

APJ ABDUL KALAM
TECHNOLOGICAL
UNIVERSITY

SEMESTER VI

KTU



CST 302	COMPILER DESIGN	Category	L	T	P	Credit	Year of Introduction
		PCC	3	1	0	4	2019

Preamble:

The purpose of this course is to create awareness among students about the phases of a compiler and the techniques for designing a compiler. This course covers the fundamental concepts of different phases of compilation such as lexical analysis, syntax analysis, semantic analysis, intermediate code generation, code optimization and code generation. Students can apply this knowledge in design and development of compilers.

Prerequisite: Sound knowledge in Data Structures, Formal Languages & Automata Theory.

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

CO1	Explain the phases in compilation process (lexical analysis, syntax analysis, semantic analysis, intermediate code generation, code optimization and code generation) and model a lexical analyzer (Cognitive Knowledge Level: Apply)
CO2	Model language syntax using Context Free Grammar and develop parse tree representation using leftmost and rightmost derivations (Cognitive Knowledge Level: Apply)
CO3	Compare different types of parsers (Bottom-up and Top-down) and construct parser for a given grammar (Cognitive Knowledge Level: Apply)
CO4	Build Syntax Directed Translation for a context free grammar, compare various storage allocation strategies and classify intermediate representations (Cognitive Knowledge Level: Apply)
CO5	Illustrate code optimization and code generation techniques in compilation (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 (Marks)	Test 2 (Marks)	
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 - 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 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 maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module - 1 (Introduction to compilers and lexical analysis)

Analysis of the source program - Analysis and synthesis phases, Phases of a compiler. Compiler writing tools. Bootstrapping. Lexical Analysis - Role of Lexical Analyser, Input Buffering, Specification of Tokens, Recognition of Tokens.

Module - 2 (Introduction to Syntax Analysis)

Role of the Syntax Analyser – Syntax error handling. Review of Context Free Grammars - Derivation and Parse Trees, Eliminating Ambiguity. Basic parsing approaches - Eliminating left recursion, left factoring. Top-Down Parsing - Recursive Descent parsing, Predictive Parsing, LL(1) Grammars.

Module - 3 (Bottom-Up Parsing)

Handle Pruning. Shift Reduce parsing. Operator precedence parsing (Concept only). LR parsing - Constructing SLR, LALR and canonical LR parsing tables.

Module - 4 (Syntax directed translation and Intermediate code generation)

Syntax directed translation - Syntax directed definitions, S-attributed definitions, L-attributed definitions, Bottom-up evaluation of S-attributed definitions. Run-Time Environments - Source Language issues, Storage organization, Storage-allocation strategies. Intermediate Code Generation - Intermediate languages, Graphical representations, Three-Address code, Quadruples, Triples.

Module 5 – (Code Optimization and Generation)

Code Optimization - Principal sources of optimization, Machine dependent and machine independent optimizations, Local and global optimizations. Code generation - Issues in the design of a code generator, Target Language, A simple code generator.

Text Books

1. Aho A.V., Ravi Sethi and D. Ullman. Compilers – Principles Techniques and Tools, Addison Wesley, 2006.

Reference Books

1. D.M.Dhamdhare, System Programming and Operating Systems, Tata McGraw Hill & Company, 1996.
2. Kenneth C. Loudon, Compiler Construction – Principles and Practice, Cengage Learning Indian Edition, 2006.

3. Tremblay and Sorenson, The Theory and Practice of Compiler Writing, Tata McGraw Hill & Company, 1984.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

- 1) Explain the phases of a compiler with a neat diagram.
- 2) Define a token. Identify the tokens in the expression $a := b + 10$.

Course Outcome 2 (CO2):

- 1) Illustrate the process of eliminating ambiguity, left recursion and left factoring the grammar.
- 2) Is the following grammar ambiguous? If so eliminate ambiguity.

$$E \rightarrow E + E \mid E * E \mid (E) \mid id$$

Course Outcome 3 (CO3):

1. What are the different parsing conflicts in the SLR parsing table?
2. Design a recursive descent parser for the grammar

$$E \rightarrow E + T \mid T$$

$$T \rightarrow T * F \mid F$$

$$F \rightarrow (E) \mid id$$

3. Construct canonical LR(0) collection of items for the grammar below.

$$S \rightarrow L = R$$

$$S \rightarrow R$$

$$L \rightarrow * R$$

$$L \rightarrow id$$

$$R \rightarrow L$$

Also identify a shift reduce conflict in the LR(0) collection constructed above.

Course Outcome 4 (CO4):

1. Write the quadruple and triple representation of the following intermediate code

$$R1 = C * D$$

$$R2 = B + R1$$

$$A = R2$$

$$B[0] = A$$

2. Differentiate S-attributed Syntax Directed Translation(SDT) and L-attributed SDT. Write S - attributed SDT for a simple desktop calculator

Course Outcome 5 (CO5):

1. List out the examples of function preserving transformations.
2. What are the actions performed by a simple code generator for a typical three-address statement of the form $x := y \text{ op } z$.

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: CST 302

Course Name: Compiler Design

**Max.Marks:100
Hours**

Duration: 3

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Specify the analysis and synthesis parts of compilation.
2. Define the terms token, lexemes and patterns with examples.
3. Is the grammar $S \rightarrow S \mid (S) S / \epsilon$ ambiguous? Justify your answer.
4. What is left recursive grammar? Give an example. What are the steps in removing left recursion?
5. Compare different bottom-up parsing techniques.
6. What are the possible actions of a shift reduce parser.

7. Differentiate synthesized and inherited attributes with examples.

8. Translate $a[i] = b * c - b * d$, to quadruple.

9. What is the role of peephole optimization in the compilation process

10. What are the issues in the design of a code generator

(10x3=30)

Part B

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

11. (a) Explain the different phases of a compiler with a running example.

(9)

(b) List and explain any three compiler construction tools.

(5)

OR

12. (a) What is a regular definition? Give the regular definition of an unsigned integer

(7)

(b) Express the role of transition diagrams in recognition of tokens.

(7)

13. (a) What is Recursive Descent parsing? List the challenges in designing such a parser?

(4)

(b) Consider the following grammar

$E \rightarrow E \text{ or } T \mid T$

$T \rightarrow T \text{ and } F \mid F$

$F \rightarrow \text{not } F \mid (E) \mid \text{true} \mid \text{false}$

(10)

(i) Remove left recursion from the grammar.

(ii) Construct a predictive parsing table.

(iii) Justify the statement “The grammar is LL (1)”.

OR

14. (a) What is Recursive Descent parsing? List the problems in designing such a parser (4)

(b) Design a recursive descent parser for the grammar $S \rightarrow cAd, A \rightarrow ab/ b$ (5)

Find the FIRST and FOLLOW of the non-terminals S, A and B in the grammar (5)

$$S \rightarrow aABe$$

$$A \rightarrow Abc \mid b$$

$$B \rightarrow d$$

15. (a) Construct the LR(0) set of items and their GOTO function for the grammar $S \rightarrow S S + \mid S S * \mid a$ (10)

(b) Is the grammar SLR? Justify your answer (4)

OR

16. (a) Identify LR(1) items for the grammar $S \rightarrow CC$ (7)

$$C \rightarrow cC \mid d$$

(b) Construct LALR table for the above grammar (7)

17. (a) Design a Syntax Directed Translator(SDT) for the arithmetic expression $(4 * 7 + 19) * 2$ and draw an annotated parse tree for the same. (8)

(b) Consider the grammar with following translation rules and E as the start symbol (6)

$$E \rightarrow E1 \# T \{ E.value = E1.value \times T.value ; \}$$

$$\quad \mid T \{ E.value = T.value ; \}$$

$$T \rightarrow T1 \& F \{ T.value = T1.value + F.value ; \}$$

$$\quad \mid F \{ T.value = F.value ; \}$$

$$F \rightarrow num \{ F.value = num.lvalue ; \}$$

Compute E.value for the root of the parse tree for the expression

$2\#3 \& 5\# 6 \& 7$

OR

18. (a) Write Syntax Directed Translator (SDT) and parse tree for infix to postfix translation of an expression. (8)
- (b) Explain the storage allocation strategies. (6)
19. (a) Describe the principal sources of optimization (7)
- (b) Illustrate the optimization of basic blocks with examples. (7)

OR

20. (a) Write the Code Generation Algorithm and explain the *getreg* function (6)
- (b) Generate target code sequence for the following statement (8)

$$d := (a-b) + (a-c) + (a-c).$$

Teaching Plan

No	Contents	No. of Lecture Hours
Module - 1(Introduction to Compilers and lexical analyzer) (8 hours)		
1.1	Introduction to compilers, Analysis of the source program	1 hour
1.2	Phases of the compiler – Analysis Phases	1 hour
1.3	Phases of the Compiler - Synthesis Phases	1 hour
1.4	Symbol Table Manager and Error Handler	1 hour
1.5	Compiler writing tools, bootstrapping	1 hour
1.6	The role of Lexical Analyzer , Input Buffering	1 hour
1.7	Specification of Tokens	1 hour
1.8	Recognition of Tokens	1 hour

Module – 2 (Introduction to Syntax Analysis) (10 hours)		
2.1	Role of the Syntax Analyser, Syntax error handling	1 hour
2.2	Review of Context Free Grammars	1 hour
2.3	Parse Trees and Derivations	1 hour
2.4	Grammar transformations, Eliminating ambiguity	1 hour
2.5	Eliminating left recursion	1 hour
2.6	Left factoring the grammar	1 hour
2.7	Recursive Descent parsing	1 hour
2.8	First and Follow	1 hour
2.9	Predictive Parsing table constructor	1 hour
2.10	LL(1) Grammars	1 hour
Module - 3 (Bottom up parsing) (9 hours)		
3.1	Bottom-up parsing - Handle Pruning	1 hour
3.2	Shift Reduce parsing	1 hour
3.3	Operator precedence parsing (Concept only)	1 hour
3.4	LR parsing , SLR Grammar, items	1 hour
3.5	Augmented Grammar, Canonical collection of LR(0) items	1 hour
3.6	SLR Parser Table Construction	1 hour
3.7	Constructing Canonical LR Parsing Tables	1 hour
3.8	Constructing LALR Parsing Tables	1 hour
3.9	LALR parser	1 hour
Module - 4 (Syntax Directed Translation and Intermediate code Generation) (9 hours)		
4.1	Syntax directed definitions	1 hour
4.2	S- attributed definitions, L- attributed definitions	1 hour
4.3	Bottom- up evaluation of S- attributed definitions.	1 hour
4.4	Source Language issues	1 hour
4.5	Storage organization	1 hour

4.6	Storage- allocation strategies	1 hour
4.7	Intermediate languages , Graphical representations	1 hour
4.8	Three-Address code	1 hour
4.9	Quadruples, Triples	1 hour
Module - 5 (Code Optimization and Generation) (9 hours)		
5.1	Principal sources of optimization	1 hour
5.2	Machine dependent optimizations	1 hour
5.3	Machine independent optimizations	1 hour
5.4	Local optimizations	1 hour
5.5	Global optimizations	1 hour
5.6	Issues in the design of a code generator – Lecture 1	1 hour
5.7	Issues in the design of a code generator – Lecture 2	1 hour
5.8	Target Language	1 hour
5.9	Design of a simple code generator.	1 hour



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Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks
	Test1 (percentage)	Test2 (percentage)	
Remember	40	40	40
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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:

COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

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 (Introduction to Machine Learning)

Introduction to Machine Learning- Examples of Machine Learning applications, Learning Associations, Classification, Regression, Unsupervised Learning, Reinforcement Learning. Supervised learning- Input representation, Hypothesis class, Version space, Vapnik-Chervonenkis(VC) Dimension. Linear Discriminants – Perceptron – Linear Separability – Linear Regression.

Module 2 (Linear Models)

Multi-layer Perceptron – Going Forwards – Going Backwards: Back Propagation Error – Multi-layer Perceptron in Practice – Examples of using the MLP– Deriving Back-Propagation – Radial Basis Functions and Splines –RBF Network – Curse of Dimensionality – Interpolations and Basis Functions – Support Vector Machines.

Module 3 (Tree and Probabilistic Models)

Ensemble Learning – Entropy, Information Gain, Gain Ratio, Classification by Regression (CART), Regression model, Boosting , Bagging , Different ways to Combine Classifiers. Probability and Learning – Data into Probabilities – Basic Statistics – Gaussian Mixture Models – Nearest Neighbor Methods – Vector Quantization – Self Organizing Feature Map.

Module 4 (Dimensionality Reduction and Evolutionary Models)

Dimensionality Reduction – Linear Discriminant Analysis, Principal Component Analysis, Factor Analysis, Independent Component Analysis, Least Squares Optimization. Evolutionary Learning – Genetic algorithms, Genetic Offspring, Genetic Operators, Using Genetic Algorithms.

Module 5 (Graphical Models)

Graphical Models -Markov Chain, Monte Carlo Methods, Markov Random Fields, Hidden Markov Models, Bayesian Networks. Clustering Methods - K-means, Expectation-Maximization Algorithm.

Text Books:

1. Stephen Marsland, Machine Learning – An Algorithmic Perspective, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series.
2. Tom M Mitchell, —Machine Learning, First Edition, McGraw Hill Education

Reference Books:

1. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
2. Ethem Alpaydm, Introduction to Machine Learning (Adaptive Computation and Machine Learning), MIT Press, 2004.
3. Margaret H. Dunham. Data Mining: introductory and Advanced Topics, Pearson, 2006
4. Mitchell. T, Machine Learning, McGraw Hill.
5. Ryszard S. Michalski, Jaime G. Carbonell, and Tom M. Mitchell, Machine Learning: An Artificial Intelligence Approach, Tioga Publishing Company.

Sample Course Level Assessment Questions

COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

Course Outcome 1 (CO1): Explain the different methods of learning.

Enumerate the concepts in a supervised approach.

Course Outcome 2 (CO2): Explain the different output activation functions.

How sequential and batch training is implemented.

Course Outcome 3(CO3): What is the purpose of the neighborhood function in the SOM? How does it change the learning?

Course Outcome 4 (CO4): Discuss genetic algorithm with an example. Explain crossover, mutation, chromosome and generations.

Course Outcome 5 (CO5): Use K-means algorithm to cluster the points (2,10), (5,2), (8,16), (6,8), (4,12), (10,8).

Model Question Paper

QP CODE:

Reg No: _____

Name: _____

PAGES : 2

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CDT 304

Subject Name: Machine Learning Concepts

Max. Marks : 100

Duration: 3 Hours

Estd.
PART A

Answer All Questions. Each Question Carries 3 Marks

1. How to overcome 'curse of dimensionality' in machine learning applications?
2. Write short notes on overfitting.
3. Discuss the gradient descent approach.
4. Discuss the need for bias in multi layer perceptrons. Justify your answer.
5. Explain the terms Entropy, Information Gain and Gain Ratio.
6. List out the features of vector quantization.

7. State the reason why people who are interested in neural networks are interested in PCA. (10x3=30)
8. Explain Kernel PCA Algorithm.)
9. What is the significance of graphical models ?
10. Explain the taxonomy of clustering. (10x3=30)

Part B

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

11. (a) Explain the different methods of learning. Enumerate the concepts in supervised approach. (10)
- (b) How prediction is done by linear regression for a data set. (4)
- OR**
12. (a) Discuss the concept of Vapnik-Chervonenkis Dimension. (6)
- (b) Given an example for linear separable problem. (8)
13. (a) Derive the back-propagation algorithm. (8)
- (b) Explain how a multi-layer perceptron can solve the XOR problem. (6)
14. (a) Explain the different output activation functions. How sequential and batch training is implemented. (4)
- (b) Explain the forward and backward pass of back propagation learning. (8)
15. (a) Explain the different algorithms to combine classifiers. (8)
- (b) List the advantages and disadvantages of Gaussian Mixture Models. (6)

OR

16. (a) A simplistic intruder detection system for a computer network consists of an attempt to categorize users according to (i) the time of day they log in, (ii) the length of time they log in for, (iii) the types of programs they run while logged in, (iv) number of programs they run while logged in. Suggest how you would train a SOM. (9)

(b) What is the purpose of the neighborhood function in the SOM? How does it change the learning? (5)

17. (a) Explain the steps of Principal Components Analysis Algorithm. (6)

(b) Explain the algorithm of Linear Discriminant Analysis. (8)

OR

18. (a) Discuss genetic algorithms with an example. Explain crossover, mutation, chromosome and generations. (10)

(b) Describe Least Squares Optimization algorithm. (4)

19. (a) Use K-means algorithm to cluster the points (2,10), (5,2), (8,16), (6,8), (4,12), (10,8) to two clusters. (6)

(b) State the principle of Hidden Markov Model and explain the different types of HMM model with a neat sketch. (8)

OR

20. (a) Explain the concept of inference in Bayesian Networks with an example. (8)

(b) Construct a Bayesian Network simulating a teacher entering and leaving a class. (6)

Teaching Plan

COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

CDT 304 Machine Learning Concepts		45 Hours
Module- 1(Introduction to Machine Learning)		(9 hours)
1.1	Introduction to Machine Learning	1 hour
1.2	Examples of Machine Learning applications	1 hour
1.3	Learning Associations, Classification	1 hour
1.4	Regression, Unsupervised Learning	1 hour
1.5	Reinforcement Learning	1 hour
1.6	Input representation, Hypothesis class	1 hour
1.7	Version space, Vapnik-Chervonenkis (VC) Dimension	1 hour
1.8	Perceptron	1 hour
1.9	Linear Separability – Linear Regression	1 hour
Module 2 (Linear Models)		(9 hours)
2.1	Multi-layer Perceptron	1 hour
2.2	Going Forward – Going Backward	1 hour
2.3	Back Propagation Error	1 hour
2.4	Multi-layer Perceptron in Practice – Examples of using the MLP	1 hour
2.5	Deriving Back-Propagation	1 hour
2.6	Radial Basis Functions and Splines	1 hour
2.7	RBF Network	1 hour
2.8	Curse of Dimensionality – Interpolations and Basis Functions	1 hour
2.9	Support Vector Machines	1 hour
Module 3 (Tree and Probabilistic Models)		(10 hours)
3.1	Entropy, Information Gain, Gain Ratio	1 hour
3.2	Classification by Regression (CART)	1 hour
3.3	Regression Model	1 hour
3.4	Boosting	1 hour
3.5	Bagging	1 hour
3.6	Different ways to Combine Classifiers	1 hour
3.7	Data into Probabilities, Basic Statistics	1 hour
3.8	Gaussian Mixture Models	1 hour
3.9	Nearest Neighbor Methods	1 hour

3.10	Vector Quantization – Self Organizing Feature Map	1 hour
Module 4 (Dimensionality Reduction and Evolutionary Models)		(8 hours)
4.1	Linear Discriminant Analysis	1 hour
4.2	Principal Component Analysis	1 hour
4.3	Factor Analysis	1 hour
4.4	Independent Component Analysis	1 hour
4.5	Least Squares Optimization	1 hour
4.6	Genetic algorithms	1 hour
4.7	Genetic Offspring	1 hour
4.8	Genetic Operators, Using Genetic Algorithms	1 hour
Module 5 (Graphical Models)		(9 hours)
5.1	Markov Chain	1 hour
5.2	Monte Carlo Methods	1 hour
5.3	Sampling	1 hour
5.4	Hidden Markov Models	1 hour
5.5	Markov Random Fields	1 hour
5.6	Bayesian Network	1 hour
5.7	K-means	1 hour
5.8	Expectation-Maximization Algorithm(Lecture 1)	1 hour
5.9	Expectation-Maximization Algorithm (Lecture 2)	1 hour

CST 306	ALGORITHM ANALYSIS AND DESIGN	Category	L	T	P	Credit	Year of Introduction
		PCC	3	1	0	4	2019

Preamble:

The course introduces students to the design of computer algorithms, as well as analysis of algorithms. Algorithm design and analysis provide the theoretical backbone of computer science and are a must in the daily work of the successful programmer. The goal of this course is to provide a solid background in the design and analysis of the major classes of algorithms. At the end of the course students will be able to develop their own versions for a given computational task and to compare and contrast their performance.

Prerequisite:

Strong Foundation in Mathematics, Programming in C, Data Structures and Graph Theory.

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

CO#	CO
CO1	Analyze any given algorithm and express its time and space complexities in asymptotic notations. (Cognitive Level: Apply)
CO2	Derive recurrence equations and solve it using Iteration, Recurrence Tree, Substitution and Master's Method to compute time complexity of algorithms. (Cognitive Level: Apply)
CO3	Illustrate Graph traversal algorithms & applications and Advanced Data structures like AVL trees and Disjoint set operations. (Cognitive Level: Apply)
CO4	Demonstrate Divide-and-conquer, Greedy Strategy, Dynamic programming, Branch-and Bound and Backtracking algorithm design techniques (Cognitive Level: Apply)
CO5	Classify a problem as computationally tractable or intractable, and discuss strategies to address intractability (Cognitive Level: Understand)
CO6	Identify the suitable design strategy to solve a given problem. (Cognitive Level: Analyze)

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	☉	☉	☉	☉								☉

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Syllabus

Module-1 (Introduction to Algorithm Analysis)

Characteristics of Algorithms, Criteria for Analysing Algorithms, Time and Space Complexity - Best, Worst and Average Case Complexities, Asymptotic Notations - Big-Oh (O), Big- Omega (Ω), Big-Theta (Θ), Little-oh (o) and Little- Omega (ω) and their properties. Classifying functions by their asymptotic growth rate, Time and Space Complexity Calculation of simple algorithms.

Analysis of Recursive Algorithms: Recurrence Equations, Solving Recurrence Equations – Iteration Method, Recursion Tree Method, Substitution method and Master’s Theorem (Proof not required).

Module–2 (Advanced Data Structures and Graph Algorithms)

Self Balancing Tree - AVL Trees (Insertion and deletion operations with all rotations in detail, algorithms not expected); Disjoint Sets- Disjoint set operations, Union and find algorithms.

DFS and BFS traversals - Analysis, Strongly Connected Components of a Directed graph, Topological Sorting.

Module–3 (Divide & Conquer and Greedy Strategy)

The Control Abstraction of Divide and Conquer- 2-way Merge sort, Strassen’s Algorithm for Matrix Multiplication-Analysis. The Control Abstraction of Greedy Strategy- Fractional Knapsack Problem, Minimum Cost Spanning Tree Computation- Kruskal’s Algorithms - Analysis, Single Source Shortest Path Algorithm - Dijkstra’s Algorithm-Analysis.

Module-4 (Dynamic Programming, Back Tracking and Branch & Bound))

The Control Abstraction- The Optimality Principle- Matrix Chain Multiplication-Analysis, All Pairs Shortest Path Algorithm - Floyd-Warshall Algorithm-Analysis. The Control Abstraction of Back Tracking – The N Queen’s Problem. Branch and Bound Algorithm for Travelling Salesman Problem.

Module-5 (Introduction to Complexity Theory)

Tractable and Intractable Problems, Complexity Classes – P, NP, NP- Hard and NP-Complete Classes- NP Completeness proof of Clique Problem and Vertex Cover Problem- Approximation algorithms- Bin Packing, Graph Coloring. Randomized Algorithms (Definitions of Monte Carlo and Las Vegas algorithms), Randomized version of Quick Sort algorithm with analysis.

Text Books

1. T.H.Cormen, C.E.Leiserson, R.L.Rivest, C. Stein, Introduction to Algorithms, 2nd Edition, Prentice-Hall India (2001)
2. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran, “Fundamentals of Computer Algorithms”, 2nd Edition, Orient Longman Universities Press (2008)

3. Sara Baase and Allen Van Gelder —Computer Algorithms, Introduction to Design and Analysis, 3rd Edition, Pearson Education (2009)

Reference Books

1. Jon Kleinberg, Eva Tardos, “Algorithm Design”, First Edition, Pearson (2005)
2. Robert Sedgewick, Kevin Wayne, “Algorithms”, 4th Edition Pearson (2011)
3. Gilles Brassard, Paul Bratley, “Fundamentals of Algorithmics”, Pearson (1996)
4. Steven S. Skiena, “The Algorithm Design Manual”, 2nd Edition, Springer(2008)

Course Level Assessment Questions

Course Outcome 1 (CO1):

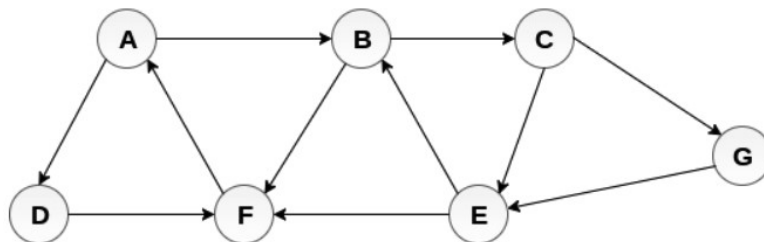
1. Is $2^{n+1} = O(2^n)$? Is $2^{2n} = O(2^n)$? Justify your answer.
2. What is the need of asymptotic analysis in calculating time complexity? What are the notations used for asymptotic analysis?
3. Calculate the time complexity for addition of two matrices.
4. Define time complexity and space complexity. Write an algorithm for adding n natural numbers and analyse the time and space requirements of the algorithm.

Course Outcome 2 (CO2):

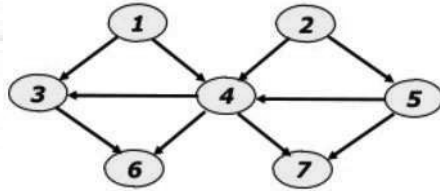
1. State Master’s theorem for solving recurrences.
2. Solve the recurrence $T(n) = 3T(n-2)$, using iteration method
3. State the conditions in recurrences where Master Theorem is not applicable.
4. Solve the following recurrence equations using Master’s theorem.
 - a) $T(n) = 8T(n/2) + 100n^2$
 - b) $T(n) = 2T(n/2) + 10n$
5. Using Recursion Tree method, Solve $T(n) = 2T(n/10) + T(9n/10) + n$. Assume constant time for small values of n.

Course Outcome 3 (CO3):

1. Explain the rotations performed for insertion in AVL tree with example.
2. Write down BFS algorithm and analyse the time complexity. Perform BFS traversal on the given graph starting from node A. If multiple node choices are available for next travel, choose the next node in alphabetical order.

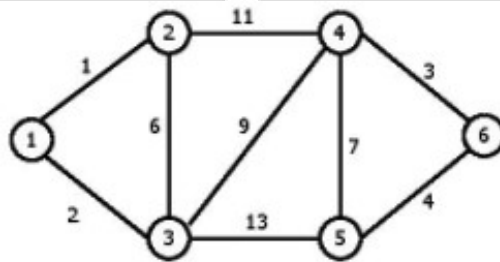


- Find the minimum and maximum height of any AVL-tree with 7 nodes? Assume that the height of a tree with a single node is 0. (3)
- Find any three topological orderings of the given graph.

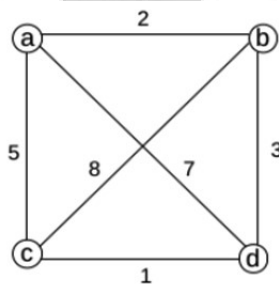


Course Outcome 4 (CO4):

- Give the control abstraction for Divide and Conquer method.
- Construct the minimum spanning tree for the given graph using Kruskal's algorithm. Analyse the complexity of the algorithm.



- Compare Divide and Conquer and Dynamic programming methodologies
- What is Principle of Optimality?
- Define Travelling Salesman Problem (TSP). Apply branch and bound algorithm to solve TSP for the following graph, assuming the start city as 'a'. Draw the state space tree.



Course Outcome 5 (CO5):

- Compare Tractable and Intractable Problems
- With the help of suitable code sequence convince Vertex Cover Problem is an example of NP-Complete Problem

3. Explain Vertex Cover problem using an example. Suggest an algorithm for finding Vertex Cover of a graph.
4. Write short notes on approximation algorithms.
5. Compare Conventional quick sort algorithm and Randomized quicksort with the help of a suitable example?

Course Outcome 6 (CO6): (CO attainment through assignment only, not meant for examinations)

Choosing the best algorithm design strategy for a given problem after applying applicable design strategies – Sample Problems Given.

1. Finding the Smallest and Largest elements in an array of 'n' numbers
2. Fibonacci Sequence Generation.
3. Merge Sort
4. Travelling Sales Man Problem
5. 0/1 Knapsack Problem

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: CST 306

Course Name: Algorithm Analysis and Design

Max. Marks : 100

Duration: 3 Hours

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Define asymptotic notation? Arrange the following functions in increasing order of asymptotic growth rate.

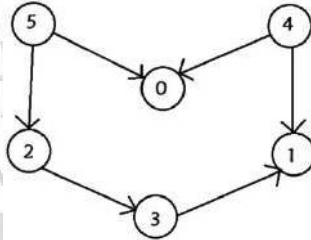
$$n^3, 2^n, \log n^3, 2^{100}, n^2 \log n, n^n, \log n, n^{0.3}, 2^{\log n}$$

2. State Master's Theorem. Find the solution to the following recurrence equations using Master's theorem.

a) $T(n) = 8T(n/2) + 100n^2$

b) $T(n) = 2T(n/2) + 10n$

3. Find any two topological ordering of the DAG given below.



4. Show the UNION operation using linked list representation of disjoint sets.
5. Write the control abstraction of greedy strategy to solve a problem.
6. Write an algorithm based on divide-and-conquer strategy to search an element in a given list. Assume that the elements of list are in sorted order.
7. List the sequence of steps to be followed in Dynamic Programming approach.
8. Illustrate how optimal substructure property could be maintained in Floyd-Warshall algorithm.
9. Differentiate between P and NP problems.
10. Specify the relevance of approximation algorithms.

(10x3=30)

Part B

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

11. (a) Define Big O, Big Ω and Big Θ Notation and illustrate them graphically. (7)
- (b) Solve the following recurrence equation using recursion tree method (7)
- $T(n) = T(n/3) + T(2n/3) + n$, where $n > 1$
- $T(n) = 1$, Otherwise

OR

12. (a) Explain the iteration method for solving recurrences and solve the following recurrence equation using iteration method. (7)

$$T(n) = 3T(n/3) + n; T(1) = 1$$

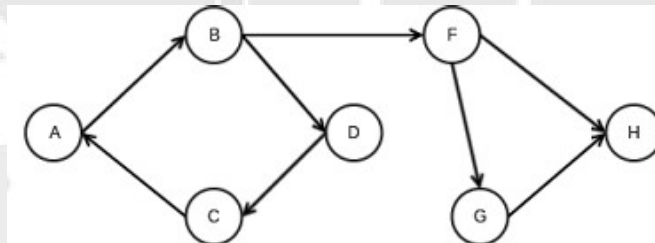
- (b) Determine the time complexities of the following two functions fun1() and fun2(). (7)

```
i) int fun1(int n)
    {
        if (n <= 1) return n;
        return 2*fun1(n-1);
    }
```

```
ii) int fun2 (int n)
     {
         if (n <= 1) return n;
         return fun2 (n-1) + fun2 (n-1)
     }
```

13. (a) Write DFS algorithm and analyse its time complexity. Illustrate the classification of edges in DFS traversal. (7)

- (b) Find the strongly connected components of the digraph given below: (7)



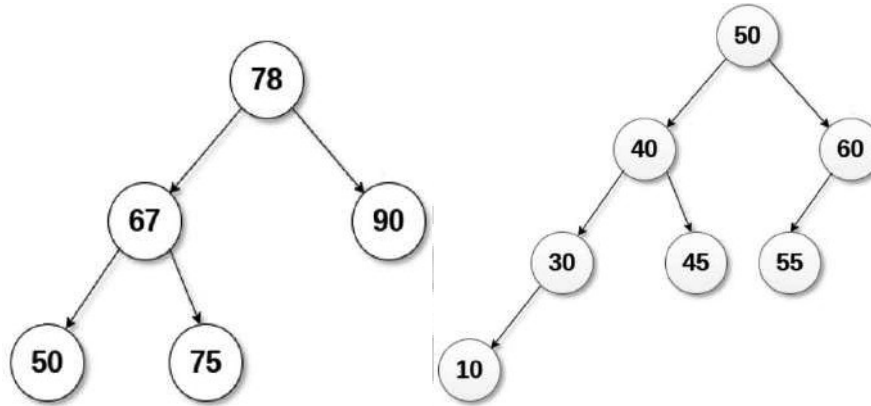
OR

14. (a) Illustrate the advantage of height balanced binary search trees over binary search trees? Explain various rotations in AVL trees with example. (7)

- (b) Perform the following operations in the given AVL trees. (7)

i) Insert 70

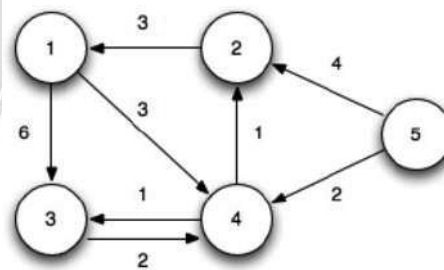
ii) Delete 55



15. (a) State Fractional Knapsack Problem and write Greedy Algorithm for Fractional Knapsack Problem. (7)
- (b) Find the optimal solution for the following Fractional Knapsack problem. (7)
 Given the number of items(n) = 7, capacity of sack(m) = 15,
 $W = \{2, 3, 5, 7, 1, 4, 1\}$ and $P = \{10, 5, 15, 7, 6, 18, 3\}$

OR

16. (a) Write and explain merge sort algorithm using divide and conquer strategy using the data $\{30, 19, 35, 3, 9, 46, 10\}$. Also analyse the time complexity. (7)
- (b) Write the pseudo code for Dijkstra's algorithm. Compute the shortest distance from vertex 1 to all other vertices using Dijkstra's algorithm. (7)

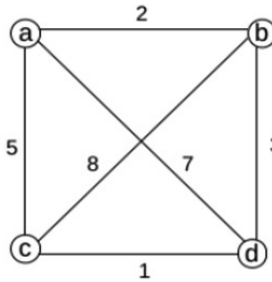


17. (a) Write Floyd-Warshall algorithm and analyse its complexity. (5)
- (b) Write and explain the algorithm to find the optimal parenthesization of matrix chain product whose sequence of dimension is $4 \times 10, 10 \times 3, 3 \times 12, 12 \times 20$. (9)

OR

18. (a) Explain the concept of Backtracking method using 4 Queens problem. (7)

- (b) Define Travelling Salesman Problem (TSP). Apply branch and bound algorithm to solve TSP for the following graph, assuming the start city as 'a'. Draw the state space tree. (7)



19. (a) State bin packing problem? Explain the first fit decreasing strategy (7)
- (b) Prove that the Clique problem is NP-Complete. (7)
- OR**
20. (a) Explain the need for randomized algorithms. Differentiate Las Vegas and Monte Carlo algorithms. (6)
- (b) Explain randomized quicksort and analyse the expected running time of randomized quicksort with the help of a suitable example? (9)

Teaching Plan

No	Topic	No. of Hours (45 hrs)
Module -1 (Introduction to Algorithm Analysis) 9 hrs.		
1.1	Introduction to Algorithm Analysis: Characteristics of Algorithms.	1 hour
1.2	Criteria for Analysing Algorithms, Time and Space Complexity - Best, Worst and Average Case Complexities.	1 hour
1.3	Asymptotic Notations - Properties of Big-Oh (O), Big- Omega (Ω), Big-Theta (Θ), Little-Oh (o) and Little- Omega (ω).	1 hour
1.4	Illustration of Asymptotic Notations	1 hour

1.5	Classifying functions by their asymptotic growth rate	1 hour
1.6	Time and Space Complexity Calculation of algorithms/code segments.	1 hour
1.7	Analysis of Recursive Algorithms: Recurrence Equations, Solving Recurrence Equations – Iteration Method.	1 hour
1.8	Recursion Tree Method	1 hour
1.9	Substitution method and Master's Theorem and its Illustration.	1 hour
Module-2 (Advanced Data Structures and Graph Algorithms) 10 Hrs.		
2.1	Self Balancing Trees - Properties of AVL Trees, Rotations of AVL Trees	1 hour
2.2	AVL Trees Insertion and Illustration	1 hour
2.3	AVL Trees Deletion and Illustration	1 hour
2.4	Disjoint set operations.	1 hour
2.5	Union and find algorithms.	1 hour
2.6	Illustration of Union and find algorithms	1 hour
2.7	Graph Algorithms: BFS traversal, Analysis.	1 hour
2.8	DFS traversal, Analysis.	1 hour
2.9	Strongly connected components of a Directed graph.	1 hour
2.10	Topological Sorting.	1 hour
Module-3 (Divide & Conquer and Greedy Method) 8 Hrs		
3.1	Divide and Conquer: The Control Abstraction.	1 hour
3.2	2-way Merge Sort, Analysis.	1 hour
3.3	Strassen's Algorithm for Matrix Multiplication, Analysis	1 hour

3.4	Greedy Strategy: The Control Abstraction.	1 hour
3.5	Fractional Knapsack Problem.	1 hour
3.6	Minimum Cost Spanning Tree Computation- Kruskal's Algorithm, Analysis.	1 hour
3.7	Single Source Shortest Path Algorithm - Dijkstra's Algorithm	1 hour
3.8	Illustration of Dijkstra's Algorithm-Analysis.	1 hour
Module-4 (Dynamic Programming, Back Tracking and Branch and Bound) 8 Hrs.		
4.1	Dynamic Programming: The Control Abstraction, The Optimality Principle.	1 hour
4.2	Matrix Chain Multiplication-Analysis.	1 hour
4.3	Illustration of Matrix Chain Multiplication-Analysis.	1 hour
4.4	All Pairs Shortest Path Algorithm- Analysis and Illustration of Floyd-Warshall Algorithm.	1 hour
4.5	Back Tracking: The Control Abstraction .	1 hour
4.6	Back Tracking: The Control Abstraction – The N Queen's Problem.	1 hour
4.7	Branch and Bound:- Travelling salesman problem.	1 hour
4.8	Branch and Bound:- Travelling salesman problem.	1 hour
Module-5 (Introduction to Complexity Theory) 10 Hrs		
5.1	Introduction to Complexity Theory: Tractable and Intractable Problems.	1 hour
5.2	Complexity Classes – P, NP.	1 hour
5.3	NP- Hard and NP-Complete Problems.	1 hour
5.4	NP Completeness Proof of Clique Problem.	1 hour

5.5	NP Completeness Proof of Vertex Cover Problem.	1 hour
5.6	Approximation algorithms- Bin Packing Algorithm and Illustration.	1 hour
5.7	Graph Colouring Algorithm and Illustration.	1 hour
5.8	Randomized Algorithms (definitions of Monte Carlo and Las Vegas algorithms).	1 hour
5.9	Randomized Version of Quick Sort Algorithm with Analysis.	1 hour
5.10	Illustration of Randomized Version of Quick Sort Algorithm with Analysis.	1 hour



CDT308	COMPREHENSIVE COURSE WORK	Category	L	T	P	Credit	Year of Introduction
		PCC	1	0	0	1	2019

Preamble: The objective of this Course work is to ensure the comprehensive knowledge of each student in the most fundamental core courses in the curriculum. Five core courses credited from semesters 3, 4 and 5 are chosen for the detailed study in this course work. This course helps the learner to become competent in cracking GATE, placement tests and other competitive examinations

Prerequisite:

1. Data Structures
2. Operating Systems
3. Computer Organization and Architecture
4. Database Management Systems
5. Data Analytics

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

CO1:	Comprehend the concepts and applications of data structures (Cognitive Knowledge Level: Understand)
CO2 :	Comprehend the concepts, functions and algorithms in Operating System (Cognitive Knowledge Level: Understand)
CO3:	Comprehend the organization and architecture of computer systems (Cognitive Knowledge Level: Understand)
CO4:	Comprehend the fundamental principles of database design and manipulation (Cognitive Knowledge Level: Understand)
CO5:	Comprehend the concepts in data analytics (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	☒	☒										☒

Assessment Pattern

Bloom's Category	End Semester Examination
Remember	10
Understand	20
Apply	20
Analyse	
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
50	0	50	1 hour

End Semester Examination Pattern: Objective Questions with multiple choice, a maximum of four options. Question paper include fifty questions of one mark each, distributed equally from all the five identified courses.

SYLLABUS

Full Syllabus of all five selected Courses.

1. **Data Structures**
2. **Operating Systems**
3. **Computer Organization and Architecture**
4. **Database Management Systems**
5. **Data Analytics**

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	DATA STRUCTURES	
1.1	Mock Test on Module 1, Module 2 and Module 3	1 hour
1.2	Mock Test on Module 4 and Module 5	1 hour
1.3	Feedback and Remedial class	
2	OPERATING SYSTEMS	
2.1	Mock Test on Module 1 and Module 2	1 hour
2.2	Mock Test on Module 3, Module 4 and Module 5	1 hour
2.3	Feedback and Remedial class	1 hour
3	COMPUTER ORGANIZATION AND ARCHITECTURE	
3.1	Mock Test on Module 1, Module 2 and Module 3	1 hour
3.2	Mock Test on Module 4 and Module 5	1 hour
4	DATABASE MANAGEMENT SYSTEMS	
4.1	Mock Test on Module 1, Module 2 and Module 3	1 hour
4.2	Mock Test on Module 4 and Module 5	1 hour
4.3	Feedback and Remedial class	

5	DATA ANALYTICS	
5.1	Mock Test on Module 1, Module 2 and Module 3	1 hour
5.2	Mock Test on Module 4 and Module 5	1 hour
5.3	Feedback and Remedial class	1 hour

Model Question Paper**QP CODE:****Reg No:** _____**Name:** _____**PAGES : 9****APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY****SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR****Course Code: CDT308****Course Name: Comprehensive Course Work****Max. Marks: 50****Duration: 1 Hour**

**Objective type questions with multiple choices. Mark one correct answer for each question.
Each Question Carries 1 Mark**

- Consider the following sequence of operations on an empty stack.
push(22); push(43); pop(); push(55); push(12); s=pop();
Consider the following sequence of operations on an empty queue.
enqueue(32);enqueue(27); dequeue(); enqueue(38); enqueue(12); q=dequeue();
The value of s+q is _____
(A) 44 (B) 54 (C) 39 (D) 70
- A B-tree of order (degree)5 and of height 3 will have a minimum of ___ keys.
A. 624
B. 249
C. 124
D. 250
- Construct a binary search tree by inserting 8, 6, 12, 3, 10, 9 one after another. To make the resulting tree as AVL tree which of the following is required?
(A) One right rotation only
(B) One left rotation followed by two right rotations
(C) One left rotation and one right rotation

- (D) The resulting tree itself is AVL
4. In a complete 4-ary tree, every internal node has exactly 4 children or no child. The number of leaves in such a tree with 6 internal nodes is:
 (A) 20 (B) 18 (C) 19 (D) 17
5. Select the postfix expression for the infix expression $a+b-c+d*(e/f)$.
 (A) $ab+c-d+e*f/$ (B) $ab+c-def/*+$
 (C) $abc-+def/*+$ (D) $ab+c-def/*+$
6. Consider a hash table of size seven, with starting index zero, and a hash function $(2x + 5) \bmod 7$. Assuming the hash table is initially empty, which of the following is the contents of the table when the sequence 1, 4, 9, 6 is inserted into the table using closed hashing? Note that ‘_’ denotes an empty location in the table.
 (A) 9, _, 1, 6, _, _, 4 (B) 1, _, 6, 9, _, _, 4
 (C) 4, _, 9, 6, _, _, 1 (D) 1, _, 9, 6, _, _, 4
7. **Compute the time complexity of the following function:**
 void function(int n)
 {
 int count = 0;
 for (int i=n/2; i<=n; i++)
 for (int j=1; j<=n; j = j + 2)
 for (int k=1; k<=n; k = k * 2)
 count++;
 }
 A. $O(n^2 \log n)$
 B. $O(n \log^2 n)$
 C. $O(n^3)$
 D. $O(n \log n^2)$
8. How many distinct binary search trees can be created out of 6 distinct keys?
 (A) 7 (B) 36 (C) 140 (D) 132
9. Which tree traversal performed on a binary search tree, results in ascending order listing of the keys?
 A. Pre-order
 B. In-order
 C. Post-order
 D. Level-order
10. You are given pointers to first and last nodes of a singly linked list, which of the following operations are dependent on the length of the linked list?
 (A) Delete the first element
 (B) Insert a new element as a first element

- (C) Add a new element at the end of the list
- (D) Delete the last element of the list

11. Suppose a disk has 400 cylinders, numbered from 0 to 399. At some time the disk arm is at cylinder 58, and there is a queue of disk access requests for cylinder 66, 349, 201, 110, 38, 84, 226, 70, 86. If Shortest-Seek Time First (SSTF) is being used for scheduling the disk access, the request for cylinder 86 is serviced after servicing _____ number of requests.

- (A) 1
- (B) 2
- (C) 3
- (D) 4

12. If frame size is 4KB then a paging system with page table entry of 2 bytes can address _____ bytes of physical memory.

- (A) 2^{12}
- (B) 2^{16}
- (C) 2^{18}
- (D) 2^{28}

13. Calculate the internal fragmentation if page size is 4KB and process size is 103KB.

- (A) 3KB
- (B) 4KB
- (C) 1KB
- (D) 2KB

14. Which of the following scheduling policy is likely to improve interactivensess?

- (A) FCFS
- (B) Round Robin
- (C) Shortest Process Next
- (D) Priority Based Scheduling

15. Consider the following program

Semaphore X=1, Y=0

```

Void A ( )
{
    While (1)
    {
        P(X);
        Print '1';
        V(Y);
    }
}

Void B ( )
{
    While (1)
    {
        P(Y);
        P(X);
        Print '0';
        V(X);
    }
}
    
```

The possible output of the program:

- (A) Any number of 0's followed by any number of 1's.
- (B) Any number of 1's followed by any number of 0's.
- (C) 0 followed by deadlock
- (D) 1 followed by deadlock

16. In a system using single processor, a new process arrives at the rate of 12 processes per minute and each such process requires 5 seconds of service time. What is the percentage of CPU utilization?

- (A) 41.66
- (B) 100.00
- (C) 240.00
- (D) 60.00

17. A system has two processes and three identical resources. Each process needs two resources to proceed. Then

- (A) Deadlock is possible
- (B) Deadlock is not possible

- (C) Starvation may be present (D) Thrashing
18. Which of the following is true with regard to Round Robin scheduling technique?
- (A) Responds poorly to short process with small time quantum.
 (B) Works like SJF for larger time quantum
 (C) Does not use a prior knowledge of burst times of processes.
 (D) Ensure that the ready queue is always of the same size.
19. Thrashing can be avoided if
- (A) the pages, belonging to working set of programs, are in main memory
 (B) the speed of CPU is increased
 (C) the speed of I/O processor is increased
 (D) none of the above
20. The circular wait condition can be prevented by
- (A) using thread
 (B) defining a linear ordering of resource types
 (C) using pipes
 (D) all of the above
21. Consider the following processor design characteristics.
- I. Register-to-register arithmetic operations only
 II. Variable instruction format
 III. Hardwired control unit
- Which of the characteristics above are used in the design of a RISC processor?
- (A) I only (B) I and II only (C) I and III only (D) I, II and III
22. A 64-bit processor can support a maximum memory of 8 GB, where the memory is word-addressable (one word is of 64 bits). The size of the address bus of the processor is atleast _____ bits.
- (A) 30 (B) 31 (C) 32 (D) None
23. The stage delays in a 4-stage pipeline are 900, 450, 400 and 350 picoseconds. The first stage (with delay 900 picoseconds) is replaced with a functionally equivalent design involving two stages with respective delays 600 and 550 picoseconds. The throughput increase of the pipeline is _____ percent.
- (A) 38 (B) 30 (C) 58 (D) 50
24. Consider a direct mapped cache of size 256 Kilo words with block size 512 words. There are 6 bits in the tag. The number of bits in block (index) and word (offset) fields of physical address are is:
- (A) block (index) field = 6 bits, word (offset) field = 9 bits
 (B) block (index) field = 7 bits, word (offset) field = 8 bits
 (C) block (index) field = 9 bits, word (offset) field = 9 bits
 (D) block (index) field = 8 bits, word (offset) field = 8 bits
25. The memory unit of a computer has 1 Giga words of 64 bits each. The computer has

- instruction format, with 4 fields: an opcode field; a mode field to specify one of 12 addressing modes; a register address field to specify one of 48 registers; and a memory address field. If an instruction is 64 bits long, how large is the opcode field?
 (A) 34 bits (B) 24 bits (C) 20 bits (D) 14 bits
26. A computer has 64-bit instructions and 28-bit address. Suppose there are 252 two-address instructions. How many 1-address instructions can be formulated?
 (A) 2^{24} (B) 2^{26} (C) 2^{28} (D) 2^{30}
27. Determine the number of clock cycles required to process 200 tasks in a six-segment pipeline. (Assume there were no stalls), each segment takes 1 cycle.
 (A) 1200 cycles (B) 206 cycles (C) 207 cycles (D) 205 cycles
28. Match the following Lists:
- | | |
|--------------------------|-------------------------------|
| P. DMA | 1. Priority Interrupt |
| Q. Processor status Word | 2. I/O Transfer |
| R. Daisy chaining | 3. CPU |
| S. Handshaking | 4. Asynchronous Data Transfer |
- (A) P-1, Q-3, R-4, S-2 (B) P-2, Q-3, R-1, S-4
 (C) P-2, Q-1, R-3, S-4 (D) P-4, Q-3, R-1, S-2
29. Pipelining improves performance by:
 (A) decreasing instruction latency
 (B) eliminating data hazards
 (C) exploiting instruction level parallelism
 (D) decreasing the cache miss rate
30. The advantage of is that it can reference memory without paying the price of having a full memory address in the instruction.
 (A) Direct addressing (B) Indexed addressing
 (C) Register addressing (D) Register Indirect addressing
31. Let E1, E2 and E3 be three entities in an E/R diagram with simple single-valued attributes. R1 and R2 are two relationships between E1 and E2, where R1 is one-to-many, R2 is many-to-many. R3 is another relationship between E2 and E3 which is many-to-many. R1, R2 and R3 do not have any attributes of their own. What is the minimum number of tables required to represent this situation in the relational model?
 (A) 3 (B) 4 (C) 5 (D) 6
32. Identify the minimal key for relational scheme R(U, V, W, X, Y, Z) with functional dependencies $F = \{U \rightarrow V, V \rightarrow W, W \rightarrow X, VX \rightarrow Z\}$
 (A) UV (B) UW (C) UX (D) UY
33. It is given that: "Every student need to register one course and each course registered by many students", what is the cardinality of the relation say "Register" from the "Student" entity to the "Course" entity in the ER diagram to implement the given requirement.

- (A) M:1 relationship (B) M:N relationship
(C) 1:1 relationship (D) option (B) or(C)

34. Consider the relation branch(branch_name, assets, branch_city)
SELECT DISTINCT T.branch_name FROM branch T, branch S WHERE T.assets>L.assets
AND S.branch_city = "TVM" .

Finds the names of

- (A) All branches that have greater assets than all branches located in TVM.
(B) All branches that have greater assets than some branch located in TVM.
(C) The branch that has the greatest asset in TVM.
(D) Any branch that has greater asset than any branch located in TVM.

35. Consider the following relation instance, where "A" is primary Key.

A1	A2	A3	A4
1	1	1	Null
5	2	5	1
9	5	13	5
13	13	9	15

Which one of the following can be a foreign key that refers to the same relation?

- (A) A2 (B) A3 (C) A4 (D) ALL

36. A relation R(ABC) is having the tuples(1,2,1),(1,2,2),(1,3,1) and (2,3,2). Which of the following functional dependencies holds well?

- (A) $A \rightarrow BC$ (B) $AC \rightarrow B$ (C) $AB \rightarrow C$ (D) $BC \rightarrow A$

37. Consider a relation R with attributes A, B, C, D and E and functional dependencies $A \rightarrow BC$, $BC \rightarrow E$, $E \rightarrow DA$. What is the highest normal form that the relation satisfies?

- (A) BCNF (B) 3 NF (C) 2 NF (D) 1 NF

38. For the given schedule S, find out the conflict equivalent schedule.

S : r1(x); r2(Z); r3(X); r1(Z); r2(Y); r3(Y); W1(X); W2(Z); W3(Y); W2(Y)

- (A) $T1 \rightarrow T2 \rightarrow T3$ (B) $T2 \rightarrow T1 \rightarrow T3$
(C) $T3 \rightarrow T1 \rightarrow T2$ (D) Not conflict serializable

39. Specialization is _____ process.

- (A) top-down (B) bottom up
(C) Both (A) and (B) (D) none of these

40. If D_1, D_2, \dots, D_n are domains in a relational model, then the relation is a table, which is a subset of

- (A) $D_1 + D_2 + \dots + D_n$ (B) $D_1 \times D_2 \times \dots \times D_n$
(C) $D_1 \cup D_2 \cup \dots \cup D_n$ (D) $D_1 - D_2 - \dots - D_n$

41. Data Analytics uses ___ to get insights from data.
- (A) Statistical figures (B) Numerical aspects
(C) Statistical methods (D) None of the mentioned above
42. Amongst which of the following is / are the branch of statistics which deals with the development of statistical methods is classified as ___.
- (A) Industry statistics (B) Economic statistics
(C) Applied statistics (D) None of the mentioned above
43. Linear Regression is the supervised machine learning model in which the model finds the best fit ___ between the independent and dependent variable.
- (A) Linear line (B) Nonlinear line
(C) Curved line (D) All of the mentioned above
44. The process of quantifying data is referred to as ___.
- (A) Decoding (B) Structure
(C) Enumeration (D) Coding
45. Data Analysis is a process of,
- (A) Inspecting data (B) Data Cleaning
(C) Transforming of data (D) All of the mentioned above
46. On which of the following platforms does Hadoop run?
- (A) Debian (B) Cross-platform
(C) Bare metal (D) Unix-like
47. Data in ___ bytes size is called big data
- (A) Meta (B) Giga
(C) Tera (D) Peta
48. Choose the primary characteristics of big data among the following
- (A) Value (B) Variety
(C) Volume (D) All of the above
49. Which of the following is not a part of the data science process.
- (A) Communication building (B) Discovery

(C)Operationalize

(D)Model planning

50. All of the following accurately describe Hadoop, except

(A)Open source

(B)Java-based

(C)Real-time

(D)Distributed computing approach

QNo	Ans. Key	QNo	Ans. Key	QNo	Ans. Key	QNo	Ans. Key	QNo	Ans. Key
1	(C)	11	(C)	21	(C)	31	(C)	41	(C)
2	(B)	12	(D)	22	(A)	32	(D)	42	(C)
3	(A)	13	(C)	23	(D)	33	(A)	43	(A)
4	(C)	14	(B)	24	(C)	34	(B)	44	(C)
5	(D)	15	(D)	25	(B)	35	(B)	45	(D)
6	(D)	16	(B)	26	(D)	36	(D)	46	(B)
7	(A)	17	(B)	27	(D)	37	(A)	47	(D)
8	(D)	18	(C)	28	(B)	38	(D)	48	(D)
9	(B)	19	(A)	29	(C)	39	(A)	49	(A)
10	(D)	20	(B)	30	(D)	40	(B)	50	(C)



CDL332	BIG DATA PROCESSING LAB	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	0	0	3	3	2020

Preamble: The purpose of the course is to offer the students a hands-on experience on Big Data concepts using open source technologies such as Hadoop, Map Reduce, Hive, Pig and Apache Spark. The hands-on experience with R Programming language helps in statistical analysis and equip the students with data driven solutions for the next-generation data management. As data continues to grow it is known that via big data solutions, organizations generate insights and make well-informed decisions, discover trends, and improve productivity and the learner will be able to work on and solve data processing problems.

Prerequisite: Fundamental knowledge in Java programming, Statistics and Python along with topics covered in the course **Big Data Processing (CST 357)**.

Course Outcomes: At the end of the course, the student should be able to:

CO1	Illustrate the setting up of and Installing Hadoop in one of the three operating modes.(Cognitive knowledge:Understand)
CO2	Implement the file management tasks in Hadoop and explore the shell commands (Cognitive knowledge: Apply)
CO3	Implement different tasks using Hadoop Map Reduce programming model.(Cognitive knowledge: Apply)
CO4	Implement Pig Scripting operations and Spark Application functionalities.(Cognitive knowledge: Apply)
CO5	Implement data extraction from files and other sources and perform various data manipulation tasks on them using R Program.(Cognitive knowledge:Apply)

COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

Mapping of course outcomes with program outcomes

	PO 1	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	Lifelong learning

Assessment Pattern:

Bloom's Category	Continuous Assessment Test (Internal Exam) Marks in percentage	End Semester Examination Marks in percentage
Remember	20	20
Understand	20	20
Apply	60	60
Analyse		
Evaluate		
Create		

Mark Distribution

Total Marks	CIE Marks	ESE Marks	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 percentage of marks will be distributed as Algorithm 30 marks, Program 20 marks, Output 20 marks and Viva 30 marks. Total 75 marks.

Operating System to Use in Lab : Linux
Compiler/Software to Use in Lab :
Programming Language to Use in Lab : Java, R, Python

Fair Lab Record:

All Students attending the Big Data 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 the Experiment and the operations performed on them, Details of experiment including algorithm and result of Experiment. The left-hand page should contain a print out of the code used for experiment and sample output obtained for a set of input.

SYLLABUS**BIG DATA PROCESSING LAB***** Mandatory**

1. Perform setting up and Installing Hadoop in any of the three operating modes: Standalone, Pseudo distributed, Fully distributed.*
2. Explore the various shell commands in Hadoop.
3. Implement the following file management tasks in Hadoop:
 - Adding Files and Directories
 - Retrieving Files
 - Deleting Files
4. Implement a word count program using Map Reduce.
5. Write a R program to find the factorial and check for palindromes.*
6. Write a R program to solve linear regression and make predictions.*
7. Write a R program to solve logistic regression.*
8. Implement statistical operations using R.*
9. Implement a program to find variance, covariance and correlation between different types of attributes.*
10. Implement SVM/Decision tree Classifier.*
11. Implement clustering algorithm.*
12. To explore Hive with its basic commands
13. Write Pig Latin scripts to sort, group, join, project, and filter your data.
14. Install, Deploy and configure Apache Spark.

BIG DATA PROCESSING LAB - PRACTICE QUESTIONS

1. Write a MapReduce Program to retrieve data from documents.
2. Write word count program that only count the words starting with 'a'
3. Write a word count program that only counts the words whose length is longer than 10.
4. Using the structure of the Word Count program, write a Hadoop program that calculates the average word length of all words that start with each character.
5. Implement matrix multiplication with Hadoop Map Reduce
6. Write a Map Reduce program for removing stop words from the given text files.
7. Write a MapReduce Program to count the number of lines in a document.
8. Write Pig Latin script to count the number of occurrences of each word in an input text file.

9. Write a program to simulate Singular Value Decomposition
10. Write a program to simulate PCA.
11. Write a single Spark application that:
 - a. Transposes the original Amazon food dataset, obtaining a Pair RDD of the type: user-id – list of the product-ids reviewed by user-id
 - b. Counts the frequencies of all the pairs of products reviewed together;
 - c. Writes on the output folder all the pairs of products that appear more than once and their frequencies.
 - d. The pairs of products must be sorted by frequency..
12. Write a program to implement a stop word elimination problem. Input: A large textual file containing one sentence per line. A small file containing a set of Stop Words (One Stop Word per line) Output:A textual file containing the same sentences of the large input file without the words appearing in the small file
13. Implement matrix multiplication with Map Reduce.
14. Implement basic Pig Latin Scripts based on different scenarios.
15. Implement Frequent Item set algorithm
16. Implement Clustering algorithm
17. Implement Page Rank algorithm
18. Implement Bloom Filter
19. Write a R program to create a sequence of numbers from 20 to 50 and find the mean of numbers from 20 to 60 and sum of numbers from 51 to 91.
20. Write a R program to create a vector which contains 10 random integer values between -50 and +50.
21. Write a R program to find the maximum and the minimum value of a given vector.
22. Write a R program to get the unique elements of a given string and unique numbers of vectors.
23. Write a R program to create a list of random numbers in normal distribution and count occurrences of each value.
24. Write a R program to read the .csv file and display the content.
25. Write a R program to create an array, passing in a vector of values and a vector of dimensions. Also provide names for each dimension.
26. Write a R program to create a simple bar plot of five subjects' marks.

27. Write a R program to compute the sum, mean and product of a given vector element.
28. Write a R program to create a Data Frames which contain details of 5 employees and display the details.



CDD324	MINI PROJECT	CATEGORY	L	T	P	CREDITS
		PWS	0	0	3	2

Preamble: The objective of this course is to apply the fundamental concepts of Data Science / Machine Learning principles for the effective development of an application/research project. Mini project enables the students to boost their skills, widen the horizon of thinking and their ability to resolve real life problems. The students are expected to design and develop a software/hardware project to innovatively solve a real-world problem.

Prerequisite : A sound knowledge in any programming language and Subjects studied up to sixth semester.

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

CO#	CO
CO1	Identify technically and economically feasible problems of social relevance (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 and identify design methodologies and develop adaptable and reusable solutions of minimal complexity by using modern tools and 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	Life long learning

Assessment Pattern**Mark Distribution**

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	75	75	3

Split-up of Continuous Internal Evaluation :

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

Split-up of End Semester Examination:

The marks will be distributed as

Presentation	: 30 marks
Demonstration	: 20 marks
Viva	: 25 marks.
Total	: 75 marks.

Course Plan

Student Groups with 3 or 4 members should identify a topic of interest in consultation with Faculty/Advisor. 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. 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 with the Head of the Department or a senior faculty, Mini Project coordinator and project guide as the members. Innovative design concepts, reliability considerations, aesthetics/ergonomic aspects taken care of in the project shall be given due weight. 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 product/application has to be demonstrated for its full design specifications.

Guidelines for the Report preparation

A bonafide report on 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 Roman 18, Bold; Heading 2 – Times New Roman 16, Bold; Heading 3 – Times New Roman 14,Bold; Body- Times New Roman12, 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 LeftAligned. 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

APJ ABDUL KALAM
TECHNOLOGICAL
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SEMESTER VI

PROGRAM ELECTIVE I



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 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

Estd.

2014

Module – 1 (Introduction to Graphs)

Introduction- Basic definition – Application of graphs – finite, infinite and bipartite graphs – Incidence and Degree – Isolated vertex, pendant vertex and Null graph. Paths and circuits – Isomorphism, sub graphs, walks, paths and circuits, connected graphs, disconnected graphs and components..

Module - 2 (Eulerian and Hamiltonian graphs)

Euler graphs, Operations on graphs, Hamiltonian paths and circuits, Travelling salesman problem. Directed graphs – types of digraphs, Digraphs and binary relation, Directed paths, Fleury's algorithm

Module - 3 (Trees and Graph Algorithms)

Trees – properties, pendant vertex, Distance and centres in a tree - Rooted and binary trees, counting trees, spanning trees, Prim's algorithm and Kruskal's algorithm, Dijkstra's shortest path algorithm.

Module - 4 (Connectivity and Planar Graphs)

Vertex Connectivity, Edge Connectivity, Cut set and Cut Vertices, Fundamental circuits, Planar graphs, Kuratowski's theorem (proof not required), Different representations of planar graphs, Euler's theorem, Geometric dual.

Module - 5 (Graph Representations and Vertex Colouring)

Matrix representation of graphs- Adjacency matrix, Incidence Matrix, Circuit Matrix, Path Matrix. Coloring- Chromatic number, Chromatic polynomial, Four color problem and Five color theorem. Greedy colouring algorithm.

Text Books

1. Narsingh Deo, Graph theory, PHI,1979

Reference Books

1. R. Diestel, *Graph Theory*, free online edition, 2016: diestel-graph-theory.com/basic.html.
2. Douglas B. West, *Introduction to Graph Theory*, Prentice Hall IndiaLtd.,2001
3. Robin J. Wilson, *Introduction to Graph Theory*, Longman GroupLtd.,2010
4. J.A. Bondy and U.S.R. Murty. *Graph theory with Applications*

Course Level Assessment Questions**Course Outcome1 (CO1):**

1. Differentiate a walk, path and circuit in a graph.
2. Is it possible to construct a graph with 12 vertices such that two of the vertices have degree 3 and the remaining vertices have degree 4? Justify
3. Prove that a simple graph with n vertices must be connected, if it has more than $\frac{(n-1)(n-2)}{2}$ edges.
4. Prove the statement: If a graph (connected or disconnected) has exactly two odd degree, then there must be a path joining these two vertices.

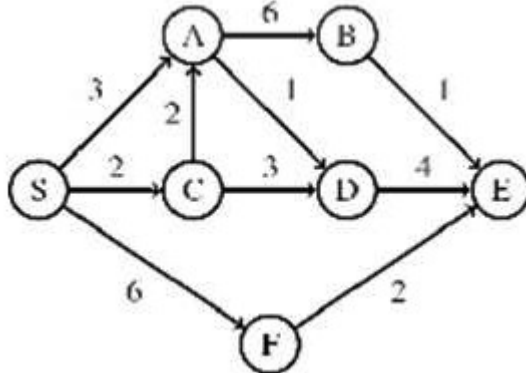
Course Outcome 2(CO2):

1. Define Hamiltonian circuit and Euler graph. Give one example for each.
2. Define directed graphs. Differentiate between symmetric digraphs and asymmetric digraphs.
3. Prove that a connected graph G is an Euler graph if all vertices of G are of even degree.

4. Prove that a graph G of n vertices always has a Hamiltonian path if the sum of the degrees of every pair of vertices V_i, V_j in G satisfies the condition $d(V_i) + d(V_j) = n - 1$

Course Outcome 3(CO3):

1. Discuss the centre of a tree with suitable example.
2. Define binary tree. Then prove that number of pendant vertices in a binary tree is $(n + 1) / 2$
3. Prove that a tree with n vertices has $n - 1$ edges.
4. Run Dijkstra's algorithm on the following directed graph, starting at vertex S .



Course Outcome 4(CO4):

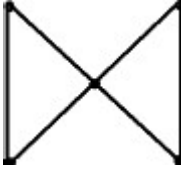
1. Define edge connectivity, vertex connectivity and separable graphs. Give an example for each.
2. Prove the statement: Every cut set in a connected graph G must also contain at least one branch of every spanning tree of G .

Course Outcome 5(CO5):

1. Show that if $A(G)$ is an incidence matrix of a connected graph G with n vertices, then rank of $A(G)$ is $n - 1$.
2. Show that if B is a cycle matrix of a connected graph G with n vertices and m edges, then rank $B = m - n + 1$.
3. Derive the relations between the reduced incidence matrix, the fundamental cycle matrix, and the fundamental cut-set matrix of a graph G .
4. Characterize simple, self-dual graphs in terms of their cycle and cut-set matrices.

Course Outcome 6 (CO6):

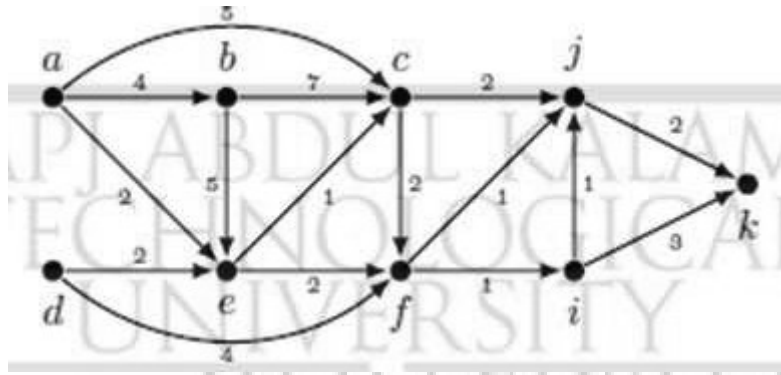
1. Show that an n vertex graph is a tree iff its chromatic polynomial is $P_n(\lambda) = \lambda(\lambda - 1)^{n-1}$
2. Define Path matrix and Circuit matrix with an example each.

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: CAT312		
Course Name: Concepts in Graph Theory		
Max. Marks : 100		Duration: 3 Hours
PART A		
Answer All Questions. Each Question Carries 3 Marks		
1.	Construct a simple graph of 12 vertices with two of them having degree 1, three having degree 3 and the remaining seven having degree 10.	(3)
2.	What is the largest number of vertices in a graph with 35 edges, if all vertices are of degree at least 3 ?	(3)
3.	Define a Euler graph. Give an example of Eulerian graph which is not Hamiltonian	(3)
4.	Give an example of a strongly connected simple digraph without a directed Hamiltonian path.	(3)
5.	What is the sum of the degrees of any tree of n vertices?	(3)
6.	How many spanning trees are there for the following graph 	(3)

7.	Show that in a simple connected planar graph G having V -vertices, E -edges, and no triangles $E \leq 3V - 6$	(3)
8.	<p>Let G be the following disconnected planar graph. Draw its dual G^*, and the dual of the dual $(G^*)^*$.</p> <p style="text-align: center;">G</p>	(3)
9.	Consider the circuit matrix B and incidence matrix A of a simple connected graph whose columns are arranged using the same order of edges. Prove that every row of B is orthogonal to every row of A ?	(3)
10.	A graph is <i>critical</i> if the removal of any one of its vertices (and the edges adjacent to that vertex) results in a graph with a lower chromatic number. how that K_n is critical for all $n > 1$.	(10x3=30)
<p>Part B (Answer any one question from each module. Each question carries 14 Marks)</p>		
11.	(a) Prove that for any simple graph with at least two vertices has two vertices of the same degree.	(6)
	(b) Prove that in a complete graph with n vertices there are $(n-1)/2$ edge disjoint Hamiltonian circuits and $n \geq 3$	(8)
<p>OR</p>		
12.	(a) Determine whether the following graphs $G_1 = (V_1, E_1)$ and $G_2 = (V_2, E_2)$ are isomorphic or not. Give justification.	(6)

	(b) Prove that a simple graph with n vertices and k components can have at most $(n-k)(n-k+1)/2$ edges.	(8)
13.	(a) Let S be a set of 5 elements. Construct a graph G whose vertices are subsets of S of size 2 and two such subsets are adjacent in G if they are disjoint. <ol style="list-style-type: none"> Draw the graph G. How many edges must be added to G in order for G to have a Hamiltonian cycle? 	(8)
	(b) Let G be a graph with exactly two connected components, both being Eulerian. What is the minimum number of edges that need to be added to G to obtain an Eulerian graph?	(6)
OR		
14.	(a) Show that a k -connected graph with no hamiltonian cycle has an independent set of size $k + 1$.	(8)
	(b) i. Let G be a graph that has exactly two connected components, both being Hamiltonian graphs. Find the minimum number of edges that one needs to add to G to obtain a Hamiltonian graph. <ol style="list-style-type: none"> For which values of n the graph Q_n (hyper-cube on n vertices) is Eulerian. 	(6)
15.	(a) A tree T has at least one vertex v of degree 4, and at least one vertex w of degree 3. Prove that T has at least 5 leaves.	(5)
	(b) Write Dijkstra's shortest path algorithm. Consider the following weighted directed graph G . Find the shortest path	(9)

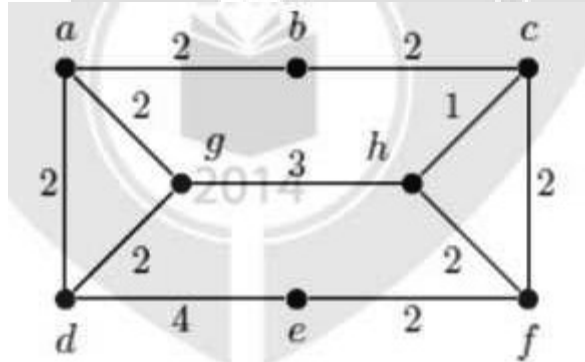
between a and every other vertices in G using Dijkstra's shortest path algorithm.



OR

16. (a) Define pendent vertices in a binary tree? Prove that the number of pendent vertices in a binary tree with n vertices is $(n+1)/2$ (5)

(b) Write Prim's algorithm for finding minimum spanning tree. Find a minimum spanning tree in the following weighted graph, using Prim's algorithm. Determine the number of minimum spanning trees for the given graph. (9)

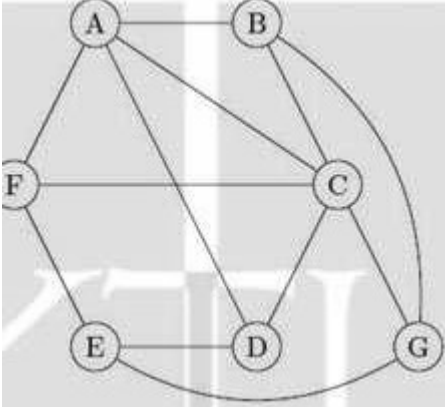


17. (a) i. State and prove Euler's Theorem relating the number of faces, edges and vertices for a planar graph. (9)

ii. If G is a 5-regular simple graph and $|V| = 10$, prove that G is non-planar.

(b) Let G be a connected graph and e an edge of G . Show that e is a cut-edge if and only if e belongs to every spanning tree. (5)

OR

<p>18.</p>	<p>(a) State Kuratowski's theorem, and use it to show that the graph G below is not planar. Draw G on the plane without edges crossing. Your drawing should use the labelling of the vertices given.</p> 	<p>(9)</p>
	<p>(b) Let G be a connected graph and e an edge of G. Show that e belongs to a loop if and only if e belongs to no spanning tree.</p>	<p>(5)</p>
<p>19.</p>	<p>(a) Define the circuit matrix $B(G)$ of a connected graph G with n vertices and e edges with an example. Prove that the rank of $B(G)$ is $e-n+1$</p>	<p>(7)</p>
	<p>(b) Give the definition of the chromatic polynomial $P_G(k)$. Directly from the definition, prove that the chromatic polynomials of W_n and C_n satisfy the identity $P_{W_n}(k) = k P_{C_{n-1}}(k-1)$.</p>	<p>(7)</p>
<p>OR</p>		
<p>20.</p>	<p>(a) Prove that the rank of an incidence matrix of a connected graph with n vertices is $n-1$.</p>	<p>(3)</p>
	<p>(b) i. A graph G has chromatic polynomial $P_G(k) = k^4 - 4k^3 + 5k^2 - 2k$. How many vertices and edges does G have? Is G bipartite? Justify your answers. i. State and prove Five Color Theorem.</p>	<p>(11)</p>

Teaching Plan

No	Contents	No. of Lecture Hours (36 hrs)
Module-1 (Introduction to Graphs) (5 hours)		
1.1	Introduction- Basic definition – Application of graphs – finite and infinite graphs, bipartite graphs,	1 hour
1.2	Incidence and Degree – Isolated vertex, pendent vertex and Null graph,	1 hour
1.3	Paths and circuits, Isomorphism	1 hour
1.4	Sub graphs, walks, Paths and circuits	1 hour
1.5	Connected graphs, Disconnected graphs and components	1 hour
Module-2 (Eulerian and Hamiltonian graphs) (7 hours)		
2.1	Euler graphs	1 hour
2.2	Operations on graphs	1 hour
2.3	Hamiltonian paths and circuits	1 hour
2.4	Hamiltonian paths and circuits, Travelling salesman problem	1 hour
2.5	Directed graphs – types of digraphs,	1 hour
2.6	Digraphs and binary relation, Directed paths	1 hour
2.7	Fleury's algorithm	1 hour
Module-3 (Trees and Graph Algorithms) (8 hours)		
3.1	Trees – properties	1 hour
3.2	Trees – properties, pendent vertex	1 hour
3.3	Distance and centres in a tree	1 hour
3.4	Rooted and binary tree	1 hour
3.5	Counting trees	1 hour
3.6	Spanning trees, Fundamental circuits	1 hour
3.7	Prim's algorithm	1 hour
	Kruskal's algorithm	

3.8	Dijkstra's shortest path algorithm	1 hour
Module-4 (Connectivity and Planar Graphs) (9 hours)		
4.1	Vertex Connectivity, Edge Connectivity	1 hour
4.2	Cut set and Cut Vertices	1 hour
4.3	Fundamental circuits	1 hour
4.4	Fundamental circuits	1 hour
4.5	Planar graphs	1 hour
4.6	Kuratowski's theorem	1 hour
4.7	Different representations of planar graphs	1 hour
4.8	Euler's theorem	1 hour
4.9	Geometric dual	1 hour
Module-5 (Graph Representations and Vertex Colouring) (7 hours)		
5.1	Matrix representation of graphs- Adjacency matrix, Incidence Matrix	1 hour
5.2	Circuit Matrix, Path Matrix	1 hour
5.3	Coloring- chromatic number,	1 hour
5.4	Chromatic polynomial	1 hour
5.5	Four color problem	1 hour
5.6	Five color Theorem and proof	1 hour
5.7	Greedy coloring algorithm.	1 hour

AIT322	CONCEPTS IN COMPUTER GRAPHICS AND IMAGE PROCESSING	Category	L	T	P	Credit	Year of Introduction
		PEC	2	1	0	3	2019

Preamble: The purpose of this course is to make awareness about strong theoretical relationships between computer graphics and image processing. This course helps the learner to understand three-dimensional environment representation in a computer, transformation of 2D/3D objects, basic mathematical techniques and algorithms used to build useful applications, imaging, and image processing techniques. The study of computer graphics and image processing develops the ability to create image processing frameworks for different domains and develops algorithms for emerging display technologies.

Prerequisite: A sound knowledge of Mathematics and a 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, transformations on 2D & 3D objects, clipping algorithms and projection algorithms(Cognitive Knowledge level: Apply)
CO4	Summarize visible surface detection methods(Cognitive Knowledge level: Understand)
CO5	Summarize the concepts of digital image representation, processing and demonstrate pixel relationships(Cognitive Knowledge level: Apply)
CO6	Solve image enhancement and segmentation problems using spatial domain techniques(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	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. 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 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 and Algorithms)**

Basics of Computer Graphics and its applications. Video Display devices- Refresh Cathode Ray Tubes, Random Scan Displays and systems, Raster scan displays and systems. Line drawing algorithms- DDA, Bresenham's algorithm. Circle drawing algorithms- Midpoint Circle generation algorithm, Bresenham's algorithm.

Module – 2 (Filled Area Primitives and transformations)

Filled Area Primitives- Scan line polygon filling, Boundary filling and flood filling. Two dimensional transformations-Translation, Rotation, Scaling, Reflection and Shearing, Composite transformations, Matrix representations and homogeneous coordinates. Basic 3D transformations.

Module - 3 (Clipping and Projections)

Window to viewport transformation. Cohen Sutherland Line clipping algorithm. Sutherland Hodgeman Polygon clipping algorithm. Three-dimensional viewing pipeline. Projections-Parallel and Perspective projections. Visible surface detection algorithms- Depth buffer algorithm, Scan line algorithm.

Module - 4 (Fundamentals of Digital Image Processing)

Introduction to Image processing and applications. Image as 2D data. Image representation in grayscale, Binary and Colour images. Fundamental steps in image processing. Components of image processing system. Coordinate conventions. Sampling and quantization. Spatial and Gray Level Resolution. Basic relationship between pixels- neighbourhood, adjacency, connectivity.

Module - 5 (Image Enhancement in Spatial Domain and Image Segmentation)

Basic gray level transformation functions- Log transformations, Power-Law transformations, Contrast stretching. Histogram equalization. Basics of spatial filtering - Smoothing spatial filter- Linear and nonlinear filters, and Sharpening spatial filters-Gradient and Laplacian.

Fundamentals of Image Segmentation. Thresholding-Basics of Intensity thresholding and Global Thresholding. Region based Approach- Region Growing, Region Splitting and Merging. Edge Detection - Edge Operators- Sobel and Prewitt.

Text Book

1. Donald Hearn and M. Pauline Baker, Computer Graphics, PHI, 2e, 1996
2. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing. Pearson, 4e, 2017

References

- 1) William M. Newman and Robert F. Sproull, Principles of Interactive Computer Graphics. McGraw Hill, 2001
- 2) Zhigang Xiang and Roy Plastock, Computer Graphics (Schaum's outline Series), McGraw Hill, 2019.

- 3) David F. Rogers , Procedural Elements for Computer Graphics, Tata McGraw Hill,2001.
- 4) M. Sonka, V. Hlavac, and R. Boyle, Image Processing, Analysis, and Machine Vision, Thomson India Edition, 4e, 2017.

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 with end points(2,3) and (5,8) using Bresenham's line drawing algorithm.
2. Explain how the 4-connected area filling approach differs from 8- connected area filling in boundary filling algorithm

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 coordinate ABC is given as A(4,1), B(5,2) and C(4,3).
2. 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)

Course Outcome 4 (CO4):

1. Explain scan line algorithm for detecting visible surfaces in an object.

Course Outcome 5 (CO5):

1. Give an image representation model and describe how the representation changes in grayscale, binary and colour images.
2. Consider an image segment shown below.

3 1 2 1 (q)

2 2 0 2

1 2 1 1

(p) 1 0 1 2

- (a) Let $V=\{0,1\}$ and compute the length of the shortest 4-,8- and m- path between p and q. If a particular path does not exist between these two points , explain why?

(b) Repeat for $V=\{1,2\}$.

3. The spatial resolution of an image is given by 128 X 128.What is its storage requirements if it is represented by 64 gray levels?

Course Outcome 6 (CO6):

1. A skilled medical technician is charged with the job of inspecting a certain class of monochrome images generated by electronic microscope. To facilitate the inspection, the technician uses image processing aids. However when he examines the images he finds the following problems.
 - (a) Presence of bright isolated dots that are not of interest.
 - (b) Lack of sharpness
 - (c) Poor contrast

Identify the sequence of preprocessing steps that the technician may use to overcome the above mentioned problems and explain it.

2. A 4x4, 4 bits/pixel original image is given by

10	12	8	9
10	12	12	14
12	13	10	9
14	12	10	12

- (a) Apply histogram equalisation to the image by rounding the resulting image pixels to integers
 - (b) Sketch the histogram of the original image and the histogram-equalised image.
3. You have Sobel operator and Laplacian operator for edge detection. Which operator will you select for edge detection in the case of noisy image? Explain. **(Assignment)**

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: AIT322

Course Name: Concepts in Computer Graphics and Image Processing

Max.Marks:100

Duration: 3 Hours

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Justify the approach of using integer arithmetic in Bresenham's line drawing algorithm.
2. Consider a raster system with a resolution of 1024×1024 . What is 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. Show that two successive reflections about either of the coordinate axes is equivalent to a single rotation about the coordinate origin.
4. Determine a sequence of basic transformations that are equivalent to the x-direction shearing matrix.
5. Find the window to viewport normalization transformation with window lower left corner at (1,1) and upper right corner at (2,6).
6. Find the orthographic projection of a unit cube onto the $x=0$, $y=0$ and $z=0$ plane.
7. Define Sampling and Quantization of an image.

8. Give any three applications of digital image processing.
9. A captured image appears very dark because of wrong lens aperture setting. Describe an enhancement technique which is appropriate to enhance such an image.
10. Suggest an approach of thresholding that should be used in case of uniform illumination. (10x3=30)

Part B

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

11. (a) Write Midpoint circle drawing algorithm and use it to plot a circle with radius=20 and center is (50,30). (10)
- (b) Draw the architecture of raster scan display systems and explain its working principle. (4)
- OR**
12. (a) Derive the initial decision parameter of Bresenham's line drawing algorithm and use the algorithm to rasterize a line with endpoints (2,2) and (10,10). (10)
- (b) Explain the working principle of color CRT monitors with suitable illustrations. (4)
13. (a) Compare boundary fill algorithm and flood fill algorithm. (5)
- (b) Reflect a triangle ABC about the line $3x-4y+8=0$. The position vector of the coordinate ABC is given as A(4,1), B(5,2) and C(4,3). (9)
- OR**
14. (a) Explain the need of using vanishing points in projections. (4)
- (b) Explain Cohen-Sutherland line clipping algorithm. Use the algorithm to clip line P1(70, 20) and P2(100,10) against a window lower left hand corner (50,10) and upper right hand corner (80,40). (10)

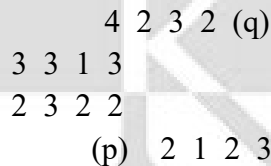
15. (a) Describe Sutherland Hodegman polygon clipping algorithm and what are its limitations. (7)
- (b) Explain how visible surfaces can be detected using depth buffer algorithm. (7)

OR

16. (a) Describe Sutherland Hodegman polygon clipping algorithm and what are its limitations. (7)
- (b) Explain how visible surfaces can be detected using depth buffer algorithm. (7)
17. (a) Explain the components of an image processing system with suitable diagram (9)
- (b) Define Resolution of an image. Explain the spatial and gray level resolution of an image with an example. (5)

OR

18. (a) Define 4-adjacency, 8 adjacency and m-adjacency. Consider the image segment shown. (7)



Let $V=\{1,2\}$ and compute the length of the shortest 4-,8- and m- path between p and q. If a particular path does not exist between these two points, explain why?

- (b) Using any one application, explain the steps involved in image processing. (7)
19. (a) A 5x5 image patch is shown below. Compute the value of the marked pixel if it is smoothened by a 3x3 average filter and median filter. (4)

$$f(m,n) = \begin{pmatrix} 0 & 1 & 2 & 3 & 2 \\ 5 & 6 & 7 & 8 & 4 \\ 4 & 3 & \textcircled{2} & 1 & 2 \\ 8 & 7 & 6 & 5 & 3 \\ 1 & 5 & 3 & 7 & 6 \end{pmatrix}$$

- (b) Define Image segmentation and describe in detail method of edge and region (10)

based segmentation technique.

OR

20. (a) Distinguish between smoothing and sharpening filters in terms of (10)
- (i) Functionality
 - (ii) Types
 - (iii) Applications
 - (iv) Mask Coefficients
- (b) Describe how an image is segmented using split and merge technique in association with the region adjacency graph. (8)

TEACHING PLAN

No	Contents	No of Lecture Hrs (36 hrs)
Module – 1 (Basics of Computer Graphics and Algorithms) (8 hrs)		
1.1	Basics of Computer Graphics and applications	1 hour
1.2	Refresh Cathode Ray Tubes	1 hour
1.3	Random Scan Displays and systems, Raster scan displays and systems	1 hour
1.4	DDA Line drawing Algorithm	1 hour
1.5	Bresenham's line drawing algorithm	1 hour
1.6	Midpoint Circle generation algorithm	1 hour
1.7	Bresenham's Circle generation algorithm	1 hour
1.8	Illustration of line drawing and circle drawing algorithms	1 hour
Module - 2 (Filled Area Primitives and transformations) (8 hrs)		
2.1	Scan line polygon filling	1 hour
2.2	Boundary filling and flood filling	1 hour
2.3	Basic 2D transformations-Translation, Rotation and Scaling	1 hour

2.4	Reflection and Shearing	1 hour
2.5	Composite transformations	1 hour
2.6	Matrix representations and homogeneous coordinates	1 hour
2.7	Basic 3D transformation-Translation and scaling	1 hour
2.8	Basic 3D transformation-Rotation	1 hour
Module - 3 (Clipping and Projections) (7 hrs)		
3.1	Window to viewport transformation	1 hour
3.2	Cohen Sutherland Line clipping algorithm	1 hour
3.3	Sutherland Hodgeman Polygon clipping algorithm	1 hour
3.4	Practice problems on Clipping algorithms	1 hour
3.5	Three-dimensional viewing pipeline, Projections-Parallel projections, Perspective projections	1 hour
3.6	Visible surface detection algorithms- Depth buffer algorithm	1 hour
3.7	Scan line visible surface detection algorithm	1 hour
Module - 4 (Fundamentals of Digital Image Processing) (6 hrs)		
4.1	Introduction to Image processing-Image as a 2D data, Image representation-Gray scale, Binary and Colour images.	1 hour
4.2	Fundamental steps in image processing and applications	1 hour
4.3	Components of image processing system	1 hour
4.4	Coordinate conventions, Sampling and quantization, Spatial and Gray Level Resolution	1 hour
4.5	Basic relationship between pixels – neighbourhood, adjacency, connectivity	1 hour
4.6	Illustration of basic relationship between pixels– neighbourhood, adjacency, connectivity	1 hour

Module - 5 (Image Enhancement in spatial domain and Image Segmentation) (7 hrs)		
5.1	Basic gray level transformation functions- Log transformations, Power law transformation, Contrast stretching	1 hour
5.2	Histogram equalization with illustration	1 hour
5.3	Basics of spatial filtering, Smoothing spatial filter- Linear and nonlinear filters	1 hour
5.4	Sharpening spatial filtering-Gradient filter mask, Laplacian Filter Mask	1 hour
5.5	Fundamentals of Image Segmentation, Basics of Intensity thresholding, Basic Global Thresholding	1 hour
5.6	Region Based Approach- Region Growing, Region Splitting and Merging	1 hour
5.7	Basics of Edge Detection- Sobel and Prewitt edge detection masks	1 hour



CST 332	FOUNDATIONS OF SECURITY IN COMPUTING	Category	L	T	P	Credit	Year Of Introduction
		PEC	2	1	0	3	2019

Preamble: The purpose of this course is to create awareness among learners about the fundamentals of security and number theory. This course covers Integer & Modular Arithmetic, Primes & Congruences, Discrete Logarithms & Elliptic Curve Arithmetic and an overview of computer security. The concepts covered in this course enable the learners in effective use of cryptographic algorithms and to identify the security threats in computing.

Prerequisite: A sound knowledge in Mathematics, Discrete Computational Structures, Operating Systems and Database Systems.

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

CO1	Illustrate the operations and properties of algebraic structures, integer arithmetic and modular arithmetic. (Cognitive Knowledge Level: Understand)
CO2	Use the concepts of prime numbers and factorization for ensuring security in computing systems (Cognitive Knowledge Level: Apply)
CO3	Illustrate the concepts of Linear Congruence, Primitive Roots, Discrete Logarithms and Elliptic Curve Arithmetic (Cognitive Knowledge Level: Apply)
CO4	Summarize the threats and attacks related to computer and program security (Cognitive Knowledge Level: Understand)
CO5	Outline the key aspects of operating system and database 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
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	30	30	30
Apply	40	40	40
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 (Modular Arithmetic)**

Integer arithmetic - Integer division, Divisibility, Greatest Common Divisor (GCD), Euclid's algorithm for GCD, Extended Euclid's algorithm, Linear Diophantine Equations. Modular

arithmetic - Operations, Properties. Algebraic structures - Groups, Rings, Fields, Finite fields, $GF(p)$, $GF(2^n)$.

Module-2 (Prime Numbers and Factorization)

Prime numbers - Prime numbers and prime-power factorization, Fermat and Mersenne primes, Fermat's theorem, Applications, Euler's theorem, Euler's totient function, Applications. Primality testing – Deterministic algorithms and Probabilistic algorithms. Factorization - Fermat's factorization, Pollard p-1 method.

Module-3 (Linear Congruence, Primitive Roots and Elliptic Curve Arithmetic)

Linear congruence - Simultaneous linear congruence, Chinese Remainder Theorem (CRT). Congruence with a prime - Power modulus, Arithmetic modulo p , Pseudoprimes and Carmichael numbers, Solving congruence modulo prime powers. Primitive roots - Existence of primitive roots for primes, Discrete logarithms. Elliptic curve arithmetic – Prime curves, Binary curves, Addition of two points, Multiplication of a point by a constant.

Module-4 (Computer and Program Security)

Introduction to computer security – Threats, Vulnerabilities, Controls. Browser attack types, Web attacks targeting users, Email attack types. Introduction to program security - Non-malicious programming oversights, Malware.

Module-5 (Operating System and Database Security)

Operating system security – Security in operating system, Security in design of operating system. Database security – Security requirements of databases, Reliability and integrity, Database disclosure.

Text Books

1. Behrouz A Forouzan, Cryptography and Network Security, 3/e, Tata McGraw-Hill.
2. Charles P Pfleeger, Shari Lawrence Pfleeger, Jonathan Margulies, Security in Computing, 5/e, Prentice Hall.
3. G.A. Jones & J.M. Jones, Elementary Number Theory, Springer UTM, 2007

References

1. William Stallings, Cryptography and Network Security Principles and Practices, 4/e, Pearson Ed.

Sample Course Level Assessment Questions**Course Outcome 1 (CO1):**

1. Find the n- bit word that is represented by the polynomial $x^2 + 1$ in $GF(2^5)$.
2. Solve the linear Diophantine equation $21x + 14y = 35$.

Course Outcome 2 (CO2):

1. Prove that a Carmichael number cannot be the product of two distinct primes.
2. Use the Pollard p-1 method to find a factor of 57247159 with the bound $B=8$.

Course Outcome 3 (CO3):

1. Find an integer that has a remainder of 3 when divided by 7 and 13, but is divisible by 12.
2. In the elliptic curve $E(1,2)$ over the field $GF(11)$, find the equation of the curve and all the points on the curve.

Course Outcome 4 (CO4):

1. List three controls that could be applied to detect or prevent off-by-one errors.
2. How does fake email messages act as spam?

Course Outcome 5 (CO5):

1. Discuss the importance of auditability and access control in database security.
2. Explain the various factors which can make data sensitive.

Model Question Paper

QP CODE: _____

PAGES: ____

Reg No: _____

Name: _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST 332

Course Name : FOUNDATIONS OF SECURITY IN COMPUTING

Max Marks: 100

Duration: 3 Hours

PART A

(Answer All Questions. Each question carries 3 marks)

1. List the four properties of divisibility with examples.
2. Find gcd (401,700) using Euclid's algorithm.
3. Use Fermat's Little theorem to show that 91 is not a prime.
4. If m is relatively prime to n , show that $\Phi(mn) = \Phi(m) \Phi(n)$.
5. Solve the congruence relation $103x \equiv 57 \pmod{211}$.
6. Find a solution for the congruence $3x \equiv 5 \pmod{7^3}$
7. What are the problems created by an off-by-one error?
8. How does a clickjacking attack succeed?
9. Explain the significance of correctness and completeness in the design of operating systems.
10. How does the two-phase update technique help the database manager in handling failures? (10x3=30)

Part B

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

11. (a) For the group $G = \langle Z_6^*, x \rangle$, prove that it is an Abelian group. Also show the result of 5×1 and $1 \div 5$. (6)

(b) Find a particular and the general solution to the following linear Diophantine equations. (8)

i) $19x + 13y = 20$ ii) $40x + 16y = 88$

OR

12. (a) Describe the properties of modular arithmetic and modulo operator. (6)

(b) Using Extended Euclidean algorithm, find the multiplicative inverse of (i) 131 in Z_{180} and (ii) 23 in Z_{100} . (8)

13. (a) State and prove Fermat's theorem. (6)

(b) Explain Fermat's factorization method and use it to factor 809009. (8)

OR

14. (a) Define Euler's totient function. Prove that, $\phi(pq) = (p-1)(q-1)$ where p and q are prime numbers. (7)

(b) Define Fermat primes. Show that any two distinct Fermat numbers are relatively prime. (7)

15. (a) Using Chinese Remainder Theorem, solve the system of congruence, $x \equiv 2 \pmod{3}$, $x \equiv 3 \pmod{5}$, $x \equiv 2 \pmod{7}$. (7)

(b) Define Carmichael number and show that a Carmichael number must be the product of at least three distinct primes. (7)

OR

16. (a) For the group $G = \langle Z_{19}^*, x \rangle$, find the primitive roots in the group. (6)

(b) Consider the elliptic curve $y^2 = x^3 + x + 1$ defined over Z_{23} . If $P = (3, 10)$ and $Q = (9, 7)$ are two points on the elliptic curve, find $2P$ and $P + Q$. (8)

17. (a) Distinguish the terms vulnerability, threat and control. (4)

(b) With the help of suitable examples, explain the security problems created by incomplete mediation and time-of-check to time-of-use. (10)

OR

18. (a) Differentiate between man-in-the-browser attack and page-in-the-middle attack. (4)

- (b) Explain the four aspects of malicious code infection. (10)
19. (a) List any six computer security related functions addressed by operating systems. (6)
- (b) How does a kernelized design support in enforcing security mechanisms? (8)
- OR**
20. (a) Explain any four security requirements of databases. (4)
- (b) How can database disclosure be prevented? With the help of suitable examples, explain any six types of disclosure. (10)

Teaching Plan

No	Contents	No.of Lecture Hrs
Module-1 (Modular Arithmetic) (6 hrs)		
1.1	Integer arithmetic, Integer division, Divisibility, Greatest Common Divisor (GCD)	1
1.2	Euclid's algorithm for GCD, Extended Euclid's algorithm	1
1.3	Linear Diophantine Equations	1
1.4	Modular arithmetic operations, Properties of modular arithmetic	1
1.5	Groups, Rings and Fields	1
1.6	Finite fields – $GF(p)$, $GF(2^n)$	1
Module-2 (Prime Numbers and Factorization) (7 hrs)		
2.1	Prime numbers and prime-power factorization	1
2.2	Fermat and Mersenne primes	1
2.3	Fermat's theorem, Applications – Exponentiation, Multiplicative inverse	1
2.4	Euler's theorem, Euler's totient function, Applications	1
2.5	Primality testing – Deterministic algorithms – Divisibility algorithm	1

2.6	Primality testing – Probabilistic algorithms-Fermat test, Square root test, Miller - Rabin test	1
2.7	Factorization - Fermat’s factorization, Pollard p-1 method	1
Module-3 (Linear Congruence, Primitive Roots and Elliptic Curve Arithmetic) (7 hrs)		
3.1	Linear congruence, Simultaneous linear congruence	1
3.2	Chinese Remainder Theorem (CRT)	1
3.3	Congruence with a Prime-Power Modulus, Arithmetic modulo p	1
3.4	Pseudo-primes and Carmichael numbers	1
3.5	Solving congruence modulo prime powers	1
3.6	Primitive roots, Existence of primitive roots for primes, Discrete logarithms	1
3.7	Elliptic curve arithmetic – Prime curves, Binary curves, Addition of two points, Multiplication of a point by a constant	1
Module-4 (Computer and Program Security) (7 hrs) (Text book2: Chapters 1, 3, 4)		
4.1	Threats, Vulnerabilities, Controls	1
4.2	Browser attack types	1
4.3	Web attacks targeting users	1
4.4	Email attack types	1
4.5	Non-malicious programming oversights (Lecture 1)	1
4.6	Non-malicious programming oversights (Lecture 2)	1
4.7	Malware – Four aspects of infection	1
Module-5 (Operating System and Database Security) (8 hrs)(Text book2: Chapters 5, 7)		
5.1	Security in operating system (Lecture 1)	1
5.2	Security in operating system (Lecture 2)	1
5.3	Security in design of operating system (Lecture 1)	1

5.4	Security in design of operating system (Lecture 2)	1
5.5	Security requirements of databases	1
5.6	Reliability & integrity	1
5.7	Database disclosure (Lecture 1)	1
5.8	Database disclosure (Lecture 2)	1



CST 342	AUTOMATED VERIFICATION	Category	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PEC	2	1	0		3

Preamble: This course is intended to impart the basic theory and algorithm for an automatic verification process namely model checking. This course covers finite-state modelling of hardware/software, linear-time properties, classification of linear-time properties, Linear Temporal Logic (LTL) - a formal language for property specification, LTL model checking algorithm and model checking case studies. This course enables the learners to prove correctness of a hardware/software used in safety critical systems in domains such as avionics, health care and automotive.

Prerequisite: NIL

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

CO1	Illustrate an application for model checking. (Cognitive Knowledge Level: Understand)
CO2	Describe finite-state modelling for hardware and software. (Cognitive Knowledge Level: Understand)
CO3	Identify linear-time properties required to represent the requirements of a system. (Cognitive Knowledge Level: Apply)
CO4	Specify a given linear-time property in Linear Temporal Logic (LTL). (Cognitive Knowledge Level: Apply)
CO5	Perform LTL model checking using the tool Symbolic Analysis Laboratory (SAL). (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 (Marks)	Test 2 (Marks)	
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 Test : 25 marks

Continuous Assessment Assignment : 15 marks (Out 15, 10 marks shall be given for a model checking project to be implemented in SAL.)

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 Model Checking)

System Verification – Hardware and Software Verification, Model Checking, Characteristics of Model Checking.

Transition Systems – Transition System, Direct Predecessors and Successors, Terminal State, Deterministic Transition System.

Executions - Execution Fragment, Maximal and Initial Execution Fragment, Execution, Reachable States.

Module - 2 (Linear Time Properties)

Linear-Time (LT) Properties - Deadlock. Linear-Time Behavior - Paths and State Graph, Path Fragment, Maximal and Initial Path Fragment, Path. Traces - Trace and Trace Fragment, LT Properties - LT Property, Satisfaction Relation for LT Properties, Trace Equivalence and LT Properties. Safety Properties and Invariants - Invariants, Safety Properties, Trace Equivalence and Safety properties. Liveness Properties - Liveness Property, Safety vs. Liveness Properties. Fairness - Fairness, Unconditional, Weak and Strong Fairness, Fairness Strategies, Fairness and Safety. (Definition and examples only for all topics - no proof required).

Module - 3 (Regular Properties)

Regular Properties - Model Checking Regular Safety properties - Regular Safety property, Verifying Regular Safety Properties. Automata on Infinite Words - ω -Regular Languages and Properties, Nondeterministic Buchi Automata (NBA), Deterministic Buchi Automata (DBA),

Generalised Buchi Automata (Definitions only). Model Checking ω -Regular Properties - Persistence Properties and Product, Nested Depth-First Search (Only algorithms required).

Module - 4 (Linear Time Logic)

Linear Temporal Logic (LTL) - Syntax, Semantics, Equivalence of LTL Formulae, Weak Until, Release and Positive Normal Form, Fairness, Safety and Liveness in LTL (Definitions only). Automata Based LTL Model Checking (Algorithms and examples only).

Module - 5 (Model Checking in SAL)

Introduction - Introduction to the tool Symbolic Analysis Laboratory (SAL).

The Language of SAL - The expression language, The transition Language, The module language, SAL Contexts.

SAL Examples - Mutual Exclusion, Peterson's Protocol, Synchronous Bus Arbiter, Bounded Bakery protocol, Bakery Protocol, Traffic Signalling System.

Text Books

1. Christel Baier and Joost-Pieter Katoen, Principles of Model Checking, The MIT Press. (Modules 1 - 4)
2. Leonardo de Moura, Sam Owre and N. Shankar, The SAL Language Manual, SRI International (<http://sal.csl.sri.com/doc/language-report.pdf>, Chapters 1, 3, 4, 5, 6, 7) (Module 5)

Reference Materials

1. SAL Examples (<http://sal.csl.sri.com/examples.shtml>) (Module 5)

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Illustrate how model checking can make a system design reliable, based on a required set of properties/constraints.

Course Outcome 2 (CO2):

1. Consider a message delivery system. The sender s is trying to send a series of messages to the receiver r in such a way that the $(i+1)^{st}$ message is sent only after the i^{th} message is delivered. There is a possibility of error in sending a message and in that case, s keeps on

trying until it is able to send the message. Show a finite state transition system modeling this system.

Course Outcome 3 (CO3):

1. Consider a shared memory segment s protected using a mutex lock variable m . Two processes p_1 and p_2 are trying to access s . List the Linear Time properties of the system which will ensure safety, liveness and fairness.

Course Outcome 4 (CO4):

1. Show the LTL specifications of the safety, liveness and fairness properties listed for the assessment question given in CO3.

Course Outcome 5 (CO5):

1. Model the system mentioned in the question given in CO3 in SAL and verify that the system is correct with respect to the LTL properties shown as the answer for CO4.

Model Question paper

QP CODE:

PAGES: 3

Reg No: _____

Name : _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST342

Course Name: Automated Verification

Max.Marks:100

Duration: 3 Hours

PART A

Answer all questions. Each question carries 3 marks.

1. Define model checking. Show the schematic diagram of the model checking approach.
2. Show a transition system modeling a coffee/Tea vending machine.

3. Define invariant as a Linear Time (LT) property. Give an example
4. List any three Linear Time properties in the Mutual Exclusion problem of processes.
5. Illustrate the construction of a product automaton from two automata.
6. Differentiate between Deterministic Buchi Automaton and Non-deterministic Buchi Automaton.
7. Specify the following statements about traffic lights in Linear Temporal Logic (LTL).
 - a. Once red, the light can not become green immediately.
 - b. Once red, the light always becomes green eventually after being yellow for some time.
8. What is Positive Normal Form (PNF) in LTL? Give an example.
9. List any three applications of the tool Symbolic Analysis Laboratory (SAL).
10. What is a SAL context? Give an example.

(10x3=30)

Part B

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

11. (a) Explain in detail the various phases of the model checking process. (8)
 - (b) Explain the strengths and weaknesses of model checking. (6)
- OR**
2014
12. (a) Define and illustrate the following terms of a transition system. (14)
 - a. Execution Fragment
 - b. Maximal and Initial Execution Fragment
 - c. Execution
 - d. Reachable States

13. (a) With an example, explain the satisfaction relation for LT properties. (7)
- (b) What is trace equivalence in Transition Systems? Give an example to show that if two transition systems satisfy the trace equivalence property, then they satisfy the same set of LT properties. (7)
- OR**
14. (a) Give the transition system for the fault tolerant variant of the dining philosophers problem. (4)
- (b) With a suitable example, explain the algorithms to check whether a Transition System satisfies an invariant or not. (10)
15. (a) Explain Regular Safety Properties with a suitable example. (7)
- (b) Illustrate an algorithm for verifying Regular Safety Properties. (7)
- OR**
16. (a) Explain ω -Regular Properties. (4)
- (b) Illustrate how ω -Regular Properties are verified. (10)
17. (a) Explain the syntax of Linear Temporal Logic (LTL). (7)
- (b) Explain the semantics of LTL. (7)
- OR**
18. (a) With an example, give the difference between until and weak until in LTL. (4)
- (b) With a suitable example, explain automata based LTL model checking. (10)
19. (a) Explain Peterson's protocol. What are the LTL properties to be verified to ensure its correctness? (8)
- (b) Write a SAL script for the verification of Peterson's protocol. (6)

OR

20. (a) Show the SAL model corresponding to Bakery protocol. (8)

(b) List any three Linear Time properties of this model and show their LTL (6)

Teaching Plan

Module 1 (Introduction to Model Checking)		4 Hours
1.1	System Verification – Hardware and Software Verification, Model Checking, Model Checking	1 Hour
1.2	Transition Systems – Transition System, Direct Predecessors and Successors, Terminal State, Deterministic Transition System	1 Hour
1.3	Executions - Execution Fragment, Maximal and Initial Execution Fragment	1 Hour
1.4	Execution, Reachable States	1 Hour
Module 2 (Linear Time Properties)		8 Hours
2.1	Linear-Time (LT) Properties - Deadlock	1 Hour
2.2	Linear-Time Behavior - Paths and State Graph, Path Fragment, Maximal and Initial Path Fragment, Path	1 Hour
2.3	Traces - Trace and Trace Fragment	1 Hour
2.4	LT Property, Satisfaction Relation for LT Properties, Trace Equivalence and LT Properties	1 Hour
2.5	Invariants	1 Hour
2.6	Safety Properties, Trace Equivalence and Safety properties	1 Hour
2.7	Liveness Property, Safety vs. Liveness Properties	1 Hour
2.8	Fairness, Unconditional, Weak and Strong Fairness, Fairness Strategies, Fairness and Safety	1 Hour
Module 3 (Regular Properties)		9 Hours
3.1	Regular Properties - Model Checking Regular Safety properties - Regular Safety property	1 Hour
3.2	Verifying Regular Safety Properties	1 Hour
3.3	Automata on Infinite Words - ω -Regular Languages and Properties	2 Hour

3.4	Nondeterministic Buchi Automata (NBA), Deterministic Buchi Automata (DBA), Generalised Buchi Automata	1 Hour
3.5	Model Checking ω -Regular Properties - Persistence Properties and Product - Lecture 1	1 Hour
3.6	Persistence Properties and Product - Lecture 2	1 Hour
3.7	Nested Depth-First Search (Lecture 1)	1 Hour
3.8	Nested Depth-First Search (Lecture 2)	1 Hour
Module 4 (Linear Time Logic)		7 Hours
4.1	Linear Temporal Logic – Linear Temporal Logic (LTL) - Syntax	1 Hour
4.2	Semantics - Lecture 1	1 Hour
4.3	Equivalence of LTL Formulae, Weak Until	1 Hour
4.4	Release and Positive Normal Form	1 Hour
4.5	Fairness, Safety and Liveness in LTL	1 Hour
4.6	Automata Based LTL Model Checking (Lecture 1)	1 Hour
4.7	Automata Based LTL Model Checking (Lecture 2)	1 Hour
Module 5 (Model Checking in SAL)		7 Hours
5.1	Introduction - Introduction to the tool Symbolic Analysis Laboratory (SAL).	1 Hour
5.2	The Language of SAL - The expression language, The transition Language	1 Hour
5.3	The module language, SAL Contexts.	1 Hour
5.4	SAL Examples - Mutual Exclusion	1 Hour
5.5	Peterson's Protocol, Synchronous Bus Arbiter	1 Hour
5.6	Bounded Bakery protocol, Bakery Protocol	1 Hour
5.7	Traffic Signalling System	1 Hour

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 (percentage)	Test2 (percentage)	
Remember	40	40	40
Understand	40	40	40
Apply	20	20	20
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 (Introduction to Data Visualization)**

Introduction to Visualization – Need and purpose, External representation – Interactivity – Difficulty in Validation, Data Abstraction; Dataset types – Attribute types – Semantics, Task Abstraction – Analyze, Produce, Search, Query, Four levels of validation – Validation approaches – Validation examples. Marks and Channels. Data Visualization tools.

Module 2 (Arranging Spatial Data and Networks)

Arrange tables: Categorical regions – Spatial axis orientation – Spatial layout density, Arrange spatial data: Geometry – Scalar fields – Vector fields – Tensor fields. Arrange networks and trees: Connections, Matrix views – Containment, Map color: Color theory, Color maps and other channels.

Module 3 (Data Visualization using R)

Basic and Interactive Plots: scatter plot, interactive scatter plot, bar plot, line plot, interactive Gantt/timeline chart, Merging histograms, interactive bubble plot, waterfall plot, Heat Maps and Dendrograms: simple dendrogram, dendrograms with colors and labels, heat map, heat map with customized colors, three-dimensional heat map and a

stereo map, tree map. Maps: regional maps, choropleth maps, contour maps, maps with bubbles, Integrating text with maps, shapefiles, cartograms, Pie Chart and Its Alternatives, Adding the Third Dimension: 3D scatter plot, 3D pie chart, 3D histogram, 3D contour plot.

Module 4 (Interactive Data Visualization using D3)

Drawing with data: Drawing divs, SVG’s, Making a bar chart, scatterplot – Scales - Axes – Updates, Transition and Motion – Modernizing the bar chart, Updating data, transitions, Interactivity – Layouts – Geomapping – Framework – D3.js, tableau.

Module 5 (Security Data Visualization)

Port scan visualization - Vulnerability assessment and exploitation - Firewall log visualization - Intrusion detection log visualization - Attacking and defending visualization systems – Creating security visualization system.

Text Books

1. Tamara Munzner, Visualization Analysis and Design, AK Peters Visualization Series, CRC Press, Nov. 2014
2. Atmajitsinh Gohil, "R Data Visualization Cookbook", PACKT, 2015.
3. Scott Murray, “Interactive data visualization for the web”, O’Reilly Media, Inc., 2013.
4. Greg Conti, “Security Data Visualization: Graphical Techniques for Network Analysis”, NoStarch Press Inc, 2007.

Reference Books

1. A Julie Steele and Noah Iliinsky, Designing Data Visualizations: Representing Informational Relationships, O’Reilly.
2. Andy Kirk, Data Visualization: A Successful Design Process, PAKT.
3. Nathan Yau, "Data Points: Visualization that means something", Wiley, 2013.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1): Explain the four levels of validation in Data Visualization.

Course Outcome 2 (CO2): Discuss the different methods to arrange spatial data.

Course Outcome 3(CO3): Write sample code in R to generate a simple pie chart showing data on brain injury across different branches of the military:

Military Branch	Army	Navy	Air Force	Marines
No:	179718	41370	41914	44280

Also draw the resultant pie chart.

Course Outcome 4 (CO4): Given a dataset: [5, 10, 13, 19, 21, 25, 22, 18, 15, 13, 11, 12, 15, 20, 18, 17, 16, 18, 23, 25] to plot a bar graph. This dataset was later

modified as [11, 12, 15, 20, 18, 17, 16, 18, 23, 25, 5, 10, 13, 19, 21, 25, 22, 18, 15, 13]. Write the sample code in d3 to update the contents of a bar chart with new data values.

Course Outcome 5 (CO5): Explain Intrusion detection log visualization.

Model Question Paper

QPCODE:

PAGES: 3

RegNo: _____

Name : _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: ADT 342

Course Name: Data Visualization

Max.Marks:100

Duration: 3 Hours

PART A

Answer all Questions. Each question carries 3 Marks

1. What is data visualization? Why do we use it? Illustrate the need of data visualization.
2. Why do data semantics and data types matter in data visualization?
3. Describe the HSL system.
4. Describe scatterplot with an example.
5. How is the waterfall plot constructed in R?
6. Compare choropleth maps and cartograms.
7. Illustrate the use of ease() and delay() functions in transitions with an example.
8. Specify any three types of D3 layouts?
9. Describe port scan visualization.
10. What is meant by vulnerability assessment in visualization? (10x3=30)

Part B

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

- 11.a “Splitting the complex problem of visualization design into four cascading (10 marks) levels provides an analysis framework that lets you address different concerns separately”. Explain the four cascading levels with a diagram?
- 11.b What are the threats to validity at each of the levels? (4 marks)

OR

- 12.a Define marks and channels. Explain how visual channels control the appearance of marks. How are these visual channels and marks used for encoding various chart types? (8 marks)
- 12.b Illustrate Various data visualization tools. (6 marks)
- 13.a Differentiate between node-link diagrams and matrix views. Also specify the costs and benefits of each. (8 marks)
- 13.b Explain Treemaps and GrouseFlocks. (6 marks)
- OR**
- 14.a What is colour mapping? Explain the different types of colour maps. (8 marks)
- 14.b Explain scalar fields, vector fields and tensor fields. (6 marks)
- 15.a What is a dendrogram? Write the R code to construct a dendrogram. (7 marks)
- 15.b What is a pie chart? What are its limitations? Write the steps involved in its construction in R. (7 marks)
- OR**
- 16.a Why do we need a 3D scatter plot? Write the sample code to generate a 3D scatter plot in R. (7 marks)
- 16.b What are shape files? Why do we use them? Write the step-by-step procedure to construct a shape file. (7 marks)
- 17.a Given a data set = [5, 10, 13, 19, 21, 25, 22, 18, 15, 13,11, 12, 15, 20, 18, 17, 16, 18, 23, 25]; Write the D3 code to plot the given data set as bar chart with dual encoding of the data values in terms of both height and color. The data bars should have centered labels. Also plot the resultant bar graph for the given data set. (7 marks)
- 17.b Given another data set dataset = [[5, 20], [480, 90], [250, 50], [100, 33], [330,95], [410, 12], [475, 44], [25, 67], [85, 21], [220, 88]]; where [[]] indicate an array within another array. Plot this data set and specify the name of the plot obtained (7 marks)
- OR**
- 18.a What are named transitions? Explain with an example. (7 marks)
- 18.b What are tooltips? Explain with an example. What are the different types of tooltips? (7 marks)
- 19.a Write about firewall log visualization. (7 marks)
- 19.b Discuss in detail about intrusion detection log visualization. (7 marks)
- OR**
- 20.a Describe the concept of attacking and defending visualization systems. (7 marks)
- 20.b Describe about security visualization system. (7 marks)

(14X5=70)

Teaching Plan

No	Contents	No. of Lecture Hours (35)
Module - 1 (Introduction to Data Visualization)		(6 hours)
1.1	Introduction to Visualization – Need and purpose	1 hour
1.2	Data Abstraction: Dataset types	1 hour
1.3	Attribute types – Semantics	1 hour
1.4	Task Abstraction, Four levels of validation	1 hour
1.5	Validation approaches	1 hour
1.6	Data Visualization tools	1 hour
Module - 2 (Arranging Spatial Data and Networks)		(7 hours)
2.1	Arrange tables: Categorical regions – Spatial axis orientation	1 hour
2.2	Spatial layout density	1 hour
2.3	Arrange spatial data: Geometry – Scalar fields	1 hour
2.4	Vector fields – Tensor fields	1 hour
2.5	Arrange networks and trees: Connections, Matrix views – Containment	1 hour
2.6	Map color: Color theory, Color maps and other channels	1 hour
2.7	Map color	1 hour
Module - 3 (Data Visualization using R)		(8 hours)
3.1	Basic and Interactive Plots: scatter plot, interactive scatter plot	1 hour
3.2	Interactive Gantt/timeline chart, Merging histograms, interactive bubble plot, waterfall plot	1 hour
3.3	Heat Maps and Dendrograms : simple dendrogram, dendrograms with colors and labels, heat map	1 hour
3.4	heat map with customized colors, three-dimensional heat map and a stereo map, tree map	1 hour
3.5	Maps: regional maps, choropleth maps, contour maps	1 hour
3.6	maps with bubbles, Integrating text with maps, shape files, cartograms	1 hour
3.7	Pie Chart and Its Alternatives	1 hour
3.8	Adding the Third Dimension: 3D scatter plot, 3D pie chart, 3D histogram, 3D contour plot.	1 hour

Module- 4 (Interactive Data Visualization using D3)		(8 hours)
4.1	Drawing with data	1 hour
4.2	Scales	1 hour
4.3	Axes	1 hour
4.4	Updates, Transition and Motion – Modernizing the bar chart	1 hour
4.5	Updating data, transitions	1 hour
4.6	Interactivity	1 hour
4.7	Layouts	1 hour
4.8	Geomapping	1 hour
Module- 5 (Security Data Visualization)		(6 hours)
5.1	Port scan visualization	1 hour
5.2	Vulnerability assessment and exploitation	1 hour
5.3	Firewall log visualization	1 hour
5.4	Intrusion detection log visualization	1 hour
5.5	Attacking and defending visualization systems	1 hour
5.6	Creating security visualization system	1 hour



AIT362	PROGRAMMING IN R	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PEC	2	1	0		3

Preamble: The objective of this course is to enable the learner to make use of R Programming language to perform analysis and extraction of information from data irrespective of the quantity. It encompasses the R programming environment, syntax, data representations, data processing, statistical analysis and visualization. This course facilitates the learner to develop modular software solutions to perform statistical analysis and data extraction.

Prerequisite: Fundamental concepts in programming in C and Probability and Statistical Modeling

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

CO 1	Illustrate uses of conditional and iterative statements in R programs. (Cognitive Knowledge level: Apply)
CO 2	Write, test and debug R programs (Cognitive Knowledge level: Apply)
CO 3	Illustrate the use of Probability distributions and basic statistical functions. (Cognitive Knowledge level: Apply)
CO 4	Visualize different types of data (Cognitive Knowledge level: Apply)
CO 5	Comprehend regression modeling using R (Cognitive Knowledge level: Understand)

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO1 0	PO1 1	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
	Test1 (percentage)	Test2 (percentage)	
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 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 (Introduction to R)

The R Environment - Command Line Interface and Batch processing, R Packages, Variables, Data Types, Vectors- vector operations and factor vectors, List- operations, Data Frames, Matrices and arrays, Control Statements- Branching and looping - For loops, While loops, Controlling loops. Functions- Function as arguments, Named arguments

Module -2(Reading and writing data)

Importing data from Text files and other software, Exporting data, importing data from databases- Database Connection packages, Missing Data - NA, NULL
Combining data sets, Transformations, Binning Data, Subsets, summarizing functions. Data Cleaning, Finding and removing Duplicates, Sorting.

Module -3 (Statistics with R)

Analyzing Data, Summary statistics, Statistical Tests- Continuous Data, Discrete Data, Power tests, Common distributions- type arguments. Probability distributions, Normal distributions

Module -4(Data Visualization)

R Graphics- Overview, Customizing Charts, Graphical parameters, Basic Graphics functions, Lattice Graphics - Lattice functions, Customizing Lattice Graphics, Ggplot.

Module - 5 (Regression Models)

Building linear models - model fitting, Predict values using models, Analyzing the fit, Refining the model, Regression- types, Unusual observation and corrective measures,

Comparison of models, Generalized linear models - Logistic Regression, Poisson Regression, Nonlinear least squares

Text Book

1. Joseph Adler, "R in a Nutshell", Second edition, O'Reilly, 2012

Reference Books

1. Jared P Lander, R for Everyone- Advanced analytics and graphics, Addison Wesley data analytics series, Pearson
2. Norman Matloff, The art of R programming, A Tour of Statistical, Software Design, O'Reilly
3. Robert Kabacoff, R in action, Data analysis and graphics with R, Manning
4. Garret Golemund, Hands-on programming with R, Write your own functions and simulations, O'Reilly

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What is Coercion? How is it done in R?
2. Write a program to find the factorial of a number.
3. Write a program to compute roots of a quadratic equation.

Course Outcome 2 (CO2):

1. Write a program to read data from a table 'table123' in a database named 'db123' and display the values .
2. Explain Data cleaning in R
3. How missing data is handled in R?

Course Outcome 3 (CO3):

1. Explain summary function in R
2. Illustrate how statistical testing is performed in R
3. Describe about probability distributions.

Course Outcome 4 (CO4):

1. Illustrate the use of ggplot() and various data visualization tools using appropriate datasets

Course Outcome 5 (CO5):

1. Illustrate the steps to predict the weight of a person when his height is unknown using linear regression for the data given below.

Height	151	174	138	186	128	136	179	163	152	130
Weight	63	81	56	91	47	57	76	72	62	48

Model Question Paper**QP CODE:****PAGES:3**

Reg No: _____

Name : _____

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

Course Code: AIT 362

Course Name: Programming in R

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

Answer all Questions. Each question carries 3 Marks

1. Write a R program to add element "23" to the vector (24,56,67) in the second position.
2. Discuss the general list operations in R with example.
3. Calculate the cumulative sum and cumulative product for the given data 23, 1, 7,2,8,10, 17 using R Program.
4. Explain aggregate function in R.
5. List the applications of R programming.
6. Illustrate summary function.
7. List any three graphics functions.
8. Explain Lattice function.
9. Suppose that you have a dataset D1 and you design a linear regression model of degree 3 polynomial and you found that the training and testing error is "0" or in other terms it perfectly fits the data. What will happen when you fit a degree 2 polynomial in linear regression?
10. Explain logistic regression function in R.

(10x3=30)

Part B

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

- 11.a Write a R program to extract every nth element from a vector. (7 marks)
- 11.b Find the Nth highest value of a vector in R. (7 marks)

OR

- 12.a Write a R program to create a data frame using two given vectors and (7 marks)
display the duplicate elements and unique rows of the said data frame.

- 12.b Write a R program to compare two data frames to find the row(s) in the first data frame that are not present in the second data frame. (7 marks)
- 13.a Write a R program to call the (built-in) dataset air quality. Remove the variables 'Solar.R' and 'Wind' and display the data frame. (7 marks)
- 13.b Illustrate transformation functions in R. (7 marks)

OR

- 14.a Write a R program to write the following data to a CSV file. (7 marks)

	Country	Population_1_july_2018	Population_1_july_2019	change_in_percents
1	China	1,427,647,786	1,433,783,686	+0.43%
2	India	1,352,642,280	1,366,417,754	+1.02%
3	United States	327,096,265	329,064,917	+0.60%
4	Indonesia	267,670,543	270,625,568	+1.10%
5	Pakistan	212,228,286	216,565,318	+2.04%

- 14.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 R program to print total cars of all companies, Find the average mileage of all companies. (7 marks)

- 15.a Write a note on data analysis using R. (7 marks)

- 15.b Explain how statistical test are performed using R functions. (7 marks)

OR

- 16.a Write R code to generate the probability distribution table for number of successes from a binomial distribution where $n=5$ and probability of success in each trial is 0.25. (7 marks)

- 16.b Fit a Poisson distribution with the following data using the following data (7 marks)

X	0	1	2	3	4	5
F	142	156	69	27	5	1

OR

- 17 Given the sales information of a company as CSV file with the following, fields month_number, face cream, facewash, toothpaste, bathingsoap, shampoo, moisturizer, total_units, total_profit. Write R codes to visualize the data as follows:

- a) Toothpaste sales data of each month and show it using a scatter plot. (7 marks)

- b) Calculate total sale data for last year for each product and show it using a Pie chart. (7 marks)

OR

- 18.a Explain ggplot() with an example. (7 marks)

- 18.b Describe how categorical data is visualized using R. (7 marks)

- 19.a Illustrate model fitting in simple linear model. (7 marks)

- 19.b Explain different types of regression. (7 marks)

OR

COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

- 20.a Describe the unusual observations in the regression model. (7 marks)
- 20.b Explain corrective measures of unusual observations in regression modelling. (7 marks)

TEACHING PLAN

No	Contents	No of Lecture Hours (35 Hours)
Module -1 (Introduction to R)		(8 hours)
1.1	The R Environment- Command Line Interface and Batch processing, R Packages	1 hour
1.2	Variables, Data Types	1 hour
1.3	Vectors- vector operations and factor vectors	1 hour
1.4	List- List operations, Data Frames	1 hour
1.5	Matrices and arrays	1 hour
1.6	Control Statements- If and else, switch, if else	1 hour
1.7	Loops- For loops, While loops, Controlling loops	1 hour
1.8	Functions- Function as arguments, Named arguments	1 hour
Module -2(Reading and writing data)		(8 hours)
2.1	Importing data from Text files and other software, Exporting data	1 hour
2.2	Importing data from databases- Database Connection packages	1 hour
2.3	Missing Data-NA, NULL	1 hour
2.4	Combining data sets, Transformations	1 hour
2.5	Binning Data, Subsets, summarizing functions	1 hour
2.6	Data Cleaning	1 hour
2.7	Finding and removing Duplicate	1 hour
2.8	Sorting	1 hour
Module -3 (Statistics with R)		(6 hours)
3.1	Analyzing Data	1 hour
3.2	Summary statistics	1 hour
3.3	Statistical Tests- Continuous Data, Discrete Data, Power tests	1 hour
3.4	Common distributions- type arguments	1 hour
3.5	Probability distributions	1 hour
3.6	Normal distributions	1 hour
Module -4(Data Visualization)		(6 hours)
4.1	R Graphics- Overview	1 hour
4.2	Customizing Charts	1 hour
4.3	Graphical parameters, Basic Graphics functions	1 hour
4.4	Lattice Graphics - Lattice functions	1 hour
4.5	Customizing Lattice Graphics	1 hour
4.6	ggplot	1 hour
Module - 5 (Regression Models)		(7 hours)

5.1	Building linear models - model fitting	1 hour
5.2	Predict values using models, Analyzing the fit, Refining the model	1 hour
5.3	Regression- types of regression	1 hour
5.4	Unusual observations and corrective measures	1 hour
5.5	Comparison of models	1 hour
5.6	Generalized linear models -Logistic Regression, Poisson Regression	1 hour
5.7	Nonlinear least squares	1 hour



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	40	40	40
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Apply	20	20	20
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 (Introduction to Malware Analysis systems)

Introduction: Malware Analysis – goals of Malware Analysis, Malware Types and Classifications - Backdoor, Botnet, Downloader, Information Stealing malware, Launcher, Rootkit, Scareware, Worm or Virus, Malware Analysis techniques – Static and Dynamic Analysis, Malware Characteristics, Data Science and Security

Module- 2 (Static Malware Analysis)

Basic Static Malware Analysis - Antivirus Scanning, Fingerprint for Malware, Portable Executable File Format, The PE File Headers and Sections, Dissecting the PE Format using pefile, Malware Images, Malware Strings
Advanced Static Malware Analysis - Reverse-Engineering- Disassembly methods, Basics of X86 Assembly Language, Disassembling using Linear Disassembly, Introduction to IDA, Factors that limit Static Analysis

Module -3 (Dynamic Analysis)

Dynamic Analysis: Malware Sandbox, Monitoring with Process Monitor, Basic Tools for Dynamic Analysis

Advanced dynamic analysis: Introduction to Debugger, OllyDbg, Malware Analysis Using OllyDbg, Malware Behavior - malicious activities and techniques, Covert Launching techniques- Process Injection, Process Replacement, Hook Injection, Detours, APC Injection, malware-focused network signatures

Module- 4 (Machine Learning based Malware Detectors)

Steps for building a Machine Learning based Detector, Feature spaces, Decision boundaries, Overfitting and underfitting, Types of Machine Learning Algorithms-Logistic Regression, K-Nearest Neighbors, Decision Trees, Random Forest. Precision, Base Rate, True Positive rate, False Positive rate, ROC Curve.

Case Study: Building a Toy Decision Tree – Based Detector

Module- 5 (Deep Learning Basics)

Introduction to Deep Learning, Building Neural Networks, Training Neural Networks – Back Propagation, Path Explosion, Vanishing Gradient. Types of Neural Networks- Feed Forward, Convolutional, Autoencoder, Generative Adversarial Network, Recurrent Neural Network, ResNet

Text Book:

1. Malware Data Science: Attack Detection and Attribution, by Joshua Saxe, Hillary Sanders, 2018, No Starch Press.
2. Michael Sikorski and Andrew Honig: Practical Malware Analysis, The Hands-On Guide to Dissecting Malicious Software. No Starch Press, 2012. ISBN: 978-1-593-27290-6
3. Monnappa K A: Learning Malware Analysis: Explore the concepts, tools, and techniques to analyze and investigate Windows malware. Packt Publishing. ISBN: 978-1788392501 , Michael Hale Ligh, Steven Adair, Blake Hartstein and Matthew Richard: Malware Analyst's

Reference Books:

1. Chris Eagle: The IDA Pro Book: The Unofficial Guide to the World's Most Popular Disassembler Second Edition. No Starch Press. ISBN: 978-1-59327-289-0
2. Christopher C. Elisan , Advanced Malware Analysis, Tata McGraw Hill, 2015
3. Cameron H. Malin, Eoghan Casey, James M. Aquilina and Curtis W. Rose,

Sample Course Level Assessment Questions

COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

Course Outcome 1 (CO1): Examine Malware and goals of Malware Analysis.

Course Outcome 2 (CO2): Examine how Image Analysis and String Analysis can be used to extract information from Malware samples.

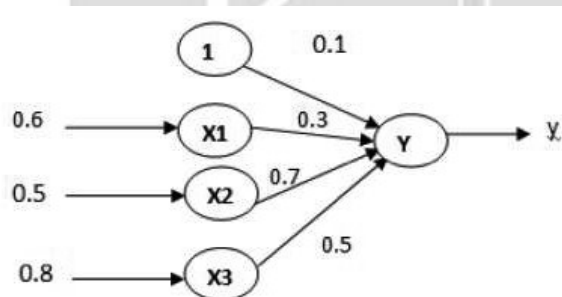
Course Outcome 3 (CO3): Identify the various tools for Dynamic Malware Analysis. Examine the limitations of Dynamic Malware Analysis.

Course Outcome 4 (CO4):

1. Suppose 10000 patients get tested for flu; out of them, 9000 are actually healthy and 1000 are actually sick. For the sick people, a test was positive for 620 and negative for 380. For healthy people, the same test was positive for 180 and negative for 8820. Construct a confusion matrix for the data and compute the accuracy, precision and recall for the data

Course Outcome 5 (CO5):

1. Describe the effect in bias and variance when a neural network is modified with more number of hidden units followed with dropout regularization.
2. Calculate the output of the following neuron Y with the activation function as a) binary sigmoid b) ReLU



2014

QP CODE:

PAGES:3

Reg No: _____

Name : _____

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

Course Code: CDT 372

Course Name: Malware Analysis in Data Science

Max.Marks:100

Duration: 3 Hours

PART A

Answer all Questions. Each question carries 3 Marks

- 1 List the goals of Malware Analysis.
- 2 Examine how data science can be applied to malware.
- 3 Define Disassembly in Static Malware Analysis.
- 4 Examine Malware Fingerprinting.
- 5 Examine the need of Malware Sandbox in Malware Analysis
- 6 Differentiate Downloaders and Launchers.
- 7 List and compare the types of machine learning algorithms.
- 8 Identify the limitations of Logistic Regression when used for Malware Analysis.
- 9 Specify the advantages of ReLU over sigmoid activation function.
- 10 Examine the Vanishing Gradient Problem associated with deep neural networks.

(10x3=30)

Part B

Answer any one Question from each module.

- 11 Define Malware. Explain the various types of Malwares. (14 marks)

OR

- 12.a Define Malware Analysis. Discuss the different Malware Analysis Techniques. (8 marks)

12.b Examine how data science can be applied to Malware Analysis. (6 marks)

13.a Define Static Malware Analysis. Analyze the methods employed in Basic Static Malware Analysis. (8 marks)

13.b Examine PE file format and its relevance in Static Malware Analysis. (6 marks)

OR

14.a Examine Disassembling using Linear Disassembly. (8 marks)

14.b Analyze the factors that limit Static Malware Analysis. (6 marks)

15 Explain the most common types of malware behaviors. (14 marks)

OR

16 Describe the various covert launching techniques employed by Malware authors (14 marks)

17.a What are decision trees. Explain how decision trees are useful in Malware Analysis. (8 marks)

17.b Given the following data, construct the ROC curve of the data. (6 marks)

Threshold	TP	TN	FP	FN
1	0	25	0	29
2	7	25	0	22
3	18	24	1	11
4	26	20	5	3
5	29	11	14	0
6	29	0	25	0
7	29	0	25	0

OR

18.a Illustrate how K-Nearest Neighbors can be used to detect previously unseen Malware. (8 marks)

18.b Illustrate with an example, the steps to generate a random forest algorithm (6 marks)

19 Discuss the most common types of Neural Networks and their application in Cybersecurity. (14 marks)

- 20.a Explain how neural networks can be employed for malware Analysis (4 marks)
 20.b Analyze the various Activation Functions and their purpose. (10 marks)

(14X5=70)

Teaching Plan

NO	CONTENTS	Total hours (35 hours)
Module- 1(Introduction to Malware Analysis systems)		(4hours)
1.1	Introduction to Malware Analysis, goals of Malware Analysis	1 hour
1.2	Malware Types and Classifications: Backdoor, Botnet, Downloader, Information Stealing malware,	1 hour
1.3	Launcher, Rootkit, Scareware, Worm or Virus	1 hour
1.4	Malware Analysis techniques – Static and Dynamic Analysis, Malware Characteristics , Data Science and Security	1 hour
Module- 2 (Static Malware Analysis)		(8hours)
2.1	Basic Static Malware Analysis - Antivirus Scanning, Fingerprint for Malware	1 hour
2.2	Portable Executable File Format, The PE File Headers and Sections	1 hour
2.3	Dissecting the PE Format using pefile	1 hour
2.4	Malware Images, Malware Strings	1 hour
2.5	Advanced Static Malware Analysis - Reverse-Engineering-Disassembly methods, Basics of X86 Assembly Language	1 hour
2.6	Basics of X86 Assembly Language	1 hour
2.7	Disassembling using Linear Disassembly	1 hour
2.8	Factors that limit Static Analysis	1 hour
Module -3 (Dynamic Malware Analysis)		(8hours)
3.1	Dynamic Analysis: Malware Sandbox, setting up Sandbox	1 hour
3.2	Monitoring with Process Monitor	1 hour
3.3	Basic Tools for Dynamic Analysis	1 hour
3.4	Advanced dynamic analysis : Introduction to Debugger, OllyDbg,	1 hour
3.5	Malware Analysis Using OllyDbg	1 hour

3.6	Malware Behavior - malicious activities and techniques,	1 hour
3.7	Covert Launching techniques- Process Injection, Process Replacement, Hook Injection	1 hour
3.8	Detours, APC Injection, malware-focused network signatures	1 hour
Module- 4 (Machine Learning based Malware Detectors)		(8hours)
4.1	Steps for building a Machine Learning based Detector	1 hour
4.2	Feature spaces, Decision boundaries, Overfitting and underfitting	1 hour
4.3	Types of Machine Learning Algorithms-Logistic Regression	1 hour
4.4	K-Nearest Neighbors	1 hour
4.5	Decision Trees	1 hour
4.6	Random Forest	1 hour
4.7	Precision, Base Rate, True Positive rate, False Positive rate, ROC Curve.	1 hour
4.8	Case Study: Building a Toy Decision Tree – Based Detector	1 hour
Module- 5 (Deep Learning Basics)		(7hours)
5.1	Introduction to Deep Learning	1 hour
5.2	How neural networks work? Common activation functions.	1 hour
5.3	Building Neural Networks	1 hour
5.4	Training Neural Networks - Back Propagation, Path Explosion, Vanishing Gradient.	1 hour
5.5	Types of Neural Networks- Feed Forward, Convolutional,	1 hour
5.6	Autoencoder, Generative Adversarial Network,	1 hour
5.7	Recurrent Neural Network, ResNet	1 hour

APJ ABDUL KALAM
TECHNOLOGICAL
UNIVERSITY

SEMESTER VI

MINOR



CST 382	INTRODUCTION TO SOFTWARE TESTING	Category	L	T	P	Credits	Year of Introduction
		VAC	3	1	0	4	2019

Preamble:

This is a course in theoretical computer science that includes test cases for white-box, black-box, and grey-box approaches. This course describes the various techniques for test case design used to test software artifacts, including requirements, design, and code. The course includes different techniques for test case design based on graphs, programming language syntaxes and inputs. The course also covers symbolic execution using PEX tool.

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	Explain 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: Understand)
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: Understand)
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
	Test 1 (Marks)	Test 2 (Marks)	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 - 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 (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 Jeff Offutt, Introduction to Software Testing.
2. Kshirasagar Naik and Priyadarshi Tripathy, Software Testing And Quality Assurance: Theory And Practice.

Reference Materials

1. <https://www.csc.ncsu.edu/academics/undergrad/honors/thesis/muclipsebinder.pdf> - Muclipse tutorial.
2. King, James C, “Symbolic Execution and Program Testing”, Association for Computing Machinery, July 1976.
- 3.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1): Explain the following types of testing methods with examples.

- (i) Black-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 maximumsize of the array is AS. But, the array size
could be smaller than AS in which case the endof 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 (α_1, α_2).

```

1. int twice (int v) {
2.   return 2 * v;
3. }
4. void testme (int x, int y) {
5.   z = twice ( y);
6.   if ( z == x ){
7.     if ( x > y + 10)
8.       ERROR;
9.   }
10. }
11. int main() {
12.   x = sym input();
13.   y = sym input();
14.   testme ( x , y);
15.   return(0);
16. }

```

Model Question Paper

QP CODE:

PAGES: 4

Reg No: _____

Name : _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B.TECH DEGREE EXAMINATION(MINOR), MONTH & YEAR

Course Code: CST 382

Course Name: Introduction to 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) Grey Box testing

(14)

(iv) Unit testing (v) Integration testing (vi) System testing (vii) Acceptance testing

OR

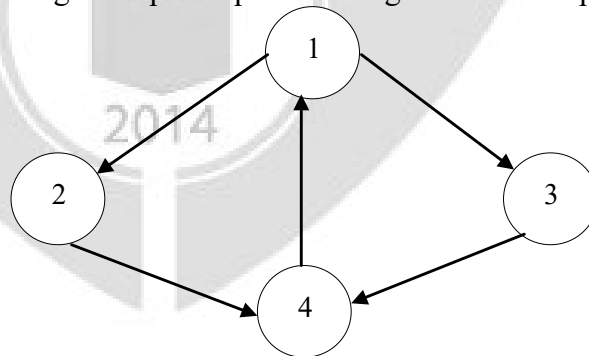
12. (a) Explain the following coverage criterias based on the code fragment given below. (i) Functional coverage (ii) Statement coverage (iii) Conditional coverage (iv) Branch coverage (8)

```
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. 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

- (i) Simple *if* (ii) Simple *while* loop (iii) Simple *for* loop (7)
- (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, or right 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 test cases to verify the boundary.
- (iii) For the boundary condition $A = B = C$ case (equilateral triangle), identify test cases 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. $Z \leftarrow 1$;
 3. $J \leftarrow 1$;
 4. LAB: IF $Y \geq J$ 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 (α_1, α_2).

(b) Explain Execution tree for POWER (α_1, α_2) in the above code fragment.

(7)

TEACHING PLAN

Index	Topics	No. of Hours (45)
Module 1 (Introduction to Software Testing) 9 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	1 Hour
1.7	Performance testing, Usability testing and Regression testing.	1 Hour
1.8	Testing Methods - Black Box testing	1 Hour
1.9	Grey Box testing.	1 Hour
Module 2 (Unit testing) 8 Hours		

2.1	Concept of Unit testing.	1 Hour
2.2	Static Unit testing.	1 Hour
2.3	Dynamic Unit testing - Control Flow testing, Data Flow testing	1 Hour
2.4	Domain testing, Functional Program testing.	
2.5	Mutation testing - Mutation and Mutants, Mutation operators, Mutation score.	1 Hour
2.6	Junit - Framework for Unit testing.	1 Hour
2.7	Case Study - Mutation testing using Junit	1 Hour
2.8	Case Study - Mutation testing using Muclipse	1 Hour
Module 3 (Unit Testing:- White Box Approaches) 10 Hours		
3.1	Overview of Graph Coverage Criteria	1 Hour
3.2	Structural Graph Coverage Criteria - Node/vertex coverage, Edge coverage, Edge pair coverage, Path coverage	1 Hour
3.3	Complete path coverage, Prime path coverage, Complete round trip coverage, Simple round trip coverage.	1 Hour
3.4	Data Flow Criteria - du paths, du pairs	1 Hour
3.5	Subsumption Relationships among Graph Coverage Criteria.	1 Hour
3.6	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
3.7	Graph Coverage for Design Elements - Call graphs and classes, Class inheritance testing: Coverage criteria, Coverage criteria on inheritance graph,	1 Hour

3.8	Data flow at the design level, Inter-procedural DU pairs, Coupling du-pairs example. Example - Quadratic Root	1 Hour
3.9	Case Study - Graph Based testing using JUnit Framework. (Lecture 1)	1 Hour
3.10	Case Study - Graph Based testing using JUnit Framework. (Lecture 2)	1 Hour
Module 4 (Unit Testing:- Black Box Approaches) 9 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	Identifying values.	1 Hour
4.4	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
4.5	TriTyp example.	1 Hour
4.6	Functional Testing - Functional Testing Concepts of Howden. Important Steps.	1 Hour
4.7	Types of Functional testing - Equivalence Class Partitioning, Boundary Value Analysis	1 Hour
4.8	Decision Tables, Random Testing.	1 Hour
4.9	Case Study - Black Box testing approaches using JUnit.	1 Hour
Module 5 (Grey Box Testing Approaches) 9 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,	1 Hour

5.3	Orthogonal Array Testing or OAT, Pattern Testing.	1 Hour
5.4	An Introduction to Pex - Parameterized Unit Testing, The Testing Problem.	1 Hour
5.5	Symbolic Execution – Example, Symbolic execution tree.	1 Hour
5.6	PEX application.	1 hour
5.7	Case Study – PEX (Lecture 1)	1 Hour
5.8	Case Study – PEX (Lecture 2)	1 Hour
5.9	Case Study – PEX (Lecture 3)	1 Hour



CST 384	CONCEPTS IN DEEP LEARNING	Category	L	T	P	Credits	Year of Introduction
		VAC	3	1	0	4	2019

Preamble:

This course aims to introduce the learner to an overview of the concepts and algorithms involved in deep learning. Deep learning is a subfield of machine learning, a subfield of artificial intelligence. Basic concepts and application areas of machine learning, deep networks, convolutional neural network and recurrent neural network are covered here. 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: Sound knowledge in Basics of linear algebra and probability theory.

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	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
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 carry 14 marks.

Syllabus

INTRODUCTION TO DEEP LEARNING

(General Instructions: Instructors are to introduce students to any one software platform and demonstrate the working of the algorithms in the syllabus using suitable use cases and public datasets to give a better understanding of the concepts discussed. Tutorial hour may be used for this purpose)

Module-1 (Introduction)

Key components - Data, models, objective functions, optimization algorithms, Learning algorithm. Supervised learning- regression, classification, tagging, web search, page ranking, recommender systems, sequence learning, Unsupervised learning, Reinforcement learning, Historical Trends in Deep Learning. 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, Structure of CNN, Convolution and Pooling as an infinitely strong prior, variants of convolution functions, structured outputs, data types, efficient convolution algorithms. Practical challenges of common deep learning architectures- early stopping, parameter sharing, dropout. Case study: AlexNet, VGG, ResNet.

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, common word embedding: continuous Bag-of-Words, Word2Vec, global vectors for word representation (GloVe). Research Areas – autoencoders, representation learning, boltzmann machines, deep belief networks.

Text Book

1. Ian Goodfellow, YoshuaBengio, 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, Aggarwal, Charu C., c Springer International Publishing AG, part of Springer Nature 2018

Reference Books

1. Neural Smithing: Supervised Learning in Feedforward Artificial Neural Networks by Russell Reed, Robert J MarksII, A Bradford Book,2014
2. Practical Convolutional Neural Networks by MohitSewak, Md. Rezaul Karim, PradeepPujari,Packt Publishing 2018
3. Hands-On Deep Learning Algorithms with Python by SudharsanRavichandran,Packt Publishing 2019
4. Deep Learning with Python by Francois Chollet,Manning Publications Co.,2018

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

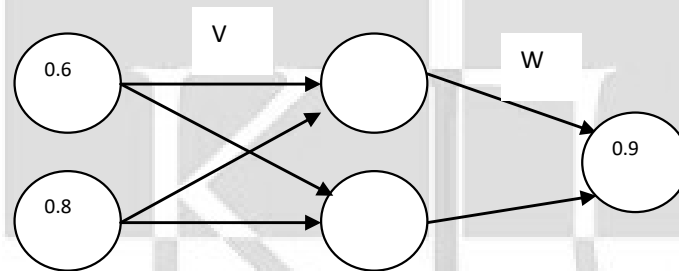
1. Compare regression and classification.
2. Define supervised learning? Distinguish between regression and classification.
3. Discuss the different learning approaches used in machine learning.

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?

Course Outcome 3 (CO3):

1. Update the parameters V_{11} in the given MLP using back propagation with learning rate as 0.5 and activation function as sigmoid. Initial weights are given as $V_{11}=0.2$, $V_{12}=0.1$, $V_{21}=0.1$, $V_{22}=0.3$, $V_{11}=0.2$, $W_{11}=0.5$, $W_{21}=0.2$



2. Draw the architecture of a multi-layer perceptron.
3. Derive update rules for parameters in the multi-layer neural network through the gradient descent.

Course Outcome 4 (CO4):

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. Explain how the cell state is updated in the LSTM model from C_{t-1} to C_t
4. Show the steps involved in an LSTM to predict stock prices.

Course Outcome 5 (CO5):

1. Explain how the cell state is updated in the LSTM model from C_{t-1} to C_t
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.

Course Outcome 6 (CO6):

1. Development a deep learning solution for problems in the domain i) natural language processing or ii Computer vision (Assignment)
2. Illustrate the workings of the RNN with an example of a single sequence defined on a vocabulary of four words.

Model Question Paper

QP CODE: _____

PAGES:4

Reg No: _____

Name: _____

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B.TECH DEGREE EXAMINATION(MINOR), MONTH & YEAR**

Course Code: CST 384

Course Name: CONCEPTS IN 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 of tasks 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 (4)

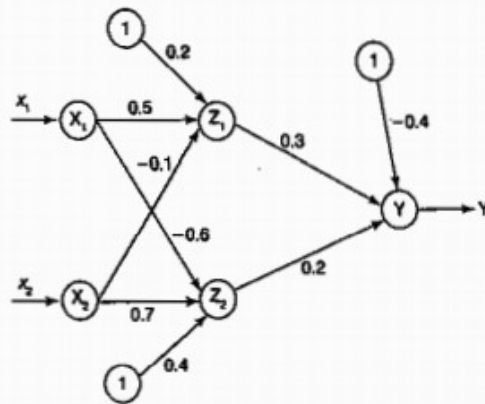
traditional machine learning models

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 backpropagation 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 $112 \times 112 \times 3$. The first convolution layer comprises of 64 kernels of size 5×5 applied with a stride of 2 and padding 0. What will be the number of parameters? (5)

- (b) Let $X = [-1, 0, 3, 5]$ $W = [0.3, 0.5, 0.2, 0.1]$ 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

CONCEPTS IN DEEP LEARNING (45 Hours)		
Module 1 : Introduction (9 hours)		
1.1	Key components - Data, models, objective functions, optimization algorithms. (TB2: Section 1.1-1.2)	1 hour

1.2	Learning algorithm (TB1: Section 5.1), Supervised learning- regression, classification (TB2: Section 1.3.1)	1 hour
1.3	tagging, web search, page ranking (TB2: Section 1.3.1)	1 hour
1.4	Recommender systems, Sequence learning, Unsupervised learning, Reinforcement learning(TB2: Section 1.3.2-1.3.4)	1 hour
1.5	Historical Trends in Deep Learning (TB1: Section 1.2).	1 hour
1.6	Concepts: over-fitting, under-fitting, hyperparameters and validation sets. (TB1: Section 5.2-5.3)	1 hour
1.7	Concepts: Estimators, bias and variance. (TB1: Section 5.4)	1 hour
1.8	Demonstrate the concepts of supervised learning algorithms using a suitable platform.	1 hour
1.9	Demonstrate the concepts of unsupervised using a suitable platform.	1 hour
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 hour
2.2	Multilayer perceptron (TB3: Section 1.2.2), (TB1: Section 6.1,6.3)	1 hour
2.3	Activation functions- Sigmoid, tanh, Softmax, ReLU, leaky ReLU (TB3: Section 1.2.1.3 - 1.2.1.5)	1 hour
2.4	Architecture design (TB1: Section 6.4, TB3: Section 1.6)	1 hour
2.5	Chain rule, back propagation (TB3: Section 1.3)	1 hour

2.6	Gradient based learning (TB1: Section 6.2)	1 hour
2.7	Gradient based optimization (TB1: Section 4.3)	1 hour
2.8	Linear least squares using a suitable platform. (TB1: Section 4.5)	1 hour
2.9	Building ML Algorithms and Challenges (TB3: 1.4, TB1; 5.10-5.11)	1 hour
Module 3 :Convolution Neural Network (10 hours)		
3.1	Convolution operation, Motivation, pooling (TB1:Section 9.1-9.3)	1 hour
3.2	Structure of CNN (TB3: Section 8.2)	1 hour
3.3	Convolution and Pooling as an infinitely strong prior (TB1: Section 9.4)	1 hour
3.4	Variants of convolution functions – multilayer convolutional network, tensors, kernel flipping, downsampling, strides and zero padding. (TB1: Section 9.5)	1 hour
3.5	Variants of convolution functions - unshared convolutions, tiled convolution, training different networks. (TB1: Section 9.5)	1 hour
3.6	Structured outputs, data types (TB1: Section 9.6-9.7)	1 hour
3.7	Efficient convolution algorithms. (TB1: Section 9.8,9.10)	1 hour
3.8	Practical challenges of common deep learning architectures- early Stopping (TB3: 4.6)	1 hour
3.9	Practical challenges of common deep learning architectures- parameter sharing, drop-out (TB3: Section 4.9, 4.5.4)	1 hour
3.10	Case Study: AlexNet,VGG, ResNet. (TB3: Section 8.4.1-8.4.3,8.4.5)	1 hour

Module 4 :Recurrent Neural Network (8 hours)

4.1	Computational graphs (TB1: Section 10.1)	1 hour
4.2	RNN (TB1: Section 10.2-10.3)	1 hour
4.3	Encoder – decoder sequence to sequence architectures. (TB1: Section 10.4)	1 hour
4.4	Deep recurrent networks (TB1: Section 10.5)	1 hour
4.5	Recursive neural networks , Modern RNNs, (TB1: Section 10.6, 10.10)	1 hour
4.6	LSTM and GRU (TB1: Section 10.10, TB3: Section 7.5-7.6)	1 hour
4.7	Practical use cases for RNNs. (TB1: Section 11.1-11.4)	1 hour
4.8	Demonstrate the concepts of RNN using a suitable platform.	1 hour

Module 5 : Applications and Research (9 hours)

5.1	Computer vision. (TB1: Section 12.2)	1 hour
5.2	Speech recognition. (TB1: Section 12.3)	1 hour
5.3	Natural language processing. (TB1: Section 12.4)	1 hour
5.4	Common Word Embedding -: Continuous Bag-of-Words, Word2Vec (TB3: Section 2.6)	1 hour
5.5	Common Word Embedding -: Global Vectors for Word Representation(GloVe) (TB3: Section 2.9.1- Pennigton 2014)	1 hour
5.6	Brief introduction on current research areas- Autoencoders, Representation learning. (TB3: Section 4.10)	1 hour

5.7	Brief introduction on current research areas- representation learning. (TB3: Section 9.3)	1 hour
5.8	Brief introduction on current research areas- Boltzmann Machines, Deep belief networks. (TB1: Section 20.1, TB3 Section 6.3)	1 hour
5.9	Brief introduction on current research areas- Deep belief networks. (TB1: Section 20.3)	1 hour



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	30	30
Understand	50	40	40
Apply	20	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 anyone. Each question can have a maximum 2 subdivisions and carries 14 marks.

Syllabus

Module- 1 (Introduction to IoT and wireless technologies required for IoT)

Internet of Things, Role of Things and the Internet, Wireless IoT. Wireless Networks - Network Topologies, Types of Networks. Role of Wireless Standards in IoT. Protocol Stack - OSI Model, TCP/IP Model, IEEE 802 Reference Model, Protocols for Wireless IoT. Bluetooth - Transceiver, Frequency Channels, Typical Range, Access and Spread Spectrum, Modulation and Data Rate, Error Correction and Detection, Network Topology. ITU G.9959, Zwave, IEEE 802.15.4, Zigbee Specification, Thread, WiFi, 6LowPAN, IPv6, LoRaWAN.

Module- 2 (IoT architecture, Data and Device management)

Internet of Things - IoT Architectural View, Technology Behind IoT - Server End Technology, Sources of Internet of Things, M2M Communication. IoT Application Areas. IoT Examples. IoT Data Management - Device Management Gateways. Design Principles for Web Connectivity - Web Communication Protocols for Connected Devices, Web Connectivity for Connected Devices using Gateways. Internet Connectivity Principles – Internet Connectivity, Internet based communication, IP addressing in the IoT.

Module- 3 (Data Acquiring and Enabling Technologies)

Data Acquiring and Storage for IoT Services- Organization of Data, Big data, Acquiring Methods, Management Techniques, Analytics, Storage Technologies. Cloud Computing for Data storage - IoT Cloud based Services using Xively, Nimbits, and Other Platforms. Sensor Technologies for IoT Devices - Sensor Technology, Participatory Sensing, Industrial IoT and Automotive IoT, Actuators for Various Devices, Sensor Data Communication Protocols, Wireless Sensor network Technology

Module-4 (Prototyping the Embedded Devices for IoT)

Embedded Computing Basics, Embedded Hardware Unit. Embedded Platforms for Prototyping - Arduino, Intel Galileo, Intel Edison, Raspberry Pi, BeagleBone, mBed. Prototyping and Designing the Software for IoT Applications- Introduction, Prototyping Embedded Device Software- Programming using Arduino, Programming for an Arduino Controlled Traffic Control Lights at a Road Junction, Basic Arduino Programs to Blink LED, Find the Distance using Ultrasonic Sensor, Estimate Room Temperature, Measuring Soil Moisture Level

Module 5 (Business Models and Case Studies)

Business Models and Processes using IoT. Value Creation in the Internet of Things. Cloud PaaS- Xively, Nimbits, IBM Bluemix, CISCO IoT, AWS IoT, TCS Connected AWS Platform, Case studies- Smart Home, Smart Environment, Smart healthcare, Smart agriculture

Text Books

1. Daniel Chew, “Wireless Internet of Things -A Guide to the lower layers”, IEEE Standards and Association, IEEE Press, Wiley
2. Rajkamal, “Internet of Things : Architecture and Design Principles”, McGraw Hill (India) Private Limited.

References

1. ArshadeepBahga, Vijay Madiseti, “Internet of Things: A hands-on approach”, University Press, 2015 (First edition)
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. Compare Bluetooth and Bluetooth LE power classes
2. Demonstrate Zigbee Specification Protocol Stack

Course Outcome 2 (CO2):

1. What are the major components of IOT system? Briefly explain each
2. Correlate M2M architectural Levels with IOT architectural Levels

Course Outcome 3 (CO3):

1. Describe the use of GPIO pins ?
2. What are actuators ? Mention the roles of actuators in IoT systems

Course Outcome 4(CO4):

1. Identify the role of HBase in Hadoop File System
2. Differentiate Edge computing and Distributed computing
3. Illustrate open protocols, tools and frameworks generally used in M2M

Course Outcome 5(CO5):

1. What do you mean by Arduino sketches?
2. Write an Arduino program to blink LED

Course Outcome 6(CO6):

1. How IoT technology helps TELEMEDICINE in India?
2. How soil moisture can be detected in Smart Agriculture?

Model Question Paper

QP CODE: _____

PAGES :2

Reg No: _____

Name: _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION(MINOR), MONTH & YEAR

Course Code: CST 386

Course Name: WIRELESS NETWORKS AND IoT APPLICATIONS

Max.Marks:100

Duration: 3 Hours

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Illustrate Role of *things* and *internet* in IoT
2. What is Bluetooth? Explain the range and frequency channels of Bluetooth?
3. List any three the features of Constrained Application Protocol (COAP).
4. Compare Raspberry Pi and BeagleBoard boards.
5. Identify the role of HBase in Hadoop File System.
6. Differentiate Edge computing and Distributed computing.
7. Give an example of Raspberry Pi applications for Industrial IoT.
8. What are the on-board functional units in Intel Galileo?
9. Interpret the concept of value creation in IoT.

10. Explain the use of PaaS in IoT Smart applications with any three examples.

(10x3=30)

Part B

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

11. (a) Compare various Network topologies used in Wireless Networks. (8)

(b) Describe the following wireless technologies on i) *Zigbee* ii) *WiFi*
iii) *Thread*. (6)

OR

12. (a) Explain protocol stacks used in wireless networks for IoT applications. (8)

(b) Illustrate the Architectural design of LoRaWAN. (6)

13. (a) Define M2M. Explain M2M architecture. Correlate M2M architectural levels with IoT architectural levels. (8)

(b) Compare SOAP and REST protocols. (6)

OR

14. (a) Summarize different Online Transactions and Processing techniques. (8)

(b) Identify the functions of Device-Management Gateway . (6)

15. (a) Define actuators ? Describe the roles of actuators in IoT systems. (8)

(b) Explain the usage contexts of analog sensors and digital sensors. (6)

OR

16. (a) How data collection, storage & computing services done using Nimbits? (10)

(b) List any four features of Xively. (4)

17. (a) What do you mean by Arduino sketches? (4)
- (b) Write an Arduino program to blink LED (10)

OR

18. (a) Demonstrate an example of Raspberry Pi applications for Industrial IoT. (10)
- (b) Compare the features of Arduino-R3 and Arduino Yun boards. (4)
19. (a) Explain various tasks of a smart irrigation monitoring service. (8)
- (b) Demonstrate the tasks of Soil-Moisture monitoring service. (6)

OR

20. (a) a) Mr. Kiran Mathew has been a chronic diabetic patient for the past few years. He was under regular check up at the hospital every two weeks. All of a sudden the pandemic like COVID-19 arises in the country and the government issues a lockdown for a period of two months. Illustrate how Mr. Kiran can be monitored by the health care worker using intelligent healthcare techniques. (10)
- (b) Mention any four sensors used in smart healthcare (4)

TEACHING PLAN

No	Contents	No of Lecture Hrs(45)
Module – 1 (Introduction to IoT and wireless technologies required for IoT) (8 hrs) (TB-1, Chapter 1...)		
1.1	Internet Of Things, Role of things and internet ,Wireless IoT	1
1.2	Wireless Networks- Network Topologies-Types of Networks,Role of	1

	Wireless standards in IoT	
1.3	Protocol Stack-OSI Model- TCP/IP Model-IEEE 802 reference model	1
1.4	Protocols for Wireless IoT-Bluetooth-Transceiver, Frequency Channels-Typical Range, Access and Spread Spectrum, Modulation and Data Rate	1
1.5	Error Correction and Detection-Network Topology.	1
1.6	ITU G.9959, Zwave, IEEE 802.15.4, Zigbee Specification	1
1.7	Thread, Wifi, 6LowPAN, IPv6	1
1.8	LoRaWAN	1
Module- 2 (IOT architecture, Data and Device management) (9hrs)		
2.1	Internet of Things -IoT Architectural view	1
2.2	Technology Behind IOT-Server End Technology,Sources of Internet of Things	1
2.3	M2M Communication.	1
2.4	IoT Application Areas. IOT Examples.	1
2.5	IoT Data Management, Device Management Gateways.	1
2.6	Design Principles for Web Connectivity	1
2.7	Web communication protocols for connected devices,	1
2.8	Web connectivity for connected devices using Gateways.	1
2.9	Internet connectivity Principles – Internet Connectivity, Internet based communication, IP addressing in the IoT.	1
Module- 3 (Data Acquiring and Enabling Technologies (8 hrs)		
3.1	Data acquiring and storage for IoT devices- Organization of Data, Big data	1
3.2	Acquiring methods, management techniques, Analytics, Storage technologies.	1
3.3	Cloud computing for Data storage-IoT Cloud based services using Xively,	1

	Nimbits, and other platforms.	
3.4	Cloud computing-Nimbits	1
3.5	Sensor Technologies for IoT Devices-Sensor Technology, Participatory sensing	1
3.6	Industrial IoT and Automotive IoT	1
3.7	Actuators for various devices, Sensor data communication protocols	1
3.8	Wireless Sensor network Technology	1
Module 4(Prototyping the Embedded Devices for IoT)(9hrs)		
4.1	Introduction, Embedded Computing Basics, Embedded Hardware Unit.	1
4.2	Embedded Platforms for Prototyping-Arduino, Intel Galileo	1
4.3	Intel Edison, Raspberry Pi, BeagleBone, mBed	1
4.4	Prototyping and designing the software for IoT applications-Introduction, Prototyping embedded device software	1
4.5	Prototyping and designing the software for IoT applications-Introduction, Prototyping embedded device software	1
4.6	Programming concepts in Arduino	1
4.7	Programming for an arduino controlled traffic control lights at a road junction	1
4.8	Basic Arduino programs to blink LED, Find the distance using ultrasonic sensor	1
4.9	Estimate room temperature, Measuring soil moisture level	1
Module 5 (higher level protocols and case studies)(9 hrs)		
5.1	Business Models and Processes using IOT, Value creation in the Internet of Things.	1

5.2	Xively, Nimbits, IBM Bluemix	1
5.3	CISCO IoT, AWS IoT, TCS Connected AWS Platform	1
5.4	Case Study- Smart Environment	1
5.5	Case Study- Smart Environment	1
5.6	Case study Smart Home	1
5.7	Case study Smart Home	1
5.8	Case study Smart healthcare (Lecture I)	1
5.9	Case study Smart healthcare (Lecture II)	1
5.10	Case study -Smart agriculture (Lecture I)	1
5.11	Case study -Smart agriculture (Lecture II)	1



APJ ABDUL KALAM
TECHNOLOGICAL
UNIVERSITY

SEMESTER VI

HONOURS



CST 394	NETWORK SECURITY	Category	L	T	P	Credits	Year of Introduction
		VAC	3	1	0	4	2019

Preamble:

The purpose of this course is to create a better understanding of the network security concepts. This course covers network security standards, email security services, web security mechanisms, firewalls and wireless security mechanisms. This course helps the learner to gain insight into the key aspects of secure network communication and enables to apply in real-life scenarios.

Prerequisite: A sound background in Number Theory and Cryptographic Algorithms.

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

CO#	Course Outcomes
CO1	Identify the key aspects of security, intrusion detection systems and digital signature schemes (Cognitive Knowledge Level: Apply)
CO2	Explain the security standards used in network communication (Cognitive Knowledge Level: Understand)
CO3	Identify the mechanisms in email security services (Cognitive Knowledge Level: Apply)
CO4	Summarize the protocols used to provide web security (Cognitive Knowledge Level: Understand)
CO5	Explain the fundamental concepts of wireless network security and firewalls (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 (%)
	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 : 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 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 (Network Security Basics)

Introduction to network security - Security requirements, Challenges of security, Network security model. Malicious programs – Worms, Viruses, Trojans, Spyware, Adware. Intrusion Detection Systems (IDS) - Uses, Techniques. Digital signatures - ElGamal, Schnorr, Digital Signature Standard (DSS).

Module – 2 (Network Security Standards)

Kerberos v4 – Configuration, Authentication, Encryption, Message formats. Kerberos v5 – Cryptographic algorithms, Message formats. Public Key Infrastructure (PKI) – Trust models, Revocation. Real-time communication security – Perfect Forward Secrecy (PFS), Denial-of-Service protection, Endpoint identifier hiding, Live partner reassurance. Internet Protocol Security (IPSec) - Authentication Header (AH), Encapsulating Security Payload (ESP), Internet Key Exchange (IKE) phases.

Module – 3 (Email Security)

Introduction to email security - Security services for email, Establishing keys, Privacy, Authentication, Message integrity, Non-repudiation. Privacy Enhanced Mail (PEM) – Encryption, Source authentication and integrity protection, Message formats. Secure/Multipurpose Internet Mail Extensions (S/MIME) – Messages, Differences from PEM. Pretty Good Privacy (PGP) - Encoding, Certificate and key revocation, Anomalies, Object formats.

Module – 4 (Web Security)

Introduction to web security - Web security considerations, Threats. Secure Sockets Layer (SSL) – Architecture, Protocols, Transport Layer Security (TLS) – Differences from SSL. Hypertext Transfer Protocol Secure (HTTPS) – Connection initiation, Closure. Secure Shell (SSH) – Transport layer protocol, User authentication protocol, Connection protocol.

Module – 5 (Wireless Network Security and Firewalls)

IEEE 802.11 Wireless LAN - Network components, Architectural model, Services. IEEE 802.11i wireless LAN security - Services, Phases of operation. Wired Equivalent Privacy (WEP), Wi-Fi Protected Access (WPA), WPA2, Wireless Application Protocol (WAP) – Services, Protocol architecture. Firewalls – Need for firewalls, Packet filters, Circuit-level firewalls, Application layer firewalls.

Text Books

1. C. Kaufman, R. Perlman and M. Speciner, “Network Security: Private Communication in a Public World”, 2/e, PHI.
2. William Stallings, “Cryptography and Network Security Principles and Practice”, 5/e, Pearson

Education Asia.

References

1. Behrouz A. Forouzan, Debdeep Mukhopadhyay, “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, Prentice Hall.
4. Schiller J., Mobile Communications, 2/e, Pearson Education.
5. Roberta Bragg et. al., “Network Security: The Complete Reference”, Tata McGraw Hill.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Using the Schnorr digital signature scheme, let $q = 83$, $p = 997$ and $d = 23$. Find values for e_1 and e_2 .
2. The Digital Signature Algorithm (DSA) specifies that if the signature generation process results in a value of zero, a new value of k should be generated and the signature should be recalculated. Give reason.

Course Outcome 2 (CO2):

1. In Kerberos v4, the authenticator field is not of security benefit when asking the Key Distribution Center (KDC) for a ticket for Bob, but useful when logging in as Bob. Give reasons for your answer.
2. How does the stateless cookie protocol provide clogging protection?

Course Outcome 3 (CO3):

1. If Alice is sending an ENCRYPTED message, she first signs the message digest with her private key and then encrypts the message digest with the pre-message secret key. Why this last encryption was considered necessary for encrypted messages and not for MIC-CLEAR or MIC-ONLY?
2. Which security services are considered desirable in the following cases? (i) Sending a purchase order (ii) Sending a ransom note. (iii) Sending a mission description to security officials.
3. Explain the security mechanism used in Gmail communication.

Course Outcome 4 (CO4):

1. Is it possible in SSL for the receiver to reorder SSL record blocks that arrive out of order? If so, how it can be done? If not, why?
2. Describe any five web security threats, their consequences and countermeasures.

Course Outcome 5 (CO5):

1. Explain the security areas addressed by IEEE 802.11i.
2. Describe the advantages and disadvantages of application layer firewalls.



Model Question Paper

QP CODE:

Reg. No: _____

Name: _____

PAGES : 3

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B.TECH. DEGREE (HONORS) EXAMINATION, MONTH & YEAR
Course Code: CST 394

Course Name: Network Security

Max.Marks:100

Duration: 3 Hours

PART A

Answer all Questions. Each question carries 3 Marks

1. Distinguish between signature-based and anomaly-based intrusion detection techniques.
2. A trusted third party is considered as a main component in a network security model. Why?
3. How is endpoint identifier hiding achieved in real-time communication?
4. Show how encryption is used to provide privacy and integrity in Kerberos v5.
5. End-to-end privacy is essential for e-mail security. How is this achieved?
6. List the four steps for preparing an EnvelopedData MIME entity.
7. Show the operation of a Secure Sockets Layer (SSL) Record protocol.
8. For Secure Shell (SSH) packets, what is the advantage of not including the MAC in the scope of packet encryption?
9. List the three security services provided by IEEE 802.11i.
10. Define the terms Access Point, Basic Service Set, Extended Service Set.

(10x3=30)

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

11. (a) Using the ElGamal scheme, let $p = 881$ and $d = 700$, find values for e_1 and e_2 . Choose $r = 17$. Find the value of S_1 and S_2 if $M = 400$. (8)
- (b) Explain the requirements and challenges of network security. (6)

OR

12. (a) In ElGamal, Schnorr and DSS, what happens if an attacker can find the value of random secret key used by the signer? Also, what happens if a user uses the same value of random secret key to sign two messages? Explain your answer for each scheme separately. (8)
- (b) Explain the network security model with the help of a neat diagram. (6)

13. (a) Alice wishes to log into Bob's workstation remotely. List the steps involved in this communication if Kerberos v4 is used. (7)
- (b) How does Diffie-Hellman technique provide perfect forward secrecy using signature keys? (7)

OR

14. (a) Explain the algorithm for Message Authentication Code (MAC) calculation and verification in Kerberos v5 rsa-md5-des. (8)
- (b) Compare the aggressive mode and main mode of Phase 1 Internet Key Exchange (IKE). (6)

15. (a) Describe the different methods by which authentication of source is performed in email communication. (7)
- (b) Explain the Signed data and Clear-signed data functions provided by S/MIME. (7)

OR

16. (a) Explain the advantages of Pretty Good Privacy (PGP) over Privacy Enhanced Mail (PEM). (7)

- (b) Define non-repudiation. Describe the different ways by which it is implemented in email communication. (7)
17. (a) Describe the significance of pseudo-random function of Transport Layer Security. (7)
- (b) Explain the four different phases of Secure Sockets Layer (SSL) Handshake Protocol. (7)
- OR**
18. (a) Describe how connection initiation and connection closure is done in Hyper Text Transfer Protocol Secure (HTTPS). (7)
- (b) Illustrate the sequence of events in Secure Shell (SSH) transport layer protocol packet exchanges. (7)
19. (a) Explain the Discovery phase and Authentication phase of IEEE 802.11i operation. (7)
- (b) Why are firewalls needed? Compare the features of packet filters and circuit level firewalls. (7)
- OR**
20. (a) Explain the two authentication methods used in Wired Equivalent Privacy (WEP). (7)
- (b) Describe the three transaction classes provided by Wireless Transaction Protocol. (7)

Teaching Plan

No	Contents	No of Lecture Hrs
Module - 1 (Network Security Basics) (7 hrs)		
1.1	Security requirements, Challenges of security	1
1.2	Network security model	1
1.3	Worms, Viruses, Trojans, Spyware, Adware	1
1.4	Intrusion Detection Systems (IDS) uses, Techniques	1
1.5	ElGamal digital signature	1
1.6	Schnorr digital signature	1
1.7	Digital Signature Standard (DSS)	1
Module - 2 (Network Security Standards) (12 hrs)		
2.1	Kerberos v4 configuration, Authentication	1
2.2	Kerberos v4 encryption	1
2.3	Kerberos v4 message formats	1
2.4	Kerberos v5 cryptographic algorithms – rsa-md5-des, des-mac, des-mac-k	1
2.5	Kerberos v5 cryptographic algorithms - rsa-md4-des, rsa-md4-des-k, Encryption for privacy and integrity	1
2.6	Kerberos v5 message formats	1
2.7	Public Key Infrastructure (PKI) trust models	1
2.8	PKI revocation	1
2.9	Perfect Forward Secrecy (PFS), Denial-of-Service protection	1
2.10	Endpoint identifier hiding, Live partner reassurance	1
2.11	Internet Protocol Security (IPSec) Authentication Header (AH), Encapsulating Security Payload (ESP)	1

2.12	Internet Key Exchange (IKE) phases	1
Module - 3 (Email Security) (9 hrs)		
3.1	Security services for email, Establishing keys, Privacy	1
3.2	Authentication, Message integrity, Non-repudiation	1
3.3	Privacy Enhanced Mail (PEM) encryption, Source authentication	1
3.4	PEM integrity protection, Message formats (Lecture 1)	1
3.5	PEM message formats (Lecture 2)	1
3.6	Secure/Multipurpose Internet Mail Extensions (S/MIME) – Messages, Differences from PEM	1
3.7	Pretty Good Privacy (PGP) encoding, Certificate and key revocation, Anomalies	1
3.8	PGP Object formats (Lecture 1)	1
3.9	PGP Object formats (Lecture 2)	1
Module – 4 (Web Security)(9 hrs)		
4.1	Web security considerations, Threats, Secure Sockets Layer (SSL) architecture	1
4.2	SSL protocols (Lecture 1)	1
4.3	SSL protocols (Lecture 2)	1
4.4	Transport Layer Security (TLS) differences from SSL (Lecture 1)	1
4.5	TLS differences from SSL (Lecture 2)	1
4.6	Hypertext Transfer Protocol Secure (HTTPS) connection initiation, Closure	1
4.7	Secure Shell (SSH) transport layer protocol	1
4.8	SSH user authentication protocol	1
4.9	SSH connection protocol	1

Module - 5 (Wireless Security and Firewalls) (8 hrs)		
5.1	IEEE 802.11 Wireless LAN network components, Architectural model, Services	1
5.2	IEEE 802.11i wireless LAN security services, Phases of operation (Lecture 1)	1
5.3	IEEE 802.11i phases of operation (Lecture 2)	1
5.4	Wired Equivalent Privacy (WEP), Wi-Fi Protected Access (WPA), WPA2	1
5.5	Wireless Application Protocol (WAP) services, Protocol architecture (Lecture 1)	1
5.6	WAP protocol architecture (Lecture 2)	1
5.7	Need for firewalls, Packet filters	1
5.8	Circuit-level firewalls, Application layer firewalls	1



AIT396	MACHINE LEARNING IN COMPUTATIONAL BIOLOGY	CATEGORY	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2020

Preamble: This course is intended to provide the learners a outlook towards application of Machine learning algorithms in the field of computational biology. This course helps the learners to apply the Machine learning methods - clustering algorithms, dimensionality reduction, decision trees, Artificial Neural Network, Support Vector Machine to the computational biology problems. Also the course discuss Challenges of Machine Learning in Computational Biology and Future directions of Machine Learning in Computational Biology.

Prerequisite: Basic background in Bioinformatics and Machine Learning

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

CO 1	Describe the basic concepts of Machine Learning, Classification, regression and clustering problems, parameters and measures (Cognitive knowledge level: Understand)
CO 2	Demonstrate the clustering algorithm on computational biology problems (Cognitive knowledge level: Apply)
CO 3	Explain Dimensionality reduction techniques and Decision Trees in computational biology (Cognitive knowledge level : Apply)
CO 4	Illustrate Feature Extraction and Pattern recognition and Classification in the domain of Computational Biology analysis (Cognitive knowledge level: Apply)
CO 5	Explain the role and challenges of Machine Learning in Computational (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:

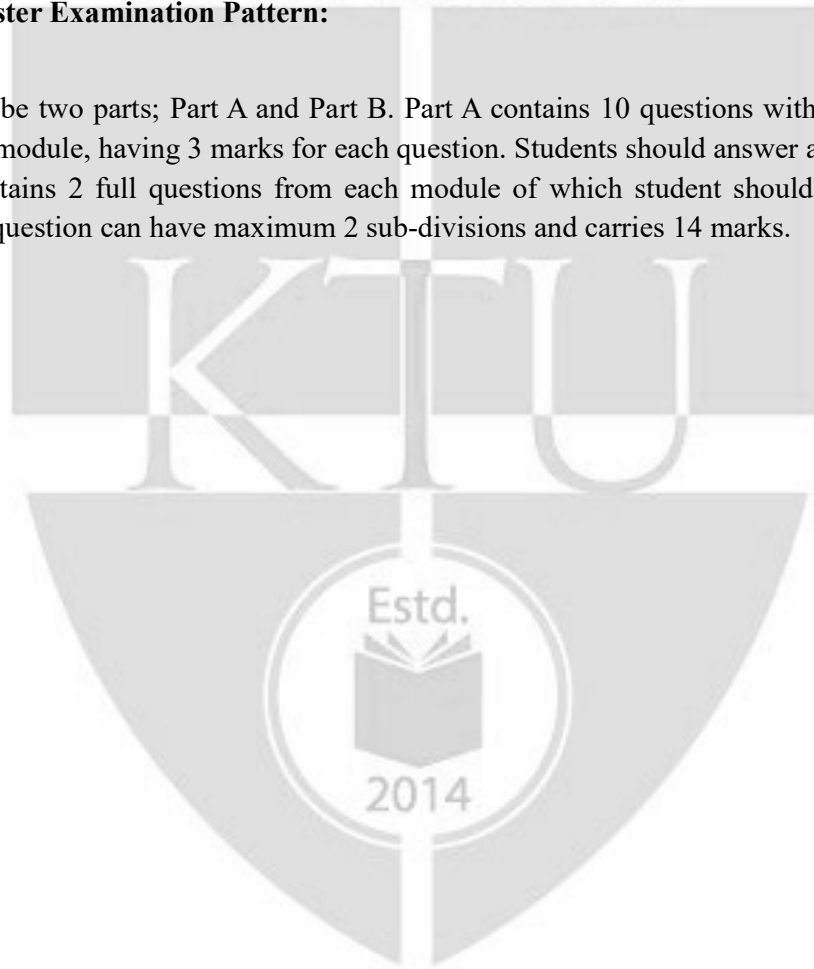
Attendance	10 marks
Continuous Assessment Tests (Average of Series Tests 1& 2)	25 marks
Continuous Assessment Assignment	15 marks

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.



Module 1 (Overview of Machine Learning)

Overview of Machine Learning, fitting predictive models to data, Supervised and unsupervised learning, Classification, regression and clustering problems, Loss or cost functions. Parameters and hyperparameters, Training, validation and testing, Inductive bias and the bias variance trade-off, Use of clustering models.

Module 2 (Clustering problems Computational Biology)

Hierarchical Clustering, Partition Clustering, Overview Model-Based Clustering, k-Means clustering, k-Means clustering algorithm, Advantages, Disadvantages, illustrative example of k-Means clustering, Clustering for creating phylogenetic trees, Using Clustering Approach to Identify Patients' Subtypes, Application of clustering algorithms on gene expression data.

Module 3 (Supervised techniques for Computational Biology)

Proteomics Dataset, Data Pre-processing Algorithms, Dimension and Feature Subset Selection, Dimensionality reduction - Principal Component Analysis (PCA), Partial Least Square (PLS), Linear Discriminant Analysis (LDA), Protein Classification, Decision Trees in Bioinformatics, Proteomic Mass Spectra Classification Using Decision Tree Technique.

Module 4 (Machine-Learning Algorithms for Computational Biology)

Machine-Learning Algorithms for Feature Selection from Gene Expression Data, Feature Extraction and Pattern recognition from sequence data, measures of a Feature. Artificial Neural Network (ANN) in Bioinformatics, Genetic Algorithms (GA) in Bioinformatics, Designing ANN for Bioinformatics, ANN in Protein Bioinformatics, Support Vector Machine with Feature Elimination.

Module 5 (Scope of Machine Learning in Computational Biology)

Role of Machine Learning in Computational Biology, Creation and analysis of sequence data, Challenges of Machine Learning in Computational Biology, Data Errors, Mean Square Error Generative versus Discriminative, Approximation Versus Explanation, Single Versus Multiple Methods, Future directions of Machine Learning in Computational Biology.

Text Books

1. Statistical Modelling and Machine Learning Principles for Bioinformatics Techniques, Tools, and Applications. Germany, Springer Singapore, 2020.
2. Yang, ZhengRong. Machine Learning Approaches to Bioinformatics. Singapore, World Scientific Publishing Company, 2010.

References

1. Izadkhah, Habib. Deep Learning in Bioinformatics: Techniques and Applications in Practice. Netherlands, Elsevier Science, 2022.
2. Agapito, Giuseppe, et al. Artificial Intelligence in Bioinformatics: From Omics Analysis to Deep Learning and Network Mining. Netherlands, Elsevier Science, 2022.
3. Data Analytics in Bioinformatics: A Machine Learning Perspective. United States, Wiley, 2021.
4. Michailidis, George, et al. Introduction to Machine Learning and Bioinformatics. United Kingdom, CRC Press, 2008.
5. Zhang, Yanqing, and Rajapakse, Jagath C, Machine Learning in Bioinformatics, Germany, Wiley, 2009.
6. Baldi, Professor Pierre, et al. Bioinformatics, Second Edition: The Machine Learning Approach. India, Bradford, 2001.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Compare and contrast Supervised and unsupervised learning
2. Differentiate Classification with regression with an example
3. Explain the parameters and hyperparameters of a model?
4. Summarize validation and testing in machine learning?

Course Outcome 2 (CO2):

1. Write K-means algorithm and separate {5, 11, 19, 27, 23, 25, 6, 18, 2, 8, 10, 12, 31, 29, 4} into 3 clusters
2. Illustrate application of clustering algorithms on gene expression data
3. Differentiate K-means clustering and hierarchical clustering

Course Outcome 3 (CO3):

1. Illustrate dimensionality reduction methods - Principal Component Analysis (PCA), Partial Least Square (PLS), Linear Discriminant Analysis (LDA)
2. Explain Decision trees in Bioinformatics with a toy example.

Course Outcome 4 (CO4):

1. Explain the process involved in feature extraction and pattern recognition from sequence data
2. Design and implement an ANN model for the prediction of relative solvent accessibility

Course Outcome 5 (CO5):

1. Summarize role of Machine Learning in Computational Biology
2. Explain Challenges of Machine Learning approaches in Computational Biology

Model Question Paper		
QP CODE:		
Reg No: _____		
Name: _____		PAGES: 3
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY		
SIXTH SEMESTER B.TECH (Honors) DEGREE EXAMINATION, MONTH & YEAR		
Course Code: AIT 396		
Course Name: MACHINE LEARNING IN COMPUTATIONAL BIOLOGY		
Max. Marks: 100		Duration: 3 Hours
PART A		
Answer All Questions. Each Question Carries 3 Marks		
1.	What does the regression line equation tell you?	(3)
2.	How do you create a predictive data model using machine learning?	(3)
3.	Write the major differences between K-means clustering and hierarchical clustering	(3)
4.	List any three resources of Proteomics Datasets	(3)
5.	What is the importance of using PCA before applying Machine learning method?	(3)
6.	Draw example of an ANN architecture including 4 independent variables, one hidden layer with 3 hidden neurons and 2 dependent variables	(3)
7.	What is the role of the Activation functions in Neural Networks?	(3)
8.	What is Hinge Loss in SVM?	(3)
9.	What is mean square error? how will you evaluate it?	(3)
10.	What are discriminative machine learning models?	(10x3=30))
Part B		
(Answer any one question from each module. Each question carries 14 Marks)		
11.	(a) With example, differentiate Supervised and unsupervised learning	(7)

	(b)	What is loss function and cost function in machine Learning. write the difference and example of loss function and cost function	(7)
OR			
12.	(a)	Define Train, Validation, and Test Datasets. how do you divide the data into Train, Validation, and Test Datasets.	(7)
	(b)	Explain Classification, regression and clustering methods with examples of each	(7)
13.	(a)	Use K Means clustering to cluster the following data into two groups. Assume cluster centroid are $m_1=2$ and $m_2=4$. The distance function used is Euclidean distance. { 2, 4, 10, 12, 3, 20, 30, 11, 25 }	(7)
	(b)	Illustrate with a toy example the application of clustering algorithms on gene expression data	(7)
OR			
14.	(a)	Explain the advantages, disadvantages of k-Means clustering	(7)
	(b)	What is the advantage of using hierarchical clustering over K means clustering? When to use the hierarchical clustering?	(7)
15.	(a)	Explain Dimension and Feature Subset Selection	(7)
	(b)	20 physicochemical properties of 100 set of proteins were given with the help of PCA, explain how will you reduce 20x100 in to Five properties (5x100) for the next level analysis	(7)
OR			
16.	(a)	Explain how Linear Discriminant Analysis can be used for the dimensionality reduction with the help of a scenario in computational biology	(7)
	(b)	How do decision tree classifiers work? what types of problems can they solve in Computational Biology	(7)
17.	(a)	Explain the process of Feature Extraction and Pattern recognition from sequence data	(7)
	(b)	Illustrate the design of Artificial Neural Network for solving Computational Biology question	(7)
OR			
18.	(a)	Explain crossover and mutation in genetic algorithm with an example	(7)
	(b)	Explain how to construct a support vector machine (SVM) to classify ovarian	(7)

		cancer from 30 individuals from the 15 features obtained from each patient.	
19.	(a)	What role does machine learning and have to play in Computational Biology?	(7)
	(b)	Explain different kinds of Data Errors in Machine Learning that would happen in case of applying it in to the Computational Biology domain?	(7)
OR			
20.	(a)	What are the advantages and disadvantages of application of machine learning in Computational Biology?	(7)
	(b)	“The transformation of huge volume of data into knowledge is the biggest challenge faced in computational biology” How can machine learning techniques help in this?	(7)

TEACHING PLAN

No	Contents	No of Lecture (45 Hrs)
Module 1 (Overview of Machine Learning) (9 hrs)		
1.1	Overview of Machine Learning	1
1.2	Fitting predictive models to data	1
1.3	Supervised and unsupervised learning	1
1.4	Classification, regression and clustering problems	1
1.5	Loss or cost functions	1
1.6	Proteins and peptides	1
1.7	Parameters and hyperparameters	1
1.8	Training. validation and testing	1
1.9	Inductive bias and the bias variance trade-off, Use of clustering models	1
Module 2 (Clustering problems Computational Biology) (9 hrs)		
2.1	Hierarchical Clustering	1
2.2	Partition Clustering, Overview Model-Based Clustering	1
2.3	k-Means clustering, k-Means clustering algorithm	1
2.4	k-Means clustering advantages, disadvantages	1
2.5	illustrative example of k-Means clustering	1

2.6	Clustering for creating phylogenetic trees	1
2.7	Using Clustering Approach to Identify Patients' Subtypes	1
2.8	Application of clustering algorithms on gene expression data	1
2.9	Application of clustering algorithms on gene expression data	1
Module 3 (Supervised techniques for Computational Biology) (9 hrs)		
3.1	Proteomics Datasets	1
3.2	Data Pre-processing Algorithms	1
3.3	Dimension and Feature Subset Selection	1
3.4	Dimensionality reduction	1
3.5	Principal Component Analysis (PCA)	1
3.6	Partial Least Square (PLS), Linear Discriminant Analysis (LDA)	1
3.7	Protein Classification case study	1
3.8	Decision Trees in Bioinformatics	1
3.9	Proteomic Mass Spectra Classification Using Decision Tree Technique	1

Module 4 (Machine-Learning Algorithms for Computational Biology) (8 hrs)		
4.1	Machine-Learning Algorithms for Feature Selection from Gene Expression Data	1
4.2	Feature Extraction and Pattern recognition from sequence data	1
4.3	Measures of a Feature	1
4.4	Artificial Neural Network (ANN) in Bioinformatics	1
4.5	Genetic Algorithms (GA) in Bioinformatics	1
4.6	Designing ANN for Bioinformatics	1
4.7	Designing ANN for Bioinformatics	1
4.8	ANN in Protein Bioinformatics	1
4.9	Support Vector Machine with Feature Elimination.	1
Module 5 (Scope of Machine Learning in Computational Biology) (10 hrs)		
5.1	Role of Machine Learning in Computational Biology	1
5.2	Creation and analysis of sequence data	1

5.3	Challenges of Machine Learning in Computational Biology	1
5.4	Data Errors in Machine Learning, Mean Square Error	1
5.5	Generative versus Discriminative	1
5.6	Approximation Versus Explanation	1
5.7	Single Versus Multiple Methods	1
5.8	Future directions of Machine Learning in Computational Biology	1
5.9	Future directions of Machine Learning in Computational Biology	1



AIT398	IMAGE AND VIDEO PROCESSING	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2020

Preamble: This course enables the learners to understand how digital images are stored and processed. The learners are exposed to different spatial and frequency domain methods for image enhancement, image restoration techniques, morphological operations that could be performed on digital images and also various image and video compression techniques. The course also gives an introduction to the basics of video processing and video segmentation.

Prerequisite: Advanced Computer Graphics, Advanced Concepts in Computer Vision

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

CO1	Summarize the steps of digital image processing and pixel relationships. (Cognitive Knowledge Level: Understand)
CO2	Apply spatial and frequency domain methods for image enhancement. (Cognitive Knowledge Level: Apply)
CO3	Apply restoration techniques and morphological operations on digital images. (Cognitive Knowledge Level: Apply)
CO4	Compare different methods for digital image and video compression. (Cognitive Knowledge Level: Apply)
CO5	Understand the basics of video processing and video segmentation. (Cognitive Knowledge Level: Understand)

Mapping of course outcomes with program outcomes

	PO 1	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 hrs

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

Fundamentals of Image processing: Basic steps of Image processing system, sampling and quantization of an Image, basic relationship between pixels and connectivity.

Image Enhancement: Spatial Domain methods - Gray level transformations, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial filters, Sharpening Spatial filters.

Module -2

Image Transforms: Unitary transforms, 2D Discrete Fourier Transform, Discrete Cosine Transform (DCT), Discrete Wavelet transforms.

Frequency Domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening, homomorphic filtering.

Module - 3

Image Restoration: Image degradation/Restoration model, Noise models, Restoration in presence of noise only - spatial filtering, Periodic Noise reduction by frequency domain filtering.

Morphological Operations: Erosion, Dilation, Opening, Closing, Hit-or-miss transformation, Boundary extraction.

Module - 4

Image compression fundamentals – Coding Redundancy, spatial and temporal redundancy.

Compression models : Lossy and Lossless, Huffman coding, Arithmetic coding, LZW coding, run length coding, Bit Plane coding, JPEG standards.

Module - 5

Video processing: Basics of Video Processing: Analog video, Digital Video.

Video segmentation: Introduction to video segmentation, Change detection.

Video Compression: Introduction to video compression, video compression based on motion compensation, Search for motion vectors, H.261 standard, Transform coding, predictive coding-MPEG.

Text Books

1. Gonzalez and Woods , “Digital Image Processing”, 3rd edition , Pearson, 2009.
2. Li, Ze-Nian, Mark S. Drew, and Jiangchuan Liu. “Fundamentals of multimedia”, Pearson Prentice Hall, 2004.
3. Bovik, Alan C. “Handbook of image and video processing”, Academic press, 2010.

Reference Books

1. David A. Forsyth & Jean Ponce, Computer vision – A Modern Approach, Prentice Hall, 2002.
2. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer.
3. Maheshkumar H Kolekar, “Intelligent Video Surveillance Systems: An Algorithmic Approach”, CRC Press.
4. Francesco Camastra, Alessandro Vinciarelli, “Machine Learning for Audio, Image and Video Analysis: Theory and Applications”, Springer 2015.
5. M. Tekalp ,”Digital video Processing”, Prentice Hall International
6. Relf, Christopher G., "Image acquisition and processing with LabVIEW", CRC press
- 7 Chris Solomon, Toby Breckon , "Fundamentals of Digital Image Processing A Practical Approach with Examples in Matlab", John Wiley & Sons,
8. Yao wang, Joem Ostarmann and Ya – quin Zhang, ”Video processing and communication “,1st edition , PHI

Course Level Assessment Questions**Course Outcome1 (CO1):**

1. Illustrate how the image is digitized by sampling and quantization.
2. Let $V = \{1,2\}$ and compute the length of the shortest 4-, 8-, and m path between p and q.
If a particular path does not exist between these two points explain why.

3	1	2	1q
2	2	0	2
1	2	1	1
p 1	0	1	2

Course Outcome 2(CO2):

1. Determine whether the given matrix is unitary or not:

$$A = \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & 1 \\ -1 & 1 \end{bmatrix}$$

2. Explain any five properties of 2D Fourier Transform.

Course Outcome 3(CO3):

1. Discuss how restoration is done in digital images.
2. Explain with examples the different morphological operations applied to images.

Course Outcome 4(CO4): .

1. With suitable examples, clearly bring out the need for compression in images and videos.
2. Discuss any one method for finding motion vectors.

Course Outcome 5(CO5):

1. Explain any one technique used for segmenting a video.
2. Compare and contrast analog video and digital video in multimedia.

Model Question Paper

QP CODE:

Reg No: _____

Name: _____

PAGES : 3

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

Course Code: AIT 398

Course Name: Image and Video Processing

Max. Marks : 100

Duration: 3 Hours

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Explain bit plane slicing and contrast stretching.
2. Discuss about pixel relationships.
3. Find the 4 order forward and inverse DFT for the following image segment:

1	1	1	1
1	1	1	1
1	1	1	1
1	1	1	1

4. Define DCT. Write the properties of DCT.
5. Discuss hit or miss transformation with appropriate examples.

6. Explain about the morphological operation dilation.
7. Explain the significance of image compression.
8. Distinguish between lossy and lossless compression.
9. Discuss the significance of change detection.
10. Explain how transform coding is used in compression algorithms.

(10x3=30
)

Part B

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

11. (a) Perform histogram specification of the following 3 bit gray scale image whose gray level distribution is given as follows. (9)

Input image

Gray level	0	1	2	3	4	5	6	7
No. of Pixels	8	10	10	2	12	16	4	2

Target image

Gray Level	0	1	2	3	4	5	6	7
No. of Pixels	0	0	0	0	20	20	16	8

- (b) Design Laplacian filter for image enhancement in spatial domain. (5)

OR

12. (a) What is histogram equalization? Explain the procedure for histogram equalization. (7)
- (b) Explain the gray level transformation functions: a) image negatives and b) log transformation c) power law transformation. (7)
13. (a) Compute the 2D DFT of the 4 X 4 grayscale image given below. (4)

- (b) Explain about smoothing and sharpening frequency domain filters. (10)

OR

14. (a) Explain Butterworth filters for image smoothening and image sharpening. (4)

- (b) Explain the steps followed in frequency domain filtering? (5)

15. (a) Apply opening and closing operation on the image sample A given below with structuring element B (10)

$$A = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{pmatrix} \quad \text{and} \quad B = \begin{bmatrix} 1 & 1 & 1 \end{bmatrix}$$

- (b) Explain Morphological operations a) opening b) closing with suitable examples. (4)

OR

16. (a) Discuss about different noise models. (7)

- (b) Explain how periodic noise reduction can be done using frequency domain filtering. (7)

17. (a) Comment on JPEG compression standard. (8)

- (b) Discuss on run-length encoding with the help of an example. (6)

OR

18. (a) Explain LZW coding with the help of a suitable example. (8)

- (b) Illustrate the concept of arithmetic coding. (6)

19. (a) Compare and contrast MPEG video coding and H.261 standard. (7)
- (b) Explain video segmentation with an example. (7)

OR

20. (a) Illustrate how motion compensation is used in video compression. (7)
- (b) With the help of a neat block diagram explain predictive coding methods. (7)

Teaching Plan

No	Contents	No. of Lecture Hours (44 hrs)
Module – 1 (7 hours)		
1.1	Fundamentals of Image processing: Basic steps of Image processing system, Sampling and quantization of an Image.	1 hour
1.2	Basic relationship between pixels and connectivity.	1 hour
1.3	Image Enhancement: Gray level transformations	1 hour
1.4	Histogram, Histogram Equalization	1 hour
1.5	Histogram specification	1 hour
1.6	Fundamentals of Spatial Filtering	1 hour
1.7	Smoothing Spatial filters	1 hour
1.8	Sharpening Spatial filters	1 hour
Module-2 (8 hours)		
2.1	Image Transforms: Unitary transforms.	1 hour
2.2	2D Discrete Fourier Transform	1 hour

2.3	Discrete Cosine Transform (DCT)	1 hour
2.4	Discrete Wavelet transforms	1 hour
2.5	Basics of filtering in frequency domain	1 hour
2.6	Image smoothing	1 hour
2.7	Image sharpening	1 hour
2.8	Homomorphic filtering.	1 hour
Module-3 (9 hours)		
3.1	Image Restoration: Image degradation/Restoration model	1 hour
3.2	Noise models	1 hour
3.3	Restoration basics	1 hour
3.4	Restoration in presence of noise only - spatial filtering	1 hour
3.5	Periodic Noise reduction by frequency domain filtering.	1 hour
3.6	Morphological Operations: basics	1 hour
3.7	Erosion, Dilation, Opening, Closing	1 hour
3.8	Hit-or-miss transformation	1 hour
3.9	Boundary extraction.	1 hour
Module-4 (10 hours)		
4.1	Image compression fundamentals - Coding Redundancy	1 hour
4.2	Spatial and temporal redundancy.	1 hour
4.3	Compression models : Lossy and Lossless	1 hour
4.4	Huffman coding	1 hour

4.6	Arithmetic coding	1 hour
4.7	LZW coding	1 hour
4.8	Run length coding	1 hour
4.9	Bit Plane coding,	1 hour
4.10	JPEG standards	1 hour
Module-5 (10 hours)		
5.1	Basics of Video Processing: Analog video, Digital Video.	1 hour
5.2	Video segmentation: Introduction to video segmentation	1 hour
5.3	Change detection.	1 hour
5.4	Introduction to video compression	1 hour
5.5	Video compression based on motion compensation	1 hour
5.6	Search for motion vectors	1 hour
5.7	Transform coding	1 hour
5.8	Predictive coding	1 hour
5.9	MPEG standards	1 hour
5.10	H.261 standard	1 hour

API ABDUL KALAM
TECHNOLOGICAL
UNIVERSITY

COMMON COURSES

(S5 & S6)



MCN	DISASTER MANAGEMENT	Category	L	T	P	CREDIT	YEAR OF INTRODUCTION
301		Non - Credit	2	0	0	Nil	2019

Preamble: The objective of this course is to introduce the fundamental concepts of hazards and disaster management.

Prerequisite: Nil

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

CO1	Define and use various terminologies in use in disaster management parlance and organise each of these terms in relation to the disaster management cycle (Cognitive knowledge level: Understand).
CO2	Distinguish between different hazard types and vulnerability types and do vulnerability assessment (Cognitive knowledge level: Understand).
CO3	Identify the components and describe the process of risk assessment, and apply appropriate methodologies to assess risk (Cognitive knowledge level: Understand).
CO4	Explain the core elements and phases of Disaster Risk Management and develop possible measures to reduce disaster risks across sector and community (Cognitive knowledge level: Apply)
CO5	Identify factors that determine the nature of disaster response and discuss the various disaster response actions (Cognitive knowledge level: Understand).
CO6	Explain the various legislations and best practices for disaster management and risk reduction at national and international level (Cognitive knowledge level: Understand).

Mapping of course outcomes with program outcomes

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

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	10	10	20
Understand	25	25	50
Apply	15	15	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 - 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

MCN 301 Disaster Management

Module 1

Systems of earth

Lithosphere- composition, rocks, soils; Atmosphere-layers, ozone layer, greenhouse effect, weather, cyclones, atmospheric circulations, Indian Monsoon; hydrosphere- Oceans, inland water bodies; biosphere

Definition and meaning of key terms in Disaster Risk Reduction and Management- disaster, hazard, exposure, vulnerability, risk, risk assessment, risk mapping, capacity, resilience, disaster risk reduction, disaster risk management, early warning systems, disaster preparedness, disaster prevention, disaster mitigation, disaster response, damage assessment, crisis counselling, needs assessment.

Module 2

Hazard types and hazard mapping; Vulnerability types and their assessment- physical, social, economic and environmental vulnerability.

Disaster risk assessment –approaches, procedures

Module 3

Disaster risk management -Core elements and phases of Disaster Risk Management

Measures for Disaster Risk Reduction – prevention, mitigation, and preparedness.

Disaster response- objectives, requirements; response planning; types of responses.

Relief; international relief organizations.

Module 4

Participatory stakeholder engagement; Disaster communication- importance, methods, barriers; Crisis counselling

Capacity Building: Concept – Structural and Non-structural Measures, Capacity Assessment; Strengthening Capacity for Reducing Risk

Module 5

Common disaster types in India; Legislations in India on disaster management; National disaster management policy; Institutional arrangements for disaster management in India.

The Sendai Framework for Disaster Risk Reduction- targets, priorities for action, guiding principles

Reference Text Book

1. R. Subramanian, Disaster Management, Vikas Publishing House, 2018
2. M. M. Sulphery, Disaster Management, PHI Learning, 2016
3. UNDP, Disaster Risk Management Training Manual, 2016
4. United Nations Office for Disaster Risk Reduction, Sendai Framework for Disaster Risk Reduction 2015-2030, 2015

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What is the mechanism by which stratospheric ozone protects earth from harmful UV rays?
2. What are disasters? What are their causes?
3. Explain the different types of cyclones and the mechanism of their formation
4. Explain with examples, the difference between hazard and risk in the context of disaster management
5. Explain the following terms in the context of disaster management (a) exposure (b) resilience (c) disaster risk management (d) early warning systems, (e) damage assessment (f) crisis counselling (g) needs assessment

Course Outcome 2 (CO2):

1. What is hazard mapping? What are its objectives?
2. What is participatory hazard mapping? How is it conducted? What are its advantages?
3. Explain the applications of hazard maps
4. Explain the types of vulnerabilities and the approaches to assess them

Course Outcome 3 (CO3):

1. Explain briefly the concept of 'disaster risk'

2. List the strategies for disaster risk management ‘before’, ‘during’ and ‘after’ a disaster
3. What is disaster preparedness? Explain the components of a comprehensive disaster preparedness strategy

Course Outcome 4 (CO4):

1. What is disaster prevention? Distinguish it from disaster mitigation giving examples
2. What are the steps to effective disaster communication? What are the barriers to communication?
3. Explain capacity building in the context of disaster management

Course Outcome 5 (CO5):

1. Briefly explain the levels of stakeholder participation in the context of disaster risk reduction
2. Explain the importance of communication in disaster management
3. Explain the benefits and costs of stakeholder participation in disaster management
4. How are stakeholders in disaster management identified?

Course Outcome 6 (CO6):

1. Explain the salient features of the National Policy on Disaster Management in India
2. Explain the guiding principles and priorities of action according to the Sendai Framework for Disaster Risk Reduction
3. What are Tsunamis? How are they caused?
4. Explain the earthquake zonation of India

Model Question paper

QP CODE:

PAGES:3

Reg No:_____

Name :_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: MCN 301

Course Name: Disaster Management

Max.Marks:100

Duration: 3 Hours

PART A

Answer all Questions. Each question carries 3 Marks

1. What is the mechanism by which stratospheric ozone protects earth from harmful UV rays?
2. What are disasters? What are their causes?
3. What is hazard mapping? What are its objectives?
4. Explain briefly the concept of 'disaster risk'
5. List the strategies for disaster risk management 'before', 'during' and 'after' a disaster
6. What is disaster prevention? Distinguish it from disaster mitigation giving examples
7. Briefly explain the levels of stakeholder participation in the context of disaster risk reduction
8. Explain the importance of communication in disaster management
9. What are Tsunamis? How are they caused?
10. Explain the earthquake zonation of India

Part B

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

11. a. Explain the different types of cyclones and the mechanism of their formation [10]
b. Explain with examples, the difference between hazard and risk in the context of disaster management [4]

OR

12. Explain the following terms in the context of disaster management [14]
(a) exposure (b) resilience (c) disaster risk management (d) early warning systems, (e) damage assessment (f) crisis counselling (g) needs assessment

13. a. What is participatory hazard mapping? How is it conducted? What are its advantages? [8]
b. Explain the applications of hazard maps [6]

OR

14. Explain the types of vulnerabilities and the approaches to assess them [14]
15. a. Explain the core elements of disaster risk management [8]
b. Explain the factors that decide the nature of disaster response [6]

OR

16. a. What is disaster preparedness? Explain the components of a comprehensive disaster preparedness strategy [6]
b. Explain the different disaster response actions [8]
17. a. Explain the benefits and costs of stakeholder participation in disaster management [10]
b. How are stakeholders in disaster management identified? [4]

OR

18. a. What are the steps to effective disaster communication? What are the barriers to communication? [7]
b. Explain capacity building in the context of disaster management [7]

19. Explain the salient features of the National Policy on Disaster Management in India

[14]

OR

20. Explain the guiding principles and priorities of action according to the Sendai Framework for Disaster Risk Reduction

[14]

Teaching Plan

	Module 1	5 Hours
1.1	Introduction about various Systems of earth, Lithosphere-composition, rocks, Soils; Atmosphere-layers, ozone layer, greenhouse effect, weather	1 Hour
1.2	Cyclones, atmospheric circulations, Indian Monsoon; hydrosphere-Oceans, inland water bodies; biosphere	1 Hour
1.3	Definition and meaning of key terms in Disaster Risk Reduction and Management- disaster, hazard,	1 Hour
1.4	Exposure, vulnerability, risk, risk assessment, risk mapping, capacity, resilience, disaster risk reduction, Disaster risk management, early warning systems	1 Hour
1.5	Disaster preparedness, disaster prevention, disaster, Mitigation, disaster response, damage assessment, crisis counselling, needs assessment.	1 Hour
	Module 2	5 Hours
2.1	Various Hazard types, Hazard mapping; Different types of Vulnerability types and their assessment	1 Hour
2.2	Vulnerability assessment and types, Physical and social vulnerability	1 Hour
2.3	Economic and environmental vulnerability, Core elements of disaster risk assessment	1 Hour
2.4	Components of a comprehensive disaster preparedness strategy approaches, procedures	1 Hour
2.5	Different disaster response actions	1 Hour
	Module 3	5 Hours
3.1	Introduction to Disaster risk management, Core elements of Disaster Risk Management	1 Hour
3.2	Phases of Disaster Risk Management, Measures for Disaster Risk Reduction	1 Hour
3.3	Measures for Disaster prevention, mitigation, and preparedness.	1 Hour

3.4	Disaster response- objectives, requirements. Disaster response planning; types of responses.	1 Hour
3.5	Introduction- Disaster Relief, Relief; international relief organizations.	1 Hour
	Module 4	5 Hours
4.1	Participatory stakeholder engagement	1 Hour
4.2	Importance of disaster communication.	1 Hour
4.3	Disaster communication- methods, barriers. Crisis counselling	1 Hour
4.4	Introduction to Capacity Building. Concept – Structural Measures, Non-structural Measures.	1 Hour
4.5	Introduction to Capacity Assessment, Capacity Assessment; Strengthening, Capacity for Reducing Risk	1 Hour
	Module 5	5 Hours
5.1	Introduction-Common disaster types in India.	1 Hour
5.2	Common disaster legislations in India on disaster management	1 Hour
5.3	National disaster management policy, Institutional arrangements for disaster management in India.	1 Hour
5.4	The Sendai Framework for Disaster Risk Reduction and targets	1 Hour
5.5	The Sendai Framework for Disaster Risk Reduction-priorities for action, guiding principles	1 Hour

HUT 300	Industrial Economics & Foreign Trade	Category	L	T	P	CREDIT
		HSMC	3	0	0	3

Preamble: To equip the students to take industrial decisions and to create awareness of economic environment.

Prerequisite: Nil

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

CO1	Explain the problem of scarcity of resources and consumer behaviour, and to evaluate the impact of government policies on the general economic welfare. (Cognitive knowledge level: Understand)
CO2	Take appropriate decisions regarding volume of output and to evaluate the social cost of production. (Cognitive knowledge level: Apply)
CO3	Determine the functional requirement of a firm under various competitive conditions. (Cognitive knowledge level: Analyse)
CO4	Examine the overall performance of the economy, and the regulation of economic fluctuations and its impact on various sections in the society. (Cognitive knowledge level: Analyse)
CO5	Determine the impact of changes in global economic policies on the business opportunities of a firm. (Cognitive knowledge level: Analyse)

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks
	Test 1 (Marks)	Test 2 (Marks)	
Remember	15	15	30
Understand	20	20	40
Apply	15	15	30

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 (2 numbers)	: 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 : 30 marks

Part B : 70 marks

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 3 sub-divisions and carries 14 marks.

SYLLABUS

HUT 300 Industrial Economics & Foreign Trade

Module 1 (Basic Concepts and Demand and Supply Analysis)

Scarcity and choice - Basic economic problems- PPC – Firms and its objectives – types of firms – Utility – Law of diminishing marginal utility – Demand and its determinants – law of demand – elasticity of demand – measurement of elasticity and its applications – Supply, law of supply and determinants of supply – Equilibrium – Changes in demand and supply and its effects – Consumer surplus and producer surplus (Concepts) – Taxation and deadweight loss.

Module 2 (Production and cost)

Production function – law of variable proportion – economies of scale – internal and external economies – Isoquants, isocost line and producer's equilibrium – Expansion path – Technical progress and its implications – Cobb-Douglas production function - Cost concepts – Social cost: private cost and external cost – Explicit and implicit cost – sunk cost - Short run cost curves - long run cost curves – Revenue (concepts) – Shutdown point – Break-even point.

Module 3 (Market Structure)

Perfect and imperfect competition – monopoly, regulation of monopoly, monopolistic completion (features and equilibrium of a firm) – oligopoly – Kinked demand curve – Collusive oligopoly (meaning) – Non-price competition – Product pricing – Cost plus pricing – Target return pricing – Penetration pricing – Predatory pricing – Going rate pricing – Price skimming.

Module 4 (Macroeconomic concepts)

Circular flow of economic activities – Stock and flow – Final goods and intermediate goods - Gross Domestic Product - National Income – Three sectors of an economy- Methods of measuring national income – Inflation- causes and effects – Measures to control inflation- Monetary and fiscal policies – Business financing- Bonds and shares -Money market and Capital market – Stock market – Demat account and Trading account - SENSEX and NIFTY.

Module 5 (International Trade)

Advantages and disadvantages of international trade - Absolute and Comparative advantage theory - Heckscher - Ohlin theory - Balance of payments – Components – Balance of Payments

deficit and devaluation – Trade policy – Free trade versus protection – Tariff and non-tariff barriers.

Reference Materials

1. Gregory N Mankiw, 'Principles of Micro Economics', Cengage Publications
2. Gregory N Mankiw, 'Principles of Macro Economics', Cengage Publications
3. Dwivedi D N, 'Macro Economics', Tata McGraw Hill, New Delhi.
4. Mithani D M, 'Managerial Economics', Himalaya Publishing House, Mumbai.
5. Francis Cherunilam, 'International Economics', McGraw Hill, New Delhi.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Why does the problem of choice arise?
2. What are the central problems?
3. How do we solve the basic economic problems?
4. What is the relation between price and demand?
5. Explain deadweight loss due to the imposition of a tax.

Course Outcome 2 (CO2):

1. What is shutdown point?
2. What do you mean by producer equilibrium?
3. Explain break-even point;
4. Suppose a chemical factory is functioning in a residential area. What are the external costs?

Course Outcome 3 (CO3):

1. Explain the equilibrium of a firm under monopolistic competition.
2. Why is a monopolist called price maker?
3. What are the methods of non-price competition under oligopoly?

4. What is collusive oligopoly?

Course Outcome 4 (CO4):

1. What is the significance of national income estimation?
2. How is GDP estimated?
3. What are the measures to control inflation?
4. How does inflation affect fixed income group and wage earners?

Course Outcome 5 (CO5):

1. What is devaluation?
2. Suppose a foreign country imposes a tariff on Indian goods. How does it affect India's exports?
3. What is free trade?
4. What are the arguments in favour of protection?

Model Question paper

QP CODE:

PAGES:3

Reg No:_____

Name :_____

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIFTH /SIXTH SEMESTER
B.TECH DEGREE EXAMINATION, MONTH & YEAR**

Course Code: HUT 300

Course Name: Industrial Economics & Foreign Trade

Max.Marks:100

Duration: 3 Hours

PART A

Answer all Questions. Each question carries 3 Marks

1. Why does an economic problem arise?
2. What should be the percentage change in price of a product if the sale is to be increased by 50 percent and its price elasticity of demand is 2?
3. In the production function $Q = 2L^{1/2}K^{1/2}$ if $L=36$ how many units of capital are needed to produce 60 units of output?
4. Suppose in the short run $AVC < P < AC$. Will this firm produce or shut down? Give reason.
5. What is predatory pricing?
6. What do you mean by non- price competition under oligopoly?
7. What are the important economic activities under primary sector?
8. Distinguish between a bond and share?
9. What are the major components of balance of payments?

10. What is devaluation?

(10 x 3 = 30 marks)

PART B

(Answer one full question from each module, each question carries 14 marks)

MODULE I

11. a) Prepare a utility schedule showing units of consumption, total utility and marginal utility, and explain the law of diminishing marginal utility. Point out any three limitations of the law.
- b) How is elasticity of demand measured according to the percentage method? How is the measurement of elasticity of demand useful for the government?

Or

12. a) Explain the concepts consumer surplus and producer surplus.
- b) Suppose the government imposes a tax on a commodity where the tax burden met by the consumers. Draw a diagram and explain dead weight loss. Mark consumer surplus, producer surplus, tax revenue and dead weight loss in the diagram.

MODULE II

13. a) What are the advantages of large-scale production?
- b) Explain Producer equilibrium with the help of isoquants and isocost line. What is expansion path?

Or

14. a) Explain break-even analysis with the help of a diagram.
- b) Suppose the monthly fixed cost of a firm is Rs. 40000 and its monthly total variable cost is Rs. 60000.
- If the monthly sales is Rs. 120000 estimate contribution and break-even sales.
 - If the firm wants to get a monthly profit of Rs.40000, what should be the sales?
- c) The total cost function of a firm is given as $TC=100+50Q - 11Q^2+Q^3$. Find marginal cost when output equals 5 units.

MODULE III

15. a) What are the features of monopolistic competition?
b) Explain the equilibrium of a firm earning supernormal profit under monopolistic competition.

Or

16. a) Make comparison between perfect competition and monopoly.
b) Explain price rigidity under oligopoly with the help of a kinked demand curve.

MODULE IV

17. a) How is national income estimated under product method and expenditure method?
b) Estimate GDPmp, GNPmp and National income

Private consumption expenditure	= 2000 (in 000 cores)
Government Consumption	= 500
NFIA	= -(300)
Investment	= 800
Net=exports	=700
Depreciation	= 400
Net-indirect tax	= 300

Or

18. a) What are the monetary and fiscal policy measures to control inflation?
b) What is SENSEX?

MODULE V

19. a) What are the advantages of disadvantages of foreign trade?
b) Explain the comparative cost advantage.

Or

20. a) What are the arguments in favour protection?
b) Examine the tariff and non-tariff barriers to international trade.

(5 × 14 = 70 marks)

Teaching Plan

Module 1 (Basic concepts and Demand and Supply Analysis)		7 Hours
1.1	Scarcity and choice – Basic economic problems - PPC	1 Hour
1.2	Firms and its objectives – types of firms	1 Hour
1.3	Utility – Law of diminishing marginal utility – Demand – law of demand	1 Hour
1.4	Measurement of elasticity and its applications	1 Hour
1.5	Supply, law of supply and determinants of supply	1 Hour
1.6	Equilibrium – changes in demand and supply and its effects	1 Hour
1.7	Consumer surplus and producer surplus (Concepts) – Taxation and deadweight loss.	1 Hour
Module 2 (Production and cost)		7 Hours
2.1	Productions function – law of variable proportion	1 Hour
2.2	Economies of scale – internal and external economies	1 Hour
2.3	producers equilibrium – Expansion path	1 Hour
2.4	Technical progress and its implications – cob Douglas Production function	1 Hour
2.5	Cost concepts – social cost: private cost and external cost – Explicit and implicit cost – sunk cost	1 Hour
2.6	Short run cost curves & Long run cost curves	1 Hour
2.7	Revenue (concepts) – shutdown point – Break-even point.	1 Hour
Module 3 (Market Structure)		6 hours
3.1	Equilibrium of a firm, MC – MR approach and TC – TR approach	1 Hour
3.2	Perfect competition & Imperfect competition	1 Hour
3.3	Monopoly – Regulation of monopoly – Monopolistic competition	1 Hour
3.4	Oligopoly – kinked demand curve	1 Hour
3.5	Collusive oligopoly (meaning) – Non price competition	1 Hour
3.6	Cost plus pricing – Target return pricing – Penetration, Predatory pricing – Going rate pricing – price skimming	1 Hour

Module 4 (Macroeconomic concepts)		7 Hours
4.1	Circular flow of economic activities	1 Hour
4.2	Stock and flow – Final goods and intermediate goods – Gross Domestic Product - National income – Three sectors of an economy	1 Hour
4.3	Methods of measuring national income	1 Hour
4.4	Inflation – Demand pull and cost push – Causes and effects	1 Hour
4.5	Measures to control inflation – Monetary and fiscal policies	1 Hour
4.6	Business financing – Bonds and shares – Money market and capital market	1 Hour
4.7	Stock market – Demat account and Trading account – SENSEX and NIFTY	1 Hour
Module 5 (International Trade)		8 Hours
5.1	Advantages and disadvantages of international trade	1 Hour
5.2	Absolute and comparative advantage theory	2 Hour
5.3	Heckscher – Ohlin theory	1 Hour
5.4	Balance of payments - components	1 Hour
5.5	Balance of payments deficit and devaluation	1 Hour
5.6	Trade policy – Free trade versus protection	1 Hour
5.7	Tariff and non tariff barriers.	1 Hour

HUT 310	Management for Engineers	Category	L	T	P	Credit
		HMC	3	0	0	3

Preamble: This course is intended to help the students to learn the basic concepts and functions of management and its role in the performance of an organization and to understand various decision-making approaches available for managers to achieve excellence. Learners shall have a broad view of different functional areas of management like operations, human resource, finance and marketing.

Prerequisite: Nil

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

CO1	Explain the characteristics of management in the contemporary context (Cognitive Knowledge level: Understand).
CO2	Describe the functions of management (Cognitive Knowledge level: Understand).
CO3	Demonstrate ability in decision making process and productivity analysis (Cognitive Knowledge level: Understand).
CO4	Illustrate project management technique and develop a project schedule (Cognitive Knowledge level: Apply).
CO5	Summarize the functional areas of management (Cognitive Knowledge level: Understand).
CO6	Comprehend the concept of entrepreneurship and create business plans (Cognitive Knowledge level: Understand).

Mapping of course outcomes with program outcomes

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

Abstract POs defined by National Board of Accreditation				
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 in percentage)
Remember	15	15	30
Understand	15	15	30
Apply	20	20	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 - 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

HUT 310 Management for Engineers (35 hrs)

Module 1 (Introduction to management Theory- 7 Hours)

Introduction to management theory, Management Defined, Characteristic of Management, Management as an art-profession, System approaches to Management, Task and Responsibilities of a professional Manager, Levels of Manager and Skill required.

Module 2 (management and organization- 5 hours)

Management Process, Planning types , Mission, Goals, Strategy, Programmes, Procedures, Organising, Principles of Organisation, Delegation, Span of Control, Organisation Structures, Directing, Leadership, Motivation, Controlling..

Module 3 (productivity and decision making- 7 hours)

Concept of productivity and its measurement; Competitiveness; Decision making process; decision making under certainty, risk and uncertainty; Decision trees; Models of decision making.

. Module 4 (project management- 8 hours)

Project Management, Network construction, Arrow diagram, Redundancy. CPM and PERT Networks, Scheduling computations, PERT time estimates, Probability of completion of project, Introduction to crashing.

Module 5 (functional areas of management- 8 hours)

Introduction to functional areas of management, Operations management, Human resources management, Marketing management, Financial management, Entrepreneurship, Business plans, Corporate social responsibility, Patents and Intellectual property rights.

References:

1. H. Koontz, and H. Weihrich, Essentials of Management: An International Perspective. 8th ed., McGraw-Hill, 2009.
2. P C Tripathi and P N Reddy, Principles of management, TMH, 4th edition, 2008.
3. P. Kotler, K. L. Keller, A. Koshy, and M. Jha, Marketing Management: A South Asian Perspective. 14th ed., Pearson, 2012.
4. M. Y. Khan, and P. K. Jain, Financial Management, Tata-McGraw Hill, 2008.
5. R. D. Hisrich, and M. P. Peters, Entrepreneurship: Strategy, Developing, and Managing a New Enterprise, 4th ed., McGraw-Hill Education, 1997.
6. D. J. Sumanth, Productivity Engineering and Management, McGraw-Hill Education, 1985.
7. K.Ashwathappa, 'Human Resources and Personnel Management', TMH, 3rd edition, 2005.
8. R. B. Chase, Ravi Shankar and F. R. Jacobs, Operations and Supply Chain Management, 14th ed. McGraw Hill Education (India), 2015.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1): Explain the systems approach to management?

Course Outcome 2 (CO2): Explain the following terms with a suitable example Goal, Objective, and Strategy.

Course Outcome 3 (CO3): Mr. Shyam is the author of what promises to be a successful novel. He has the option to either publish the novel himself or through a publisher. The publisher is offering Mr. Shyam Rs. 20,000 for signing the contract. If the novel is successful, it will sell 200,000 copies. Else, it will sell 10,000 copies only. The publisher pays a Re. 1 royalty per copy. A market survey indicates that there is a 70% chance that the novel will be successful. If Mr. Shyam undertakes publishing, he will incur an initial cost of Rs. 90,000 for printing and marketing., but each copy sold will net him Rs. 2. Based on the given information and the

decision analysis method, determine whether Mr. Shyam should accept the publisher's offer or publish the novel himself.

Course Outcome 4 (CO4): Explain the concepts of crashing and dummy activity in project management.

Course Outcome 5 (CO5): Derive the expression for the Economic order quantity (EOQ)?

Course Outcome 6 (CO6): Briefly explain the theories of Entrepreneurial motivation.?

Model Question Paper

QP CODE:

PAGES: 4

Reg No: _____

Name: _____

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

Course Code: HUT 310

Course name: Management for Engineers

Max Marks: 100

Duration: 3 Hours

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

1. "Management is getting things done through other." Elaborate.
2. Comment on the true nature of management. Is it a science or an art?
3. Planning is looking ahead and controlling is looking back. Comment with suitable examples
4. Explain the process of communication?
5. Explain the hierarchy of objectives?
6. Explain the types of decisions?
7. Describe the Economic man model?
8. Explain the concepts of crashing and dummy activity in project management.
9. Differentiate the quantitative and qualitative methods in forecasting.
10. What are the key metrics for sustainability measurement? What makes the measurement and reporting of sustainability challenging?

PART-B (Answer any one question from each module)

11. a) Explain the systems approach to management. (10)
b) Describe the roles of a manager (4)

OR

12. a) Explain the 14 principles of administrative management? **(10)**

b) Explain the different managerial skills **(4)**

13. a) What are planning premises, explain the classification of planning premises. **(10)**

b) Distinguish between strategy and policy. How can policies be made effective. **(4)**

OR

14 a) Explain three motivational theories. **(9)**

b) Describe the managerial grid. **(5)**

15. a) Modern forest management uses controlled fires to reduce fire hazards and to stimulate new forest growth. Management has the option to postpone or plan a burning. In a specific forest tract, if burning is postponed, a general administrative cost of Rs. 300 is incurred. If a controlled burning is planned, there is a 50% chance that good weather will prevail and burning will cost Rs. 3200. The results of the burning may be either successful with probability 0.6 or marginal with probability 0.4. Successful execution will result in an estimated benefit of Rs. 6000, and marginal execution will provide only Rs. 3000 in benefits. If the weather is poor, burning will be cancelled incurring a cost of Rs. 1200 and no benefit. i) Develop a decision tree for the problem. (ii) Analyse the decision tree and determine the optimal course of action. **(8)**

b) Student tuition at ABC University is \$100 per semester credit hour. The Education department supplements the university revenue by matching student tuition, dollars per dollars. Average class size for typical three credit course is 50 students. Labour costs are \$4000 per class, material costs are \$20 per student, and overhead cost are \$25,000 per class. (a) Determine the total factor productivity. (b) If instructors deliver lecture 14 hours per week and the semester lasts for 16 weeks, what is the labour productivity? **(6)**

OR

16. a) An ice-cream retailer buys ice cream at a cost of Rs. 13 per cup and sells it for Rs. 20 per cup; any remaining unsold at the end of the day, can be disposed at a salvage price of Rs. 2.5 per cup. Past sales have ranged between 13 and 17 cups per day; there is no reason to believe that

sales volume will take on any other magnitude in future. Find the expected monetary value and EOL, if the sales history has the following probabilities:
(9)

Market Size	13	14	15	16	17
Probability	0.10	0.15	0.15	0.25	0.35

b) At Modern Lumber Company, Kishore the president and a producer of an apple crates sold to growers, has been able, with his current equipment, to produce 240 crates per 100 logs. He currently purchases 100 logs per day, and each log required 3 labour hours to process. He believes that he can hire a professional buyer who can buy a better quality log at the same cost. If this is the case, he increases his production to 260 crates per 100 logs. His labour hours will increase by 8 hours per day. What will be the impact on productivity (measured in crates per labour-hour) if the buyer is hired? What is the growth in productivity in this case?
(5)

17. a) A project has the following list of activities and time estimates:

Activity	Time (Days)	Immediate Predecessors
A	1	-
B	4	A
C	3	A
D	7	A
E	6	B
F	2	C, D
G	7	E, F
H	9	D
I	4	G, H

(a) Draw the network. (b) Show the early start and early finish times. (c) Show the critical path.
(10)

b) An opinion survey involves designing and printing questionnaires, hiring and training personnel, selecting participants, mailing questionnaires and analysing data. Develop the precedence relationships and construct the project network. **(4)**

OR

18. a) The following table shows the precedence requirements, normal and crash times, and normal and crash costs for a construction project:

Activity	Immediate Predecessors	Required Time (Weeks)		Cost (Rs.)	
		Normal	Crash	Normal	Crash
A	-	4	2	10,000	11,000
B	A	3	2	6,000	9,000
C	A	2	1	4,000	6,000
D	B	5	3	14,000	18,000
E	B, C	1	1	9,000	9,000
F	C	3	2	7,000	8,000
G	E, F	4	2	13,000	25,000
H	D, E	4	1	11,000	18,000
I	H, G	6	5	20,000	29,000

Draw the network. (b) Determine the critical path. (c) Determine the optimal duration and the associated cost. **(10)**

b) Differentiate between CPM and PERT. **(4)**

19. a) What is meant by market segmentation and explain the process of market segmentation **(8)**

b) The Honda Co. in India has a division that manufactures two-wheel motorcycles. Its budgeted sales for Model G in 2019 are 80,00,000 units. Honda's target ending inventory is 10,00,000 units and its beginning inventory is 12,00,000 units. The company's budgeted selling price to its distributors and dealers is Rs. 40,000 per motorcycle. Honda procures all its wheels from an

outside supplier. No defective wheels are accepted. Honda's needs for extra wheels for replacement parts are ordered by a separate division of the company. The company's target ending inventory is 3,00,000 wheels and its beginning inventory is 2,00,000 wheels. The budgeted purchase price is Rs. 1,600 per wheel.

(a) Compute the budgeted revenue in rupees.

(b) Compute the number of motorcycles to be produced.

Compute the budgeted purchases of wheels in units and in rupees.? (6)

OR

20. a) a) "Human Resource Management policies and principles contribute to effectiveness, continuity and stability of the organization". Discuss. (b) What is a budget? Explain how sales budget and production budgets are prepared? (10)

b) Distinguish between the following: (a) Assets and Liabilities (b) Production concept and Marketing concept (c) Needs and Wants (d) Design functions and Operational control functions in operations (4)

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