and M2M, Software Defined Networking, Network Function virtualization, Need for IoT System Management, Simple Network Management Protocol (SNMP), NETCONF, YANG;	**9**
III	Platforms for IoT Applications:LPWAN - LPWAN applications, LPWAN technologies, Cellular (3GPP) and Non 3GPP standards, Comparison of various protocols like Sigfox, LoRA, LoRAWAN, Weightless, NB-IoT, LTE-M.	**9**
IV	Developing IoT - IoT design methodology, Case study on IoT system for weather monitoring, Motivations for using python, IoT-system Logical design using python, Python Packages of Interest for IoT - JSON, XML, HTTPlib & URLLib, SMTPLib	**9**
V	Programming Raspberry Pi with Python-Controlling LED with Raspberry Pi,Interfacing an LED and switch with Raspberry Pi, Other IoT devices- PcDino, Beagle bone Black, Cubieboard, Data Analytics for IoT	**9**
	Total Hours	**45**

ASSESSMENT PATTERN

Continuous Assessment

Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignment	:	15 marks
Total	:	**50 marks**
End Semester Examination	:	**100 marks**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS2U44C	Big Data and Database Management	PEC	2	1	0	3	2022

COURSE OVERVIEW

This course provides a comprehensive understanding of database management systems (DBMS) and big data technologies. It covers fundamental database concepts, relational models, normalization techniques, and SQL queries before transitioning into big data analytics, NoSQL databases, and Hadoop-based distributed computing.

COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Explain the fundamental concepts and architecture of Database Management Systems and their advantages over traditional file systems.	Understand
CO 2	Utilize the concepts of relational database and apply normalization techniques and functional dependencies for optimal relational database design.	Apply
CO 3	Explain the characteristics, types, implementation platforms and challenges of Big Data, and differentiate it from traditional data management systems	Understand
CO 4	Apply the types of analytics in Big Data and fundamental principles such as the CAP theorem and BASE concepts.	Apply
CO 5	Make use of the Hadoop ecosystem, architecture and components and apply Data Intensive tasks using the Map Reduce Paradigm	Apply

SYLLABUS

Introduction to DBMS: Overview of DBMS,DBMS vs. Files
Relational Database design: E-R Model, Constraints, SQL, Keys, Joins, Normalization (1NF-BCNF).
Big Data: Types, Characteristics (3Vs), Challenges, BI vs. Big Data, Data Warehouse, Hadoop.
Big Data Analytics: CAP Theorem, BASE, NoSQL (Types, SQL vs. NoSQL vs. NewSQL).
Hadoop Ecosystem: HDFS, MapReduce, YARN, Architecture, Components, Searching, Sorting, Compression.

TEXT BOOKS

1.Silberschatz A, Korth H F and Sudharshan S, “Database System Concepts”, Sixth Edition, Tata McGraw-Hill Publishing Company Limited, 2010.
2.Seema Acharya, Subhashini Chellappan, “Big Data and Analytics”, Wiley Publication, 2015.

REFERENCES

1. Judith Hurwitz, Alan Nugent, Dr. Fern Halper, Marcia Kaufman, “Big Data for Dummies”,John Wiley & Sons, Inc., 2013.
2. Tom White, “Hadoop: The Definitive Guide”, O’Reilly Publications, 2011.

COURSE PLAN

Module	Contents	Hours
I	Introduction: Overview of DBMS, File vs DBMS, elements of DBMS. Database design: E-R model, Notations, constraints, cardinality and participation constraints.	**8**
II	Relational Data Model: Introduction to relational model, Structure of relational mode, domain,keys, tuples to relational models, sql queries.Relational Database Design: Functional dependency, Normalization: 1NF,2NF,3NF,BCNF,table joins.	**10**
III	Introduction to Big Data: Types of Digital Data – Characteristics of Data – Evolution of Big Data – Definition of Big Data – Challenges with Big Data-3Vs of Big Data – Non Definitional traits of Big Data – Business Intelligence vs. Big Data – Data warehouse and Hadoop environment – Coexistence.	**10**
IV	Big Data Analytics: Classification of analytics – Data Science – Terminologies in Big Data – CAP Theorem – BASE Concept. NoSQL: Types of Databases – Advantages – NewSQL – SQL vs. NOSQL vs NewSQL	**9**
V	Introduction to Hadoop: Features – Advantages – Versions – Overview of Hadoop Eco systems – Hadoop distributions – Hadoop vs. SQL – RDBMS vs. Hadoop – Hadoop Components – Architecture – HDFS – Map Reduce: Mapper – Reducer – Combiner – Partitioner – Searching – Sorting – Compression. Hadoop 2 (YARN): Architecture – Interacting with Hadoop Eco systems.	**8**
	Total Hours	**45**

ASSESSMENT PATTERN

Continuous Assessment		
Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignment	:	15 marks
Total	:	**50 marks**
End Semester Examination	:	**100 marks**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U44F	BIOINFORMATICS	PEC	2	1	0	3	2022

COURSE OVERVIEW

The objective of this course is to help the learners to understand the fundamental concepts in Molecular Biology, Genomics, Proteomics and Modelling. This course introduces bio macromolecules such as genes and proteins, different biological databases, and tools and algorithms for biological data processing, analysis and interpretation, and the elements of the systems approach to Molecular Biology. This course enables the learners to contribute towards drug discovery and computational analysis and modelling of biological processes.

COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Explain the basic concepts of Bioinformatics with an emphasis on structure, function and synthesis of biomolecules.	Understand
CO 2	Identify biological data formats and databases, retrieve bio-sequences, and align bio- sequences to identify similarity.	Apply
CO 3	Make use of similarity searching tools and algorithms to align sequences to highlight the similarity and describe the structure of genes.	Apply
CO 4	Make use of tools to demonstrate and visualize protein structure.	Apply
CO 5	Explain the fundamental aspects of Systems Biology, Computational Modeling and properties of models.	Understand

SYLLABUS

Introduction to bioinformatics, the Central Dogma, gene structure, and transcription-translation processes. Biological databases, sequence formats, and alignment methods. Database similarity searching with BLAST, multiple sequence alignment, and gene structure in prokaryotes and eukaryotes. Proteomics, including protein structure, visualization, and interaction networks. Systems biology, computational modelling, and data integration techniques.

TEXT BOOKS

1. Zvelebil, Marketa J., and Jeremy O. Baum. Understanding bioinformatics. Garland Science, 2007.
2. Xiong, Jin. Essential bioinformatics. Cambridge University Press, 2006.
3. Klipp, E., Herwig, R., Kowald, A., Wierling, C., &Lehrach, H. Systems biology in practice: concepts, implementation and application. John Wiley & Sons. 2005.

REFERENCES

1. Baxevanis, Andreas D., Gary D. Bader, and David S. Wishart, eds. Bioinformatics. John Wiley & Sons, 2020.

2. Shaik, Noor Ahmad, et al. Essentials of Bioinformatics, Volume I. Springer, 2019.

3. Selzer, Paul M., Richard J. Marhöfer, and Andreas Rohwer, Applied bioinformatics. An introduction–Springer, Verlag,, 2008.
4. S C Rastogi, N Mendiratta and PRastogi, Bioinformatics: Methods and Applications, PHI Learning Private Limited, New Delhi, 2015.
5. D E Krane and M L Raymer, Fundamental Concepts of Bioinformatics, Pearson Education, 2006.
6. Andreas D.Baxevanis, B F Francis Ouellette, Bioinformatics - A Practical Guide to the Analysis of Genes and Proteins, Third Edition, John Wiley & Sons INC. , U.K. 2006.
7. Neil C Jones and Pavel A Pevzner, An Introduction to Bioinformatics Algorithms, MIT press, 2004.

COURSE PLAN

Module	Contents	Hours
I	**Introduction to Bioinformatics** – Nature and scope of Bioinformatics, DNA, RNA & protein: The Central Dogma, Messenger RNA, tRNA, rRNA, Genetic code, Gene Structure and Control, Transcription, Translation.	**8**
II	**Introduction to Bio Sequences and Analysis** - Introduction to Biological Databases, NCBI, GenBank, Bio sequence formats- FASTA, Sequence alignment- Global Alignment and Local Alignment, Dot Matrix Method, Dynamic Programming Method, Gap Penalties, Amino Acid Scoring Matrices - PAM and BLOSUM.	**10**
III	**Database Similarity Searching and genomics-** Database Similarity Searching, BLAST – Variants -BLASTN, BLASTP, BLASTX, Statistical Significance, Needleman and Wunsch and Smith–Waterman Method, Multiple Sequence Alignment, scoring function, Clustal, introduction to structure of prokaryotic and eukaryote gene.	**10**
IV	**Proteomics -** Protein Structure, Ramachandran Plot, Hierarchies of Protein Structure, Determination of Protein three-dimensional structure, protein structure database-PDB, Protein structure visualization, introduction to Protein protein interaction, STRING database.	**9**
V	**Systems Biology -** Introduction to Systems Biology, Models and Modelling, Properties of models, Systems state and steady state, Variables, Parameters, and Constants in modelling, Purpose and Adequateness of Models, Advantages of Computational Modelling, Model Development, Network Versus Elements, Modularity, Robustness and Sensitivity, Data Integration.	**8**
	Total Hours	**45**

ASSESSMENT PATTERN

Continuous Assessment		
Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignment	:	15 marks
Total	:	**50 marks**
End Semester Examination	:	**100 marks**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U44G	COMPUTATIONAL LINGUISTICS	PEC	2	1	0	3	2020

COURSE OVERVIEW

The course to teach the basics of Computational Linguistics to the students viewing language phenomena from a computational/statistical standpoint. This involves ideas about statistical and computational models and how these could be linked with various language processing tasks. The course helps the learner to appreciate the complexities involved in language processing tasks using a machine, in contrast with the ease with which human beings handle them. Some practical aspects are also discussed using the Python and NLTK framework to equip the student with the capability to design solutions to linguistic problems.

COURSE OUTCOMES

After the completion of the course the student will be able to

CO1	Explain the fundamental concepts of language processing.	Understand
CO2	Demonstrate the concepts of probability, statistical inference and hidden Markov model.	Apply
CO3	Compare and summarize the various methods of word sense disambiguation, lexical acquisition and selectional preferences.	Apply
CO4	Make use of different Part-of- Speech Tagging methods for language modeling	Apply
CO5	Examine Probabilistic Context Free Grammars and various probabilistic parsing methods	Apply
CO6	Develop simple systems linguistic tasks using Python and NLTK.	Apply

SYLLABUS

Introduction to Computational Linguistics, The Ambiguity of Language, Linguistic Essentials, Part of Speech and Morphology, Phrase structure grammars, Probability Theory, Bayes theorem, Statistical Inference, n-gram Models, Markov Models, Word Sense Disambiguation, Dictionary based Disambiguation, Evaluation Measures, Semantic Similarity – Vector space measures – Probabilistic measures, Grammar – Part-of-Speech Tagging, Probabilistic Context Free Grammars Language Processing with Python- Introduction to NLTK.

TEXT BOOKS

1.C.D. Manning and H. Schutze. Foundations of Statistical Natural Language Processing. MIT Press.
2. Steven Bird, fEwan Klein, fEdward Lopper, Natural Language Processing with Python and NLTK. O'reilly Pub.

REFERENCES

1. D. Jurafsky and J.H. Martin: Speech and Language Processing: Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition, PHI.James Allen: Natural Language Understanding. Pearson Pub.
2.Nitin Hardeniya, Jacob Perkins, Deepti Chopra, Nisheeth Joshi, ItiMathur: Natural Language Processing: Python and NLTK., 1st Edition. Packt Publishing

COURSE PLAN

Module	Contents	No. of Hours
I	Introduction: Rationalist and Empiricist Approaches to Language Questions that linguistics should answer, Non- categorical phenomena in language-Language and	8

	cognition as probabilistic phenomena, The Ambiguity of Language: Why natural language processing is difficult, Lexical resources – Word counts, Zipf's laws – Collocations-Concordances, Linguistic Essentials: Parts of Speech Morphology – Nouns and pronouns, Words that accompany nouns: Determiners and adjectives-Verbs Other parts of speech, Phrase Structure – Phrase structure grammars, Semantics and Pragmatics – Corpus Based Work	
II	Probability Theory – Probability spaces, Conditional probability and independence-Bayes'theorem, Random variables – Expectation and variance Notation, Joint and conditional distributions – Standard distributions – Bayesian statistics, Statistical Inference: n-gram Models over Sparse Data Bins: Forming Equivalence Classes, Markov Models – Hidden Markov Models: Why use HMMs?, General form of an HMM- Finding the probability of an observation – Finding the best state sequence	9
III	Methodological Preliminaries – Supervised and unsupervised learning, Upper and lower bounds on performance – Supervised Disambiguation, Bayesian classification- Dictionary based Disambiguation, Disambiguation based on sense definitions. Thesaurus based disambiguation, Lexical Acquisition Evaluation Measures, Verb Sub categorization- Attachment Ambiguity, PP attachment – Selectional Preferences, Semantic Similarity: Vector space measures – Probabilistic measures	10
IV	Part-of-speech Tagging – The Information Sources in Tagging, Markov Model Taggers – Hidden Markov Model Taggers, Applying HMMs to POS tagging- The effect of initialization on HMM training, Transformation – Based Learning of Tags, Probabilistic Context Free Grammars- Some Features of PCFGs, Questions for PCFGs, The Probability of a String – Using inside probabilities Using outside probabilities, Finding the most likely parse for a sentence parsing for disambiguation, parsing model vs. language model	9
V	Language Processing with Python- Introduction to NLTK, Text Wrangling and Text cleansing: Sentence Splitter, Tokenization, Stemming, Lemmatization, Stop word removal, Rare word removal, Spell Correction, Part of Speech Tagging and NER, Parsing Structure in Text: Shallow versus deep parsing, types of parsers	9
	Total hours	**45**

ASSESSMENT PATTERN

Continuous Assessment		
Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignment	:	15 marks
Total	:	**50 marks**
End Semester Examination	:	**100 marks**

HONOURS

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1H40A	CYBER FORENSICS	VAC	3	1	0	4	2022

COURSE OVERVIEW

The course on Cyber Forensics aims at exploring the basics of Cyber Forensics and Cyber security, the forensic investigation process and principles and the different types of cybercrimes and threats. This course also focuses on the forensic analysis of File systems, the Network, the Windows and Linux Operating systems. The course gives a basic understanding of the forensics analysis tools and a deep understanding of Anti forensics practices and methods. All the above aspects are dealt with case studies of the respective areas.

COURSE OUTCOMES

After the completion of the course the student will be able to

Course Outcomes	Description	Level
CO1	Explain thebasic concepts in Cyber Forensics, Forensics Investigation Process and Cyber security	Understand
CO2	Infer the basic concepts of File Systems and its associated attribute definitions	Understand
CO3	Utilize the methodologies used in data analysis and memory analysis for detection of artefacts.	Apply
CO4	Identify web attacks and detect artefacts using OWASP and penetration testing.	Apply
CO5	Summarize anti-forensics practices and data hiding methods .	Understand

SYLLABUS

Computer Forensics: History of computer forensics, preparing for computer investigations, understanding Public and private investigations- Forensics Investigation Principles - Forensic Protocol for Evidence Acquisition - Digital Forensics -Standards and Guidelines - Digital Evidence –Data Acquisition - storage formats for digital evidence, determining the best acquisition method, contingency planning for image acquisitions, Cyber Forensics tools- Challenges in Cyber Forensics, Skills Required to Become a Cyber Forensic Expert

Cyber Security: Cybercrimes, Types of Cybercrimes - Recent Data Breaches - Recent Cyber security Trends - Case Study: Sim Swapping Fraud, ATM Card Cloning, Hacking email for money,

Google Nest Guard, Email Crimes, Phishing, Types of Phishing.

File system Analysis: FAT and NTFS concepts and analysis -File system category, Content category, Metadata category, File name category, Application category,Application-level search techniques, Specific file systems, File recovery, Consistency check. FAT data structure-Boot sector, FAT 32 FS info, directory entries, Long file name directory entries.

Windows Forensics: Live Response- Data Collection- Locard's Exchange Principle, Order of Volatility Volatile and Non Volatile Data Live-Response Methodologies: Data Analysis- Agile Analysis, Windows Memory Analysis, Rootkits and Rootkit detection.

Linux Forensics: Live Response Data Collection- Prepare the Target Media, Format the Drive, Gather Volatile Information, Acquiring the Image, Initial Triage, Data Analysis- Log Analysis, Keyword Searches, User Activity, Network Connections, Running Processes, Open File Handlers, The Hacking Top Ten, Reconnaissance Tools

Network Forensics: The OSI Model, Forensic Footprints, Seizure of Networking Devices, Network Forensic Artifacts, ICMP Attacks, Drive-By Downloads, Network Forensic Analysis Tools, Case Study: Wireshark. Web Attack Forensics: OWASP Top 10, Web Attack Tests, Penetration Testing.

Anti-Forensics: Anti-forensic Practices - Data Wiping and Shredding- Data Remanence, Degaussing, Case Study: USB Oblivion, Eraser - Trail Obfuscation: Spoofing, Data Modification, Case Study: Timestamp – Encryption, Case Study: VeraCrypt, Data Hiding: Steganography and Cryptography, Case Study: SilentEye, Anti-forensics Detection Techniques, Case Study: Stegdetect.

TEXT BOOKS

1. Bill Nelson, Amelia Phillips and Christopher Steuart, Computer forensics - Guide to Computer Forensics and Investigations, 4/e, Course Technology Inc.
2. Brian Carrier, File System Forensic Analysis, Addison Wesley, 2005.
3. Harlan Carvey, Windows Forensic Analysis DVD Toolkit, 2/e, Syngress.
4. Cory Altheide, Todd Haverkos, Chris Pogue,Unix and Linux Forensic Analysis DVD Toolkit, 1/e, Syngress.
5. William Stallings,Network Security Essentials Applications and Standards, 4/e, Prentice Hall
6. Eric Maiwald, Fundamentals of Network Security, McGraw-Hill, 2004.

REFERENCES

1. Michael. E. Whitman, Herbert. J. Mattord, Principles of Information Security, Course Technology, 2011.
2. William Stallings, Cryptography and Network Security Principles and Practice, 4/e, Prentice Hall.
3. Niranjan Reddy, Practical Cyber Forensics: An Incident-Based Approach to Forensic Investigations, Apress, 2019.

COURSE PLAN

Module	Contents	No. of Hours
1	**Cyber Forensics and Cyber Security** History of computer forensics, preparing for computer investigations, Understanding Public and private investigations- Forensics	12

	Investigation Principles, Forensic Protocol for Evidence Acquisition, Digital Forensics -Standards and Guidelines - Digital Evidence, Data Acquisition - storage formats for digital evidence, determining the best acquisition method, Contingency planning for image acquisitions, Cyber Forensics tools, Challenges in Cyber Forensics, Skills Required to Become a Cyber Forensic Expert, Cybercrimes, Types of Cybercrimes - Recent Data Breaches - Recent Cyber security Trends, Case Study: Sim Swapping Fraud, ATM Card Cloning, Case Study:Hacking email for money, Google Nest Guard, Email Crimes, Phishing, Types of Phishing	
2	**File System Forensics** FAT and NTFS concepts and analysis, File system category, Content category, Metadata category, File name category,Application category, Application-level search techniques, Specific file systems, File recovery, Consistency check, FAT data structure-Boot sector, FAT 32 FS info, directory entries, Long file name directory entries	12
3	**Operating System Forensics** Live Response- Data Collection- Locard's Exchange Principle, Order of Volatility, Volatile and Non Volatile Data, Live-Response Methodologies: Data Analysis- Agile Analysis, Windows Memory Analysis, Rootkits and Rootkit detection, Linux Forensics: Live Response Data Collection, Prepare the Target Media, Format the Drive, Gather Volatile Information, Acquiring the Image, Initial Triage, Data Analysis- Log Analysis, Keyword Searches, User Activity, Data Analysis- Network Connections, Running Processes, Open File Handlers, The Hacking Top Ten, Reconnaissance Tools	12
4	**Network Forensics** OSI Model, Forensic Footprints, Seizure of Networking Devices, Network Forensic Artifacts, ICMP Attacks, Drive-By Downloads, Network Forensic Analysis Tools, Web Attack Forensics, OWASP Top 10, Web Attack Tests, Penetration Testing-1, Penetration Testing.-2	12
5	**Anti-Forensics** Anti-forensic Practices - Data Wiping and Shredding, Data Remanence, Degaussing, Trail Obfuscation: Spoofing, Data Modification, Role of Encryption in Forensics, Data Hiding: Steganography and Cryptography, Anti-forensics Detection Techniques	12
	Total hours	60

Course Code	Course Name	Category	L	T	P	Credit	Year of introduction
CS2H40A	**COMPUTATIONAL HEALTH INFORMATICS**	**VAC**	**3**	**1**	**0**	**3**	**2022**

COURSE OVERVIEW

This course helps learners to develop know-how in computational methods, algorithms, and tools commonly used in health informatics. This includes data mining, machine learning, statistical analysis, and visualization techniques. Also, the course helps to gain knowledge of applications of machine learning in healthcare and how to analyze medical images, interpret healthcare data, and understand the role of informatics in disease diagnosis.

COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Describe health informatics, including its principles, concepts, and applications of computational methods and techniques used in health informatics.	**Understand**
CO 2	Illustrate latest trends, advancements, and emerging technologies in computational health informatics.	**Apply**
CO 3	Demonstrate application of computational methods and techniques to analyze and manipulate medical images for various purposes, such as diagnosis, treatment planning, and research .	**Apply**
CO 4	Use the machine learning techniques to health images to aid in various aspects of healthcare, including diagnosis, treatment planning, and disease monitoring.	**Apply**
CO 5	Implement deep learning techniques to analyze and interpret medical images	**Apply**

SYLLABUS

Introduction to Health Informatics,Emerging Technologies in Health Informatics,Medical Image Processing,Machine Learning in Medical Image Analysis,Deep Learning for Medical Image Processing.

TEXTBOOKS

1. Translational Bioinformatics in Healthcare anMedicine. (2021). Netherlands: Elsevier Science.
2. Computational Analysis and Deep Learning for Medical Care: Principles, Methods, and Applications. (2021). United Kingdom: Wiley.

REFERENCES

1. Introduction to Computational Health Informatics. United States (2020) CRC Press.
2. Signal Processing Techniques for Computational HealthInformatics. (2020). Germany: Springer International Publishing.
3. Computational Intelligence and Healthcare Informatics. (2021). UnitedKingdom: Wiley.
4. Computational Intelligence for Machine Learning and Healthcare Informatics. (2020). Germany: De Gruyter.
5. Smart Computational Intelligence in Biomedical and Health Informatics. (2021). United States: CRC Press.
6. Healthcare Systems and Health Informatics: Using Internet of Things. (2022). United States: CRC Press.

COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Health Informatics** Definition, scope, and objectives of health informatics, Historical development and current trends in health informatics, Health informatics frameworks and models, Health data standards (HL7, SNOMED CT, ICD, etc.), Interoperability challenges and solutions, Data capture, storage, and retrieval in health informatics, Data quality and integrity, Data analytics techniques and applications in healthcare, Data visualization for decision support.	9
II	**Emerging Technologies in Health Informatics** Artificial intelligence (AI) and machine learning in healthcare, Internet of Things (IoT) and its applications in healthcare, Hybrid IoT-NG-PON system, Blockchain technology in health informatics, Clinical research informatics, Genome sequencing and translational bioinformatics approach to genomics and precision medicine, IoT devices for healthcare, IoT beneficiaries in healthcare, IoT architecture, Data sharing and secondary use of health data.	**9**
III	**Medical Image Processing** Overview of medical image processing and its significance in healthcare, Challenges and opportunities in medical image analysis, Principles of X-ray imaging, Magnetic Resonance Imaging (MRI) basics, Computed Tomography (CT) fundamentals, Ultrasound imaging and its characteristics, Image Enhancement Techniques, Contrast enhancement methods for medical images, Noise reduction and image denoising techniques, Image sharpening and edge enhancement.	**10**
IV	**Machine Learning in Medical Image Analysis** Image Segmentation, Thresholding techniques for image segmentation,	**8**

	Region-based segmentation algorithms, Edge detection and contour-based segmentation, Feature Extraction and Representation, Supervised and unsupervised learning algorithms, Classification and regression techniques for medical image analysis, Performance evaluation and validation of machine learning models.	
V	**Deep Learning for Medical Image Processing** Convolutional Neural Networks (CNNs) for medical image analysis, Segmentation and object detection using deep learning, Transfer learning and pretrained models in medical imaging, Volumetric image analysis and 3D reconstruction, Image-based modeling and simulation, Advanced imaging modalities (functional MRI, diffusion tensor imaging), Artificial intelligence in medical image processing.	**9**
	Total	**45**

ASSESSMENT PATTERN

Continuous Assessment		
Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignment	:	15 marks
Total	:	**50 marks**
End Semester Examination	:	**100 marks**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS2H40B	Surveillance Video Analytics	**VAC**	**3**	**1**	**0**	**4**	**2022**

COURSE OVERVIEW

This course aims to introduce students to basics of image processing, object detection, face recognition and video analytics.

COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Explain the basics of image processing techniques for computer vision and video analysis.	Understand
CO 2	Explain the techniques used for image pre-processing.	Understand
CO 3	Develop various object detection techniques.	Apply
CO 4	Explain the various face recognition mechanisms.	Understand
CO 5	Elaborate on deep learning-based video analytics.	Understand

SYLLABUS

Computer Vision – Image representation and image analysis tasks-Local pre-processing - Image smoothing-Object detection– Object detection methods -FaceRecognition-Introduction-Applications of Face Recognition-Video Processing – use cases of video analytics

TEXT BOOKS

1. Milan Sonka, Vaclav Hlavac, Roger Boyle, “Image Processing, Analysis, and Machine Vision”, 4nd edition, Thomson Learning, 2013
2. Vaibhav Verdhan, 2021, Computer Vision Using Deep Learning Neural Network Architectures with Python and Keras, Apress 2021(UNIT-III,IV and V)

REFERENCES

1. Richard Szeliski, “Computer Vision: Algorithms and Applications”, Springer Verlag London Limited,2011.

2. Caifeng Shan, FatihPorikli, Tao Xiang, Shaogang Gong, “Video Analytics for Business Intelligence”, Springer, 2012.

3. D. A. Forsyth, J. Ponce, “Computer Vision: A Modern Approach”, Pearson Education, 2003.

COURSE PLAN

Module	Contents	Hours
I	Computer Vision – Image representation and image analysis tasks - Image representations – digitization – properties – color images – Data structures for Image Analysis - Levels of image data representation - Traditional and Hierarchical image data structures.	**9**
II	Local pre-processing - Image smoothing - Edge detectors - Zero-crossings of the second derivative - Scale in image processing - Canny edge detection - Parametric edge models - Edges in multispectral images - Local pre-processing in the frequency domain - Line detection by local preprocessing operators - Image restoration.	**9**
III	Object detection– Object detection methods – Deep Learning framework for Object detection– bounding box approach-Intersection over Union (IoU) – Deep Learning Architectures-R-CNN-Faster R-CNN-You Only Look Once(YOLO)-Salient features-Loss Functions-YOLO architectures	**9**
IV	Face Recognition-Introduction-Applications of Face Recognition-Process of Face Recognition- DeepFace solution by Facebook-FaceNet for Face Recognition- Implementation using FaceNetGesture Recognition.	**9**
V	Video Processing – use cases of video analytics-Vanishing Gradient and exploding gradient problem - RestNet architecture-RestNet and skip connections-Inception Network-GoogleNet architecture Improvement in Inception v2-Video analytics-RestNet and Inception v3.	**9**
	Total Hours	**45**

ASSESSMENT PATTERN

Continuous Assessment		
Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignment	:	15 marks
Total	:	**50 marks**
End Semester Examination	:	**100 marks**

CS1H49A	MINI PROJECT	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PWS	0	1	6	4	2020

COURSE OVERVIEW: The objective of this course is to apply the fundamental concepts of courses learned in respective Honors Streams: Security in Computing, Machine Learning and Formal Methods. This course helps the learners to get an exposure to the development of application software/hardware solutions/ software simulations in the field of Computer Science and Engineering. It enables the learners to understand the different steps to be followed such as literature review and problem identification, preparation of requirement specification & design document, testing, development and deployment. Mini project enables the students to boost their skills, widen the horizon of thinking and their ability to resolve real life problems.

COURSE OUTCOMES : After the completion of the course the student will be able to

CO#	CO	
CO1	Identify technically and economically feasible problems **.**	**Apply**
CO2	Identify and survey the relevant literature for getting exposed to related solutions.	**Apply**
CO3	Perform requirement analysis, identify design methodologies and develop adaptable & reusable solutions of minimal complexity by using modern tools & advanced programming techniques.	**Apply**
CO4	Prepare technical report and deliver presentation **.**	**Apply**
CO5	Apply engineering and management principles to achieve the goal of the project .	**Apply**

COURSE PLAN

Students are expected to follow the following steps.

1. Review of Literature and Identification of a problem
2. Create an abstract with a problem statement, solution approach, technology stack, team, etc.
3. Create Requirements Specification
4. Create Design Document . This may include designs like,
    a. System Architecture Design

b. Application Architecture Design
c. GUI Design
d. API Design
e. Database Design
f. Technology Stack

5. Deployment, Test Run & Get Results
6. Prepare Project Report

Guidelines for the Report preparation

A bonafide report on the mini project shall be submitted within one week after the final presentation. Minimum number of pages should be 40.

- Use Times New Roman font for the entire report – Chapter/Section Title – Times New Roman18, Bold; Heading 2 – Times New Roman16, Bold; Heading 3 – Times New Roman14, Bold; Body- Times New Roman 12, Normal.
- Line Spacing – Between Heading 2 – 3 lines, between lines in paragraph 1.5 lines.
- Alignments – Chapter/Section Title – Center, Heading 2 & 3 should be Left Aligned. Ensure that all body text is paragraph justified.
- Figures & Tables – Ensure that all Figures and Tables are suitably numbered and given proper names/headings. Write figure title under the figure and table title above the table.

- Suggestive order of documentation:
  i. Top Cover
  ii. Title page
  iii. Certification page
  iv. Acknowledgment
  v. Abstract
  vi. Table of Contents
  vii. List of Figures and Tables
  viii. Chapters
  ix. Appendices, if any
  x. References/Bibliography