SEMESTER

VII

AIT 401	FOUNDATIONS OF DEEP LEARNING	CATEGORY	L	T	P	CREDIT
		PCC	2	1	0	3

Preamble: Study of 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, generative models. The students will be able to implement deep learning algorithms to solve real-world problems.

Prerequisite: Machine learning concepts

Course Outcomes: After the completion of the course the student will be able to

CO 1	Illustrate the basic concepts of neural networks, deep learning and its practical issues **(Cognitive Knowledge Level : Apply)**
CO 2	Outline the standard regularization and optimization techniques for the effective training of deep neural networks. **(Cognitive Knowledge Level: Understand)**
CO 3	Build convolutional Neural Network (CNN) models for different use cases. **(Cognitive Knowledge Level: Apply)**
CO 4	Apply the concepts of Recurrent Neural Network (RNN), Long Short Term Memory(LSTM), Gated Recurrent Unit (GRU**). (Cognitive Knowledge Level: Apply)**
CO 5	Explain the concepts of auto encoder, generative models **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✔	✔	✔	✔								✔
CO 2	✔	✔	✔	✔								✔
CO 3	✔	✔	✔	✔	✔							✔
CO 4	✔	✔	✔	✔	✔							✔
CO 5	✔	✔	✔	✔								✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication

PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks**
	Test1 (in %)	**Test2 (in %)**	
Remember	20	20	20
Understand	40	40	40
Apply	40	40	40
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance: 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment: 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module 1: Introduction to Neural Networks and Deep learning

Introduction, The Basic Architecture of Neural Networks - Single Computational Layer: The Perceptron, Multilayer Neural Networks. Activation functions – Sign, Sigmoid, Tanh, ReLU, leaky ReLU, Hard Tanh, Softmax. Loss function. Training a Neural Network with Backpropagation. Practical issues in neural network training. Overfitting, Underfitting, Hyper parameters and Validation sets, Estimators -Bias and Variance.Introduction to deep learning, Deep feed forward network.

Module 2: Training deep models

Introduction, setup and initialization- Kaiming, Xavier 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 tying and sharing, Ensemble methods, Dropout, Batch normalization.

Module 3: Convolutional Neural Networks

Convolutional Neural Networks –Architecture, Convolution operation, Motivation, pooling .Variants of convolution functions, Structured outputs, Data types, Efficient convolution algorithms, Applications of Convolutional Networks, Pre-trained convolutional Architectures : AlexNet, ZFNet, VGGnet-19, ResNet-50.

Module 4: Recurrent Neural Networks

Recurrent neural networks – Computational graphs. RNN design. Encoder – decoder sequence to sequence architectures. Language modeling example of

RNN. Deep recurrent networks. Recursive neural networks. Challenges of training Recurrent Networks. Gated RNNs LSTM and GRU.

Case study: BERT, Social Media Sentiment Analysis.

Module 5: Auto-encoders and Generative models.

Autoencoders, *Variational Auto-Encoder*-under complete Auto-encoder, stochastic encoder, denoising encoder, Applications of Autoencoders. Generative models - Boltzmann machines, Deep Belief Networks, Generative Adversarial Networks.

Reference Books

1. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.
2. Neural Networks and Deep Learning, Aggarwal, Charu C., c Springer International Publishing AG, part of Springer Nature 2018
3. Deep Learning, Core Conceps, Methods and Applications- M Gopal, Pearson Education
4. Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms (1st. ed.). Nikhil Buduma and Nicholas Locascio. 2017. O'Reilly Media, Inc.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Suppose you have a 3-dimensional input x = (x1, x2, x3) = (2, 2, 1) fully connected with weights (0.5, 0.3, 0.2) to one neuron which is in the hidden layer with sigmoid activation function. Calculate the output of the hidden layer neuron.
2. Consider the case of the XOR function in which the two points {(0, 0),(1, 1)} belong to one class, and the other two points {(1, 0),(0, 1)} belong to the other class. Design a multilayer perceptron for this binary classification problem.
3. Sketch the typical learning curves for the training and validation sets, for a setting where overfitting occurs at some point. Assume that the training set and the validation set are of the same size.

Course Outcome 2 (CO2):

1. Explain how L2 regularization improves the performance of deep feed forward neural networks.
2. Explain how L1 regularization method leads to weight sparsity.
3. Derive update rules for parameters in the multi-layer neural network through the gradient descent.

Course Outcome 3(CO3):

1. Give two benefits of using convolutional layers instead of fully connected ones for visual tasks.

2. Suppose that a CNN was trained to classify images into different categories. It performed well on a validation set that was taken from the same source as the training set but not on a testing set. What could be the problem with the training of such a CNN? How will you ascertain the problem? How can those problems be solved?

3. Weight sharing allows CNNs to deal with image data without using too many parameters. Does weight sharing increase the bias or the variance of a model?

Course Outcome 4 (CO4):

1. Illustrate the workings of the RNN with an example of a single sequence defined on a vocabulary of four words.

2. List the differences between LSTM and GRU

3. Show the steps involved in an LSTM to predict stock prices.Give one advantage of using an RNN rather than a convolutional network.

Course Outcome 5 (CO5):

1. Is an autoencoder for supervised learning or for unsupervised learning? Explain briefly.

2. List the difference between Boltzmann Machine and Deep Belief Network.

Model Question Paper

QP CODE: PAGES:3

Reg No:

Name :

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

***Course Code:* AIT 401**

Course Name: Foundations of Deep Learning

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. Illustrate the limitation of a single layer perceptron with an example
2. Specify the advantages of ReLU over sigmoid activation function.
3. Derive weight updating rule in gradient descent when the error function is a) mean squared error b) cross entropy
4. List any three methods to prevent overfitting in neural networks
5. Illustrate the strengths and weaknesses of convolutional neural networks.
6. What happens if the stride of the convolutional layer increases? What can be the maximum stride? Justify your answer
7. List the differences between LSTM and GRU
8. How does a recursive neural network work?
9. List the difference between Boltzmann Machine and Deep Belief Network.
10. How does the variational auto-encoder(VAE) architecture allow it to generate new data points, compared to auto-encoder, which cannot generate new data points?

(10x3=30)

Part B

Answer any one Question from each module. Each question carries 14 Marks

11.

a. Explain back propagation algorithm for neural network training. (9 marks)

b. “How does bias and variance trade-off affect machine learning algorithms? (5 marks)

OR

12.

a. With an example classification problem, explain the following terms:
   a) Hyper parameters b) Training set c) Validation sets d) Bias e) Variance (8 marks)

b. Compare overfitting and underfitting. How it can affect model generalization ?
   (6 marks)

13.

a. Differentiate gradient descent with and without momentum. Give equations for weight updation in GD with and without momentum. Illustrate plateaus, saddle points and slowly varying gradients. (8 marks)

b. Describe the effect in bias and variance when a neural network is modified with more number of hidden units followed with dropout regularization. (6 marks)

OR

14.

a. Explain how L2 regularization improves the performance of deep feed forward neural networks.
   (7 marks)

b. Initializing the weights of a neural network with very small or large random numbers is not advisable. Justify.

(7 marks)

15.

a. Consider an activation volume of size 13×13×64 and a filter of size 3×3×64. Discuss whether it is possible to perform convolutions with strides 2, 3 and 5. Justify your answer in each case. (6 marks)

b. Suppose that a CNN was trained to classify images into different categories. It performed well on a validation set that was taken from the same source as the training set but not on a testing set. What could be the problem with the training of such a CNN? How will you ascertain the problem? How can those problems be solved?

(8 marks)

OR

16.

a. Explain the following convolution functions a)tensors b) kernel flipping c) down sampling d) strides e) zero padding. (10 marks)

b. What is the motivation behind convolution neural networks? (4 marks)

17. a. If we have a recurrent neural network (RNN), we can view it as a different type of network by "unrolling it through time". Briefly explain what that means. (6 marks)

b. Explain the architecture of GRU. (8 marks)

OR

18.

a. The vanishing gradient problem is more pronounced in RNN than in traditional neural networks. Give reason. Discuss a solution for the problem. (7 marks)

b. Show the steps involved in an LSTM to predict stock prices.Give one advantage of using an RNN rather than a convolutional network. (7 marks)

19.

a. Generative Adversarial Networks(GANs) include a generator and a discriminator. Sketch a basic GAN using those elements, a source of real images, and a source of randomness. (10 marks)

b. The word “adversarial” in the acronym for GANs suggests a two-player game. What are the two players, and what are their respective goals? (4 marks)

OR

20.

a. Explain auto encoder with an example. (7 marks)

b. Explain Generative Adversarial Networks using suitable diagram. (7 marks)

(14X5=70)

Teaching Plan

No	Topic	No. of Lectures (**36 Hours**)
1	**Module 1: Introduction to neural network and Deep Learning**	**7**
1.1	Introduction, The Basic Architecture of Neural Networks - Single Computational Layer: The Perceptron.	1 hour
1.2	Multilayer Neural Networks.	1 hour
1.3	Activation functions - Sigmoid, Tanh, ReLU, leaky ReLU, Hard Tanh, Softmax. Loss function.	1 hour
1.4	Training a Neural Network with Backpropagation.	1 hour
1.5	Practical issues in neural network training	1 hour
1.6	Overfitting, Underfitting, Hyper parameters, Validation sets	1 hour
1.7	Estimators -Bias and Variance, Introduction to deep learning, Deep feed forward network	1 hour
2	**Module 2: Training deep models**	**8**
2.1	Introduction, setup and initialization issues- Kaiming and Xavier weight initializations	1 hour
2.2	Vanishing and exploding gradient problems	1 hour
2.3	Concepts of optimization, Gradient Descent (GD)	1 hour
2.4	Stochastic GD, GD with momentum, GD with Nesterov momentum	1 hour
2.5	AdaGrad, RMSProp, Adam	1 hour
2.6	Concepts of Regularization, L1 and L2 regularization	1 hour
2.7	Early stopping, Dataset augmentation	1 hour

2.8	Parameter tying and sharing, Ensemble methods, Dropout, Batch Normalization	1 hour
3	**Module 3: Convolutional Neural Network**	**8**
3.1	Convolutional Neural Networks, Architecture	1 hour
3.2	Convolution operation	1 hour
3.3	Motivation, pooling	1 hour
3.4	Variants of convolution functions	1 hour
3.5	Structured outputs, Data types	1 hour
3.6	Efficient convolution algorithms	1 hour
3.7	Applications of Convolutional Networks	1 hour
3.8	Case Studies of Convolutional Architectures : AlexNet, ZFNet, VGGNet-19, ResNet-50	1 hour
4	**Module 4 : Recurrent Neural Network**	**7**
4.1	Recurrent neural networks – Computational graphs	1 hour
4.2	RNN design, Encoder – decoder sequence to sequence architectures	1 hour
4.3	Language modeling example of RNN	1 hour
4.4	Deep recurrent networks, Recursive neural networks, Challenges of training Recurrent Networks	1 hour
4.5	LSTM	1 hour
4.6	GRU	1 hour
4.7	Case Study- BERT, Sentiment Analysis	1 hour
5	**Module 5 : Autoencoders and Generative models**	**6**
5.1	Autoencoders	1 hour
5.2	VariationalAutoEncoder , Applications of utoencoders	2 hour
5.3	Boltzmann machines,	1 hour
5.4	Deep Belief Networks,	1 hour
5.5	Generative Adversarial Networks.	1 hour

SEMESTER VII

PROGRAM

ELECTIVE II

AIT 413	ADVANCED CONCEPTS OF MICROPROCESSOR AND MICRO CONTROLLER	Category	L	T	P	Credit
		Program Elective II	2	1	0	3

Preamble: The course enables the learners capable of understanding the fundamental architecture of microprocessors and micro controllers. This course focuses on the architecture, assembly language programming, interrupts, interfacing of microprocessors with peripheral devices and microcontrollers and its programming. It helps the learners to extend the study of latest advanced microprocessors and develop hardware-based solutions.

Prerequisite: Sound knowledge in Logic System Design and Computer organization & architecture.

CO#	Course Outcomes
CO1	Illustrate the **architecture**, modes of operation and addressing modes of microprocessors **(Cognitive knowledge: Understand)**
CO2	Develop 8086 **assembly** language programs. Demonstrate interrupts, its **handling** in 8086 **(Cognitive Knowledge Level: Apply**)
CO3	Illustrate how different peripherals are interfaced with 8086 microprocessors (8259,8255,8254,8257) (**Cognitive Knowledge Level: Understand**)
CO4	Illustrate the architecture and features of advanced microprocessors (**Cognitive knowledge: Understand)**
CO5	Outline features of **microcontrollers** and develop low level programs. **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓									✓
CO2	✓	✓	✓	✓								✓
CO3	✓	✓	✓									✓
CO4	✓	✓	✓									✓
CO5	✓	✓	✓									✓

Abstract POs defined by National Board of Accreditation

PO#	Broad PO	PO#	Broad PO
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test1 (%)	Test2 (%)	
Remember	20	20	20
Understand	40	40	40
Apply	40	40	40
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Tests : **25 marks**

Continuous Assessment Assignment : **15 marks**

Internal Examination Pattern:

Each of the two internal examinations must be conducted out of 50 marks

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

SYLLABUS

Module-1(Evolution of microprocessors):

8086 microprocessor – Architecture and signals, Stack structure of 8086, Physical Memory organization, Minimum and maximum mode of 8086 system and timings. Comparison of 8086 and 8088.

Module-2 (Addressing modes and instructions):

Addressing Modes of 8086. Instruction set – data copy /transfer instructions, arithmetic instructions, logical instructions, string manipulation instructions, branch instructions, unconditional and conditional branch instruction, flag manipulation and processor control instructions. Assembler Directives and operators. Basic Assembly Language Programming with 8086.Interrupts - Types of Interrupts and Interrupt Service Routine- Handling Interrupts in 8086

Module- 3 (Interfacing chips):

Programmable Interrupt Controller - 8259, Architecture (Just mention the control word, no need to memorize the control word). Programmable Peripheral Input/output port 8255 - Architecture and modes of operation- Programmable interval timer 8254-Architecture and modes of operation- DMA controller 8257 Architecture (Just mention the control word, no need to memorize the control word of 8254 and 8257).

Module- 4 (Advanced Microprocessors):

Introduction to 32-bit advanced microprocessors- Salient Features and comparison of 80286, 80386 and 80486. Introduction to Pentium Microprocessors-Salient features of 80586-System Architecture-Brach predication-Enhanced Instruction set of Pentium-Journey to Pentium -Pro and Pentium-II.

Module- 5 (Microcontrollers):

8051 Architecture- Register Organization- Memory and I/O addressing- Interrupts and Stack- 8051 Addressing Modes- Instruction Set- data transfer instructions, arithmetic instructions, logical instructions, Boolean instructions, control transfer instructions- Simple programs.

Text Books

1. Bhurchandi and Ray, Advanced Microprocessors and Peripherals, Third Edition McGraw Hill.
2. Raj Kamal, Microcontrollers: Architecture, Programming, Interfacing and System Design, Pearson Education.
3. Ramesh Gaonkar, Microprocessor Architecture, Programming, and Applications with the 8085, Penram International Publishing Pvt. Ltd.

Reference Books

1. Barry B. Brey, The Intel Microprocessors – Architecture, Programming and Interfacing, Eighth Edition, Pearson Education.
2. A. NagoorKani, Microprocessors and Microcontrollers, Second Edition, Tata McGraw Hill
3. Douglas V. Hall, SSSP Rao, Microprocessors and Interfacing, Third Edition, McGrawHill Education.

Sample Course Level Assessment Questions

Course Outcome1 (CO1):

1) Describe how pipelining is implemented in 8086 microprocessors
2) Illustrate maximum mode signals in 8086.

Course Outcome 2(CO2):

1) Write an 8086-assembly language program for sorting a sequence of N, 8-bit numbers. Describe the modifications that can be done on the above program so that it will sort N, 16-bit numbers. Rewrite the program with those modifications also.

Course Outcome 3 (CO3):

1) Give the sequence of instructions for setting the IVT for interrupt type 23H. Assume the Interrupt Service Routine, is present in the code segment named CODE.
2) Describe the role of Interrupt Request register and In service register in 8259.
3) Specify the importance of the DMA address register and Terminal count register in 8257

Course Outcome 4(CO4):

1) What are the four major architectural advancement in 80486 over 80386? What are the data types supported by 80486?
2) Classify the instruction set of Pentium processor?
3) Explain branch prediction mechanism for Pentium processor.

Course Outcome 5(CO5):

1) Write an 8051-assembly language program to count the number of 1’s and 0’s in each8-bit number
2) Write an 8051-assembly language program for computing the square root of an 8-bit number.

Model Question Paper

QP CODE:

Reg No: _______________

Name: _________________ **PAGES: 4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH. DEGREE EXAMINATION, MONTH & YEAR

Course Code: AIT413

Course Name: ADVANCED CONCEPTS OF MICROPROCESSOR AND MICRO CONTROLLER

Max.Marks:100

Duration: 3 Hours

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Describe the functions of following signals in 8086
   a) NMI b) ALE

2. The value of Code Segment (CS) Register is 4042H and the value of different offsets is as follows:
   BX:2025H,
   IP:0580H,
   DI:4247H
   Calculate the effective address of the memory location pointed by the CS register.

3. Explain the following instructions with example.
   AAD b. AAS c. AAA

4. Specify the use of following assembler directives - EQU, EVEN

5. Differentiate between maskable and non-maskable interrupts?

6. What are the three different I/O modes supported by 8255?

7. Explain the branch prediction in Pentium processors.

8. Compare the features of 80286,80386 and 80486?

9. Differentiate between indirect and indexed addressing modes in 8051.

10. Write the sequence of 8051 instructions to store any two numbers at two consecutive locations 70H and 71H, multiply them and store the result in location 72H. **(10x3=30)**

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Specify the significance of segmentation and how it is implemented in 8086 **(5)**

(b) Explain the maximum mode signals in 8086. **(9)**

OR

12. (a) Explain the physical address calculation in 8086 with example. **(4)**

(b) Explain the physical memory organization of 8086 with a neat diagram. How does the 8086 processor access a word from an odd memory location? How many memory cycles does it take? **(10)**

13. (a) Write an 8086-assembly language program for finding the sum of the squares of first N natural numbers. Calculate the **(10)**

squares of each number using a subroutine SQUARE.

(b) Describe any four control transfer instructions in 8086. **(4)**

OR

14. (a) Write an 8086-assembly language program for printing the reverse of a given input string. **(5)**

(b) Explain the addressing modes for sequential control flow instructions in 8086. **(9)**

15. (a) Discuss the following control words of 8259 **(5)**
    a) Initialization command word
    b) Operating Command word

(b) Explain the architecture of 8259 with diagram **(9)**

OR

16. (a) Describe the internal architecture of 8255 with block diagram. **(10)**

(b) Identify the mode and I/O configuration for ports A, B and C of an 8255 after its control register is loaded with 86 H? **(4)**

17. (a) Explain the architecture of Pentium processors with a neat diagram **(10)**

(b) Explain the features of Pentium-Pro and Pentium -II. **(4)**

OR

18. (a) Explain the enhanced instruction sets of Pentium processors in detail **(8)**

	(b)	Explain the super scalar execution of Pentium processors.	**(6)**
19.	(a)	Explain the architecture of 8051 microcontroller.	**(9)**
	(b)	Write an 8051-assembly language program for adding two matrices whose elements are stored sequentially in some memory location. Assume suitable locations.	**(5)**

OR

20.	(a)	Explain the internal data memory organization of 8051.	**(9)**
	(b)	Describe the control transfer instructions of 8051microcontroller.	**(5)**

Teaching Plan

No	Contents	No of Lecture Hrs
Module 1: (Evolution of microprocessors) (7hours)		
1.1	Architecture of 8086	1hour
1.2	Signals in 8086	1hour
1.3	Memory Segmentation	1hour
1.4	Physical Memory organization	1hour
1.5	Minimum and maximum mode 8086 system and timings (Lecture 1)	1hour
1.6	Minimum and maximum mode 8086 system and timings (Lecture 2)	1hour
1.7	Comparison of 8086 and 8088	1hour
Module 2 :(programming of 8086) (8 hours)		
2.1	Addressing Modes of 8086	1 hour
2.2	Instruction set – data copy/transfer instructions	1hour
2.3	arithmetic instructions, logical instructions	1hour
2.4	unconditional and conditional branch instruction	1hour
2.5	flag manipulation and processor control instructions	1hour
2.6	Assembler Directives and operators	1hour
2.7	Assembly Language Programming with 8086(Lecture 1)	1hour
2.8	Types of interrupts, ISR and handling interrupts in 8086	1hour
Module 3: (Interfacing chips) (7 hours)		

3.1	Programmable Interrupt Controller -8259 (Lecture 1)	1hour
3.2	Programmable Peripheral Input/output port- 8255 (Lecture 1)	1hour
3.3	Programmable Peripheral Input/output port- 8255 (Lecture 2)	1hour
3.4	Programmable interval timer 8254 (Lecture 1)	1hour
3.5	Programmable interval timer 8254 (Lecture 2)	1hour
3.6	DMA controller 8257 Architecture (Lecture 1)	1hour
3.7	DMA controller 8257 Architecture (Lecture 2)	1hour
Module 4 :(Advanced Microprocessors) (7 hours)		
4.1	Introduction to 32-bit microprocessors	1hour
4.2	Salient features of 808286, 80386 and 80486 and comparison (Lecturer 1)	1hour
4.3	Salient features of 808286,80386 and 80486 and comparison (Lecturer 2)	1hour
4.4	80586 -Pentium System Architecture	1hour
4.5	Branch prediction and Enhanced instruction sets	1hour
4.6	MMX architecture, Data types and instruction sets.	1hour
4.7	Journey to Pentium -pro and Pentium -II	1hour
Module 5: (Microcontrollers) (7 hours)		
5.1	8051 Architecture (Lecture 1)	1hour
5.2	8051 Architecture (Lecture 2)	1hour
5.3	Register Organization, Memory and I/O addressing	1hour
5.4	Interrupts and Stack,Addressing Modes	1hour
5.5	Data transfer instructions, Arithmetic instructions, Logical instructions,	1hour

5.6	Boolean instructions, Control transfer instructions	1hour
5.7	Programming of 8051 (Lecture 1)	1hour

CST423	CLOUD COMPUTING	CATEGORY	L	T	P	CREDIT
		Program Elective II	2	1	0	3

Preamble: This course helps the learners to understand cloud computing concepts. This course includes basic understanding of virtualization, fundamentals of cloud security, cloud computing based programming techniques and different industry popular cloud computing platforms. This course enables the student to suggest cloud based solutions to real world problems.

Prerequisite: Basic understanding of computer networks and operating systems.

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the various cloud computing models and services. **(Cognitive Knowledge Level: Understand)**
CO2	Demonstrate the significance of implementing virtualization techniques. **(Cognitive Knowledge Level: Understand**)
CO3	Explain different cloud enabling technologies and compare private cloud platforms **(Cognitive Knowledge Level: Understand**)
CO4	Apply appropriate cloud programming methods to solve big data problems. (Cognitive Knowledge Level: **Apply**)
CO5	Describe the need for security mechanisms in cloud (**Cognitive Knowledge Level: Understand**)
CO6	Compare the different popular cloud computing platforms **(Cognitive Knowledge Level: Understand**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔											✔
CO2	✔	✔	✔									✔
CO3	✔											✔
CO4	✔	✔	✔	✔	✔							✔
CO5	✔	✔										✔
CO6	✔				✔							✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO 1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO 2	Problem Analysis	**PO8**	Ethics
PO 3	Design/Development of solutions	**PO9**	Individual and team work
PO 4	Conduct investigations of complex problems	**PO10**	Communication
PO 5	Modern tool usage	**PO11**	Project Management and Finance
PO 6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks
	Test1 (Percentage)	Test2 (Percentage)	
Remember	30	30	30
Understand	40	40	40
Apply	30	30	30
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance: 10 marks

Continuous Assessment Tests: 25 marks

Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks.

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing the remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have a maximum of 2 subdivisions and carries 14 marks.

SYLLABUS

Module 1: Fundamental Cloud Computing (7 Hours)

Traditional computing- Limitations. Overview of Computing Paradigms-Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing. NIST reference Model-Basic terminology and concepts. Cloud characteristics, benefits and challenges, Roles and Boundaries. Cloud delivery (service) models-Infrastructure-as-a-Service (IaaS), Platform-as-a-Service(PaaS),Software-as-a-Service (SaaS), XaaS (Anything-as-a-service)-Cloud deployment models- Public cloud, Community cloud, Private cloud, Hybrid cloud.

Module 2: Virtualization (7 Hours)

Introduction to virtualization-Virtualizing physical computing resources, Virtual Machines (Machine virtualization), non-virtualized v/s virtualized machine environments. Types of VMs- process VM v/s system VM, Emulation, interpretation and binary translation. Hardware-level virtualization-Hypervisors/VMM. Types of Hypervisors. Full Virtualization, Para-Virtualization, Hardware-assisted virtualization, OS level virtualization. Basics of Network Virtualization, Storage Virtualization and Desktop Virtualization, Pros and cons of virtualization. Case Study- Xen: Para-virtualization, VMware: full virtualization.

Module 3: Cloud-Enabling Technologies, Private cloud platforms and programming (7 Hours)

Broadband networks and internet architecture- Internet Service Providers (ISPs), Data center technology, Web technology, Multitenant technology, Service technology. Resource provisioning techniques-static and dynamic provisioning.

Open-source software platforms for private cloud-OpenStack, CloudStack, Basics of Eucalyptus, Open Nebula, Nimbus.

Cloud Programming- Parallel Computing and Programming Paradigms. Map Reduce – Hadoop Library from Apache, HDFS, Pig Latin High Level Languages, Apache Spark.

Module 4: Fundamental Cloud Security (7 Hours)

Basic terms and concepts in security- Threat agents, Cloud security threats/risks, Trust. Operating system security-Virtual machine security-Security of virtualization- Security Risks Posed by Shared Images, Security

Risks Posed by Management OS. Infrastructure security- Network Level Security, Host Level Security, Application level security, Security of the Physical Systems. Identity & Access Management- Access Control.

Module 5: Popular Cloud Platforms (9 Hours)

Amazon Web Services(AWS):- AWS ecosystem- Computing services, Amazon machine images, Elastic Compute Cloud (EC2), Advanced compute services. Storage services-Simple Storage System (Amazon S3), Elastic Block Store (Amazon EBS), Database Services, Amazon CDN Services and Communication services.
Google Cloud Platform:- IaaS Offerings: Compute Engine (GCE), Cloud Storage, PaaS Offerings: Google App Engine (GAE), Storage services, Application services, Compute services, Database Services, SaaS Offerings: Gmail, Docs, Google Drive.
Microsoft Azure: Azure Platform Architecture, Hyper-V, Azure Virtual Machine, Compute services, Storage services.

Text Books

1. Thomas, E., Zaigham M., Ricardo P "Cloud Computing Concepts, Technology &Architecture.", (2013 Edition). Prentice Hall.
2. Buyya, R., Vecchiola, C., & Selvi, S. T. "Mastering cloud computing: foundations and applications programming", (2017 Edition), Morgan Kaufmann.
3. Bhowmik, S., "Cloud computing", (2017 Edition). Cambridge University Press.

References

1. Marinescu, D. C., "Cloud computing: theory and practice.", (2017 Edition). Morgan Kaufmann.
2. Buyya, R., Broberg, J., & Goscinski, A. M., "Cloud computing: Principles and paradigms" (2011 Edition). John Wiley & Sons.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. "*A hybrid cloud is a combination of two or more other cloud deployment models*". Justify the statement with an example.
2. What are the main characteristics of a Platform-as-a-Service solution?
3. How does cloud computing help to reduce the time to market for applications and to cut down capital expenses?
4. Differentiate public and private clouds in terms of flexibility.

Course Outcome 2 (CO2):

1. Define virtualization. What is the role of VMM in virtualization?
2. Explain various implementation levels of Virtualization.
3. State the differences between a traditional computer and a virtual machine.

Course Outcome 3 (CO3):

1. Differentiate between on-premise and cloud-based internetworking.
2. What are the benefits of Data Center Technologies?
3. What are the characteristics of Multi-tenant technology?
4. How can virtualization be implemented at the hardware level?

Course Outcome 4 (CO4):

1. Write a Hadoop MapReduce program that counts the number of occurrences of each character in a file.
2. Write a Hadoop MapReduce program to find the maximum temperature in the weather dataset.

Course Outcome 5 (CO5):

1. Why is it harder to establish security in the cloud?
2. Explain in detail about the security issues one should discuss with a cloud-computing vendor.
3. List and Explain major cloud security challenges.

Course Outcome 6 (CO6):

1. Explain the cloud based databases.
2. With a neat diagram, write about Google App Engine for PaaS applications.
3. Differentiate between amazon SimpleDB and Amazon RDS.
4. *"Storage services in the cloud are offered in two different forms as IaaS and as SaaS".*
   Explain.

B TECH IN ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Model Question Paper

QP Code: **Total Pages : 3**

Reg No:_______________ **Name :__________________**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST423
Course Name: Cloud Computing

Duration: 3 Hrs **Max. Marks :100**

PART A

Answer all Questions. Each question carries 3 Marks (10 x 3 = 30 Marks)

1. Is the IT outsourcing model of traditional computing similar to cloud computing?Justify.
2. Why is grid computing considered as the predecessor of cloud computing? Explain.
3. What is virtualization and what are its benefits?
4. Explain why a hypervisor is also called a virtual machine monitor?
5. Differentiate between multi-tenancy and virtualization.
6. "*The field of service technology is a keystone foundation of cloud computing*". Explain.
7. Discuss any two identity management techniques used in cloud computing.
8. Differentiate between mandatory access control (MAC) and discretionary AccessControl (DAC).
9. Differentiate between Amazon S3 and Amazon EBS.
10. Explain the database service offered by google cloud.

(10 x3 =30)

PART B

Answer any one Question from each Module. Each question carries 14 Marks

11.	**(a)**	Discuss the cloud computing reference model.	**(8)**
	(b)	Which are the basic components of an IaaS-based solution for cloud computing? Also provide some examples of IaaS implementations.	**(6)**
		OR	
12.	**(a)**	List down the characteristics and challenges of cloud computing.	**(6)**
	(b)	Classify the various types of clouds.	**(8)**
13.	**(a)**	List and discuss various types of virtualization.	**(8)**
	(b)	Differentiate between full virtualization and paravirtualization.	**(6)**
		OR	
14.	**(a)**	What is Xen? Discuss its elements for virtualization.	**(8)**
	(b)	Explain the design requirements for Virtual Machine Monitor (VMM).	**(6)**
15.	**(a)**	Explain the broadband networks and internet architecture.	**(8)**
	(b)	List and explain the technologies and components of data centers.	**(6)**
		OR	
16.	**(a)**	What are the major functions of the MapReduce framework? Explain the logical data flow of MapReduce function using a suitable example .	**(8)**
	(b)	Write a Hadoop MapReduce program that counts the number of occurrences of each word in a file.	**(6)**

17. (a) Explain common threats and vulnerabilities in cloud-based environmentswith suitable examples. **(8)**

(b) Discuss the security risks posed by shared images with suitable examples. **(6)**

OR

18. **(a)** Explain the operating system security in cloud computing. **(8)**

(b) What do you mean by threat agents?. Explain different types of threatagents. **(6)**

19. **(a)** Describe Amazon EC2 and its basic features. **(8)**

(b) Illustrate the architecture of Amazon S3. **(6)**

OR

20. **(a)** Describe the core components of Google AppEngine. **(8)**

(b) Explain the architecture of Windows Azure. **(6)**

Teaching Plan

No	CONTENTS	No. of Lecture Hours (37 hrs)
Module 1 (Fundamental Cloud Computing) (6 hours)		
1.1	Traditional computing: Limitations.	1
1.2	Overview of Computing Paradigms: Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing.	1
1.3	NIST reference Model, Basic terminology and concepts.	1
1.4	Cloud characteristics and benefits, challenges. Roles and Boundaries.	1
1.5	Cloud delivery (service) models: Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), Software-as-a-Service (SaaS), XaaS (Anything-as-a-service).	1
1.6	Cloud deployment models: Public cloud, Community cloud, Private cloud, Hybrid cloud.	1
Module 2(Virtualization)(7 Hours)		
2.1	Introduction to virtualization, Virtualizing physical computing resources Virtual Machines (Machine virtualization):- non-virtualized v/s virtualized machine environments.	1
2.2	Types of VMs: process VM v/s system VM, Emulation, interpretation and binary translation.	1
2.3	Hardware-level virtualization: Hypervisors/VMM, Types of Hypervisors.	1
2.4	Full Virtualization, Para-Virtualization, Hardware-assisted virtualization, OSlevel virtualization.	1
2.5	Basics of Network Virtualization, Storage Virtualization and Desktop Virtualization, Pros and cons of virtualization.	1
2.6	Case Study: Xen: Para-virtualization.	1
2.7	Case Study: VMware: full virtualization.	1

Module 3 (Cloud-Enabling Technologies, Private cloud platforms and programming) (9 Hours)		
3.1	Broadband networks and internet architecture: Internet Service Providers (ISPs), Data center technology, Web technology, Multitenant technology, Service technology.	1
3.2	Resource provisioning techniques: static and dynamic provisioning.	1
3.3	Open-source software platforms for private cloud: OpenStack, CloudStack.	1
3.4	Basics of Eucalyptus, Open-Nebula, Nimbus.	1
3.5	Cloud Programming: Parallel Computing and Programming Paradigms.	1
3.6	Map Reduce.	1
3.7	Hadoop Library from Apache, HDFS.	1
3.8	Pig Latin High Level Languages	1
3.9	Apache Spark.	1
Module 4 (Fundamental Cloud Security) (7 Hours)		
4.1	Basic terms and concepts in security, Threat agents.	1
4.2	Cloud security threats/risks, Trust.	1
4.3	Operating system security, Virtual machine security.	1
4.4	Security of virtualization.	1
4.5	Security Risks posed by Shared Images, Security Risks posed by ManagementOS.	1
4.6	Infrastructure security: - Network Level Security, Host Level Security,Application level security, Security of the Physical Systems.	1
4.7	Identity & Access Management, Access Control.	1
Module 5 (Popular Cloud Platforms) (8 Hours)		

5.1	Amazon Web Services(AWS):- AWS ecosystem, Computing services: Amazon machine images, Elastic Compute Cloud (EC2).	1
5.2	Advanced computing services, Storage services: Simple Storage System (Amazon S3), Elastic Block Store (Amazon EBS).	1
5.3	Database Services, Amazon CDN Services and Communication services.	1
5.4	Google Cloud Platform:- IaaS Offerings: Compute Engine (GCE), Cloud Storage.	1
5.5	PaaS Offerings: Google App Engine (GAE), Storage services, Application services, Compute services.	1
5.6	Database Services, SaaS Offerings: Gmail, Docs, Google Drive.	1
5.7	Microsoft Azure: Azure Platform Architecture, Hyper-V, Azure Virtual Machine.	1
5.8	Azure Compute services, Storage services.	1

CST433	SECURITY IN COMPUTING	CATEGORY	L	T	P	CREDIT
		Program Elective II	2	1	0	3

Preamble: This course helps the learners to explore various algorithms to offer confidentiality, integrity, authentication &non-repudiation services and different attacks on system security with their countermeasures. It covers classical encryption techniques, symmetric and public key crypto-system, key distribution techniques, authentication functions, intruders, malicious software, and DDoS attacks. The concepts covered in this course enable the learners in effective use of cryptographic algorithms and appropriate countermeasures for securing real life applications.

Prerequisite: A fundamental knowledge in mathematical foundations of security.

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

CO1	Identify the security services provided against different types of securityattacks. **(Cognitive Knowledge Level: Understand)**
CO2	Illustrate classical encryption techniques for information hiding. **(Cognitive Knowledge Level: Apply)**
CO3	Illustrate symmetric/asymmetric key cryptosystems for securecommunication. **(Cognitive Knowledge Level: Apply)**
CO4	Explain message integrity and authentication methods in a securecommunication scenario. **(Cognitive Knowledge Level: Understand)**
CO5	Interpret public/secret key distribution techniques for secure communication. **(Cognitive Knowledge Level: Understand)**
CO6	Identify the effects of intruders, malicious software and distributed denial of service attacks on system security. **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓									✓
CO2	✓	✓	✓									✓
CO3	✓	✓	✓		✓							✓
CO4	✓	✓	✓			✓						✓
CO5	✓	✓	✓									✓
CO6	✓	✓	✓			✓		✓				✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	**Test 1 (%)**	**Test 2 (%)**	**End Semester Examination (%)**
Remember	30	30	30
Understand	40	40	40
Apply	30	30	30
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Test : **25 marks**

Continuous Assessment Assignment : **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

SYLLABUS

Module-1 (Basics of Security and Traditional Cryptosystems)

OSI security architecture – Security attacks, Services, Mechanisms. Cryptography vs Cryptanalysis. Classical encryption techniques – Symmetric cipher model. Substitution ciphers

– Monoalphabetic vs Polyalphabetic ciphers, Caesar cipher, Affine cipher, Playfair cipher, Vigenere cipher, Hill cipher. Transposition ciphers – Keyless, Keyed, Double transposition.

Module-2 (Modern Symmetric Key Cryptosystems)

Symmetric key ciphers – Block vs Stream ciphers, Block cipher components, Product ciphers, Feistel and Non-Feistel ciphers. Data Encryption Standard (DES) – Structure, Key generation, Design criteria, Weaknesses, Double DES, Triple DES. Advanced Encryption Standard (AES) – Structure, Key expansion. Block cipher modes of operation – Electronic Codebook Mode (ECB), Cipher Block Chaining Mode (CBC), Cipher Feedback Mode (CFB), Output Feedback Mode (OFB), Counter Mode (CTR). Stream ciphers – Structure, RC4.

Module-3 (Public Key Cryptosystems)

Introduction to public key cryptosystems – Principles, Applications, Requirements, Conventional vs Public key cryptosystems. RSA cryptosystem – Algorithm, Security, Attacks. ElGamal cryptosystem – Algorithm. Diffie-Hellman key exchange – Algorithm, Man-in-the- middle attack. Elliptic Curve Cryptography (ECC) – ElGamal ECC, Key exchange using ECC.

Module-4 (Message Integrity and Authentication)

Hash functions – Security requirements, Secure Hash Algorithm (SHA-512). Message Authentication Code (MAC) – Requirements, Uses, Hash-based MAC (HMAC), Cipher-based MAC (CMAC). Digital signatures – Attacks, Forgeries, Requirements, Direct vs Arbitrated digital signatures, RSA digital signature, ElGamal digital signature, Digital Signature Standard(DSS).

Module-5 (Key Distribution and System Security)

Key management – Distribution of secret keys using symmetric and asymmetric encryption, Distribution of public keys. System security – Intruders, Intrusion detection techniques, Password management. Malicious software – Viruses, Related threats, Countermeasures. Distributed Denial of Service (DDoS) attacks – Types, Countermeasures.

Text Books

1. William Stallings, Cryptography and Network Security Principles and Practice, 4/e, Pearson Ed.
2. Behrouz A Forouzan, Cryptography and Network Security, 3/e, Tata McGraw-Hill.

References

1. Charles P Pfleeger, Shari Lawrence Pfleeger, Jonathan Margulies, Security in Computing, 5/e, Prentice Hall.
2. G.A. Jones & J.M. Jones, Elementary Number Theory, Springer UTM, 2007.

Sample Course Level Assessment

QuestionsCourse Outcome 1 (CO1):

1. Define the type of security attack in the following case: A student breaks into ateacher's office to obtain a copy of the next day's exam question paper.
2. Which security mechanism is provided in the following case: A bank requires thecustomer's signature for a withdrawal.

Course Outcome 2 (CO2):

1. Alice wishes to send the message "COME BACK EARLY" to Bob, using Playfaircipher. The key to be used is "SAFFRON". Show the process of encryption.
2. Using Affine cipher, encrypt "HOT" and decrypt "JDG". Key is (7, 3).
3. Implement the Vigenere cipher method in a suitable programming language.(Assignment)

Course Outcome 3 (CO3):

1. If the DES key with parity bit is 0123 ABCD 2562 1456, find the first round key.
2. In RSA, given p=19, q=23, public key(e)=3, find n, ϕ(n) and private key(d).
3. Implement any two symmetric/asymmetric encryption techniques in a suitableprogramming language. (Assignment)

Course Outcome 4 (CO4):

1. Describe the steps involved in generating a Hash-based MAC.
2. Using ElGamal scheme, generate the signatures for the message M=400 with p=881, d=700 and r=17.
3. A company wishes to implement a secure authentication mechanism for communication. As a system security admin suggest any two ways of implementing such a mechanism. (Assignment)

Course Outcome 5 (CO5):

1. List any two ways in which secret keys can be distributed to two communicating parties.
2. Explain the significance of a public-key authority in the distribution of public keys.

Course Outcome 6 (CO6):

1. What are false positives and negatives in the context of Intrusion Detection Systems?How can we reduce these two?
2. Distinguish between a direct DDoS attack and a reflector DDoS attack.
3. Bob works as a network administrator in ABC & Co. On a day of his absence, he shared his admin password with one of his colleagues, John, to manage a network issue. Later John started misusing this privilege by launching DoS attacks in the network. Describe the ethical issues in this scenario and how can this be avoided? (Assignment)

Model Question Paper

QP CODE: **PAGES: ___**

Reg No:______________
Name:________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST433
Course Name: SECURITY IN COMPUTING

Max Marks: 100 **Duration: 3 Hours**

PART A
(Answer All Questions. Each question carries 3 marks)

1. Differentiate between passive attack and active attack.
2. Use an Affine cipher to encrypt the message "SECURITY" with the key pair(7,2) in modulus 26.
3. Compare stream cipher and Block cipher with example.
4. Differentiate between diffusion and confusion.
5. Define the elliptic curve logarithm problem.
6. Consider an ElGamal scheme with a common prime q = 71 and a primitive root α = 7. If B has a public key YB = 3 and A chose the random number k = 2, what is the ciphertext of the message M = 30?
7. Give the requirements of MAC function.
8. Specify the different types of forgery in digital signature.
9. List three different classes of intruders.
10. Mention the phases of operation of a virus.

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Illustrate the two approaches to attack a conventional encryption scheme. **(4)**

(b) A Hill cipher is setup with the key matrix $\begin{matrix} 9 & 4 \\ 5 & 7 \end{matrix}$. **(10)**

Encrypt the text "COMPUTER". Show the calculations for the correspondingdecryption of the ciphertext to recover the original text back.

OR

12. (a) Encrypt the text "this is an exercise and complete it" using transposition cipher with the key (3,2,1,4,5). Show decryption of the ciphertext to recover the original text back. **(6)**

(b) Encrypt the message "the house is being sold tonight"using the followingciphers. Ignore the space between words. **(8)**

i) Vigenere cipher with key = "largest".

ii) Autokey system of Vigenere cipher with key ="largest".

13. (a) How is round key generated in DES? **(4)**

(b) Illustrate AES encryption in detail. **(10)**

OR

14. (a) Explain the construction of S-box in AES. **(5)**

(b) Summarize the primitive operations in RC4 algorithm. **(9)**

15. (a) Compare the Cipher Block Chaining Mode (CBC) and Cipher Feedback Mode (CFB) of block ciphers. **(6)**

(b) Explain RSA cryptosystem. In an RSA cryptosystem a participant A uses two prime numbers p=13 and q=17 to generate public key and private key. The public key of A is 35. Find the private key of A. **(8)**

OR

16. (a) Illustrate ElGamal cryptosystem. **(6)**

(b) Consider a Diffie–Hellman scheme with a common prime q=11 and a primitive root α=2. **(8)**

i) Show that 2 is a primitive root of 11.

ii) If User A has public key YA= 9, what is A's private key XA?

iii) If User A has public key YB= 3, what is the shared secret key K, shared with A?

17. (a) Describe different types of arbitrated digital signature techniques. **(6)**

(b) Explain Cipher – Based Message Authentication Code. **(8)**

OR

18. (a) Explain the attacks on digital signature. **(5)**

(b) Describe the working of SHA-512 with diagrams. **(9)**

19. (a) Explain four techniques used to avoid guessable passwords. **(6)**

(b) Describe the different techniques for public key distribution. **(8)**

OR

20. (a) Explain different types of Simple DDoS attack and its countermeasures. **(6)**

(b) Differentiate between statistical anomaly detection and rule-based intrusion detection. **(8)**

Teaching Plan

No	Contents	No.of Lecture Hours (35Hrs)
	Module-1 (Basics of Security and Traditional Cryptosystems) (6 hrs)	
1.1	OSI security architecture – Security attacks, Services, Mechanisms	1
1.2	Cryptography vs Cryptanalysis. Classical encryption techniques – Symmetric cipher model	1
1.3	Substitution ciphers – Monoalphabetic vs Polyalphabetic ciphers, Caesar cipher, Affine cipher	1
1.4	Playfair cipher, Vigenere cipher	1
1.5	Hill cipher	1
1.6	Transposition ciphers – Keyless, Keyed, Double transposition	1
	Module-2 (Modern Symmetric Key Cryptosystems) (9hrs)	
2.1	Symmetric key ciphers – Block vs Stream ciphers, Block cipher components, Product ciphers, Feistel and Non-Feistel ciphers	1
2.2	Data Encryption Standard (DES) – Structure, Key	1

	generation	
2.3	Design criteria, Weaknesses	1
2.4	Double DES, Triple DES	1
2.5	Advanced Encryption Standard (AES) – Overall Structure	1
2.6	Stages of encryption/decryption	1
2.7	Key expansion	1
2.8	Block cipher modes of operation – Electronic Codebook Mode (ECB), Cipher Block Chaining Mode (CBC), Cipher Feedback Mode (CFB), Output FeedbackMode (OFB), Counter Mode (CTR).	1
2.9	Stream ciphers – Structure, RC4	1
Module-3 (Public Key Cryptosystems)(7hrs)		
3.1	Public key cryptosystems – Principles, Applications, Requirements,Conventional vs Public key cryptosystems	1
3.2	RSA cryptosystem – Algorithm	1
3.3	RSA Security, Attacks	1
3.4	ElGamal cryptosystem – Algorithm	1
3.5	Diffie-Hellman key exchange – Algorithm, Man-in-the-middle attack	1
3.6	Elliptic Curve Cryptography (ECC) – ElGamal ECC	1

3.7	Key exchange using ECC	1
Module-4 (Message Integrity and Authentication) (6 hrs)		
4.1	Hash functions – Security requirements, Secure Hash Algorithm (SHA-512)	1
4.2	Message Authentication Code (MAC) – Requirements, Uses	1
4.3	Hash-based MAC (HMAC), Cipher-based MAC (CMAC)	1
4.4	Digital signatures – Attacks, Forgeries, Requirements, Direct Vs Arbitrated digital signatures	1
4.5	RSA digital signature, ElGamal digital signature	1
4.6	Digital Signature Standard (DSS)	1
Module-5 (Key Distribution and System Security) (7hrs)		
5.1	Key management – Distribution of secret keys using symmetric and asymmetric encryption	1
5.2	Distribution of public keys	1
5.3	System security – Intruders, Intrusion detection techniques	1
5.4	Password management	1
5.5	Malicious software – Viruses, Related threats	1
5.6	Virus countermeasures	1
5.7	Distributed Denial of Service (DDoS) attacks – Types, Countermeasures	1

CST443	MODEL BASED SOFTWARE DEVELOPMENT	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PEC	2	1	0	3	2019

Preamble: The objective of the course is to familiarize learners about the concepts and advantages of using model based software development. This course covers the methodologies in developing the model of a software, perform analysis on the model and automatic generation of code from the model. The OSATE framework and its plugins using the Architecture Analysis and Design Language(AADL) language is used in the course to demonstrate the end-to-end concept of MBSD which helps the learners to get a hands on experience.

Prerequisite: Software Engineering

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the relevance of model based software development in the software development process. (**Cognitive Knowledge level: Understand**)
CO2	Explain Model Driven Architecture with Computation Independent Model (CIM), Platform Independent Model(PIM), Platform Specific Model (PSM). (**Cognitive Knowledge level: Apply**)
CO3	Illustrate software modeling with Architecture Analysis and Design Language (AADL). (**Cognitive Knowledge level: Apply**)
CO4	Explain error annex using error modelling concepts and illustrate error modelling in AADL. (**Cognitive Knowledge level: Understand**)
CO5	Illustrate the process of code generation from an AADL model. (**Cognitive Knowledge level: Understand**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔	✔									✔
CO2	✔	✔	✔	✔								✔
CO3	✔	✔	✔	✔								✔
CO4	✔	✔	✔									✔
CO5	✔	✔	✔									✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Test 1 (Marks in percentage)	Test 2 (Marks in percentage)	End Semester Examination Marks
Remember	30	30	30
Understand	50	50	50
Apply	20	20	20
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test : 25 marks
Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. The first series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing the remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have a maximum of 2 sub-divisions and carries 14 marks.

Syllabus

Module - 1 (Introduction to Model Based Software Development)

Software faults, Introduction to Model checking, Introduction to Automated Testing, Model Based Software Development (MBSD) – Need, MBSD Approach, Learning MBSD from the perspective of Architecture Analysis and Design Language (AADL).

Module - 2 (More on MBSD)

MBSD based software development – Requirements, Analysis, Design and Implementation. Model-Driven Architecture **-** Definitions and Assumptions, Overview of MBSD methodology, The modeling levels-Computation Independent Model (CIM), Platform Independent Model (PIM), Platform Specific Model (PSM). Introduction to AADL, Basic Comparison of AADL with other modeling languages - Comparison with UML.

Module -3 (Modeling using AADL)

Modeling: Developing a Simple Model - Define the components - Explain with example (powerboat autopilot system), Develop a top-level model - Use example Powerboat Autopilot (PBA) system.

AADL: Components - Software, Hardware, Composite, Runtime semantics, Language syntax, AADL declarations, AADL classifiers, AADL system models and specifications

Case Study: Powerboat Autopilot System.

Module - 4 (Model Analysis)

Safety Analysis -Fault tree analysis, Minimal cutsets. Error Modeling in AADL-Error Model Libraries and Subclause Annotations, Error Types and Common Type Ontology, Error Sources and Their Impact, Component Error Behavior, Compositional Abstraction of Error Behavior, Use of Properties in Architecture Fault Models, Error modeling example.

Module - 5 (Code Generation)

Need for code generation, Categorization, Code Generation Techniques, Code Generation in AADL Model – Ocarina.

Text Books

1. Marco, Brambilla, Jordi Cabot, Manuel Wimmer, Model-Driven Software Engineering in Practice, 2/e, Synthesis Lectures on Software Engineering, 2017.
2. Christel Baier and Joost-Pieter Katoen, Principles of model checking, The MIT Press.
3. Thomas Stahl and Markus Volter, Model-Driven Software Development, Wiley, 2006.
4. David P. Gluch, Peter H. Feiler, Model-Based Engineering with AADL: An Introduction to the SAE Architecture Analysis & Design Language, Adison-Wesley, 2015.

References:

1. Automated software testing : http://www2.latech.edu
2. Peter H. Feiler, David P. Gluch, John J. Hudak.The Architecture Analysis & Design Language(AADL): An Introduction.
3. de Niz, Dionisio, Diagrams and Languages for Model-Based Software Engineering of EmbeddedSystems: UML and AADL
4. FAA System Safety Handbook, Chapter 8: Safety Analysis/Hazard Analysis Tasks
5. Enno Ruijters, Marielle Stoelinga, Fault tree analysis: A survey of the state-of-the-art in modeling, analysis and tools.
6. Larson, Brian &Hatcliff, John & Fowler, Kim &Delange, Julien. (2013). Illustrating the AADL error modeling annex (v.2) using a simple safety-critical medical device. ACM SIGAda Ada Letters. 33. 65-84. 10.1145/2527269.2527271.
7. Delange, Julien&Feiler, Peter &Hudak, John &Gluch, Dave. (2016). Architecture Fault Modeling and Analysis with the Error Model Annex, Version 2. 10.13140/RG.2.1.4224.7927.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Justify the need of model based software development?
2. Explain the advantages of model based software development?

Course Outcome 2 (CO2):

1. Explain infrastructure of model driven architecture.
2. Describe about MDA modeling levels.

Course Outcome 3 (CO3):

1. Illustrate the basic components of an AADL Model.

2. Assume we have a system to regulate the fuel valve of a boiler by monitoring the steam flow and steam pressure. Identify the basic components of this system and design its AADL model.

Course Outcome 4 (CO4):

1. Suppose we have an isolette system which ensures the temperature is within a specified temperature range with following components:

   i) temperature sensor - detects air temperature.

   iii) heat source - supply hot air to maintain temperature.

   iv) operator interface - specify target temperature range(lower desired temperature, upper desired temperature.)

   iv) thermostat - takes as input an air temperature value from a temperature sensor and controls a heat source to produce an air temperature within a target range.

   Model the error flows, error propagations, component error behaviour and error properties for the value error in the isolette system.

Course Outcome 5 (CO5):

1. Illustrate code generation from an AADL model.

Model Question Paper

QP CODE:

Reg No: _______________

Name: ___________________ **PAGES : 4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST443

Course Name: Model Based Software Development

Max. Marks : 100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1. List any three advantages of automated software testing.

2. Specify the steps and their purpose in the model checking process.

3. Compare Analysis And Design Language (AADL) with Unified modeling language (UML).

4. Describe the design phase in the model based software development process.

5. Represent interface component with an out data port and an out event port in AADL.
   a) textual b)graphical

6. Give the textual top level model of a powerboat autopilot system in AADL.

7. What is an error type? Mention any two pre-declared timing and value errors in AADL.

8. Define : (i) Fault Tree Analysis (ii) Minimal cutsets

9. Explain templates and filtering code generation technique.

10. How does automated code generation help to deal with faults in a software system?

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Explain model based software development approach. **(12)**

(b) Why is model based software development important? **(2)**

OR

12. (a) What are software faults? Mention any three software faults and its consequences. **(5)**

(b) Explain two approaches for ensuring software reliability? **(9)**
(i) Model Checking
(ii) Automated Testing

13. (a) Illustrate model based software development process. **(8)**

(b) Explain infrastructure of model driven architecture. **(6)**

OR

14. (a) What is AADL? Compare AADL and UML. **(6)**

(b) Explain in detail about MDA modeling levels. **(8)**

15. (a) Illustrate the components of an AADL model. **(12)**

(b) What is the AADL language syntax? **(2)**

OR

16. (a) Explain the following:

i) AADL classifiers

ii) AADL declarations **(2)**

(2)

(b) Design an AADL model which controls the speed of a vehicle. Also describe the basic components of the designed model. **(10)**

17. (a) Illustrate how value error can be modelled using AADL in the isolette system. **(10)**

(b) With a diagram explain error propagation, termination and transformation in AADL models. **(4)**

OR

18. (a) Illustrate error state machines in AADL using proper textual representations. **(8)**

(b) Suppose we have a train door controller system with following components **(6)**

i) door_controller - ensures safe opening of the door.

ii) train_controller - sends train speed and transit status to the door_controller.

iii) alarm - triggered when an emergency occurs in other components.

Model the error flows, error propagations, component error behaviour and error properties for the value error in the component door_controller.

19. (a) Explain templates and meta model type code generation? **(4)**

(b) Illustrate how the code can be generated from an AADL model. **(10)**

OR

20. (a) Describe any four code generation techniques. **(10)**

(b) Explain the advantages of automatic code generation. **(4)**

Teaching Plan

Sl No	Contents	Number of Lecture Hours (35)
	Module 1 (Introduction) (7 Hours)	
1.1	Software faults	1
1.2	Introduction to Model Checking	1
1.3	Introduction to Automated Testing (Lecture 1)	1
1.4	Introduction to Automated Testing (Lecture 2)	1
1.5	Need for MBSD, MBSD Approach	1
1.6	Architecture centric model driven software development	1
1.7	AADL and architecture-centric model-based software systems	1
	Module 2 (Model Based Software Development) (7 Hours)	
2.1	Model based software development process	1
2.2	Overview of MBSD methodology	1
2.3	Model Driven Architecture	1
2.4	MDA Definitions and Assumptions	1
2.5	The modeling levels	1
2.6	Introduction to AADL	1
2.7	Comparison of AADL with other modeling languages	1
	Module 3 (Modeling using AADL) (7 Hours)	
3.1	Modeling in detail: AADL components	1
3.2	Modeling in detail: Developing a simple model	1

3.3	Modeling in detail: Define top level model with an example	1
3.4	AADL in detail: Explain AADL components, Language syntax	1
3.5	AADL declarations and classifiers	1
3.6	AADL system models and specifications	1
3.7	Case study: Power boat auto pilot system	1
	Module 4 (Model Analysis)(7 Hours)	
4.1	Introduction to safety analysis	1
4.2	Fault tree analysis, minimal cutsets	1
4.3	Error modeling with AADL - Error Model Libraries and Subclause Annotations	1
4.4	Error modeling with AADL - Error Types and Common Type Ontology,	1
4.5	Error modeling with AADL - Error Sources and Their Impact, Component Error Behavior	1
4.6	Error modelling with AADL - Compositional Abstraction of Error Behavior, Use of Properties in Architecture Fault Models	1
4.7	Illustrate isolette error model	1
	Module 5 (Code Generation) (7 Hours)	
5.1	Code generation and its advantages	1
5.2	Categorization	1
5.3	Code generation techniques - Templates + filtering, Template + metamodel, Frame processors	1
5.4	Code generation techniques - API-based generators, In-line generation, Code attributes	1
5.5	Code generation techniques - Code weaving Commonalities and Differences Between the Different Code generation Approaches	1
5.6	Code generation in AADL - Ocarina	1
5.7	Illustration of code generation using AADL model	1

CMT 453	Fundamentals of Business Analytics	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: The course aims to introduce the fundamental concepts of business analytics to students. This involves basic concepts of business analytics, descriptive analytics, predictive analytics, forecasting techniques, prescriptive analytics and to apply the appropriate analytics for generating solutions.

Prerequisite: Basic knowledge in Probability and Statistical Modelling.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the concept of Business Analytics process and the role of Business Analytics in decision making**. (Cognitive Knowledge level: Understand)**
CO 2	Use appropriate methods for solving problems in Descriptive analytics **(Cognitive knowledge level: Apply)**
CO 3	Use appropriate methods to solve problems using Predictive analytics techniques. **(Cognitive Knowledge level: Apply)**
CO 4	Use appropriate forecasting techniques to inference analyze business trends. **(Cognitive Knowledge level: Apply)**
CO 5	Formulate linear programming model for solving a problem **(Cognitive Knowledge level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓				✓							✓
CO2	✓	✓	✓		✓							✓
CO3	✓	✓	✓		✓							✓
CO4	✓	✓	✓		✓							✓
CO5	✓	✓	✓		✓							✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks
	Test1 (percentage)	Test2 (percentage)	
Remember	20	20	20
Understand	40	40	40
Apply	40	40	40
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance: 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment: 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing the remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have a maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module -1 (Introduction To Business Analytics)

Business Analytics - Terminologies, Business Analytics Process, Importance, Relationship of BA process and Organization Decision-Making process, Managing BA Personnel, Data and Technology. Organization Structures aligning BA. Management Issues – Establishing an Information policy, Outsourcing BA, Data quality, Measuring BA contribution, Change Management in BA.

Module -2 (Descriptive Analytics)

Introduction to Descriptive analytics – Visualizing and Exploring Data – Descriptive Statistics - Sampling and Estimation - Probability Distribution for Descriptive Analytics - Marketing/Planning Case Study Example : Descriptive analytics step in the BA process.

Module -3 (Predictive Analytics)

Introduction to Predictive analytics – Predictive Modeling - Logic and Data Driven

Models - Predictive Analysis Modeling and procedure. Data Mining: Simple Illustration of Data Mining, Data Mining Methodologies. Prescriptive Analysis step in the BA Process - Analysis of Predictive analytics.

Module - 4 (Forecasting Techniques)

Introduction - Types of Variation in Time Series Data - Simple Regression Model - Multiple Regression Models - Simple Exponential Smoothing - Smoothing Averages - Fitting Models to Data - How to Select Models and Parameters for Models - Forecasting Practice Problems.

Module - 5 (Prescriptive Analytics)

Introduction to Prescriptive analytics - Prescriptive Modeling - Non Linear Optimization. Prescriptive step in the BA Analysis – Background Review and Prescriptive Analysis.

Linear Programming – Types of Linear Programming Problems/Models - Linear Programming Problems/Model Elements - Linear Programming Problems/Model Formulation Procedure.

Text Books

1. Marc J. Schniederjans, Dara G. Schniederjans and Christopher M. Starkey, "Business Analytics Principles, Concepts, and Applications - What, Why, and How", Pearson Ed, 2014.
2. James R. Evans, "Business Analytics - Methods, Models and Decisions", Pearson Ed, 2012

Reference Books

1. Christian Albright S and Wayne L. Winston, "Business Analytics - Data Analysis and Decision Making", Fifth edition, Cengage Learning, 2015.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Compare business analytics and organization decision-making process.
2. Explain how business analytics can help an organization achieve a competitive advantage.

Course Outcome 2 (CO2):

1. Describe the sampling methods useful in BA. What is sampling estimation and describe how it can aid in the BA process.
2. The Homes Golf Ball Company has made a number of different golf products over the years. Research on thousands of balls revealed the mean flight distance of its Maximum Fly golf ball product to be 450 yards, with a standard error of the mean of 145 yards. The company is hoping to improve the product to fly an additional 290 yards. What is the probability of the improvement from 450 to 740 yards?

Course Outcome 3(CO3):

1. Discuss the logic-driven and data-driven models used in Business analytics.
2. With an investment of \$100,000 in radio commercials and \$300,000 in TV commercials, what is the prediction on dollar product sales. Use the formula

   Y_p= -17150.4555 + 275.691X_1 + 48.341X_2 where

   Y_p= the estimated number of dollars of product sales

   X_1 = the number of dollars to invest in radio commercials

   X_2 = the number of dollars to invest in TV commercials

Course Outcome 4 (CO4):

1. What is forecasting accuracy? Discuss the most commonly used forecast accuracy statistics.
2. Give the forecasting model formula for a weighted moving average. Using a two-value (k) moving average with equal weights of 0.5?

Time Period	Sales
1	49
2	56
3	67
4	78

Course Outcome 5 (CO5):

1. Explain how to formulate a linear programming model?
2. A trucking firm must transport exactly 900, 800, 700 and 1000 units of a product to four cities: A, B, C and D. The product is manufactured and supplied in two other

cities X and Y, in the exact amounts to match the total demand. The production of units from the two cities is 1900 and 1500 units respectively to X and Y. The cost per unit to transport the product between the manufacturing plants in cities X and Y and the demand market cities A, B, C and D are given as :

	DEMAND MARKET			
SUPPLY PLANT	A	B	C	D
X	0.65	0.70	0.80	0.90
Y	0.60	0.60	0.80	0.70

For example, in the table $0.655 is the cost to ship one unit from Supply Plant X to Demand Market A. The trucking firm needs to know how many units should be shipped from each supply city to each demand city in such a way that it minimizes total cost. What is the LP model formulation for this problem?

Model Question paper

QP CODE: PAGES:3

Reg No:__________

Name :__________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

***Course Code:* CMT 453**

Course Name: Fundamentals of Business Analytics

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. Explain the relationship of business intelligence to the subject of business analytics.
2. Justify the statement: “ Establishing an information policy affect BA”.
3. Differentiate skewedness and kurtosis.

4. What is the 99 percent confidence interval for a problem with a mean value of 120 and a standard error of the mean 20?
5. Illustrate the importance of establishing clusters in BA.
6. How are neural networks helpful in determining both associations and classification tasks required in BA analyses?
7. Differentiate between additive time series model and multiplicative time series model.
8. What is meant by absolute deviation?
9. List the commonly used prescriptive analytics in the business analytics process.
10. How are prescriptive and descriptive analytics related?

(10x3=30)

PART B

Answer any one Question from each module. Each question carries 14 Marks

11. (a) The complete business analytic process involves the three major component steps applied sequentially to a source of data. Justify. (8 marks)
    (b) Compare business analytics and organization decision-making process. (6 marks)

OR

12. (a) Explain how business analytics can help an organization to achieve a competitive advantage. (7 marks)
    (b) Discuss the general management issues related to a BA program. (7 marks)

13. (a) Describe various types of statistical charts and how to apply them. (8 marks)
    (b) Discuss the use of confidence intervals and probability distributions. (6 marks)

OR

14. (a) Describe the sampling methods useful in BA. What is sampling estimation and describe how it can aid in the BA process. (8 marks)
    (b) The Homes Golf Ball Company has made a number of different golf products over the years. Research on thousands of balls revealed the mean flight distance of its Maximum Fly golf ball product to be 450 yards, with a standard error of the mean of 145 yards. The company is hoping to improve the product to fly an additional 290 yards. What is the probability of the improvement from 450 to 740 yards? (6 marks)

15. (a) Discuss the logic-driven and data-driven models used in Business analytics. (7 marks)

(b) With an investment of \$100,000 in radio commercials and \$300,000 in TV commercials, what is the prediction on dollar product sales. Use the formula (7 marks)

Y_p= -17150.4555 + 275.691X_1 + 48.341X_2 where

Y_p= the estimated number of dollars of product sales

X_1 = the number of dollars to invest in radio commercials

X_2 = the number of dollars to invest in TV commercials

OR

16. (a) Explain how data mining is an ideal predictive analytics tool used in the BA process. (7 marks)

(b) Assume for this problem the following table would have held true for the resulting marketing/planning case study problem. Which combination of variables is estimated here to be the best predictor set? Explain why. (7 marks)

Variable Combination	R –Square	R –Square (Adjusted)	F-Ratio
POS/radio	0.057	0.009	2.977
POS/TV	0.120	0.100	3.662
POS/radio/TV	0.179	0.101	4.315
Radio/TV	0.879	0.853	122.555

17. (a) What is forecasting accuracy? Discuss the most commonly used forecast accuracy statistics. (8 marks)

(b) Give the forecasting model formula for a weighted moving average. Using a two-value (k) moving average with equal weights of 0.5? (6 marks)

Time Period	Sales
1	49
2	56
3	67
4	78

OR

18. (a) Use the following data to construct a linear regression model for the auto insurance premium as a function of driving experience. (6 marks)

Driving Experience (in years)	5	2	12	9	15	6	25	16
Monthly auto insurance premium(\$)	64	87	50	71	44	56	42	60

(b) Explain multiple regression models with an example. Discuss the limitations on the use of multiple regression models in forecasting time series data. (8 marks)

19. (a) Explain how to formulate a linear programming model? (7 marks)

(b) A trucking firm must transport exactly 900, 800, 700 and 1000 units of a product to four cities: A, B, C and D. The product is manufactured and supplied in two other cities X and Y, in the exact amounts to match the total demand. The production of units from the two cities is 1900 and 1500 units respectively to X and Y. The cost per unit to transport the product between the manufacturing plants in cities X and Y and the demand market cities A, B, C and D are given as : (7 marks)

	DEMAND MARKET			
SUPPLY PLANT	A	B	C	D
X	0.65	0.70	0.80	0.90
Y	0.60	0.60	0.80	0.70

For example, in the table $0.655 is the cost to ship one unit from Supply Plant X to Demand Market A. The trucking firm needs to know how many units should be shipped from each supply city to each demand city in such a way that it minimizes total cost. What is the LP model formulation for this problem?

OR

20. (a) Explain the linear programming complications that prevent the simplex method from generating a desired optimal solution? (8 marks)

(b) Describe the five necessary assumptions that need to be met for Linear Programming to be used in a modeling situation. (6 marks)

Teaching Plan

Topics		No. of Lecture Hours (33)
Module - 1 (Introduction To Business Analytics)		**(6 hours)**
1.1	Business Analytics - Terminologies, Business Analytics Process	1 hour
1.2	Relationship of BA process and Organization Decision-Making process	1 hour
1.3	Managing BA Personnel, Data and Technology	1 hour
1.4	Organization Structures aligning BA.	1 hour
1.5	Management Issues – Establishing an Information policy, Outsourcing BA	1 hour

1.6	Data quality, Measuring BA contribution, Change Management in BA	1 hour
	Module - 2 (Descriptive Analytics)	**(6 hours)**
2.1	Introduction to Descriptive analytics	1 hour
2.2	Visualizing and Exploring Data, Descriptive Statistics	1 hour
2.3	Sampling and Estimation	1 hour
2.4	Probability Distribution for Descriptive Analytics	1 hour
2.5	Marketing/Planning Case Study Example	1 hour
2.6	Descriptive analytics step in the BA process	1 hour
	Module - 3 (Predictive Analytics)	**(7 hours)**
3.1	Introduction to Predictive analytics, Predictive Modeling	1 hour
3.2	Logic and Data Driven Models	1 hour
3.3	Predictive Analysis Modeling and procedure	1 hour
3.4	Data Mining: Simple Illustration of Data Mining	1 hour
3.5	Data Mining Methodologies	1 hour
3.6	Prescriptive Analysis step in the BA Process	1 hour
3.7	Analysis of Predictive analytics.	1 hour
	Module - 4 (Forecasting Techniques)	**(7 hours)**
4.1	Introduction - Types of Variation in Time Series Data	1 hour
4.2	Simple Regression Model	1 hour
4.3	Multiple Regression Models	1 hour
4.4	Simple Exponential Smoothing	1 hour
4.5	Smoothing Averages, Fitting Models to Data	1 hour
4.6	How to Select Models and Parameters for Models	1 hour
4.7	Forecasting Practice Problems	1 hour
	Module - 5 (Prescriptive Analytics)	**(7 hours)**
5.1	Introduction to Prescriptive analytics - Prescriptive Modeling	1 hour
5.2	Non Linear Optimization	1 hour
5.3	Prescriptive step in the BA Analysis	1 hour
5.4	Background Review and Prescriptive Analysis	1 hour
5.5	Linear Programming – Types of Linear Programming Problems/Models	1 hour

5.6	Linear Programming Problems/Model Elements	1 hour
5.7	Linear Programming Problems/Model Formulation Procedure.	1 hour

CST463	WEB PROGRAMMING	CATEGORY	L	T	P	CREDIT
		Program Elective II	2	1	0	3

Preamble: This course helps the learners to understand the web programming concepts. Itincludes the essential frontend and backend technologies needed for the development of web applications. The learners will have an opportunity to gain necessary web development skills such as HTML, CSS, JavaScript, PHP, MySQL integration, JSON and Laravel framework.

Prerequisite: Knowledge of Programming is required.

Course Outcomes: After the completion of the course the student will be able to

CO1	Use HyperText Markup Language (HTML) for authoring web pages and understandthe fundamentals of WWW. **(Cognitive Knowledge Level: Understand)**
CO2	Construct and visually format responsive, interactive web pages using CSS andJavaScript (JS) **(Cognitive Knowledge Level: Apply)**
CO3	Construct websites using advanced sever side programming tool PHP **(CognitiveKnowledge Level: Apply)**
CO4	Develop dynamic web applications using PHP and perform MySQL databaseoperations. **(Cognitive Knowledge Level: Apply)**
CO5	Explain the importance of object exchange formats using JSON and the MVC based web application development frameworks (Laravel) **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓				✓							✓
CO2	✓	✓	✓		✓							✓
CO3	✓	✓	✓	✓	✓							✓
CO4	✓	✓	✓	✓	✓							✓
CO5	✓	✓			✓							✓

Abstract POs defined by National Board of Accreditation

PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test 1 (%)	Test 2 (%)	
Remember	**20**	**20**	**20**
Understand	**40**	**40**	**40**
Apply	**40**	**40**	**40**
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3**

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Continuous Assessment Tests (Average of Internal Tests 1 & 2) **25 marks**

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern

Each of the two internal examinations has to be conducted out of 50 marks.

First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing the remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have a maximum of 2 subdivisions and carries 14 marks.

SYLLABUS

Module – 1 (WWW, HTML)

Introduction to the Internet & WWW: Evolution of Internet & World Wide Web- Web Basics,URI's & URL-MIME.

Introduction to HTML5: Structuring & editing an HTML5 document, Fundamentals of HTML - Headings-Hyper Links- Images - Special Characters & Horizontal Rules-Lists- Tables -Forms - Internal Linking- Meta Elements-HTML5 Form input types -Input and Data List Elements and autocomplete attribute- Page Structure Elements -Multimedia-HTML5 Audio & video elements..

Module -2 (CSS, JavaScript)

Introduction to Stylesheets : Introduction to CSS-Basic syntax and structure- Inline Styles, Embedded Style Sheets, Conflict Resolution, Linking External Style Sheets-Exploring CSS Selectors-Properties, values, Positioning Elements: Absolute Positioning, Relative Positioning -

Backgrounds-List Styles-Element Dimensions- Table Layouts-Box Model and Text Flow-div and span -Basics of Responsive CSS, Media port & Media Queries.

Introduction to JavaScript : Introduction to Scripting- Programming fundamentals of JavaScript

-Obtaining User Input with prompt Dialogs-Arithmetic-Decision Making -Control Statements - Functions -Arrays -Objects -Document Object Model (DOM) -Form processing

Module- 3 (PHP Basics)

PHP Language Structure: Introduction- **B**uilding blocks of PHP-Variables, Data Types -simple PHP program-Converting between Data Types- Operators and Expressions -Flow Control functions - Control statements- Working with Functions- Initialising and Manipulating Arrays-- Objects- String Comparisons-

String processing with Regular Expression

Module -4 (PHP- MySQL, JSON)

Advanced PHP: Form processing and Business Logic-Cookies- Sessions & MySQL Integration- Connecting to MySQL with PHP- Performing CREATE, DELETE, INSERT, SELECT and UPDATE operations on MySQL table -Working with MySQL data-Reading from Database- Dynamic Content.

Module- 5 (JSON, Laravel)

JSON Data Interchange Format: Syntax, Data Types, Object, JSON Schema, ManipulatingJSON data with PHP

Web Development Frameworks: Laravel Overview-Features of Laravel-Setting up a Laravel Development Environment-Application structure of Laravel-Routing -Middleware-Controllers- Route Model Binding-Views-Redirections-Request and Responses.

Text Books

1 Paul J. Deitel, Harvey M. Deitel, Abbey Deitel, Internet & World Wide Web How to Program 5th Edition **[Module 1,2,3,4]**
2. Lindsay Bassett, Introduction to JavaScript Object Notation: A To-the-Point Guide to JSON 1st Edition, O'Reilly **[Module 5]**
3. Julie C. Meloni, Pearson -PHP, MySQL & JavaScript All in One, Sams Teach Yourself,5th Ed[**Module 4]**
4. Matt Stauffer," LARAVEL up and Running, A framework for building modern PHP apps"1st Edition, O'REILLY **[Module 5]**

Reference Books

1. Robert W Sebesta, Programming the World Wide Web, 7/e, Pearson Education Inc,8th Edition
2. Larry Ullman, Pearson- PHP 6 and MySQL 5 for Dynamic Web Sites: Visual QuickPro Guide
3. Eric van der Vlist, Danny Ayers, Erik Bruchez, Joe Fawcett, Alessandro Vernet",Wrox-Professional Web 2.0 Programming, Wiley-India edition
4. Web Technologies Black Book 2018(As per Mumbai University Syllabus) HTML, CSS3,JavaScript, iQuery, AJAX,PHP,XML,MVC and Laravel DT Editorial Services (ISBN: 9789386052490)

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Construct a valid HTML document for your personal Profile registration page for a Job Site www.123Jobs.com. Add relevant HTML elements in a table, to accept a minimum of 10 different fields which includes your name, address, phone, email address, your picture, your college; your branch, fields for your personal history (Minimum 3 fields), favourite theory and practical subjects (Checkbox), Username, Password(password)
2. What is MIME? Give the expansion of MIME. List four examples for MIME types. State the reason why MIME type specification is necessary in a request-response transaction between a browser and server.
3. What is codec? Recognize the role of controls attribute in <video> & <audio> tag in HTML. Use the COVID vaccination promotional video 'MySafety.mp4' in a web page with suitable HTML code, 'autoplay' option enabled and displayed in a standard dimension 750 X500.

Course Outcome 2 (CO2):

1. Organize a sample web page for the event 'Raagam2021' at your campus and use embedded Style sheets to apply a minimum 5 styles. State the Style Specification format of embedded style sheets.
2. Write CSS style rules to implement the following in a web page:

   a. to display the content of hyperlinks with yellow background color and in italics

   b. to display the contents of unordered lists in bold and in Arial font

   c. to display a background image titled "birds.jpg" with no tiling.
3. Write the code for an HTML document with embedded JavaScript scripts, which initially displays a paragraph with text "Welcome" and a button titled "Click". When the button is clicked, the message "Hello from JavaScript" in bold should replace the paragraph text

Course Outcome 3 (CO3):

1. Write a PHP program to store the name and roll no of 10 students in an Associative Array and Use for each loop to process the array and Perform a sort, r sort and k sort in the array. Illustrate with suitable output data
2. Design an HTML page which enters a given number, write a PHP program to displaya message indicating, whether the number is odd or even, when clicking on the submit button.
3. Write a PHP program to compute the sum of the positive integers up to 100 using do while.

Course Outcome 4 (CO4):

1. Write a PHP form handling program to verify the user authentication credentials of a web page using MySQL connection and store the userid value as a Session variable if the userid is valid.
2. Create a valid HTML document for yourself, including your name, address, and email address. Also add your college; your major and the course. Perform form handling in PHP and process the output using POST method.
3. Write an embedded PHP script which displays the factorial of all numbers from 1 to 10 in a table in the web page. The factorial should be calculated and returned from a function. The table headings should be "Number" and "Factorial"

Course Outcome 5 (CO5):

1. What is Route Model Binding in Laravel? Which types of route model binding aresupported in Laravel?
2. Explain how laravel performs route handling using routes calling controller methods?
3. List the data types used in JSON? Explain the use of parse () and stringify()functions in JSON with examples.

Model Question Paper

QP CODE:

Reg No: _______________

Name:__________________ **PAGES : 4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST463

Course Name: Web Programming

Max. Marks : 100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Define WWW. List any two examples of web server & web browser. Differentiate between URL and a domain?
2. Write the syntax of the URL? Rewrite the default URL of your university website by adding a sub domain named 'Research' and a web page named 'FAQ.html'. Also link this URL through the logo of 'kturesearch.png' placed in a web page. The FAQ page should be opened in a new window.
3. Illustrate the implementation of a JavaScript function greeting () using external .js file, to display a welcome message, when you click on a Button in an HTML page.
4. What are different ways of adjusting spacing in a text with suitable example.

5. Discuss the various CSS style sheet levels with suitable examples. How are conflicts resolved when multiple style rules apply to a single web page element?

6. Describe how input from an HTML form is retrieved in a PHP program, with an example

7. Write a PHP program to check whether a number is prime number or not.

8. Discuss the various steps for establishing PHP-MySQL connection with a MySQL database?

9. Describe the schema of a document implemented in JSON with suitable examples

10. Explain the role of Resource controllers in Laravel.

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Design a webpage that displays the following table. **(6)**

(b) What is the difference between radio buttons and checkboxes when implemented using HTML? Write HTML code to implement a form which has the following elements: **(8)**

i. A textbox which can accept a maximum of 25 characters
ii. Three radio buttons with valid Label, Names and values
iii. Three check boxes buttons with valid Label, Names and values

iv. A selection list containing four items, two which are always visible

v. A submit button clicking on which will prompt the browser to send the form data to the server "http://www..mysite.com/reg.php" using "POST" method and reset button to clear its contents. You can use any text of your choice to label the form elements.

OR

12. (a) Write the equivalent HTML code to implement the following in a web page: **(6)**

(i) An image titled "birds.jpg" with a height of 100 pixels and width of 200 pixels. If the image cannot be accessed, a message "No image available" should be displayed (ii) A hyperlink to the URL "www.mysite.com/birds.jpg". The hyperlink should have the label "Click Here".

(b) Create a static HTML document for your portfolio, which includes the following contents: your name, address, Mobile Number and email address.Also add the details about your college, university, your major and the batch of study. Include a picture of yourself and at least one other image (friend/pet/role model) to the document with a short description about that. Add three paragraphs about your personal history, with links to your social media profile. Also create an ordered list for describing your Skill Set & an unordered list showing your Strengths & Weaknesses. **(8)**

13. (a) Illustrate the usage of JavaScript DOM in event handling and explain anythree methods with example. **(8)**

(b) Write CSS and the corresponding HTML code for the following: **(6)**

i. Set the background color for the hover and active link states to "green"

ii. Set the list style for unordered lists to "square".

iii. Set "Flower.png" as the background image of the page and set 3%margin for the pages

iv. Set dashed border for left and right and double border for top & bottomofa table with 2 rows.

OR

14. (a) List the order of precedence of style levels. Organize a sample web page for providing 'KTU BTech Honours Regulation 19' for KTU and use embedded Style sheet to apply minimum 5 styles for list, tables and pages. **(6)**

(b) Illustrate the different ways of Array declaration in JavaScript. Describe thefunction of the following JavaScript Array object methods with examples. **(8)**

(i) join (ii) slice

15. (a) Explain any six string handling functions used in PHP with example. **(6)**

(b) How does a PHP array differ from an array in C? List the different ways to create an array in PHP with an example. Explain any 4 functions that deals with PHP array. **(8)**

OR

16. (a) During the process of fetching a web page from a web server to a client browser, at what point does an embedded PHP script get executed. What are the two modes that the PHP processor operates in? Explain **(6)**

(b) Why is PHP considered to be dynamically typed? Distinguish between **(8)** implode and explode function in PHP with suitable examples.

17. (a) Write equivalent PHP statements corresponding to the following: **(8)**

i. Declare an associative array named “ages” to store the key-value pairs(“Alice”, 30), (“Bob”, 30), (“Harry”, 35), (“Mary”, 32).

ii. Modify the value associated with the key “Mary” to 28.

iii. Sort the array according to values maintaining the key-value relationships and print the sorted key-value pairs.

iv. The entry identified by the key “Bob”

(b) What are the uses of cookies in web pages? Describe syntax for setting cookies in PHP. How can you access and delete the cookie using setcookie() function? **(6)**

OR

18. (a) Write a PHP form handling program to perform the user registration of any website with a minimum of 5 different fields and insert the data into aMySQL table after establishing necessary connections with the DB, **(8)**

(b) Design the HTML page which enters a given number and embed the PHP code to display a message indicating, whether the number is odd or even, when clicking on the ‘CHECK NUMBER’ button. **(6)**

19. (a) With a neat diagram, explain about Laravel MVC Framework. **(6)**

(b) Discuss in detail about Laravel’s Routing mechanisms. **(8)**

OR

20. (a) Enumerate the data types in JSON. Illustrate the document definition of a'Studentdocument 'using JSON Schema. **(8)**

(b) Discuss the following in Laravel Views **(6)**

i. Creating & Rendering Views

ii. Passing Data to Views

iii. Sharing Data with All Views

Teaching Plan

No	CONTENTS	No of Lecture Hrs (35 hrs)
	Module 1 (7 hours)	
	Introduction to Internet and WWW	
1.1	Evolution of Internet &World Wide Web- Web Basics URI's & URL -MIME[Book 1 - Chapter 1]	1
	Introduction to HTML5	
1.2	Structuring & editing an HTML5 document- Fundamentals of HTML, Headings-Images [Book 1 - Chapter 2]	1
1.3	Hyper Links, Internal Linking- Lists [Book 1 - Chapter 2]	1
1.4	Special Characters & Horizontal Rules- meta Elements- div and span[Book 1 - Chapter 2]	1
1.5	Tables- Forms [Book 1 - Chapter 2]	1
1.6	HTML5 Form input types, input and data list Elements and autocomplete attributes- Page Structure Elements [Book 1 - Chapter 3]	1
1.7	Multimedia-HTML5 Audio & video elements [Book 1 - Chapter 9]	1

Module 2 (10 hours)		
Introduction to Cascading Style Sheets(CSS)		
2.1	Introduction to CSS3-Basic syntax and structure-Inline Styles [Book 1 - Chapter 4]	1
2.2	Embedded Style Sheets-Linking External Style Sheets [Book 1 - Chapter 4]	1
2.3	Exploring CSS Selectors-Properties-values [Book 1 - Chapter 4]	1
2.4	Positioning Elements: Absolute Positioning- Relative Positioning -Backgrounds-List Styles- Table Layouts [Book 1 - Chapter 4]	1
2.5	Box Model and Text Flow, Basics of Responsive CSS-Media port &MediaQueries [Book 1 - Chapter 4]	1
Introduction to JavaScript		
2.6	Introduction to Scripting- Programming fundamentals of JavaScript -ObtainingUser Input with prompt Dialogs [Book 1 - Chapter 6]	1
2.7	Arithmetic-Decision Making [Book 1 - Chapter 6]	1
2.8	Control Statements [Book 1 - Chapter 7]- Functions [Book 1 - Chapter 9]	1
2.9	Arrays [Book 1 - Chapter 10] - Objects [Book 1 - Chapter 11]	1
2.10	Document Object Model (DOM)- Form processing [Book 1 - Chapter 12,13]	1
Module 3 (6 hours)		

	Introduction to PHP	
3.1	Building blocks of PHP-Variables, Data Types simple PHP program [Book3-Chapters 4]	1
3.2	Converting between Data Types, Operators and Expressions -Flow Controlfunctions [Book 1- Chapters 19]	1
3.3	Control Statements -Working with Functions [Book 3- Chapters 6]	1
3.4	Initialising and Manipulating Arrays- Objects [Book 1- Chapters 19]	1
3.5	Working with Strings-String processing with Regular expression, PatternMatching[Book 1- Chapters 19]	1
3.6	Form processing and Business Logic [Book 1- Chapters 19]	1
	Module 4 (6 hours)	
	PHP -MYSQL	
4.1	Cookies- Sessions [Book 1- Chapters 19]	1
4.2	PHP& MySQL Integration-Connecting to MySQL withPHP .[Book 4- Chapters 18]	1
4.3	Working with MySQL data [Book 4- Chapters 18]	1
4.4	Performing CREATE, DELETE, INSERT operations on MySQL table from PHPProgram. [Book 4- Chapters 16]	1
4.5	Performing SELECT and UPDATE operations on MySQL table from PHPProgram. [Book 4- Chapters 16]	1
4.6	Building Dynamic Content in PHP application [Book1- Chapter19]	1
	Module 5 (6 hours)	
	JSON	
5.1	JSON Data Interchange Format -Syntax, Data Types, Object[Book 2 - Chapters 1-2]	1

5.2	JSON Schema, Manipulating JSON data with PHP [Book 2 - Chapter 3,4]	1
	LARAVEL	
5.3	Laravel Overview**-** Design Pattern- Laravel Features [Book 4- Chapters 1] Setting up a Laravel Development Environment- Application structure of Laravel[Book 4- Chapters 2]	1
5.4	**Laravel Basics** Routing -middleware - Controllers [Book 4- Chapters 3]	1
5.5	Route Model Binding-Views-Redirections [Book 4- Chapters 3]	1
5.6	**Blade Templating-**echoing data, control structures [Book 4- Chapters 4]	1

B TECH IN ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

AMT 473	OPTIMIZATION TECHNIQUES IN MACHINE LEARNING	Category	L	T	P	Credit
		Program Elective II	3	0	0	3

Preamble:

Most problems in machine learning can be viewed as optimizing an objective function,that is often related to the performance measure used in the given problem under a given set of constraints. Many of these optimization tasks have special properties such as sparsity, convexity, smoothness or separability, which invokes a certain family of efficient solutions. This course focuses on optimization techniques used in machine learning algorithms and models. Students will learn various optimization algorithms and methodologies to train and optimize machine learning models. The course covers both classical and modern optimization methods applicable to machine learning problems. This course helps the students to gain a comprehensive understanding of optimization techniques and their practical implementation in machine learning.

Prerequisite:

- Basic knowledge of linear algebra and calculus.
- Familiarity with machine learning concepts and algorithms.

Mapping of course outcomes with program outcomes

CO1	Understand the basics of optimization techniques and their application in machine learning.**(Cognitive Knowledge Level: Understand)**
CO2	Apply gradient descent and its variants to optimize machine learning models effectively.**(Cognitive Knowledge Level: Apply)**
CO3	Understand and solve convex optimization problems encountered in machine learning**.(Cognitive Knowledge Level: Understand)**
CO4	Apply appropriate methods to handle non-convex optimization problems in machine learning.**(Cognitive Knowledge Level: Apply)**

CO5	Utilize advanced optimization techniques to optimize complex machine learning models.**(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											✓
CO2	✓	✓	✓									✓
CO3	✓	✓	✓	✓	✓							✓
CO4	✓	✓	✓	✓	✓							✓
CO5	✓	✓		✓	✓							✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics

PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks (%)**
	Test 1 (%)	**Test 2 (%)**	
Remember	**20**	**20**	**20**
Understand	**50**	**50**	**50**
Apply	**30**	**30**	**30**
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	**50**	**100**	**3**

Continuous Internal Evaluation Pattern:

Attendance	**10 marks**
Continuous Assessment Tests (Average of Internal Tests1&2)	**25 marks**
Continuous Assessment Assignment	**15 marks**

Internal Examination Pattern

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

B TECH IN ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Syllabus

Module 1(Introduction to Optimization in Machine Learning)

General form of optimization problem, the basic convex optimization problem formulation. Convex and non-convex optimization problems. Unconstrained and constrained optimization. Overview of optimization techniques and their role in machine learning. Introduction to objective functions, constraints, and optimization problems. Algorithms for solving optimization problems in machine learning.

Module 2(Gradient Descent and Variants)

Gradient descent algorithm and its variants: gradient descent, stochastic gradient descent, and mini-batch gradient descent, Adaptive learning rate algorithms - AdaGrad (Adaptive Gradient), RMSprop (Root Mean Square Propagation), Adam (Adaptive Moment Estimation). Convergence analysis and learning rate selection. Regularization techniques for gradient descent - L1 (Lasso), L2 (Ridge), Elastic Net, Dropout, Early Stopping, Batch Normalization, Data Augmentation.

Module 3(Convex Optimization)

Introduction to convex optimization and its significance in machine learning. Convex sets, Convex functions, and optimization problems. Convex optimization algorithms: subgradient method, projected gradient descent, and interior-point methods. Linear programming, Quadratic programming, Geometric programming, Semi-definite programming.

Module 4(Non-convex Optimization)

Challenges and techniques for non-convex optimization in machine learning. Examples of non-convex functions. Local search algorithms: hill climbing, simulated annealing, and genetic algorithms. Convex relaxations of non-convex functions and global optimization techniques - Bayesian optimization. Applications - matrix completion, Image reconstruction, recommendation systems.

Module 5(Advanced Optimization Techniques)

Newton's method and its variants: Newton-Raphson and Gauss-Newton. Conjugate gradient method and its applications in machine learning. Quasi-Newton methods: Broyden-Fletcher-Goldfarb-Shanno(BFGS) and limited-memory Broyden-Fletcher-Goldfarb-Shanno(L-BFGS).

Reference Books

1. Boyd, S., & Vandenberghe, L. (2004). Convex optimization. Cambridge University Press.
2. Bottou, L., Curtis, F. E., & Nocedal, J. (2018). Optimization methods for large-scale machine learning. SIAM Review, 60(2), 223-311.
3. Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep learning. MIT Press.
4. Nocedal, J., & Wright, S. (2006). Numerical optimization. Springer Science & Business Media.
5. Sra, S., Nowozin, S., & Wright, S. J. (2012). Optimization for machine learning. MIT Press.

B TECH IN ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Course Level Assessment Questions

Course Outcome1 (CO1):

1. Suppose that there are **m** basic nutrients. A healthy diet needs $\mathbf{b_j}$ units of $\mathbf{j}^{th}$ nutrient per day. There are **n** different food items available, with one unit of item **i** containing $\mathbf{a_{ji}}$ units of nutrient **j**. Price of food item **i** is $\mathbf{c_i}$ per unit. Formulate this as an optmization problem to minimize the cost of food per day, while keeping the diet healthy.
2. In portfolio optimization, we seek the best way to invest some capital in a set of **n** assets. The variable $\mathbf{x_i}$ represents the investment in the ith asset, so the vector $\mathbf{x}$ □ $\mathbf{R^n}$ describes the overall portfolio allocation across the set of assets. The constraints might represent a limit on the budget (i.e., a limit on the total amount to be invested), the requirement that investments are nonnegative (assuming short positions are not allowed), and a minimum acceptable value of expected return for the whole portfolio. The objective or cost function might be a measure of the overall risk or variance of the portfolio return. Formulate this as an optimization problem that corresponds to choosing a portfolio allocation that minimizes risk, among all possible allocations that meet the firm requirements.
3. Consider the task of choosing the width and length of each device in an electronic circuit. Here the variables represent the widths and lengths of the devices. The constraints represent a variety of engineering requirements, such as limits on the device sizes imposed by the manufacturing process, timing requirements that ensure that the circuit can operate reliably at a specified speed, and a limit on the total area of the circuit. A common objective in a device sizing problem is the total power consumed by the circuit. The optimization problem is to find the device sizes that satisfy the design requirements (on manufacturability, timing, and area) and are most power efficient. Formulate this as an optmization problem.
4. In data fitting, the task is to find a model, from a family of potential models, that best fits some observed data and prior information. Here the

variables are the parameters in the model, and the constraints can represent prior information or required limits on the parameters (such as nonnegativity). The objective function might be a measure of misfit or prediction error between the observed data and the values predicted by the model, or a statistical measure of the unlikeliness or implausibility of the parameter values. The optimization problem is to find the model parameter values that are consistent with the prior information, and give the smallest misfit or prediction error with the observed data. Formulate this as an optmization problem.

5. Consider a manufacturing company that produces two products, Product A and Product B. The company wants to determine the optimal production quantities of each product to maximize the total profit. The profit per unit for Product A is Rs 10, and for Product B is Rs 15. The production of Product A requires 2 units of labor and 3 units of raw material, while the production of Product B requires 3 units of labor and 4 units of raw material. The company has 100 units of labor and 120 units of raw material available. Formulate the optimization problem to find the optimal production quantities of Product A and Product B.

Course Outcome 2(CO2):

1. Consider a non-linear regression problem with a single feature (x) and a target variable (y). The true relationship between x and y is y = sin(x) + ε, where ε is random noise. Generate a synthetic dataset of 100 samples from this relationship. Use gradient descent to find the optimal parameters that fit a sine function to the data by minimizing the mean squared error loss function. Start with initial guesses for the amplitude, frequency, and phase of the sine function, and perform 20 iterations of gradient descent with a learning rate of 0.1.
2. Use mini-batch gradient descent to train a neural network with two hidden layers on the MNIST dataset for digit classification. Set the batch size to 64 and the learning rate to 0.001. Perform 100 iterations of mini-batch gradient descent and monitor the training loss and accuracy.

3. Implement batch gradient descent to solve a multivariate linear regression problem with three features (x_1, x_2, x_3) and a target variable (y). Use the following data points:
   (x_{11}, x_{12}, x_{13}, y_1) = (1, 2, 3, 5)
   (x_{21}, x_{22}, x_{23}, y_2) = (2, 3, 4, 8)
   (x_{31}, x_{32}, x_{33}, y_3) = (3, 4, 5, 12)
   Initialize the weights randomly and perform 10 iterations of gradient descent with a learning rate of 0.01.
4. You are given the function f(x) = 3x^2 + 2x - 5. Use gradient descent to find the minimum of this function. Start with an initial guess of x = 0 and a learning rate of 0.01. Perform five iterations of gradient descent and report the updated value of x after each iteration.

Course Outcome 3(CO3):

1. Given an example of a closed set in $\mathbf{R^2}$whose convex hull is not closed.
2. Show that if $\mathbf{S_i} \square \mathbf{R^n}$**,** $\mathbf{i} \square \mathbf{I}$ is a collection of convex sets, then their intersection is also convex.
3. Let $\mathbf{A} \square \mathbf{R^{m\times n}}$. Show that if $\mathbf{S} \square \mathbf{R^n}$ is convex then so is $\mathbf{A(S) = \{Ax : x \square S\}}$, called the image of **S** under **A**.
4. Give an example of a strictly convex function that does not attain its infimum.
5. Show that a set is convex if and only if its intersection with any line is convex. Show that a set is affine if and only if its intersection with any line is affine.
6. Give an explicit solution to the following Linear Program.

$$\begin{array}{ll} \text{minimize} & c^T x \\ \text{subject to} & Ax = b. \end{array}$$

$$\begin{array}{ll} \text{minimize} & x^T B x \\ \text{subject to} & x^T A x \leq 1, \end{array}$$

where $A \in \mathbf{S}^n_{++}$ and $B \in \mathbf{S}^n_+$. Also consider the nonconvex extension with $B \notin \mathbf{S}^n_+$.

7. Provide necessary and sufficient conditions under which a quadratic optimization problem be written as a linear least squares problem.
8. State the first- and second-order conditions for optimality for Linear least squares and Quadratic Optimization.
9. A company wants to optimize the production of two products, Product A and Product B. The profit per unit for Product A is given by f1(x, y) = 5x + 3y, and for Product B is given by f2(x, y) = 4x + 6y, where x and y represent the production quantities of Product A and Product B, respectively. The company has constraints on the labor and raw material availability given by g1(x, y) = 2x + 3y ≤ 10 and g2(x, y) = x + y ≤ 6. Formulate a convex optimization problem to maximize the total profit while satisfying the constraints.
10. Solve the following convex optimization problem using the subgradient method:

Minimize: f(x) = |x - 3| + |x + 2|

Start with an initial guess of x = 0 and iterate until the subgradient norm falls below a tolerance of 0.01.

Course Outcome 4(CO4): .

1. Consider a traveling salesperson problem where you want to find the shortest route to visit a set of cities and return to the starting city. Implement a hill climbing algorithm to solve this problem, starting from a randomly chosen initial route. Perform iterations of the hill climbing algorithm until convergence, and report the final shortest route discovered.
2. You are given a two-dimensional landscape represented by a matrix where each element represents the height at that position. You want to find the highest point in the landscape using a hill climbing algorithm. Starting

from a randomly chosen position, perform iterations of the hill climbing algorithm until convergence, and report the final highest point discovered.

3. You are given a function f(x) = -x^2 + 3x - 2 and want to find the maximum value using simulated annealing. Start with an initial solution x = 0 and perform iterations of simulated annealing until convergence. Report the final maximum value discovered.
4. You have a function f(x, y) = sin(x) + cos(y) and want to find the maximum value using simulated annealing. Start with an initial solution (x, y) = (0, 0) and perform iterations of simulated annealing until convergence. Report the final maximum value discovered and the corresponding (x, y) coordinates.
5. You have a function f(x, y) = sin(x) + cos(y) and want to find the maximum value using a genetic algorithm. Implement the genetic algorithm with appropriate selection, crossover, and mutation operators. Start with a randomly generated initial population of solutions, perform iterations until convergence, and report the final maximum value discovered and the corresponding (x, y) coordinates.
6. Consider a function f(x) = -x^2 + 3x - 2 and want to find the maximum value using Bayesian optimization. Start with an initial set of data points, perform iterations of Bayesian optimization until convergence, and report the final maximum value discovered.
7. You have a set of design parameters and want to optimize the performance of a machine learning model using Bayesian optimization. Implement Bayesian optimization with appropriate acquisition function and surrogate model. Start with an initial set of design parameters, perform iterations until convergence, and report the final optimized design parameters.
8. For the following optimization problem, derive the KKT conditions. Find all solutions that satisfy the KKT conditions. Which pair corresponds to the optimum?

$$\begin{array}{ll} \text{minimize} & -3x_1^2 + x_2^2 + 2x_3^2 + 2(x_1 + x_2 + x_3) \\ \text{subject to} & x_1^2 + x_2^2 + x_3^2 = 1, \end{array}$$

Course Outcome 5(CO5):

1. You are given the equation f(x) = e^x - x^2 + 4. Use the Newton-Raphson method to find a root of this equation, starting with an initial guess of x_0 = 2. Perform four iterations and report the approximate root after each iteration.
2. Solve the equation f(x) = 2x^3 + 5x^2 - 3x + 1 using the Newton-Raphson method. Start with an initial guess of x_0 = -1. Perform five iterations and report the approximate root after each iteration.
3. You are trying to find a root of the equation f(x) = sin(x) - x^2 + 2. Use the Newton-Raphson method to find an approximate root, starting with an initial guess of x_0 = 1. Perform three iterations and report the approximate root after each iteration.
4. You are given a set of data points (x_i, y_i) and want to fit a model of the form f(x;θ) = θ_1x^3 + θ_2x^2 + θ_3x + θ_4 to the data. Use the Gauss-Newton method to find the optimal values of the parameters θ = (θ_1, θ_2, θ_3, θ_4). Start with an initial guess of θ_0 = (1, 1, 1, 1). Perform three iterations and report the updated values of θ after each iteration.
5. Consider the following system of linear equations: A * x = b where A is a symmetric positive definite matrix, x is the unknown vector, and b is the right-hand side vector.

   (a) Describe the Conjugate Gradient method for solving the system of linear equations. (b) Apply the Conjugate Gradient method to solve the following system of equations: A = [[4, -1, 0], [-1, 4, -1], [0, -1, 4]] b = [2, 3, 5] Start with an initial guess of x_0 = [0, 0, 0] and perform iterations until convergence. Report the final solution vector x. Make sure to explain the steps of the Conjugate Gradient method, including the calculation of the search direction, step size, and updating of the solution vector at each iteration.

   Note: You can assume that the tolerance for convergence is 0.001.

6. Consider the following system of linear equations:

$$A * x = b,$$

where A is a symmetric positive definite matrix, x is the unknown vector, and b is a given vector. Solve the system of equations using the Conjugate Gradient method. Use the initial guess x_0 = [1, 1, 1]T and perform three iterations of the Conjugate Gradient method. Report the approximate solution after each iteration. Make sure to provide the necessary steps involved in the Conjugate Gradient method, such as calculating the residual, direction vectors, and updating the solution vector at each iteration.

7. Consider the following function f(x) = x^4 - 2x^2 + 5x + 2. Use the Quasi-Newton method with BFGS update to find the minimum of the function. Perform iterations of the Quasi-Newton method until convergence, and report the final minimum point discovered. Show all the steps and calculations involved in each iteration, including the initial guess, gradient calculation, search direction, step size, updated solution, and updated Hessian approximation.
8. Consider the following unconstrained optimization problem:
   Minimize the function f(x) = x^4 + 2x^3 - 5x^2 + x + 1 using the Quasi-Newton method. Start with an initial guess of x = 1. Perform iterations of the Quasi-Newton method until convergence, and report the final minimized value of the function and the corresponding value of x. Show all the steps and calculations involved in each iteration, including the update formula used for the Hessian approximation and the update formula used for the next iterate.

B TECH IN ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Model Question Paper

QP CODE:

Reg No: _______________

Name: _________________ **PAGES : 5**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: AMT 473

Course Name: OPTIMIZATION TECHNIQUES IN MACHINE LEARNING

Max.Marks:100

Duration: 3 Hours

PART A

Answer All Questions. Each Question Carries 3 Marks

1. You want to find the maximum value of a function $\mathbf{f(x) = sin(x) + 2x}$ on the interval $\mathbf{[0, \pi]}$. Formulate an unconstrained optimization problem to find the maximum value and the corresponding value of $\mathbf{x}$.

2. Describe the difference between a constrained optimization problem and an unconstrained optimization problem.

3. Explain the intuition behind the Adagrad algorithm

4. Describe the concept of Momentum in Gradient Descent and how it helps accelerate convergence.

5. Let $\mathbf{C}$ □ $\mathbf{R^n}$ be a convex set, with $\mathbf{x_1, \ldots, x_k}$ □ $\mathbf{C}$, and let

$\theta_1, \ldots, \theta_k$ □ **R** satisfy $\theta_i \geq 0, \theta_1 + \cdots + \theta_k = 1$. Show that $\theta_1 x_1 + \cdots + \theta_k x_k$ □ **C**.

6. Consider the function $f(x) = e^x$. Is this function convex or concave? Justify your answer.

7. Consider a function $f(x) = x^3 - 2x^2 + 5x - 6$ and want to find the minimum value using simulated annealing. Start with an initial solution $x = 0$ and perform iterations of simulated annealing until convergence. Report the final minimum value discovered.

8. Explain the concepts of crossover and mutation in the context of Genetic Algorithms.

9. Explain how to find a steepest descent direction in the ℓ_2-norm, and give a simple interpretation.

10 Describe the convergence properties of the Conjugate Gradient Method and explain how it relates to the eigenvalues of the coefficient matrix. **(10x3=30)**

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11 (a) A farmer wants to determine the optimal allocation of land for planting two crops: Wheat and Corn. The farmer has a total of 100 acres of land available. Each acre of Wheat yields a profit of Rs 200, while each acre of Corn yields a profit of Rs 300. Additionally, planting Wheat requires 2 units of labour per acre, and planting Corn requires 3 units of labour per acre. The farmer has a total of 200 units of labour **(10)**

available. Formulate and solve the optimization problem to maximize the farmer's profit.

(b) Describe the steps involved in formulating an optimization problem. **(4)**

OR

12 (a) You are designing a rectangular garden and want to maximize the total area while keeping the perimeter less than or equal to 100 meters. Formulate a constrained optimization problem to determine the dimensions of the rectangular garden that maximize the area. **(8)**

(b) Explain the difference between a single-objective optimization problem and a multi-objective optimization problem with an examples. **(3)**

(c) Describe the role of decision variables in optimization problems and how they are used to formulate the problem. **(3)**

13 (a) Consider a simple linear regression problem with a single feature (**x**) and a single target variable (**y**). Given the following data points: **(8)**

$$(x_1, y_1) = (1, 3)$$

$$(x_2, y_2) = (2, 5)$$

$$(x_3, y_3) = (3, 7)$$

Use gradient descent to find the best-fit line (**y = mx + b**) by minimizing the mean squared error loss function. Start with an initial guess for the slope (**m**) and y-intercept (b), and perform 3 iterations of gradient descent with a learning rate of 0.01.

(b) What is the role of regularization techniques, such as L1 and L2 regularization, in Gradient Descent algorithms? **(6)**

OR

14 (a) What is Mini-Batch Gradient Descent, and how does it strike a balance between Batch Gradient Descent and Stochastic Gradient Descent? **(6)**

(b) Consider the function **f(x) = x^2**. Find the minimum of this function using gradient descent. Start with an initial guess of **x = 3** and a learning rate of 0.1. Perform three iterations of gradient descent and report the updated value of **x** after each iteration. **(8)**

15 (a) You have a dataset of **(x, y)** points and want to find the best-fit line that minimizes the sum of absolute residuals. Formulate a convex optimization problem to determine the optimal slope and intercept of the line. **(7)**

(b) Consider the following constrained optimization problem: **(7)**

Minimize: f(x) = x^2 + y^2

Subject to: x + y ≥ 1, x ≥ 0, y ≥ 0

Solve this problem using Projected Gradient Descent. Start with an initial guess of **(x, y) = (0, 0)** and iterate for 5 steps.

OR

16 (a) Consider the following convex optimization problem: **(7)**

$$\textbf{Minimize: } f(x) = |x - 1| + |x - 2| + |x - 3|$$

Solve this problem using the subgradient method. Start with an initial guess of $x = 0$ and iterate for 5 steps.

(b) Solve the following linear programming problem using the interior-point method: **(7)**

$$\textbf{Minimize: } f(x) = 2x + 3y$$

Subject to:

$$x + 2y \le 6$$

$$3x + y \le 9$$

$$x, y \ge 0$$

Start with an initial guess of $(x, y) = (0, 0)$ and iterate until the duality gap falls below a tolerance of 0.001.

17 (a) You have a function $f(x, y) = x^2 + y^2$ representing a two-dimensional landscape. Implement a hill climbing algorithm to find the minimum point of this function. Start with a randomly chosen initial point (x, y), perform iterations until convergence, and report the final minimum point discovered. **(7)**

(b) Consider a neural network architecture search problem where the goal is to find the optimal network architecture for a given task. Use a Genetic Algorithm to evolve the architecture by selecting and combining different network components. Start with an initial population of size 50 and iterate for 200 generations. **(7)**

OR

18 (a) Consider a binary string optimization problem where the goal is to maximize the number of ones in the string. Use Simulated Annealing to find the optimal binary string of length 10. Start with a randomly generated initial string and iterate until the cooling schedule reaches a certain temperature. **(7)**

(b) Consider a job scheduling problem where the goal is to minimize the total completion time of a set of jobs on a single machine. Use a Genetic Algorithm to find a near-optimal schedule. Start with an initial population of size 50 and iterate for 150 generations. **(7)**

19 (a) Consider the equation $\mathbf{f(x) = x^3 - 3x + 1}$. Use the Newton-Raphson method to find a root of this equation, starting with an initial guess of $\mathbf{x_0 = 1}$. Perform three iterations and report the approximate root after each iteration. **(7)**

(b) Solve the following linear system of equations using the Conjugate Gradient Method: **(7)**

$$\mathbf{Ax = b}$$

where **A** is a symmetric positive-definite matrix and **b** is a given vector. Start with an initial guess $\mathbf{x^{(0)}}$ and iterate until the residual norm falls below a certain tolerance.

OR

20 (a) Consider a nonlinear regression problem where you have a set of data points $\mathbf{(x_i, y_i)}$ and want to fit a model of the form $\mathbf{f(x;\theta) = \theta_1 \sin(\theta_2 x) + \theta_3 \cos(\theta_4 x)}$ to the data. Use the Gauss-Newton method to find the optimal values of the parameters **(7)**

$\theta = (\theta_1, \theta_2, \theta_3, \theta_4)$. Start with an initial guess of **$\theta_0 = (1, 1, 1, 1)$**. Perform five iterations and report the updated values of **θ** after each iteration.

(b) Describe a real-world application or problem that can be solved using the Conjugate Gradient Method and explain the steps involved in applying the method to that problem. **(7)**

B TECH IN ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Teaching Plan

No	Topic	No. of Lectures (40)
1	**Module 1 (Introduction to Convex optimization and Convex Sets)**	
1.1	General form of optimization problem, the basic convex optimization problem formulation	1
1.2	Important classes of convex optimization, generalized problem, example: semidefinite programming and its application in portfolio optimization	1
1.3	Convex and non-convex optimization problems	1
1.4	Unconstrained and constrained optimization	1
1.5	Overview of optimization techniques and their role in machine learning	1
1.6	Introduction to objective functions, constraints, and optimization problems	1
1.7	Introduction to objective functions, constraints, and optimization problems	1
2	**Module 2 (Gradient Descent and Variants)**	
2.1	Gradient descent, stochastic gradient descent, and mini-batch gradient descent	1
2.2	Gradient descent, stochastic gradient descent, and mini-batch gradient descent	1
2.3	AdaGrad (Adaptive Gradient). RMSprop (Root Mean Square Propagation), Adam (Adaptive Moment Estimation)	1

2.4	AdaGrad (Adaptive Gradient). RMSprop (Root Mean Square Propagation), Adam (Adaptive Moment Estimation)	1
2.5	Convergence analysis and learning rate selection	1
2.6	L1 (Lasso), L2 (Ridge),	1
2.7	L1 (Lasso), L2 (Ridge),	1
2.8	Elastic Net, Dropout, Early Stopping, Batch Normalization, Data Augmentation.	1
2.9	Elastic Net, Dropout, Early Stopping, Batch Normalization, Data Augmentation.	1
3	**Module 3 (Convex Optimization)**	
3.1	Convex sets, Convex functions, and optimization problems	1
3.2	Subgradient method, projected gradient descent, and interior-point methods	1
3.3	Subgradient method, projected gradient descent, and interior-point methods	
3.4	Linear programming	1
3.5	Quadratic programming	1
3.6	Geometric programming	1
3.7	Semi-definite programming	1
4	**Module 4 (Non-convex Optimization)**	
4.1	Challenges and techniques for non-convex optimization in machine learning	1
4.2	Examples of non-convex functions	1
4.3	Hill climbing, simulated annealing, and genetic algorithms	1

4.4	Hill climbing, simulated annealing, and genetic algorithms	1
4.5	Hill climbing, simulated annealing, and genetic algorithms	1
4.6	Convex relaxations of non-convex functions	1
4.7	Bayesian optimization	1
4.8	Applications - matrix completion, Image reconstruction, recommendation systems.	1
4.9	Applications - matrix completion, Image reconstruction, recommendation systems.	1
5	**Module 5 (Advanced Optimization Techniques)**	
5.1	Newton's method and its variants: Newton-Raphson and Gauss-Newton	1
5.2	Newton's method and its variants: Newton-Raphson and Gauss-Newton	1
5.3	Newton's method and its variants: Newton-Raphson and Gauss-Newton	1
5.4	Conjugate gradient method and its applications in machine learning	1
5.5	Conjugate gradient method and its applications in machine learning	1
5.6	Quasi-Newton methods: Broyden-Fletcher-Goldfarb-Shanno(BFGS) and limited-memory Broyden-Fletcher-Goldfarb-Shanno(L-BFGS).	1
5.7	Quasi-Newton methods: Broyden-Fletcher-Goldfarb-Shanno(BFGS) and limited-memory Broyden-Fletcher-Goldfarb-Shanno(L-BFGS).	1
5.8	Quasi-Newton methods: Broyden-Fletcher-Goldfarb-Shanno(BFGS) and limited-memory Broyden-Fletcher-Goldfarb-Shanno(L-BFGS).	1

B TECH IN ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

SEMESTER VII

OPEN ELECTIVE

CST415	INTRODUCTION TO MOBILE COMPUTING	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		OEC	2	1	0	3	2019

Preamble: 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.

Prerequisite: A good knowledge of data communication and computer networks.

Course Outcomes: After the completion of the course the student will be able to

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

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔										✔
CO2	✔	✔	✔									✔
CO3	✔	✔	✔									✔
CO4	✔	✔	✔									✔
CO5	✔	✔	✔									✔
CO6	✔	✔	✔									✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination (%)
	Test 1 (%)	Test 2 (%)	
Remember	30	30	30
Understand	50	50	50
Apply	20	20	20
Analyse			
Evaluate			

Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Test : **25 marks**

Continuous Assessment Assignment : **15 marks**

Internal Examination Pattern:

Each of the two internal examinations shall be conducted for 50 marks. First series test shall be conducted preferably after completing the first half of the syllabus and the second series test shall be conducted preferably after completing the remaining part of the syllabus. There shall be two parts for the question paper: Part A and Part B. Part A shall contain five questions (preferably, two questions each from the fully completed modules and one question from the partly covered module), having three marks for each question adding up to 15 marks for part A. A student is expected to answer all questions from Part A. Part B shall contain seven questions (preferably, three questions each from the fully completed modules and one question from the partially completed module), each having seven marks. Out of the seven questions, a student is expected to answer any five.

End Semester Examination Pattern:

There shall be two parts; Part A and Part B. Part A shall contain 10 questions with 2 questions from each module, having 3 marks for each question. A student is expected to answer all questions from Part A. Part B shall contain 2 questions from each module, out of which a student is expected to answer any one. Each question shall have a maximum of two sub-divisions and shall carry 14 marks.

Syllabus

Module-1 (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.

Module-2 (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.

Module-3 (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.

Module-4 (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.

Module-5 (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.

Reference Books

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 Level Assessment Questions

Course Outcome 1 CO1):

1. Describe the design considerations in mobile computing.
2. Give five examples of mobile computing applications.

Course Outcome 2 (CO2):

1. Draw a call flow diagram for a theatre ticket booking system.
2. Illustrate the GSM architecture with figure.

Course Outcome 3 (CO3):

1. Illustrate the billing and charging services in GPRS.
2. Describe the SMS architecture.

Course Outcome 4 (CO4):

1. Compare IEEE 802.11, HIPERLAN with respect to their ad-hoc capabilities.
2. Discuss the security mechanism used in WLAN.

Course Outcome 5 (CO5):

1. With the help of a suitable example, show the working of Diffie-Hellman key exchange algorithm.
2. Bob chooses 7 and 11 as two prime numbers and chooses e as 13. Find an appropriate value for d and decrypt the plaintext 5 send by Alice to Bob.
3. Describe the security issues in mobile computing.

Course Outcome 6 (CO6):

1. Describe WATM and Multimedia broadcast services.
2. Describe the significance of Orthogonal Frequency Division Multiplexing (OFDM) in next generation networks.

Model Question Paper

QP CODE: **PAGES: 3**

Reg No:_______________
Name:_________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST415

Course Name : INTRODUCTION TO MOBILE COMPUTING

Max Marks: 100 **Duration: 3 Hours**

PART-A
(Answer All Questions. Each question carries 3 marks)

1. Explain the different types of middleware and gateways required in mobile computing.
2. List any six limitations of mobile computing.
3. Compare and contrast the satellite systems – GEO, LEO and MEO.
4. How is frequency allocation done in GSM?
5. What are the various strengths of SMS?
6. How is billing and charging done in GPRS?
7. What are the different types of Wireless LANs?
8. Describe the architecture of a Wireless Local Loop.
9. Explain the key features of TLS protocol.
10. How are attacks classified?

(10x3=30)

Part B
(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Describe any four mobile computing functions. **(4)**

    (b) Explain the three-tier architecture of mobile computing with figure. **(10)**

OR

12.	(a)	Describe the significance and functions of core, edge and access network.	**(6)**
	(b)	Explain the terms (i) Client Context Manager (ii) Policy Manager (iii) Security Manager (iv) Adaptability Manager	**(8)**
13.	(a)	Why is multiple access important? With the help of suitable examples, explain the various multiple access techniques.	**(7)**
	(b)	Describe the different algorithms used for security and authentication in GSM.	**(7)**

OR

14.	(a)	Show how call routing is done in GSM. Give an example.	**(7)**
	(b)	Explain the process of handover. How does handover differ from roaming?	**(7)**
15.	(a)	With the help of neat sketches, explain the difference between Short Message Mobile Terminated (SM MT) and Short Message Mobile Originated (SM MO) messages.	**(6)**
	(b)	Explain the network operations in GPRS.	**(8)**

OR

16.	(a)	How does operator-centric pull differ from operator-independent push and pull?	**(7)**
	(b)	Describe the data services and applications of GPRS.	**(7)**
17.	(a)	Compare the HIPERLAN and OSI layered architecture.	**(4)**
	(b)	Explain the 802.11 architecture.	**(10)**

OR

18.	(a)	Compare 3G and WiFi.	**(7)**
	(b)	Explain the HIPERLAN communication models with suitable diagrams.	**(7)**
19.	(a)	Given p = 7, q = 17 and e = 5. Find the value of d and also encrypt the message P = 65 using RSA.	**(7)**
	(b)	Explain the role of MPLS in service provisioning.	**(7)**

OR

20.	(a)	With the help of a suitable example, show the working of Diffie-Hellman key exchange algorithm.	**(7)**
	(b)	Explain the features of any three multimedia broadcast services.	**(7)**

TEACHING PLAN

No	Contents	No.of Lecture Hrs (35 hrs)
Module-1 (Mobile Computing Architecture) (6 hrs)		
1.1	Introduction to mobile computing – Functions, Devices, Middleware and gateways	1
1.2	Applications, services, limitations, Internet: The ubiquitous network	1
1.3	Three-tier architecture (Lecture 1)	1
1.4	Three-tier architecture (Lecture 2)	1
1.5	Design considerations for mobile computing (Lecture 1)	1
1.6	Design considerations for mobile computing (Lecture 2)	1
Module-2 (Communication Systems) (7hrs)		
2.1	Evolution of telephony, Multiple access procedures – FDMA, TDMA, CDMA, SDMA	1
2.2	Satellite communication systems – GEO, MEO, LEO, Satellite phones	1
2.3	Interactive Voice Response (IVR) architecture, Overview of voice software, Developing an IVR application (Call flow diagram)	1
2.4	Introduction to GSM,Architecture	1
2.5	GSM entities, Call routing	1
2.6	Mobility management	1
2.7	Frequency allocation, Authentication and security	1
Module-3 (Short Messaging Service and General Packet Radio Service) (8hrs)		
3.1	SMS Strengths, Architecture, Short Message Mobile Terminated (SM MT) and Short Message Mobile Originated (SM MO) messages	1
3.2	SMS Architecture - Operator-centric pull, operator-	1

	independent push/pull, Value added services	
3.3	Accessing the SMS bearer (Lecture 1)	1
3.4	Accessing the SMS bearer (Lecture 2)	1
3.5	GPRS architecture	1
3.6	Network operations	1
3.7	Data services, Applications	1
3.8	Limitations, Billing and charging	1
Module-4 (Wireless Local Area Networks) (7 hrs)		
4.1	WLAN Advantages, Evolution, Applications	1
4.2	WLAN Architecture (Lecture 1)	1
4.3	WLAN Architecture (Lecture 2)	1
4.4	Mobility, Security	1
4.5	Deploying WLAN	1
4.6	WLL Architecture, HIPERLAN	1
4.7	WiFi Vs 3G	1
Module-5 (Mobile Security and Next Generation Networks) (7hrs)		
5.1	Information security – Attacks, Components	1
5.2	Security techniques and algorithms – Stream Vs Block cipher, Symmetric Vs Asymmetric cryptography	1
5.3	Security techniques and algorithms – RSA, Diffie Hellman Key exchange	1
5.4	Security protocols – Secure Socket Layer, Transport Layer Security, Wireless Transport Layer Security	1
5.5	The Converged Scenario, Narrowband to broadband	1
5.6	Orthogonal Frequency Division Multiplexing (OFDM) and Multi Protocol Label Switching (MPLS)	1
5.7	Wireless Asynchronous Transfer Mode (WATM) and Multimedia broadcast services	1

CST425	INTRODUCTION TO DEEP LEARNING	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		OEC	2	1	0	3	2019

Preamble: 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.

Prerequisite: Basics of linear algebra and probability.

Course Outcomes: After the completion of the course the student will be able to

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

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔										✔
CO2	✔	✔										✔
CO3	✔	✔	✔	✔								✔
CO4	✔	✔	✔	✔								✔
CO5	✔	✔	✔	✔								✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		End Semester Examination Marks (%)
	Test 1 (%)	**Test 2 (%)**	
Remember	**30**	**30**	**30**
Understand	**30**	**30**	**30**
Apply	**40**	**40**	**40**
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Syllabus

Module-1 (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.

Module- 2 (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.

Module -3 (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.

Module- 4 (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.

Module-5 (Application Areas)

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

Text Book

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 Co.

Sample Course Level Assessment Questions

Course Outcome1(CO1):

1. Compare regression and classification.
2. Define supervised learning? Distinguish between regression and classification.
3. Discuss the different learning approaches used in machine learning.
4. You train an initial model that achieves a 90% accuracy on the training dataset. What kind of problems your model is experiencing, and suggest a possible solution.
5. How does splitting a dataset into train, validation and test sets help identify overfitting?
6. Consider solving a classification task. You first train your network on 20 samples. Training converges, but the training loss is very high. You then decide to train this network on 10,000 examples. Is your approach to fixing the problem correct? If yes, explain the most likely results of training with 10,000 examples. If not, give a solution to this problem.

7. Describe one advantage of using mini-batch gradient descent instead of full-batch gradient descent.
8. Sketch the typical learning curves for the training and validation sets, for a setting where overfitting occurs at some point. Assume that the training set and the validation set are of the same size

Course Outcome 2(CO2):

1. What are hyperparameters? Why are they needed?
2. What issues are to be considered while selecting a model for applying machine learning in a given problem?
3. Update the parameters V11 in the given MLP using back propagation with learning rate as 0.5 and activation function as sigmoid. Initial weights are given as V11= 0.2, V12=0.1, V21=0.1, V22=0.3, V11=0.2, W11=0.5, W21=0.2
4. Draw the architecture of a multi-layer perceptron.
5. Derive update rules for parameters in the multi-layer neural network through the gradient descent.
6. Why is it important to place non-linearities between the layers of neural networks?
7. You design a fully connected neural network architecture where all activations are sigmoids. You initialize the weights with large positive numbers. Is this a good idea? Explain your answer.
8. You are doing full batch gradient descent using the entire training set (not stochastic gradient descent). Is it necessary to shuffle the training data? Explain your answer.
9. Consider training a fully-connected neural network with 5 hidden layers, each with 10 hidden units. The input is 20-dimensional and the output is a scalar. What is the total number of trainable parameters in your network?
10. Consider building a 10-class neural network classifier. Given a cat image, you want to classify which of the 10 cat breeds it belongs to. What loss function do you use? Introduce the appropriate notation and write down the formula of the loss function.
11. Why is the sigmoid activation function susceptible to the vanishing gradient problem?

Course Outcome 3 (CO3):

1. Give two benefits of using convolutional layers instead of fully connected ones for visual tasks.
2. Suppose that a CNN was trained to classify images into different categories. It performed well on a validation set that was taken from the same source as the training set but not on a testing set. What could be the problem with the training of such a CNN? How will you ascertain the problem? How can those problems be solved?
3. You are given a dataset of 10 x 10 grayscale images. Your goal is to build a 5-class classifier. You have to adopt one of the following two options: a) the input is flattened into a 100-dimensional vector, followed by a fully-connected layer with 5

neurons, b) the input is directly given to a convolutional layer with five 10 x 10 filters. Explain which one you would choose and why.

4. Weight sharing allows CNNs to deal with image data without using too many parameters. Does weight sharing increase the bias or the variance of a model?
5. Why do the layers in a deep architecture need to be non-linear?
6. A convolutional neural network has 4 consecutive layers as follows:
   3 x 3 conv (stride 2) - 2 x 2 Pool - 3 x 3 conv (stride 2) - 2 x 2 Pool
   How large is the set of image pixels which activate a neuron in the 4th non-image layer of this network?
7. Consider a convolution layer. The input consists of 6 feature maps of size 20 x 20. The output consists of 8 feature maps, and the filters are of size 5 x 5. The convolution is done with a stride of 2 and zero padding, so the output feature maps are of size 10 x 10. Determine the number of weights in this convolution layer

Course Outcome 4(CO4):

1. Explain how the cell state is updated in the LSTM model from Ct-1 to Ct
2. Show the steps involved in an LSTM to predict stock prices.
3. Illustrate the workings of the RNN with an example of a single sequence defined on a vocabulary of four words.
4. If we have a recurrent neural network (RNN), we can view it as a different type of network by "unrolling it through time". Briefly explain what that means.
5. Briefly explain how “unrolling through time” is related to “weight sharing” in convolutional networks.
6. Explain how the cell state is updated in the LSTM model from Ct-1 to Ct
7. Show the steps involved in an LSTM to predict stock prices.Give one advantage of using an RNN rather than a convolutional network.

Course Outcome 5 (CO5):

1. Development a deep learning solution for problems in the domain i) natural language processing or ii Computer vision (Assignment)
2. Is an autoencoder for supervised learning or for unsupervised learning? Explain briefly.
3. Sketch the architecture of an autoencoder network.
4. Describe how to train an autoencoder network.
5. Write down the formula for the energy function (E) of a Restricted Boltzmann Machine (RBM).

Model Question Paper

QP CODE:

Reg No: _______________

Name: _________________ **PAGES : 4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST425

Course Name: Introduction To Deep Learning

Max. Marks : 100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Distinguish between supervised learning and Reinforcement learning. Illustrate with an example.
2. Differentiate classification and regression.
3. Compare overfitting and underfitting. How it can affect model generalization.
4. Why does a single perceptron cannot simulate simple XOR function? Explain how this limitation is overcome?
5. Illustrate the strengths and weaknesses of convolutional neural networks.
6. Illustrate convolution and pooling operation with an example
7. How many parameters are there in AlexNet? Why the dataset size (1.2 million) is important for the success of AlexNet?
8. Explain your understanding of unfolding a recursive or recurrent computation into a computational graph.
9. Illustrate the use of deep learning concepts in Speech Recognition.
10. What is an autoencoder? Give one application of an autoencoder

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11.	(a)	"A computer program is said to learn from experience E with respect to some class oftasks T and performance measure P, if its performance at tasks in T, as measured by P, improves with experience E." What is your understanding of the terms task, performance and experience. Explain with two example	**(10)**
	(b)	"How does bias and variance trade-off affect machine learning algorithms?	**(4)**

OR

12. (a) Illustrate the concepts of Web search, Page Ranking, Recommender systems with suitable examples. **(10)**

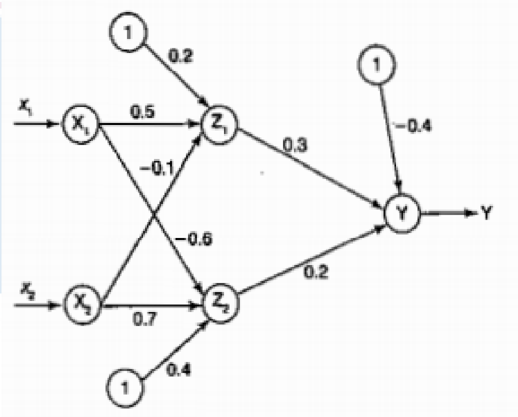
(b) List and discuss the different hyper parameters used in fine tuning the traditional machine learning models **(4)**

13. (a) How multilayer neural networks learn and encode higher level features from input features. **(7)**

(b) Explain gradient decent and delta rule? Why stochastic approximation to gradient descent is needed? **(7)**

OR

14. (a) Find the new weights for the network using backpropogation algorithm, the network is given with a input pattern[-1,1] and target output as +1, Use learning rate of alpha=0.3 and bipolar sigmoid function. **(7)**



(b) Write an algorithm for backpropagation which uses stochastic gradient descent method. Comment on the effect of adding momentum to the network. **(7)**

15. (a) Input to CNN architecture is a color image of size 112x112x3. The first convolution layer comprises of 64 kernels of size 5x5 applied with a stride of 2 and padding 0. What will be the number of parameters? **(5)**

(b) Let X=[-1, 0, 3, 5] W=[.3 ,.5 .2,.1] be the the input of i^{th} layer of a neural network and to apply softmax function. What should be the output of it? **(4)**

(c) Draw and explain the architecture of convolutional network **(5)**

OR

16. (a) Explain the concept behind i) Early stopping ii) dropout iii) weight decay **(9)**

(b) How backpropagation is used to learn higher-order features in a convolutional Network? **(5)**

17. (a) Explain the working of RNN and discuss how backpropagation through time is used in recurrent networks. **(8)**

(b) Describe the working of a long short term memory in RNNs. **(6)**

OR

18. (a) What is the vanishing gradient problem and exploding gradient problem? **(8)**

(b) Why do RNNs have a tendency to suffer from exploding/vanishing gradient? How to overcome this challenge? **(6)**

19. (a) Explain any two word embedding techniques **(8)**

(b) Explain the merits and demerits of using Auto encoders in Computer Vision. **(6)**

OR

20. (a) Illustrate the use of representation learning in object classification. **(7)**

(b) Compare Boltzmann Machine with Deep Belief Network. **(7)**

Teaching Plan

No	Contents	No. of Lecture Hours (37 hrs)
Module 1 : Introduction (8 hours)		
1.1	Key components - Data, models, objective functions, optimization algorithms. (TB2: Section 1.1-1.2)	1
1.2	Learning algorithm (TB1: Section 5.1), Supervised learning- regression, classification, tagging, web search, page ranking (TB2: Section 1.3.1)	1
1.3	Recommender systems, Sequence learning, Unsupervised learning, Reinforcement learning(TB2: Section 1.3.2-1.3.4)	1
1.4	Historical Trends in Deep Learning (TB1: Section 1.2).	1
1.5	Concepts: overfit, underfit, hyperparameters and validation sets. (TB1: Section 5.2-5.3)	1
1.6	Concepts: Estimators, bias and variance. (TB1: Section 5.4)	1
1.7	Demonstrate the concepts of supervised learning algorithms using a suitable platform.	1
1.8	Demonstrate the concepts of unsupervised using a suitable platform.	1
Module 2 : Optimization and Neural Networks (9 hours)		
2.1	Perceptron, Stochastic Gradient descent, Gradient descent solution for perceptron (TB3: Section 1.1 - 1.2.1)	1
2.2	Multilayer perceptron (TB3: Section 1.2.2), (TB1: Section 6.1,6.3)	1
2.3	Activation functions- Sigmoid, tanh, Softmax, ReLU, leaky ReLU (TB3: Section 1.2.1.3 - 1.2.1.5)	1
2.4	Architecture design (TB1: Section 6.4, TB3: Section 1.6)	1
2.5	Chain rule, back propagation (TB3: Section 1.3)	1
2.6	Gradient based learning (TB1: Section 6.2)	1
2.7	Gradient based optimization (TB1: Section 4.3)	1
2.8	Linear least squares using a suitable platform. (TB1: Section 4.5)	1
2.9	Building ML Algorithms and Challenges (TB3: 1.4, TB1: 5.10-5.11)	1
Module 3 :Convolution Neural Network (8 hours)		
3.1	Convolution operation (TB1:Section 9.1)	1
3.2	Motivation, pooling (TB1:Section 9.2-9.3)	1

3.3	Convolution and Pooling as an infinitely strong prior (TB1: Section 9.4)	1
3.4	Variants of convolution functions – multilayer convolutional network, tensors, kernel flipping, downsampling, strides and zero padding. (TB1: Section 9.5)	1
3.5	Variants of convolution functions - unshared convolutions, tiled convolution, training different networks. (TB1: Section 9.5)	1
3.6	Structured outputs, data types (TB1: Section 9.6-9.7)	1
3.7	Efficient convolution algorithms. (TB1: Section 9.8,9.10)	1
3.8	Case Study: AlexNet, VGG, ResNet. (TB3: Section 8.4.1, 8.4.3, 8.4.5)	1
Module 4 :Recurrent Neural Network (7 hours)		
4.1	Computational graphs (TB1: Section 10.1)	1
4.2	RNN (TB1: Section 10.2-10.3)	1
4.3	Encoder – decoder sequence to sequence architectures. (TB1: Section 10.4)	1
4.4	Deep recurrent networks (TB1: Section 10.5)	1
4.5	Recursive neural networks , Modern RNNs, LSTM and GRU (TB1: Section 10.6, 10.10)	1
4.6	Practical use cases for RNNs. (TB1: Section 11.1-11.4)	1
4.7	Demonstrate the concepts of RNN using a suitable platform.	1
Module 5 : Applications and Research (5 hours)		
5.1	Computer vision. (TB1: Section 12.2)	1
5.2	Speech recognition. (TB1: Section 12.3)	1
5.3	Natural language processing. (TB1: Section 12.4)	1
5.4	Brief introduction on current research areas- Autoencoders, Representation learning. (TB1: Section 14.1-14.2, TB3: 9.3)	1
5.5	Brief introduction on current research areas- Boltzmann Machines, Deep belief networks. (TB1: Section 20.1, 20.3)	1

CST435	COMPUTER GRAPHICS	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		OEC	2	1	0	3	2019

Preamble: 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.

Prerequisite: A sound knowledge of Mathematics and concepts of any programming language.

Course Outcomes: After the completion of the course the student will be able to

CO#	CO
CO1	Describe the working principles of graphics devices**(Cognitive Knowledge level: Understand)**
CO2	Illustrate line drawing, circle drawing and polygon filling algorithms**(Cognitive Knowledge level: Apply)**
CO3	Demonstrate geometric representations and transformations on 2D & 3D objects **(Cognitive Knowledge level: Apply)**
CO4	Demonstrate the working of line and polygon clipping algorithms**(Cognitive Knowledge level: Apply)**
CO5	Summarize visible surface detection methods and illustrate projection algorithms. **(Cognitive Knowledge level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔										✔
CO2	✔	✔	✔	✔	✔							✔
CO3	✔	✔	✔	✔	✔							✔
CO4	✔	✔	✔	✔	✔							✔
CO5	✔	✔										✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test 1 (%)	Test 2 (%)	
Remember	30	30	30
Understand	30	30	30
Apply	40	40	40
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Continuous Assessment Tests (Average of SeriesTests1& 2) **25 marks**

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. The first series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing the remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one full question. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module – 1(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.

Module – 2 (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.

Module - 3 (Geometric transformations)

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

Module - 4 (Clipping)

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

Module - 5 (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 Book

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 Level Assessment Questions

Course Outcome 1 (CO1):

1. Compare the working principle of raster scan systems and random scan systems.
2. How much time is spent scanning across each row of pixels during screen refresh on a raster system with resolution of 1280*1024 and a refresh rate of 60 frames per second?

Course Outcome 2 (CO2):

1. Rasterize the line using Bresenham's line drawing algorithm with end points (2,3) and (5,8) accepted from the user and implement it using any appropriate programming language. (Assignment)
2. Illustrate how the 4-connected boundary filling approach differs from 8-connected boundary filling and implement it using any appropriate programming language. (Assignment)

Course Outcome 3 (CO3):

1. Rotate a triangle ABC 45 degree counter clockwise about the pivot point (10,3) , where the position vector of the coordinates is given as A(4,1), B(5,2) and C(4,3).
2. Implement the above transformation using any appropriate programming language with user inputs. (Assignment)
3. Illustrate the steps required for a general 3D rotation if the rotation axis is not parallel to any one of the principal axis. The rotation axis is defined by the points P1(x1,y1,z1) and P2(x2,y2,z2). Give its composite matrix representation.

Course Outcome 4 (CO4):

1. Given a clipping window A(20,20), B(60,20), C(60,40) and D(20,40). Using Cohen Sutherland algorithm, find the visible portion of the line segment joining the points P(40,80) and Q(120,30).

2. Implement Cohen Sutherland clipping algorithm using any appropriate programming language with user inputs. (Assignment)

Course Outcome 5 (CO5):

1. Explain scan line algorithm for detecting visible surfaces in an object.
2. Derive the matrix for performing perspective projection and parallel projection.

Model Question Paper

QP CODE:

Reg No: _______________

Name: _________________ **PAGES : 3**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST435

Course Name: Computer Graphics

Max. Marks : 100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Describe Flat Panel display and its categories.
2. Consider a raster system with a resolution of 1024*1024. Compute the size of the raster needed to store 4 bits per pixel? How much storage is needed if 8 bits per pixel are to be stored?
3. Justify the usage of integer arithmetic in Bresenham's line drawing algorithm.
4. How 8-way symmetry of circle can be used for developing circle drawing algorithms?
5. Show that two successive reflections about either of the coordinate axes is equivalent to a single rotation about the coordinate origin.
6. Determine a sequence of basic transformations that is equivalent to x-direction shearing.
7. Find the window to viewport normalization transformation with window lower left corner at (1,1) and upper right corner at (2,6).

8. How does Cohen Sutherland algorithm determine whether a line is visible, invisible or a candidate for clipping based on the region codes assigned to the end points of the line?

9. Define the terms (i) Centre of projection (ii) Principal vanishing point

10. Differentiate between the object space and image space method for the hidden surface removal of an image. **(10x3=30)**

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Explain the working principle of beam penetration method and shadow mask method with suitable illustrations. **(8)**

(b) Draw the architecture of raster scan display systems and explain its working principle. **(6)**

OR

12. (a) Explain the working principle of a Refresh CRT monitor with suitable diagrams. **(8)**

(b) Describe random graphics system with suitable illustrations. **(6)**

13. (a) Differentiate between boundary fill and flood fill algorithms. **(5)**

(b) Derive the initial decision parameter of Bresenham's line drawing algorithm and rasterize a line with endpoints (2,2) and (10,10). **(9)**

OR

14. (a) Write Midpoint circle drawing algorithm and identify the points in the circle with radius as 20 and center at (50,30) using the algorithm. **(8)**

(b) Illustrate the working principle of scan line polygon filling algorithm. **(6)**

15. (a) Reflect a triangle ABC about the line 3x-4y+8=0, where the coordinates of the triangle are given as A(4,1), B(5,2) and C(4,3). **(8)**

(b) A diamond shaped polygon is located at P(-1,0), Q(0,-2), R(1,0) and S(0,2). Find the transformation matrix which would rotate the triangle by 90 degree counter clockwise about the point Q. Using the transformation matrix, find the coordinates of the rotated polygon. **(6)**

OR

16. (a) Describe the steps required for a general 3D rotation if the rotation axis is not parallel to any one of the principal axis. The rotation axis is defined by the points P1(x1,y1,z1) and P2(x2,y2,z2). Give its composite matrix representation. **(8)**

(b) Consider a triangle at (2,2), (10,2), (2,10). Perform the following 2D transformations in succession and find the resultant vertices. **(6)**

i) Scale with respect to (2,2) by scaling factors (2,2) along x and y directions.
ii) Rotate by 90 degree counter clockwise direction.
iii) Reflection based on y=x

17. (a) Illustrate Weiler – Atherton polygon clipping algorithm. **(6)**

(b) Explain Cohen-Sutherland line clipping algorithm. Use the algorithm to clip line with end points P1 (70, 20) and P2(100,10) against a window with lower left hand corner (50,10) and upper right hand corner (80,40). **(8)**

OR

18. (a) Describe Sutherland Hodgeman polygon clipping algorithm and list out its limitations. **(7)**

(b) Explain the steps involved in clipping a line using Mid point Subdivision algorithm. **(7)**

19. (a) Explain how visible surfaces can be detected using depth buffer algorithm. **(7)**

(b) Define parallel projection. Describe orthographic and oblique parallel projection. **(7)**

OR

20. (a) Illustrate the scan line method used in visible surface detection. **(7)**

(b) Derive the matrix needed for performing perspective projections. **(7)**

TEACHING PLAN

No	Contents	No of Lecture Hrs (35 hrs)
Module – 1 (Basics of Computer Graphics) (6 hrs)		
1.1	Basics of Computer Graphics and applications	1
1.2	Refresh Cathode Ray Tubes	1
1.3	Random Scan Displays and systems	1
1.4	Raster scan displays and systems	1
1.5	Color CRT displays	1
1.6	Flat panel display and its categories.	1
Module - 2 (Line drawing, Circle drawing and Filled Area Primitives) (7 hrs)		
2.1	DDA Line drawing Algorithm	1
2.2	Bresenham's line drawing algorithm	1
2.3	Midpoint Circle generation algorithm	1
2.4	Bresenham's Circle generation algorithm	1
2.5	Illustration of line drawing and circle drawing algorithms	1
2.6	Scan line polygon filling	1
2.7	Boundary filling and flood filling	1
Module - 3 (Geometric transformations) (8 hrs)		
3.1	Basic 2D transformations-Translation and Rotation	1
3.2	Basic 2D transformations- Scaling	1
3.3	Reflection and Shearing	1
3.4	Illustration of 2D Transformations	1
3.5	Composite transformations	1
3.6	Matrix representations and homogeneous coordinates	1
3.7	Basic 3D transformations	1
3.8	Illustration of basic 3D transformations	1
Module - 4 (2D Clipping) (6 hrs)		
4.1	Window to viewport transformation	1
4.2	Cohen Sutherland Line clipping algorithm	1
4.3	Midpoint subdivision Line clipping algorithm	1
4.4	Sutherland Hodgeman Polygon clipping algorithm	1
4.5	Weiler Atherton Polygon clipping algorithm	1
4.6	Practice problems on Clipping algorithms	1
Module - 5 (Three dimensional graphics)(8 hrs)		
5.1	Three dimensional viewing pipeline, Projections-Parallel projections	1

5.2	Projections- Perspective projections	1
5.3	Visible surface detection algorithms- Back face detection.	1
5.4	Depth buffer algorithm	1
5.5	Depth buffer algorithm	1
5.6	Scan line visible surface detection algorithm	1
5.7	Scan line visible surface detection algorithm	1
5.8	A buffer algorithm	1

CST445	PYTHON FOR ENGINEERS	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		OEC	2	1	0	3	2019

Preamble: The objective of the course is to provide learners 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.

Prerequisite: NIL

Note : *Students who have successfully completed CST 283 - Python for Machine Learning (Minor) are not eligible to opt this course.*

Course Outcomes: After the completion of the course the student will be able to

CO1	Write, test and debug Python programs **(Cognitive Knowledge level: Apply)**
CO2	Illustrate uses of conditional (if, if-else, if-elif-else and switch-case) and iterative (while and for) statements in Python programs **(Cognitive Knowledge level: Apply)**
CO3	Develop programs by utilizing the modules Lists, Tuples, Sets and Dictionaries in Python **(Cognitive Knowledge level: Apply)**
CO4	Implement Object Oriented programs with exception handling **(Cognitive Knowledge level: Apply)**
CO5	Analyze, Interpret, and Visualize data according to the target application (**Cognitive Knowledge level: Apply**)
CO6	Develop programs in Python to process data stored in files by utilizing the modules Numpy, Matplotlib, and Pandas **(Cognitive Knowledge level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										✓
CO2	✓	✓										✓
CO3	✓	✓										✓
CO4	✓	✓	✓		✓							✓
CO5	✓	✓	✓		✓							✓
CO6	✓	✓	✓		✓							✓

Abstract POs defined by National Board of Accreditation

#PO	Broad PO	#PO	Broad PO
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Life long learning

Assessment Pattern

Bloom's Category	Test 1 (*Marks in percentage*)	Test 2 (*Marks in percentage*)	End Semester Examination Marks
Remember	20	20	20
Understand	30	30	30
Apply	50	50	50
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test : 25 marks
Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. The first series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing the remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have a maximum of 2 sub-divisions and carries 14 marks.

Syllabus

Module 1 (Basics of Python)

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.

Module 2 (Functions and Python Data Structures)

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.

Module 3 (Object Oriented Programming)

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.

Module 4 (Visualization and File handling)

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.

Module 5 (Scientific Computing)

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.

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

Reference Books:

1. Wes McKinney, Python for Data Analysis, 2/e, Shroff / O'Reilly Publishers, 2017
2. Allen B. Downey, Think Python: How to Think Like a Computer Scientist, 2/e, Schroff, 2016
3. Michael Urban and Joel Murach, Python Programming, Shroff/Murach, 2016
4. David M.Baezly, Python Essential Reference. Addison-Wesley Professional; 4/e, 2009.
5. Charles Severance. Python for Informatics: Exploring Information,
6. http://swcarpentry.github.io/python-novice-gapminder/

Sample Course Level Assessment Questions

Course Outcome1(CO1):

1. What is type conversion? How is it done in Python?

Course Outcome 2(CO2):

1. Given is a list of of words, *wordlist*, and a string, *name.* Write a Python function which takes *wordlist* and *name* as input and returns a tuple. The first element of the output tuple is the number of words in the *wordlist* which have *name* as a substring in it. The second element of the tuple is a list showing the index at which the *name* occurs in each of the words of the *wordlist* and a 0 if it doesn't occur.

Course Outcome 3(CO3):

1. Write a Python program to implement the addition, subtraction, and multiplication of complex numbers using classes. Use constructors to create objects. The input to the program consist of real and imaginary parts of the complex numbers.

Course Outcome 4(CO4):

1. Plot the function $y = 3x^2$ for $-1 \leq x \leq 3$ as a continuous line. Include enough points so that the curve you plot appears smooth. Label the axes x and y

Course Outcome 5(CO5):

1. Given a file "auto.csv" of automobile data with the fields *index, company, body-style, wheel-base, length, engine-type, num-of-cylinders, horsepower, average-mileage,* and *price***,** write python code to
   i. Clean and Update the CSV file
   ii. Print total cars of all companies
   iii. Find the average mileage of all companies
   iv. Find the highest priced car of all companies.

Model Question Paper

QP CODE: PAGES:

Reg No:_______________
Name:_________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR
Course Code: CST445

Course name : PYTHON FOR ENGINEERS

Max Marks: 100 **Duration: 3 Hours**

PART-A

(Answer All Questions. Each question carries 3 marks)

1. Explain the basic data types available in Python, with examples.
2. Write a Python program to reverse a number and also find the sum of digits of the number. Prompt the user for input.
3. Compare tuples, lists, and dictionaries.
4. Explain the concept of scope and lifetime of variables in Python programming language, with a suitable example.
5. What is polymorphism? Give an example in the context of OOP in Python.
6. How is exception handling accomplished in Python programs?
7. Describe the characteristics of the CSV format.

8. Plot the function $y = 3x^2$ for $-1 \le x \le 3$ as a continuous line. Include enough points so that the curve you plot appears smooth. Label the axes x and y

9. Describe random number generation using Python

10. How can a generalized eigen value problem can be solved using Python?

PART-B

(Answer any one full question from each module)

Module -1

11. (a) Compare and contrast interpreted languages and compiled languages. How does it affect the quality of program development and execution of the program? (6)

(b) What are the possible errors in a Python program. Write a Python program to print the value of $2^{2n}+n+5$ for n provided by the user. (8)

OR

12. (a) Describe Arithmetic operators, Assignment operators, Comparison operators, Logical operators, and Bitwise operators in detail with examples. (6)

(b) Input 4 integers (+ve and −ve). Write a Python code to find the sum of negative numbers, positive numbers, and print them. Also, find the averages of these two groups of numbers and print (8)

Module -2

13. (a) Write a Python code to create a function called *list_of_frequency* that takes a string and prints the letters in non-increasing order of the frequency of their occurrences. Use dictionaries. (5)

(b) Write a Python program to read a list of numbers and sort the list in a non-decreasing order without using any built in functions. Separate function should be written to sort the list wherein the name of the list is passed as the parameter. (9)

OR

14. (a) Illustrate the following Set methods with an example. (8)

i. *intersection( )* ii. *Union( )* iii. *Issubset( )* iv. *Difference( )* v. *update( )* vi. *discard( )*

(b) Write a Python program to check the validity of a password given by the user. (6)

The Password should satisfy the following criteria:

1. Contains at least one letter between a and z
2. Contains at least one number between 0 and 9
3. Contains at least one letter between A and Z

4. Contains at least one special character from $, #, @

5. Minimum length of password: 6

Module -3

15. (a) How can a class be instantiated in Python? Write a Python program to express the instances as return values to define a class RECTANGLE with parameters *height, width, corner_x,* and *corner_y* and member functions to find center, area, and perimeter of an instance. (5)

(b) Explain inheritance in Python. Give examples for each type of inheritance. (9)

OR

16. (a) Write a Python class named Circle constructed by a radius and two methods which will compute the area and the perimeter of a given circle (6)

(b) Define a class in Python to store the details of a ship (name, source,destination) with the following methods: (8)

i) *get_details( )* - to assign values to class attributes

ii) *print_details( )* - to display the attribute values

Create an object of the class and invoke the methods

Module -4

17. (a) Plot the functions *sin x* and *cos x* vs *x* on the same plot with x going from $-\pi$ to π. Make sure the limits of the *x*-axis do not extend beyond the limits of the data. Plot *sin x* in the color orange and *cos x* in the color green and include a legend to label the two curves. Place the legend within the plot, but such that it does not cover either of the sine or cosine traces. Draw thin gray lines behind the curves, one horizontal at $y = 0$ and the other vertical at $x = 0$. (10)

(b) Explain semi-log plots and log-log plots along with the functions used in creating such plots. (4)

OR

18. (a) Explain how *matplotlib* can be used to create dimensional contour plots and vector field plots. (6)

(b) Given a file "*auto.csv*" of automobile data with the fields *index, company, body-style, wheel-base, length, engine-type, num-of-cylinders, horsepower, average-mileage,* and *price,* write Python codes using Pandas to (8)

1) Clean and Update the CSV file
2) Print total cars of all companies
3) Find the average mileage of all companies
4) Find the highest priced car of all companies.

Module -5

19. (a) Write python program to solve the following system of equations (4)

$x_1 - 2x_2 + 9x_3 + 13x_4 = 1$

$-5x_1 + x_2 + 6x_3 - 7x_4 = -3$

$4x_1 + 8x_2 - 4x_3 - 2x_4 = -2$

$8x_1 + 5x_2 - 7x_3 + x_4 = 5$

(b) Given the sales information of a company as CSV file with the following fields *month_number, facecream, facewash, toothpaste, bathingsoap, shampoo, moisturizer, total_units, total_profit*. Write Python codes to visualize the data as follows (10)

1) Toothpaste sales data of each month and show it using a scatter plot
2) Face cream and face wash product sales data and show it using the bar chart

Calculate total sale data for last year for each product and show it using a Pie chart.

OR

20. (a) Write Python program to write the data given below to a CSV file. (9)

SN	Name	Country	Contribution	Year
1	Linus Torvalds	Finland	Linux Kernel	1991
2	Tim Berners-Lee	England	World Wide Web	1990
3	Guido van Rossum	Netherlands	Python	1991

(b) Explain how integration is performed with SciPy. Illustrate the same with the two sample integrals using SciPy function. (5)

Teaching Plan

Sl No	Contents	Number of Hours (35 Hrs)
Module 1: Basics of Python (8 hours)		
1.1	Getting Started with Python Programming: Running code in the interactive shell Editing, Saving, and Running a script	1 hour
1.2	Using editors: IDLE, Jupyter	1 hour
1.3	Basic coding skills: Working with data types, Numeric data types and Character sets, Keywords, Variables and Assignment statement, Operators, Expressions,	1 hour
1.4	Working with numeric data, Type conversions, Comments in the program, Input Processing, and Output. Formatting output	1 hour
1.5	How Python works. Detecting and correcting syntax errors. Using built in functions and modules in math module.	1 hour
1.6	Control statements : Selection structure, if-else, if ~~elif~~else	1 hour
1.7	Iteration structure - for, while	1 hour
1.8	Testing the control statements, Lazy evaluation.	1 hour
Module 2: Functions and Python Data Structures (8 hours)		
2.1	Functions: Hiding redundancy and complexity, Arguments and return values	1 hour
2.2	Variable scopes and parameter passing	1 hour
2.3	Named arguments, Main function,	1 hour
2.4	Working with recursion, Lambda functions	1 hour
2.5	Strings - String function	1 hour
2.6	Lists - Basic list Operations and functions, List of lists, Slicing, Searching and sorting list, List comprehension.	1 hour
2.7	Work with tuples. Sets.	1 hour
2.8	Dictionaries - Dictionary functions, dictionary literals, adding and removing keys, Accessing and replacing values, traversing dictionaries, reverse lookup	1 hour
Module 3: Object Oriented Programming (6 hours)		
3.1	Design with classes : Objects and Classes, Methods, Instance Variables	1 hour
3.2	Constructor, Accessors, and Mutators	1 hour
3.3	Structuring classes with Inheritance	1 hour
3.4	Polymorphism	1 hour
3.5	Abstract Classes	1 hour
3.6	Exceptions: Handle a single exception, Handle multiple exception	1 hour
Module 4: Visualization and File handling (6 hours)		

4.1	Plotting - An Interactive Session with PyPlot, Basic Plotting,	1 hour
4.2	Logarithmic Plots, More Advanced Graphical Output	1 hour
4.3	Plots with multiple axes, Mathematics and Greek symbols	1 hour
4.4	The Structure of matplotlib, Contour and Vector Field Plots	1 hour
4.5	File Processing -The *os* and *sys* modules, Introduction to file I/O, Reading and writing text files	1 hour
4.6	Working with CSV files	1 hour
Module 5: Scientific Computing (7 hours)		
5.1	Numerical Routines: SciPy and NumPy - Basics, Creating arrays, Arithmetic, Slicing	1 hour
5.2	Matrix Operations, Special Functions, Random Numbers	1 hour
5.3	Linear Algebra, Solving Nonlinear Equations	1 hour
5.4	Numerical Integration, Solving ODEs	1 hour
5.5	Data Manipulation and Analysis: Pandas - Reading Data from Files Using Pandas	1 hour
5.6	Data Structures - Series and DataFrame	1 hour
5.7	Extracting Information from a DataFrame, Grouping and Aggregation	1 hour

CST455	OBJECT ORIENTED CONCEPTS	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		OEC	2	1	0	3	2019

Preamble: 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.

Prerequisite: A sound background in any of the programming languages like C, C++, Python etc is mandatory. Students who completed the minor stream course CST 281 Object Oriented Programming are not allowed to choose this Open Elective Course.

Course Outcomes: After the completion of the course the student will be able to

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

Mapping of course outcomes with program outcomes

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO11	PO1 2
CO1	✓	✓	✓									✓
CO2	✓	✓	✓									✓
CO3	✓	✓	✓									✓
CO4	✓	✓	✓									✓
CO5	✓	✓	✓									✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test 1 (%)	Test 2 (%)	
Remember	20	20	20
Understand	40	40	40
Apply	40	40	40
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Continuous Assessment Tests(Average of Internal Tests1&2) **25 marks**

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module – 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.

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.

Module – 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.

Module - 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 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***.

Module - 4 (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.

Module - 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.

Text Books

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

Reference Books

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 Level Assessment Questions

Course Outcome1 (CO1):

1. Three types of employees work in an organization: Regular, Contract and Hourly. Regular employees are permanent workers of the organization. Their salary is computed as the sum of basic pay, DA (50% of basic pay) and HRA. Contract employees work for the organization only for the contract period and earn a fixed salary. Hourly employees work for a fixed number of hours each day. Their salary is computed based on the total number of hours worked.

   Using object oriented principles, write a Java program to prepare pay roll of the organization.

2. Write a java program to create an abstract class named Shape that contains two integers and an empty method named printArea(). Provide three classes named Rectangle, Square, Triangle and Circle with proper class hierarchy. Each one of the classes contain only the method printArea( ) that prints the area of the given shape.

Course Outcome 2(CO2):

1. Write a Java program that reads a file and displays the file on the screen, with a line number before each line.
2. Write a Java program to prepare the rank list of computer science students based on their performance in the first Semester B.Tech. Degree examination at APJ Abdul Kalam Technological University. The output should be stored in a file.

Course Outcome 3(CO3):

1. Write a program to demonstrate the use of *throws* clause to handle an exception occurred within a method.
2. Write a program to demonstrate how exception handling is supported in Java.

Course Outcome 4(CO4):

1. Write a program to compute the sum of elements in an array using two threads in a parallel way. The first thread sums up the first half of the array and the second thread sums up the second half of the array. Finally, the main thread adds these partial sums and prints the result.
2. Write a java program that implements a multi-thread application that has three threads. First thread generates random integer every 1 second and ifthe value is even, second thread computes the square of the number and prints. If the value is odd, the third thread will print the value of cube of the number.

Course Outcome 5(CO5):

1. Write a GUI based program to convert temperature from degree Celsius to Fahrenheit.
2. Write a java program that simulates a traffic light. The program lets the user select one of three lights: red, yellow, or green with buttons. On selecting a button, an appropriate message with "stop" or "ready" or "go" should appear above the buttons in a selected color. Initially there is no message shown.

Model Question Paper

QP CODE:

Reg No: _______________

Name: _________________ **PAGES :4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST455

Course Name: Object Oriented Concepts

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Java is considered to be secure and portable. Justify this statement.
2. Describe the concept of dynamic binding.
3. Explain the different arithmetic operators in Java.
4. What does the following Java function compute? Justify your answer.

```
intgreater(int a, int b)
{
while(a!=b)
{
```

```
    if(a>b)
a=a-b;
    else
b=b-a;
}
return a;
}
```


5. Explain the use of CLASSPATH with an example.

6. What are the different types of exceptions?

7. Explain file handling features available in Java.

8. Write a simple program to read an integer value from console and print it.

9. Explain the concept of *main thread* in multi-threading.

10. Explain any two Event classes in Java. **(10x3=30)**

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Describe in detail polymorphism, abstraction and inheritance with suitable examples. **(9)**

(b) What is Java Virtual Machine? **(5)**

OR

12. (a) Explain the salient features of Java language. How does Java Enterprise Edition (J2EE) differ from Java Standard Edition (Java SE)? **(9)**

(b) Explain the declaration and use of multi-dimensional array variables in Java, with example. **(5)**

13. (a) Explain iteration control statements in Java. Give examples. **(8)**

(b) Write a recursive program to compute the factorial of a number. **(6)**

OR

14. (a) Using a suitable Java program, explain the concept of methods and constructors. **(6)**

(b) Write a Java program that prompts the user for an integer and then prints out all the prime numbers up to that number. **(8)**

15. (a) In a table format, show the effect of access specifiers within and outside packages in Java. **(6)**

(b) Describe exception handling using **try** block and **catch** clause in Java with the help of a suitable Java program. **(8)**

OR

16. (a) What is an interface in Java? Explain with a suitable example. **(6)**

(b) Write a program that perform integer divisions. The user enters two input data (any data type) through console into variables Num1 and Num2. If Num1 or Num2 were not an integer, the program would throw a Number Format Exception. If Num2 were Zero, the program would throw an Arithmetic Exception. Display the appropriate exception or result. **(8)**

17. (a) Write a Java program that displays the number of characters, lines and words in a text file. **(8)**

(b) Explain any three String constructors with the help of sample code for each. **(6)**

OR

18. (a) Write a program to demonstrate the usage of the *PrintWriter* class. **(7)**

(b) Write a Java program for sorting a given list of names in ascending order. **(7)**

19. (a) Explain Delegation Event model for event handling in Java. **(7)**

(b) Write a program to compute the sum of elements in an array using two **(7)** threads in a parallel way. The first thread sums up the first half of the array and the second thread sums up the second half of the array. Finally, the main thread adds these partial sums and prints the result.Use Runnable interfacefor the creation of a thread.

OR

20. (a) What are the differences between a process and a thread? **(4)**

(b) Write a Graphical User Interface (GUI) based Java program to implement a simple calculator supporting the operations addition, subtraction, multiplication and division. Use Swing controls to implement GUI. There may be three text boxes, the first two for accepting the operands and the last for displaying the result. Add four buttons for the above operations. Write neat comments in your program to show how you handle events. **(10)**

Teaching Plan

No	Contents	No. of Lecture Hours (36hrs)
	Module – 1 (Object Orientation and Java basics) (7 hrs)	
1.1	Object Orientation Principles – Object and Class, Data abstraction and Encapsulation	1 hour
1.2	Inheritance, Polymorphism	1 hour
1.3	Dynamic binding, Message communication, Benefits of using Object orientation.	1 hour
1.4	Java programming Environment and Runtime Environment, Development Platforms -Standard, Enterprise. JVM, Java compiler, Bytecode	1 hour
1.5	Java applet, Java Buzzwords, Java program structure, Comments, Garbage Collection, Lexical Issues	1 hour
1.6	Primitive Data types - Integers, Floating Point Types, Characters, Boolean	1 hour
1.7	Literals, Type Conversion and Casting, Variables, Arrays, Strings, Vector	1 hour

	class.	
Module - 2 (Core Java Fundamentals) (7 hrs)		
2.1	Operators - Arithmetic Operators, Bitwise Operators, Relational Operators, Boolean Logical Operators, Assignment Operator, Conditional (Ternary) Operator, Operator Precedence.	1 hour
2.2	Control Statements - Selection Statements, Iteration Statements and Jump Statements.	1 hour
2.3	Object Oriented Programming in Java - Class Fundamentals, Declaring Objects	1 hour
2.4	Object Reference, Introduction to Methods, Constructors, ***this*** Keyword	1 hour
2.5	Method Overloading, Using Objects as Parameters, Returning Objects	1 hour
2.6	Recursion, Access Control, static Members	1 hour
2.7	Command-Line Arguments, Variable Length Arguments	1 hour
Module - 3 (More features of Java) (8 hrs)		
3.1	Inheritance - Super class, Sub class, the keyword super, protected Members	1 hour
3.2	Calling Order of Constructors, Method Overriding, the Object class	1 hour
3.3	Abstract Classes and Methods, Using final with Inheritance	1 hour
3.4	Packages and Interfaces - Defining Package, CLASSPATH, Access Protection	1 hour
3.5	Importing Packages, Interfaces	1 hour
3.6	Exception Handling - Checked Exceptions, Unchecked Exceptions, ***try*** Block and ***catch*** Clause	1 hour
3.7	Multiple ***catch*** Clauses, Nested ***try*** Statements	1 hour
3.8	***throw***, ***throws*** and ***finally***	1 hour
Module - 4 (Advanced features of Java) (6 hrs)		
4.1	Input/Output - I/O Basics, Reading Console Input	1 hour
4.2	Writing Console Output, PrintWriter Class	1 hour
4.3	Working with Files (Lecture-1)	1 hour

4.4	Working with Files (Lecture-2)	1 hour
4.5	Java Library - String Handling – String Constructors, String Length	1 hour
4.6	Special String Operations - Character Extraction, String Comparison, Searching Strings, Modifying Strings, Using valueOf( ), Comparison of StringBuffer and String.	1 hour
Module - 5 (GUI Programming, Event Handling and Multithreaded Programming) (8hrs)		
5.1	Multithreaded Programming - The Java Thread Model, The Main Thread, Creating Thread	1 hour
5.2	Creating Multiple Threads	1 hour
5.3	Suspending, Resuming and Stopping Threads.	1 hour
5.4	Event handling **-** Event Handling Mechanisms, Delegation Event Model	1 hour
5.5	Event Classes,Sources of Events, Event Listener Interfaces	1 hour
5.6	Using the Delegation Model, Swing fundamentals, Swing Key Features	1 hour
5.7	Model View Controller (MVC), Swing Controls, Components and Containers	1 hour
5.8	Exploring Swing –JFrame, JLabel, JButton, JTextField	1 hour

AIL 411	DEEP LEARNING LAB	CATEGORY	L	T	P	CREDIT
		Laboratory	0	0	3	2

Preamble: This course aims to offer students hands-on experience on deep learning algorithms. Students will be able to familiarize basic python packages for deep learning, computer vision concepts for deep learning, sequence modelling and recurrent neural network. This course helps the learners to enhance the capability to design and implement a deep learning architecture for a real time application.

Prerequisite: A sound knowledge in python programming, machine learning concepts, deep learning algorithms.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Implement advanced machine learning concepts using python. **(Cognitive Knowledge Level: Apply)**
CO 2	Apply basic data pre-processing and tuning techniques. **(Cognitive Knowledge Level: Apply)**
CO 3	Experiment behaviour of neural networks and CNN on datasets. **(Cognitive Knowledge Level: Analyse)**
CO 4	Design and Implement sequence modelling schemes.**(Cognitive Knowledge Level: Apply)**
CO 5	Implement auto encoders on standard datasets and analyse the performance. **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO	✔	✔	✔	✔	✔			✔		✔		✔

1												
CO 2	✔	✔	✔	✔	✔			✔		✔		✔
CO 3	✔	✔	✔	✔	✔	✔		✔		✔		✔
CO 4	✔	✔	✔	✔	✔	✔		✔		✔		✔
CO 5	✔	✔	✔	✔	✔	✔		✔		✔		✔

Assessment Pattern

Bloom's Category	Continuous Assessment Test %	End Semester Examination %
Remember		
Understand	20	20
Apply	80	80
Analyze		
Evaluate		
Create		

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 15 marks

Continuous Evaluation in Lab : 30 marks

Continuous Assessment Test : 15 marks

Viva-voce : 15 marks

Internal Examination Pattern: The marks will be distributed as Algorithm 30 marks, Program 20 marks, Output 20 marks and Viva 30 marks. Total 100 marks which will be converted out of 15 while calculating Internal Evaluation marks.

End Semester Examination Pattern: The marks will be distributed as Algorithm 30 marks, Program 20 marks, Output 20 marks and Viva 30 marks. Total 100 marks will be converted out of 75 for End Semester Examination.

Operating System to Use in Lab :Linux/Windows

Programming Language/Software to Use in Lab :matlab or python

Fair Lab Record:

All Students attending the Deep Learning Lab should have a Fair Record. The fair record should be produced in the University Lab Examination. Every experiment conducted in the lab should be noted in the fair record. For every experiment in the fair record the right hand page should contain Experiment Heading, Experiment Number, Date of Experiment, Aim of Experiment, Details of Experiment including algorithm and Result of Experiment. The left hand page should contain a print out of the code used for the experiment and sample output obtained for a set of input.

SYLLABUS

Familiarize python frameworks for deep learning, Data Preprocessing, Supervised Unsupervised Learning, Design and Implementation of SimpleNueral Networks, Back Propagation, Regularization, Dropout, Build and analyze deep learnimg architectures like CNN, RNN, LSTM, GRU, Autoencoders.

LIST OF PRACTICE QUESTIONS

**mandatory

1. Familiarize basic python packages for deep learning such as Keras, Tensorflow etc.
2. Data pre-processing operations such as outliers and/or inconsistent data value management. **
3. Implement Feed forward neural network with three hidden layers for classification on CIFAR-10 dataset.**
4. Analyse the impact of optimization and weight initialization techniques such as Xavier initialization, Kaiming Initialization, dropout and regularization techniques and visualize the change in performance. **
5. Digit classification using CNN architecture for MNIST dataset. **
6. Digit classification using pre-trained networks like VGGnet-19 for MNIST dataset and analyse and visualize performance improvement.**
7. Implement a simple RNN for review classification using IMDB dataset.**
8. Analyse and visualize the performance change while using LSTM and GRU instead of simple RNN.**
9. Implement time series forecasting prediction for NIFTY-50 dataset. **
10. Implement a shallow auto encoder and decoder network for machine translation(by using Kaggle English to Hindi neural translation dataset). **

Note: Any suitable dataset and deep learning specific packages can be used. Number of epochs can be reduced to complete the training in the prescribed 3 hour lab sessions.

Reference Books

1. Deep Learning with Python, by François Chollet, Manning, 2021
2. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.
3. Neural Networks and Deep Learning, Aggarwal, Charu C., c Springer International Publishing AG, part of Springer Nature 2018

AMT413	SEMINAR	CATEGORY	L	T	P	CREDIT
		PWS	0	0	3	2

Preamble: 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 Objectives:

- To do literature survey in a selected area ofstudy.
- To understand an academic document from the literate and to give a presentation about it.
- To prepare a technical report.

Course Outcomes [COs] : After successful completion of the course, the students will be able to:

CO1	Identify academic documents from the literature which are related to her/his areas of interest (Cognitive knowledge level: **Apply**).
CO2	Read and apprehend an academic document from the literature which is related to her/ his areas of interest (Cognitive knowledge level: **Analyze**).
CO3	Prepare a presentation about an academic document (Cognitive knowledge level: **Create**).
CO4	Give a presentation about an academic document (Cognitive knowledge level: **Apply**).
CO5	Prepare a technical report (Cognitive knowledge level: **Create**).

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1		2	1					3
CO2	3	3	2	3		2	1					3
CO3	3	2			3			1		2		3
CO4	3				2			1		3		3
CO5	3	3	3	3	2	2		2		3		3

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Life long learning

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 University 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 project team 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 submitted to the IEC.
- 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 on her/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.).

AIM415	PROJECT PHASE I	CATEGORY	L	T	P	CREDIT
		PWS	0	0	6	2

Preamble: 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 7^{th} and 8^{th} semester separately, based on the achieved objectives. One third of the project credits shall be completed in 7^{th} semester and two third in 8^{th} 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 Objectives

- To apply engineering knowledge in practical problem solving.
- To foster innovation in design of products, processes or systems.
- To develop creative thinking in finding viable solutions to engineering problems.

Course Outcomes [COs] : After successful completion of the course, the students will be able to:

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

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	1	2	2	2	1	1	1	1	2
CO2	2	2	2		1	3	3	1	1		1	1
CO3									3	2	2	1
CO4					2			3	2	2	3	2
CO5	2	3	3	1	2							1
CO6					2			2	2	3	1	1

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Lifelong learning

PROJECT PHASE I

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 coordinator and project supervisor).

Evaluation by the Guide

The guide/supervisor shall monitor the progress being carried out by the project groups on a regular basis. In case it is found that progress is unsatisfactory it shall be reported to the Department Evaluation Committee for necessary action. The presence of each student in the group and their involvement in all stages of execution of the project shall be ensured by the guide. Project evaluation by the guide: 30 Marks. This mark shall be awarded to the students in his/her group by considering the following aspects:

Topic Selection: innovativeness, social relevance etc. (2)

Problem definition: Identification of the social, environmental and ethical issues of the project problem. (2)

Purpose and need of the project: Detailed and extensive explanation of the purpose and need of the project. (3)

Project Objectives: All objectives of the proposed work are well defined; Steps to be followed to solve the defined problem are clearly specified. (2)

Project Scheduling & Distribution of Work among Team members: Detailed and extensive Scheduling with timelines provided for each phase of project. Work breakdown structure well defined. (3)

Literature survey: Outstanding investigation in all aspects. (4)

Student's Diary/ Daily Log: The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students' thought process and reasoning abilities. The students should record in the daily/weekly activity diary the day to day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. The daily/weekly activity diary shall be signed after every day/week by the guide. (7)

Individual Contribution: The contribution of each student at various stages. (7)

EVALUATION RUBRICS for PROJECT Phase I: Interim Evaluation

No.	Parameters	Marks	Poor	Fair	Very Good	Outstanding
1-a	Topic identification, selection, formulation of objectives and/or literature survey. (Group assessment) [CO1]	10	The team has failed to come with a relevant topic in time. Needed full assistance to find a topic from the guide. They do not respond to suggestions from the evaluation committee and/or the guide. No literature review was conducted. The team tried to gather easy information without verifying the authenticity. No objectives formed yet.	The team has identified a topic. The originally selected topic lacks substance and needs to be revised. There were suggestions given to improve the relevance and quality of the project topic. Only a few relevant references were consulted/ studied and there is no clear evidence to show the team's understanding on the same. Some objectives identified, but not clear enough.	Good evidence of the group thinking and brainstorming on what they are going to build. The results of the brainstorming are documented and the selection of topic is relevant. The review of related references was good, but there is scope of improvement. Objectives formed with good clarity, however some objectives are not realistic enough.	The group has brainstormed in an excellent manner on what they were going to build. The topic selected is highly relevant, real world problem and is potentially innovative. The group shows extreme interest in the topic and has conducted extensive literature survey in connection with the topic. The team has come up with clear objectives which are feasible.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
1-b	Project Planning, Scheduling and Resource/ Tasks Identification and allocation. (Group assessment) [CO4]	10	No evidence of planning or scheduling of the project. The students did not plan what they were going to build or plan on what materials / resources to use in the project. The students do not have any idea on the budget required. The team has not yet decided on who does what. No project journal kept.	Some evidence of a primary plan. There were some ideas on the materials /resources required, but not really thought out. The students have some idea on the finances required, but they have not formalized a budget plan. Schedules were not prepared. The project journal has no details. Some evidence on task allocation among the team members.	Good evidence of planning done. Materials were listed and thought out, but the plan wasn't quite complete. Schedules were prepared, but not detailed, and needs improvement. Project journal is presented but it is not complete in all respect / detailed. There is better task allocation and individual members understand about their tasks. There is room for improvement.	Excellent evidence of enterprising and extensive project planning. Gantt charts were used to depict detailed project scheduling. A project management/version control tool is used to track the project, which shows familiarity with modern tools. All materials / resources were identified and listed and anticipation of procuring time is done. Detailed budgeting is done. All tasks were identified and incorporated in the schedule. A well-kept project journal shows evidence for all the above, in addition to the interaction with the project guide. Each member knows well about their individual tasks.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)

Phase 1 Interim Evaluation Total Marks: 20

EVALUATION RUBRICS for PROJECT Phase I: Final Evaluation

Sl. No.	Parameters	Marks	Poor	Fair	Very Good	Outstanding
1-c	Formulation of Design and/or Methodology and Progress. (Group assessment) [CO1]	5	None of the team members show any evidence of knowledge about the design and the methodology adopted till now/ to be adopted in the later stages. The team has not progressed from the previous stage of evaluation.	The students have some knowledge on the design procedure to be adopted, and the methodologies. However, the team has not made much progress in the design, and yet to catch up with the project plan.	The students are comfortable with design methods adopted, and they have made some progress as per the plan. The methodologies are understood to a large extent.	Shows clear evidence of having a well- defined design methodology and adherence to it. Excellent knowledge in design procedure and its adaptation. Adherence to project plan is commendable.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
1-d	Individual and Teamwork Leadership (Individual assessment) [CO3]	10	The student does not show any interest in the project activities, and is a passive member.	The student show some interest and participates in some of the activities. However, the activities are mostly easy and superficial in nature.	The student shows very good interest in project, and takes up tasks and attempts to complete them. Shows excellent responsibility and team skills. Supports the other members well.	The student takes a leadership position and supports the other team members and leads the project. Shows clear evidence of leadership.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
1-e	Preliminary Analysis/ Modeling / Simulation/ Experiment / Design/ Feasibility study [CO1]	10	The team has not done any preliminary work with respect to the analysis/modeling/ simulation/experiment/design/feasibility study/ algorithm development.	The team has started doing some preliminary work with respect to the project. The students however are not prepared enough for the work and they need to improve a lot.	There is some evidence to show that the team has done good amount of preliminary investigation and design/ analysis/ modeling etc. They can improve further.	Strong evidence for excellent progress in the project. The team has completed the required preliminary work already and are poised to finish the phase I in an excellent manner. They have shown results to prove their progress.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)

1-f	Documentation and presentation. (Individual & group assessment). [CO6]	5	The team did not document the work at all. The project journal/diary is not presented. The presentation was shallow in content and dull in appearance. The individual student has no idea on the presentation of his/her part.	Some documentation is done, but not extensive. Interaction with the guide is minimal. Presentation include some points of interest, but overall quality needs to be improved. Individual performance to be improved.	Most of the project details were documented well enough. There is scope for improvement. The presentation is satisfactory. Individual performance is good.	The project stages are extensively documented in the report. Professional documentation tools like LaTeX were used to document the progress of the project along with the project journal. The documentation structure is well-planned and can easily grow into the project report. The presentation is done professionally and with great clarity. The individual's performance is excellent.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
Total		**30**	**Phase - I Final Evaluation Marks: 30**			

EVALUATION RUBRICS for PROJECT Phase I: Report Evaluation

Sl. No.	Parameters	Marks	Poor	Fair	Very Good	Outstanding
1-g	Report [CO6]	20	The prepared report is shallow and not as per standard format. It does not follow proper organization. Contains mostly Unacknowledged content. Lack of effort in preparation is evident.	Project report follows the standard format to some extent. However, its organization is not very good. Language needs to be improved. All references are not cited properly in the report.	Project report shows evidence of systematic documentation. Report is following the standard format and there are only a few issues. Organization of the report is good. Most of references are cited properly.	The report is exceptionally good. Neatly organized. All references cited properly. Diagrams/Figures, Tables and equations are properly numbered, and listed and clearly shown. Language is excellent and follows standard styles.
			(0 - 7 Marks)	(8 - 12 Marks)	(13 - 19 Marks)	(20 Marks)
Phase - I Project Report Marks: 20						

SEMESTER VII

MINOR

CSD481	MINI PROJECT	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PWS	0	0	3	4	2019

Preamble: 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.

Prerequisite:

A sound knowledge in courses studied in respective minor stream.

Course Outcomes: After the completion of the course the student will be able to

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

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔	✔	✔		✔	✔	✔	✔	✔	✔	✔
CO2	✔	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔
CO3	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
CO4	✔	✔	✔	✔	✔			✔	✔	✔	✔	✔
CO5	✔	✔	✔	✔	✔	✔	✔	✔	✔		✔	✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**
150	**75**	**75**

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Project Guide **15 marks**

Project Report **10 marks**

Evaluation by the Committee (will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, work knowledge and involvement) : **40 marks**

Student Groups with 4 or 5 members should identify a topic of interest in consultation with a Faculty Advisor/Project Coordinator/Guide. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design/fabrication or develop codes/programs to achieve the objectives by strictly following steps specified in the teaching plan. Innovative design concepts, performance, scalability, reliability considerations, aesthetics/ergonomic, user experience and security aspects taken care of in the project shall be given due weight.

The progress of the mini project is evaluated based on a minimum of two reviews. The review committee may be constituted by a senior faculty member, Mini Project coordinator and project guide. The internal evaluation shall be made based on the progress/outcome of the project, reports and a viva-voce examination, conducted internally by a 3-member committee. A project report is required at the end of the semester. The project has to be demonstrated for its full design specifications.

End Semester Examination Pattern:

The marks will be distributed as

Presentation	: **30 marks**
Demo	: **20 marks**
Viva	: **25 marks.**
Total	: **75 marks**.

TEACHING 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. Acknowledgement
  v. Abstract
  vi. Table of Contents
  vii. List of Figures and Tables
  viii. Chapters
  ix. Appendices, if any
  x. References/Bibliography

SEMESTER VII

HONOURS

CST495	CYBER FORENSICS	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		VAC	3	1	0	4	2019

Preamble: 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.

Prerequisite: Knowledge in File Systems, Operating systems, Networks and a general awareness on Cyber Technologies.

Course Outcomes: After the completion of the course the student will be able to

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

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓				✓						✓
CO2	✓	✓										✓
CO3	✓	✓	✓	✓	✓							✓
CO4	✓	✓	✓	✓	✓							✓
CO5	✓	✓			✓							✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks
	Test1 (Percentage)	Test2 (Percentage)	
Remember	30	30	30
Understand	40	40	40
Apply	30	30	30
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks.

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module-1(Cyber Forensics and Cyber Security)

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.

Module-2 (File System Forensics)

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

Module-3 (Operating System Forensics)

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

Module-4 (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.

Module-5 (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.

Sample Course Level Assessment Questions

CourseOutcome1(CO1): Explain the Forensics principles and protocols for evidence acquisition.

Discuss the different cyber forensics tools used for image acquisition.

CourseOutcome2(CO2): Explain the pros and cons of NTFS and FAT File systems. Also give the challenges the investigators would face in extracting evidences from these file systems.

CourseOutcome3 (CO3): Apply any memory forensics methodologies/tools to extract volatile and nonvolatile data from a Windows based system.

CourseOutcome4 (CO4): Use web attacks test tools like netcraft to identify web application vulnerabilities of a particular site say **www.xyz.com**

Course Outcome 5 (CO5): Explain the different anti-forensics practices used to destroy or conceal data in order to prevent others from accessing it.

Model Question Paper

QP CODE:

Reg No: _______________

Name: __________________ **PAGES : 3**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST495

Course Name: Cyber Forensics

Max. Marks : 100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Distinguish between public and private investigations.

2. What are the three computer forensics data acquisitions formats?
3. List any three features of NTFS which are not in FAT.
4. Define the terms file slack, RAM slack and drive slack.
5. What is Locard's exchange principle? Why is it important in forensic investigations?
6. Why would you conduct a live response on a running system?
7. What are the different tools used in Network Forensics?
8. Explain how Risk Analysis and Penetration Testing are different.
9. Why we are using Steganography?
10. How is data wiping done in hard drive?

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11.	(a)	Discuss the different types of Cybercrimes. List the tools used for identifying Cyber Crimes.	**(8)**
	(b)	Differentiate between Static acquisition and Live acquisition with example.	**(6)**
		OR	
12.	(a)	Explain the principles of Digital Forensic Investigation? Why is it important? Comment.	**(8)**
	(b)	When you perform an acquisition at a remote location, what should you consider preparing this task?	**(6)**
13.	(a)	Discuss the FAT File Structure.	**(8)**
	(b)	Does Windows NT use FAT or NTFS? Explain.	**(6)**

14. (a) What is Metadata? Discuss the first 16 metadata records you would find in the MFT? **(6)**

(b) Explain the different data categories in a File System. **(8)**

15. (a) What is Agile requirement analysis? **(6)**

(b) Explain the different types of volatile information in a live response system. List any two tools used for obtaining volatile information. **(8)**

16. (a) What are the main live response methodologies? **(6)**

(b) What is Physical Memory Dump? Explain how a physical memory dump is analysed. **(8)**

17. (a) What is OWASP? Also mention the Top 10 web application vulnerabilities in 2021. **(8)**

(b) How would you setup Wireshark to monitor packets passing through aninternet router? **(6)**

18. (a) What are the goals of conducting a pentesting exercise? **(3)**

(b) Discuss the types of penetration testing methodologies. **(5)**

(c) Define OSI Layers. **(6)**

19. (a) How is Steganography done? **(7)**

(b) Why does data need Cryptography? **(4)**

(c) What is the difference between a Cryptographer and a Crypter? **(3)**

OR

20. (a) Explain the different types of Anti-forensics Detection Techniques. **(8)**

(b) What is Spoofing? How to prevent spoofing attack? **(6)**

TEACHING PLAN

Sl.No.	**Contents**	**No of Lecture Hrs (44hrs)**
Module-1 (Cyber Forensics and Cyber Security) (11 Hrs)		
1.1	History of computer forensics, preparing for computer investigations	1 hour
1.2	Understanding Public and private investigations- Forensics Investigation Principles	1 hour
1.3	Forensic Protocol for Evidence Acquisition	1 hour
1.4	Digital Forensics -Standards and Guidelines - Digital Evidence	1 hour
1.5	Data Acquisition - storage formats for digital evidence, determining the best acquisition method	1 hour
1.6	Contingency planning for image acquisitions, Cyber Forensics tools	1 hour
1.7	Challenges in Cyber Forensics, Skills Required to Become a Cyber Forensic Expert	1 hour
1.8	Cybercrimes, Types of Cybercrimes - Recent Data Breaches - Recent Cyber security Trends	1 hour
1.9	Case Study: Sim Swapping Fraud, ATM Card Cloning	1 hour
1.10	Case Study:Hacking email for money, Google Nest Guard	1 hour
1.11	Email Crimes, Phishing, Types of Phishing	1 hour
Module-2 (File System Forensics) (9 Hrs)		

2.1	FAT and NTFS concepts and analysis	1 hour
2.2	File system category, Content category	1 hour
2.3	Metadata category	1 hour
2.4	File name category,Application category	1 hour
2.5	Application-level search techniques	1 hour
2.6	Specific file systems, File recovery, Consistency check	1 hour
2.7	FAT data structure-Boot sector	1 hour
2.8	FAT 32 FS info, directory entries	1 hour
2.9	Long file name directory entries	1 hour
Module-3 (Operating System Forensics) (11 Hrs)		
3.1	Live Response- Data Collection- Locard's Exchange Principle	1 hour
3.2	Order of Volatility, Volatile and Non Volatile Data	1 hour
3.3	Live-Response Methodologies: Data Analysis- Agile Analysis	1 hour
3.4	Windows Memory Analysis	1 hour
3.5	Rootkits and Rootkit detection	1 hour
3.6	Linux Forensics: Live Response Data Collection	1 hour
3.7	Prepare the Target Media, Format the Drive, Gather Volatile Information	1 hour
3.8	Acquiring the Image, Initial Triage	1 hour
3.9	Data Analysis- Log Analysis, Keyword Searches, User Activity	1 hour

3.10	Data Analysis- Network Connections, Running Processes, Open File Handlers	1 hour
3.11	The Hacking Top Ten, Reconnaissance Tools	1 hour
	Module-4 (Network Forensics) (7 Hrs)	
4.1	OSI Model	1 hour
4.2	Forensic Footprints, Seizure of Networking Devices, Network Forensic Artifacts	1 hour
4.3	ICMP Attacks, Drive-By Downloads, Network Forensic Analysis Tools	1 hour
4.4	Web Attack Forensics	1 hour
4.5	OWASP Top 10, Web Attack Tests	1 hour
4.6	Penetration Testing-1	1 hour
4.7	Penetration Testing.-2	1 hour
	Module – 5 (Anti-Forensics) (6 Hrs)	
5.1	Anti-forensic Practices - Data Wiping and Shredding	1 hour
5.2	Data Remanence, Degaussing	1 hour
5.3	Trail Obfuscation: Spoofing, Data Modification	1 hour
5.4	Role of Encryption in Forensics	1 hour
5.5	Data Hiding: Steganography and Cryptography	1 hour
5.6	Anti-forensics Detection Techniques	1 hour

AIT 497	COMPUTATIONAL HEALTH INFORMATICS	CATEGORY	L	T	P	Credit
		Honors	3	1	0	4

Preamble:

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

Prerequisite: Basic background in Programming, Computational Biology and Machine learning

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 (**Cognitive knowledge level: Understand**)
CO 2	Illustrate latest trends, advancements, and emerging technologies in computational health informatics(**Cognitive knowledge level: 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 (**Cognitive knowledge level: 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 (**Cognitive knowledge level: Apply)**
CO 5	Implement deep learning techniques to analyze and interpret medical images (**Cognitive knowledge level: Apply**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔										✔
CO2	✔	✔	✔	✔	✔							✔
CO3	✔	✔	✔	✔	✔							✔
CO4	✔	✔	✔	✔								✔
CO5	✔	✔			✔							✔

PO#	Broad PO	PO#	Broad PO
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	Test1 (%)	**Test2 (%)**	
Remember	**30**	**30**	**30**
Understand	**50**	**50**	**50**
Apply	**20**	**20**	**20**
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Continuous Assessment Tests (Average of Series Tests 1& 2) **25 marks**

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

SYLLABUS`

Module -01 (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

Module-02 (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

Module-03 (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,

Module-04 (Machine Learning in Medical Image Analysis)

Image Segmentation, Thresholding techniques for image segmentation, 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

Module-05 (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

Books

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.
7. Deep Learning Techniques for Biomedical and Health Informatics. (2020). United Kingdom: Elsevier Science.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Summarize Health informatics frameworks and models
2. Explain Health data standards HL7, SNOMED CT and ICD
3. Illustrate data analytics techniques and applications in healthcare

Course Outcome 2 (CO2):

1. Explain Blockchain technology in health informatics.
2. Illustrate Internet of Things (IoT) and its applications in healthcare with examples
3. How can translational bioinformatics facilitate the identification of disease-associated genetic variants and the development of targeted therapies?

Course Outcome 3 (CO3):

1. Differentiate principles and fundamentals of X-ray imaging, MRI, and CT
2. Explain the importance of image enhancement techniques in medical imaging and how they contribute to improved diagnosis and treatment
3. Explain the concept of edge detection in medical imaging and its role in image sharpening and feature extraction.

Course Outcome 4 (CO4):

1. Explain the concept of image segmentation and its significance in medical image analysis and diagnosis.
2. Compare and contrast different supervised learning algorithms used in medical image analysis

Course Outcome 5 (CO5):

1. Explain the process of training a CNN for medical image analysis, including data preprocessing, feature extraction, and backpropagation.
2. Discuss the potential benefits of applying AI in medical image processing, including improved accuracy, efficiency, and diagnostic outcomes.

TEACHING PLAN

No	Contents	No of Lecture (45Hrs)
Module -01 (Introduction to Health Informatics) (9hrs)		
1.1	Definition, scope, and objectives of health informatics	1
1.2	Historical development and current trends in health informatics	1
1.3	Health informatics frameworks and models,	1
1.4	Health data standards (HL7, SNOMED CT, ICD)	1
1.5	Interoperability challenges and solutions	1
1.6	Data capture, storage, and retrieval in health informatics	1
1.7	Data quality and integrity	1
1.8	Data analytics techniques and applications in healthcare	1
1.9	Data visualization for decision support	1
Module-02 (Emerging Technologies in Health Informatics)(9hrs)		
2.1	Artificial intelligence (AI) and machine learning in healthcare	1
2.2	Internet of Things (IoT) and its applications in healthcare	1
2.3	Hybrid IoT-NG-PON system	1
2.4	IoT devices for healthcare	1
2.5	IoT beneficiaries in healthcare, IoT architecture	1
2.6	Blockchain technology in health informatics	1
2.7	Clinical research informatics	1
2.8	Translational bioinformatics	1
2.9	Data sharing and secondary use of health data	1
Module-03 (Medical Image Processing) (10hrs)		
3.1	Overview of medical image processing and its significance in healthcare	1
3.2	Challenges and opportunities in medical image analysis	1
3.3	Principles of X-ray imaging	1
3.4	Magnetic Resonance Imaging (MRI) basics	1
3.5	Computed Tomography (CT) fundamentals	1
3.6	Ultrasound imaging and its characteristics	1
3.7	Image Enhancement Techniques	1
3.8	Contrast enhancement methods for medical images	1
3.9	Noise reduction and image denoising techniques	1
3.10	Image sharpening and edge enhancement	1

Module-04 (Machine Learning in Medical Image Analysis) (8hrs)		
4.1	Image Segmentation, Thresholding techniques for image segmentation	1
4.2	Region-based segmentation algorithms	1
4.3	Edge detection and contour-based segmentation	1
4.4	Feature Extraction and Representation	1
4.5	Supervised and unsupervised learning algorithms for medical	1

	image analysis	
4.6	Classification techniques for medical image analysis	1
4.7	Regression techniques for medical image analysis	1
4.8	Performance evaluation and validation of machine learning models	1
	Module-05 (Deep Learning for Medical Image Processing)(9hrs)	
5.1	Convolutional Neural Networks (CNNs) for medical image analysis	1
5.2	Segmentation and object detection using deep learning	1
5.3	Transfer learning and pretrained models in medical imaging	1
5.4	Volumetric image analysis and 3D reconstruction	1
5.5	Image-based modeling and simulation	1
5.6	Advanced imaging modalities (functional MRI)	1
5.7	Advanced imaging modalities (diffusion tensor imaging)	1
5.8	Artificial intelligence in medical image processing	1
5.9	Artificial intelligence in medical image processing Challenges	1

Model Question Paper

QP CODE:

Reg No: _______________

Name: _________________ **PAGES: 4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: AIT 497

Course Name: COMPUTATIONAL HEALTH INFORMATICS

Max. Marks: 100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1.	Compare and contrast the techniques, SNOMED CT and ICD	**3**
2.	List any three tools commonly used for data visualization in healthcare decision support within the field of Health Informatics with their use.	**3**
3.	Give examples of specific use cases where blockchain can improve healthcare systems.	**3**
4.	List any three IoT devices for healthcare with application.	**3**
5.	Explain the basic principles of Magnetic Resonance Imaging?	**3**
6.	Specify the different categories of image enhancement techniques used in health informatics.	**3**
7.	Give examples of different types of medical image segmentation techniques and applications.	**3**
8.	List of any three commonly used supervised and unsupervised learning algorithms for medical image analysis.	**3**
9.	Draw the architecture of a typical CNN.	**3**
10.	Give the concept of functional MRI and its applications.	**3** **(10x3=30)**

Part B
(Answer any one question from each module. Each question carries 14 Marks)

11.	(a)	Explain the purpose and role of HL7 standards in healthcare data interoperability. Provide examples of HL7 standards commonly used in clinical settings.	**(7)**

	(b)	Discuss the privacy and security concerns related to data capture, storage, and retrieval in health informatics. What are some strategies and best practices to mitigate these concerns and protect patient information?	**(7)**
	OR		
12.	(a)	Explain the importance of standardizing health data using controlled vocabularies and classifications like SNOMED CT and ICD. What are the benefits of using standardized codes?	**(7)**
	(b)	Discuss the importance of data capture in health informatics. Explain the different methods of data capture used in healthcare settings.	**(7)**
13.	(a)	Discuss the impact of emerging technologies on health informatics, highlighting their potential benefits and challenges in the healthcare industry.	**(7)**
	(b)	Explain the concept of precision medicine and its relationship with translational bioinformatics. How can bioinformatics tools and techniques contribute to the development of personalized treatment approaches?	**(7)**
OR			
14.	(a)	Describe the potential uses of IoT devices in healthcare and discuss their impact on patient care and health monitoring.	**(7)**
	(b)	Discuss the types of machine learning algorithms commonly used in healthcare. Provide examples of supervised, unsupervised, and reinforcement learning algorithms and describe their specific applications in healthcare settings.	**(7)**
15.	(a)	Describe the characteristics of ultrasound waves used in imaging. How does ultrasound utilize sound waves to create images of internal body structures?	**(7)**
	(b)	Explain the concept of contrast enhancement in medical image processing. Why is contrast enhancement important in improving the visual quality and diagnostic utility of medical images?	**(7)**
OR			
16.	(a)	Discuss the challenges in medical image analysis posed by the complexity and variability of anatomical structures and diseases. How can these challenges be addressed to improve the accuracy and reliability of image analysis?	**(7)**
	(b)	Describe the different types of noise commonly encountered in medical images. Why is it necessary to remove or reduce noise to improve medical images' visual quality and interpretability?	**(7)**
17.	(a)	Describe the basic principles of supervised learning for classification in medical image analysis. Discuss the steps involved, including data preparation, feature extraction, model training, and model evaluation.	**(7)**
	(b)	Discuss the concept of training, validation, and testing datasets in machine learning. Discuss the purpose of each dataset and their roles in evaluating	**(7)**

		model performance and generalization.	
		OR	
18.	(a)	How do regression techniques contribute to tasks such as disease prognosis, treatment response prediction, and quantitative analysis in healthcare?	**(7)**
	(b)	Discuss the application of edge detection and edge-based features in medical image analysis. List any two edge detection algorithms which can be used to extract edge-based features with their pros and cons	**(7)**
19.	(a)	Evaluate the future prospects and advancements in volumetric image analysis and 3D reconstruction in health. Discuss emerging technologies and trends in healthcare.	**(7)**
	(b)	Discuss the challenges and considerations in object detection and segmentation using deep learning.	**(7)**
		OR	
20.	(a)	Explain the concept of diffusion tensor imaging and its significance in medical imaging. Discuss how diffusion tensor imaging captures and measures the diffusion of water molecules in biological tissues.	**(7)**
	(b)	Explain the challenges associated with variability in medical images. Also, explain the challenges of model interpretability and explainability in AI-based medical image processing	**(7)**

AIT 499	SURVEILLANCE VIDEO ANALYTICS	Category	L	T	P	Credit
		Honors	**3**	**1**	**0**	**3**

Preamble:

This course provide a comprehensive understanding of the principles, techniques, and applications of video analytics in the field of surveillance. The ability to extract meaningful insights and actionable intelligence from surveillance videos is crucial for enhancing situational awareness, detecting anomalies, and making informed decisions. **Prerequisite:** Basic knowledge in set theory.

Prerequisite: Basic concepts in Basic Image Processing and video analytics

Mapping of course outcomes with program outcomes

CO1	Use the probability concepts, statistical pattern recognition to analyze image and video **(Cognitive Knowledge level: Apply)**
CO2	Demonstrate knowledge and skills to effectively preprocess and post-process data **(Cognitive knowledge level: Apply)**
CO3	Explain the video analytic architectures, hardware devices, classification trees, and various algorithms for attribute classification **(Cognitive Knowledge level: Understand)**
CO4	Describe the techniques and algorithms in video processing and motion estimation **(Cognitive Knowledge level: Understand)**
CO5	Demonstrate the concepts of video coding **(Cognitive Knowledge level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓											✓
CO2	✓	✓	✓									✓
CO3	✓	✓										✓
CO4	✓	✓										✓
CO5	✓	✓	✓	✓	✓							✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test 1 (%)	Test 2 (%)	
Remember	20	20	20
Understand	50	50	50
Apply	30	30	30
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance	**10 marks**
Continuous Assessment Tests(Average of Internal Tests1&2)	**25 marks**
Continuous Assessment Assignment	**15 marks**

Internal Examination Pattern

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module – 1 (Fundamentals and Requirements)

Probability concepts, Sampling Concepts, Generating Random Variables, Exploratory Data Analysis, Monte Carlo Methods for Inferential Statistics, Data Partitioning, Probability Density Estimation, Statistical Pattern Recognition, and Nonparametric Regression.
Basic image analysis, and the four core analytics categories used in video surveillance; VMD, Heuristics, Conventional Object Detection, and Deep Learning Object Detection(Basics) deep learning neural networks for video analytics, datasets for neural network training (e.g. COCO, ImageNet, Pascal2, Wider, Government datasets)

Module - 2(Pre-processing and Feature Extraction)

Preprocessing and Post processing in data mining – Steps in Preprocessing, Discretization, Manual Approach, Binning, Entropy- based Discretization, Gaussian Approximation, K-tile method, Chi Merge, Feature extraction, selection and construction, Feature extraction Algorithms, Feature selection, Feature construction, Missing Data, Post processing

Module - 3 (**Video analytic architecture**)

Video analytic architectures, video analytic hardware devices, Classification trees, Algorithms for Normal Attributes, Information Theory and Information. Entropy, Building tree, Highly-Branching Attributes, ID3 to c4.5, CHAID, CART, Regression Trees, Model Trees, Pruning.

Module - 4 (**Steps of Video Processing**)

Basic Steps of Video Processing: Analog video, Digital Video, Time varying Image Formation models : 3D motion models, Geometric Image formation , Photometric Image formation, sampling of video signals, filtering operations 2-D Motion Estimation: Optical flow, general methodologies, pixel based motion estimation, Block matching algorithm

Module - 5 (**Motion Estimation**)

Motion estimation: Mesh based motion Estimation, global Motion Estimation, Region based motion estimation, multi resolution motion estimation. Coding: Waveform based coding, Block based transform coding, predictive coding, Application of motion estimation in video coding.

Text Books

1. Richard Szeliski , Computer Vision: Algorithms and Applications, A free electronic copy is available online.
2. Emanuele Trucco and Alessandro Verri, Introductory techniques for 3-D Computer Vision,

Reference Books

1. Multiple View Geometry in Computer Vision (2nd edition) by Richard hartley and Andrew Zisserman
2. Computer Vision: A Modern Approach by David Forsyth and Jean Ponce.
3. Digital Image Processing (Rafael Gonzalez and Richard Woods)
4. Yao wang, Joem Ostarmann and Ya – quin Zhang, Video processing and communication ,1st edition , PHI.
5. M. Tekalp , Digital video Processing, Prentice Hall International

Course Level Assessment Questions

Course Outcome1 (CO1):

1. Explain Monte Carlo Simulation.
2. Discuss the importance of data partitioning in data mining and statistical analysis
3. Explain the concept of deep learning object detection and its significance in computer vision applications.

Course Outcome 2(CO2):

1. Explain the concept of entropy-based discretization in data mining and its role in feature transformation

2. Discuss the challenges and techniques associated with handling missing data in Video analysis.
3. Explain the concept of binning in data preprocessing and its significance in handling continuous variables. Discuss the steps involved in the binning process, including defining bin boundaries, assigning data points to bins, and aggregating data within each bin.

Course Outcome 3 (CO3):

1. Describe the components and architecture of video analytics systems. Explain the key elements involved in video analytic architectures, including hardware devices, software algorithms, and network infrastructure.
2. Discuss the different discretization techniques, such as equal-width binning, equal-frequency binning, and entropy-based discretization.
3. Describe the concept of feature construction in machine learning and its role in enhancing the predictive power of models

Course Outcome 4(CO4): .

1. Explain the concept of geometric image formation in computer vision and its role in understanding the relationship between the 3D world and 2D image observations
2. Discuss the concept of filtering operations in video processing and their significance in enhancing visual quality and extracting relevant information.
3. Explain the concept of the block matching algorithm in motion estimation and its significance in video analysis

Course Outcome 5(CO5):

1. Describe the concept of mesh-based motion estimation in video analysis and its role in accurately tracking object motion
2. Explain the concept of multi-resolution motion estimation in video analysis and its significance in capturing motion information at different levels of detail.

Model Question Paper

QP CODE:

Reg No: _______________

Name: _________________ **PAGES : 4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: AIT 493

Course Name SURVEILLANCE VIDEO ANALYTICS

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1. List the pre and post processing techniques used in data mining.
2. Discuss the importance of data partitioning in data mining and statistical analysis.
3. List the data compression technique used in decision tree and types of pruning.
4. Derive the optical flow constraint equation.
5. Explain Gaussian Approximation and its relevance in data analysis.
6. Give the different video analytic architectures available, and specify how they contribute to video analytics.
7. How can 3D motion models be applied in the field of augmented reality (AR)?
8. List any three potential applications of optical flow in computer vision and video analysis?
9. Derive the equation for mesh-based motion estimation technique.
10. How does block-based transform coding contribute to video compression by

exploiting spatial and temporal redundancies? **(10x3=30)**

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Describe the Monte Carlo method for inferential statistics, steps involved and its significance in addressing complex statistical problems. **(7)**

(b) Explain the concept of conventional object detection in computer vision and its key components. **(7)**

OR

12. (a) Define random variables in probability theory and explain their significance in statistical analysis **(7)**

(b) Define the four core analytics categories used in video surveillance **(7)**

13. (a) Explain the importance of preprocessing and postprocessing in data mining and their respective roles in the overall Video analysis process **(14)**

OR

14. (a) Explain the k-tile method in inferential statistics, its steps, purpose, and significance. **(7)**

(b) Explain the Chi-Merge algorithm used in statistical analysis for merging adjacent intervals in a discretized dataset **(7)**

15. (a) Discuss how entropy is calculated and interpreted for various video analysis tasks. **(7)**

(b) Explain Regression Trees (CART) algorithm in machine learning, the key steps involved in building CART models. **(7)**

OR

16. (a) Describe the algorithm for handling normal attributes in statistical analysis. **(7)**

(b) Explain the concepts of regression trees and pruning in decision tree-based **(7)** modeling.

17. (a) Explain in detail the steps involved in structure from motion (SSM) method for 3D reconstruction. **(14)**

OR

18. **(a)** Describe the pixel-based motion estimation in video analysis, its principles, methodologies, and applications. **(7)**

    (b) Describe the concept of mesh-based motion estimation in video analysis and its role in accurately tracking object motion **(7)**

19. (a) Explain the concept of multi-resolution motion estimation in video analysis and its significance in capturing motion information at different levels. **(14)**

OR

20. (a) Discuss the various applications of motion estimation in video coding. **(14)**

Teaching Plan

Module - 1 (Fundamentals and Requirements)		(10 hours)
1.1	Probability concepts, Sampling Concepts, Generating Random Variables	2 hour
1.2	Exploratory Data Analysis, Monte Carlo Methods for Inferential Statistics, Data Partitioning, Probability Density Estimation, Statistical Pattern Recognition, and Nonparametric Regression.	3 hour
1.3	Basic image analysis, and the 4 core analytics categories used in video surveillance;	2 hour
1.4	VMD, Heuristics, Conventional Object Detection, and Deep Learning Object Detection, deep learning.	2 hour
1.5	neural networks for video analytics, datasets for neural network training (e.g. COCO, ImageNet, Pascal2, Wider, Government datasets)	1 hour
Module - 2 (Pre-processing and Feature Extraction)		(9 hours)
2.1	Preprocessing and Post processing in data mining – Steps in Preprocessing	1 hour

2.2	Discretization, Manual Approach, Binning	2 hour
2.3	Entropy- based Discretization, Gaussian Approximation	1 hour
2.4	K-tile method, Chi Merge	1 hour
2.5	Feature extraction algorithms	1 hour
2.6	Feature selection	1 hour
2.7	Feature construction	1 hour
2.8	Missing Data, Post processing	1 hour
Module - 3 (Video analytic architecture)		(9 hours)
3.1	Video analytic architectures, video analytic hardware devices	2 hour
3.2	Classification trees, Algorithms for Normal Attributes	2 hour
3.3	Information Theory and Information. Entropy,Building tree	2 hour
3.4	Highly- Branching Attributes, ID3 to c4.5	1 hour
3.5	CHAID, CART	1 hour
3.6	Regression Trees, Model Trees, Pruning.	1 hour
Module - 4 (Steps in video processing)		(9 hours)
4.1	Basic Steps of Video Processing: Analog video, Digital Video sampling	1 hour
4.2	Time varying Image Formation models : 3D motion models	2 hour
4.3	Geometric Image formation , Photometric Image formation	2 hour
4.4	video signals, filtering operations	1 hour
4.5	2-D Motion Estimation: Optical flow, general methodologies	2 hour
4.6	pixel based motion estimation, Block matching algorithm.	1 hour
Module - 5 (Video Compression)		(8 hours)
5.1	Motion estimation: Mesh based motion Estimation, global Motion estimation	2 hour
5.2	Region based motion estimation	1 hour
5.3	multi resolution motion estimation	1 hour
5.4	Coding: Waveform based coding	1 hour
5.5	Block based transform coding	1 hour
5.6	predictive coding	1 hour

5.7	Application of motion estimation in video coding.	1 hour

SEMESTER VIII

B TECH IN ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

CMT 402	INTRODUCTION TO INTERNET OF THINGS	Category	L	T	P	Credit
		PCC	2	1	0	3

Preamble:

This course equips the learners with fundamental of the Internet of Things(IoT) and the IoT ecosystem. It covers the architecture of IoT, communication mechanisms, protocols, hardware, software, data analytics, and the cloud platforms for IoT. This course enables the students to design smart IoT applications for real world problems using Raspberry Pi.

Prerequisite: Basicknowledge in Data Communication, Computer Networks and Programming in Python

Course Outcomes: After the completion of the course the students will be able to

CO1	Outline the fundamentals of IoT and its underlying physical and logical architecture**(Cognitive Knowledge Level: Understand)**
CO2	Explain the hardware architectures for IoT **(Cognitive Knowledge Level : Understand)**
CO3	Outline the Network architectures for IoT**(Cognitive Knowledge Level : Understand)**
CO4	Implement data analytics on the IoT platforms **(Cognitive Knowledge Level : Apply)**
CO5	Appreciate the security considerations in IoT **(Cognitive Knowledge Level : Understand)**
CO6	Implement IoT applications using the available hardware and software. **(Cognitive Knowledge Level : Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓									✓
CO2	✓	✓	✓									✓
CO3	✓	✓	✓									✓
CO4	✓	✓	✓	✓	✓							✓
CO5	✓	✓	✓		✓							✓
CO6	✓	✓	✓	✓	✓	✓						✓

Abstract POs Defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and teamwork
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance

PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Blooms Category	**Continuous Assessment Tests**		**End Semester Examination Marks**
	Test 1 (Percentage)	**Test 2 (Percentage)**	
Remember	30	20	30
Understand	60	50	40
Apply	10	30	30
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	**50**	**100**	**3 Hours**

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Continuous Assessment Tests	**25 marks**
Continuous Assessment Assignment	**15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First Internal Examination shall be preferably conducted after completing the first half of the syllabus, and the Second Internal Examination shall be preferably conducted after completing the remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer anyone. Each question can have a maximum 2 subdivisions and carries 14 marks.

B TECH IN ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

SYLLABUS

Module- 1 (IoT Architecture)

What is IoT, Genesis of IoT, IoT and Digitization, IoT Impact, Convergence of IT and IoT, IoT Challenges, IoT Network Architecture and Design, Drivers Behind New Network Architectures, Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack, IoT Data Management and Compute Stack.

Module- 2 (Engineering IoT Networks)

Smart Objects: The "Things" in IoT, Sensors, Actuators, and Smart Objects, Sensor Networks, Connecting Smart Objects, Communications Criteria, IoT Access Technologies

Module- 3 (IoT Network Layer)

IP as the IoT Network Layer, The Business Case for IP, The need for Optimization, Optimizing IP for IoT, Profiles and Compliances, Application Protocols for IoT, The Transport Layer, IoT Application Transport Methods

Module 4 (Data Analytics for IoT)

Data and Analytics for IoT, An Introduction to Data Analytics for IoT, Machine Learning, Big Data Analytics Tools and Technology, Edge Streaming Analytics, Network Analytics, Securing IoT, A Brief History of OT Security, Common Challenges in OT Security, Differences between IT and OT Security Practices and Systems, Formal Risk Analysis Structures: OCTAVE and FAIR.

Module 5 (Developing IoT Systems)

IoT Logical Design using Python, IoT Physical Devices and Endpoints - Raspberry Pi interfaces, Programming Raspberry Pi using Python, Other IoT devices, IoT Physical devices and Cloud offerings, Cloud Storage Models, WAMP

- Autobahn for IoT, Django, Designing RESTful Web API, Cloud Web Services for IoT.

TEXTBOOKS

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", 1st Edition, Pearson Education (Cisco Press Indian Reprint)
2. ArshadeepBahga, Vijay Madisetti, "Internet of Things: A hands-on approach", University Press, 2015 (First edition)

REFERENCES

1. Rajkamal, "Internet of Things: Architecture and Design Principles", McGraw Hill (India) Private Limited

2. Dieter Uckelmann, Mark Harrison, Michahelles Florian (Ed.), Architecting the internet of things, Springer, 2011

3. Dr. Ovidiu Vermesan, Dr. Peter Friess, Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, River Publishers, 2013

4. Simon Monk, "Programming Arduino: Getting Started with Sketches", McGraw Hill Publications

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Write a short note on the impact of IoT in the real world
2. Explain the challenges of IoT.
3. Compare OT and IT Technology.
4. Describe the elements of one M2M architecture of IoT

Course Outcome 2 (CO2):

1. Mention any four wireless technologies and its architectural characteristics
2. Comment things in IoT
3. Compare biosensors and biodegradable sensors used in IoT
4. Explain the term NBIoT(Narrow Band IoT)

Course Outcome 3 (CO3):

1. Discuss the need for optimization
2. Compare MQTT and COAP
3. Explain different schedule management and packet forwarding models of 6TiSCH

Course Outcome 4(CO4):

1. Compare Bigdata and edge analytics
2. Compare structured and unstructured data
3. Describe the components of FNF

Course Outcome 5(CO5):

1. What are the major challenges in IoT security?
2. Explain the impact of OT Network Characteristics onIoT Security.

Course Outcome 6(CO6):

1. Implement LDR interfacing with Raspberry Pi
2. Explain the development of a RESTful web API.

B TECH IN ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Model Question Paper

QP CODE:

PAGES :3

Reg No: _______________

Name: _________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CMT 402

Course Name: Introduction To Internet Of Things

Max.Marks: 100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Explain the role of IoT in connected roadways,
2. Describe the functions of the various layers of simplified IoT Architecture Model.
3. Explain the communication protocols employed in Wireless Sensor Networks
4. What are the essential performance considerations of constrained-node networks?
5. Explain the parameters to be considered while choosing between IP adaptation / adoption for last mile communication.
6. With neat diagrams compare the IoT protocol stacks using 6LoWPAN and IP.

B TECH IN ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

7. Differentiate the types of IoT data analytics results.

8. How can the insecure operational protocols be characterized?

9. Write a program to interface an LED and a switch with Raspberry Pi

10. List down the Raspberry Pi interfaces and explain. **(10x3=30)**

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Illustrate the impact of IoT in at least 2 domains of normal human life. **(9)**

(b) Describe the Application and Analytics sublayer of IoT Architecture **(6)**

OR

12. (a) Describe the Standardized IoT architectures. **(8)**

(b) Explain the functions of Access Network Sublayer of IoT Architecture **(6)**

13. (a) Describe the LoRaWAN technology as an IoT communication paradigm. **(10)**

(b) Describe various types of sensors. **(4)**

OR

14. (a) Define actuators. Describe the roles of actuators in IoT **(6)**

systems.

(b) Explain the IEEE 802.15.4 standard for wireless communication. **(8)**

15. (a) Explain Message Queuing Telemetry Transport framework and message format. **(8)**

(b) Explain tunneling of legacy SCADA over IP Networks with a neat diagram. **(6)**

OR

16. (a) Explain SCADA Transport over LLNs with MAP-T. **(7)**

(b) Explain RPL encryption and authentication on constrained nodes. **(7)**

17. (a) Explain the Hadoop ecosystem with a neat diagram. **(7)**

(b) Explain the Flexible NetFlow Architecture. **(7)**

OR

18. (a) Explain the "The Purdue Model for Control Hierarchy" and OT network characteristics. **(8)**

(b) Explain any twpformal risk analysis structures **(6)**

19. (a) Explain the working of WAMP protocol. **(8)**

(b) Describe how AWS supports IoT development **(6)**

OR

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20. (a) Demonstrate an example of Raspberry Pi applications for Industrial IoT. **(8)**

(b) Explain the Django Architecture **(6)**

B TECH IN ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

TEACHING PLAN

No	Contents	No of Lecture Hrs (35 Hrs)
Module – 1 (IoT Architecture) (6 hrs) (TB-1, Chapter 1,2)		
1.1	What is IoT, Genesis of IoT, IoT and Digitization,	1
1.2	IoT Impact, Convergence of IT and IoT, IoT Challenges	1
1.3	IoT Network Architecture and Design	1
1.4	Drivers Behind New Network Architectures, Comparing IoT Architectures	1
1.5	A Simplified IoT Architecture,	1
1.6	The Core IoT Functional Stack, IoT Data Management and Compute Stack.	1
Module- 2 (Engineering IoT Networks) (7hrs)(TB-1, Chapter 3,4)		
2.1	Smart Objects: The “Things” in IoT,	1
2.2	Sensors, Actuators, and Smart Objects	1
2.3	Sensor Networks	1
2.4	Connecting Smart Objects	1
2.5	IoT Access Technologies –IEEE 802.15.4 (g/e), 1901.2a	1

2.6	IoT Access Technologies - 802.11ah, LoRaWAN	1
2.7	IoT Access Technologies – LoRaWAN, NBIoT, LTE	1
Module- 3 (IoT Network Layer) (7 hrs)(TB-1, Chapter 5,6)		
3.1	IP as the IoT Network Layer, The Business Case for IP	1
3.2	The need for Optimizing IP for IoT	1
3.3	Optimizing IP for IoT, Profiles, and Compliance	1
3.4	Application Protocols for IoT - CoAP	1
3.5	Application Protocols for IoT - MQTT	1
3.6	The Transport Layer, IoT Application Transport Methods	1
3.7	The Transport Layer, IoT Application Transport Methods	1
Module 4 (Data Analytics for IoT) (6hrs)(TB-1, Chapter 7,8)		
4.1	An Introduction to Data Analytics for IoT, Machine Learning	1
4.2	Big Data Analytics Tools and Technology	1
4.3	Edge Streaming Analytics, Network Analytics	1
4.4	A Brief History of OT Security, Common Challenges in OT Security	1
4.5	Differences between IT and OT Security Practices and Systems	1
4.6	Formal Risk Analysis Structures: OCTAVE and FAIR	1
Module 5 (Developing IoT Systems)(9 hrs) (TB-2, Chapter 6,7,8)		

5.1	IoT Logical Design using Python,	1
5.2	IoT Physical Devices and Endpoints	1
5.3	Raspberry Pi interfaces, Programming Raspberry Pi using Python	1
5.4	Other IoT devices	1
5.5	Cloud Storage Models	1
5.6	WAMP-Autobahn for IoT	1
5.7	Django	1
5.8	Designing RESTful Web API	1
5.9	Cloud Web Services for IoT.	1

SEMESTER VIII

PROGRAM ELECTIVE III

AMT 414	GPU COMPUTING	Category	L	T	P	Credit
		Program Elective III	2	1	0	3

Preamble: The course equips the students to understand the benefit of massive parallelisation algorithms and use GPU-based computing to implement it. The student will appreciate the underlying GPU architecture, programming model, and how solutions can be designed to use the architecture for better performance.

Prerequisite: Basic Concepts in Computer Organization and architecture

Mapping of course outcomes with program outcomes

CO1	Explain the massive parallelization of programs and GPU-based computing. **(Cognitive Knowledge Level: Understand)**
CO2	Explain CUDA architecture and programming model for parallel computing. **(Cognitive Knowledge Level: Understand)**
CO3	Describe memory and performance considerations for CUDA-based parallel computing. **(Cognitive Knowledge Level: Understand)**
CO4	Illustrate the parallel floating point arithmetic using CUDA **(Cognitive Knowledge Level: Understand)**
CO5	Appreciate the application of GPU-based parallel computation in multiple domains. **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO8	PO 9	PO 10	PO1 1	PO 12

CO1	✔		✔									✔
CO2	✔		✔									✔
CO3	✔		✔									✔
CO4	✔		✔									✔
CO5	✔		✔									✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test 1 (%)	Test 2 (%)	
Remember	20	20	20
Understand	50	50	50
Apply	30	30	30
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Continuous Assessment Tests(Average of Internal Tests 1 & 2) **25 marks**

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

SYLLABUS

Module 1 – (Introduction)

Introduction - GPUs as Parallel Computers- Architecture of a Modern GPU- Why More Speed or Parallelism? - Parallel Programming Languages and Models.

History of GPU Computing- Evolution of Graphics Pipelines - The Era of Fixed-Function Graphics Pipelines- Evolution of Programmable Real-Time Graphics- Unified Graphics and Computing Processors- GPU Computing- Scalable GPUs

Module 2 – (CUDA Parallelism and Threads)

Introduction to CUDA- Data Parallelism- CUDA Program Structure- A Matrix–Matrix Multiplication Example - Device Memories and Data Transfer - Kernel Functions and Threading

CUDA Threads - CUDA Thread Organization- Using blockIdx and threadIdx - Synchronization and Transparent Scalability - Thread Assignment - Thread Scheduling and Latency Tolerance

Module 3 – (CUDA Memories and Performance Considerations)

CUDA Memories Importance of Memory Access Efficiency- CUDA Device Memory Types - A Strategy for Reducing Global Memory Traffic- Memory as a Limiting Factor to Parallelism

Performance Considerations- More on Thread Execution- Global Memory Bandwidth - Dynamic Partitioning of SM Resources- Data Prefetching- Instruction Mix- Thread Granularity

Module 4 – (Floating Point Considerations and Parallel Thinking)

Floating Point Considerations- Floating-Point Format – Normalized Representation of M- Excess Encoding of E - Representable Numbers- Special Bit Patterns and Precision- Arithmetic Accuracy and Rounding - Algorithm Considerations

Parallel Programming and Computational Thinking- Goals of Parallel Programming - Problem Decomposition - Algorithm Selection - Computational Thinking

Module 5 – (Case Studies)

Application Case Study: Advanced MRI Reconstruction Application Background - Iterative Reconstruction- Computing FHd- Determine the Kernel Parallelism Structure - Getting Around the Memory Bandwidth Limitation - Using Hardware Trigonometry Functions- Experimental Performance Tuning

Application Case Study: Molecular Visualization and Analysis Application Background - A Simple Kernel Implementation - Instruction Execution Efficiency - Memory Coalescing - Additional Performance Comparisons - Using Multiple GPUs

Text Books

1. Kirk, David B., and W. Hwu Wen-Mei. *Programming massively parallel processors: a hands-on approach*. Morgan Kaufmann, 2016.
2. Cook, Shane. *CUDA programming: a developer's guide to parallel computing with GPUs*. Newnes, 2012.

Reference Book

1. Bandyopadhyay. Avimanyu, *Hands-On GPU Computing with Python Explore the capabilities of GPUs for solving high performance computational problems,* Packt Publishing, 2019

Course Level Assessment Questions

Course Outcome1 (CO1):

1. Illustrate the speed up in computing achieved by parallelizing matrix multiplication.
2. Explain how the architecture of a GPU provides for high performance compared to a CPU.

Course Outcome 2(CO2):

1. Explain the structure of a CUDA program and how it gets executed.
2. Explain the CUDA device memory model.

Course Outcome 3(CO3):

1. Use a real life problem to illustrate how a problem can be decomposed for parallel execution and illustrate the speedup achieved by parallelization.
2. Illustrate with algorithm, the use of tiling and prefetching to improve the performance of matrix multiplication.

Course Outcome 4(CO4):

1. Assume that in a new processor design, due to technical difficulty, the floating-point arithmetic unit that performs addition can only do "round to zero" (rounding by truncating the value toward 0). The hardware maintains a sufficient number of bits that the only error introduced is due to rounding. What is the maximal ulp error value for add operations on this machine?
2. How is the arithmetic accuracy and rounding achieved in GPUs?

Course Outcome 5(CO5):

1. Explain the linear-solver-based iterative reconstruction algorithm for non-Cartesian MRI scan data.
2. Describe the major computational challenges involved in visualizing molecular orbitals.

Model Question Paper		
QP CODE:		
Reg No: _______________		
Name: _________________		**PAGES : 4**
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY		
EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR		
Course Code: AMT 414		
Course Name: GPU Computing		
Max. Marks : 100 **Duration: 3 Hours**		
PART A		
Answer All Questions. Each Question Carries 3 Marks		
1.	Compare many-core and multi-core processors.	
2.	Explain how the architecture of a GPU facilitates for high performance compared to a CPU.	
3.	Illustrate data parallelism using matrix-matrix multiplication.	
4.	Explain how a CUDA program is compiled to run on both CPU and GPU.	
5.	Given a variable declared in a CUDA program with the following keywords - __device__, __constant__, int ConstVar; - describe the type of memory, the scope and lifetime of the variable.	

6.	Explain the factors that limit performance in thread execution.		
7.	Illustrate the Excess Encoding of E and explain the advantage of excess representation.		
8.	Illustrate Amdahl's law with an example.		
9.	Describe the challenges involved in MRI image reconstruction from non-Cartesian trajectory data.		
10.	Describe the major computational challenges involved in visualizing molecular orbitals.		**(10x3=30)**
	Part B **(Answer any one question from each module. Each question carries 14 Marks)**		
11.	(a)	Explain with the help of a figure, the architecture of a CUDA-capable GPU.	**(6)**
	(b)	Compare the following parallel programming language models: (i) Message Passing Interface (MPI) (ii) OpenMP (iii) CUDA (iv) OpenCL	**(8)**
		OR	
12.	(a)	Describe the evolution of Three-dimensional (3D) graphics	**(10)**

		pipeline hardware	
	(b)	Explain the technological factors that resulted in high scalability in GPU computing.	**(4)**
13.	(a)	List the keywords used by a CUDA programmer to introduce parallelism into a traditional C program.	**(4)**
	(b)	Explain the structure of a CUDA program and how it gets executed.	**(10)**
		OR	
14.		Explain the CUDA thread organization and illustrate how the code identifies the part of the input data to read from and the part of the output data structure to write to.	**(14)**
15.	(a)	Explain the CUDA device memory model.	**(10)**
	(b)	Illustrate how a single global memory can limit the performance of a GPU processor.	**(4)**
		OR	
16.	(a)	Illustrate with algorithm, the use of tiling and prefetching to improve the performance of matrix multiplication.	**(10)**
	(b)	Illustrate how instruction mixture limits the achievable performance of programs on CUDA to no more than 1/3 of the peak bandwidth.	**(4)**
17.	(a)	Explain the issues with representation of representable numbers.	**(7)**

	(b)	Illustrate the representation of representable numbers in IEEE format and show how the issues in representation can be resolved.	**(7)**
		OR	
18.	(a)	Use a real life problem to illustrate how a problem can be decomposed for parallel execution.	**(8)**
	(b)	Illustrate how the speedup is achieved by parallelization.	**(6)**
19.	(a)	Explain the linear-solver-based iterative reconstruction algorithm for non-Cartesian MRI scan data.	**(14)**
		OR	
20.		Explain the kernel design for Direct Coulomb summation (DCS).	**(14)**

Teaching Plan

No	Contents	No. of Lecture Hours (40 hrs)
Module 1 – (Introduction) (8 hours)		
1.1	Introduction - GPUs as Parallel Computers	1 hour
1.2	Architecture of a Modern GPU- Why More Speed or Parallelism?	1 hour
1.3	Parallel Programming Languages and Models	1 hour
1.4	History of GPU Computing	1 hour
1.5	Evolution of Graphics Pipelines - The Era of Fixed-Function Graphics Pipelines	1 hour
1.6	Evolution of Programmable Real-Time Graphics	1 hour
1.7	Unified Graphics and Computing Processor	1 hour
1.8	GPU Computing- Scalable GPUs	1 hour
Module-2 (CUDA Parallelism and Threads) (9 hours)		
2.1	Introduction to CUDA	1 hour
2.2	Data Parallelism- CUDA Program Structure	1 hour
2.3	A Matrix–Matrix Multiplication Example	1 hour
2.4	Device Memories and Data Transfer	1 hour

2.5	Kernel Functions and Threading	1 hour
2.6	CUDA Threads - CUDA Thread Organization	1 hour
2.7	Using blockIdx and threadIdx	1 hour
2.8	Synchronization and Transparent Scalability - Thread Assignment	1 hour
2.9	Thread Scheduling and Latency Tolerance	1 hour
Module-3 (CUDA Memories and Performance Considerations) (6 hours)		
3.1	CUDA Memories Importance of Memory Access Efficiency- CUDA Device Memory Types	1 hour
3.2	A Strategy for Reducing Global Memory Traffic- Memory as a Limiting Factor to Parallelism	1 hour
3.3	Performance Considerations- More on Thread Execution- Global Memory Bandwidth	1 hour
3.4	Dynamic Partitioning of SM Resources	1 hour
3.5	Data Prefetching	1 hour
3.6	Instruction Mix- Thread Granularity	1 hour
Module-4 (Floating Point Considerations and Parallel Thinking) (7 hours)		
4.1	Floating Point Considerations- Floating-Point Format – Normalized Representation of M- Excess Encoding of E	1 hour
4.2	Representable Numbers	1 hour
4.3	Special Bit Patterns and Precision- Arithmetic Accuracy and Rounding	1 hour
4.4	Algorithm Considerations	1 hour

4.5	Parallel Programming and Computational Thinking- Goals of Parallel Programming	1 hour
4.6	Problem Decomposition	1 hour
4.7	Algorithm Selection - Computational Thinking	1 hour
Module-5 (Case Studies) (10 hours)		
5.1	Application Case Study: Advanced MRI Reconstruction Application Background	1 hour
5.2	Iterative Reconstruction	1 hour
5.3	Computing FHd	1 hour
5.4	Determine the Kernel Parallelism Structure	1 hour
5.5	Getting Around the Memory Bandwidth Limitation	1 hour
5.6	Using Hardware Trigonometry Functions- Experimental Performance Tuning	1 hour
5.7	Application Case Study: Molecular Visualization and Analysis Application Background	1 hour
5.8	A Simple Kernel Implementation	1 hour
5.9	Instruction Execution Efficiency - Memory Coalescing	1 hour
5.10	Additional Performance Comparisons - Using Multiple GPUs	1 hour

CST424	PROGRAMMING PARADIGMS	CATEGORY	L	T	P	CREDIT
		Program Elective III	2	1	0	3

Preamble: The course provides the learners a clear understanding of the main constructs of contemporary programming languages and the various systems of ideas that have been used to guide the design of programming languages. This course covers the concepts of Names, Bindings & Scope, Statement-Level Control Structures, Sub Programs, Support for Object Oriented Programming, Exception Handling, Concurrency Control, Functional Programming and Logic Programming. This course helps the learners to equip with the knowledge necessary for the critical evaluation of existing and upcoming programming languages. It also enables the learner to choose the most appropriate language for a given programming task, apply that language's approach to structure or organize the code, classify programming languages based on their features and to design new generation languages.

Prerequisite: Sound knowledge in Programming in C and Object-Oriented Programming.

Mapping of course outcomes with program outcomes

CO1	Explain the criteria for evaluating programming languages and compare Imperative, Functional and Logic programming languages (**Cognitive Knowledge Level: Understand**)
CO2	Illustrate the characteristics of data types and variables (**Cognitive Knowledge Level: Apply**)
CO3	Comprehend how control flow structures and subprograms help in developing the structure of a program to solve a computational problem (**Cognitive Knowledge Level: Apply)**
CO4	Explain the characteristics of Object-Oriented Programming Languages (**Cognitive Knowledge Level: Understand)**

CO5	Compare concurrency constructs in different programming languages (**Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓									✓
CO2	✓	✓										✓
CO3	✓	✓	✓	✓								✓
CO4	✓	✓										✓
CO5	✓	✓	✓									✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication

PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test 1 (%)	Test 2 (%)	
Remember	30	30	30
Understand	40	40	40
Apply	30	30	30
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Continuous Assessment Tests (Average of Internal Tests 1 & 2) **25 marks**

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing the remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the two completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed two modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Course Level Assessment Questions

Course Outcome1 (CO1):

1. Compare any three programming languages based on the language evaluation criteria. Prepare a list of characteristics that affect the language evaluation criteria.
2. Identify the advantages and disadvantages of imperative, functional and logic programming languages.

Course Outcome 2 (CO2):

1. Two most important design issues that are specific to character string types are
   (1) whether a string is simply a special kind of character array or a primitive type.
   (2) whether strings have static or dynamic length.
   Identify the implementations options for the above two cases.
2. Consider the following records of a particular language. Let the size of each char variable be 1 byte, int be 4 bytes and and Boolean be 1 bit.

```
Struct Student
{
        int id;
        char
        name[2];
        int age;
        boolean scholarship;
}
```

   Draw and comment on the possible memory layouts for the record for a 32-bit aligned machine

Course Outcome 3(CO3):

1. Explain three situations where a combined counting and logical looping statement is needed.

2. Describe the ways that aliases can occur with pass-by-reference parameters.
3. Identify the two fundamental design considerations for parameter-passing methods.
4. What will be the output of the given program segment if it uses the following parameterpassing mechanisms:

   a) call by reference

   b) call by value

```
x : integer – – global
procedure foo(y :
integer)y := 3
print x
. . .
x := 2
foo(x)
print x
```

Course Outcome 4 (CO4):

1. Describe the role of a virtual method table in implementing dynamic method binding.
2. Identify the merits and demerits of inheritance.

Course Outcome 5 (CO5):

1. Evaluate the use of semaphores and monitors for providing competition synchronizationand cooperation synchronization.

SYLLABUS

Module 1

Introduction – Role of Programming Languages, Programming Domains, Language Evaluation Criteria, Influence on Language Design, Language Design Trade-offs, Implementation Methods. Names, Bindings & Scope – Names, Variables, Concept of Binding, Scope and Lifetime, Referencing Environments.

Module - 2

Data Types – Primitive Data Types, Character String Types, User-Defined Ordinal Types, Array Types, Record Types, List Types, Pointer & Reference Types, Type Checking, Strong Typing, Type Equivalence. Expressions – Arithmetic Expressions, Overloaded Operators, Type Conversions, Relational and Boolean Expressions, Short-Circuit Evaluation. Assignment - Assignment Statements, Mixed-mode Assignment.

Module - 3

Statement-Level Control Structures – Selection Statements, Iterative Statements, Unconditional Branching, Guarded Commands. Subprograms – Design Issues of Subprograms, Local Referencing Environments, Parameter Passing Methods, Subprograms as Parameters, Overloaded Subprograms, Closures, Co-routines

Module - 4

Support for Object Oriented Programming – Inheritance, Dynamic Binding, Design Issues for Object Oriented Languages, Support for Object Oriented Programming in C++, Implementation of Object-oriented Constructs. Exception Handling – Basic Concepts, Design Issues.

Module - 5

Concurrency – Subprogram Level Concurrency, Semaphores, Monitors, Message Passing. Functional Programming Languages – Introduction to LISP and Scheme, Comparison of

Functional and Imperative Languages. Logic Programming Languages – Basic Elements of Prolog, Applications of Logic Programming.

Text Books

1. Robert W Sebesta, Concepts of Programming Languages, 10th Edition, Pearson.
2. Scott M L, Programming Language Pragmatics, 3rd Edition, Morgan Kauffman Publishers.

Reference Books

1. Kenneth C. Louden, Programming Languages: Principles and Practice, 2nd Edition, Cengage Learning.
2. Tucker A. B. and R. E. Noonan, Programming Languages: Principles and Paradigms, 2nd Edition. –TMH.
3. Ravi Sethi, Programming Languages: Concepts & Constructs, 2nd Edition., Pearson Education.
4. David A. Watt, Programming Language Design Concepts, Wiley Dreamtech.

	Model Question Paper
QP CODE:	
Reg No: ______________	
Name:_________________	**PAGES : 4**
	APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
	EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR
	Course Code: CST424
	Course Name: Programming Paradigms
Max. Marks : 100	**Duration: 3 Hours**
	PART A
	Answer All Questions. Each Question Carries 3 Marks
1.	Differentiate between readability and writability.
2.	Define binding and binding time.
3.	What are the advantages of user-defined enumeration types?
4.	Define narrowing and widening conversions.
5.	Why for statement in C language is more flexible than that of older languages?
6.	What are the advantages and disadvantages of dynamic local variables isubprograms?
7.	Illustrate the concept of dynamic method binding with an example.
8.	Is it mandatory to use constructors in object-oriented languages? Justify your answer.
9.	What are the applications of logic programming languages?
10.	Explain the working of let and let-rec constructs in Scheme.
	(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11.	(a)	Explain different criteria used for evaluating languages.	**(7)**
	(b)	Consider the following pseudocode: **x : integer** **:= 3 y :** **integer := 4** **procedure** **add x := x +** **y** **procedure second(P :** **procedure) x : integer := 5** **P()** **procedure** **first y :** **integer := 6** **second(add)** **first()** **write integer(x)** (a) What does this program print if the language uses static scoping? Give reasons. (b) What does it print if the language uses dynamic scoping? Give reasons.	**(7)**
		OR	
12.	(a)	With respect to storage binding, explain the meanings, purposes, advantages and disadvantages of four categories of scalar	**(7)**

		variables.	
	(b)	What is meant by referencing environment of a statement? Show the	**(7)**

		referencing environment at the indicated program points (1), (2), (3) & (4) for the following program segment. Assume that the programming language is statically scoped.	

```
program example;
        var a, b :
        integer;
        procedure
        sub1;
            var x, y: integer;
                begin { sub1 }
                ...........             (1)
                end      {
        sub1    }   procedure
        sub2;
            var x : integer;
            ........
            procedure
            sub3;
                var x: integer;
                    begin { sub3 }
                        ...........     (2)
                    end { sub3 }
                begin { sub2 }
                    ...........         (3)
                end      {
        sub2}           begin
```

		{example} .... **(4)** **end {example }**	
13.	(a)	Explain any two issues associated with the pointer data types and also indicate how dangling pointer problem can be solved.	**(7)**
	(b)	Describe the lazy and eager approaches for reclaiming garbage.	**(7)**
		OR	
14.	(a)	What is meant by side effect and illustrate the advantages of referential transparency?	**(8)**
	(b)	Explain the terms: compound assignment operator, coercion and short circuit evaluation.	**(6)**
15.	(a)	Illustrate the different categories of iteration control statements.	**(8)**

	(b)	Explain the techniques used for identifying the correct referencing environmentfor a subprogram that was sent as a parameter.	**(6)**
		OR	
16.	(a)	Describe the implementation models of Parameter passing.	**(10)**
	(b)	Differentiate coroutines from conventional subprograms.	**(4)**
17.	(a)	What is meant by an exception handler? Explain how exceptions are handled inobject-oriented languages.	**(7)**
	(b)	Describe the design issues in object-oriented languages.	**(7)**
		OR	
18.	(a)	Illustrate how a virtual method table can be used for implementing dynamicmethod binding.	**(7)**
	(b)	Explain the different categories, merits and demerits of inheritance.	**(7)**
19.	(a)	Compare functional and imperative programming languages.	**(7)**
	(b)	Explain the role of monitors in concurrency.	**(7)**
		OR	
20.	(a)	Explain the searching strategies used in Prolog. Why backward chaining ispreferred over forward chaining in Prolog?	**(10)**
	(b)	**(let ((a 6)** **(b 8)** **(square (lambda (x) (* x** **x)))(plus +))** **(sqrt (plus (square a) (square b))))** Write the output of the above code? Explain how let and lambda constructworks?	**(4)**

Teaching Plan

No	CONTENTS	No. of Lecture Hours (36 hrs.)
	Module-1 (7 hours)	
1.1	Introduction: Reasons for studying Concepts of programming languages, Programming Domains	1 hour
1.2	Language Evaluation Criteria	1 hour
1.3	Influence on Language Design, Language Design Trade-offs	1 hour
1.4	Implementation Methods	1 hour
1.5	Names, Variables	1 hour
1.6	Concept of Binding	1 hour
1.7	Scope and Lifetime, Referencing Environments	1 hour
	Module-2 (7 hours)	
2.1	Primitive Data Types, Character String Types	1 hour
2.2	User-Defined Ordinal Types, Array Types	1 hour
2.3	Record Types, List Types, Pointer and Reference Types	1 hour
2.4	Implementation of pointer and reference types, Type Checking, StrongTyping, Type Equivalence	1 hour
2.	Expressions and Assignment Statements,	1 hour

5	Arithmetic Expressions	
2.6	Overloaded Operators, Type Conversions	1 hour
2.7	Relational and Boolean Expressions, Short-Circuit Evaluation, Assignment Statements, Mixed-mode Assignment	1 hour
	Module-3 (8 hours)	
3.1	Selection Statements, Iterative Statements	1 hour
3.2	Unconditional Branching	1 hour
3.3	Guarded Commands	1 hour
3.4	Subprograms: Design Issues of Subprograms	1 hour
3.5	Local Referencing Environments	1 hour
3.6	Parameter Passing Methods	1 hour
3.7	Subprograms as Parameters, Overloaded Subprograms	1 hour
3.8	Closures, Co-routines	1 hour
	Module-4 (7 hours)	
4.1	Inheritance	1 hour
4.2	Dynamic Binding	1 hour
4.3	Design Issues for Object Oriented Languages	1 hour
4.4	Support for Object Oriented Programming in C++	1 hour
4.5	Implementation of Object-Oriented Constructs	1 hour
4.6	Exception Handling – Basic Concepts	1 hour
4.7	Exception Handling - Design Issues	1 hour
	Module-5 (7 hours)	
5.1	Subprogram Level Concurrency	1 hour
5.2	Semaphores, Monitors	1 hour
5.3	Message Passing	1 hour
5.4	Introduction to LISP and Scheme	1 hour

5.5	Comparison of Functional and Imperative Languages	1 hour
5.6	Basic Elements of Prolog	1 hour
5.7	Applications of Logic Programming	1 hour

CST434	NETWORK SECURITY PROTOCOLS	CATEGORY	L	T	P	CREDIT
		Program Elective III	2	1	0	3

Preamble: This course helps the learners to explore various network and system security protocols. This course covers authentication protocols, firewalls and security protocols from different layers such as data link, network, transport and application. The concepts covered in this course enable the learners in effective use of security protocols for securing network applications.

Prerequisite: A fundamental knowledge in the concepts of Security in Computing.

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

CO1	Explain authentication protocols, X.509 authentication service and Public Key Infrastructure (PKI).**(Cognitive Knowledge Level: Understand)**
CO2	Identify the security mechanisms in E mail security services. **(Cognitive Knowledge Level: Understand)**
CO3	Summarize the network and transport layer security services provided in a secure communication scenario. **(Cognitive Knowledge Level: Apply)**
CO4	Describe real time communication security and application layer security protocols. **(Cognitive Knowledge Level: Apply)**
CO5	Explain the concepts of firewalls and wireless network security. **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔		✔									✔

CO2	✔	✔	✔									✔
CO3	✔	✔	✔									✔
CO4	✔	✔	✔			✔						✔
CO5	✔	✔	✔									✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO 1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO 2	Problem Analysis	**PO8**	Ethics
PO 3	Design/Development of solutions	**PO9**	Individual and team work
PO 4	Conduct investigations of complex problems	**PO10**	Communication
PO 5	Modern tool usage	**PO11**	Project Management and Finance
PO 6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Test 1 (%)	Test 2 (%)	End Semester Examination (%)
Remember	20	20	20
Understand	50	50	50
Apply	30	30	30
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Test : **25 marks**

Continuous Assessment Assignment : **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

SYLLABUS

Module-1 (Authentication Protocols)

Authentication Protocols – Mutual authentication, One way authentication. Kerberos – Kerberos Version 4, Kerberos Version 5. X.509 Authentication service. Public Key Infrastructure (PKI) – Trust models, Revocation.

Module-2 (E-mail Security)

Pretty Good Privacy (PGP) – Operational Description, Cryptographic keys and key rings, Message format, PGP message generation, PGP message reception, Public key management. S/MIME – Functionality, Messages, Certificate processing, Enhanced security services.

Module-3 (Network Layer Security and Web Security)

Internet Protocol Security (IPSec) – Overview, IP security architecture, Authentication Header (AH), Encapsulating Security Payload (ESP), Combining Security Associations, Key management. Internet Key Exchange (IKE) - Phases. Web Security – Web security considerations. Secure Socket Layer and Transport Layer Security (SSL/TLS) – SSL Architecture, SSL protocols, Cryptographic computations, Transport layer security.

Module-4 (Real-time Security and Application Layer Security)

Real-time communication security – Perfect Forward Secrecy (PFS), Denial-of-Service protection, Endpoint identifier hiding, Live partner reassurance. Hypertext Transfer Protocol Secure (HTTPS) – Connection initiation, Closure. Secure Shell (SSH) – Transport layer protocol, User authentication protocol, Connection protocol. Secure Electronic Transaction (SET) – Overview, Features, Participants, Dual signature, Payment processing.

Module-5 (System Security and Wireless Security)

Firewalls – Firewall characteristics, Types of Firewalls, Firewall configurations, Encrypted Tunnels, Trusted systems – Data access control, The concept of Trusted Systems, Trojan horse defense. IEEE 802.11i wireless LAN security - Services, Phases of operation, Wired Equivalent

Privacy (WEP), Wi-Fi Protected Access (WPA), WPA2.

Text Books

1. William Stallings, Cryptography and Network Security Principles and Practice, 4/e,Pearson Ed.
2. C. Kaufman, R. Perlman and M. Speciner, "Network Security: Private Communication in a Public World", 2/e, PHI.

References

1. Behrouz A. Forouzan, DebdeepMukhopadhyay, "Cryptography and Network Security", 3/e,Tata McGraw Hill.
2. Tyler Wrightson, "Wireless Network Security A Beginner's Guide", 2012, Tata McGraw Hill.
3. William Stallings, "Network Security Essentials: Applications and Standards", 4/e, PrenticeHall.
4. Schiller J., Mobile Communications, 2/e, Pearson Education.
5. Roberta Bragg et. al., "Network Security: The Complete Reference", Tata McGraw Hill

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Identify the threats associated with user authentication over a network or Internet.
2. In the context of Kerberos, mention the significance of a realm.

Course Outcome 2 (CO2):

1. Mention the use of R64 conversion for an e-mail application.
2. Give the general structure of Private and Public Key rings in PGP.

Course Outcome 3 (CO3):

1. In AH protocol, identify the fields in an IP header which are included in MAC calculation. For each of the fields in the IP header, indicate whether the field is immutable, mutable but predictable, or mutable. Justify your decision for each field.
2. Is it possible for the receiver to reorder SSL record blocks that arrive out of order? If so, explain how it can be done. If not, why?

Course Outcome 4 (CO4):

1. Devise a protocol based on a pre-shared secret key that hides identities and gives Perfect Forward Secrecy (PFS) for identity hiding. Make two variants, one in which an active attacker can learn only the initiator's identity, and one in which an active attacker can learn only the target's identity.
2. Explain the tasks performed by the payment gateway during Payment Authorization in SET.

Course Outcome 5 (CO5):

1. List the weaknesses of a packet-filtering router.
2. Give the relevance of pair wise keys and group keys in IEEE 802.11i.
3. State the design goals of firewalls.

Model Question Paper

QP CODE: **PAGES: __**

Reg No:______________

Name:________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST434

Course Name: NETWORK SECURITY PROTOCOLS

Max Marks: 100 **Duration: 3 Hours**

PART A

(Answer All Questions. Each question carries 3 marks)

1. List any three requirements of Kerberos.
2. Specify the significance of key pair recovery. When is the key pair updated?
3. Why does PGP generate signature before applying compression?
4. List the four principal services provided by S/MIME.
5. Explain the significance of Alert protocol in SSL and list out any three Alertmessages with their uses.
6. Specify the purpose of MAC during the change cipher spec TLS exchange.
7. What is the advantage, if any, of not including the MAC in the scope of packetencryption in SSH packets?
8. Givethe significance of dual signature in SET.

9. List the IEEE 802.11i services.

10. How is the concept of association related to that of mobility in wireless networks? **(10x3=30)**

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Describe the requirements for a public-key certificate scheme. **(8)**

(b) Explain the significance of chain of certificates. **(6)**

OR

12. (a) Specify the purpose of the X.509 standard. How is an X.509 certificate revoked? **(8)**

(b) Describe the management functions of a PKI. What is a cross certificate? **(6)**

13. (a) List the services provided by PGP and explain how authentication and confidentiality are provided. **(8)**

(b) Explain the functionalities provided by S/MIME. **(6)**

OR

14. (a) Give the format of a PGP message and specify the significance of each field in the message. **(8)**

(b) Explain the enhanced security services provided in S/MIME. **(6)**

15. (a) Explain the parameters that identify an SSL session state. **(8)**

(b) Differentiate between transport mode and tunnel mode in IPSec. **(6)**

OR

16. (a) The IPsec architecture document states that when two transport mode SAs arebundled to allow both AH and ESP protocols on the same end-to-end flow, only one ordering of security protocols seems appropriate: performing the ESP protocol before performing the AH protocol. Why is this approach recommended rather than authentication before encryption? **(8)**

(b) List and explain the purpose each Alert Codes supported by SSL. **(6)**

17. (a) Illustrate the significance ofperfect forward secrecy. **(6)**

(b) Explain the key features provided by SET. **(8)**

OR

18. (a) List and explain the SSH protocols. **(8)**

(b) "The HTTPS capability is built into all modern web browsers". Justify. **(6)**

19. (a) Explain the phases of operations in IEEE 802.11i. **(8)**

(b) Give the significances of Encrypted Tunnels **(6)**

OR

20. (a) Compare the features of three types of firewalls. **(8)**

(b) Compare the Wireless LAN protocols WEP, WPA and WPA2 **(6)**

TEACHING PLAN

NO	CONTENTS	No: of Lecture hours (35)
Module-1 (Authentication Protocols)(7hrs)		
1.1	Authentication Protocols – Mutual authentication, One wayauthentication	1
1.2	Kerberos –Version 4	1
1.4	Differences between Kerberos Version 4 and Version 5, Kerberos Version 5	1
1.5	X.509 Authentication service – Certificates, Authentication Procedures, X.509 Version 3	1
1.6	Public Key Infrastructure (PKI) – Trust models	1
1.7	Public Key Infrastructure (PKI) – Revocation	1
Module-2 (E-mail Security) (6 hrs)		
2.1	Pretty Good Privacy (PGP) – Operational Description	1
2.2	Cryptographic keys and key rings, Message format	1
2.3	PGP message generation, PGP message reception	1
2.4	PGP -Public key management	1
2.5	S/MIME – Overview of MIME, Functionality, Messages	1
2.6	S/MIME - Certificate processing, Enhanced security services	1

Module-3 (Network Layer Security and Web Security)(8 hrs)		
3.1	Internet Protocol Security (IPSec) – Overview, IP securityarchitecture	1
3.2	Authentication Header (AH)	1
3.3	Encapsulating Security Payload (ESP)	1
3.4	Combining Security Associations, Key management	1
3.5	Internet Key Exchange (IKE) – Phases	1
3.6	Web Security – Web security considerations. Secure Socket Layer and Transport Layer Security (SSL/TLS) – SSL Architecture	1
3.7	SSL Protocols - Record Protocol, Change Cipher Spec Protocol,Alert Protocol	1
3.8	SSL Handshake Protocol, Cryptographic computations,Transport Layer Security	1
Module-4 (Real-time Security and Application Layer Security) (8hrs)		
4.1	Real-time communication security – Perfect Forward Secrecy(PFS)	1
4.2	Denial-of-Service protection, Endpoint identifier hiding, Livepartner reassurance	1
4.3	Hypertext Transfer Protocol Secure (HTTPS) – Connectioninitiation, Closure	1
4.4	Secure Shell (SSH) – Transport layer protocol	1
4.5	User authentication protocol	1
4.6	Connection protocol	1
4.7	Secure Electronic Transaction (SET) – Overview, Features,Participants	1

4.8	Dual signature, Payment processing	1
Module-5 (System Security and Wireless Security) (6 hrs)		
5.1	Firewalls – Firewall characteristics, Types of Firewalls	1
5.2	Firewalls – Firewall configurations, Encrypted Tunnels	1
5.3	Trusted systems – Data Access Control, The Concept of TrustedSystems, Trojan Horse Defense	1
5.4	IEEE 802.11i wireless LAN security - Services, Phases ofoperation	1
5.5	Wired Equivalent Privacy (WEP)	1
5.6	Wi-Fi Protected Access (WPA), WPA2	1

CST444	SOFT COMPUTING	CATEGORY	L	T	P	CREDIT
		Program Elective III	2	1	0	3

Preamble: This course enables the learners to understand the concepts of Soft Computing techniques and its applications. It covers Artificial Neural Networks, operations and models of fuzzy logic, genetic algorithms and multi objective optimization techniques. This course helps the students to develop algorithms and solutions for different real world applications.

Prerequisite: NIL.

Mapping of course outcomes with program outcomes

CO1	Describe soft computing techniques and the basic models of Artificial Neural Network **(Cognitive Knowledge Level: Understand)**
CO2	Solve practical problems using neural networks **(Cognitive Knowledge Level: Apply)**
CO3	Illustrate the operations, model and applications of fuzzy logic **(Cognitive Knowledge Level: Apply)**
CO4	Illustrate the concepts of Genetic Algorithm **(Cognitive Knowledge Level: Apply)**
CO5	Describe the concepts of multi-objective optimization models and the need for usinghybrid soft computing approaches**(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔	✔									✔
CO2	✔	✔	✔	✔								✔

CO3	✔	✔	✔	✔								✔
CO4	✔	✔	✔	✔								✔
CO5	✔	✔	✔									✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks (%)**
	Test 1 (%)	**Test 2 (%)**	
Remember	**30**	**30**	**30**
Understand	**30**	**30**	**30**

Apply	**40**	**40**	**40**
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Continuous Assessment Tests(Average of Internal Tests 1 & 2) **25 marks**

Continuous AssessmentAssignment **15 marks**

Internal Examination Pattern

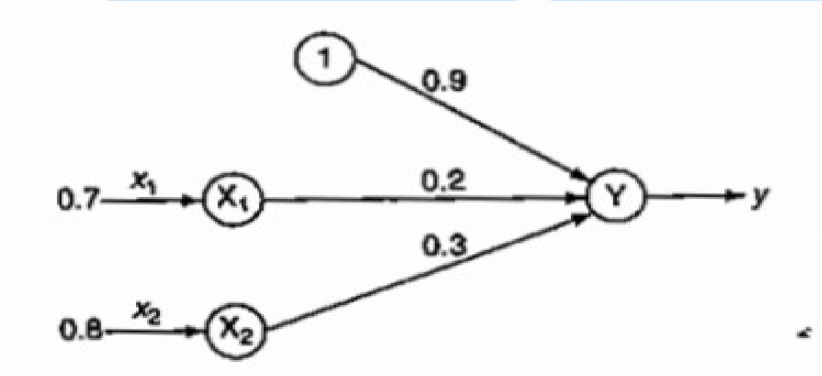
Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Course Level Assessment QuestionsCourse Outcome 1 (CO1):

1. Describe the necessity of Activation function? Examine the various aspects of sigmoidal activation function. List the drawbacks. Calculate the net output of the following neuralnetwork using the bipolar and binary sigmoidal activation function.



2. Explain the architecture of McCulloch-Pitts Neuron network model. ImplementNAND(NOT-AND) gate function using M-P Neuron Model(with binary input).

Course Outcome 2(CO2):

1. Find the weights required to perform classification of patterns shown below usingperceptron network. The patterns (1,1,-1) and (1, -1,-1) are belonging to the target class -1. The patterns (-1,1,1) and (-1,-1,1) are belonging to the target class +1. Assume suitablelearning rate and initial weights.
2. Explain the architecture and training algorithm of Adaline network . Use Adaline nerworkto train NOR logic function with bipolar inputs and targets. Perform 2 epochs of training.

Course Outcome 3(CO3):

1. There is an imprecise relationship between the ambient temperature for clay masonry bricks and their compressive strengths. Let X be a fuzzy set

$$X=\left\{\frac{1.0}{1500}+\frac{0.8}{2175}+\frac{0.6}{7000}+\frac{0.5}{12750}+\frac{0.3}{16500}+\frac{0.1}{20000}\right\}$$

$$Y=\left\{\frac{0.2}{20}+\frac{0.4}{25}+\frac{0.5}{32}+\frac{1.0}{50}+\frac{0.6}{90}+\frac{0.3}{105}\right\}$$

of fracture strengths and Y be a fuzzy set of temperatures with the following membership functions:

(a) Find the Cartesian Product of X and Y and represent it as relation R.

Suppose there is a second fuzzy set of masonry lengths given as

$$Z=\left\{\frac{0.4}{1500}+\frac{0.5}{2175}+\frac{0.6}{7000}+\frac{0.8}{12750}+\frac{0.9}{16500}+\frac{1.0}{20000}\right\}$$

(b) Find S=ZoR using max-min composition (c) Find T=ZoR using max-product composition

2. Given two universes X={x1,x2,x3,x4,x5} and Y={y1,y2,y3,y4,y5},the fuzzy sets Adefined on X and fuzzy set B defined on Y are given below:

$$A=\left\{\frac{0.4}{x_1}+\frac{0.7}{x_2}+\frac{1}{x_3}+\frac{0.8}{x_4}+\frac{0.6}{x_5}\right\} \quad B=\left\{\frac{0.2}{y_1}+\frac{0.6}{y_2}+\frac{1}{y_3}+\frac{0.9}{y_4}+\frac{0.7}{y_5}\right\}$$

(i) Find the relation R = A × B

Consider another fuzzy set C defined on the universe V={v1,v2,v3},

$$C=\left\{\frac{0.4}{v_1}+\frac{1}{v_2}+\frac{0.8}{v_3}\right\}$$

F i n

(ii) Find P = B × C. Using max-min composition, d RoP. $v1$ v $v3$

2

Course Outcome 4(CO4):

1. Illustrate the various types of cross over with suitable examples.
2. Using Genetic algorithm with Roulette wheel selection method maximize the function f(x)=x2 over {0, 1, 2, ..., 31} with initial x values of (13, 24, 8, 19). Show one crossover and mutation.

Course Outcome 5(CO5):

1. Explain strong dominance and weak pareto-optimality.
2. What are the different classifications of neuro-fuzzy hybrid systems?

SYLLABUS

Module – 1 (Introduction to Soft Computing & Artificial Neural Network)

Introduction to Soft Computing. Difference between Hard Computing & Soft Computing. Applications of Soft Computing. Artificial Neurons Vs Biological Neurons. Basic models of artificial neural networks – Connections, Learning, Activation Functions. McCulloch and Pitts Neuron. Hebb network.

Module – 2 (Supervised Learning Network)

Perceptron Networks– Learning rule, Training and testing algorithm. Adaptive Linear Neuron– Architecture, Training and testing algorithm. Back propagation Network – Architecture, Training and testing algorithm.

Module - 3 (Fuzzy Logic & Defuzzification)

Fuzzy sets – properties, operations on fuzzy set. Fuzzy membership functions, Methods of membership value assignments – intuition, inference, Rank Ordering. Fuzzy relations– operations on fuzzy relation. Fuzzy Propositions. Fuzzy implications. Defuzzification– Lamda cuts, Defuzzification methods.

Module - 4 (Fuzzy Inference System & Genetic Algorithm)

Fuzzy Inference Systems - Mamdani and Sugeno types. Fuzzy Logic Controller. Concepts of genetic algorithm. Operators in genetic algorithm - coding, selection, cross over, mutation. Stopping condition for genetic algorithm.

Module - 5 (Multi Objective Optimization & Hybrid Systems)

Multi objective optimization problem. Principles of Multi- objective optimization, Dominance and pareto-optimality. Optimality conditions. Neuro-fuzzy hybrid systems. Genetic – neuro hybrid systems.

Text Books

1. S.N.Sivanandam and S.N. Deepa, Principles of Soft Computing , 2ndEdition, John Wiley &Sons.
2. Kalyanmoy Deb, Multi-objective Optimization using Evolutionary Algorithms, 1stEdition, John Wiley & Sons.

ReferenceBooks

1. Timothy J Ross, Fuzzy Logic with Engineering Applications, John Wiley & Sons, 2016.
2. T.S.Rajasekaran, G.A.Vijaylakshmi Pai "Neural Networks, Fuzzy Logic & GeneticAlgorithms Synthesis and Applications", Prentice-Hall India.
3. Simon Haykin, "Neural Networks- A Comprehensive Foundation", 2/e, Pearson Education.
4. Zimmermann H. J, "Fuzzy Set Theory & Its Applications", Allied Publishers Ltd.

Model Question Paper

QP CODE:

Reg No: _______________

Name:__________________ **PAGES : 4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST 444

Course Name: Soft Computing

Max. Marks : 100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Explain the architecture of a simple Artificial Neural network? Compare it with abiological neuron.
2. A 4-input neuron has weights 1, 2, 3 and 4. The transfer function is linear with theconstant of proportionality being equal to 2. The inputs are 4, 10, 5 and 20 respectively. Predict the output?
3. Explain the Widrow-Hoff learning rule for supervised learning in neural networkswith help of an example. Why is it sometimes called the LMS learning rule?
4. Implement one epoch of Adaline algorithm for AND logic function with binary inputs and bipolar outputs. Initial weights are w1=0.2, w2=0.1 and learning rateparameter η=0.2.

5. Consider two fuzzy sets $A = \left\{ \frac{0.2}{0} + \frac{0.3}{1} + \frac{1}{2} + \frac{0.1}{3} + \frac{0.5}{4} \right\}$ $B = \left\{ \frac{0.1}{0} + \frac{0.25}{1} + \frac{0.9}{2} + \frac{0.7}{3} + \frac{0.3}{4} \right\}$ Find the following: (a) Algebraic sum (b) Algebraic product(c) Bounded sum.

6. Using your own intuition and definition of universe of discourse, plot membership functions for liquid level (Empty, very less, less, full, very full) in a tank.

7. Explain Stochastic Universal Sampling with an example.

8. Explain any two mutation methods.

9. Differentiate between linear and nonlinear Multi Objective Optimization Problem.

10. What are the characteristics of neuro fuzzy hybrid systems?

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Implement XOR function using M-P Neuron Model (with binary input).WhyM-P neuron is widely used in processing binary data? **(8)**

(b) Using Hebb Network calculate the weight required to perform the following classification of given input pattern. **(6)**

L □belongs to the members of the class(+)□target value +1 U□does not belongs to members of class(.)□target value -1

+	.	.
+	.	.
+	+	+

+	.	+
+	.	+
+	+	+

L U

OR

12. (a) Compare the three learning approaches in Artificial Neural Network. How is the critic information used in learning process. **(8)**

(b) Define Hebb Law. Design a Hebb Network to implement logical AND function. Use bipolar input and targets. **(7)**

13.	(a)	Discuss the training algorithm and explain the weight updates in backpropagation networks.	**(10)**
	(b)	Implement one epoch of Perceptron training algorithm for OR logic function with binary input and bipolar output.	**(4)**
		OR	
14.	(a)	Explain how synaptic weights are adapted iteration by iteration using error correction rule in Perceptron convergence algorithm for an OR gate with bipolar inputs and outputs. Initial weights are all zero and learning rate parameter η=0.1.	**(10)**
	(b)	Explain Perceptron convergence theorem and discuss Perceptron algorithm based on XOR logic function.	**(4)**
15.	(a)	Three fuzzy sets are defined as follows: $A = \{\frac{0.1}{30} + \frac{0.2}{60} + \frac{0.3}{90} + \frac{0.4}{120}\}$, $B = \{\frac{1}{1} + \frac{0.2}{2} + \frac{0.5}{3} + \frac{0.7}{4} + \frac{0.3}{5} + \frac{0}{6}\}$, $C = \{\frac{0.33}{100} + \frac{0.65}{200} + \frac{0.92}{300} + \frac{0.21}{400}\}$. Find: (i) $= A \times B$ (ii) $S = B \times C$ (iii) $T = RoS$, using Max-Min composition (iv) $T = RoS$, using Max-Product composition.	**(10)**
	(b)	For the fuzzy sets given $A = \{\frac{0.5}{x1} + \frac{0.2}{x2} + \frac{0.9}{x3}\}$ and $B = \{\frac{1}{y1} + \frac{0.5}{y2} + \frac{1}{y3}\}$. Find	**(4)**

relation R by performing Cartesian product over the given fuzzy sets.

OR

16. (a) Using inference approach, find the membership values for each of the triangular shapes (I, R, IR, T) for a triangle with angles 120°, 50°, 10°. **(8)**

(b) Using Zadeh's notation, determine the λ - cut sets for the given fuzzy sets: **(6)**

$$S_1 = \left\{\frac{0}{0} + \frac{0.5}{20} + \frac{0.65}{40} + \frac{0.85}{60} + \frac{1.0}{80} + \frac{1.0}{100}\right\}$$

$$S_2 = \left\{\frac{0}{0} + \frac{0.45}{20} + \frac{0.6}{40} + \frac{0.8}{60} + \frac{0.95}{80} + \frac{1.0}{100}\right\}$$

Express the following for $\lambda = 0.5$: a) $S_1 \cup S_2$ b) $\acute{S}_2$ c) $S_1 \acute{\cap}\ _2$

17. (a) Differentiate between value encoding and permutation encoding. **(8)**

(b) Explain the stopping conditions for genetic algorithm. **(6)**

OR

18. (a) Apply Mamdani fuzzy model to design a controller to determine the wash time of a domestic washing machine. Assume input is dirt and grease of the cloth. Use three descriptors for input variable and five descriptors for outputvariables .Derive the set of rules for controller action and defuzzification. Design should be supported by figure wherever possible. **(10)**

(b) Explain Single-Point Crossover and Two-Point Crossover with example. **(4)**

19. (a) Explain convex and non convex MOOP? How to find a non dominated set. **(10)**

(b) What are the properties of dominance relation? **(4)**

OR

20. (a) Explain Genetic Neuro-Hybrid System with block diagram. Also write the advantages of Genetic- Neuro Hybrid systems. **(8)**

(b) Discuss the classification of Neuro-Fuzzy Hybrid System. **(6)**

Teaching Plan

No	CONTENTS	No. of Lecture Hours (35 hrs)
	Module-1 (Introduction to Soft Computing & Artificial Neural Network) (6 hours)	
1.1	Introduction to Soft Computing	1 hour
1.2	Difference between Hard Computing & Soft Computing & Applications ofSoft Computing	1 hour
1.3	Artificial Neurons Vs Biological Neurons, Basic models of artificial neuralnetworks	1 hour
1.4	Activation Functions	1 hour
1.5	McCulloch and Pitts Neuron	1 hour
1.6	Hebb network	1 hour
	Module-2 (Supervised Learning Network) (7 hours)	
2.1	Perceptron networks – Learning rule, Training and testing algorithm	1 hour
2.2	Perceptron networks – Problems	1 hour
2.3	Adaptive Linear Neuron (Lecture I)	1 hour
2.4	Adaptive Linear Neuron (Lecture II)	1 hour

2.5	Adaptive Linear Neuron-Problems (Lecture III)	1 hour
2.6	Back propagation Network (Lecture I)	1 hour
2.7	Back propagation Network (Lecture II)	1 hour
Module-3 (Fuzzy Logic & Defuzzification) (8 hours)		
3.1	Introduction to Fuzzy Set, Properties & operations on fuzzy sets	1 hour
3.2	Fuzzy membership functions, Fuzzification	1 hour
3.3	Methods of membership value assignments	1 hour
3.4	Fuzzy relations, Operations on Fuzzy Relation	1 hour
3.5	Fuzzy Propositions & Fuzzy Implications	1 hour
3.6	Lamda cuts for fuzzy sets	1 hour
3.7	Defuzzification methods(Lecture I)	1 hour
3.8	Defuzzification methods(Lecture II)	1 hour
Module-4 (Fuzzy Inference System & Genetic Algorithm) (6 hours)		
4.1	Fuzzy Inference Systems - Mamdani type	1 hour
4.2	Fuzzy Inference Systems - Sugeno type	1 hour
4.3	Fuzzy Logic Controller	1 hour
4.4	Introduction to genetic algorithm, operators in genetic algorithm - coding	1 hour
4.5	Selection, Cross over	1 hour
4.6	Mutation, stopping condition for genetic algorithm	1 hour
Module-5 (Multi-Objective Optimization & Hybrid System) (8 hours)		
5.1	MOOP-Linear &Non linear, Convex & Non Convex	1 hour

5.2	Principles of MOO-Illustrating Pareto Optimal Solutions, Objectives in MOO	1 hour
5.3	Dominance & Pareto-Optimality-Concept of Domination	1 hour
5.4	Properties of Dominance Relation, Pareto Optimality	1 hour
5.5	Procedure for finding a non dominated set	1 hour
5.6	Optimality Conditions	1 hour
5.7	Neuro Fuzzy hybrid system-Classification& characteristics	1 hour
5.8	Genetic –neuro hybrid systems	1 hour

CST454	FUZZY SET THEORY AND APPLICATIONS	CATEGORY	L	T	P	CREDIT
		Program Elective III	2	1	0	3

Preamble: This course equips the students to understand the concepts of fuzziness and its use in building better solutions to problems. The course covers basic concepts of fuzzy sets, fuzzy relations, fuzzy logic and building of fuzzy approximation-based solutions. It helps students to design and develop fuzzy based solutions to real world applications.

Prerequisite: Basic knowledge in set theory.

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

CO1	Explain fuzzy logic based problem solving **(Cognitive Knowledge Level: Understand)**
CO2	Summarize the concepts of crisp sets, crisp relations, crisp logic with fuzzy sets, fuzzyrelations and fuzzy logic**(Cognitive Knowledge Level: Apply)**
CO3	Develop fuzzy systems by selecting appropriate membership functions, fuzzificationand defuzzification methods **(Cognitive Knowledge Level: Apply)**
CO4	Develop solutions using graphical and rule-based methods**(Cognitive Knowledge Level: Apply)**
CO5	Make use of fuzzy logic inference to solve real world problems**(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 1 0	PO1 1	PO 1 2
CO 1	✔											✔

CO 2	✓	✓	✓									✓
CO 3	✓	✓	✓	✓	✓							✓
CO 4	✓	✓	✓	✓	✓							✓
CO5	✓	✓		✓	✓							✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks (%)**
	Test 1 (%)	**Test 2 (%)**	
Remember	**20**	**20**	**20**

Understand	50	50	50
Apply	30	30	30
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Continuous Assessment Tests(Average of Internal Tests1&2) **25 marks**

Continuous AssessmentAssignment **15 marks**

Internal Examination Pattern

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

SYLLABUS

Module – (Basic Fuzzy Set Theory)

The case for imprecision, Utility and Limitations of Fuzzy Systems, Fuzzy Sets and Membership, Classical Sets – Properties, Operations, Fuzzy Sets – Properties and Operations, Classical Relations – Cartesian Product, Operations and Properties of Crisp Relations, Composition, Fuzzy Relations – Cardinality, Operations, Properties, Fuzzy Cartesian Product and Composition.

Module – 2 (Fuzzy Membership Functions)

Tolerance and Equivalence Relations – Crisp and Fuzzy, Similarity Methods – Cosine, Min-max, Fuzzy Membership Functions – Features, Fuzzification, Defuzzification to Crisp Sets, λ-Cutsfor Fuzzy Relations, Linguistic Hedges.

Module - **3** (**Fuzzification and Defuzzification Methods**)

Development of Membership Functions –Intuition, Inference, Rank ordering, Inductive reasoning. Defuzzification to Scalars - Max membership principle, Centroid method, Weighted average method, Mean max membership, Center of sums, Center of largest area, First (or last) of maxima.

Module - 4 (Fuzzy Inference)

Classical Logic, Fuzzy Logic, Approximate Reasoning, Fuzzy (Rule-Based) Systems - Multiple conjunctive antecedents, Multiple disjunctive antecedents, Aggregation of fuzzy rules, Graphical Techniques of Inference.

Module - **5** (**Fuzzy Applications**)

Applications of Fuzzy Systems - Fuzzy Classification, Fuzzy Pattern Recognition, Fuzzy Control Systems, Fuzzy Systems and Neural Networks, Fuzzy Clustering, Fuzzy Databases and Information retrieval systems.

Text Books

1. Fuzzy Logic with Engineering Applications – Timothy J. Ross, Third Edition, John Wileyand Sons, 2010
2. Fuzzy Sets and Fuzzy Logic: Theory and Applications - George J. Klir

and Bo Yuan ,Prentice Hall, 1995.

Reference Books

1. Kenneth H. Rosen, Discrete Mathematics and Its Applications with Combinatorics and GraphTheory, Seventh Edition, MGH,2011
2. Trembly J.P and Manohar R, "Discrete Mathematical Structures with Applications to Computer Science", TataMc Graw Hill Pub. Co. Ltd., New Delhi,2003.
3. Bernard Kolman, Robert C. Busby, Sharan Cutler Ross, "Discrete Mathematical Structures",Pearson Education Pvt Ltd., New Delhi,2003
4. Kenneth H .Rosen, "Discrete Mathematics and its Applications", 5/e, TataMc Graw Hill Pub.Co. Ltd, New Delhi2003

Course Level Assessment Questions

Course Outcome1 (CO1):

1. What are the limitations of crisp systems?
2. Explain the difference between randomness and fuzziness.
3. Find some examples of prospective fuzzy variables in daily life.

Course Outcome 2(CO2):

1. The strength of two types of concrete needs to be compared. Four concrete masonry units (CMUs) from each type of concrete are stressed until they fail. The lowest stress at failure of a CMU is denoted 1, and the highest stress at failure is denoted 4,so the CMUs are rank ordered by failure stress, that is, X = {1, 2, 3, 4}. Since "failure" of CMUs is fuzzy, the membership value for a specific CMU represents the judgment that the CMU really failed. The following fuzzy sets represent the failure estimates for the two different concrete types:

$$A = \left\{ \frac{0.15}{1} + \frac{0.25}{2} + \frac{0.6}{3} + \frac{0.9}{4} \right\}$$

$$B = \left\{ \frac{0.2}{1} + \frac{0.3}{2} + \frac{0.5}{3} + \frac{0.8}{4} \right\}$$

Calculate the union, intersection and difference for the two concrete types.

2. An engineer is testing the properties, strength and weight of steel. Suppose he has two fuzzy sets A , defined on a universe of three discrete strengths, $\{s1, s2, s3\}$, and B, definedon a universe of three discrete weights, $\{w1, w2, w3\}$. Suppose A and B represent a "high- strength steel" and a "near-optimum weight," respectively, as shown below

$$A = \left\{ \frac{1}{s_1} + \frac{0.5}{s_2} + \frac{0.2}{s_3} \right\}$$

$$B = \left\{ \frac{1}{w_1} + \frac{0.5}{w_2} + \frac{0.2}{w_3} \right\}$$

a) Find the fuzzy relation for the Cartesian product, R, of A and B

b) Introducing another fuzzy set, C, which represents a set of "moderately good" steel strengths

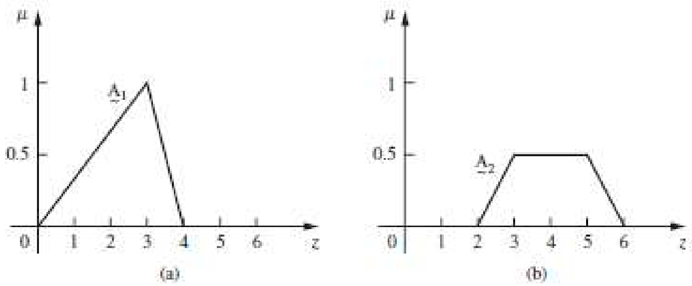
$$C = \left(\frac{0.1}{s_1} + \frac{0.6}{s_2} + \frac{1}{s_3}\right)$$

Find C◦R using max–min composition

Course Outcome 3(CO3):

1. Using your own intuition and your own definitions of the universe of discourse,plot fuzzymembership functions for “age of people” who are:
   (i) very young
   (ii) young
   (iii) middle-aged
   (iv) old
2. a) Define membership functions for approximately isosceles triangle, approximatelyequilateral and approximately right-angled triangles.

   b) Find the membership value for the triangle represented by the angles 80°, 75°, 25°, in theabove triangles.
3. In metallurgy, materials are made with mixtures of various metals and other elements to achieve certain desirable properties. In a particular preparation of steel, three elements, namely, iron, manganese, and carbon, are mixed in two different proportions. The samples obtained from these two different proportions are placed on a normalized scale and are represented as fuzzy sets A1 and A2. Do a logical union of the membership functions A1 and A2 and find the defuzzified value of the resulting membership function.



Course Outcome 4(CO4): .

1. Consider the following two discrete fuzzy sets, which are defined on universeX = {−5, 5}:

$$A = \text{"zero"} = \left\{ \frac{0}{-2} + \frac{0.5}{-1} + \frac{1}{0} + \frac{0.5}{1} + \frac{0}{2} \right\}$$

$$B = \text{"positive medium"} = \left\{ \frac{0}{0} + \frac{0.6}{1} + \frac{1}{2} + \frac{0.6}{3} + \frac{0}{4} \right\}$$

Construct the relation for IF x is "zero" THEN y is "positive medium"

2. A metro train system uses fuzzy logic in ensuring smooth ride on the train. The metro train system has fixed stops and the distance between the stops are known. The system uses fuzzy logic in deciding the pressure applied on the brakes. The amount of pressure applied depends on the distance to the next stop and the speed of the train. Design appropriate membership functions for the input and illustrate the use of Mamdani Inference in arriving at the brake pressure.

Course Outcome 5(CO5):

1. A fuzzy systems needs to be designed to provide a rating for a web store as "excellent", "good" or "poor". The web store can be rated based on the products available, the customer service and the discount provided. Design appropriate membership functions and fuzzy rules for generating the fuzzy based rating system.
2. Design a fuzzy control system for an air-conditioning application. Make appropriate decisions regarding inputs and outputs.

Model Question Paper

QP CODE:

Reg No: _____________

Name:________________ **PAGES : 4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST454

Course Name: Fuzzy Set Theory and Applications

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Illustrate where a fuzzy logic based application is suitable.

2. Consider a LAN using Ethernet protocol with maximum bandwidth of 10 Mbps. Traffic rates can be represented using two fuzzy variables, Quiet and Congested. Ifthe universal set X = {0,1,2,3,4,5,6,7,8,9,10} represents bandwidth usage in Mbps, then draw possible membership functions for the fuzzy variables.

3. Define fuzzy tolerance and equivalence relations.

4. Given two data points, illustrate how a similarity measure between them can becomputed.

5. Define a convex normalized fuzzy set.

6. How does augmented query help in information retrieval.

7. Given the propositions

   (i) C ∨ D

   (ii) ~H => (A ∧ ~B)

   (iii) (C ∨ D) => ~H

   (iv) (A ∧ ~B) => (R ∨ S)

   Infer (R ∨ S) from the above propositions and state the tautologies used.

8. Write a predicate logic statement for “Ram likes all kinds of food”.

9. Given the relation R below, find λ-cut for the relation using suitable λ value.

$$\begin{bmatrix} 1 & 0.8 & 0 & 0.1 & 0.2 \\ 0.8 & 1 & 0.4 & 0 & 0.9 \\ 0 & 0.4 & 1 & 0 & 0 \\ 0.1 & 0 & 0 & 1 & 0.5 \\ 0.2 & 0.9 & 0 & 0.5 & 1 \end{bmatrix}$$

10. Define maximum approaching degree.

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) An engineer is testing the properties, strength and weight of steel. Suppose he has two fuzzy sets A, defined on the universe of three discrete strengths { s1, s2, s3 } and B, defined on the universe of discrete weights { w1, w2, w3}. **(4)**

Suppose A represents a "high-strength steel" and B a "near-optimum weight".

$$A = \left\{ \frac{1}{s1} + \frac{0.5}{s2} + \frac{0.2}{s3} \right\},\ B = \left\{ \frac{1}{w1} + \frac{0.5}{w2} + \frac{0.3}{w3} \right\}$$

Find fuzzy Cartesian product, R, of A and B.

(b) Let a fuzzy set $C = \left\{ \frac{0.1}{s1} + \frac{0.6}{s2} + \frac{1}{s3} \right\}$ be introduced, which represents a set of "moderately good" steel strength. Find the max-min composition of C and R. **(5)**

(c) Define 5 operations associated with crisp relations. **(5)**

OR

12. (a) How is excluded middle axiom different for crisp and fuzzy sets? **(4)**

(b) Differentiate between crisp and fuzzy sets with respect to their membershipfunctions. **(4)**

(c) Illustrate any 4 operations associated with a fuzzy relation. **(6)**

13. (a) A structural designer is considering four different kinds of structural beams { S1, S2, S3, S4} for a new building. Laboratory experiments on the deflection resistance for these four kinds of beams have been performed, and the engineer wants to determine their suitability in the new structure. The following data have been observed based on the overall deflection capacity ofeach beam type: **(10)**

		S1	S2	S3	S4
No deflection	X_1	0.3	0.6	0.5	0.8
Some deflection	X_2	0.6	0.3	0.5	0.2
Excessive deflection	X_3	0.1	0.1	0	0

Use cosine amplitude method to determine the similarity of the four beamtypes.

(b) Given a fuzzy set "tall" = $\left\{\frac{0.1}{s1} + \frac{0.6}{s2} + \frac{1}{s3}\right\}$, illustrate how the fuzzy set "very tall" be defined? **(4)**

OR

14. (a) Define tolerance and equivalence relations. Check whether the relation Rgiven below is tolerance or equivalence relation. **(4)**

$$\begin{bmatrix} 1 & 0.8 & 0 & 0.1 & 0.2 \\ 0.8 & 1 & 0.4 & 0 & 0.9 \\ 0 & 0.4 & 1 & 0 & 0 \\ 0.1 & 0 & 0 & 1 & 0.5 \\ 0.2 & 0.9 & 0 & 0.5 & 1 \end{bmatrix}$$

(b) Given the following data regarding three cities and the quality of their bridges, find the similarity between the cities using max-min method. **(10)**

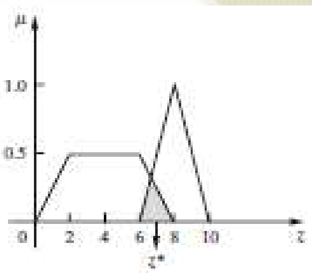
		C1	C2	C3
Poor	Q_1	0.00	0.10	0.10
Fair	Q_2	0.04	0.04	0.08
Good	Q_3	0.02	0.04	0.06

15. (a) Explain the process of developing membership functions using the inference method. **(6)**

(b) The following raw data were determined in a pair wise comparison of new premium car preferences in a poll of 100 people. When it was compared with a Porsche (P), 79 of those polled preferred a BMW (B), 85 preferred a Mercedes (M), 59 preferred a Lexus (L), and 67 preferred an Infinity (I). When a BMW was compared, the preferences were 21 – P, 23 – M, 37 – L, and 45 – I. When a Mercedes was compared, the preferences were 15 – P, 77 – B, 35 – L, and 48 – I. When a Lexus was compared, the preferences were 41 – P, 63 – B, 65 – M, and 51 – I. Finally, when an Infinity was compared, the preferences were 33 – P, 55 – B, 52 – M, and 49 – L. Using rank ordering, plot the membership function for "most preferred car." **(8)**

OR

16. (a) **1.** Defuzzify the following region using centroid method. **(9)**



(b) 2. Defuzzify the region given in 16(a) using weighted average method. **(5)**

17. (a) For a distillation process, the objective is to separate components of a mixture in the input stream. The relationship between the input variable, temperature, and the output variable, distillate fractions, is not precise but the human operator of this process has developed an intuitive understanding of this relationship. The universe for each of these variables is **(8)**

X = universe of temperatures (degree fahrenheit) = {160, 165, 170, 175, 180, 185, 190, 195}.

Y = universe of distillate fractions (percentage) = {77, 80, 83, 86, 89, 92, 95, 98}.

Given two fuzzy sets

A = "temperature of input steam is hot" = $\left\{ \frac{0}{175} + \frac{0.7}{180} + \frac{1}{185} + \frac{0.4}{190} \right\}$

B = "separation of mixture is good" = $\left\{\frac{0}{89} + \frac{0.5}{92} + \frac{0.8}{95} + \frac{1}{98}\right\}$.

Find the fuzzy relation corresponding to " IF x is $\tilde{A}$ THEN y is $\tilde{B}$

(b) Show how inference is done using Generalized Modus Ponens **(6)**

OR

18. (a) Illustrate how graphical inference is done using Mamdani method. **(6)**

(b) A restaurant uses a fuzzy inference system to calculate the tips given to its employees. The tips are based on the timeliness of service and quality of service of the waiters. Design appropriate membership functions for the inputand illustrate the use of Sugeno Inference in arriving at the tip amount. **(8)**

19. (a) Explain fuzzy pattern recognition using multiple features. **(7)**

(b) Describe how fuzziness in information retrieval can enhance the quality ofsearch results. **(7)**

OR

20. (a) Design a fuzzy control system for an air-conditioning system. **(7)**

(b) Illustrate how the join operation is performed in fuzzy databases. **(7)**

Teaching Plan

No	CONTENTS	No. of Lecture Hours (36 hrs)
	Module-1(Basic Fuzzy Set Theory) (6 hours)	
1.1	Introduction to Fuzzy Concepts – Case for imprecision- utility and limitations of Fuzzy Systems	1 hour
1.2	Classical Sets – Properties, Operations	1 hour
1.3	Fuzzy Sets – Properties, Operations	1 hour
1.4	Classical Relations – Properties, Operations – Cartesian Product,	1 hour
	Composition	
1.5	Fuzzy Relations – Properties, Operations, Cardinality	1 hour
1.6	Fuzzy Cartesian Product, Fuzzy Composition	1 hour
	Module-2 (Fuzzy Membership Functions) (6 hours)	
2.1	Tolerance and Equivalence Relations - Crisp	1 hour
2.2	Tolerance and Equivalence Relations - Fuzzy	1 hour
2.3	Similarity Methods – Cosine, Minmax	1 hour
2.4	Fuzzy Membership Functions- Features	1 hour
2.5	Fuzzification, Defuzzification to crisp sets – λ-cuts	1 hour
2.6	Linguistic Hedges	1 hour
	Module-3 (Fuzzification and Defuzzification Methods) (7 hours)	
3.1	Development of Membership Functions – Intuition, Inference	1 hour
3.2	Development of Membership Functions – Rank Ordering	1 hour
3.3	Development of Membership Functions – Inductive reasoning	1 hour

3.4	Defuzzification – Max membership principle, weighted average method, mean max membership	1 hour
3.5	Defuzzification – Centroid method	1 hour
3.6	Defuzzification – Center of Sums, Center of Largest area, First/Last of maxima	1 hour
3.7	Defuzzification - exercises	1 hour
Module-4 (Fuzzy Inference) (9 hours)		
4.1	Classical Logic – Propositional Logic	1 hour
4.2	Classical Logic – Predicate Logic	1 hour
4.3	Fuzzy Logic	1 hour
4.4	Fuzzy Approximation based reasoning	1 hour
4.5	Fuzzy Rule based systems	1 hour
4.6	Multiple conjunctive and disjunctive antecedents, aggregation	1 hour
4.7	Graphical Techniques for Inference	1 hour
4.8	Illustration of Graphical Techniques for Inference	1 hour
4.9	Fuzzy Inference - Exercises	1 hour
Module-5 (Fuzzy Applications) (8 hours)		
5.1	Fuzzy Control Systems	1 hour
5.2	Illustration of Fuzzy Control Systems	1 hour
5.3	Fuzzy Classification	1 hour
5.4	Fuzzy Pattern Recognition	1 hour
5.5	Fuzzy Systems and Neural Networks	1 hour
5.6	Fuzzy Clustering	1 hour
5.7	Fuzzy Databases	1 hour
5.8	Fuzzy Information Retrieval Systems	1 hour

AMT 464	SOCIAL AND INFORMATION NETWORKS	Category	L	T	P	Credit
		Program Elective III	2	1	0	3

Preamble:

By the end of the course, students should have a solid understanding of the significance and applications of social network analysis. They should be able to comprehend and analyze social networks using appropriate terminology, grasp the fundamentals of graph theory and network representation, and visualize and explore networks to gain insights into their structure and characteristics. They should be able to apply community detection algorithms and modularity optimization techniques to identify and analyze communities in networks.

Prerequisite: Nil.

Mapping of course outcomes with program outcomes

CO1	Understand the significance and applications of social network analysis in various domains, and demonstrate knowledge of the fundamental concepts and terminology used in social network analysis.**(Cognitive Knowledge Level: Understand)**
CO2	Explain the basic terminology and concepts of graph theory in the context of social networks, as well as understand the fundamental concepts of network formation and random graph models.**(Cognitive Knowledge Level: Understand)**
CO3	Explain the concept of centrality in social networks and its significance in identifying influential nodes.**(Cognitive Knowledge Level: Understand)**
CO4	Apply network analysis techniques to model and analyze markets and incentives in networks, as well as apply resilience analysis techniques to identify critical nodes and edges in a network.**(Cognitive**

	Knowledge Level: Apply)
CO5	Understand the concept of communities in networks and their importance in social network analysis.**(Cognitive Knowledge Level: Understand)**
CO6	Apply data mining techniques to extract meaningful insights and patterns from network data.**(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO8	PO 9	PO 10	PO1 1	PO 12
CO1	✓											✓
CO2	✓	✓										✓
CO3	✓	✓										✓
CO4	✓	✓	✓	✓								✓
CO5	✓	✓		✓								✓
CO6	✓	✓	✓	✓								✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability

PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks (%)**
	Test 1 (%)	**Test 2 (%)**	
Remember			
Understand	**70**	**50**	**50**
Apply	**30**	**50**	**50**
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Continuous Assessment Tests(Average of Internal Tests1&2) **25 marks**

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

SYLLABUS

Module – 1 (Introduction to Social Network Analysis and Graph Theory)

Introduction to Social Network Analysis - Overview of social networks and their importance, Basic network terminology and concepts. Graph Theory and Network Basics: Graph representation and terminology, Types of networks- directed, undirected, weighted, Network visualization and exploration.

Module - 2(Random Graphs and Centrality Measure)

Measures of Centrality and Influence: Degree centrality and eigenvector centrality, Betweenness centrality and closeness centrality, Hubs and authorities. Network Formation and Random Graphs: Random graph models: Erdos-Renyi and preferential attachment, Small-world networks and the Watts-Strogatz model, Scale-free networks and the Barabasi-Albert model

Module - 3 (**Game Theory, Strategic and Cascading Behaviour in Networks**)

Cascading Behavior in Networks: Diffusion and contagion in networks, Threshold models and cascades, Influence maximization and viral marketing. Game Theory and Strategic Behavior: Strategic interactions on networks, Network games and the prisoner's dilemma, Evolutionary game theory and network effects.

Module - 4 (**Markets and Incentives in Networks**)

Markets and Incentives in Networks- The influence of network structure on market dynamics, Information cascades and herding behavior, Network externalities and network markets. Network Resilience and Robustness- Vulnerability and robustness of networks, Attack strategies and network resilience, Cascading failures and network recovery.

Module - 5 (**Communities and Data Analysis and Mining in Networks**)

Communities and Clustering in Networks- Community detection algorithms, Modularity optimization, Structural balance and triadic closure. Network Data Analysis and Mining- Data collection and pre-processing techniques, Link prediction and recommendation systems, Visualization and analysis of large-scale networks

Text Books

1. Wasserman, Stanley, and Katherine Faust. "Social network analysis: Methods and applications." (1994).
2. Easley, David, and Jon Kleinberg. Networks, crowds, and markets: Reasoning about a highly connected world. Cambridge university press, 2010.
3. Jackson, Matthew O. Social and economic networks. Vol. 3. Princeton: Princeton university press, 2008.

ReferenceBooks

1. Kadushin, Charles. Understanding social networks: Theories, concepts, and findings. Oxford university press, 2012.

Course Level Assessment Questions

Course Outcome1 (CO1):

1. Explain the significance of social network analysis in various domains and provide examples of its applications in real-world scenarios.
2. Define the fundamental concepts of social network analysis, including nodes, edges, and ties. Illustrate these concepts with a practical example.
3. Describe the role of social network analysis in understanding information flow and influence within a network. Provide an example to support your explanation.
4. Provide an overview of the key measures used in social network analysis, such as degree centrality and betweenness centrality. Explain how these measures help in identifying important nodes within a network.
5. Describe the concept of network motifs in social network analysis. Discuss their significance in uncovering recurring patterns and understanding network dynamics.
6. Discuss the process of network data collection and the challenges associated with it. Explain the importance of data pre-processing in social network analysis.

Course Outcome 2(CO2):

1. Define and explain the basic terminology of graph theory in the context of social networks. Illustrate your explanation with a simple example of a social network graph.
2. Explain the concept of nodes and edges in the context of graph theory and how they relate to individuals and relationships in social networks.
3. Discuss the concept of clustering coefficient in graph theory and its significance in identifying tightly-knit groups or communities in social networks.

4. Explain the concept of network formation and its role in understanding the emergence and evolution of social networks. Provide examples of real-world scenarios where network formation principles apply.
5. Describe the small-world phenomenon and its relevance to social networks. Explain the Watts-Strogatz model and how it captures the characteristics of small-world networks.
6. Explain the concept of scale-free networks and the Barabási-Albert model. Discuss the mechanisms behind the formation of scale-free networks and their implications in social network analysis.

Course Outcome 3(CO3):

1. Discuss the importance of studying network structure in social network analysis. Explain the concepts of density, centrality, and clustering coefficient in relation to network analysis.
2. Define centrality in the context of social networks and explain its significance in understanding network dynamics and identifying influential nodes.
3. Discuss the concept of degree centrality and its role in measuring node importance in a social network. Provide an example to illustrate your explanation.
4. Explain the concept of betweenness centrality and how it identifies nodes that control information flow in a social network. Discuss its applications in real-world scenarios.
5. Discuss the concept of degree centrality and its role in measuring node importance in a social network. Provide an example to illustrate your explanation.
6. Explain the concept of betweenness centrality and how it identifies nodes that control information flow in a social network. Discuss its applications in real-world scenarios.

Course Outcome 4(CO4):

1. Define network analysis techniques and their application in modeling and analyzing markets and incentives in networks. Provide examples to support your explanation.
2. Explain the concept of resilience analysis and its relevance in identifying critical nodes and edges in a network. Discuss why this analysis is important in understanding network robustness.
3. Discuss the role of network analysis techniques in uncovering market dynamics and understanding the influence of network structure on market behavior. Provide real-world examples to illustrate your explanation.
4. Imagine you have a social network representing a market. Apply network analysis techniques to identify influential nodes that can potentially drive market behavior. Justify your choices based on the analysis results.
5. Design a recommendation system for an online social network based on network analysis principles. Explain the techniques you would use and how they contribute to providing relevant recommendations to users.
6. Given a network representing a supply chain, apply resilience analysis techniques to identify critical nodes and edges that, if disrupted, would have the most significant impact on the entire network's functionality. Explain the implications of your findings for supply chain management.

Course Outcome 5(CO5):

1. Define the concept of communities in the context of social networks and explain their significance in social network analysis. Provide examples to support your explanation.
2. Discuss the characteristics of communities in social networks and how they contribute to understanding the structure and dynamics of

the network. Provide real-world examples to illustrate your explanation.

3. Describe the concept of modularity optimization and how it is used to partition a network into communities. Discuss its advantages and potential challenges.
4. Analyze a given social network and identify the communities present within it. Discuss the characteristics of each community and their implications for understanding the network.
5. Discuss the challenges and limitations in identifying communities in large-scale social networks. Provide strategies or techniques that can be employed to overcome these challenges.
6. Explain the concept of overlapping communities in social networks and their significance in capturing the multi-faceted nature of relationships. Provide examples to illustrate your explanation.

Course Outcome 6(CO6):

1. Given a social network dataset, apply data mining techniques to identify influential nodes or communities within the network. Explain the techniques you would use and interpret the insights obtained.
2. Given a large-scale network dataset, apply data mining techniques to detect anomalous behavior or outliers within the network. Describe the techniques you would employ and discuss the potential applications of identifying such anomalies.
3. Compare and contrast different data mining techniques commonly used in network analysis, such as clustering, classification, and link prediction. Discuss their respective strengths and limitations.

B TECH IN ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

MODEL QUESTION PAPER

QP CODE:

Reg No: _______________

Name: _________________ **PAGES : 4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: AMT 464

Course Name: Social andInformation Networks

Max.Marks:100

Duration: 3 Hours

PART A

Answer All Questions. Each Question Carries 3 Marks

1.	What is social network analysis?	
2.	Compare and contrast directed and undirected networks, highlighting their characteristics and applications.	
3.	Explain the concept of degree centrality and its significance in network analysis.	
4.	Explain the Erdos-Renyi model of random graph formation and discuss its properties.	
5.	Discuss the role of social norms and cooperation in network games and their implications.	

6.	Provide examples of real-world applications where network effects play a significant role.	
7.	Discuss the influence of network structure on market dynamics and provide example.	
8.	Explain the concept of network markets and how they differ from traditional markets.	
9.	Explain the process of data collection and pre-processing techniques for network analysis.	
10.	Discuss the challenges and considerations in collecting and handling large-scale network data.	**(10x3=30)**

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11.	(a)	Explain the significance of network visualization in social network analysis and discuss different visualization techniques.	**(9)**
	(b)	Provide an overview of the key metrics used in social network analysis.	**(5)**
		OR	
12.	(a)	Discuss the importance of social network analysis and its applications in various fields.	**(9)**
	(b)	What are the basic concepts and terminology used in social network analysis?	**(5)**

13.	(a)	Discuss the small-world phenomenon and explain how the Watts-Strogatz model generates small-world networks.	**(7)**
	(b)	Explain the concept of scale-free networks and the power-law degree distribution associated with them.	**(7)**
OR			
14.	(a)	Define eigenvector centrality and discuss its interpretation in terms of influence and importance.	**(7)**
	(b)	Describe the process of network evolution and growth in the Barabási-Albert model.	**(7)**
15.	(a)	Explain the concept of diffusion and contagion in networks and how it affects the spread of information or behaviors.	**(6)**
	(b)	Explain the concept of influence maximization and its applications in viral marketing strategies.	**(8)**
OR			
16.	(a)	Explain the concept of network formation games and how they contribute to the study of network evolution.	**(9)**
	(b)	Discuss the limitations and challenges in applying game theory to study strategic behavior in real-world networks.	**(5)**
17.	(a)	Explain the process of network recovery after cascading failures and the factors influencing it.	**(8)**
	(b)	Discuss the importance of network resilience in critical infrastructure systems	**(6)**

		OR	
18.	(a)	Explain how network topology and node characteristics affect network resilience.	**(6)**
	(b)	Discuss the role of redundancy and resilience strategies in enhancing network robustness.	**(8)**
19.	(a)	Discuss community detection algorithms in networks and explain how they identify clusters of nodes with similar connectivity patterns.	**(7)**
	(b)	Explain the concept of modularity optimization and its role in community detection.	**(7)**
		OR	
20.	(a)	Explain the concept of link prediction in network analysis and discuss common techniques used for link prediction.	**(7)**
	(b)	How can recommendation systems be built based on network analysis and mining techniques?	**(7)**

Teaching Plan

No	Contents	No. of Lecture Hours (35 hrs)
Module – 1 (Introduction to Social Network Analysis and Graph Theory) (5 hours)		
1.1	Introduction to Social Network Analysis	1 hour
1.2	Overview of social networks and their importance	1 hour
1.3	Graph Theory and Network Basics: Graph representation and terminology	1 hour
1.4	Types of networks- directed, undirected, weighted	1 hour
1.5	Network visualization and exploration.	1 hour
Module - 2(Random Graphs and Centrality Measure) (8 hours)		
2.1	Measures of Centrality and Influence: Degree centrality	1 hour
2.2	Eigenvector centrality	1 hour
2.3	Betweenness centrality and closeness centrality, Hubs and authorities.	1 hour
2.4	Random graph models: Erdős-Rényi and preferential attachment	2 hours
2.5	Small-world networks and the Watts-Strogatz model	1 hour

2.6	Scale-free networks and the Barabási-Albert model	2 hours
Module - 3 (Game Theory, Strategic and Cascading Behaviour in Networks) (7 hours)		
3.1	Cascading Behavior in Networks: Diffusion and contagion in networks	1 hour
3.2	Threshold models and cascades	2 hours
3.3	Influence maximization and viral marketing	1 hour
3.4	Game Theory and Strategic Behavior: Strategic interactions on networks	1 hour
3.5	Network games and the prisoner's dilemma	1 hour
3.6	Evolutionary game theory and network effects.	1 hour
Module - 4 (Markets and Incentives in Networks)(7 hours)		
4.1	Markets and Incentives in Networks- The influence of network structure on market dynamics	1 hour
4.2	Information cascades and herding behaviour	1 hour
4.3	Network externalities and network markets	1 hour
4.4	Network Resilience and Robustness- Vulnerability and robustness of networks	1 hour
4.5	Attack strategies and network resilience	2 hours
4.6	Cascading failures and network recovery.	1 hour
Module - 5 (Communities and Data Analysis and Mining in Networks) (8		

	hours)	
5.1	Communities and Clustering in Networks	1 hour
5.2	Community detection algorithms,	1 hour
5.3	Modularity optimization	1 hour
5.4	Structural balance and triadic closure	1 hour
5.5	Network Data Analysis and Mining- Data collection and pre-processing techniques	1 hour
5.6	Link prediction and recommendation systems	1 hour
5.7	Visualization and analysis of large-scale networks	2 hours

CST474	COMPUTER VISION	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PEC	2	1	0	3	2019

Preamble: 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.

Prerequisite: Nil

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. **(Cognitive Knowledge Level: Understand)**
CO2	Explain basic methods of computer vision related to multi-scale representation, edge detection, detection of other primitives, stereo, motion and object recognition. **(Cognitive Knowledge Level: Understand)**
CO3	Describe principles of Segmentation, Motion Segmentation and Classification **(Cognitive Knowledge Level: Understand)**
CO4	Select appropriate object Tracking and detection methods for computer vision applications **(Cognitive Knowledge Level: Understand).**
CO5	Implement a computer vision system for a specific problem **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔		✔									✔
CO2	✔		✔									✔
CO3	✔		✔									✔

CO4	✓		✓									✓
CO5	✓	✓	✓	✓	✓							✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks (%)**
	Test 1 (%)	**Test 2 (%)**	
Remember	**30**	**30**	**30**
Understand	**50**	**50**	**50**
Apply	**20**	**20**	**20**
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Continuous Assessment Tests(Average of Internal Tests1&2) **25 marks**

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

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

Reference Books

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 Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the relationship between coordinates involved in a pinhole camera imaging setup.
2. Explain the basic principle behind geometric camera calibration**.**
3. Describe how linear filters can be used for smoothing digital images.
4. How does normalised correlation help in matching patterns in images?

Course Outcome 2 (CO2):

1. Describe edge detection methods for computer vision.
2. List any five applications of object recognition.
3. Explain how the epipolar constraint simplifies the correspondence search between two stereo images.
4. List and explain the different methods used for binocular fusion.
5. Explain the different corner detection methods.

Course Outcome 3 (CO3):

1. Explain the principle of background subtraction.
2. Describe the watershed algorithm for image segmentation.
3. What is meant by optical flow? How can it be utilized for segmenting images?
4. Describe motion segmentation with layers.
5. What is overfitting in the context of classification?
6. Explain the principle behind classification of single images.

Course Outcome 4 (CO4):

1. Explain 'Mean Shift Algorithm' to track an object using matching.
2. Describe an algorithm to track a moving object (dynamic object).
3. Explain the sliding window method for object detection.
4. Assume that we have the dynamics

$$x_i \sim N(d_i x_{i-1}, \sigma_{d_i}^2)$$

$$y_i \sim N(m_i x_i, \sigma_{m_i}^2)$$

   a. $P(x_i|x_{i-1})$ is a normal density with mean $d_i x_{i-1}$ and variance $\sigma_{d_i}^2$. Whatis$(x_{i-1}|x_i)$?
   b. Show how to obtain a representation of $P(x_i|y_{i+1}, \ldots, y_N)$ usinga KalmanFilter.

Course Outcome 5(CO5):

1. Explain how to implement a computer vision system.
2. Illustrate a computer vision system with the help of a neat diagram.
3. Discuss the components of a computer vision system for object recognition.
4. Explain how activity recognition can be done using computer vision.
5. Illustrate a face recognition system with the help of a diagram.

Assignment Questions

6. Implement a voxel-based approach to visual hull construction.
7. Implement a computer vision system for object recognition.

Model Question Paper

QP CODE:

Reg No: _______________

Name: _________________ **PAGES : 3**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST474

Course Name: COMPUTER VISION

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1. State three properties of shift invariant linear systems.
2. Explain the term normalized correlation.
3. What is image rectification? Mention its significance?
4. Illustrate epipolar geometry and showepipolar lines and epipoles.
5. Explain the term flow model.
6. How does background subtraction help in segmenting an image?
7. What is a Kalman filter? Give its applications.
8. State any three simple tracking strategies.
9. State the goals of an object recognition system.
10. Explain the task of face recognition. **(10x3=30)**

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Demonstrate the relationship between a point in the world coordinate frame and its corresponding image point using camera parameters. **(9)**

(b) Show that convolving a function with a δ function simply reproduces the original function. **(5)**

OR

12. (a) What is linear filtering? Explain two applications of linear filtering to image processing. **(7)**

(b) Explain an application of normalised correlation to find patterns. **(7)**

13. (a) Show that smoothing an image and then computing the gradient is same as convolving an image with the derivative of a smoothing function. **(5)**

(b) State the epipolar constraint and derive its representations using the Essential matrix and the Fundamental matrix. **(9)**

OR

14. (a) Explain the algorithm for computing edges using gradients. **(9)**

(b) Define binocular fusion. Explain two local methods for binocular fusion. **(5)**

15. (a) Discuss the different interactive segmentation approaches. **(7)**

(b) What is meant by optical flow? How can it be utilized for segmenting images? **(7)**

OR

16. (a) Explain the Watershed algorithm. **(7)**

(b) How can we perform motion segmentation by parameter estimation? **(7)**

17. (a) Explain tracking algorithm using Kalman filtering. **(7)**

(b) Illustrate the tracking by detection algorithm. **(7)**

OR

18. (a) Explain the various kinds of errors in classification and the relationship between them. **(7)**

(b) What is overfitting and how does regularization help to minimise it? **(7)**

19. (a) Explain human activity recognition with appearance features. **(7)**

CSE (ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING)

(b) Describe the Sliding window method for detecting objects in images. **(7)**

OR

20. (a) Explain the principle of detecting faces in an image. **(7)**

(b) What are the various strategies for object recognition? **(7)**

Teaching Plan

No	Contents	No. of Lecture Hours (36hrs)
Module 1 Image Formation and Filtering (7)		
1.1	Geometric Camera model - Pinhole perspective	1
1.2	Geometric Camera model - Intrinsic Parameters	1
1.3	Geometric Camera model - Extrinsic Parameters	1
1.4	Geometric Camera Calibration – Linear Approach	1
1.5	Linear Filters and Convolution	1
1.6	Shift Invariant Linear Systems - Discrete convolution	1
1.7	Normalized Correlation and Finding patterns	1
Module 2 Local Image Features and Stereo Vision (8)		
2.1	Local Image Features - Computing the Image Gradient	1
2.2	Gradient Based Edge Detection	1
2.3	Gradient Based Corner Detection	1
2.4	Stereopsis - Binocular Camera Geometry and Epipolar Constraint	1
2.5	Essential Matrix and Fundamental Matrix	1
2.6	Binocular Reconstruction	1
2.7	Local Methods for Binocular Fusion	1
2.8	Global Methods for Binocular Fusion	1
Module 3 Segmentation (6)		

3.1	Segmentation basics	1
3.2	Applications - Background Subtraction, Interactive Segmentation	1
3.3	Forming Image Regions	1
3.4	Segmentation by clustering - The Watershed Algorithm	1
3.5	Motion Segmentation by Parameter Estimation - Optical Flow and Motion	1
3.6	Flow Models and Motion Segmentation with Layers	1
Module 4 Classification and Tracking (8)		
4.1	Classification Basics, Two-class and Multiclass classifier	1
4.2	Error, Overfitting and Regularization	1
4.3	Cross Validation, Classifying Images of Single Objects	1
4.4	Tracking Basics, Simple Tracking Strategies	1
4.5	Tracking by detection	1
4.6	Linear Dynamical models	1
4.7	The Kalman Filter background	1
4.8	Kalman filter algorithm	1
Module 5 Finding Objects and other Applications (7)		
5.1	Detecting Objects in Images- The Sliding Window Method	1
5.2	Object Recognition - Goals of Object Recognition System	1
5.3	Application of binocular stereo vision - Robot Navigation	1
5.4	Face detection	1
5.5	Face recognition	1
5.6	Activity recognition	1
5.7	Tracking people	1

SEMESTER VIII

PROGRAM ELECTIVE IV

AMT 416	HUMAN COMPUTER INTERACTION	CATEGORY	L	T	P	CREDIT
		Program Elective IV	2	1	0	3

Preamble:.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.

Prerequisite: Skill in any programming language. Exposure to web designing is preferred.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Describe the usability based on a variety of classic universal user-centric models. **(Cognitive Knowledge level: Understand)**
CO 2	Comprehend the different interaction styles and the methodologies for designing interactive systems. **(Cognitive Knowledge level: Understand)**
CO 3	Investigate the core and complex user experience design issues. **(Cognitive Knowledge level: Understand)**
CO 4	Examine the evaluation methodologies of interactive system design. **(Cognitive Knowledge level: Apply)**
CO 5	Explore the different contexts and suggest suitable designs for applications related to web, mobile and wearable computing. **(Cognitive Knowledge level: Apply)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO 1	✔	✔	✔	✔								✔
CO 2	✔	✔	✔	✔								✔
CO 3	✔	✔	✔	✔		✔						✔
CO 4	✔	✔	✔	✔	✔							✔
CO 5	✔	✔	✔	✔	✔	✔						✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication

PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks**
	Test1 (percentage)	**Test2 (percentage)**	
Remember	20	20	20
Understand	60	60	60
Apply	20	20	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance: **10 marks**

Continuous Assessment Tests :**25 marks**

Continuous Assessment Assignment: **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

SYLLABUS

Module -1(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.

Module -2 (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.

Module -3 (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

Module -4 (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.

Module -5 (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 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.

Text Book

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

Reference Books

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

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What are the general principles of user interface design?
2. How can designers encourage novice users to use a system?
3. Define user interface. List and explain the benefits of good design.

Course Outcome 2 (CO2):

1. Design a touch screen music jukebox, which allows the user to select from a
   menu of the five most popular songs of the week. Draw a sketch of this interface for each of the following menu types—binary menu, multiple-item menu, check boxes, pull-down menus. Argue which design serves the user best.
2. List several situations when command languages can be attractive for users.

Course Outcome 3(CO3):

1. Explain how data visualization caters to the perceptual abilities of humans.
2. Demonstrate the five stage framework in designing the advanced search interface.

Course Outcome 4 (CO4):

1. Discuss the GOMS Model
2. Explain how Fitt's Law predictive model has been influential in HCI and Interaction design.

Course Outcome 5 (CO5):

3. Distinguish between GUI and Web user interface.
4. List the issues faced for cooperative working.

Model Question paper

			Total Pages: 2
Reg No.:__________			**Name:**________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: AMT 416

Course Name: HUMAN COMPUTER INTERACTION

Max. Marks: 100 | **Duration: 3 Hours**

PART A

		Answer all questions, each carries 3 marks.	Marks
1		Define Principles, Standards, Guidelines and Rules.	(3)
2		Explain the term Universal Usability.	(3)
3		Prototyping will solve all problems associated with user interface design. Justify this statement.	(3)
4		List the three principles of direct manipulation.	(3)
5		Describe frustrating experiences.	(3)
6		List any three reasons for using animation in display design.	(3)
7		Explain how Fitt's Law predictive model has been influential in HCI and Interaction design.	(3)
8		Coordination is a task concept that describes how information objects change based on user actions. Cite any two coordination that should be supported by interface designers.	(3)
9		Discuss any three principles of designing rich web interface.	(3)
10		Summarize three guidelines for developing applications for pocket PCs.	(3)

PART B

Answer any one full question from each module, each carries 14 marks.			
		Module I	
11	a)	Explain the relationship between the user experience and usability.	(7)
	b)	Describe user-centered design. What are its benefits?	(7)
		OR	
12	a)	Explain the difference between good and poor interaction design.	(4)
	b)	What is cognitive and perceptual ability? Discuss with an example cognitive perception.	(10)
		Module II	
13	a)	Outline the various interface styles used in interactive systems.	(7)
	b)	Discuss the obstacles to speech recognition and production.	(7)
		OR	
14	a)	Data entry is challenging for small devices. Explain the ways in which this issue can be addressed?	(7)
	b)	Explain the different phases involved in an interactive design process.	(7)
		Module III	
15	a)	How do rule and heuristics help interface designers in taking account of cognitive psychology? Illustrate your answer with the design of Microsoft Office Word.	(8)
	b)	Discuss three human values that are necessary to be understood by interface designers in order to ensure a timely user experience. State any three system response time (SRT) guidelines.	(6)
		OR	
16	a)	Explain how data visualization caters to the perceptual abilities of humans.	(9)
	b)	Colour displays are attractive to users and can often improve task performance, but the danger of misuse is high. List five guidelines for using colour and give an example of each.	(5)

		Module IV	
17	a)	What is meant by design evaluation? Describe the approaches to expert analysis.	(8)
	b)	What is a cognitive model? Classify cognitive models and discuss the same.	(6)
		OR	
18	a)	How are download delays masked by well-designed websites?	(7)
	b)	Discuss the GOMS Cognitive task analysis model.	(7)
		Module V	
19	a)	List and explain the key attributes of wearable computing.	(8)
	b)	Describe how the UCAMP framework helps designers of wearable systems to focus on the key design issues.	(6)
		OR	
20	a)	Illustrate any two applications of agent-based interaction.	(8)
	b)	Describe the main types of technologies that support cooperative working.	(6)
		****	

Teaching Plan

	Topics	No. of Lecture Hours (36 Hours)
Module -1 (Introduction to HCI and Usability)		**(8 hours)**
1.1	Introduction- - Components of Interaction – Ergonomics	1 hour
1.2	Designing Interactive systems – Understanding Users cognition and cognitive frameworks	1 hour
1.3	User Centered approaches, Usability goals and measures	1 hour
1.4	Universal Usability	1 hour
1.5	Diverse Cognitive and Perceptual abilities	1 hour
1.6	Personality differences, Cultural and International diversity,	1 hour
1.7	Users with disabilities- Older Adult users and Children.	1 hour
1.8	Guidelines, Principles and Theories.	1 hour
Module -2 Design Process and Interaction Styles		**(6 hours)**
2.1	HCI patterns, Design frameworks. Design considerations.	1 hour
2.2	Understanding interaction styles- Direct Manipulation and Immersive environments,	1 hour
2.3	Fluid navigation -Navigation by Selection, Small Displays, Content Organization	1 hour
2.4	Expressive Human and Command Languages-Speech Recognition, Traditional Command Languages	1 hour
2.5	Communication and Collaboration-Models of Collaboration	1 hour

2.6	Design methods, Prototyping	1 hour
Module -3 User Experience Design		**(7 hours)**
3.1	Frameworks for User Centric Computing	1 hour
3.2	Computational models of users,	1 hour
3.3	Advancing the User Experience- Display Design, View (Window) Management,	1 hour
3.4	Animation, Webpage Design, Color	1 hour
3.5	Timely user Experience-Models of System Response Time (SRT) Impacts, Frustrating Experiences.	1 hour
3.6	Information Search- Five Stage Search Framework,	1 hour
3.7	Data Visualization-Tasks in Data Visualization, Challenges	1 hour
Module -4 Cognitive Systems and Evaluation of HCI		**(7 hours)**
4.1	Cognitive Models- Goal and task hierarchies.	1 hour
4.2	GOMS Model.	1 hour
4.3	Introducing Evaluation- Types of Evaluation	1 hour
4.4	Other Issues to Consider When Doing Evaluation.	1 hour
4.5	Conducting Experiments	1 hour
4.6	Usability testing – Heuristic evaluation and walkthroughs	1 hour
4.7	Analytics and predictive models	1 hour
Module -5 Contexts for Designing UX		**(8 hours)**
5.1	Designing apps and websites – Website and app development	1 hour
5.2	The information architecture of apps and websites.	1 hour
5.3	Social media -Social Networking, Sharing with others.	1 hour
5.4	Collaborative environments- Issues for cooperative working, Technologies to support cooperative working	1 hour

5.5	AI and Interface Agents	1 hour
5.6	Ubiquitous computing -Blended Spaces.	1 hour
5.7	Mobile Computing – Designing for Mobiles.	1 hour
5.8	Wearable Computing- Smart Materials, Material Design.	1 hour

CST426	CLIENT SERVER ARCHITECTURE	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: The syllabus is prepared with the view of preparing the Engineering Graduates to build effective Client/Server applications. This course aims at providing a foundation in decentralized computer systems, using the client/server model. The course content is decided to cover the essential fundamentals which can be taught within the given slots in the curriculum.

Prerequisite: Computer Networks

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the basics of client/server systems and the driving force behind the development of client/server systems **(Cognitive Knowledge Level: Understand)**
CO 2	Outline the architecture and classifications of client/server systems **(Cognitive Knowledge Level: Understand)**
CO 3	Choose the appropriate client/server network services for a typical application **(Cognitive Knowledge Level: Understand)**
CO 4	Describe management services and issues in network **(Cognitive Knowledge Level: Understand)**
CO 5	Compare and summarize the web extensions and choose appropriate web services standards for an application **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✔	✔										✔
CO 2	✔	✔										✔

CO 3	✔	✔			✔							✔
CO 4	✔											✔
CO 5	✔	✔	✔									✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks**
	Test 1 (Marks)	**Test 2 (Marks)**	
Remember	30	30	30
Understand	70	70	50
Apply			

Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test 1 (for theory, for 2 hrs) : 20 marksContinuous Assessment Test 2 (for lab, internal examination, for 2hrs) : 20 marks

Internal Examination Pattern: There will be two parts; Part A and Part B. Part A contains 5 questions with 2 questions from each module (2.5 modules x 2 = 5), having 3 marks for each question. Students should answer all questions. Part B also contains 5 questions with 2 questions from each module (2.5 modules x 2 = 5), of which a student should answer any one. The questions should not have sub- divisions and each one carries 7 marks.

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the driving forces behind the development of Client/ Server system from different perspectives.

Course Outcome 2 (CO2):

1. How two-tier computing and three-tier computing improves the performance of Client/Server system.

Course Outcome 3(CO3):

1. Explain the role of client in Client/Server computing and also explain the various services provided by client.
2. What is the primary motivation behind the RPC facility ? How does a RC facility makes the job of distributed application programmers simpler?
3. Implement RPC concept using suitable language/tool(Assignment)

Course Outcome 4 (CO4):

1. Explain Connectivity and Communication Interface Technology in Client/Server application. How does transmission protocol work in Client/Server application?

Course Outcome 5 (CO5):

1. Discuss the role of web browser for providing web service in Client/Server environment.
2. Identify and explain the social relevance of web services (Assignment)

SYLLABUS

Module – 1 (Introduction)

Introduction to Client/Server computing - Driving forces behind Client/ Server, Client/ Server development tools, Development of client/server systems, Client/Server security, Organizational Expectations, Improving performance of client/server applications, Single system image, Downsizing and Rightsizing, Advantages of client server computing, Applications of Client/Server.

Module -2 (Client/Server Application Components)

Classification of Client/Server Systems- Two-Tier Computing, Middleware, Three-Tier Computing- Model View Controller (MVC), Principles behind Client/Server Systems. Client/Server Topologies. Existing Client/Server Architecture. Architecture for Business Information System.

Module -3 (Client/Server Network)

Client- Services, Request for services, RPC, Windows services, Print services, Remote boot services, other remote services, Utility Services. Dynamic Data Exchange (DDE). Object Linking and Embedding (OLE). Common Object Request Broker Architecture(CORBA).

Server- Detailed server functionality, Network operating system, Available platforms,Server operating system.

Module -4 (Client/ Server Systems Development)

Services and Support- System administration, Availability, Reliability, Scalability, Observability, Agility, Serviceability. Software Distribution, Performance, Network management. Remote Systems Management- RDP, Telnet, SSH, Security. LAN and Network Management issues, Training, Connectivity, Communication interface technology, Interprocess communication, Wide area network technologies, Network Acquisition, PC-level processing unit, X-terminals, Server hardware.

Module -5 (Client/Server Technology and Web Services)

Web Services History. Web Server Technology- Web Server, Web Server Communication, Role of Java for Client/Server on Web. Web Services-MicroServices, APIs, API Gateway, Authentication of users/clients, Tokens/Keys for Authentication, Service Mesh, Message Queues, SaaS, Web Sockets.

Client/Server/Browser – Server Technology, Client/Server Technology and Web Applications, Balanced Computing and the Server's Changing Role. Thin client computing

- Computing models-Comparison-Computing Environment.

Future of client/ server Computing Enabling Technologies, Transformational system.

Text Books

1. Patrick Smith & Steave Guengerich, "Client / Server Computing", PHI
2. Dawna Travis Dewire, "Client/Server Computing", TMH

Reference Books

1. Jeffrey D.Schank, "Novell's Guide to Client-Server Application & Architecture" NovellPress
2. Robert Orfali, DanHarkey, Jeri Edwards, Client/Server Survival Guide, Wiley-India Edition, Third Edition
3. W. H. Inman, Developing Client Server Applications, BPB

Model Question Paper

QP CODE:

Reg No: ___________

Name:________________ **PAGES : 4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST426

Course Name : Client Server Architecture

Max. Marks : 100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1. How client/server computing environment is different from mainframe basedcomputing environment?
2. Write short notes on single system image and downsizing.
3. Discuss the topologies of Clients/Server system with suitable examples.
4. Discuss the relevance of Clients/Server system in adopting open system standards.Justify your answer.
5. Enumerate the services provided in a client/server system.
6. List out the features of network operating system.
7. How interposes communication is established?.
8. Write short note on x-terminals.
9. Explain the history of web services.

10.		With an example, explain the role of java for client/server on web	**(10x3= 30)**

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11.	(a)	Explain the driving forces behind the development of Client/ Server system from different perspectives.	**(10)**
	(b)	Explain the various Clients/Server system development tools.	**(4)**
		OR	
12.	(a)	Explain Client/Server System development methodology and explain various phases and their activities involved in System Integration Life Cycle.	**(10)**
	(b)	Write short notes on the following. (a) Single system image. (b) Downsizing and Client/Server computing.	**(4)**
13.	(a)	How two-tier computing and three-tier computing improves the performance of Client/Server system.	**(10)**
	(b)	List out the principles behind client/server systems .	**(4)**
		OR	
14.	(a)	Explain the architecture of Business Information System.	**(10)**
	(b)	Explain different ways to improve performance in Client/Server developed applications.	**(4)**
15.	(a)	In Client/Server computing, explain the following with example in detail (a) Dynamic Data Exchange (b) RPC (c) Remote Boot Service (d) Object-linking and embedding.	**(10)**

	(b)	Explain the role of client in Client/Server computing and also explain thevarious services provide by client.	**(4)**

OR

16.	(a)	Explain the architecture of CORBA.	**(10)**
	(b)	Explain the server functionality in detail, for Client/Server computing.	**(4)**
17.	(a)	Explain Connectivity and Communication Interface Technology in Client/Server application. How does transmission protocol work in Client/Server application?	**(10)**
	(b)	Comment on the network service acquisition mechanism for the client/servicemodel.	**(4)**

OR

18.	(a)	In client server architecture, what do you mean by Availability, Reliability,Serviceability and Security? Explain with examples	**(10)**
	(b)	How remote systems management security is ensured in a Client/Serverapplication.	**(4)**
19.	(a)	What is the future of Client/Server computing in the following technologies (i) Electronic Document Management. (ii) Full Text Retrieval. (iii)Geographic Information System.	**(10)**
	(b)	Discuss the role of web browser for providing web service in Client/Serverenvironment.	**(4)**

OR

20.	(a)	Explain end-to-end working of Client/Server web model.	**(10)**

(b) Explain the architecture of Transformational system. **(4)**

Teaching Plan

Sl No	Contents	No. of Lecture Hours (35)
	Module- 1(Introduction) (7 hours)	
1.1	Driving forces behind Client/ Server	1 hour
1.2	Client Server development tools	1 hour
1.3	Development of client/server systems	1 hour
1.4	Client/Server security, Organizational Expectations	1 hour
1.5	Improving performance of client/server applications	1 hour
1.6	Single system image, Downsizing and Rightsizing	1 hour
1.7	Advantages and Applications of client server computing	1 hour
	Module- 2(Client/Server Application Components) (8 hours)	
2.1	Classification of Client/Server Systems	1 hour
2.2	Open System Standards	1 hour
2.3	Two-Tier Computing	1 hour

2.4	Three-Tier Computing, Middleware	1 hour
2.5	Principles behind Client/Server Systems	1 hour
2.6	Client/Server Topologies	1 hour
2.7	Existing Client/Server Architecture	1 hour
2.8	Architecture for Business Information System	1 hour
Module- 3(Client/Server Network) (6 hours)		
3.1	The client: Services, Request for services, RPC, Windows services, Printservices	1 hour
3.2	Remote boot services, Utility Services & Other Services	1 hour
3.3	Dynamic Data Exchange (DDE), Object Linking and Embedding (OLE)	1 hour
3.4	Common Object Request Broker Architecture (CORBA)	1 hour
3.5	The server: Detailed server functionality, the network operating system	1 hour
3.6	Available platforms, the server operating system	1 hour
Module- 4(Client Server Systems Development) (7 hours)		
4.1	Services and Support, System administration	1 hour
4.2	Availability, Reliability, Scalability, Observability, Agility Serviceability,Software Distribution, Performance	1 hour
4.3	Network management, Remote Systems Management, RDP,Telnet,SSH	1 hour
4.4	Security ,LAN and Network Management issues	1 hour

4.4	Training, Connectivity, Communication interface technology	1 hour
4.5	Interposes communication, wide area network technologies	1 hour
4.6	Network Acquisition, PC-level processing unit, x-terminals, server Hardware	1 hour
	Module -5(Client/Server Technology And Web Services) (7 hours)	
5.1	Web Services History , Web Server Technology , Web Server	1 hour
5.2	Web Server Communication , Role of Java for Client/Server on Web	1 hour
5.3	Web Services , MicroServices, APIs, API Gateway, Authentication ofusers/clients	1 hour
5.4	Tokens/Keys for Authentication ,Service Mesh, Message Queues	1 hour
5.5	SaaS, Web Sockets ,Client/Server Technology and Web Applications	1 hour
5.6	Balanced Computing and the Server's Changing Role ,Thin client computing ,Computing models, Computing Environment	1 hour
5.7	Future of client/ server Computing Enabling Technologies, Transformationalsystem	1 hour

CST436	PARALLEL COMPUTING	CATEGORY	L	T	P	CREDIT
		Program Elective IV	2	1	0	3

Preamble: This course helps the learners to understand basic and advanced concepts of parallel computing. It covers Principles of Parallel Algorithm Design, Communication operations, Programming Using the Message Passing Paradigm, Programming Shared Address Space Platforms Thread Basics, and GPU Programming. This course enables a learner to design solutions to complex real world problems using parallel computing paradigms including thread parallelism, shared memory program, message passing interfaces, and vector processing.

Prerequisite: Knowledge in Computer Organization and Architecture.

Course Outcomes: After the completion of the course the students will be able to

CO1	Summarize the key parallel computational models **(Cognitive Knowledge Level :Understand)**
CO2	Appreciate and apply parallel and distributed algorithms in problem Solving **(Cognitive Knowledge Level :Apply)**
CO3	Appreciate the communication models for parallel algorithm development (**Cognitive Knowledge Level : Understand**)
CO4	Develop parallel algorithms using message passing paradigm **(Cognitive Knowledge Level : Apply)**
CO5	Formulate parallel algorithms for shared memory architectures. **(Cognitive Knowledge Level : Apply)**
CO6	Demonstrate the fundamental skills of heterogeneous computing with GPUs**(Cognitive Knowledge Level : Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	✔	✔										✔
CO2	✔	✔	✔									✔
CO3	✔	✔										✔
CO4	✔	✔	✔	✔	✔							✔
CO5	✔	✔	✔	✔	✔							✔
CO6	✔	✔	✔	✔	✔							✔

Abstract POs Defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and teamwork
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance

PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Blooms Category	**Continuous Assessment Tests**		**End Semester Examination Marks**
	Test 1 (Percentage)	**Test 2 (Percentage)**	
Remember	30	20	20
Understand	50	40	40
Apply	20	40	40
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	**50**	**100**	**3 Hours**

Continuous Internal Evaluation Pattern:

Attendance	**10 marks**
Continuous Assessment Tests	**25 marks**
Continuous Assessment Assignment	**15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First Internal Examination shall be preferably conducted after completing the first half of the syllabus, and the Second Internal Examination shall be preferably conducted after completing the remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer anyone. Each question can have a maximum 2 subdivisions and carries 14 marks.

Syllabus

Module- 1 (Principles of Parallel Algorithm Design)

Basic Introduction to Parallel Processing platforms. Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, Parallel Algorithm Models.

Module- 2 (Communication Operations)

Basic Communication Operations - One-to-All Broadcast and All-to-One Reduction, All-to-All Broadcast and Reduction, All-Reduce and Prefix-Sum Operations, Scatter and Gather, All-to-All Personalized Communication, Circular Shift, Improving the Speed of Some Communication Operation

Module-3 (Programming Using the Message Passing Paradigm)

Principles of Message-Passing Programming, The Building Blocks: Send and Receive Operations, MPI: The Message Passing Interface, Overlapping Communication with Computation, Collective Communication and Computation Operations, Groups and Communicators.

Module 4 (Programming Shared Address Space Platforms Thread Basics)

Thread Basics, Why Threads? The POSIX Thread Application Programme Interface, Synchronization Primitives in POSIX, Controlling Thread and Synchronization Attributes, Thread Cancellation, Composite Synchronization Constructs, OpenMP: a Standard for Directive Based Parallel Programming, Specifying Concurrent Tasks in OpenMP, Synchronization Constructs in OpenMP, Data Handling in OpenMP, OpenMP Library Functions, OpenMP Applications: Parallel algorithm development for Matrix multiplication

Module 5 (GPU Programming)

Heterogeneous Parallel Computing, Architecture of a Modern GPU, Speeding up Real Applications, Data parallel computing, CUDA C Program Structure, A Vector Addition Kernel, Device Global Memory and Data Transfer, Kernel Functions and Threading, Kernel Launch, CUDA Thread Organization, Mapping Threads to Multidimensional Data, Synchronization and Transparent Scalability, Resource Assignment, Querying Device Properties, Thread Scheduling and Latency Tolerance, Importance of Memory Access Efficiency, Cuda Memory Types, Tiling for Reduced Memory Traffic, Tiled Matrix Multiplication Kernel, Boundary Checks

Text Books

1. Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, Introduction to Parallel Computing, 2nd Ed, Addison-Wesley, 2003
2. David B. Kirk, Wen-mei W. Hwu, Programming Massively Parallel Processors: A Hands-on Approach, 3rd Ed., Morgan Kaufman, 2016.

References

1. Steven Brawer, Introduction to Parallel Computing, Academic Press, (1989)
2. Barbara Chapman, Gabriele Jost, Ruud van der Pas, Using OpenMP: Portable Shared Memory Paralwlel Programming , MIT Press, 2008.
3. William Gropp, Ewing Lusk, Anthony Skjellum Using MPI: Portable Parallel Programming with the Message-Passing Interface, 3rd Ed, MIT Press, 2014.
4. Thomas Rauber, Gudula Rünger, Parallel Programming for Multicore and Cluster Systems, Springer, 2010

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Differentiate between static and dynamic task mapping
2. Explain partitioning of data with an example

Course Outcome 2 (CO2):

1. Explain the handshaking sequence of Blocking Non-Buffered Send/Receive operationwith a neat diagram.
2. In the algorithm, assume a decomposition such that each execution of Line 7 is a task. Draw a task-dependency graph and a task-interaction graph.

```
1. procedure FFT_like_pattern(A, n)
2. begin
3. m := log2 n;
4. for j := 0 to m - 1 do
5. k := 2j;
6. for i := 0 to n - 1 do
7. A[i] := A[i] + A[i XOR 2j];
8. end  // for
9. end     // FFT_like_pattern
```

Course Outcome 3 (CO3):

1. Write a procedure for performing all-to-all reduction on a mesh
2. Give a hypercube algorithm to compute prefix sums of n numbers if *p* is the number of nodes and n/p is an integer greater than 1. Assuming that it takes time t_{add} to add two numbers and time ts to send a message of unit length between two directly-connected nodes, give an exact expression for the total time taken by the algorithm.

Course Outcome 4(CO4):

1. Show how the two-dimensional matrix-vector multiplication program

needs to be changed so that it will work correctly for a matrix of size $n \times m$ on a $q \times r$ process grid

2. One of the advantages of non-blocking communication operations is that they allow the transmission of the data to be done concurrently with computations. Discuss the type of restructuring that needs to be performed on a program to allow for the maximal overlap of computation with communication. Is the sending process in a better position to benefit from this overlap than the receiving process

Course Outcome 5(CO5):

1. Implement a multi-access threaded queue with multiple threads inserting and multiple threads extracting from the queue. Use mutex-locks to synchronize access to the queue. Document the time for 1000 insertions and 1000 extractions each by 64 insertion threads (producers) and 64 extraction threads (consumers).
2. Implement a producer-consumer framework in OpenMP using sections to create a single producer task and a single consumer task. Ensure appropriate synchronization using locks.

Course Outcome 6 (CO6):

1. Consider a hypothetical block with 8 threads executing a section of code before reaching a barrier. The threads require the following amount of time (in microseconds) to execute the sections: 2.0, 2.3, 3.0, 2.8, 2.4, 1.9, 2.6, and 2.9 and to spend the rest of their time waiting for the barrier. What percentage of the total execution time of the thread is spent waiting for the barrier?
2. Write and explain the CUDA program for vector addition.

Model Question Paper

QP CODE: PAGES :3

Reg No: _______________

Name: _________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST436

Course Name: PARALLEL COMPUTING

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1.	Explain partitioning of data with an example	
2.	Which are the characteristics of tasks influencing the selection of mapping scheme?	
3.	Describe the scatter - gather communication.	
4.	Explain the Circular Shift operation.	
5.	Explain the handshaking sequence of Blocking Non-Buffered Send/Receiveoperation with a neat diagram.	
6.	Describe the six fundamental routines of MPI.	

7.		Explain thread cancellation.	
8.		Explain how concurrent tasks are specified in openMP	
9.		Explain the architecture of modern GPU with a diagram.	
10.		Describe how the data transfer between GPU device and the host memories aremanaged.	**(10x3=30)**
		Part B **(Answer any one question from each module. Each question carries 14 Marks)**	
11.	(a)	Describe recursive decomposition with an example.	**(8)**
	(b)	Compare various parallel algorithm models	**(6)**
		OR	
12	**(a)**	Differentiate between static and dynamic task mapping	**(8)**

	(b)	In the algorithm, assume a decomposition such that each execution of Line 7 is a task. Draw a task-dependency graph and a task-interaction graph.
		procedure FFT_like_pattern(A, n)
		begin
		m := log2 n;
		for j := 0 to m
		- 1 do5. k := j;
		for i := 0 to n - 1 do
		A[i] := A[i] + A[i XOR 2j];
			(6)

		end // for end // FFT_like_pattern	
13	**(a)**	Illustrate the All-to-All Broadcast and Reduction with an example	**(6)**
	(b)	Explain any three techniques to improve the speed of communication operations	**(8)**
		OR	
14	**(a)**	Explain the One-to-All Broadcast and All-to-One Reduction with an example	**(8)**
	(b)	Explain the Ring and Mesh techniques of All-to-All Personalized communication	**(6)**
15	**(a)**	Explain Collective Communication and Computation Operations in MPI	**(9)**
	(b)	Show the impact of finite buffers in message passing.	**(5)**
		OR	
16	**(a)**	Write algorithm for Collective Communication and Computation Operations using MPI.	**(9)**
	(b)	How is deadlock avoided in *MPI_Send* and *MPI_Recv*	**(5)**

17. (a) Explain how mutual exclusion for shared variables are accomplished in threads. **(6)**

(b) Explain the nesting of parallel directives with a suitable example. **(8)**

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18.	(a)	Explain the compilation operations of an example openMP program alongwith its *pThread* translations.	**(4)**
	(b)	Explain the parallel matrix multiplication using openMP	**(10)**
19.	(a)	Describe the CUDA Kernel functions.	**(6)**
	(b)	How is synchronization between CUDA threads achieved?	**(8)**

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20.	(a)	Explain the two-level hierarchical organization of CUDA threads.	**(10)**
	(b)	Write and explain the CUDA program for vector addition.	**(4)**

TEACHING PLAN

No	Contents	No of Lecture Hrs (37)
Module – 1 (Basic Introduction to Parallel Processing) (TB-1, Ch. 3) (7 hrs)		
1.1	Basic Introduction to Parallel Processing platforms. Preliminaries	1
1.2	Decomposition Techniques – Recursive, Data	1
1.3	Decomposition Techniques – Exploratory, Speculative, Hybrid	1
1.4	Characteristics of Tasks and Interactions	1
1.5	Mapping Techniques for Load Balancing -Static	1
1.6	Mapping Techniques for Load Balancing - Dynamic	1
1.7	Methods for Containing Interaction Overheads, Parallel Algorithm Models.	1
Module- 2 (Basic Communication Operations) (TB-1, Ch. 4) (6hrs)		
2.1	One-to-All Broadcast and All-to-One Reduction	1
2.2	All-to-All Broadcast and Reduction	1
2.3	All-Reduce and Prefix-Sum Operations, Scallter Gather	1
2.4	All-to-All Personalized Communication	1
2.5	Circular Shift	1
2.6	Improving the Speed of Some Communication Operation	1

Module- 3 (Programming Using the Message Passing Paradigm) (TB-1, Ch. 6) (7 hrs)		
3.1	Principles of Message-Passing Programming, The Building Blocks: Send and Receive Operations	1
3.2	MPI: The Message Passing Interface	1
3.3	MPI: The Message Passing Interface : Illustration	1
3.4	Overlapping Communication with Computation	1
3.5	Overlapping Communication with Computation : Illustration	1
3.6	Collective Communication and Computation Operations	1
3.7	Collective Communication and Computation Operations : Illustration	1
Module 4 (Programming Shared Address Space Platforms) (TB-1, Ch. 7, 8) (8hrs)		
4.1	Thread Basics, Why Threads? The POSIX Thread API	1
4.2	Synchronization Primitives in POSIX	1
4.3	Controlling Thread and Synchronization Attributes	1
4.4	Thread Cancellation, Composite Synchronization Constructs,	1
4.5	OpenMP: a Standard for Directive Based Parallel Programming	1
4.6	Specifying Concurrent Tasks in OpenMP, Synchronization Constructs in OpenMP	1
4.7	Data Handling in OpenMP, OpenMP Library Functions	1
4.8	OpenMP Applications: Parallel algorithm development for Matrix multiplication	1
Module 5 (GPU Programming) (TB-2, Ch. 1, 2) (9 hrs)		

5.1	Heterogeneous Parallel Computing, Architecture of a Modern GPU, Speedingup Real Applications	1
5.2	Data parallel computing – CUDA C Program Structure	1
5.3	Vector Addition Kernel, Device Global Memory and Data Transfer	1
5.4	Kernel Functions and Threading, Kernel Launch	1
5.5	CUDA Thread Organization, Mapping Threads to Multidimensional Data	1
5.6	Synchronization and Transparent Scalability, Resource Assignment, Querying Device Properties, Thread Scheduling and Latency Tolerance	1
5.7	Importance of Memory Access Efficiency, Cuda Memory Types	1
5.8	Tiling for Reduced Memory Traffic	1
5.9	Tiled Matrix Multiplication Kernel, Boundary Checks	1

CST446	**DATA COMPRESSION TECHNIQUES**	**CATEGORY**	**L**	**T**	**P**	**CREDIT**
		Program Elective IV	**2**	**1**	**0**	**3**

Preamble: This course helps the learners to understand compression techniques on text, image, audio and video data. It covers lossy &lossless compression, RLE, JPEG, MPEG and its variants. This course enables the students to develop and implement compression algorithms on different domains.

Prerequisite: Knowledge of probability theory, computation on matrices, basic topics in datastructures, storage and efficiency

Course Outcomes: After the completion of the course the student will be able to

CO#	**CO**
CO1	Describe the fundamental principles of data compression**(Cognitive Knowledge level: Understand)**
CO2	Make use of statistical and dictionary based compression techniques for various applications **(Cognitive Knowledge level: Apply)**
CO3	Illustrate various image compression standards. **(Cognitive Knowledge level: Apply)**
CO4	Summarize video compression mechanisms to reduce the redundancy in video.**(Cognitive Knowledge level: Understand)**
CO5	Use the fundamental properties of digital audio to compress audio data.**(Cognitive Knowledge level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔											✔
CO2	✔	✔	✔		✔							✔
CO3	✔	✔	✔		✔							✔
CO4	✔											✔

CO5	✔	✔	✔									✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complexproblems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks (%)**
	Test 1 (%)	**Test 2 (%)**	
Remember	30	30	30
Understand	40	40	40
Apply	30	30	30
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Continuous Assessment Tests(Average of SeriesTests1& 2) **25 marks**

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a studentshould answer any5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

SYLLABUS

Module-1 (Modelling and types of compression)) 1

Introduction to Compression Techniques- Lossy compression & Lossless compression, Measures of Performance, Modeling and coding. Mathematical modelling for Lossless and lossy compression
- Physical models and probability models.

Module – 2 (Basic Compression Methods)

Basic Compression Technique- Run length encoding, RLE Text compression. Statistical Methods- Prefix Codes, Binary Huffman coding, non-binary Huffman Algorithms, Arithmetic Coding.

Module - 3 (Text & Image Compression)

Dictionary based Coding- LZ77, LZ78 and LZW compression.Image Compression- Image standards, JPEG image Compression- Baseline JPEG, JPEG-LS.

Module - 4 (Video Compression)

Video Compression- Analog video, Digital Video, Motion Compensation. MPEG standards- MPEG 1, MPEG 4

Module - 5 (Audio Compression)

Audio Compression- Basics of Digital Audio, Basic Audio Compression Techniques, MPEG Audio Compression-Layer 1 coding, Layer 2 coding and Layer 3 coding.

Text Book

1. David Solomon, Data compression: the complete reference, 4/e, Springer, January 2007
2. Khalid Sayood, Introduction to data compression, Morgan Kaufmann Publishers,2003.

References

1) Stephen Welstead, Fractal and wavelet Image Compression techniques, PHI, 1999.
2) Sleinreitz, Multimedia System, Addison Wesley.
3) Mark Nelson and Jean-loup Gailly, The Data Compression Book, M&T Books.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Discuss different types of compression performance metrics
2. Explain mathematical model for lossless compression

Course Outcome 2 (CO2):

1. Explain RLE based text compression and identify a example with compression ratio of 2.
2. Given the eight symbols A, B, C, D, E, F, G, and H with probabilities 1/30, 1/30, 1/30, 2/30, 3/30, 5/30, 5/30, and 12/30, draw three different Huffman trees with heights 5 and 6for these symbols and calculate the average code size for each tree.

Course Outcome 3 (CO3):

1. Differentiate the LZ77 and LZ78 performance with the input given as‘sirsideastmaneasilyteasesseasickseals’
2. Explain why the continuous-tone images is required for JPEG and the main steps used inimage compression.

Course Outcome 4 (CO4):

1. Briefly explain MPEG-4 video compression standard
2. How H.261 video compression is completed.

Course Outcome 5 (CO5):

1. Explain critical bands, thresholding and masking related to audio compression
2. Explain the working of -law encoder and decoder with an example

Model Question Paper

QP CODE:

Reg No: _____________

Name:________________ **PAGES : 2**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST446

Course Name: Data Compression Techniques

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Specify different quantities used to measure the performance of a datacompression technique
2. Explain mathematical model for lossless compression
3. State and prove Kraft-McMillan inequality
4. Compare Huffman and Arithmetic coding
5. Describe LZ77 approach of encoding a string with the help of an example
6. Compare and contrast JPEG and JPEG-LS differences in working.
7. Discuss different components of video
8. Identify the advantage of MPEG-4 over MPEG
9. Explain critical bands, thresholding and masking related to audio compression
10. Explain the working of -law encoder and decoder with an example

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11.	(a)	Explain mathematical model for lossy compression and lossless compression	**(10)**
	(b)	Define compression ratio with an example	**(4)**
		OR	
12.	(a)	Discuss any probability model and identify the shortcoming of the solution.	**(7)**
	(b)	Identify the mathematical preliminaries for Lossless Compression	**(7)**
13.	(a)	With a help of flowchart discuss the RLE text compression for text data given below *'ABBBBBBBBBCDEEEEF'*	**(10)**
	(b)	calculate the compression ratio for the example while taking repetitions = 4	**(4)**
		OR	
14.	(a)	Illustrate with a example why Huffman coding is preferred than Shannon Fano Algorithm for compression	**(10)**
	(b)	How Huffman coding is handling the unpredictability of input data stream	**(4)**
15.	(a)	Explain in detail the working of LZ78 with example and dictionary Tree	**(10)**
	(b)	Illustrate with example, how the compression factor LZW differ from the LZ78	**(4)**
		OR	
16.	(a)	How quantization and coding helps in compression and their role in JPEG.	**(6)**
	(b)	With the help of the given example illustrate the compression ratio of JPEG and JPEG-LS	**(8)**

17.	(a)	With the help of equations discuss Composite and Components Video	**(7)**
	(b)	Differentiate the major changes in MPEG - 2 and MPEG-4 Video	**(7)**

OR

18.	(a)	Describe in details about functionalities for MPEG-4	**(8)**
	(b)	How Motion Compensation help in video compression	**(6)**
19.	(a)	How The Human Auditory System limitations can be taken in audio compressions	**(7)**
	(b)	Discuss the complexity of Layer III compared to others in MPEG Audio Coding	**(7)**

OR

20.	(a)	Discuss Format of Compressed Data and encoding in layer I and II	**(9)**
	(b)	Differentiate Spectral and Temporal Masking	**(5)**

TEACHING PLAN

No	CONTENTS	No of Lecture Hrs (36 Hours)
	Module – 1 (Modelling and types of compression) (7 hrs)	
1.1	Introduction to Compression Techniques- Lossy compression & Lossless compression, Measures of Performance	2
1.2	Modelling and coding.	1
1.3	Physical model for lossless compression	1
1.4	Physical model for lossy compression	1
1.5	Probability model for lossless compression	1
1.6	Probability model for lossly compression	1
	Module - 2 (Basic Compression Methods) (8 hrs)	
2.1	Run length encoding, RLE Text compression	1
2.2	Statistical methods-Prefix Codes	1
2.3	Binary Huffman coding	1
2.4	Illustration of Binary Huffman coding	1
2.5	Non-binary Huffman Algorithms	1
2.6	Arithmetic Coding algorithm	1
2.7	Illustration of Arithmetic Coding algorithm	2
	Module - 3 (Text & Image Compression) (8 hrs)	
3.1	LZ77 compression	2

3.2	LZ78 Compression	1
3.3	LZW Compression	1
3.4	Basics of Image compression and Image standards	1
3.5	Baseline JPEG Image compression	1
3.6	JPEG-LS Image compression	1
Module - 4 (Video Compression) (7 hrs)		
4.1	Basics of Video Compression- Analog video and Digital Video.	2
4.2	Motion Compensation	1
4.3	MPEG-1 standard and Video Syntax	1
4.4	MPEG-1 Pel Reconstruction	1
4.5	MPEG-4 standard	1
4.6	Functionalities for MPEG-4	1
Module - 5 (Audio Compression) (6 hrs)		
5.1	Basics of Audio Compression, Digital Audio	1
5.2	Basic Audio Compression Techniques	1
5.3	MPEG Audio Compression basics- Frequency Domain Coding	1
5.4	Encoding: Layers I and II	1
5.5	Encoding: Layer II -Psychoacoustic Models	1
5.6	Psychoacoustic Models - Encoding: Layer III	1

CST466	DATA MINING	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PEC	2	1	0	3	2019

Preamble: 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.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO#	CO
CO1	Employ the key process of data mining and data warehousing concepts in application domains. (**Cognitive Knowledge Level: Understand**)
CO2	Make use of appropriate preprocessing techniques to convert raw data into suitable format for practical data mining tasks (**Cognitive Knowledge Level**: **Apply**)
CO3	Illustrate the use of classification and clustering algorithms in various application domains (**Cognitive Knowledge Level: Apply**)
CO4	Comprehend the use of association rule mining techniques. (**Cognitive Knowledge Level: Apply)**
CO5	Explain advanced data mining concepts and their applications in emerging domains (**Cognitive Knowledge Level: Understand**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔										✔
CO2	✔	✔	✔	✔	✔							✔
CO3	✔	✔	✔	✔	✔							✔

CO4	✔	✔	✔	✔	✔							✔
CO5	✔	✔										✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks (%)**
	Test 1 (%)	**Test 2 (%)**	
Remember	**20**	**20**	**20**
Understand	**30**	**30**	**30**
Apply	**50**	**50**	**50**
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	**50**	**100**	**3**

Continuous Internal Evaluation Pattern:

Attendance	**10 marks**
Continuous Assessment Test(Average of Internal Test1&2)	**25 marks**
Continuous Assessment Assignment	**15 marks**

Internal Examination Pattern

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing the remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the seven questions, a student should answer any five.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have a maximum 2 subdivisions and carries 14 marks.

Syllabus

Module – 1 (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, Data Mining Concepts and Applications, Knowledge Discovery in Database Vs Data mining, Architecture of typical data mining system, Data Mining Functionalities, Data Mining Issues.

Module - 2 (Data Preprocessing)

Data Preprocessing-Need of data preprocessing, Data Cleaning- Missing values, Noisy data, Data Integration and Transformation, Data Reduction-Data cube aggregation, Attribute subset selection, Dimensionality reduction, Numerosity reduction, Discretization and concept hierarchy generation.

Module - 3 (Advanced classification and Cluster analysis)

Classification- Introduction, Decision tree construction principle, Splitting indices -Information Gain, Gini indexDecision tree construction algorithms-ID3, Decision tree construction with presorting-SLIQ, Classification Accuracy-Precision, Recall.

Introduction to clustering-Clustering Paradigms, Partitioning Algorithm- PAM, Hierarchical Clustering-DBSCAN, Categorical Clustering-ROCK

Module 4: (Association Rule Analysis)

Association Rules-Introduction, Methods to discover Association rules, Apriori(Level-wise algorithm), Partition Algorithm, Pincer Search Algorithm, Dynamic Itemset Counting Algorithm, FP-tree Growth Algorithm.

Module 5 (Advanced Data Mining Techniques)

Web Mining - Web Content Mining, Web Structure Mining- Page Rank, Clever, Web Usage Mining- Preprocessing, Data structures, 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.

Text Books

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

Reference Books

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

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. (a) Explain the OLAP operations in a multidimensional model.
   (b) Compare the techniques used in ROLAP, MOLAP and HOLAP
2. Explain the various data mining issues with respect to mining methodology, user interaction and diversity of data types.
3. Suppose that a data warehouse consists of the three dimensions time, doctor, and patient, and the two measures count and charge, where charge is the fee that a doctor charges a patient for a visit.
   a) Draw star and snowflake schema diagrams for the data warehouse.
   b) Starting with the base cuboid [day; doctor; patient], what specific OLAP operations should be performed in order to list the total fee collected by each doctor in 2004?

Course Outcome 2 (CO2):

1. Use the methods below to normalize the following group of data:100, 200, 300, 400,550, 600, 680, 850, 1000
   (a) min-max normalization by setting min = 0 and max = 1
   (b) z-score normalization
   (c) Normalization by decimal scaling

   Comment on which method you would prefer to use for the given data, givingreasons as to why.
2. Identify a suitable dataset from any available resources and apply different preprocessing steps that you have learned. Observe and analyze the output obtained. (Assignment)

Course Outcome 3 (CO3):

1. Illustrate the working of ID3 algorithm with the following example

MOTOR	WHEEELS	DOORS	SIZE	TYPE	CLASS
NO	2	0	small	cycle	bicycle
NO	3	0	small	cycle	tricycle
YES	2	0	small	cycle	motorcycle
YES	4	2	small	automobile	Sports car
YES	4	3	medium	automobile	minivan
YES	4	4	medium	automobile	sedan
YES	4	4	large	automobile	sumo

2. Illustrate the working of K medoid algorithm for the given dataset. A1=(3,9), A2=(2,5), A3=(8,4), A4=(5,8), A5=(7,5), A6=(6,4), A7=(1,2), A8=(4,9).

3. Take a suitable dataset from available resources and apply all the classification and clustering algorithms that you have studied on original and preprocessed datasets. Analyze the performance variation in terms of different quality metrics. Give a detailed report based on the analysis. (Assignment)

Course Outcome 4 (CO4):

1. A database has five transactions. Let min sup = 60% and min con f = 80%.

TID	*items_bought*
T100	{M, O, N, K, E, Y}
T200	{D, O, N, K, E, Y }
T300	{M, A, K, E}
T400	{M, U, C, K, Y}
T500	{C, O, O, K, I ,E}

a) Find all frequent item sets using Apriori and FP-growth, respectively. Compare the efficiency of the two mining processes.

b) List all of the strong association rules (with support s and confidence c) matching the following metarule, where X is a variable representing customers, and $item_i$ denotes variables representing items (e.g., “A”, “B”, etc.)

$$\forall x \in transaction, buys(X, item_1) \wedge buys(X, item_2) \Rightarrow buys\ (X, item_3) \quad [s, c]$$

2. Identify and list some scenarios in which association rule mining can be used, and then use at least two appropriate association rule mining techniques in one of the two scenarios. (Assignment)

Course Outcome 5 (CO5):

1. Consider an e-mail database that stores a large number of electronic mail (e-mail) messages. It can be viewed as a semi structured database consisting mainly of text data. Discuss the following.
   a. How can such an e-mail database be structured so as to facilitate multidimensional search, such as by sender, by receiver, by subject, and by time?
   b. What can be mined from such an e-mail database?
   c. Suppose you have roughly classified a set of your previous e-mail messages as junk, unimportant, normal, or important. Describe how a data mining system may take this as the training set to automatically classify new e-mail messages or unclassified ones.
2. Precision and recall are two essential quality measures of an information retrieval system.
   (a) Explain why it is the usual practice to trade one measure for the other.
   (b) Explain why the F-score is a good measure for this purpose.

(c) Illustrate the methods that may effectively improve the F-score in an information retrieval system.

3. Explain HITS algorithm with an example.

Model Question Paper

QP CODE:

Reg No: _______________

Name: _________________ **PAGES : 4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST466

Course Name: Data Mining

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Differentiate between OLTP and OLAP.
2. Compare the techniques of ROLAP, MOLAP and HOLAP
3. Explain Concept hierarchy with an example.
4. Explain heuristic methods of attribute subset selection techniques.
5. Consider a two-class classification problem of predicting whether a photograph contains a man or a woman. Suppose we have a test dataset of 10 records with expected outcomes and a set of predictions from our classification algorithm.

	Expected	Predicted
1	man	woman
2	man	man
3	woman	woman
4	man	man
5	woman	man
6	woman	woman
7	woman	woman
8	man	man
9	man	woman
10	woman	woman

Calculate precision, recall of the data.

6. Given two objects represented by the tuples (22,1,42,10) and (20,0, 36,8). Compute the Euclideanand Manhattan distance between the two objects.

7. The pincer search algorithm is a bi-directional search, whereas the level wise algorithm is a unidirectional search. Express your opinion about the statement.

8. Define support, confidence and frequent set in association data mining context.

9. Distinguish between focused crawling and regular crawling.

10. Describe any two-text retrieval indexing techniques. **(10x3=30)**

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Suppose a data warehouse consists of three measures: customer, account and branch and two measures count (number of customers in the branch) and balance. Draw the schema diagram using snowflake schema and star schema. **(7)**

(b) Explain three- tier data warehouse architecture with a neat diagram. **(7)**

OR

12 (a) Illustrate different OLAP operations in multidimensional data model **(7)**

(b) Describe different issues in data mining **(7)**

13 (a) Suppose that the data for analysis includes the attribute age. The age values for the data tuples are (in increasing order) 13, 15, 16, 16, 19, 20, 20, 21, 22, 22, 25, 25, 25, 25, 30, 33, 33, 35, 35, 35, 35, 36, 40, 45, 46, 52, 70. **(8)**

(a) Use min-max normalization to transform the value 35 for age onto

the
range [0-1].

(b) Use z-score normalization to transform the value 35 for age, where the standard deviation of age is 12.94 years.

(c) Use normalization by decimal scaling to transform the value 35 for age.

(d) Use smoothing by bin means to smooth the above data, using a bin depth of 3. Illustrate your steps. Comment on the effect of this technique for the given data.

(b) With proper illustration, explain how PCA can be used for dimensionality reduction? Explain **(6)**

OR

14 (a) Suppose a group of 12 sales price records has been sorted as follows: 5, 10, 11, 13, 15, 35, 50, 55, 72, 92, 204, 215. Sketch examples of each of the following sampling techniques: SRSWOR, SRSWR, cluster sampling, stratified sampling. Use samples of size 5 and the strata "youth," "middle-aged," and "senior." **(8)**

(b) Partition the above data into three bins by each of the following methods: **(6)**
(i) equal-frequency (equi-depth) partitioning
(ii) equal-width partitioning

15 (a) Explain the concept of a cluster as used in ROCK. Illustrate with examples **(9)**

(b) Consider the following dataset for a binary classification problem. **(5)**

A	B	Class Label
T	F	+
T	T	+
T	T	+
T	F	-
T	T	+
F	F	-
F	F	-
F	F	-
T	T	-
T	F	-

Calculate the gain in Gini index when splitting on A and B respectively. Which attribute would the decision tree induction algorithm choose?

OR

16 (a) For a sunburn dataset given below, find the first splitting attribute for the decision tree by using the ID3 algorithm. **(10)**

Name	**Hair**	**Height**	**Weight**	**Lotion**	**Class**
Sarah	Blonde	Average	Light	No	Sunburn
Dana	Blonde	Tall	Average	Yes	None
Alex	Brown	Tall	Average	Yes	None
Annie	Blonde	Short	Average	No	Sunburn
Emily	Red	Average	Heavy	No	Sunburn
Pete	Brown	Tall	Heavy	No	None
John	Brown	Average	Heavy	No	None
Katie	Blonde	Short	Light	Yes	None

(b) Explain the working of SLIQ algorithm. **(4)**

17 (a) Illustrate the working of Pincer Search Algorithm with an example. **(7)**

(b) Describe the working of dynamic itemset counting technique? Specify when to move an itemset from dashed structures to solid structures? **(7)**

OR

18 (a) A database has six transactions. Let min_sup be 60% and min_conf be 80%. **(9)**

TID	*items_bought*
T1	I1, I2, I3
T2	I2, I3, I4
T3	I4, I5
T4	I1, I2, I4
T5	I1, I2, I3, I5
T6	I1, I2, I3, I4

Find frequent itemsets using FP Growth algorithm and generate strong association rules from a three item dataset.

(b) Write partitioning algorithm for finding large itemset and compare its efficiency with apriori algorithm **(5)**

19 (a) Describe web content mining techniques. **(7)**

(b) Write an algorithm to find maximal frequent forward sequences to mine log traversal patterns. Illustrate the working of this algorithm. **(7)**

OR

20 (a) Explain how web structure mining is different from web usage mining and web content mining? Write a CLEVER algorithm for web structure mining. **(7)**

(b) Describe different Text retrieval methods. Explain the relationship between text mining and information retrieval and information extraction. **(7)**

Teaching Plan

No	Contents	No. of lecture hours (36 Hrs)
Module 1(Introduction to Data Mining and Data Warehousing) (Text3) (6 hours)		
1.1	Data warehouse-Differences between Operational Database Systems and Data Warehouses, Multidimensional data model- Warehouse schema	1
1.2	OLAP Operations	1
1.3	DataWarehouse Architecture, Data Warehousing to Data Mining	1
1.4	Datamining Concepts and Applications, Knowledge Discovery in Database Vs Data mining	1
1.5	Architecture of typical data mining system,Data Mining Functionalities	1
1.6	Data Mining Functionalities, Data Mining Issues	1
Module 2(Data Preprocessing) (6 hours) (Text3)		
2.1	Data Preprocessing: Need of Data Preprocessing, Data Cleaning- Missing values, Noisy data.	1
2.2	Data integration	1
2.3	Data transformation	1
2.4	Data Reduction-Data cube aggregation, Attribute subset selection	1
2.5	Data Reduction-Dimensionality reduction	1

2.6	Numerosity reduction, Discretization and concept hierarchy generation	1
Module 3(Advanced classification and Cluster analysis)(9 hours)(Text2,Text3)		
3.1	Classification- Introduction, Decision tree construction principle, Splitting indices-Information Gain, Gini index	1
3.2	Decision Tree- ID3	1
3.3	Decision Tree- ID3	1
3.4	Decision tree construction with presorting- SLIQ	1
3.5	Accuracy and error measures, evaluation	1
3.6	Introduction to clustering, Clustering Paradigms	1
3.7	Partitioning Algorithm- PAM	1
3.8	Hierarchical Clustering-DBSCAN	1
3.9	Categorical Clustering-ROCK	1
Module 4(Association Rule Analysis) (8 hours) (Text2,Text3,Text1)		
4.1	Association Rules: Introduction, Methods to discover association rules	1
4.2	A priori algorithm (Level-wise algorithm)	1
4.3	A priori algorithm (Level-wise algorithm)	1
4.4	Partition Algorithm	1
4.5	Pincer Search Algorithm	1
4.6	Pincer Search Algorithm	1
4.7	Dynamic Itemset Counting Algorithm	1
4.8	FP-tree Growth Algorithm	1
Module 5(Advanced Data Mining Techniques) (7 hours) (Text1, Text3		
5.1	Web Mining - Web Content Mining	1
5.2	Web Structure Mining- Page Rank	1
5.3	Web Structure Mining –Clever algorithm	1
5.4	Web Usage Mining- Preprocessing, Data structures	1

5.5	Web Usage Mining -Pattern Discovery, Pattern Analysis	1
5.6	Text Mining-Text Data Analysis and information Retrieval, Basic measures for Text retrieval	1
5.7	Text Retrieval methods, Text Indexing Techniques Query Processing Techniques	1

AIT 476	BIO-INSPIRED OPTIMIZATION TECHNIQUES	Category	L	T	P	Credit
		Program Elective IV	3	0	0	3

Preamble:

The aim of this course is to provide the students with the knowledge and skills required to design and implement Bio-inspired optimization techniques to problems for which a direct solution is impractical or unknown. This course covers concepts of evolutionary algorithms like genetic algorithms and various swarm optimization techniques like ACO, PSO. The learners will be able to provide Bio-inspired optimization solutions to real world problems.

Course Outcomes: After the completion of the course the student will be able to

CO1	Understand the fundamentals in bio-inspired optimization techniques which influence computing **(Cognitive Knowledge Level: Understand)**
CO2	Make use of the concepts of Evolutionary Algorithms, genetic algorithms in various domains. **(Cognitive Knowledge Level: Apply)**
CO3	Comprehend the concepts of Swarm Intelligence and collective systems such as ACO, PSO **(Cognitive Knowledge Level: Understand)**
CO4	Illustrate the concepts of biologically inspired algorithmic design**(Cognitive Knowledge Level: Understand)**
CO5	Select the most appropriate types of algorithms for different data analysis problems **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO8	PO 9	PO 10	PO1 1	PO 12
CO1	✓											✓
CO2	✓	✓			✓							✓
CO3	✓	✓			✓							✓
CO4	✓	✓			✓							✓
CO5	✓	✓			✓							✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test 1 (%)	Test 2 (%)	
Remember	**20**	**20**	**20**
Understand	**70**	**70**	**70**
Apply	**10**	**10**	**10**
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3**

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Continuous Assessment Tests(Average of Internal Tests1&2) **25 marks**

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

SYLLABUS

Module – 1 (Optimization Techniques) (7 hours)

Optimization Techniques: Understanding optimization process- Objective function, minima & maxima, convergence. Optimization methods- conventional methods, Gradient descent algorithm- drawbacks. Introduction to Optimization Problems – classification- Single and Muti- objective Optimization – Classical Techniques – Overview of various Optimization methods . Bio- inspired Computing (BIC): Motivation – Overview of BIC – usage of BIC – merits and demerits of BIC.

Module– 2(Evolutionary Computing) (7 hours)

Evolutionary Computing: Motivation, Genetic Algorithm and Genetic Programming: Basic concept – encoding – representation – fitness function – Population, Operators – Selection, Mutation, Crossover, Reproduction – Types of Evolutionary Algorithms, Differences between GA and Traditional optimization methods – Applications.

Module- 3 (Ant Colony Systems) (8 hours)

Swarm intelligent systems – Background. Ant colony systems – Biological systems, Development of the ant colony system- - Working of ACO Algorithm - Pheromone updating- Types of ant systems- ACO algorithms for TSP.

Module- 4 (Particle Swarm Optimization) (7 hours)

Foraging for food – Clustering of objects – Collective Prey retrieval –Scope of Swarm Robotics –Social Adaptation of Knowledge: Particle Swarm – Particle Swarm Optimization (PSO) – Particle Swarms for Dynamic Optimization Problems – Bee-inspired optimization, Artificial Bee Colony (ABC) Optimization , applications.

Module- 5 (Case Studies) (6 hours)

Other Swarm Intelligence algorithms: Fish Swarm – Bacteria foraging – Intelligent Water Drop Algorithms – Applications of biologically inspired algorithms in engineering. Case Studies: ACO for NP-hard problems – Routing problems – Assignment problems –Scheduling problems.

ReferenceBooks

1. A. E. Elben and J. E. Smith, “Introduction to Evolutionary Computing”, Springer,2010.
2. S. N. Sivanandam and S.N. Deepa, Principles of Soft Computing , 2nd Edition, John Wiley & Sons.
3. Marco Dorigo and Thomas Stutzle, “Ant Colony optimization”, Prentice Hall of India, New Delhi,2005.
4. FloreanoD. and Mattiussi C., "Bio-Inspired Artificial Intelligence: Theories,Methods, and Technologies", MIT Press, Cambridge, MA, 2008.
5. Leandro Nunes de Castro, " Fundamentals of Natural Computing, BasicConcepts, Algorithms and Applications", Chapman & Hall/ CRC, Taylor andFrancis Group, 2007.
6. SatyobrotoTalukder, Blekinge Institute of Technology, Mathematical Modelling and Applications of Particle Swarm Optimization, February 2011.
7. Christian Blum and Daniel Merkle, “Swarm Intelligence Introduction and Application”, Springer 2008.

Course Level Assessment Questions

Course Outcome1 (CO1):

1. Explain the need for bio-inspired computation algorithms.
2. Differentiate between Bio-inspired optimization and other optimization techniques.

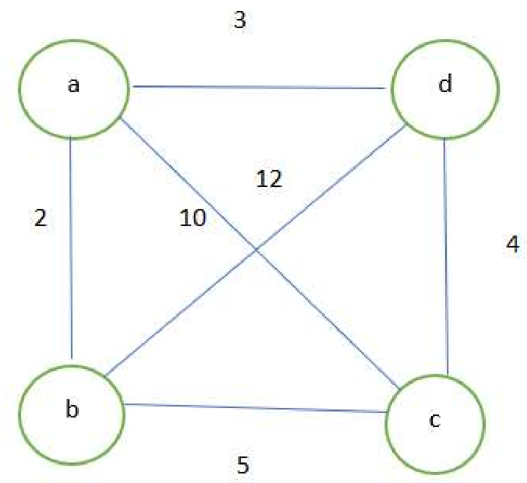
Course Outcome 2(CO2):

1. Describe how the Roulette wheel is used for selection. Draw the Roulette wheel for six chromosomes corresponding to the table given below.

Chromosome #	***Fitness***
1	10
2	5
3	25
4	15
5	30
6	20

Course Outcome 3(CO3):

1. Consider an Ant Colony System based on the Ant Quantity model for solving the following Travelling Salesman Problem. Compute the pheromone content at each of the edges after 4 steps (1 iteration). Assume pheromone decay factor ρ= 0.1, Q = 120. Assume an initial pheromone of 50 units at each of the edges and that three ants k1, k2 and k3 follow the paths given below in the first iteration. k1= a b c d a; k2=a c b d a; k3=a d c b a



Course Outcome 4(CO4): .

1. Consider a particle swarm optimization system composed of three particles and maximum velocity 10. Assume that both the random numbers r1 and r2 used for computing the movement of the particle towards the individual best position and social best position are 0.5. Also assume that the space of solutions is the two dimensional real valued space and the current state of swarm is as follows: Position of particles: x1 = (4,4); x2 = (8,3); x3 = (6,7) Individual best positions : x14,4 = (*); x2 = (* 7,3); x35,6 = (*) Velocities: v1 = (2,2); v2 = (3,3); v3 = (4,4) .What would be the next position of each particle after one iteration of the PSO algorithm if the inertia parameter ω that is used along with current velocity update formula is 0.8 ?

Course Outcome 5(CO5):

1. Discuss applications of bio-optimization techniques (ACO) for solving NP-hard problems.

Model Question Paper

QP CODE:

Reg No: _______________

Name: _________________ **PAGES : 4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: AIT 476

Course Name: Bio-Inspired Optimization Techniques

Max.Marks:100

Duration: 3 Hours

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Differentiate Optimization and Constraint Satisfaction problems.
2. Define bio-Inspired Optimization.
3. Specify the importance of objective (fitness) function in genetic algorithm.
4. Compare Single-Point Crossover and Two-Point Crossover.
5. Describe how pheromone is updated.
6. Define Swarm Intelligence and list the algorithms under SI.
7. What is the significance of pbest and gbest particles in solving

problems with particle swarm optimization?

8. List the scope of swarm robotics.

9. What is Fish Swarm optimization algorithm.

10. Define an assignment problem? List the different types of Assignment problems.

(10x3= 30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11.	(a)	Discuss about Optimization, modelling, and simulation problems.	**(7)**
	(b)	Differentiate between Bio-inspired optimization and other optimization techniques	**(7)**

OR

12.	(a)	What is Bio-Inspired Computing? Explain the working of BIC algorithms.	**(7)**
	(b)	Discuss the merits and demerits of BIC.	**(7)**
13.	(a)	Explain any procedure to map a solution to the corresponding chromosome and vice versa in genetic algorithms. Also illustrate it with an example:	**(7)**

(b) Describe two methods used to select individuals from a population for the mating pool in Genetic Algorithms. **(7)**

OR

14. (a) Explain any two mutation methods. **(4)**

(b) Differentiate between value encoding and permutation encoding. **(10)**

15. (a) Describe Ant Colony System. What are the different types of Ant systems? **(7)**

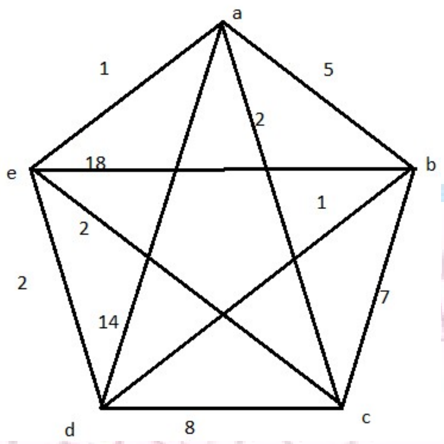
(b) Using the equation $T_{ij}(t+1)=(1-\rho)T_{ij}(t) + \Delta T_{ij}(t,t+1)$, compute the T_{ij} of the edge when 10 ants uses the edges, using the following models: **(7)**

i. Ant Density Model (Constant Q=10)

ii. Ant Quantity Model(Constant Q=100) , where Q is the constant related to the pheromone updation

OR

16. (a) Consider the TSP with the following edge costs. Given the evaporation factor ρ =0.02 and initial pheromone at all **(4)**



edges Tij=100.

Compute the cost of the best tour?

(b) Describe ACO algorithm for TSP problems. **(10)**

17. (a) Illustrate Artificial Bee Colony optimization **(10)**

(b) List the advantages of Particle Swarm Optimization (PSO). **(4)**

OR

18. (a) Discuss Particle Swarm Optimization (PSO). **(6)**

(b) Explain the working of Particle Swarm Optimization (PSO) Algorithm. **(8)**

19. (a) Describe the working of Bacteria Foraging Algorithms. **(7)**

(b) Explain Intelligent Water Drop Algorithms . **(7)**

OR

20. (a) Discuss the different types of routing problems. **(6)**

(b) Discuss any four Applications of biologically inspired algorithms in engineering. **(8)**

Teaching Plan

No	Contents	No. of Lecture Hours (35hrs)
	Module-1(Optimization Techniques) (7 hours)	
1.1	Understanding optimization process- Objective function, minima & maxima, convergence. Optimization methods- Gradient descent algorithm- drawbacks.	2hour
1.2	Introduction to Optimization Problems – classification- Single and Muti- objective Optimization	1 hour
1.3	Classical Techniques	1 hour
1.4	Overview of various Optimization methods	1 hour
1.5	Bio- inspired Computing (BIC): Motivation – Overview of BIC	1 hour
1.6	Usage of BIC – merits and demerits of BIC.	1 hour
	Module-2 (Evolutionary Computing) (7hours)	
2.1	Evolutionary Computing: Motivation, Genetic Algorithm and Genetic Programming: Basic concepts	1 hour
2.2	Encoding – Representation	1 hour
2.3	Fitness function, Population, Reproduction	1 hour
2.4	Operators - Selection, Mutation	1 hour
2.5	Crossover, Reproduction	1 hour
2.6	Types of Evolutionary Algorithms	1 hour

2.7	Differences between GA and Traditional optimization methods – Applications.	1 hour
Module-3 (Ant colony systems) (8 hours)		
3.1	Swarm intelligent systems	1 hour
3.2	Background...	1 hour
3.3	Ant colony systems – Biological systems	1 hour
3.4	Development of the ant colony system	1 hour
3.5	Working of ACO Algorithm	1 hour
3.6	Pheromone updating	1 hour
3.7	Types of ant systems	1 hour
3.8	ACO algorithms for TSP	1 hour
Module-4 (Particle Swarm Optimization)) (7 hours)		
4.1	Foraging for food	1 hour
4.2	Clustering of objects	1 hour
4.3	Collective Prey retrieval	1 hour
4.4	Scope of Swarm Robotics	1 hour
4.5	Particle Swarm — Particle Swarms for Dynamic Optimization Problems	1 hour
4.6	Particle Swarm Optimization (PSO)	1 hour
4.7	Bee-inspired optimization, Artificial Bee Colony (ABC) Optimization , Applications	1 hour

Module-5 (CASE STUDIES) (6 hours)		
5.1	Other Swarm Intelligence algorithms: Fish Swarm	1 hour
5.2	Bacteria foraging	1 hour
5.3	Intelligent Water Drop Algorithms	1 hour
5.4	Applications of biologically inspired algorithms in engineering	1 hour
5.5	Case Studies: ACO for NP-hard problems – Routing problems – Assignment problems	1 hour
5.6	Scheduling problems	1 hour

SEMESTER VIII

PROGRAM ELECTIVE V

CST418	HIGH PERFORMANCE COMPUTING	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PEC	2	1	0	3	2019

Preamble: 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. This course enables the students to provide solutions to real-world problems making use of the capabilities of HPC systems.

Prerequisite: Basic knowledge in Computer System architecture, Microprocessors, Operating systems, and System software.

Course Outcomes: After the completion of the course the student will be able to

CO1	Describe different types of modern processing environments and parallel computing hardware (**Cognitive Knowledge Level: Understand**)
CO2	Summarize the concepts of Instruction Level Parallelism (**Cognitive Knowledge Level: Understand**)
CO3	Appreciate the idea of Data Level Parallelism (**Cognitive Knowledge Level: Apply**)
CO4	Demonstrate the concept of Thread Level Parallelism (**Cognitive Knowledge Level: Apply**)
CO5	Describe the basics of GPU architecture. (**Cognitive Knowledge Level: Understand**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										✓
CO2	✓	✓										✓
CO3	✓	✓	✓									✓
CO4	✓	✓	✓									✓
C05	✓	✓										✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and teamwork
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test 1 (%)	Test 2 (%)	
Remember	20	20	20
Understand	50	50	50
Apply	30	30	30
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks.	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance	**10 marks**
Continuous Assessment Tests (Average of Internal Tests 1 & 2)	**25 marks**
Continuous Assessment Assignment	**15 marks**

Internal Examination Pattern

Each of the two internal examinations have to be conducted out of 50 marks. The first series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing the remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which students should answer anyone. Each question can have a maximum of 2 sub-divisions and carries 14 marks.

Syllabus

Module-1 (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

Module-2 (Instruction-Level Parallelism)

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

Module-3 (Data-Level Parallelism)

Vector Architecture – SIMD Instruction Set Extensions for Multimedia – Graphics Processing Units – Detecting and Enhancing Loop-Level Parallelism

Module-4 (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

Module-5 (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

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.

Reference Books

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 Level Assessment Questions

Course Outcome 1 (CO1):

1. Differentiate different classes of computer-based on features like microprocessor cost, system cost, and system design issues.
2. Explain the different methods by which computer hardware exploits application-level parallelism.
3. Explain in detail the instruction set architecture
4. Describe the encoding scheme specified as part of ISA

Course Outcome 2 (CO2):

1. Differentiate data, name, and control dependencies with suitable examples.
2. Explain loop unrolling with suitable coding demonstration
3. Explain in detail about Tournament Predictors.
4. Describe the unique features of very long instruction word processors.

Course Outcome 3 (CO3):

1. What are the three things conveyed through a data dependence? Explain the Data Dependencies of the following code:

```
Loop: fld     f0,0(x1)    //f0=array element
      fadd.d  f4,f0,f2    //add scalar in f2
      fsd     f4,0(x1)    //store result
      addi    x1,x1,-8    //decrement pointer 8 bytes
      bne     x1,x2,Loop  //branch x1≠x2
```

2. Assume a single-issue pipeline. Unroll the loop as many times as necessary to schedule it without any stalls, collapsing the loop overhead instructions. How many times must the loop be unrolled? Show the instruction schedule. What is the execution time per element of the result?
3. Explain the SIMD Instruction Set Extensions for Multimedia.

Course Outcome 4 (CO4):

1. With the help of a neat diagram illustrate a single-chip multicore with a distributed cache.
2. Demonstrate the Implementation of cache coherence in a distributed-memory multiprocessor by adding a directory to each node with a suitable diagram.
3. Consider the following code segments running on two processors P1 and P2. Assume A, and B, are initially 0. Explain how an optimizing compiler might make it impossible for B to be ever set to 2 in a sequentially consistent execution model.

P1:	P2:
A=1;	B=1;
A=2;	While (A <> 1);
While (B == 0);	B= 2;

Course Outcome 5 (CO5):

1. Explain the benefits of potential GPU.
2. Illustrate GPU system as an accelerated computational platform.
3. Discuss CPU to GPU data transfer overhead.

Model Question Paper

QP CODE:

Reg No: _______________

Name: _________________ **PAGES : 4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST418

Course Name: High Performance Computing

Max. Marks : 100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Differentiate between Data level parallelism and Task level parallelism
2. Explain the principle of locality
3. Define Instruction Level Parallelism with an example.
4. Devise the importance of loop unrolling with an example.
5. What is the equation of CPI (cycles per instruction) for a pipelined processor? How can we set the ideal pipeline CPI?
6. Explain the two types of name dependencies between an instruction i that precedes instruction j in program order.
7. Differentiate between module reliability and module availability measures with suitable examples.
8. Why SMP architectures are called UMA multiprocessors and DSM multiprocessors as NUMA processors.

9. Explain the need for GPU.

10. List the characteristics of GPU memory spaces.

3x10=30

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Describe the quantitative principle of computer design with Amdahl's law. (8)

(b) Discuss in detail the importance of considering processor performance for the design of an efficient computer system. (6)

OR

12. (a) Illustrate how processes are protected with the help of virtual memory. (7)

(b) Discuss the role played by virtual machines in providing protection for processes. (7)

13. (a) Explain in detail data dependence and hazards. **(8)**

(b) With neat sketches explain how data-level parallelism is achieved in vector, and SIMD architectures. **(6)**

OR

14. (a) Describe the unique features of very long instruction word processors. **(8)**

(b) Consider a three-way superscalar machine renaming these three instructions concurrently: **(6)**

```
addi x1, x1, x1
addi x1, x1, x1
addi x1, x1, x1
```

If the value of x1 starts at 5, then what will be its value when after this sequence is executed?

15. (a) The following loop has multiple types of dependences. Find all the true dependences, output dependencies, and anti-dependencies, and eliminate the output dependencies and anti-dependencies by renaming. **(8)**

```
for (i=0; i<100; i=i+1) {
    Y[i] = X[i] / c;  /* S1 */
    X[i] = X[i] + c;  /* S2 */
    Z[i] = Y[i] + c;  /* S3 */
    Y[i] = c - Y[i];  /* S4 */
}
```

(b) Describe the limitations of Symmetric Shared-Memory Multiprocessors and Snooping Protocols **(6)**

OR

16. (a) Demonstrate the different types of hardware approaches required for the working of multithreading. **(8)**

(b) Consider the following loop: **(6)**

```
for (i=0;i<100;i++) {
 A[i] = A[i] + B[i]; /* S1 */
 B[i+1] = C[i] + D[i]; /* S2 */
}
```

Are there exist dependencies between S1 and S2? Determine whether the above loop is parallel? If not, show how to make it parallel.

17. (a) Consider an 8-processor multicore where each processor has its own L1 and L2 caches. Here snooping is performed on a shared bus among the L2 caches. Assume that the average L2 request is 15 cycles for a coherence miss or other miss and a clock rate of 3.0 GHz, a CPI of 0.7, and a load/store frequency of 40%. If the goal set is that no more than 50% of the L2 bandwidth is consumed by coherence traffic, then what is the maximum coherence miss rate per processor? **(8)**

(b) Explain the basic structure of a centralized shared-memory multiprocessor **(6)** based on a multicore chip.

OR

18. (a) Suppose an application running on a 100-processor multiprocessor use 1, 50, or 100 processors. If for 95% of the time all 100 processors are used, illustrate how the remaining 5% of the execution time employs 50 processors for a speedup of 80? **(6)**

(b) With a neat diagram, demonstrate invalidate cache coherence protocol for a private write-back cache, showing the states and state transitions for each block in the cache. **(8)**

19. (a) Explain the multi-GPU platform. **(8)**

(b) Explain some of the benefits of GPU. **(6)**

OR

20. (a) Discuss in detail the characteristics of GPU memory spaces. **(8)**

(b) Explain about GPU thread engine. **(6)**

Teaching Plan

No	Contents	No. of Lecture Hours (36 hrs)
Module 1 - Basics of Architecture (7 hours)		
1.1	Classes of Computers	1 hour
1.2	Classes of Parallelism and Parallel Architectures	1 hour
1.3	Dependability	1 hour
1.4	Quantitative Principles of Computer Design.	1 hour

1.5	Basics of Memory Hierarchies	1 hour
1.6	Virtual Memory and Virtual Machines	1 hour
1.7	Pipelining	1 hour
Module -2 (Introduction to Syntax Analysis) (7 hours)		
2.1	Instruction-Level Parallelism: Concepts and Challenges	1 hour
2.2	Basic Compiler Techniques for Exposing ILP	1 hour
2.3	Reducing Branch Costs With Advanced Branch Prediction	1 hour
2.4	Hardware-Based Speculation	1 hour
2.5	Multithreading	1 hour
2.6	Exploiting Thread-Level Parallelism to Improve Uniprocessor Throughput – Lecture 1.	1 hour
2.7	Exploiting Thread-Level Parallelism to Improve Uniprocessor Throughput – Lecture 2.	1 hour
Module- 3 - Data-Level Parallelism (7 hours)		
3.1	Vector Architecture -Lecture 1	1 hour
3.2	Vector Architecture -Lecture 2	1 hour
3.3	SIMD Instruction Set Extensions for Multimedia – Lecture 1	1 hour
3.4	SIMD Instruction Set Extensions for Multimedia – Lecture 2	1 hour
3.5	Graphics Processing Units	1 hour
3.6	Detecting and Enhancing Loop-Level Parallelism – Lecture 1	1 hour
3.7	Detecting and Enhancing Loop-Level Parallelism – Lecture 2	1 hour
Module 4– Thread Level Parallelism (8 hours)		
4.1	Multiprocessor Architecture: Issues and Approach	1 hour
4.2	Centralized Shared-Memory Architectures – Lecture 1	1hour
4.3	Centralized Shared-Memory Architectures – Lecture 2	1hour
4.4	Performance of Symmetric Shared-Memory Multiprocessors	1hour
4.5	Distributed Shared-Memory	1hour
4.6	Directory-Based Coherence	1hour
4.7	Synchronization	1hour

4.8	Introduction to Memory Consistency	1hour
Module 5 – GPU Architectures (7 hours)		
5.1	The CPU-GPU system as an accelerated computational platform	1 hour
5.2	The GPU and the thread engine – Lecture 1	1 hour
5.3	The GPU and the thread engine – Lecture 2	1 hour
5.4	Characteristics of GPU memory spaces	1hour
5.5	PCI bus: CPU to GPU data transfer overhead	1hour
5.6	Multi-GPU platforms	1hour
5.7	Potential benefits of GPU-accelerated platforms	1hour

CST428	BLOCKCHAIN TECHNOLOGIES	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PEC	2	1	0	3	2019

Preamble: 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.

Prerequisite: Basic knowledge in data structures and operating systems.

Course Outcomes: After the completion of the course the student will be able to

CO1	Illustrate the cryptographic building blocks of blockchain technology. **(Cognitive Knowledge Level: Understand)**
CO2	Explain the fundamental concepts of blockchain technology. **(Cognitive Knowledge Level: Understand)**
CO3	Summarize the classification of consensus algorithms. (**Cognitive Knowledge Level: Understand)**
CO4	Explain the concepts of first decentralized cryptocurrency bitcoin. (**Cognitive Knowledge Level: Understand)**
CO5	Explain the use of smart contracts and its use cases. **(Cognitive Knowledge Level: Understand)**
CO6	Develop simple applications using Solidity language on Ethereum platform. **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										✓
CO2	✓	✓										✓

CO3	✓	✓										✓
CO4	✓	✓										✓
CO5	✓	✓										✓
CO6	✓	✓	✓	✓	✓							✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks (%)**
	Test 1 (%)	**Test 2 (%)**	
Remember	**30**	**30**	**30**
Understand	**50**	**50**	**50**
Apply	**20**	**20**	**20**
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Continuous Assessment Tests(Average of Internal Tests 1 & 2) **25 marks**

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module – 1 (Fundamentals of Cryptography)

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.

Module – 2 (Fundamentals of Blockchain Technology)

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.

Module - 3 (Consensus Algorithms and Bitcoin)

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.

Module - 4 (Smart Contracts and Use cases)

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.

Module - 5 (Ethereum and Solidity)

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.

Text Book

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

References

2. Ritesh Modi, Solidity Programming Essentials: A beginner's guide to build smart contracts for Ethereum and blockchain, Packt Publishing, First edition, 2018.
3. Kumar Saurabh, Ashutosh Saxena, Blockchain Technology: Concepts and Applications, First Edition, Wiley Publications, First edition, 2020.
4. Chandramouli Subramanian, Asha A George, et al, Blockchain Technology, Universities Press (India) Pvt. Ltd, First edition, August 2020.

5. Lorne Lantz, Daniel Cawrey, Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications, O'Reilly Media, First edition, 2020.

6. Andreas M. Antonopoulos, Gavin Wood, Mastering Ethereum: Building Smart Contracts and DApps, O'Reilly Media, First edition, 2018.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Distinguish between Symmetric cryptography and asymmetric cryptography.
2. Explain the working of AES algorithm.

Course Outcome 2 (CO2):

1. Categorize consensus mechanism used in blockchain.
2. Define Blockchain. Explain how decentralization of computing or processing power is achieved by a blockchain.

Course Outcome 3 (CO3):

1. Explain how Proof of Stake can achieve consensus among peers.
2. Explain the working of Raft protocol.

Course Outcome 4 (CO4):

1. Describe the use of genesis block.
2. Explain the mining algorithm used in bitcoin.

Course Outcome 5 (CO5):

1. Illustrate how blockchain technology can be used in supply chain management.
2. What are oracles in a blockchain ecosystem? Explain the generic data flow from a smart contract to an oracle.

Course Outcome 6 (CO6):

1. Develop a smart contract for voting process. In this application, delegated voting is allowed and the counting is automatic and completely transparent at the same time.
2. Develop a smart contract for auction process. The contract should be a blind auction where it is not possible to see the actual bid until the bidding period ends.

Model Question Paper

QP CODE:

Reg No: _______________

Name: _________________ **PAGES : 2**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST428

Course Name: BLOCK CHAIN TECHNOLOGIES

Max. Marks : 100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Discuss the role of secure hash functions in blockchain.
2. List out the properties of digital signatures.
3. Illustrate the blockchain based decentralized system.
4. Explain how Proof of Stake can achieve consensus among peers.
5. If your blockchain network has 5 Byzantine nodes, what is the minimum number of nodes that are required to ensure Byzantine fault tolerance using PBFT protocol?
6. How are transactions verified in a Bitcoin network?
7. Explain how smart contracts can be used for enforcing agreements between parties in the form of business logic.
8. Explain the concept of blockchain-based digital identity cards.
9. Explain error handling in Solidity language.

10. With the help of a figure show the relationship between the transaction, transaction trie, and block header in Ethereum. **(10x3=30)**

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Explain the design of SHA-256 and its compression function using a diagram. **(9)**

(b) Explain how hash functions are used to build Merkle trees in blockchain. **(5)**

OR

12. (a) Explain public and private keys. Perform encryption and decryption using RSA for p=3, q=11, e= 7 and M=5. **(7)**

(b) Explain elliptic curve digital signature algorithm. **(7)**

13. (a) Illustrate and explain how blockchain works using a neat diagram. **(7)**

(b) Explain the benefits, features and limitations of blockchain. **(7)**

OR

14. (a) Explain consensus mechanisms used in blockchain. List out any six consensus algorithms used in the context of blockchain. **(7)**

(b) Define blockchain. Explain how decentralization of computing or processing power is achieved by a blockchain. **(7)**

15. (a) Explain and illustrate how Paxos protocol can be used to achieve consensus. **(7)**

(b) Show how Practical Byzantine Fault Tolerance can achieve consensus in the presence of Byzantine faults. **(7)**

OR

16. (a) Describe the various fields that make up a transaction in Bitcoin. **(7)**

(b) What is the role of a Bitcoin miner? Explain the mining algorithm used in **(7)**

Bitcoin with the help of a flowchart.

17. (a) Illustrate how blockchain technology can be implemented in finance sector. **(7)**

(b) Discuss oracles in a blockchain ecosystem. Explain the generic data flow from a smart contract to an oracle. **(7)**

OR

18. (a) Explain the design process of decentralized applications with diagrams. **(7)**

(b) Explain the use of blockchain technology in supply chain management. **(7)**

19. (a) Using Solidity language, create a simple bank contract that allows a user to deposit, withdraw and view balance. **(7)**

(b) Define block difficulty. Explain how block difficulty is adjusted in Ethereum blockchain network. **(7)**

OR

20. (a) Using Solidity language, create a simple voting smart contract where a chairperson will give the right to vote to each address individually. **(7)**

(b) Explain the concept of Gas in Ethereum. Explain how transaction cost can be calculated in an Ethereum blockchain network. **(7)**

Teaching Plan

No	Contents	No. of Lecture Hours (35 hours)
	Module-1 (Fundamentals of Cryptography) (7 hours)	
1.1	Introduction to cryptography	1 hour
1.2	Symmetric cryptography, AES	1 hour
1.3	Asymmetric cryptography, RSA	1 hour
1.4	Elliptic curve cryptography	1 hour
1.5	Digital signatures – RSA digital signature algorithm	1 hour
1.6	Secure Hash Algorithms – SHA-256	1 hour
1.7	Applications of cryptographic hash functions – Merkle trees, Distributed hash tables	1 hour
	Module-2 (Fundamentals of Blockchain Technology) (6 hours)	
2.1	Blockchain – definition and architecture	1 hour
2.2	Elements of blockchain.	1 hour
2.3	Blockchain – benefits and limitations, types.	1 hour
2.4	Consensus – definition, types, consensus in blockchain	1 hour
2.5	Decentralization using blockchain, Methods of decentralization	1 hour
2.6	Routes to decentralization, Blockchain and full ecosystem decentralization	1 hour
	Module-3 (Consensus Algorithms and Bitcoin) (7 hours)	
3.1	Consensus Algorithms – Crash fault-tolerance (CFT) algorithms – Paxos, Raft (working is expected).	1 hour
3.2	Byzantine fault-tolerance (BFT) algorithms – Practical Byzantine Fault Tolerance (PBFT) (working is expected).	1 hour
3.3	Proof of work (PoW), Proof of stake (PoS), Types of PoS	1 hour
3.4	Bitcoin – Definition, Cryptographic keys – Private keys, public keys, addresses.	1 hour
3.5	Transactions – Lifecycle, coinbase transactions, transaction validation	1 hour

3.6	Blockchain – The genesis block. Mining – Tasks of miners	1 hour
3.7	Mining – mining algorithm, hash rate. Wallets – Types of wallets.	1 hour
Module-4 (Smart Contracts and Use cases) (6 hours)		
4.1	Smart Contracts – Definition, Smart contract templates	1 hour
4.2	Oracles, Types of oracles, Deploying smart contracts.	1 hour
4.3	Decentralization terminology –Decentralized applications, Decentralized Autonomous Organizations.	1 hour
4.4	Use cases of Blockchain technology – Government, Health care.	1 hour
4.5	Use cases of Blockchain technology – Finance, Supply chain management.	1 hour
4.6	Blockchain and Allied Technologies – Blockchain and Cloud Computing, Blockchain and Artificial Intelligence.	1 hour
Module-5 (Ethereum and Solidity) (9 hours)		
5.1	Ethereum - The Ethereum network, Components of the Ethereum ecosystem – Keys and addresses, Accounts	1 hour
5.2	Components of the Ethereum ecosystem – Transactions and messages	1 hour
5.3	The Ethereum Virtual Machine	1 hour
5.4	Ethereum Blocks and blockchain	1 hour
5.5	The Solidity language – The layout of a Solidity source code, Structure of a smart contract, variables, data types	1 hour
5.6	The Solidity language – control structures, events, inheritance, libraries	1 hour
5.7	The Solidity language – functions, error handling.	1 hour
5.8	Smart contracts Case study: Voting.	1 hour
5.9	Smart contracts Case study: Auction.	1 hour

CST438	IMAGE PROCESSING TECHNIQUE	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PEC	2	1	0	3	2019

Preamble: This course helps the learners understand the core concepts and applications of Digital Image Processing. It covers Digital Image Fundamentals, Image Transforms, Image Enhancement in Spatial and Frequency Domain, Image Restoration & Image Segmentation and Morphological Operations & Representation and Description. The learners will be able to develop new algorithms, tools, and application software for real-world applications involving image processing.

Prerequisite: A basic knowledge of Computer Graphics and Image representation

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

CO1	Explain the concepts of image formation and the basis of digital image processing. **(Cognitive Knowledge Level: Understand)**
CO2	Demonstrate the role of image transforms in representing, highlighting, and modifying image features. **(Cognitive Knowledge Level: Apply)**
CO3	Solve image enhancement problems using spatial and frequency domain techniques. **(Cognitive Knowledge Level: Apply)**
CO4	Make use of the concept of image restoration and image segmentation techniques in real-world problems. **(Cognitive Knowledge Level: Apply)**
CO5	Interpret morphological operations, image representation, and description techniques. **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔										✔
CO2	✔	✔			✔							✔
CO3	✔	✔	✔									✔
CO4	✔	✔	✔	✔	✔	✔						✔
CO5	✔	✔										✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and teamwork
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test 1 (%)	Test 2 (%)	
Remember	30	30	30
Understand	40	40	40
Apply	30	30	30
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance	**10 marks**
Continuous Assessment Tests (Average of Internal Tests 1 & 2)	**25 marks**
Continuous Assessment Assignment	**15 marks**

Internal Examination Pattern

Each of the two internal examinations has to be conducted out of 50 marks. The first series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing the remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which students should answer anyone. Each question can have a maximum 2 subdivisions and carries 14 marks.

Syllabus

Module – 1 (Digital Image Fundamentals)

Elements of Visual Perception, A Simple Image Formation Model. Spatial and Intensity Resolution. Image Interpolation. Classification of Digital Images. Image Types. Image Storage Mechanisms. Arithmetic and Logical Operations. Geometric Spatial Transformations and Image Registration. Image File Formats. Colour Fundamentals and Colour Models.

Module - 2 (Image Transforms)

Basic concept of spatial domain and frequency domain, Unitary transform, Discrete Fourier Transform- 2D DFT, 4 order DFT Transform coefficients, Forward and inverse transform, Discrete Cosine Transform- 2D DCT, 4 order DCT Transform Coefficients(No derivation needed), Forward and Inverse DCT, Hadamard Transform.

Module - 3 (Image Enhancement in Spatial and Frequency Domain)

Point operations- Clipping and Thresholding, Digital Negative, Intensity Level Slicing, Bit Extraction, Range Compression. Spatial Operations- Fundamentals of spatial convolution and correlation, Spatial averaging and spatial Low pass filtering, Directional Smoothing, Median Filtering, Unsharp masking and Crispening.

Basics of Filtering in Frequency Domain, Filters, Smoothing Frequency Domain Filters-Sharpening Frequency Domain Filters

Module - 4 (Image Restoration & Image Segmentation)

Image degradation model, Noise models, Mean Filters, Order Statistic filter, Adaptive filters.
Edge Detection, gradient operators, Laplace operators and zero crossings. Thresholding, Basic Global Thresholding, Optimum global thresholding using Otsu method, Multiple thresholds, Variable thresholding, Multivariable thresholding. Region-Based Approach to Segmentation.

Module - 5 (Morphological Operations & Representation and Description)

Structuring Element, Dilation and Erosion, Opening and Closing, Hit or Miss Transformation.

Boundary Following. Chain Codes. Polygonal Approximation. Boundary Descriptors. Regional Descriptors. Relational Descriptors.

Text Books

1. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing (English) 3rd Edition, Pearson India, 2013
2. A K. Jain, Fundamentals of digital image processing, Prentice Hall of India, 1989.

Reference Books

1. Al Bovik, The Essential Guide to Image Processing, Academic Press, 2009.
2. Milan Sonka, Vaclav Hlavac and Roger Boyle, Image Processing, Analysis, and Machine Vision, Thomson Learning, 2008.
3. S Jayaraman, S Esakkirajan and T Veerakumar, Digital Image Processing, McGraw Hill Education, 2009.

Course Level Assessment Questions

Course Outcome1 (CO1) :

1. Find the number of bits required to store a 256 X 256 image with 32 gray levels.
2. Explain the reasons for blocking artifacts and false contours in an image.

Course Outcome 2 (CO2) :

1. Compare different image transforms based on their roles, properties and applications.
2. Compute the inverse 2D DFT of the transform coefficients F(k,l) given below.

$$F(k,l) = \begin{pmatrix} 64 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}$$

3. Use Discrete Fourier transform to construct 2D DFT for a 4x4 image given below. Assume that indices start from (0,0)

6	6	6	6
6	6	6	6
6	6	6	6
6	6	6	6

Course Outcome 3 (CO3) :

1. Perform intensity level slicing on the 3 BPP (Bit Per Pixel) image. Let r1=3 and r2=5. Draw the modified image with/without background transformations.

$$\begin{bmatrix} 2 & 1 & 2 & 2 & 1 \\ 2 & 3 & 4 & 5 & 2 \\ 6 & 2 & 7 & 6 & 0 \\ 2 & 6 & 6 & 5 & 1 \\ 0 & 3 & 2 & 2 & 1 \end{bmatrix}$$

2. Let y(m) = {2,3,8,4,2}. Obtain the median filter output for the window W = [-1,0,1,2] and show how salt and pepper noise is reduced.
3. Consider a 3*3 spatial mask that averages the four closest neighbors of a point(x,y), but excludes the point itself from the average.

   (a) Find the equivalent filter H(u,v) in the frequency domain.

   (b) Show that H(u,v) is a lowpass filter (ASSIGNMENT)

Course Outcome 4 (CO4) :

1. Compare Region and Edge-based techniques in segmentation.

2. Consider a noisy image that is restored using arithmetic mean filter of size 3x3 and using the geometric mean filter of the same size. Which image will be less blurred and why?
3. Suppose that you want to help a radiologist to extract the tumor portion from an MRI image for volumetric analysis. This volumetric analysis determines the effect of treatment on the patient, which can be judged from the extracted size and shape of the abnormal portion. Manual tracing of the tumor regions is very difficult since the tumor portion on the MRI image is inhomogeneous, with complex shapes and ambiguous boundaries. Suggest a sequence of steps that you may use to automate this process as an image processing student. (ASSIGNMENT)

Course Outcome 5 (CO5) :

4. Explain the significance of structuring elements in morphological operations with example.
5. Explain how chain codes are used to represent boundaries of a region with examples.

Model Question Paper

QP CODE:

Reg No: _______________

Name: _________________ **PAGES : 4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST438

Course Name: IMAGE PROCESSING TECHNIQUE

Max. Marks : 100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Give an image representation model and describe how the representation changes in different types of images.
2. Describe any three types of color models.
3. Obtain the HADAMARD basis matrix for N=8.
4. Prove that DFT is a unitary transform.
5. Sketch perspective plot of a 2-D ideal low pass filter transfer function and filter cross-section. List its usefulness in Image enhancement.
6. Explain the significance of directional smoothing technique.
7. Specify the significance of the Zero crossing detector.
8. Describe region growing technique for image segmentation.
9. Define 'Structuring Element' used in morphological operations. Give samples for Structuring Elements.
10. Explain image boundary representation using polygonal approximation.

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Explain a Simple Image Formation Model with the help of a neat diagram. **(7)**
    (b) Explain the relationship between image size, spatial resolution, and image quality. Compare gray level and intensity resolution. **(7)**

OR

12. (a) Describe arithmetic, logical and geometrical operations on Image. **(7)**

(b) Explain the significance of image interpolation and describe its various types. **(7)**

13. (a) State the advantages of Discrete Cosine Transform over Discrete Fourier Transform. **(4)**

(b) You are given a 4 X 4 image patch Compute 2D DCT for the image patch. Reconstruct the original image patch by neglecting the last four coefficients in 2D DCT. Comment on the observed result. **(10)**

$$\begin{bmatrix} 12 & 4 & 2 & 6 \\ 5 & 10 & 12 & 24 \\ 6 & 8 & 10 & 12 \\ 14 & 12 & 8 & 10 \end{bmatrix}$$

OR

14. (a) Discuss the concept of sequency in Hadamard transform. **(4)**

(b) Find the 2D forward DFT of the image segment **(10)**

1 1 1 1

1 1 1 1

1 1 1 1

Prove the unitary property of the given image segment.

15. (a) Explain the output and application of the following point processing techniques **(9)**

(i)Range Compression (ii) Bit Extraction (iii) Thresholding

(b) State and explain the features of median filtering. Compute the output of the median filtering for Y(m)={2,4,8,3,2} , w={-1,0,1,2} where Y(m) is an array and w is a window. **(5)**

OR

16. (a) Describe the role of Unsharp masking with its applications **(4)**

(b) Explain and compare the basic frequency domain filters for image sharpening **(10)**

17. (a) A 4×4 image is given by **(8)**

2	4	8	7
12	6	9	8
13	7	4	3
8	12	4	9

Filter the above image using

(a) MIN filter (b) MAX filter using the filter mask

0 1 0
1 1 1
0 1 0

(Assume replicate padding of the input image)

(b) Explain any two types of thresholding techniques. Describe the threshold detection algorithm using Otsu's method. **(6)**

OR

18. (a) Explain Image degradation model with the help of a neat diagram. **(8)**

(b) Illustrate the split and merge algorithm for image segmentation using neat sketches. **(6)**

19. (a) Explain the purpose of morphological operations in digital image? Describe the opening and closing operations with examples. **(7)**

(b) Illustrate Hit or Miss Transformation. **(7)**

OR

20. (a) Explain the concept of the chain coding scheme with its applications. **(6)**

(b) Describe in detail any two boundary representation schemes and illustrate with examples. **(8)**

Teaching Plan

No	Contents	No. of Lecture Hours (36 hrs)
	Module-1 (Digital Image Fundamentals) (7 hours)	
1.1	Elements of Visual Perception, A Simple Image Formation Model	1
1.2	Spatial and Intensity Resolution, Image Interpolation, Classification of Digital Image.	1
1.3	Image Types, Image Storage Mechanisms.	1
1.4	Arithmetic and Logical Operations.	1
1.5	Geometric Spatial Transformations and Image Registration.	1
1.6	Image File Formats.	1

1.7	Colour Fundamentals and Colour Models.	1
	Module-2 (Image Transforms) (8 hours)	
2.1	Basic concept of spatial domain and frequency domain.	1
2.2	Need of Image Transform, Basic properties of unitary transform.	1
2.3	Discrete Fourier transform, Proof DFT is Unitary.	1
2.4	4 order DFT Transform coefficients (Derivation).	1
2.5	Problems (4 order DFT).	1
2.6	Discrete Cosine Transform- 2D DCT.	1
2.7	4 order DCT Transform Coefficients(No derivation needed).	1
2.8	Hadamard Transform.	1
	Module-3 (Image Enhancement in spatial and frequency domain) (8 hours)	
3.1	Point operations- Clipping and Thresholding, Digital Negative. Intensity Level Slicing.	1
3.2	Bit Extraction, Range Compression + (Work out problems).	1
3.3	Spatial Operations-Fundamentals of spatial convolution and correlation.	1
3.4	Spatial averaging and spatial Low pass filtering, Directional Smoothing.	1
3.5	Median Filtering, Unsharp masking and Crispening.	1
3.6	Basics of Filtering in Frequency Domain.	1
3.7	Smoothing Frequency Domain Filters : Ideal Low Pass Filter; Gaussian Low Pass Filter; Butterworth Low Pass Filter;	1
3.8	Sharpening Frequency Domain Filters: Ideal High Pass Filter; Gaussian High Pass Filter; Butterworth High Pass filter.	1
	Module-4 (Image Restoration & Image Segmentation) (6 hours)	
4.1	Image degradation model, Noise models.	1
4.2	Mean Filters – Order Statistic filter – Adaptive filters.	1
4.3	Edge Detection, Gradient operators, Laplace operators and zero crossings.	1

4.4	Thresholding- Basic Global Thresholding, Optimum global thresholding using Otsu method.	1
4.5	Multiple thresholds, Variable thresholding, Multivariable thresholding.	1
4.6	Region-Based Approach to Segmentation.	1
Module-5 (Morphological Operations & Representation and Description) (7 hours)		
5.1	Structuring Element. Dilation and Erosion,	1
5.2	Morphological Opening, Closing.	1
5.3	Hit or Miss Transformation.	1
5.4	Boundary Following. Chain Codes, Polygonal Approximation.	1
5.5	Boundary Descriptors.	1
5.6	Regional Descriptors.	1
5.7	Relational Descriptors.	1

AIT 458	Speech Processing and Analytics	Category	L	T	P	Credit
		Program Elective V	2	1	0	3

Preamble:

This course equips the students to understand the concepts of speech production, speech analysis and speech perception. The course covers speech production, feature extraction and hearing mechanism fundamentals. It helps students to apply speech processing methodologies to real world applications.

Prerequisite: Basic knowledge in signal processing.

Mapping of course outcomes with program outcomes

CO1	Explain speech production and acoustic phonetics **(Cognitive Knowledge Level: Understand)**
CO2	Illustrate time domain and frequency domain analysis **(Cognitive Knowledge Level: Apply)**
CO3	Articulate speech production and feature extraction **(Cognitive Knowledge Level: Apply)**
CO4	Use the applications of speech processing in enhancement, coding and recognition **(Cognitive Knowledge Level: Apply)**
CO5	Explain Signal Processing models of audio perception **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO	✓											✓

1												
CO 2	✔	✔	✔									✔
CO 3	✔	✔	✔	✔	✔							✔
CO 4	✔	✔	✔	✔	✔							✔
CO 5	✔	✔		✔	✔							✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test 1 (%)	Test 2 (%)	
Remember	20	20	20
Understand	50	50	50
Apply	30	30	30
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Continuous Assessment Tests (Average of InternalTests1&2) **25 marks**

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and

Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

SYLLABUS

Module 1

Speech Production:- Acoustic theory of speech production- -Source/Filter model - Pitch, Formant, Spectrogram-- Discrete model for speech production, Articulatory Phonetics -Acoustic Phonetics- Basic speech units and their classification.

Module 2

Short-Time Speech Analysis, Windowing, STFT, spectra of windows- Wide and narrow band spectrogram -Time domain parameters (Short time energy, short time zero crossing Rate, ACF). Frequency domain parameters-Filter bank analysis. STFT Analysis. Prosody of speech.

Module 3

Mel-frequency cepstral coefficient (MFCC)-computation -Pitch Estimation ACF/AMDF approaches, Cepstral analysis- Pitch and Formant estimation using cepstral analysis. LPC Analysis -LPC model, Auto correlation method-Levinson Durbin Algorithm

Module 4

Speech Enhancement: Spectral subtraction and Filtering, Harmonic filtering, parametric resynthesis. Speech coding: fundamentals, class of coders -Time domain/spectral domain/vocoders. Sub band coding, adaptive transform coding, phase vocoder. Speaker Recognition: Speaker verification and speaker identification- log-likelihood. Language identification-implicit and explicit models. Machine learning models in Speaker Recognition

Module 5

Signal Processing models of audio perception: Basic anatomy of hearing System: Basilar membrane behaviour. Sound perception: Auditory Filter

Banks, Critical Band Structure, Absolute Threshold of Hearing, Masking-Simultaneous Masking, Temporal Masking. Models of speech perception

Text Books

1. Douglas O'Shaughnessy, *Speech Communications: Human & Machine*, IEEE Press,

Hardcover 2nd edition, 1999; ISBN: 0780334493.

2. Thomas F. Quatieri, Discrete-*Time Speech Signal Processing: Principles and Practice,*

Prentice Hall,1 edition,2001.

Reference Books

1. Rabiner and Schafer, *Theory and Application of Digital Processing of Speech Signals,*

Prentice Hall, 2010

2. Nelson Morgan and Ben Gold, *Speech and Audio Signal Processing: Processing and*

Perception Speech and Music, July 1999, John Wiley & Sons, 2nd edition, 2011

3. Rabiner and Juang, *Fundamentals of Speech Recognition,* Prentice Hall, 1994.

Course Level Assessment Questions

Course Outcome1 (CO1):

1. What are liquids and glides. Give one example for each.
2. What is the range of pitch values for male and female speakers

Course Outcome 2(CO2):

1. Explain the difference between narrowband and wideband spectrogram
2. What is prosody of speech?

Course Outcome 3(CO3):

1. What is MFCC?
2. Apply ACF/AMDF approaches for pitch estimation

Course Outcome 4(CO4): .

1. Apply sub-band approach for speech coding
2. What is the latest trends in machine learning for speech recognition?

Course Outcome 5(CO5):

1. What is absolute threshold of hearing?.
2. Explain two models for speech perception.

Model Question Paper		
QP CODE:		
Reg No: _______________		
Name: _________________ PAGES : 4		
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY		
EIGHTH SEMESTER B. TECH DEGREE EXAMINATION, MONTH & YEAR		
Course Code: AIT 458		
Course Name: Speech Processing and Analytics		
Max.Marks:100 **Duration: 3 Hours**		
PART A		
Answer All Questions. Each Question Carries 3 Marks		
1.	Define vowel triangle with a neat illustration. Mark the vertices in Hz.	
2.	Explain narrow-band spectrogram. What is the typical window length used for computing narrow-band spectrogram?	
3.	Give equation to compute ZCR? Why it is not considered as a robust parameter ?	
4.	How silence can be discriminated from speech using time domain parameters?	
5.	What is Mel scale? What is frequency warping?	
6.	Explain autocorrelation method of LPC parameter estimation?	
7.	What is the concept of phase vocoder?	

8.		What is log-likelihood in speaker recognition model?	
9.		Differentiate spectral and temporal masking.	
10.		What is absolute threshold of hearing ?.	**(10x3=30)**
		Part B **(Answer any one question from each module. Each question carries 14 Marks)**	
11.	(a)	Explain speech production mechanism with a neat diagram	**(10)**
	(b)	What are the basic speech units? How can you distinguish a voiced speech segment from an unvoiced speech segment?	**(4)**
		OR	
12.	(a)	Why speech signal is considered to be highly redundant? Assuming a speaker is producing 10 phonemes per second and there are 64 distinct phonemes, find the average information rate of speech signal.	**(10)**
	(b)	Explain source filter model of speech production. What are the limitations of this model?	**(4)**
13.		Give the equation for STFT. How can you use it to measure the formant frequencies of speech signal?	**(14)**
		OR	
14.	a	Explain with equations (a) Short time energy (b) ACF	**(9)**

	b	Are Short time energy and ACF parameters dependent on the window length used during analysis? Justify your answer.	**(5)**
15.	a	Derive Levinson-Durbin algorithm for LPC coefficients. How will you fix order of LPC?	**(10)**
	b	What is the effect of using a very high order for LPC?	**(4)**
		OR	
16.		What is liftering in cepstral processing?	**(4)**
		Explain the steps involved in MFCC computation.	**(10)**
17.	(a)	How doesparametric resynthesis achieve speech enhancement?	**(8)**
	(b)	Explain adaptive transform coding	**(6)**
		OR	
18.	(a)	What is harmonic filtering?	**(6)**
	(b)	What is implicit and explicit models of Language identification?	**(8)**
19.	(a)	Explain basic anatomy of hearing system with a neat diagram. What you mean by tonotopic behaviour of basilar membrane?	**(7)**
	(b)	What is critical band structure? Differentiate between simultaneous and non-simultaneous masking.	**(7)**
		OR	
20.	(a)	Explain any three models of speech perception	**(7)**
	(b)	Explain auditory filter banks with neat illustrations	**(7)**

Teaching Plan

No	Contents	No. of Lecture Hours (36 hrs)
	Module-1 (6 hours)	
1.1	Speech Production:- Acoustic theory of speech production	1 hour
1.2	Source/Filter model	1 hour
1.3	Pitch, Formant, Spectrogram	1 hour
1.4	Discrete model for speech production	1 hour
1.5	Articulatory Phonetics	1 hour
1.6	Acoustic Phonetics- Basic speech units and their classification.	1 hour
	Module-2 (6 hours)	
2.1	Short-Time Speech Analysis, Windowing, STFT,	1 hour
2.2	Spectra of windows- Wide and narrow band spectrogram	1 hour
2.3	Time domain parameters (Short time energy, short time zero crossing Rate, ACF).	1 hour
2.4	Frequency domain parameters	1 hour
2.5	Filter bank analysis. STFT Analysis	1 hour
2.6	Prosody of speech.	1 hour
	Module-3 (7 hours)	
3.1	Mel-frequency cepstral coefficient (MFCC)-computation	1 hour
3.2	Pitch Estimation ACF/AMDF approaches,	1 hour
3.3	Cepstral analysis- Pitch and Formant estimation using cepstral analysis	1 hour
3.4	*LPC Analysis* -LPC model	1 hour
3.5	Auto correlation method	1 hour
3.6	Levinson Durbin Algorithm	2hours

Module-4 (9 hours)		
4.1	*Speech Enhancement*: Spectral subtraction and Filtering,	1 hour
4.2	Harmonic filtering, parametric resynthesis.	1 hour
4.3	*Speech coding*: fundamentals, class of coders -Time domain/spectral domain/vocoders.	1 hour
4.4	Sub band coding, adaptive transform coding, phase vocoder	1 hour
4.5	*Speaker Recognition*: Speaker verification	1 hour
4.6	Speaker identification- log-likelihood.	1 hour
4.7	*Language identification*-implicit and explicit models.	1 hour
4.8	*Machine learning* models in Speaker Recognition -I	1 hour
4.9	*Machine learning* models in Speaker Recognition-II	1 hour
Module-5 (8 hours)		
5.1	signal Processing models of audio perception	1 hour
5.2	Basic anatomy of hearing System: Basilar membrane behavior.	1 hour
5.3	Sound perception: Auditory Filter Banks	1 hour
5.4	Critical Band Structure, Absolute Threshold of Hearing,	1 hour
5.5	Masking-Simultaneous Masking,	1 hour
5.6	Temporal Masking.	1 hour
5.7	Models of speech perception-I	1 hour
5.8	Models of speech perception-II	1 hour

CST458	SOFTWARE TESTING	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PEC	2	1	0	3	2019

Preamble: This is a course in theoretical computer science that introduces the concepts and methods in software testing. It covers various techniques for test case design used to test software artifacts, including requirements, design, and code, the different techniques for test case design based on graphs, programming language syntaxes and symbolic execution using PEX tool. It enables the learners to follow a systematic software testing approaches while developing applications.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to:-

CO1	List a range of different software testing techniques and be able to apply specific unit testing method to the projects using Junit**.(Cognitive Knowledge Level: Understand)**
CO2	Illustrate using appropriate tools the mutation testing method for a given piece of code to identify hidden defects that can't be detected using other testing methods.**(Cognitive Knowledge Level: Apply)**
CO3	Explain graph coverage criteria in terms of control flow graph and data flow graph for a given program.**(Cognitive Knowledge Level: Understand**)
CO4	Demonstrate the importance of black-box approaches in terms of domain and functional testing.**(Cognitive Knowledge Level: Apply)**
CO5	Illustrate the use of PEX tool with symbolic execution.**(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO10	PO11	PO12
CO1	✓	✓	✓									✓
CO2	✓	✓	✓	✓	✓					✓		✓
CO3	✓	✓	✓							✓		✓
CO4	✓	✓	✓	✓								✓

CO5	✔	✔	✔	✔	✔					✔		✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Life long learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks**
	Test 1 (Marks)	**Test 2 (Marks)**	
Remember	30	30	30
Understand	40	40	40
Apply	30	30	30
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance	**10 marks**
Continuous Assessment Tests(Average of SeriesTests1& 2)	**25 marks**
Continuous Assessment Assignment	**15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module - 1 (Introduction to Software Testing)

Some Popular Errors – Ariane 5, Therac 25, Intel Pentium Bug. What is Software testing? Why should it be tested? Software Quality, Role of Testing. Testing Process - Level 0 thinking, Level 1 thinking, Level 2 thinking, Level 3 thinking, Level 4 thinking. Software Testing Terminologies - Verification, Validation and Testing, Faults, Error and Bug, Test cases, Coverage Criteria. Types of Testing- Unit testing, integration testing, System testing, Acceptance testing, Beta testing, Functional testing, Stress testing, Performance testing, Usability testing and Regression testing. Testing Methods - Black Box testing, White Box testing, Grey Box testing.

Module - 2 (Unit Testing)

Concept of Unit testing. Static Unit testing. Dynamic Unit testing - Control Flow testing, Data Flow testing, Domain testing, Functional Program testing. Mutation testing - Mutation and Mutants, Mutation operators, Mutation score. Junit - Framework for Unit testing. Case Study - Mutation testing using Junit and Muclipse.

Module - 3 (Unit Testing - White Box Approaches)

Overview of Graph Coverage Criteria. Structural Graph Coverage Criteria - Node/vertex coverage, Edge coverage, Edge pair coverage, Path coverage, Complete path coverage, Prime path coverage, Complete round trip coverage, Simple round trip coverage. Data Flow Criteria - du paths, du pairs. Subsumption Relationships among Graph Coverage Criteria. Graph Coverage for Source Code - Control flow graphs for code, CFG: If statement, CFG: If statement with return, CFG: Switch-case, CFG: Loops, CFG: Exceptions (try-catch). Example program – Statistics. Graph Coverage for Design Elements - Call graphs and classes, Class inheritance testing: Coverage criteria, Coverage criteria on inheritance graph, Data flow at the design level, Inter-procedural DU pairs, Coupling du-pairs example. Example - Quadratic Root. Case Study - Graph Based testing using JUnit Framework.

Module - 4 (Unit Testing - Black Box Approaches)

Domain Testing / Input Space Partitioning - Partitions of a set. Input domain modelling - Interface-based approach, Functionality-based approach. Identifying values. Multiple partitions of the input domain - All Combinations Coverage (ACoC), Each Choice Coverage (ECC), Pair-wise Coverage, T-wise Coverage, Base Choice Coverage, Multiple Base Choices Coverage. TriTyp example. Functional Testing - Functional Testing Concepts of Howden. Functional testing - Important Steps. Types of Functional testing - Equivalence Class Partitioning, Boundary Value Analysis, Decision Tables, Random Testing. Case Study - Black Box testing approaches using JUnit.

Module - 5 (Grey Box Testing Approaches)

Introduction to Grey Box testing - Why Grey Box testing, Gray Box Methodology, Advantages and Disadvantages. Techniques of Grey Box Testing - Matrix Testing, Regression Testing, Orthogonal Array Testing or OAT, Pattern Testing. An Introduction to PEX - Parameterized Unit Testing, The Testing Problem. Symbolic Execution – Example, Symbolic execution tree. PEX application Case Study – PEX.

Text Books

1. Paul Ammann and JeffOffutt , Introduction to Software Testing, Cambridge University Press
2. Kshirasagar Naik and Priyadarshi Tripathy, Software Testing And Quality Assurance: Theory And Practice, Wiley.

Reference Materials

1. King, James C, "Symbolic Execution and Program Testing", Association for Computing Machinery, July 1976.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

Explain the following types of testing methods with examples.

(i) Balck-box testing.

(ii) White-box testing.

(iii) Grey-box testing.

Course Outcome 2 (CO2):

Define 12 mutants for the following method *power*() using effective mutation operators. Try to use each mutation operator at least once. Approximately, how many mutants do you think there would be, if all mutants for *power*() were created?

```
public static int power (int left, int right)
{
//**************************************
// Raises Left to the power of Right
// precondition : Right >= 0
// postcondition: Returns Left**Right
//**************************************
```

```
intrslt;
rslt = Left;
if (Right == 0)
{
rslt = 1;
}
else
{
for (int i = 2; i <= Right; i++)
rslt = rslt * Left;
}
return (rslt);
}
```

Course Outcome 3 (CO3):

Draw the control flow graph and data flow graph of given piece of code.

```
public static double ReturnAverage(int value[],int AS, int MIN, int MAX){
/*
Function: ReturnAverageComputes the averageof all those numbers in the input array in
the positive range [MIN, MAX]. The maximum size of the array is AS. But, the array size
could be smaller than AS in which case the end of input is represented by -999.
*/
int i, ti, tv, sum;
doubleav;
i = 0; ti = 0; tv = 0; sum = 0;
while (ti< AS && value[i] != -999) {
ti++;
if (value[i] >= MIN && value[i] <= MAX) {
tv++;
sum = sum + value[i];
}
i++;
}
```

```
if (tv> 0)
av = (double)sum/tv;
else
av = (double) -999;
return (av);
}
```

Course Outcome 4 (CO4):

Explain the following with examples.

1. Input domain modelling.
2. All Combinations Coverage (ACoC)
3. Each Choice Coverage (ECC)
4. Pair-wise Coverage
5. T-wise Coverage
6. Base Choice Coverage
7. Multiple Base Choices Coverage.

Course Outcome 5 (CO5):

Draw the symbolic execution tree for the following program code and explain the symbolic execution of testme (α1, α2).

```
int twice (int v) {
 return 2 ∗ v;
 }
 void testme (int x, int y ) {
 z = twice ( y);
 if ( z == x ){
 if ( x > y + 10)
ERROR;
 }
 }
int main() {
 x = sym input();
 y = sym input();
testme ( x , y);
```

return(0);

Model Question Paper

QP CODE: **PAGES: 3**

Reg No:______________ **Name :______________**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST458

Course Name: Software Testing

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. Explain the differences between Validation and Verification?
2. Explain the differences between Fault, Error, and Bug?
3. Define Ground string, Mutation score, and Mutants?
4. What are the functions of Test driver and Test stubs in dynamic unit testing?
5. Define Node coverage, Edge coverage and Prime path coverage in a control flow graph?
6. What are du paths and du pairs in a data flow graph?
7. Explain the two approaches in input domain modelling?
8. Explain the difference between Equivalence Class Partitioning and Boundary Value Analysis?
9. Briefly explain three techniques of Grey box testing?
10. Explain the concept of symbolic execution with the help of a toy example?

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Explain the following types of testing

(i) Black Box testing (ii) White Box testing (iii) GreyBox testing (iv) Unit testing (v) Integration testing (vi) System testing (vii) Acceptance testing **(14)**

OR

12. (a) Explain the following coverage criterias based on the code fragment given below? (i) Functional coverage (ii) Statement coverage (iii)Conditional coverage (iv)Branch coverage **(8)**

```
int foo (int x, int y){
    int z = 0;
    if ((x > 0) && (y > 0)){
    z = x;}
    return z;
    }
```

(b) Write positive and negative test cases for an ATM Machine? **(6)**

13. (a) Explain Dynamic unit test environment with a neat figure. **(8)**

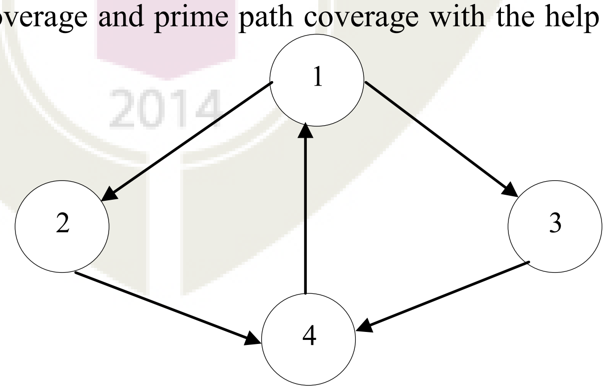
(b) Explain the major difference between control flow testing and data flow testing. **(6)**

OR

14. (a) Explain seven types of mutation operators with neat examples? **(14)**

15. (a) Explain touring, side trips and detours with a neat example **(7)**

(b) Explain simple path coverage and prime path coverage with the help of CFG given below? **(7)**



OR

16. (a) Draw CFG fragment for **(7)**

(i) Simple *if* (ii) Simple *while* loop (iii) Simple *for* loop

(b) Explain the following concepts with examples? **(7)**

(i)Call graph (ii) Inheritance graph (iii) Coupling du-pairs

17. (a) What are the four important steps in functional testing? **(7)**

(b) Briefly explain input domain modelling approaches? **(7)**

OR

18. (a) Consider the triangle classification program with a specification: **(6)**

The program reads floating values from the standard input. The three values *A*, *B*, and *C* are interpreted as representing the lengths of the sides of triangle. The program then prints a message to the standard output that states whether the triangle, if it can be formed, is scalene, isosceles, equilateral, orright angled. Determine the following for the above program:

(i) For the boundary condition $A + B > C$ case (scalene triangle), identify test cases to verify the boundary.

(ii) For the boundary condition $A = C$ case (isosceles triangle), identify testcases to verify the boundary.

(iii) For the boundary condition $A = B = C$ case (equilateral triangle), identify testcases to verify the boundary.

(b) Develop a decision table to generate test cases for this specification. **(8)**

19. (a) Explain the importance of grey box testing, its advantages and disadvantages? **(9)**

(b) Explain the concept of symbolic execution tree? **(5)**

OR

20. (a) Consider the code fragment given below: - **(7)**

1. POWER: PROCEDURE(X, Y);
2. Z ← 1;

3. J ← 1;
4. LAB: IF Y ≥ J THEN
5. DO; Z← Z * X;
6. J ← J + 1;
7. GO TO LAB; END;
8. RETURN (Z) ;
9. END;

a) Explain Symbolic execution of POWER (αl, α2).

(b) Explain Execution tree for POWER (αl, α2). **(7)**

TEACHING PLAN

No	Contents	No of Lecture Hrs (35 hrs)
	Module 1 (Introduction to Software Testing) -(7 Hours)	
1.1	Some Popular Errors– Ariane 5, Therac 25, Intel Pentium Bug.	1 Hour
1.2	What is Software testing? Why should it be tested? Software Quality, Role of Testing.	1 Hour
1.3	Testing Process - Level 0 thinking, Level 1 thinking, Level 2 thinking, Level 3 thinking, Level 4 thinking.	1 Hour
1.4	Software Testing Terminologies- Verification, Validation and Testing, Faults, Error and Bug, Test cases, Coverage Criteria.	1 Hour
1.5	Types of Testing- Unit testing, integration testing, System testing, Acceptance testing, Beta testing	1 Hour
1.6	Functional testing, Stress testing, Performance testing, Usability testing and Regression testing.	1 Hour
1.7	Testing Methods - Black Box testing, White Box testing, Grey Box testing.	1 Hour
	Module 2 (Unit testing)- (6 Hours)	
2.1	Concept of Unit testing, Static Unit Testing	1 Hour

2.2	Dynamic Unit testing - Control Flow testing, Data Flow testing, Domain testing, Functional Program testing.	1 Hour
2.3	Mutation testing - Mutation and Mutants, Mutation operators, Mutation score.	1 Hour
2.4	Junit - Framework for Unit testing.	1 Hour
2.5	Case Study - Mutation testing using Junit	1 Hour
2.6	Case Study - Mutation testing using Muclipse	1 Hour
Module 3 (Unit Testing:- White Box Approaches)- (8 Hours)		
3.1	Structural Graph Coverage Criteria - Node/vertex coverage, Edge coverage, Edge pair coverage, Path coverage	1 Hour
3.2	Complete path coverage, Prime path coverage, Complete round trip coverage, Simple round trip coverage.	1 Hour
3.3	Data Flow Criteria - du paths, du pairs	1 Hour
3.4	Subsumption Relationships among Graph Coverage Criteria	1 Hour
3.5	Graph Coverage for Source Code – Control Flow Graphs (CFG) for code, CFG: If statement, CFG: If statement with return, CFG: Switch-case, CFG: Loops, CFG: Exceptions (try-catch). Example program - Statistics	1 Hour
3.6	Graph Coverage for Design Elements – Structural graph coverage and data flow graph coverage for design elements	1 Hour
3.7	Case Study - Graph Based testing using JUnit Framework. (Lecture 1)	1 Hour
3.8	Case Study - Graph Based testing using JUnit Framework. (Lecture 2)	1 Hour
Module 4 (Unit Testing:- Black Box Approaches) -(7 Hours)		
4.1	Domain Testing / Input Space Partitioning - Partitions of a set.	1 Hour
4.2	Input domain modelling - Interface-based approach, Functionality-based approach.	1 Hour

4.3	Multiple partitions of the input domain - All Combinations Coverage (ACoC), Each Choice Coverage (ECC), Pair-wise Coverage, T-wise Coverage, Base Choice Coverage, Multiple Base Choices Coverage.	1 Hour
4.4	Functional Testing - Functional Testing Concepts of Howden. Important Steps.	1 Hour
4.5	Types of Functional testing - Equivalence Class Partitioning, Boundary Value Analysis	1 Hour
4.6	Decision Tables, Random Testing.	1 Hour
4.7	Case Study - Black Box testing approaches using JUnit.	1 Hour
	Module 5 (Grey Box Testing Approaches)- (7 Hours)	
5.1	Introduction to Grey Box testing - Why Grey Box testing, Gray Box Methodology, Advantages and Disadvantages.	1 Hour
5.2	Techniques of Grey Box Testing - Matrix Testing, Regression Testing, Orthogonal Array Testing or OAT, Pattern Testing.	1 Hour
5.3	An Introduction to Pex - Parameterized Unit Testing, The Testing Problem.	1 Hour
5.4	Symbolic Execution – Example, Symbolic execution tree.	1 Hour
5.5	Case Study – PEX (Lecture 1)	1 Hour
5.6	Case Study – PEX (Lecture 2)	1 Hour
5.7	Case Study – PEX (Lecture 3)	1 Hour

CST468	BIOINFORMATICS	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PEC	2	1	0	3	2019

Preamble: This course helps 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 process.

Prerequisite: Basic background in higher secondary biology

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

CO 1	Describe the basic concepts of Bioinformatics with an emphasis on structure, function and synthesis of biomolecules (**Cognitive knowledge level : Understand**)
CO 2	Identify biological data formats and databases, retrieve bio-sequences, and align bio-sequences to identify similarity (**Cognitive knowledge level : Apply)**
CO 3	Employ similarity searching tools and algorithms to align sequences to highlight the similarity, and describe the structure of genes (**Cognitive knowledge level : Apply)**
CO 4	Demonstrate Protein Structure, visualize protein structure using tools, and explain how proteins interact (**Cognitive knowledge level : Apply)**
CO 5	Explain the fundamental aspects of Systems Biology, Computational Modeling and properties of models (**Cognitive knowledge level : Understand**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔										✔
CO2	✔	✔	✔	✔	✔							✔
CO3	✔	✔	✔	✔	✔							✔

CO4	✔	✔	✔	✔								✔
CO5	✔	✔			✔							✔

PO#	Broad PO	PO#	Broad PO
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	Test1 (%)	**Test2 (%)**	
Remember	**30**	**30**	**30**
Understand	**50**	**50**	**50**
Apply	**20**	**20**	**20**
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance	**10 marks**
Continuous Assessment Tests (Average of Series Tests 1& 2)	**25 marks**
Continuous Assessment Assignment	**15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module-1 (Introduction to bioinformatics)

Introduction to bioinformatics, Nature & Scope of Bioinformatics, DNA, RNA, and Protein: The Central Dogma, Messenger RNA, tRNA, rRNA, Genetic code, Gene Structure and Control, Transcription, translation

Module-2 (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

Module-3 (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

Module-4 (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

Module-5 (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

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 Level Assessment Questions

Course Outcome 1 (CO1):

1. Compare and contrast the DNA and RNA on the basis of structure and functions.
2. Demonstrate with the help of a flow diagram the generation of protein using the transcription and translation process.

Course Outcome 2 (CO2):

1. Download DNA sequence of human insulin form NCBI
2. Identify the following qualifiers for GenBank and give their definitions: [ACCN], [ALL], [AUTH], [ECNO], [FKEY], [GENE], [JOUR], [KYWD]
3. Construct a dot plot and find the sequence alignment between the following two sequences:
   Sequence1: GATTCTATCTAACTA, Sequence2: GTTCTATTCTAAC

Course Outcome 3 (CO3):

1. Apply Needleman-Wunsch Algorithm to perform sequence alignment for the following sequences: CGTGAATTCAT (sequence #1), GACTTAC (sequence #2)
2. Construct a BLAST procedure for sequence alignment(HSP) if a sequence and its corresponding database sequence are given. Assume the necessary data and demonstrate the procedure.

Course Outcome 4 (CO4):

1. Differentiate between the different protein molecular structure visualizations. Also mention the advantages and uses of each visualization technique.
2. Make use of an example and demonstrate the steps in protein comparison. Show how root mean square deviationis calculated while comparing two proteins.

Course Outcome 5 (CO5):

1. Explain how systems biology is used in data integration.
2. Explain the process of model development.

Model Question Paper

QP CODE:

Reg No: _______________

Name: ___________________ **PAGES : 3**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST468

Course Name: Bioinformatics

Max. Marks : 100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Differentiate DNA, Gene, genome and chromosome.
2. What are the functions of mRNA, tRNA and rRNA?
3. What do you mean by Gene expression?
4. Write difference between local and global alignment.
5. Write short note on Gap penalties and its usage in comparing Biological sequences.
6. List any three typesof BLAST and make short description on each.
7. What are the principle underlying the formation of Ramachandran plot?.
8. What are the experimental methods for determining protein structure?
9. What do you mean by steady state in a biological system.
10. Justify the statement - systems are modular. **(10x3=30)**

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) What is the central dogma of molecular biology? **(6)**

    (b) Explain the steps involved in the process of transcription. How is the primary transcript produced by a prokaryote different from that produced by a eukaryotic cell? **(8)**

OR

12. (a) Discuss translation process in protein synthesis. **(6)**

(b) Explain bio-molecules involved in central dogma, its structure and types. **(8)**

13. (a) Explain the importance of Primary and secondary databases in Bioinformatics **(6)**

(b) Illustrate the methods of pairwise sequence alignment. What is the use of assigning gap penalties in alignment? **(8)**

OR

14. (a) Illustrate sequence alignment. What are the applications of sequence alignment in Bioinformatics? **(7)**

(b) What is the use of scoring matrices? Differentiate between PAM and BLOSUM matrices and its usage in alignment. **(7)**

15. (a) Using Needleman and Wunsch dynamic programming method, construct the partial alignment score table for the following two sequences, using the scoring parameters: match score: +5, mismatch score: -1, gap penalty: -2. **(9)**
CCATGCU
GATTACA
Also write down the optimal global alignment between these sequences along with the optimal score.

(b) Interpret the blast result and statistical significance of the alignment by analyzing the results. **(5)**

OR

16. (a) Using Smith Waterman method construct the partial alignment scoring table and obtain the optimal local alignment of the following two sequences: **(9)**
ACGTATCGCGTATA
GATGCTCTCGGAJAA

(b) Illustrate multiple sequence alignment. **(5)**

17. (a) Discuss hierarchies of protein structure. **(6)**

(b) Explain how the protein structure is determined by using experimental techniques. **(8)**

OR

18. (a) Discuss protein interaction. How it contributes to the complexity of an organism? **(9)**

(b) Discuss on Protein Structure Database. **(5)**

19. (a) Discuss systems biology approach of understanding complex biological systems. **(6)**

(b) Explain on Variables, Parameters, and Constants in modeling biological systems. **(8)**

OR

20. (a) Explain on advantages of Computational Modeling of biological system. **(7)**

(b) What are the properties of models in biological system? **(7)**

TEACHING PLAN

No	Contents	No of Lecture (36 Hrs)
	Module-1 (Introduction to bioinformatics)(8 hrs) Text 1 (Relevant topics from chapter 1.1, 1.2, 1.3)	
1.1	Introduction to bioinformatics	1
1.2	Nature & Scope of Bioinformatics	1
1.3	DNA, RNA, and Protein	1
1.4	The Central Dogma introduction	1
1.5	Messenger RNA, tRNA, rRNA,	1
1.6	Genetic code,	1
1.7	Gene Structure and Control	1
1.8	Transcription, Translation	1
	Module-2 (Introduction to bio sequences and analysis) (7 hrs) Text 2 (Relevant topics from chapter 2, 3)	
2.1	Introduction to Biological Databases	1
2.2	NCBI Sequence retrieval	1
2.3	Genbank, Bio sequence formats- FASTA	1
2.4	Sequence alignment- Global Alignment and Local Alignment	1
2.5	Dot Matrix Method, Dynamic Programming Method	1

2.6	Gap Penalties	1
2.7	Amino Acid Scoring Matrices – PAM, BLOSUM	1
Module-3 (Database Similarity Searching and genomics) (7 hrs) Text 2 (Relevant topics from chapter 4 5 and 8)		
3.1	Database Similarity Searching, BLAST, Variants of BLAST - BLASTN, BLASTP, BLASTX	1
3.2	BLAST Analysis - Statistical Significance	1
3.3	Needleman and Wunsch Method	1
3.4	Smith–Waterman Method	1
3.5	Multiple Sequence Alignment, scoring function	1
3.6	Clustal tool	1
3.7	Gene Structure of prokaryotic, eukaryote	1

Module-4 (Proteomics) (7 hrs) Text 2 (Relevant topics from chapter 12, 13 and 19)		
4.1	Protein Structure, Ramachandran Plot	1
4.2	Hierarchies of Protein Structure	1
4.3	Determination of Protein three-dimensional structure	1
4.4	protein structure database-PDB	1
4.5	Protein structure visualization	1
4.6	Protein protein interaction	1
4.7	Protein protein interaction networks, STRING database	1
Module-5 (Systems Biology) (7 hrs) Text 3 (Relevant topics from Section 1.1-1.4)		
5.1	Introduction to Systems Biology, Properties of models	1
5.2	Systems state and steady state	1
5.3	Variables, Parameters, and Constants in modelling	1
5.4	Purpose and Adequateness of Models	1
5.5	Advantages of Computational Modelling ,Model Development (introduction only)	1
5.6	Network Versus Elements, Modularity,	1

5.7	Robustness and Sensitivity, Data Integration	1

CST478	COMPUTATIONAL LINGUISTICS	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PEC	2	1	0	3	2019

Preamble: The course aims to teach the basics of Computational Linguistics to the students viewing language phenomena from a computational/statistical standpoint. This involves ideas about statstical 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.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

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

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											✓
CO2	✓	✓										✓
CO3	✓	✓	✓									✓
CO4	✓		✓		✓							✓
CO5	✓	✓	✓									✓
CO6	✓	✓	✓	✓	✓							✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test 1 (%)	Test 2 (%)	
Remember	30	30	30
Understand	30	30	30
Apply	40	40	40
Analyze			
Evaluate			

Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3Hrs

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Continuous Assessment Tests(Average of SeriesTests1& 2) **25 marks**

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module- 1 (Preliminaries)

Introduction: Rationalist and Empiricist Approaches to Language-Questions that linguistics should answer-Noncategorical phenomena in language-Language and 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 and 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

Module -2 (Mathematical Essentials:)

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-Reliability vs discrimination-n gram models

Markov Models-Hidden Markov Models-Why use HMMs?-General form of an HMM-Finding the probability of an observation-Finding the best state sequence

Module -3 (Word Sense Disambiguation)

Methodological Preliminaries- Supervised and unsupervised learning-Pseudowords-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 Subcategorization -Attachment Ambiguity-PP attachment- Selectional Preferences

Semantic Similarity: Vector space measures-Probabilistic measures

Module -4 (Grammar)

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 versus language model

Module -5 (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, different types of parsers and dependency parsing.

Text Books :

1. C.D. Manning and H. Schutze. Foundations of Statistical Natural Language Processing. MIT Press.
2. Steven Bird, Ewan Klein, Edward Loper, 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.
2. James Allen: Natural Language Understanding. Pearson Pub.
3. Nitin Hardeniya, Jacob Perkins, Deepti Chopra, Nisheeth Joshi, ItiMathur: Natural Language Processing: Python and NLTK., 1st Edition. Packt Publishing

Course Level Assessment Questions

Course Outcome 1 (CO1):
1. What do you understand by the term *collocations?* List their properties.
2. Define the term phrase structure grammar formally.

Course Outcome 2 (CO2):
1. State Bayes' theorem and explain briefly. Comment on it's usefulness in NLP.
2. How can n-grams be used to model natural language statistically?

Course Outcome 3 (CO3):
1. What is meant by attachment ambiguity? Show it using English sentences
2. What is meant by Word Sense Disambiguation (WSD)? Outline any one WSD algorithm

Course Outcome 4 (CO4):
1. How can HMM be used for Parts of speech tagging?
2. Outline an implementation procedure for HMM

Course Outcome 5 (CO5):
1. Show with an example how can probabilistic grammars be used to model human preferences in parsing.
2. Give the technique of Transformation-Based Learning of Tags

Course Outcome 6 (CO6):
1. Implement a python program for stop word removal in a simple paragraph.
2. Write a code to access a weather site and extract the forecast top temperature for your town or city today.

Model Question Paper

QP CODE:

Reg No: _______________

Name: _________________ **PAGES : 3**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST478

Course Name: Computational Linguistics

Max. Marks : 100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Define Zipf's law.
2. List the uses of a corpus in language processing?
3. What is a Hidden Markov Model?
4. State Bayes' theorem and explain briefly. Comment on its usefulness in NLP.
5. What is meant by supervised disambiguation? What are its prerequisites ?
6. Consider the sentence: "the children ate the cake with a spoon". Construct the parse tree for it and explain the attachment ambiguity.
7. Discuss the properties of Markov chain useful in POS tagging.
8. Explain the features of PCFG.
9. What is NLTK? How is it useful in text processing ?
10. Write a Python program to extract different date formats from a text document.

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Write a note on the following terms with example: **(9)**
(i) Collocations (ii) Concordances (iii) Phrase structure grammars

(b) Differentiate stemming and lemmatization with examples. **(5)**

OR

12. (a) Write a note on all parts of speech tags of English language **(9)**

(b) What are the differences between Rationalist and Empiricist to Language approaches **(5)**

13. (a) What do you mean by a probability distribution? **(5)**
What are the approaches used in SNLP to estimate probability distribution of linguistic events?

(b) Give a formal definition of Hidden Markov Model (HMM) and state the relevant assumption while using HMM for language modeling **(9)**

OR

14. (a) Assume that a particular type of syntactic error detected by a system A occurs once in 1,00,000 sentences on an average. This system detects an error correctly with a probability 0.05. Suppose the system reports an error in a test sentence. What is the probability that this is true? **(5)**

(b) List some of the problems associated with sparse data in SNLP. **(9)**
Write a note on n-gram Models over Sparse Data

15. (a) What do you understand by Disambiguation based on sense definitions. **(9)**
Write and explain any one algorithm for this.

(b) With the help of Bayes' rule, explain the Bayesian disambiguation algorithm. **(5)**

OR

16. (a) Write a note on selectional preferences with an example **(5)**

(b) What is meant by attachment ambiguity? List different attachment issues. **(9)**

17. (a) Write a note on Transformation-Based Learning of tags. Give it's algorithm **(9)**

(b) How can HMM be used for parts of speech tagging **(5)**

OR

18. (a) Write the formal definition of PCFG. **(5)**

Apply probabilistic parsing on the following sentence and find the correct parsing using the given grammar

Sentence: Astronomers saw stars with ears.

Probabilistic grammar:

S → NP VP	1.0	NP → NP PP	0.4
PP → P NP	1.0	NP → *astronomers*	0.1
VP → V NP	0.7	NP → *ears*	0.18
VP → VP PP	0.3	NP → *saw*	0.04
P → *with*	1.0	NP → *stars*	0.18
V → *saw*	1.0	NP → *telescopes*	0.1

(b) How do you find the probability of a string using inside and outside probabilities ? **(9)**

19. (a) Write a Python program for PoS tagging using the necessary Python packages. **(9)**

(b) Explain the process of Named Entity Recognition. **(5)**
List its uses and challenges involved.

OR

20. (a) Write a regular expression for removing punctuations, numbers and white spaces in a piece of text. **(9)**

(b) Write a Python program to count the number of sentences, words and line numbers in a given piece of text. Display each sentence along with that. **(5)**

TEACHING PLAN

No	Contents	No of Lecture Hrs (36 hrs)
	Module - 1 (Preliminaries) (9 hrs)	
1.1	Introduction: Rationalist and Empiricist Approaches to Language-Questions that linguistics should answer-	1
1.2	Non-categorical phenomena in language-Language and cognition as probabilistic phenomena	1
1.3	The Ambiguity of Language: Why natural language processing is difficult	1
1.4	Lexical resources-Word counts	1
1.5	Zipf's laws-Collocations-Concordances	1
1.6	Linguistic Essentials: Parts of Speech and Morphology -Nouns and pronouns	1
1.7	Words that accompany nouns: Determiners and adjectives-Verbs-Other parts of speech	1
1.8	Phrase Structure-Phrase structure grammars	1
1.9	Semantics and Pragmatics-Corpus Based Work	1
	Module – 2 (Mathematical Essentials) (7 hrs)	
2.1	Probability Theory-Probability spaces	1
2.2	Conditional probability and independence-Bayes' theorem	1
2.3	Random variables-Expectation and variance-Notation	1
2.4	Joint and conditional distributions-Standard distributions-Bayesian statistics	1
2.5	Statistical Inference: n-gram Models over Sparse Data-Bins: Forming Equivalence Classes	1
2.6	Markov Models-Hidden Markov Models: Why use HMMs?	1
2.7	General form of an HMM-Finding the probability of an observation-Finding the best state sequence	1
	Module – 3 (Word Sense Disambiguation) (7 hrs)	
3.1	Methodological Preliminaries-Supervised and unsupervised learning	1
3.2	Upper and lower bounds on performance-Supervised Disambiguation	1
3.3	Bayesian classification-Dictionary based Disambiguation-	1
3.4	Disambiguation based on sense definitions-Thesaurus based disambiguation	1
3.5	Lexical Acquisition-Evaluation Measures	1

3.6	Verb Subcategorization-Attachment Ambiguity, PP attachment-Selectional Preferences	1
3.7	Semantic Similarity:Vector space measures-Probabilistic measures	1

Module – 4 (Grammar) (8 hrs)		
4.1	Part-of-Speech Tagging-The Information Sources in Tagging	1
4.2	Markov Model Taggers-Hidden Markov Model Taggers-	1
4.3	Applying HMMs to POS tagging-The effect of initialization on HMM training-	1
4.4	Transformation-Based Learning of Tags	1
4.5	Probabilistic Context Free Grammars-Some Features of PCFGs	1
4.6	Questions for PCFGs	1
4.7	The Probability of a String -Using inside probabilities Using outside probabilities	1
4.8	Finding the most likely parse for a sentence-parsing for disambiguation, parsing model *vs.* language model	1
Module - 5 (Language Processing with Python) (5 hrs)		
5.1	Introduction to NLTK	1
5.2	Text Wrangling and Text cleansing : Sentence Splitter, Tokenization, Stemming,	1
5.3	Lemmatization, Stop word removal , Rare word Removal, Spell Correction.	1
5.4	Part of Speech Tagging and NER.	1
5.5	Parsing Structure in Text: Shallow versus deep parsing, types of parsers	1

CST404	COMPREHENSIVE COURSE VIVA	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	1	0	0	1	2019

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**

CSD416	PROJECT PHASE II	CATEGORY	L	T	P	CREDIT
		PWS	0	0	12	4

Preamble: 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 Objectives

- To apply engineering knowledge in practical problem solving.
- To foster innovation in design of products, processes or systems.
- To develop creative thinking in finding viable solutions to engineering problems.

Course Outcomes [COs]: After successful completion of the course, the students will be able to:

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

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	1	2	2	2	1	1	1	1	2
CO2	2	2	2		1	3	3	1	1		1	1
CO3									3	2	2	1
CO4					2			3	2	2	3	2
CO5	2	3	3	1	2							1
CO6					2			2	2	3	1	1

CSE (ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING)

Abstract POs defined by National Board of Accreditation			
PO #	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO0	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Lifelong learning

PROJECT PHASE II

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).

Evaluation by the Guide

The guide/supervisor must monitor the progress being carried out by the project groups on regular basis. In case it is found that progress is unsatisfactory it should be reported to the Department Evaluation Committee for necessary action. The presence of each student in the group and their involvement in all stages of execution of the project shall be ensured by the guide. Project evaluation by the guide: 30 Marks. This mark shall be awarded to the students in his/her group by considering the following aspects:

Project Scheduling & Distribution of Work among Team members: Detailed and extensive Scheduling with timelines provided for each phase of project. Work breakdown structure well defined. (5)

Literature survey: Outstanding investigation in all aspects. (4)

Student's Diary/ Daily Log: The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students' thought process and reasoning abilities. The students should record in the daily/weekly activity diary the day to day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. The daily/weekly activity diary shall be signed after every day/week by the guide. (7)

Individual Contribution: The contribution of each student at various stages. (9)

Completion of the project: The students should demonstrate the project to their respective guide. The guide shall verify the results and see that the objectives are met. (5)

EVALUATION RUBRICS for PROJECT Phase II: Interim Evaluation - 1

No.	Parameters	Marks	Poor	Fair	Very Good	Outstanding
2-a	Novelty of idea, and Implementation scope [CO5] [Group Evaluation]	**5**	The project is not addressing any useful requirement. The idea is evolved into a non-implementable one. The work presented so far is lacking any amount of original work by the team.	Some of the aspects of the proposed idea can be implemented. There is still lack of originality in the work done so far by the team. The project is a regularly done theme/topic without any freshness in terms of specifications, features, and/or improvements.	Good evidence of an implementable project. There is some evidence for the originality of the work done by the team . There is fresh specifications/ features/improvements suggested by the team. The team is doing a design from fundamental principles, and there is some independent learning and engineering ingenuity.	The project has evolved into incorporating an outstandingly novel idea. Original work which is not yet reported anywhere else. Evidence for ingenious way of innovation which is also Implementable. Could be a patentable / publishable work.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
2-b	Effectiveness of task distribution among team members. [CO3] [Group Evaluation]	**5**	No task distribution of any kind. Members are still having no clue on what to do.	Task allocation done, but not effectively, some members do not have any idea of the tasks assigned. Some of the tasks were identified but not followed individually well.	Good evidence of task allocation being done, supported by project journal entries, identification of tasks through discussion etc. However, the task distribution seems to be skewed, and depends a few members heavily than others. Mostly the tasks are being followed by the individual members.	Excellent display of task identification and distribution backed by documentary evidence of team brainstorming, and project journal entries. All members are allocated tasks according to their capabilities, and as much as possible in an equal manner. The individual members are following the tasks in an excellent manner.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
2-c	Adherence to project schedule. [CO4] [Group Evaluation]	**5**	Little or no evidence of continued planning or scheduling of the project. The students did not stick to the plan what they were going to build nor plan on what materials / resources to use in the project. The students do not have any idea on the budget required even after the end of phase - I. No project journal kept or the journal.	There is some improvement in the primary plan prepared during phase I. There were some ideas on the materials /resources required, but not really thought out. The students have some idea on the finances required, but they have not formalized a budget plan. Schedules were not prepared. The project journal has no useful details on the project.	Good evidence of planning done and being followed up to a good extent after phase I. Materials were listed and thought out, but the plan wasn't followed completely. Schedules were prepared, but not detailed, and needs improvement. Project journal is presented but it is neither complete nor updated regularly.	Excellent evidence of enterprising and extensive project planning and follow-up since phase I. Continued use of project management/version control tool to track the project. Material procurement if applicable is progressing well. Tasks are updated and incorporated in the schedule. A well-kept project journal showed evidence for all the above, in addition to the interaction with the project guide.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)

CSE (ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING)

2-d	Interim Results. [CO6] [Group assessment]	**5**	There are no interim results to show.	The team showed some interim results, but they are not complete / consistent to the current stage, Some corrections are needed.	The interim results showed were good and mostly consistent/correct with respect to the current stage. There is room for improvement.	There were significant interim results presented which clearly shows the progress.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-e	Presentation [Individual assessment]	**5**	Very poor presentation and there is no interim results. The student has no idea about the project proposal.	Presentation is average, and the student has only a feeble idea about the team work.	Good presentation. Student has good idea about the team's project. The overall presentation quality is good.	Exceptionally good presentation. Student has excellent grasp of the project. The quality of presentation is outstanding.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Phase-II Interim Evaluation - 1 Total Marks: 25						

EVALUATION RUBRICS for PROJECT Phase II: Interim Evaluation – 2

No	Parameters	Marks	Poor	Fair	Very Good	Outstanding
2-f	Application of engineering knowledge [CO1] [Individual Assessment]	**10**	The student does not show any evidence of applying engineering knowledge on the design and the methodology adopted. The student's contribution in application of engineering knowledge in the project is poor.	The student appears to apply some basic knowledge, but not able to show the design procedure and the methodologies adopted in a comprehensive manner.	The student is able to show some evidence of application of engineering knowledge in the design and development of the project to good extent.	Excellent knowledge in design procedure and its adaptation. The student is able to apply knowledge from engineering domains to the problem and develop solutions.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
2-g	Involvement of individual members [CO3] [Individual Assessment]	**5**	No evidence of any Individual participation in the project work.	There is evidence for some amount of individual contribution, but is limited to some of the superficial tasks.	The individual contribution is evident. The student has good amount of involvement in core activities of the project.	Evidence available for the student acting as the core technical lead and has excellent contribution to the project.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-h	Results and inferences upon execution [CO5] [Group Assessment]	**5**	None of the expected outcomes are achieved yet. The team is unable to derive any inferences on the failures/ issues observed. Any kind o f observations or studies are not made.	Only a few of the expected outcomes are achieved. A few inferences are made on the observed failures/issues. No further work suggested.	Many of the expected outcomes are achieved. Many observations and inferences are made, and attempts to identify the issues are done. Some suggestions are made for further work.	Most of the stated outcomes are met. Extensive studies are done and inferences drawn. Most of the failures are addressed and solutions suggested. Clear and valid suggestions made for further work.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-i	Documentation and presentation. .[CO6] [Individual assessment]	**5**	The individual student has no idea on the presentation of his/her part. The presentation is of poor quality.	Presentation's overall quality needs to be improved.	The individual's presentation performance is satisfactory.	The individual's presentation is done professionally and with great clarity. The individual's performance is excellent.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
			Phase-II Interim Evaluation - 2 Total Marks: 25			

EVALUATION RUBRICS for PROJECT Phase II: Final Evaluation

No	Parameters	Marks	Poor	Fair	Very Good	Outstanding
2-j	Engineering knowledge. [CO1] [Group Assessment]	10	The team does not show any evidence of applying engineering knowledge on the design and the methodology adopted.	The team is able to show some of the design procedure and the methodologies adopted, but not in a comprehensive manner.	The team is able to show evidence of application of engineering knowledge in the design and development of the project to good extent. There is scope for improvement.	Excellent knowledge in design procedure and its adaptation. The team is able to apply knowledge from engineering domains to the problem and develop an excellent solution.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
2-k	Relevance of the project with respect to societal and/or industrial needs. [Group Assessment] [CO2]	5	The project as a whole do not have any societal / industrial relevance at all.	The project has some relevance with respect to social and/or industrial application. The team has however made not much effort to explore further and make it better.	The project is relevant to the society and/or industry. The team is mostly successful in translating the problem into an engineering specification and managed to solve much of it.	The project is exceptionally relevant to society and/or industry. The team has made outstanding contribution while solving the problem in a professional and/ or ethical manner.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-i	Innovation / novelty / Creativity [CO5] [Group Assessment]	5	The project is not addressing any useful requirement. The idea is evolved into a non-implementable one. The work presented so far is lacking any amount of original work by the team.	Some of the aspects of the proposed idea appears to be practical. There is still lack of originality in the work done. The project is a regularly done theme/topic without any freshness in terms of specifications, features, and/ or improvements.	Good evidence of an implementable project. There is some evidence for the originality of the work done by the team. There is fresh specifications/ features/improvements suggested by the team. The team is doing a design from fundamental principles, and there is some independent learning and engineering ingenuity. Could be translated into a product / process if more work is done.	The project has evolved into incorporating an outstandingly novel idea. Original work which is not yet reported anywhere else. Evidence for ingenious way of innovation which is also Implementable. Could be a patentable publishable work.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-m	Quality of results / conclusions / solutions. [CO1] [Group Assessment]	10	None of the expected outcomes are achieved. The team is unable to derive any inferences on the failures/issues observed. Any kind of observations or studies is not made.	Only a few of the expected outcomes are achieved. A few inferences are made on the observed failures/issues. No further work suggested.	Many of the expected outcomes are achieved. Many observations and inferences are made, and attempts to identify the issues are done. Some suggestions are made for further work.	Most of the stated outcomes are met. Extensive studies are done and inferences drawn. Most of the failures are addressed and solutions suggested. Clear and valid suggestions made for further work.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)

2-n	Presentation - Part I Preparation of slides. [CO6] [Group Assessment].	5	The presentation slides are shallow and in a clumsy format. It does not follow proper organization.	Presentation slides follow professional style formats to some extent. However, its organization is not very good. Language needs to be improved. All references are not cited properly, or acknowledged. Presentation slides needs to be more professional.	Presentation slides follow a good style format and there are only a few issues. Organization of the slides is good. Most of references are cited properly. The flow is good and team presentation is neatly organized. Some of the results are not clearly shown. There is room for improvement.	The presentation slides are exceptionally good. Neatly organized. All references cited properly. Diagrams/Figures, Tables and equations are properly numbered, and l i s ted. Results/ inferences clearly highlighted and readable.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
	Presentation - Part II: Individual Communication [CO6] [Individual Assessment].	5	The student is not communicating properly. Poor response to questions.	The student is able to explain some of the content. The student requires a lot of prompts to get to the idea. There are language issues.	Good presentation/ communication by the student. The student is able to explain most of the content very well. There are however, a few areas where the student shows lack of preparation. Language is better.	Clear and concise communication exhibited by the student. The presentation is outstanding. Very confident and tackles all the questions without hesitation. Exceptional traits of communicator.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Phase-II Final Evaluation, Marks: 40						

EVALUATION RUBRICS for PROJECT Phase II: Report Evaluation						
Sl. No.	Parameters	Marks	Poor	Fair	Very Good	Outstanding
2-o	Report [CO6]	30	The prepared report is shallow and not as per standard format. It does not follow proper organization. Contains mostly unacknowledged content. Lack of effort in preparation is evident. References are not cited. Unprofessional and inconsistent formatting.	Project report follows the standard format to some extent. However, its organization is not very good. Language needs to be improved. All references are not cited properly in the report. There is lack of formatting consistency.	Project report shows evidence of systematic documentation. Report is mostly following the standard style format and there are only a few issues. Organization of the report is good. Mostly consistently formatted. Most of references/sources are cited/ acknowledged properly.	The report is exceptionally good. Neatly organized. All references cited properly. Diagrams/Figures, Tables and equations are properly numbered, and listed and clearly shown. Language is excellent and follows professional styles. Consistent formatting and exceptional readability.
			(0 - 11 Marks)	(12 - 18 Marks)	(19 - 28 Marks)	(29 - 30 Marks)
Phase - II Project Report Marks: 30						

SEMESTER VIII

MINOR

CMD482	MINI PROJECT	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PWS	0	0	3	4	2019

Preamble: 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.

Prerequisite: A sound knowledge in courses studied in respective minor stream.

Course Outcomes: After the completion of the course the student will be able to

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

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔	✔	✔		✔	✔	✔	✔	✔	✔	✔
CO2	✔	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔
CO3	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
CO4	✔	✔	✔	✔	✔			✔	✔	✔	✔	✔
CO5	✔	✔	✔	✔	✔	✔	✔	✔	✔		✔	✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Mark Distribution

Total Marks	CIE Marks	ESE Marks
150	75	75

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Project Guide **15 marks**

Project Report **10 marks**

Evaluation by the Committee (will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, work knowledge and involvement) : **40 marks**

Student Groups with 4 or 5 members should identify a topic of interest in consultation with a Faculty Advisor/Project Coordinator/Guide. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design/fabrication or develop codes/programs to achieve the objectives by strictly following steps specified in the teaching plan. Innovative design concepts, performance, scalability, reliability considerations, aesthetics/ergonomic, user experience and security aspects taken care of in the project shall be given due weight.

The progress of the mini project is evaluated based on a minimum of two reviews. The review committee may be constituted by a senior faculty member, Mini Project coordinator and project guide. The internal evaluation shall be made based on the progress/outcome of the project, reports and a viva-voce examination, conducted internally by a 3-member committee. A project report is required at the end of the semester. The project has to be demonstrated for its full design specifications.

End Semester Examination Pattern:

The marks will be distributed as

Presentation	: **30 marks**
Demo	: **20 marks**
Viva	: **25 marks.**
Total	: **75 marks**.

TEACHING 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. Acknowledgement
  v. Abstract
  vi. Table of Contents
  vii. List of Figures and Tables
  viii. Chapters
  ix. Appendices, if any
  x. References/Bibliography

SEMESTER VIII

HONOURS

CMD496	MINI PROJECT	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PWS	0	0	3	2	2019

Preamble: 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.

Prerequisite: A sound knowledge in courses studied in respective honor stream.

Course Outcomes: After the completion of the course the student will be able to

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

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔	✔	✔		✔	✔	✔	✔	✔	✔	✔
CO2	✔	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔
CO3	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
CO4	✔	✔	✔	✔	✔			✔	✔	✔	✔	✔
CO5	✔	✔	✔	✔	✔	✔	✔	✔	✔		✔	✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Mark Distribution

Total Marks	CIE Marks	ESE Marks
150	75	75

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Project Guide **15 marks**

Project Report **10 marks**

Evaluation by the Committee (will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, work knowledge and involvement) **: 40 marks**

Student Groups with 4 or 5 members should identify a topic of interest in consultation with a Faculty Advisor/Project Coordinator/Guide. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design/fabrication or develop codes/programs to achieve the objectives by strictly following steps specified in the teaching plan. Innovative design concepts, performance, scalability, reliability considerations, aesthetics/ergonomic, user experience and security aspects taken care of in the project shall be given due weight.

The progress of the mini project is evaluated based on a minimum of two reviews. The review committee may be constituted by a senior faculty member, Mini Project coordinator and project guide. The internal evaluation shall be made based on the progress/outcome of the project, reports and a viva-voce examination, conducted internally by a 3-member committee. A project report is required at the end of the semester. The project has to be demonstrated for its full design specifications.

End Semester Examination Pattern:

The marks will be distributed as

Presentation	: **30 marks**
Demo	: **20 marks**
Viva	: **25 marks.**
Total	: **75 marks**.

TEACHING 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 figuretitle 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

END