SEMESTER VI

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.Dhamdhere, System Programming and Operating Systems, Tata McGraw Hill & Company, 1996.
2. Kenneth C. Louden, 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→E + E | E*E |(E) | 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→E + T | T

   T→T*F | F

   F→(E) | id
3. Construct canonical LR(0) collection of items for the grammar below.

   S → L = R

   S → R

   L → * R

   L → id

   R → 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 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 **Duration: 3 Hours**

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 --> S | (S) S / Ɛ 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 **(10)**

E-→E or T | T

T→ T and F |F

F→not F | (E) | true | false

(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→cAd, A→ab/ b **(5)**

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

S→aABe
A→Abc | b
B→d

15. (a) Construct the LR(0) set of items and their GOTO function for the grammar **(10)**
S→S S + | S S * | a

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

OR

16. (a) Identify LR(1) items for the grammar
S→ CC **(7)**
C→ cC | 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 → E1 # T {E.value=E1.value x T.value ;}
| T{E.value=T.value ;}
T → T1 & F{ T.value=T1.value + F.value ;}
| F{T.value= F.value ; }
F → 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

CCT304	CYBER FORENSICS	CATEGORY	L	T	P	CREDITS
		PCC	3	1	0	4

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

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

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

CO#	Course Outcomes
CO1	Explain the basic concepts in cyber forensics, forensics Investigation Process and the usage of Cyber Forensics Tools in investigations (**Cognitive Knowledge Level: Understand**)
CO2	Infer the basic concepts of file systems, its associated attribute definitions (**Cognitive Knowledge Level: Understand)**
CO3	Utilize the methodologies used in memory analysis and network analysis for detection of artifacts **(Cognitive Knowledge Level: Apply)**
CO4	Explain the basic concepts in cyber security and study the essence of IT Act. **(Cognitive Knowledge Level: Understand)**
CO5	Summarize anti forensics practices and data hiding methods **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

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

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

Assessment Pattern

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

Mark Distribution

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

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

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

End Semester Examination Pattern:

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

Syllabus

Module-1 (Cyber Forensics)

Cyber Forensics: Cyber Technology- Technological Aspects of Cyber Forensics-Governance Aspects of Cyber Forensics- Judicial Aspects of Cyber Forensics- Legal Perspective of Cyber Forensic investigations.

Computer Forensic Investigations: -Preparing for computer investigations, understanding Public and private investigationsForensics Investigation Principles - Forensic Protocol for Evidence Acquisition - Digital Forensics Standards and Guidelines - Digital Evidence – Data Acquisition - storage formats for digital evidence, determining the best acquisition method, contingency planning for image acquisitions.

Module-2: (Cyber Forensics Tools and Types of Forensics)

Cyber Forensics Tools-Computer Forensics software and hardware tools -Open Source and Proprietory -Challenges in Cyber Forensics, Skills Required to Become a Cyber Forensic Expert-Physical Requirements of a Cyber forensics Lab,Types of Cyber forensics.

File System Forensics-Working with windows and DOS systems- file systems, exploring Microsoft file structures, examining FAT and NTFS disks, whole disk encryption, the windows registry, Microsoft and MS-DOS startup tasks, Examining UNIX and LINUX disk structures and boot processes, examining CD data structures, examining IDE/EIDE and SATA devices.

Module-3 (OS and Network Forensics)

Windows and Linux Forensics:

Windows Forensics-Live Response: Data Collection- Introduction , Locard's Exchange Principle, Order of Volatility - Volatile and Non Volatile Data Live-Response Methodologies: Data Analysis, Windows Memory Analysis, Rootkits and Rootkit detection.LinuxForensics:Live Response Data Collection- Data Analysis- Log Analysis, Keyword Searches, User Activity, Network Connections, Running Processes, Open File Handlers, The Hacking Top Ten, Reconnaissance Tools.

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

Module-4 (Cyber Security)

Cyber Security: Cybercrimes, Types of Cybercrimes –Cyber Security Steps taken to protect ICT and prevent Misuse of Internet- IT Act 2000- Social Cyber Media.

Module-5: (Anti-Forensics)

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

Text Books

1. Nishesh Sharma "Cyber Forensics in India- A Legal Perspective", Universal Law Publishing, First Edition,March 2017
2. Bill Nelson, Amelia Philipps and Christopher Steuart, "Computer forensics- Guide to computer forensics and investigations", Course Technology Inc**,**3rd Edition,2009
3. Brian Carrier "File System Forensic Analysis, Addison-Wesley,1st Edition, 2005
4. Harlan Carvey, "Windows Forensics Windows Forensic Analysis DVD Toolkit" O'Reilly,2nd Edition, 2018.
5. Chris Pogue , Cory Altheide, Todd Haverkos, "Linux Forensics- Unix and Linux Forensic Analysis DVD Toolkit",Syngress,First Edition,2008
6. William Stallings "Network Security Essentials Applications and Standards" Pearson Education,4th Edition,2011.
7. E. Maiwald, "Fundamentals of Network Security", McGraw-Hill,First Edition, 2004

References

1. Michael. E. Whitman, Herbet. J. Mattord,"Cyber Security Principles of Information Security",Course Technology Ptr ,4th Edition,2011.
2. William Stallings "Cryptography and Network Security",Pearson,5th Edition,2018.
3. Niranjan Reddy, "Practical Cyber Forensics: An Incident-Based Approach to Forensic Investigations", Apress, First Edition, 2019

Course Level Assessment Questions

CourseOutcome1(CO1):

1. Explain the Forensics principles and protocols for evidence acquisition.
2. Explain the different storage formats tools used for Digital evidence.

CourseOutcome2(CO2):

1. Explain the pros and cons of NTFS and FAT File systems. Also give the challenges the Investigators would face in extracting evidence from these file systems.

CourseOutcome3 (CO3):

1. Describe any memory forensics methodologies/tools to extract volatile and nonvolatile data from a Windows based system.

2. Use web attacks test tools like netcraft to identify web application vulnerabilities of a particular site say www.xyz.com

CourseOutcome4 (CO4):

1. Explain the different steps taken to protect ICT and prevent Misuse of Internet.

2. Explain the impact of Section 66 in IT Act to General Public.

Course Outcome 5 (CO5):

1. Explain the different anti-forensics practices used to destroy or conceal data inorder to prevent others from accessing it.

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: CcT304
Course Name: Cyber Forensics

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

PART A

Answer all Questions. Each question carries 3 Marks

1. Distinguish between public and private investigations.
2. What are the three computer forensics data acquisitions formats?
3. List any three features of NTFS that the FAT does not have.
4. Define the terms file slack, RAM slack and drive slack.
5. Why is it important to collect nonvolatile information in forensic investigations?
6. Why would you conduct a live response on a running system?
7. What are the different tools used in Network Forensics?
8. Explain how Risk Analysis and Penetration Testing are different.
9. Define Steganography. Discuss its need.
10. How is data wiping done on the hard drive? **(10 x 3 = 30 Marks)**

PART B

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

11. (a) Explain the different types of Investigations. **(8 marks)**
    (b) Differentiate between Static acquisition and Live acquisition with example. **(6 marks)**

OR

12. (a) Explain the principles of Digital Forensic Investigation. Why is it important? **(8 marks)**
    (b) When you perform an acquisition at a remote location, what should you consider to prepare for this task? **(6 marks)**

13. (a) Write down the FAT File Structure? **(8 marks)**
    (b) Does Windows NT use FAT or NTFS. Explain. **(6 marks)**

OR

14. (a) Explain the different Open Source Tools used in Image Acquisition**.** **(6 marks)**
    (b) What are the physical requirements of a Cyber Forensics Lab.? **(8 marks)**

15. (a) What is Locard's Exchange Principle? Explain with suitable examples. **(6 marks)**
    (b) Explain the different types of volatile information in a live response system. List any two tools used for obtaining volatile information. **(8 marks)**

OR

16. (a) What is OWASP? Mention the Top 10 web application vulnerabilities in 2021. **(8 marks)**
    (b) How would you set up Wireshark to monitor packets passing through an internet router? **(6 marks)**

17. (a) What is Cyber Security? Discuss the major Cyber Crimes? **(7 marks)**
    (b) Explain the impact of Social Cyber Media. **(7 marks)**

OR

18. (a) What are the measures taken to prevent the misuse of the Internet? **(7 marks)**
    (b) What is the the essence of IT Act 2000? **(7 marks)**

19. (i) How is Steganography done? **(7 marks)**
    (ii) (a) Why does data need Cryptography? **(4 marks)**
    (b) What is the difference between a Cryptographer and a Crypter? **(3 marks)**

OR

20. (a) Explain the different types of Anti-forensics Detection Techniques. **(8 marks)**
(b) What is Spoofing? How to prevent spoofing attacks? **(6 marks)**

TEACHING PLAN

No.	Contents	No of Lecture Hrs
Module-1 (Cyber Forensicsand Cyber Security) (11hrs)		
1.1	Cyber Technology- Technological Aspects of Cyber Forensics	1
1.2	Governance Aspects of Cyber Forensics- Judicial Aspects of Cyber Forensics	1
1.3	Legal Perspective of Cyber Forensic investigations	1
1.4	Preparing for computer investigations, understanding Public and private investigations	1
1.5	Forensics Investigation Principles - Forensic Protocol for Evidence Acquisition	1
1.6	Digital Forensics Standards and Guidelines	1
1.7	Digital Evidence	1
1.8	Data Acquisition	1
1.9	Storage formats for digital evidence	1
1.10	Determining the best acquisition method	1
1.11	Contingency planning for image acquisitions	1
Module-2 (Cyber Forensics Tools and Types of Forensics) (9hrs)		
2.1	Computer Forensics software and hardware tools -Open Source and Proprietary	1
2.2	Challenges in Cyber Forensics, Skills Required to Become a Cyber Forensic Expert	1
2.3	Physical Requirements of a Cyber forensics Lab,Types of Cyber forensics	1

2.4	Working with windows and DOS systems- file systems	1
2.5	Exploring Microsoft file structures, examining FAT and NTFS disks	1
2.6	Whole disk encryption, Windows registry	1
2.7	Microsoft and MS-DOS start up tasks, Examining UNIX and LINUX disk structures and boot processes,.	1
2.8	Examining CD data structures	1
2.9	Examining IDE/EIDE and SATA devices	
Module-3 (Operating System Forensics) (12hrs)		
3.1	Windows Forensics-Live Response: Data Collection- Introduction	1
3.2	Locard's Exchange Principle, Order of Volatility - Volatile and Non Volatile Data	1
3.3	Linux Forensics:Live Response Data Collection- Data Analysis- Log Analysis.	1
3.4	Keyword Searches, User Activity, Network Connections, Running Processes, Open File Handlers	1
3.5	The Hacking Top Ten, Reconnaissance Tools- I	1
3.6	The Hacking Top Ten, Reconnaissance Tools- II	1
3.7	The OSI Model, Forensic Footprints	1
3.8	Seizure of Networking Devices, Network Forensic Artifacts, ICMP Attacks	1
3.9	Drive-By Downloads, Network Forensic Analysis Tools	1
3.10	Case Study: Wireshark.	1
3.11	Web Attack Forensics: OWASP Top 10, Web Attack Tests,	1
3.12	Penetration Testing	1

Module-4 (Cyber Security) (7 hrs)		
4.1	Cybercrimes, Types of Cybercrimes	1
4.2	Cyber Security Steps taken to protect ICT and prevent Misuse of Internet	1
4.3	IT Act 2000- Lecture I	1
4.4	IT Act 2000- Lecture II	1
4.5	IT Act 2000- Lecture III	1
4.6	Social Cyber Media- Lecture I	1
4.7	Social Cyber Media- Lecture II	1
Module – 5 (Anti-Forensics) (6 Hrs)		
5.1	Anti-forensic Practices - Data Wiping and Shredding	1
5.2	Data Remanence, Degaussing	1
5.3	Trail Obfuscation: Spoofing, Data Modification	1
5.4	Role of Encryption in Forensics	1
5.5	Data Hiding: Steganography and Cryptography	1
5.6	Anti-forensics Detection Techniques	1

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	✓	✓	✓	✓								✓

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

Assessment Pattern

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

Analyze			
Evaluate			
Create			

Mark Distribution

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

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

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

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern:

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

End Semester Examination Pattern:

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

Syllabus

Module-1 (Introduction to 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 Brately, "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):

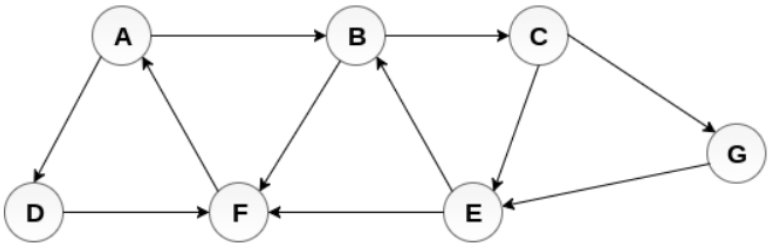
1. Is $2^{n+1} = O(2^n)$? Is $2^{2n} = O(2^n)$? Justify your answer.
2. What is the need of asymptotic analysis in calculating time complexity? What are the notations used for asymptotic analysis?
3. Calculate the time complexity for addition of two matrices.
4. Define time complexity and space complexity.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

Course Outcome 2 (CO2):

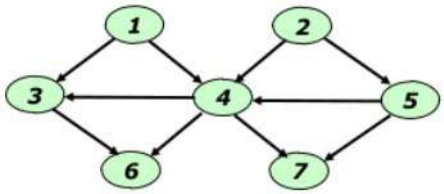
1. State Master's theorem for solving recurrences.
2. Solve the recurrence T(n) = 3T(n-2), using iteration method
3. State the conditions in recurrences where Master Theorem is not applicable.
4. Solve the following recurrence equations using Master's theorem.
   a) $T(n) = 8T(n/2) + 100\ n^2$
   b) $T(n) = 2T(n/2) + 10\ n$
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.

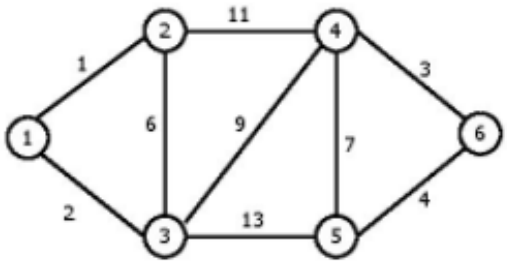


3. Find the minimum and maximum height of any AVL-tree with 7 nodes? Assume that the height of a tree with a single node is 0. (3)
4. Find any three topological orderings of the given graph.

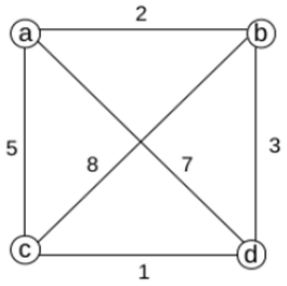


Course Outcome 4 (CO4):

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



3. Compare Divide and Conquer and Dynamic programming methodologies
4. What is Principle of Optimality?
5. 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):

1. Compare Tractable and Intractable Problems
2. 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

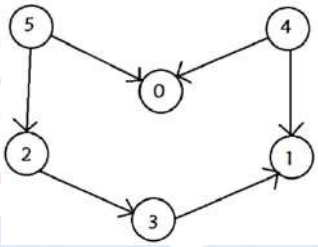
Answer All Questions. Each Question Carries 3 Marks

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) $T(n) = 8T(n/2) + 100\ n^2$
   b) $T(n) = 2T(n/2) + 10\ n$

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)**

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

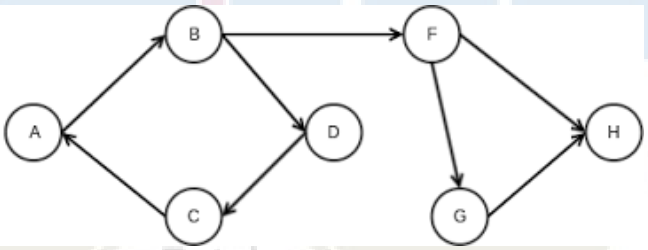
(b) Determine the time complexities of the following two functions fun1( ) and fun2( ). **(7)**

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)**



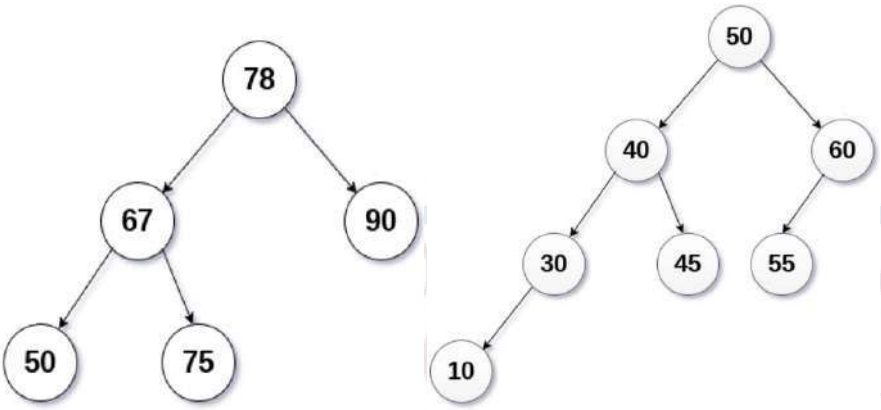
OR

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



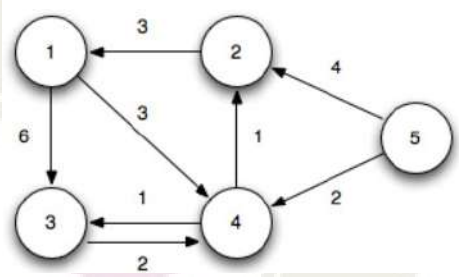
15. (a) State Fractional Knapsack Problem and write Greedy Algorithm for Fractional Knapsack Problem. **(7)**

(b) Find the optimal solution for the following Fractional Knapsack problem. 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} **(7)**

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)**



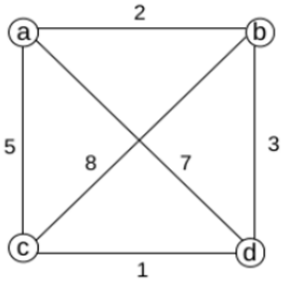
17. (a) Write Floyd-Warshall algorithm and analyse its complexity. **(5)**

(b) Write and explain the algorithm to find the optimal parenthesization of matrix chain product whose sequence of dimension is 4x10,10x3, 3x12,12x20. **(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

CCT 308	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. Six 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 Networks**
4. **Database Management Systems**
5. **Applied Cryptography**

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

CO#	Course Outcomes
CO1	Comprehend the basic concepts and applications of data structures (Cognitive Knowledge Level: **Understand**)
CO2	Comprehend the basic concepts, functions and algorithms in Operating Systems (CognitiveKnowledge Level: **Understand**)
CO3	Comprehend the organization and architecture of computer Networks (CognitiveKnowledge Level**: Understand**)
CO4	Comprehend the fundamental principles of database design and manipulation (Cognitive Knowledge Level**: Understand**)
CO5	Comprehend the basic concepts and algorithms in Applied Cryptography (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 includes 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(CST201)**
2. **Operating Systems(CST206)**
3. **Database Management Systems(CST204)**
4. **Computer Networks(CST303)**
5. **Applied Cryptography(CCT307)**

Course Contents and Lecture Schedule

No	Topic	No. of Lecture Hrs
1	**DATA STRUCTURES**	
1.1	Mock Test on Module 1, Module 2 and Module 3	1
1.2	Mock Test on Module 4 and Module 5	1
1.3	Feedback and Remedial class	1
2	**OPERATING SYSTEMS**	
2.1	Mock Test on Module 1 and Module 2	1
2.2	Mock Test on Module 3, Module 4 and Module 5	1
2.3	Feedback and Remedial class	1
3	**DATABASE MANAGEMENT SYSTEMS**	
3.1	Mock Test on Module 1 and Module 2	1
3.2	Mock Test on Module 3, Module 4 and Module 5	1
3.3	Feedback and Remedial class	1
4	**COMPUTER NETWOKS**	
4.1	Mock Test on Module 1, Module 2 and Module 3	1
4.2	Mock Test on Module 4 and Module 5	1

4.3	Feedback and Remedial class	1
5	**APPLIED CRYPTOGRAPHY**	
5.1	Mock Test on Module 1, Module 2 and Module 3	1
5.2	Mock Test on Module 4 and Module 5	1
5.3	Feedback and Remedial class	1

Model Question Paper

QP CODE:

Reg No: _____ **PAGES: 10**

Name: _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR Course Code: CCT308

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

1. 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

2. The following postfix expression with single digit operands is evaluated using a stack: 8 2 2 ^ / 4 3 * + 5 1 * - Note that ^ is the exponentiation operator. The top two elements of the stack after the first *is evaluated are:
   (A) 12,2 (B) 12,5 (C) 2,12 (D) 2,5

3. 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) mod7. 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 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 interactiveness?
(A) FCFS (B) Round Robin
(C) Shortest Process Next (D) Priority Based Scgeduling
15. Consider the following program
Semaphore X=1, Y=0

```
Void A ( )                    Void B ( )
{                             {
   While (1)                     While (1)
   {                             {
   P(X);                         P(Y);
   Print'1';                     P(X);
   V(Y);                         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. 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 manyto-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

22. Identify the minimal key for relational scheme R(U, V, W, X, Y, Z) with functional dependencies F = {U → V, V → W, W → X, VX → Z}
(A) UV (B) UW (C) UX (D) UY

23. 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)

24. 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

25. 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

26. 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 → BC (B) AC → B (C) AB → C (D) BC → A

27. Consider a relation R with attributes A, B, C, D and E and functional dependencies A→BC, BC→E, E→DA. What is the highest normal form that the relation satisfies?
(A) BCNF (B) 3 NF (C) 2 NF (D) 1 NF
28. 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→T2→T3 (B) T2->T1->T3
(C) T3→T1→T2 (D) Not conflict serializable
29. Specialization is _____ process.
(A) top-down (B) bottom up (C) Both (A) and (B) (D) none of these
30. If D1, D2, .., Dn are domains in a relational model, then the relation is a table, which is a subset of
(A) D1+D2+ … +Dn
(B) D1×D2× … ×Dn
(C) D1∪D2∪ … ∪Dn
(D) D1–D2– … –Dn
31. Which network security system monitors and controls incoming & outgoing network traffic based on predetermined security rules
(A)Spyware (B) Cookie (C) Spam (D) Firewall
32. Wireless Application Layer has several layers. Which of the following is the Security Layer?
(A) Wireless Security Layer (B) Wireless Transport layer
(C) Wireless Transport Layer Security (D) Wireless Security Layer Transport
33. Which anti-malware tool found in newer OS is designed for protecting computers from viruses, spyware & other malware?
(A) Norton Antivirus (B) Windows Defender
(C)Anti-malware (D) Microsoft Security Essentials
34. When an attempt is to make a machine or network resource unavailable to its intended users, the attack is called _____
(A)Denial-of-service attack (B) Slow read attack
(C)Spoofed attack (D) Starvation attack
35. Which of the following is not an appropriate way to compromise web servers?
(A)Misconfiguration in OS (B) Using network vulnerabilities
(C) Misconfiguration in networks
(D) Bugs in OS which allow commands to run on web servers
36. Which of the following is not a web server attack type?
(A) DOS attack (B) Website Defacement using SQLi
(C) Directory Traversal (D) Password guessing
37. Which one of the following is a cryptographic protocol used to secure HTTP connection?
(A) Stream control transmission protocol (SCTP)
(B) Transport layer security (TLS)
(C) Explicit congestion notification (ECN)
(D) Resource reservation protocol
38. The main motive for using steganography is that hackers or other users can hide a secret

message behind a
(A) Special file (B) Ordinary file (C) Program file
(D) Encrypted file

39. Which among them has the strongest wireless security?
(A)WEP (B) WPA (C)WPA2 (D) WPA3
40. When a user authenticates to an AP, both go in the path of four-step authentication progression which is known as
(A) 4-way handshake (B) AP-handshaking
(C) Wireless handshaking (D) 4-way connection
41. In asymmetric key cryptography, the private key is kept by _____
(A) sender (B) receiver
(C)sender and receiver (D) all the connected devices to the network
42. Which one of the following algorithm is not used in asymmetric-key cryptography?
(A) RSA algorithm (B) Diffie- hellman algorithm
(C) Electronic code book algorithm (D) DSA algorithm
43. In cryptography, the order of the letters in a message is rearranged by _____
(A) Transpositional ciphers (B) Substitution ciphers
(C) Both transpositional ciphers and substitution ciphers
(D) Quadratic ciphers
44. Which one of the following is a cryptographic protocol used to secure HTTP connection?
(A) Stream control transmission protocol (SCTP) (B) Transport layer security (TLS)
(C) Explicit congestion notification (ECN) (D) Resource reservation protocol
45. Blowfish encrypts blocks of plaintext which have size
(A) 256 bits (B) 64 bits (C) 72 bits (D) 128 bits
46. Cryptanalysis is used _____
(A) To find some insecurity in a cryptographic scheme
(B) To increase the speed
(C) To encrypt the data
(D) To make new ciphers
47. Which of the following security services cannot be achieved using the Hash functions?
(A) Password Check (B) Data Integrity check
(C) Digital Signature (D) Data retrieval in its original form
48. In the DES algorithm the Round Input is 32 bits, which is expanded to 48 bits via _____
(A) Scaling of the existing bits
(B) Duplication of the existing bits
(C) Addition of zeros
(D) Addition of ones
49. Which one of the following modes of operation in DES is used for operating short data?
(A) Cipher Feedback Mode (CFB)
(B) Cipher Block chaining (CBC)
(C) Electronic code book (ECB)
(D) Output Feedback Modes (OFB)
50. All the below-stated processes are performed in the AES (Advanced Encryption

Standard) Algorithm. Which of the following process(s) are not performed in the final round of the AES?

I. Substitution bytes
II. Shift rows
III. Mix columns
IV. Add round key

(A)I (B)III (C)All of the above (D)None of the above

ANSWER KEY:-

Q.No	Ans.Key	Q.No	Ans.Key	Q.No	Ans. Key	Q.No	Ans. Key	Q. No	Ans. Key
1	(C)	11	(C)	21	(C)	31	(D)	41	(B)
2	(A)	12	(D)	22	(D)	32	(C)	42	(C)
3	(A)	13	(C)	23	(A)	33	(B)	43	(A)
4	(C)	14	(B)	24	(B)	34	(A)	44	(B)
5	(D)	15	(D)	25	(B)	35	(B)	45	(B)
6	(D)	16	(B)	26	(D)	36	(D)	46	(A)
7	(A)	17	(B)	27	(A)	37	(B)	47	(D)
8	(D)	18	(C)	28	(D)	38	(B)	48	(A)
9	(B)	19	(A)	29	(A)	39	(D)	49	(C)
10	(D)	20	(B)	30	(B)	40	(A)	50	(B)

CCT332	STORAGE MANAGEMENT AND SECURITY	CATEGORY	L	T	P	CREDITS
		PEC	2	1	0	3

Preamble: To enable students to understand, explore and acquire a critical understanding about comprehensive learning on storage technology, which will enable them to make more informed decisions in an increasingly complex IT environment. It builds a strong understanding of underlying storage technologies and prepares them to learn advanced concepts, technologies and products.Students will learn about the architectures, features, and benefits of intelligent storage systems; storage networking technologies such as FC-SAN, IP-SAN, NAS, object-based and unified storage; business continuity solutions such as backup and replication; the increasingly critical area of Information Security and Management.

Prerequisite: A basic understanding of Computer Architecture, Operating Systems, Networking, and databases.

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

CO#	Course Outcomes
CO1	Explain storage architectures and key data center elements**(Cognitive Knowledge Level: Understand)**
CO2	Explain physical and logical components of a storage infrastructure including storage subsystems and RAID**(Cognitive Knowledge Level: Understand)**
CO3	Summarize storage networking technologies such as FCSAN, IP-SAN, NAS **(Cognitive Knowledge Level: Understand)**
CO4	Describebusiness continuity backup and replicationssolutions**.(Cognitive Knowledge Level: Understand)**
CO5	Explain the storage security aspects and the virtualization technologies. **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
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 Tests		
	Test 1 (%)	Test 2 (%)	End Semester Examination (%)
Remember	30	30	30
Understand	50	50	50
Apply	20	20	20
Analyze			
Evaluate			
Create			

Mark Distribution

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

Continuous Internal Evaluation Pattern:

Attendance 10 marks

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

Continuous Assessment Assignment 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. The first series test shall be preferably conducted after completing the first half of the syllabus. 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 contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer anyone. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module-1(Introduction)

Introduction to Storage Technology- Review data creation-amount of data being created- understand the value of data to business- challenges in data storage and data management-solutions available for data storage-core elements of a data center infrastructure- role of each element in supporting business activities.

Module-2(Storage system architecture)

Storage system architecture-Hardware and software components of the host environment-Key protocols and concepts used by each component-physical and logical components of a connectivity environment- major physical components of a disk drive and their function-logical constructs of a physical disk-Access characteristics-Performance implications-Concept ofRAID and its components-Different RAID levels and their sustainability for different application environments-Compare and contrast integrated and modular storage systems-High-level architecture and working of an intelligent storage system.

Module-3(Network Storage)

Introduction to Networked Storage-Evolution of networked storage- Architecture-Components-Topologies of FC- SAN- NAS - IP- SAN- Benefits of the different networked storage options-understand the need for long- Term archiving solutions- Describe how CAS fulfill the need-Understand the appropriateness- Different networked storage options-Different application environments.

Module-4(Management of Information)

Information Availability, Monitoring & Managing Data centers- List reasons for planned or unplanned outages- Impact of downtime-Business continuity(BC)-Disaster recovery(DR)-RTO-RPO-Identify single points of failure- List solutions to mitigate failures –Architecture of backup/recovery-Different backup or recovery topologies-Replication technologies-Role in ensuring information availability and business continuity- Remote replication technologies-Role in providing disaster recovery and business continuity capabilities-Identify key areas to monitor in a data center- Industry standards for data monitoring and management-key metrics-key management tasks.

Module-5(Storage Security)

Securing storage and storage virtualization-Information security- Critical security attributes- storage security domains –List and analyzes the common threats in each domain –Virtualization technologies-Block-level and file-level virtualization technologies and processes.

Text/Reference Books

1. EMC Corporation,"Information Storage and Management: Storing, Managing and Protecting Digital Information",Wiley,India, 2nd Edition,2012.
2. Marc Farley, "Building storage networks", Tata McGraw Hill", Osborne, 2nd Edition,2001.
3. Robert Spalding, "Storage Networks: The complete Reference", Tata McGraw hill, Osborne, First Edition,2003.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What are the key requirements needed for designing a data center for storage?

Course Outcome 2 (CO2):

1. Explain the Evolution of storage Technology and Architecture.

Course Outcome 3 (CO3):

1. Explain Network-attached storage (NAS) its future and benefits.

Course Outcome 4 (CO4):

1. What is the need of data management and monitoring in storage?

Course Outcome 5 (CO5):

1. Explain the storage security aspects and the virtualization technology.

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: CCT 332
Course Name: STORAGE MANAGEMENT AND SECURITY

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

PART A
Answer all Questions. Each question carries 3 Marks

1. Which are the challenges in data storage?
2. Which are the elements needs for a data center infrastructure?
3. Explain about key protocols used in host environment.
4. What is the importance of High-level architecture in storage?
5. Describe in detail about NAS topology.
6. Which are the different application environments in storage?
7. What is the need of ensuring information availability and business continuity?
8. Which are the key areas to monitor in a data center?
9. ExplainhowInformation Security is achieved in storage.
10. Discuss the different Virtualization technologies.

(10x3=30 Marks)

PART B

Answer any one Question from each module.

Each question carries 14 Marks

11) a) Describe the evolution of storage technology and architecture. **(7Marks)**

b) Describe the core elements of a data centre infrastructure and explain role of each element in supporting business activities. **(7Marks)**

OR

12) a) Explain the value of data to business. **(4Marks)**

b) Describe the challenges faced and the solutions in storage management. **(10Marks)**

13) a) Explain Storage security domains. **(8 Marks)**

b) Explain the major physical components of a disk drive. **(6 Marks)**

OR

14) a) Write down the Different RAID levels and their sustainability for different application environments **(10 Marks)**

b) Compare integrated and modular storage systems. **(4 Marks)**

15) a) What are the components of NAS? Explain NAS Implementations. **(7 Marks)**

b) Briefly explain the architecture and components of networked storage. **(7 Marks)**

OR

16) a) Explain the topologies used in networked storage management. **(7 Marks)**

b) What are the benefits of different network storage devices? **(7 Marks)**

17) a) List the reasons for planned or unplanned outages. **(10 Marks)**

b) Explain disaster recovery(DR)-RTO-RPO. **(4 Marks)**

OR

18) a) Explain industry standards for data monitoring and management **(6 Marks)**

b) Explain the key metrics and key task for storage management **(8 Marks)**

19) a) Explain Critical security attributes in storage. **(8 Marks)**

b) Explain the storage security domains in storage management. **(6 Marks)**

OR

20) a) What isStorage Virtualization? Explain how it can be done. **(8 Marks)**

b) List and analyzes the common threats in security storage management **(6 Marks)**

TEACHING PLAN

No	Contents	No of Lecture Hrs
Module-1(Introduction)(5 hrs)		
1.1	Introduction to Information Storage Management –Evolution of Storage Technology	1
1.2	Data Centre Infrastructure-Key Challenges in managing Information	1
1.3	Solutions available for data storage	1
1.4	Core elements of a data center infrastructure	1
1.5	Role of each element in supporting business activities	1
Module-2(Storage system architecture)(9 hrs)		
2.1	Hardware and software components of the host environment	1
2.2	Key protocols and concepts used by each component	1
2.3	Physical and logical components of a connectivity environment	1
2.4	Major physical components of a disk drive and their function	1
2.5	Logical constructs of a physical disk-Access characteristics-Performance implications	1
2.6	Concept of RAID and its components	1

2.7	Different RAID levels and their sustainability for different application environments	1
2.8	Compare and contrast integrated and modular storage systems-	1
2.9	High-level architecture and working of an intelligent storage system.	1
Module-3(Network Storage)(8 hrs)		
3.1	Evolution of networked storage	1
3.2	Architecture-Components	1
3.3	Topologies of FC- SAN- NAS	1
3.4	Topologies of IP- SAN	1
3.5	Benefits of the different networked storage options	1
3.6	Understand the need for long- Term archiving solutions	1
3.7	Describe how CAS fulfill the need- Understand the appropriateness	1
3.8	Different networked storage options-Different application environments.	1
Module-4(Management of Information)(8hrs)		
4.1	List reasons for planned or unplanned outages- Impact of downtime-Business continuity(BC)	1
4.2	Disaster recovery(DR)-RTO-RPO-Identify single points of failure	1
4.3	Identify single points of failure- List solutions to mitigate failures – Architecture of backup/recovery systems	1

4.4	Different backup or recovery topologies-Replication technologies	1
4.5	Role in ensuring information availability and business continuity	1
4.6	Remote replication technologies-Role in providing disaster recovery and business continuity capabilities	1
4.7	Identify key areas to monitor in a data center	1
4.8	Industry standards for data monitoring and management-key metrics-key management tasks.	1
Module-5(Storage Security)(5hrs)		
5.1	Information security- Critical security attributes	1
5.2	Storage security domains –List and analyzes the common threats in each domain	1
5.3	Virtualization technologies	1
5.4	Block-level virtualization technologies and processes	1
5.5	File-levelvirtualization technologies and processes	1

CCD334	MINI PROJECT	CATEGORY	L	T	P	CREDITS
		PCC	0	0	3	2

Preamble: The objective of this course is to apply the fundamental concepts of Software Engineering principles for the effective development of an application/research project. This course helps the learners to practice the different steps to be followed in the software development process such as literature review and problem identification, preparation of Software Requirement Specification &Software Design Document (SDD), testing, development and deployment. Mini project enables the students to boost their skills, widen the horizon of thinking and their ability to resolve real life problems.

Prerequisite: A sound knowledge in any programming language and fundamental concepts of Software Engineering.

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

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

Mapping of course outcomes with program outcomes

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

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

Assessment Pattern

Mark Distribution

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

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Project Guide **15 marks**

Project Report **10 marks**

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

Student Groups with 3 or 4 members should identify a topic of interest in consultation with a 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 by strictly following steps specified in the teaching plan. Innovative design concepts, performance, scalability, reliability considerations, aesthetics/ergonomic, user experience and security aspects taken care of in the project shall be given due weight.

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

End Semester Examination Pattern:

The marks will be distributed as

Presentation:**30 marks**

Demo : **20 marks**

Viva : **25 marks.**

Total : **75 marks**.

TEACHING PLAN

Students are expected to follow the following steps.

1. Review of Literature and Identification of a problem
2. Create an abstract with a problem statement, solution approach, technology stack, team, etc. and get department approval. Register Online course/ Collect study materials.
3. Create Software Requirements Specification (SRS Document)
4. Create Software Design Document (SDD). This may include designs like,
    a. System Architecture Design
    b. Application Architecture Design
    c. GUI Design (Mockups)
    d. API Design
    e. Database Design
    f. Technology Stack
5. Create Test Plan, Test Scenarios and Test Cases (Test Case Document) & Traceability Matrix
6. Create a Project Plan (with Modules, Tasks, Resources, Time schedule) [May use any project management tool or excel for this] – Choose and follow agile or waterfall models.
7. Development
    a. Set coding standards
    b. Environment Setup
    c. Source Code Control Setup (Like Subversion(SVN), Git)
    d. Development
    e. Unit Testing
    f. Integration Testing
    g. Testing /Quality Assurance(QA)
        i. Functional Testing
        ii. Load Testing
        iii. Report Bugs
    h. Resolve Bugs & Retest

8. Deployment (of software from local development environment to a production environment)

9. Test Run & Get Results

10. Prepare Project Report

Guidelines for the Report preparation

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

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

- **Suggestive order of documentation:**

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

SEMESTER VI

PROGRAM ELECTIVE I

CST 312	FOUNDATIONS OF MACHINE LEARNING	Category	L	T	P	Credit	Year of Introduction
		PEC	2	1	0	3	2019

Preamble:

This course enables the learners to understand the mathematical foundations of Machine Learning concepts. This course covers Linear Algebra, Probability and Distributions. Concepts in this course help the learners to identify the inherent assumptions & limitations of the current methodologies and develop new Machine Learning solutions.

Prerequisite: A sound background in higher secondary school Mathematics.

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

CO 1	Illustrate operations and applications of linear equations, matrix algebra, vector spaces, eigen values & eigenvectors **(Cognitive Knowledge Level: Apply)**
CO 2	Illustrate the concepts of orthogonality & diagonalization. **(Cognitive Knowledge Level: Apply)**
CO 3	Solve computational problems using probability and random variables. **(Cognitive Knowledge Level: Apply)**
CO 4	Identify an appropriate probability distribution for a given discrete or continuous random variable and use its properties. (**Cognitive Knowledge Level: Apply)**
CO 5	Illustrate moment generating function, law of large numbers and central limit theorems (**Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

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

CO 5	✓	✓	✓	✓								✓

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**
	1	**2**	
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 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 contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer anyone. Each question can have maximum 2 sub-divisions and carry 14 marks.

Syllabus

Module 1 (LINEAR ALGEBRA)

Systems of Linear Equations – Matrices, Solving Systems of Linear Equations. Vector Spaces - Linear Independence, Basis and Rank, Linear Mappings.

Module 2 (LINEAR ALGEBRA)

Norms - Inner Products, Lengths and Distances, Angles and Orthogonality. Orthonormal Basis, Orthogonal Complement, Orthogonal Projections. Matrix Decompositions - Eigenvalues and Eigenvectors, Eigen decomposition and Diagonalization.

Module 3 (PROBABILITY AND DISTRIBUTIONS)

Probability Space - Sample Spaces, Probability Measures, Computing Probabilities, Conditional Probability, Baye's Rule, Independence. Random Variables - Discrete Random Variables (Bernoulli Random Variables, Binomial Distribution, Geometric and Poisson Distribution, Continuous Random Variables (Exponential Density, Gamma Density, Normal Distribution, Beta Density)

Module 4 (RANDOM VARIABLES)

Functions of a Random Variable. Joint Distributions - Independent Random Variables, Conditional Distributions, Functions of Jointly Distributed Random Variables.

Expected Values - Expected Value of a Random Variable, Expectations of Functions of Random Variables, Expectations of Linear Combinations of Random Variables, Variance and Standard Deviation, Covariance and Correlation, Conditional Expectation

Module 5 (LIMIT THEOREMS)

Moment-Generating Function. Limit Theorems(Proof not expected) - Law of Large Numbers, Convergence in Distribution and the Central Limit Theorem. Distributions derived from the Normal Distribution - Chi-square, t, and F Distributions, Sample Mean and the Sample Variance.

Text book:

1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press (freely available at https://mml – book.github.io)
2. John A. Rice, Mathematical Statistics and Data Analysis, University of California, Berkeley, Third edition, published by Cengage.

Reference books:

1. Gilbert Strang, Linear Algebra and Its Applications, 4th Edition,
2. Axler, Sheldon, Linear Algebra Done Right, 2015 Springer
3. Stephen Boyd and Lieven Vandenberghe, Introduction to Applied Linear Algebra, 2018 published by Cambridge University Press

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Find the set ***S*** of all solutions in ***x*** of the following inhomogeneous linear systems ***Ax = b***, where ***A*** and ***b*** are defined as follows:

$$A = \begin{bmatrix} 1 & -1 & 0 & 0 & 1 \\ 1 & 1 & 0 & -3 & 0 \\ 2 & -1 & 0 & 1 & -1 \\ -1 & 2 & 0 & -2 & -1 \end{bmatrix}, \quad b = \begin{bmatrix} 3 \\ 6 \\ 5 \\ -1 \end{bmatrix}$$

2. Determine the inverses of the following matrix if possible

$$A = \begin{bmatrix} 1 & 0 & 1 & 0 \\ 0 & 1 & 1 & 0 \\ 1 & 1 & 0 & 1 \\ 1 & 1 & 1 & 0 \end{bmatrix}$$

3. Are the following sets of vectors linearl independent?

$$x_1 = \begin{bmatrix} 2 \\ -1 \\ 3 \end{bmatrix}, \quad x_2 = \begin{bmatrix} 1 \\ 1 \\ -2 \end{bmatrix}, \quad x_3 = \begin{bmatrix} 3 \\ -3 \\ 8 \end{bmatrix}$$

4. A set of ***n*** linearly independent vectors in R^n forms a basis. Does the set of vectors **(2, 4,−3) (0, 1, 1)** , **(0, 1,−1**) form a basis for R^3? Explain your reasons.

Course Outcome 2 (CO2):

1. Determine which of the following sets are orthogonal sets.

$$\left\{\begin{bmatrix}3\\1\\1\end{bmatrix},\begin{bmatrix}-1\\2\\1\end{bmatrix},\begin{bmatrix}-1/2\\-2\\7/2\end{bmatrix}\right\} \qquad \left\{\begin{bmatrix}1\\-1\\1\end{bmatrix},\begin{bmatrix}2\\1\\-1\end{bmatrix},\begin{bmatrix}3\\0\\-3\end{bmatrix}\right\} \qquad \left\{\begin{bmatrix}3\\-2\\1\\3\end{bmatrix},\begin{bmatrix}-1\\3\\-3\\4\end{bmatrix},\begin{bmatrix}3\\8\\7\\0\end{bmatrix}\right\}$$

2. Find the characteristic equation, eigenvalues, and eigenspaces corresponding to each eigenvalue of the following matrix.

$$\begin{bmatrix}2&0&4\\0&3&0\\0&1&2\end{bmatrix}$$

3. Diagonalize the following matrix, if possible

$$\begin{bmatrix}3&0&0&0\\0&2&0&0\\0&0&2&0\\1&0&0&3\end{bmatrix}$$

Course Outcome 2 (CO3):

1. Let ***J*** and ***T*** be independent events, where ***P(J)=0.4*** and ***P(T)=0.7***.
   i. Find ***P(J∩T)***
   ii. Find ***P(J∪T)***
   iii. Find ***P(J∩T')***

2. Let ***A*** and ***B*** be events such that ***P(A)=0.45*** , ***P(B)=0.35*** and ***P(A∪B)=0.5***. Find ***P(A/B)***.

3. A random variable **R** has the probability distribution as shown in the following table:

r	1	2	3	4	5
P(R=r)	0.2	a	b	0.25	0.15

i. Given that ***E(R)=2.85***, find ***a*** and ***b***.
ii. Find ***P(R>2)***.

4. A biased coin (with probability of obtaining a head equal to $p > 0$) is tossed repeatedly and independently until the first head is observed. Compute the probability that the first head appears at an even numbered toss.

5. Two players A and B are competing at a quiz game involving a series of questions. On any individual question, the probabilities that A and B give the correct answer are ***p*** and ***q*** respectively, for all questions, with outcomes for different questions being independent. The game finishes when a player wins by answering a question correctly. Compute the probability that A wins if
   i. A answers the first question,
   ii. B answers the first question.

6. A coin for which ***P(heads) = p*** is tossed until two successive tails are obtained. Find the probability that the experiment is completed on the n^{th} toss.

Course Outcome- 3 (CO4):

1. An urn contains **p** black balls, **q** white balls, and **r** red balls; and **n** balls are chosen without replacement.
   a. Find the joint distribution of the numbers of black, white, and red balls in the sample.
   b. Find the joint distribution of the numbers of black and white balls in the sample.
   c. Find the marginal distribution of the number of white balls in the sample.
2. Suppose that two components have independent exponentially distributed lifetimes, T_1 and T_2, with parameters α and β, respectively. Find (a) $P(T_1 > T_2)$ and (b) $P(T_1 > 2T_2)$.
3. Let Z_1 and Z_2 be independent random variables each having the standard normal distribution. Define the random variables X and Y by $X = Z_1 + 3Z_2$ and $Y = Z_1 + Z_2$. Argue that the joint distribution of (X, Y) is a bivariate normal distribution. What are the parameters of this distribution?

4. Given a continuous random variable x, with cumulative distribution function $F_x(x)$, show that the random variable $y = F_x(x)$ is uniformly distributed.
5. You roll a fair dice twice. Let the random variable X be the product of the outcomes of the two rolls. What is the probability mass function of X? What are the expected values and the standard deviation of X?
6. Let X be a continuous random variable with the density function $f(x) = 2x,\ 0 \le x \le 1$
   a. Find $E(X)$.
   b. Find $E(X^2)$ and $Var(X)$.

Course Outcome 5 (CO5):

1. Find the moment-generating function of a Bernoulli random variable, and use it to find the mean, variance, and third moment.
2. Use moment-generating functions to show that if **X** and **Y** are independent, then $Var(aX + bY) = a^2Var(X) + b^2Var(Y)$.
3. Suppose that you bet Rs 5 on each of a sequence of 50 independent fair games. Use the central limit theorem to approximate the probability that you will lose more than Rs 75.
4. Suppose that the number of insurance claims, N, filed in a year is Poisson distributed with $E(N) = 10,000$. Use the normal approximation to the Poisson to approximate $P(N > 10,200)$.

Model Question paper

QP Code : **Total Pages: 4**

Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION (ELECTIVE), MONTH and YEAR

Course Code: CST 312

Course Name: FOUNDATIONS OF MACHINE LEARNING

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks.

1 Show that with the usual operation of scalar multiplication but with addition on reals given by $x \# y = 2(x + y)$ is not a vector space.

2 Are the following vectors linearly independent? Justify your answer.

$$x_1 = \begin{bmatrix} 2 \\ -1 \\ 3 \end{bmatrix}, \quad x_2 = \begin{bmatrix} 1 \\ 1 \\ -2 \end{bmatrix}, \quad x_3 = \begin{bmatrix} 3 \\ -3 \\ 8 \end{bmatrix}$$

3 Find the eigenvalues of the following matrix in terms of k. Can you find an eigenvector corresponding to each of the eigenvalues?

$$\begin{bmatrix} 1 & k \\ 2 & 1 \end{bmatrix}$$

4 Find a unit vector in $\mathbf{R^2}$ that is orthogonal to **(-1 , 2)**.

5 The first three digits of a telephone number are 452. If all the sequences of the remaining four digits are equally likely, what is the probability that a randomly selected telephone number contains seven distinct digits?

6 Show that if two events ***A*** and ***B*** are independent, then ***A*** and ***B'*** are independent.

7 Prove that ***X*** and ***Y*** are independent if and only if $f_{X|Y}(x|y) = f_X(x)$ for all ***x*** and ***y***.

8 If ***X*** is a discrete uniform random variable, i.e., $P(X = k) = 1/n$ for $k = 1, 2, \ldots, n$, find ***E(X)*** and ***Var(X)***.

9 Compare the Poisson cdf and the normal approximation for (a) $\lambda = 10$, (b) $\lambda = 20$, and (c) $\lambda = 40$.

10 State law of large numbers. **10 x 3 = 30**

PART B

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

11 a) Find all solutions to the system of linear equations **(8)**

$$\begin{aligned} -4x + 5z &= -2 \\ -3x - 3y + 5z &= 3 \\ -x + 2y + 2z &= -1 \end{aligned}$$

b) Consider the transformation $T(x, y) = (x + y, x + 2y, 2x + 3y)$. Obtain **ker T** and use this to calculate the nullity. Also find the transformation matrix for **T**. **(6)**

OR

12 a) Consider the following linear mapping **(8)**

$$\Phi : \mathbb{R}^3 \to \mathbb{R}^4$$

$$\Phi\left(\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}\right) = \begin{bmatrix} 3x_1 + 2x_2 + x_3 \\ x_1 + x_2 + x_3 \\ x_1 - 3x_2 \\ 2x_1 + 3x_2 + x_3 \end{bmatrix}$$

i. Find the transformation matrix T.

ii. Determine rank(T).

iii. Compute the kernel and image of the mapping and find their dimension

b) Prove that all vectors orthogonal to $[2, -3, 1]^T$ forms a subspace W of R^3. What is $dim\ (W)$ and why? **(6)**

13 a) Find an orthonormal basis of R^3 consisting of eigenvectors for the following matrix **(8)**

$$\begin{bmatrix} 1 & 0 & -2 \\ 0 & 5 & 0 \\ -2 & 0 & 4 \end{bmatrix}$$

b) Find a 3 × 3 orthogonal matrix S and a 3 × 3 diagonal matrix D such that $A = SDS^T$ **(6)**

OR

14 a) Find an orthogonal basis for the subspace of R^4 spanned by $\{ w_1 = (1, 1, 3, 2), w_2 = (1, -2, 0, -1), w_3 = (0, 2, 1, 2) \}$. **(8)**

b) Find the characteristic equation, eigenvalues, and eigenspaces corresponding tc each eigenvalue of the following matrix **(6)**

$$\begin{bmatrix} 2 & 0 & 4 \\ 0 & 3 & 0 \\ 0 & 1 & 2 \end{bmatrix}$$

15 a) Three players play 10 independent rounds of a game, and each player has probability 1/3 of winning each round. Find the joint distribution of the numbers of games won by each of the three players. **(7)**

b) An experiment consists of throwing a fair coin four times. Find the probability mass function and the cumulative distribution function of the following random variables: **(7)**

i. the number of heads before the first tail

ii. the number of heads following the first tail

iii. the number of heads minus the number of tails

iv. the number of tails times the number of heads.

OR

16 a) A factory runs three shifts. On a given day, 1% of the items produced by the first shift are defective, 2% of the second shift's items are defective, and 5% of the third shift's items are defective. If the shifts all have the same productivity, what percentage of the items produced in a day are defective? If an item is defective, what is the probability that it was produced by the third shift? **(8)**

b) Show that if A and B are two independent events, then $P(A \cup B) = P(A) + P(B) - P(A)P(B)$ **(6)**

17 a) Find the joint density of $X + Y$ and X/Y, where X and Y are independent exponential random variables with parameter λ. Show that $X + Y$ and X/Y are independent. **(8)**

b) Let X be a discrete random variable that takes on values 0, 1, 2 with probabilities 1/2 , 3/8 , 1/8 , respectively. **(6)**

i. Find **E(X)** and **Var(X)**.

ii. Let $Y = X^2$. Find the probability mass function of Y and use it to find **E(Y)**.

18 a) A random square has a side length that is a uniform [0, 1] random variable. Find the expected area of the square. **(7)**

b) Let X be a continuous random variable with probability density function on $0 <= x <= 1$ defined by $f(x) = 3x^2$. Find the pdf of $Y = X^2$. **(7)**

19 a) Using the fact that the mean of the chi-squared distribution is $(n-1)$, prove that $E(S^2) = \sigma^2$. **(7)**

b) i. Random samples of size 36 are taken from an infinite population whose mean is 80 and standard deviation is 18. Find the mean and standard error of the **(7)**

sampling distribution.

ii. Why is the Central Limit Theorem so important to statistical analysis?

OR

20 a) A six-sided die is rolled 100 times. Using the normal approximation, find the probability that the face showing a six turns up between 15 and 20 times. Find the probability that the sum of the face values of the 100 trials is less than 300. **(8)**

b) Determine an interval **(a, b)** such that $P[a \leq t \leq b\ ] = 0.80$, and that 10% of the area is on each side of a and b, assuming that the sample is of size 21. **(6)**

Teaching Plan		
No	**Topic**	**No. of Lectures (35)**
1	**Module-1 (LINEAR ALGEBRA) TB-1(Ch 2,3,4) (6 hours)**	
1.1	Systems of Linear Equations – Matrices, Solving Systems of Linear Equations.	1 hour
1.2	Vector Spaces, sub space	1 hour
1.3	Linear Independence,	1 hour
1.4	Basis and Rank	1 hour
1.5.	Linear Mappings- Kernel, Range	1 hour
1.6.	Linear Mappings- Rank, Nullity	
2	**Module-2 (LINEAR ALGEBRA) (6 hours)**	
2.1.	Norms, Inner Products, Lengths and Distances, Angles and Orthogonality,	1 hour
2.2	Orthonormal Basis, Orthogonal Complement,	1 hour
2.3	Orthogonal Projections	1 hour
2.4.	Eigenvalues and Eigenvectors	1 hour
2.5.	Eigen decomposition	1 hour
2.6.	Eigen Diagonalization	1 hour
3.	**Module-3 (PROBABILITY AND DISTRIBUTIONS) TB-2(Ch 1,2) (9 hours)**	

3.1	Sample Spaces, Probability Measures, Computing Probabilities	1 hour
3.2	Conditional Probability,	1 hour
3.3	Baye's Rule	1 hour
3.4	Independence of events	1 hour
3.5	Discrete Random Variables -Bernoulli Random Variables, Binomial Distribution	1 hour
3.6	Discrete Random Variables -Geometric Distribution	1 hour
3.7	Discrete Random Variables -Poisson Distribution	1 hour
3.8	Continuous Random Variables - Exponential Density, Gamma Density,	1 hour
3.9	Continuous Random Variables - Normal Distribution, Beta Density	1 hour
4.	**Module-4 (RANDOM VARIABLES) TB-2 (Ch 3, 4, 5, 6) (9 hours)**	
4.1	Functions of a Random Variable	1 hour
4.2	Joint Distributions - Independent Random Variables	1 hour
4.3	Conditional Distributions	1 hour
4.4	Functions of Jointly Distributed Random Variables	1 hour
4.5	Expected Value of a Random Variable,	1 hour
4.6	Expectations of Functions of Random Variables,	1 hour
4.7	Expectations of Linear Combinations of Random Variables	1 hour
4.6	Variance and Standard Deviation	1 hour
4.9	Covariance and Correlation	1 hour

5	Module-5 (LIMIT THEOREMS) (6 hours)	
5.1	Conditional Expectation,	1 hour
5.2	Moment-Generating Function	1 hour
5.3	Limit Theorems(Proof not expected) - Law of Large Numbers,	1 hour
5.4	Convergence in Distribution and the Central Limit Theorem.	1 hour
5.5	Distributions derived from the Normal Distribution - Chi-square and, and F Distributions,	1 hour
5.6	Distributions derived from the Normal Distribution - Sample Mean and the Sample Variance.	1 hour

CST 322	DATA ANALYTICS	Category	L	T	P	Credits	Year of Introduction
		PEC	2	1	0	3	2019

Preamble:

This course helps the learner to understand the basic concepts of data analytics. This course covers mathematics for data analytics, predictive and descriptive analytics of data, Big data and its applications, techniques for managing big data and data analysis & visualization using R programming tool. It enables the learners to perform data analysis on a real world scenario using appropriate tools.

Prerequisite: NIL

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

CO#	Course Outcomes
CO1	Illustrate the mathematical concepts for data analytics **(Cognitive Knowledge Level: Apply)**
CO2	Explain the basic concepts of data analytics **(Cognitive Knowledge Level: Understand)**
CO3	Illustrate various predictive and descriptive analytics algorithms (**Cognitive Knowledge Level: Apply)**
CO4	Describe the key concepts and applications of Big Data Analytics **(Cognitive Knowledge Level: Understand)**
CO5	Demonstrate the usage of Map Reduce paradigm for Big Data Analytics **(Cognitive Knowledge Level: Apply)**
CO6	Use R programming tool to perform data analysis and visualization **(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**	Lifelong learning

Assessment Pattern

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

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 any5.

End Semester Examination Pattern:

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

Syllabus

Module – 1 (Mathematics for Data Analytics)

Descriptive statistics - Measures of central tendency and dispersion, Association of two variables - Discrete variables, Ordinal and Continuous variable, Probability calculus - probability distributions, Inductive statistics - Point estimation, Interval estimation, Hypothesis Testing - Basic definitions, t-test

Module - 2 (Introduction to Data Analytics)

Introduction to Data Analysis - Analytics, Analytics Process Model, Analytical Model Requirements. Data Analytics Life Cycle overview. Basics of data collection, sampling, preprocessing and dimensionality reduction

Module - 3 (Predictive and Descriptive Analytics)

Supervised Learning - Classification, Naive Bayes, KNN, Linear Regression. Unsupervised Learning - Clustering, Hierarchical algorithms – Agglomerative algorithm, Partitional algorithms - K- Means. Association Rule Mining - Apriori algorithm

Module - 4 (Big Data Analytics)

Big Data Overview – State of the practice in analytics, Example Applications - Credit Risk Modeling, Business Process Analytics.Big Data Analytics using Map Reduce and Apache Hadoop, Developing and Executing a HadoopMapReduce Program.

Module - 5 (R programming for Data Analysis)

Overview of modern data analytic tools.Data Analysis Using R - Introduction to R - R Graphical User Interfaces, Data Import and Export, Attribute and Data Types, Descriptive Statistics, Exploratory Data Analysis - Visualization Before Analysis, Dirty Data, Visualizing a Single Variable, Examining Multiple Variables, Data Exploration Versus Presentation, Statistical Methods for Evaluation

Text Book

1. Bart Baesens," Analytics in a Big Data World: The Essential Guide to Data Science and its Business Intelligence and Analytic Trends", John Wiley & Sons, 2013.
2. David Dietrich, "EMC Education Services, Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", John Wiley & Sons, 2015.
3. Jaiwei Han, MichelineKamber, "Data Mining Concepts and Techniques", Elsevier, 2006.
4. Christian Heumann and Michael Schomaker, "Introduction to Statistics and DataAnalysis", Springer, 2016

References

1. Margaret H. Dunham, Data Mining: Introductory and Advanced Topics. Pearson, 2012.
2. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the measures of central tendency.
2. Drive the mean and variance of normal distribution.
3. Collect sample data associated with a real world scenario, and identify central tendency and dispersion measures. Explain your inferences.

Course Outcome 2 (CO2):

1. Explain the life cycle of Data Analytics.
2. Discuss in detail the relevance of data sampling.

Course Outcome 3 (CO3):

1. The following table shows the midterm and final exam marks obtained for students in a database course.

X (Midterm exam)	Y (Final exam)
72	84
50	63

81	77
74	78
94	90
86	75
59	49
83	79
65	77
33	52
88	74
81	90

a) Use the method of least squares to find an equation for the prediction of a student's final exam marks based on the student's midterm grade in the course.
b) Predict the final exam marks of a student who received an 86 on the midterm exam.

2. Perform knn classification on the following dataset and predict the class for the data point X (P1 = 3, P2 =7), assuming the value of k as 3.

P1	P2	Class
7	7	False
7	4	False
3	4	True
1	4	True

Course Outcome 4 (CO4):

1. List down the characteristics of Big Data.
2. Illustrate process discovery task in business analytics using the scenario of insurance claim handling process. Draw the annotated process map.

Course Outcome 5 (CO5):

1. Explain how fault tolerance is achieved in HDFS.
2. Write down the pseudocode for Map and Reduce functions to solve any one data analytic problem.

Course Outcome 6 (CO6):

1. Illustrate any three R functions used in data analytics.
2. Explain the different categories of attributes and data types in R.

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 322

Course Name: Data Analytics

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

PART A

(Answer all Questions. Each question carries 3 Marks)

1. Outline the errors that arise in hypothesis testing.

2. The number of members of a millionaires' club were as follows:

Year	2011	2012	2013	2014	2015	2016
Members	23	24	27	25	30	28

(a)What is the average growth rate of the membership?

(b)Based on the results of (a), how many members would one expect in 2018?

3. List and explain any two methods for dealing with missing values in a dataset.

4. Consider the following data (in increasing order) for the attribute age: 13, 15, 16, 16, 19, 20, 20, 21, 22, 22, 25, 25, 25, 25, 30, 33, 33, 35, 35, 35, 35, 36, 40, 45, 46, 52, 70. Sketch an example for stratified sampling using samples of size 5 and the strata "youth," "middle-aged," and "senior."

5. Why is k nearest neighbor classifier called a lazy learner?

6. Find the absolute support, relative support and confidence of the rule (bread => jam) in the following set of transactions

   T1 {bread, butter}, T2{bread, jam, milk}

   T3{Milk, curd}, T4{bread, jam}

7. Explain the 3 Vs of Big Data.

8. Discuss the application of big data analytics in credit risk modeling.

9. Why is Exploratory Data Analysis important in business application ?

10. Explain how box plots be used for data summarization.

(10x3=30)

Part B

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

11. (a) Illustrate the Maximum Likelihood Estimation of Bernoulli distribution. **(8)**

    (b) A hiking enthusiast has a new app for his smartphone which summarizes his hikes by using a GPS device. Let us look at the distance hiked (in km) and maximum altitude (in m) for the last 10 hikes: **(6)**

Distance	12.5	29.9	14.8	18.7	7.6	16.2	16.5	27.4	12.1	17.5
Altitude	342	1245	502	555	398	670	796	912	238	466

Calculate the arithmetic mean and median for both distance and altitude.

OR

12. (a) Explain the steps in conducting a hypothesis test. **(8)**

(b) A total of 150 customers of a petrol station are asked about their satisfaction with their car and motorbike insurance. The results are summarized below: Determine and interpret Pearson's $\chi 2$ statistic and Cramer's V. **(6)**

	Satisfied	Unsatisfied	Total
Car	33	25	58
Car (Diesel engine)	29	31	60
Motor bike	12	20	32
Total	74	76	150

13. (a) Explain the data analytical process model. **(8)**

(b) Discuss the methods for handling noisy data. Consider the following sorted data for price (in dollars) 4, 8, 15, 21, 21, 24, 25, 28, 34. **(6)**
Illustrate smoothing by bin means and bin boundaries

OR

14. (a) a) What is the need for sampling in data analytics? Discuss the different sampling techniques. **(8)**

(b) Use these methods to *normalize* the following group of data: **(6)**

200, 300, 400, 600, 1000

(i) min-max normalization by setting *min* = 0 and *max* = 1
(ii) z-score normalization
(iii) normalization by decimal scaling .

15. (a) A database has five transactions. Let min_sup be 60% and min_conf be 80%.
.

TID	*items_bought*
T100	{M, O, N, K, E, Y}
T200	{D, O, N, K, E, Y}
T300	{M, A, K, E}
T400	{M, U, C, K, Y}
T500	{C, O, O, K, I, E}

(a) Find all frequent itemsets using Apriori algorithm **(10)**

(b) Generate strong association rules from any one 3 itemset. **(4)**

OR

16. (a) Explain agglomerative hierarchical clustering with an example. **(8)**

(b) Suppose that the data mining task is to cluster points (with (x, y) representing location) into three clusters, where the points areA1(2,10), A2 (2,5), A3 (8,4), B1 (5,8), B2 (7,5), B3 (6,4), C1(1,2), C2 (4,9). The distance function is Euclidean distance. Suppose initially we assign A1, B1, and C1as the center of each cluster, respectively. Use the k-means algorithm to show only **(6)**
(a) The three cluster centers after the first round of execution.
(b) The final three clusters.

17. (a) Illustrate the working of a Map Reduce program with example. **(8)**

(b) Explain the data analytic architecture with a diagram. **(6)**

OR

18. (a) Discuss the architecture of HDFS and its features. **(8)**

(b) Illustrate the use of big data analytics in credit risk modeling. **(6)**

19. (a) List and explain the R functions used in descriptive statistics. **(8)**

(b) Explain hypothesis testing using ANOVA. **(6)**

OR

20. (a) Discuss the data visualization for multiple variables in R **(8)**

(b) Describe the R functions used for cleaning dirty data. **(6)**

(5 x 14 = 70)

Teaching Plan

No	Contents	No of Lecture Hrs
Module – 1(Mathematics for Data Analytics) (7 hrs)		
1.1	Descriptive statistics - Measures of central tendency	1
1.2	Measures of dispersion	1
1.3	Association of two variables - Discrete Variables	1
1.4	Association of two variables - Ordinal and Continuous variable	1
1.5	Probability calculus - Probability distributions	1
1.6	Inductive statistics - Point estimation, Interval estimation	1
1.7	Hypothesis Testing - Basic definitions, t-test	1
Module – 2 (Introduction to Data Analytics) (6 hrs)		
2.1	Introduction to Data Analysis –Analytics, Analytics process model	1
2.3	Analytical model requirements	1
2.4	Data Analytics Life Cycle overview	1
2.5	Basics of data collection	1
2.6	Basics of sampling and preprocessing	1
2.7	Dimensionality reduction	1
Module - 3 (Predictive and Descriptive Analytics) (8 hrs)		
3.1	Supervised Learning, Naive Bayes classification	1
3.2	KNN algorithm	1

3.3	Linear Regression	1
3.4	Unsupervised Learning- Clustering	1
3.5	Hierarchical algorithms Agglomerative algorithm	1
3.6	Partitional algorithms -K- Means	1
3.7	Association Rule Mining	1
3.8	Apriori algorithm	1
Module - 4 (Big Data Analytics) (7 hrs)		
4.1	Big Data Overview – State of the practice in analytics.	1
4.2	Example Applications - Credit Risk Modeling	1
4.3	Business Process Analytics.	1
4.4	Big Data Analytics using Map Reduce and Apache Hadoop	1
4.5	Big Data Analytics using Map Reduce and Apache Hadoop	1
4.6	Developing and Executing a Hadoop MapReduce Program	1
4.7	Developing and Executing a Hadoop MapReduce Program	1
Module - 5 (R programming for Data Analysis) (8 hrs)		
5.1	Overview of modern data analytic tools, Introduction to R, R Graphical User Interfaces	1
5.2	Data Import and Export, Attribute and Data Types	1

5.3	Descriptive Statistics	1
5.4	Exploratory Data Analysis, Visualization Before Analysis	1
5.5	Dirty Data, Visualizing a Single Variable	1
5.6	Examining Multiple Variable	1
5.7	Data Exploration Versus Presentation	1
5.8	Statistical Methods for Evaluation	1

CCT332	STORAGE MANAGEMENT AND SECURITY	CATEGORY	L	T	P	CREDITS
		PEC	2	1	0	3

Preamble: To enable students to understand, explore and acquire a critical understanding about comprehensive learning on storage technology, which will enable them to make more informed decisions in an increasingly complex IT environment. It builds a strong understanding of underlying storage technologies and prepares them to learn advanced concepts, technologies and products.Students will learn about the architectures, features, and benefits of intelligent storage systems; storage networking technologies such as FC-SAN, IP-SAN, NAS, object-based and unified storage; business continuity solutions such as backup and replication; the increasingly critical area of Information Security and Management.

Prerequisite: A basic understanding of Computer Architecture, Operating Systems, Networking, and databases.

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

CO#	Course Outcomes
CO1	Explain storage architectures and key data center elements**(Cognitive Knowledge Level: Understand)**
CO2	Explain physical and logical components of a storage infrastructure including storage subsystems and RAID**(Cognitive Knowledge Level: Understand)**
CO3	Summarize storage networking technologies such as FCSAN, IP-SAN, NAS **(Cognitive Knowledge Level: Understand)**
CO4	Describebusiness continuity backup and replicationssolutions**.(Cognitive Knowledge Level: Understand)**
CO5	Explain the storage security aspects and the virtualization technologies. **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
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 Tests		
	Test 1 (%)	Test 2 (%)	End Semester Examination (%)
Remember	30	30	30
Understand	50	50	50
Apply	20	20	20
Analyze			
Evaluate			
Create			

Mark Distribution

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

Continuous Internal Evaluation Pattern:

Attendance 10 marks

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

Continuous Assessment Assignment 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. The first series test shall be preferably conducted after completing the first half of the syllabus. 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 contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer anyone. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module-1(Introduction)

Introduction to Storage Technology- Review data creation-amount of data being created- understand the value of data to business- challenges in data storage and data management-solutions available for data storage-core elements of a data center infrastructure- role of each element in supporting business activities.

Module-2(Storage system architecture)

Storage system architecture-Hardware and software components of the host environment-Key protocols and concepts used by each component-physical and logical components of a connectivity environment- major physical components of a disk drive and their function-logical constructs of a physical disk-Access characteristics-Performance implications-Concept ofRAID and its components-Different RAID levels and their sustainability for different application environments-Compare and contrast integrated and modular storage systems-High-level architecture and working of an intelligent storage system.

Module-3(Network Storage)

Introduction to Networked Storage-Evolution of networked storage- Architecture-Components-Topologies of FC- SAN- NAS - IP- SAN- Benefits of the different networked storage options-understand the need for long- Term archiving solutions- Describe how CAS fulfill the need-Understand the appropriateness- Different networked storage options-Different application environments.

Module-4(Management of Information)

Information Availability, Monitoring & Managing Data centers- List reasons for planned or unplanned outages- Impact of downtime-Business continuity(BC)-Disaster recovery(DR)-RTO-RPO-Identify single points of failure- List solutions to mitigate failures –Architecture of backup/recovery-Different backup or recovery topologies-Replication technologies-Role in ensuring information availability and business continuity- Remote replication technologies-Role in providing disaster recovery and business continuity capabilities-Identify key areas to monitor in a data center- Industry standards for data monitoring and management-key metrics-key management tasks.

Module-5(Storage Security)

Securing storage and storage virtualization-Information security- Critical security attributes- storage security domains –List and analyzes the common threats in each domain –Virtualization technologies-Block-level and file-level virtualization technologies and processes.

Text/Reference Books

1. EMC Corporation,"Information Storage and Management: Storing, Managing and Protecting Digital Information",Wiley,India, 2nd Edition,2012.
2. Marc Farley, "Building storage networks", Tata McGraw Hill", Osborne, 2nd Edition,2001.
3. Robert Spalding, "Storage Networks: The complete Reference", Tata McGraw hill, Osborne, First Edition,2003.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What are the key requirements needed for designing a data center for storage?

Course Outcome 2 (CO2):

1. Explain the Evolution of storage Technology and Architecture.

Course Outcome 3 (CO3):

1. Explain Network-attached storage (NAS) its future and benefits.

Course Outcome 4 (CO4):

1. What is the need of data management and monitoring in storage?

Course Outcome 5 (CO5):

1. Explain the storage security aspects and the virtualization technology.

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: CCT 332
Course Name: STORAGE MANAGEMENT AND SECURITY

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

PART A
Answer all Questions. Each question carries 3 Marks

1. Which are the challenges in data storage?
2. Which are the elements needs for a data center infrastructure?
3. Explain about key protocols used in host environment.
4. What is the importance of High-level architecture in storage?
5. Describe in detail about NAS topology.
6. Which are the different application environments in storage?
7. What is the need of ensuring information availability and business continuity?
8. Which are the key areas to monitor in a data center?
9. ExplainhowInformation Security is achieved in storage.
10. Discuss the different Virtualization technologies.

(10x3=30 Marks)

PART B

Answer any one Question from each module.

Each question carries 14 Marks

11)	a) Describe the evolution of storage technology and architecture.	**(7Marks)**
	b) Describe the core elements of a data centre infrastructure and explain role of each element in supporting business activities.	**(7Marks)**
	OR	
12)	a) Explain the value of data to business.	**(4Marks)**
	b) Describe the challenges faced and the solutions in storage management.	**(10Marks)**
13)	a) Explain Storage security domains.	**(8 Marks)**
	b) Explain the major physical components of a disk drive.	**(6 Marks)**
	OR	
14)	a) Write down the Different RAID levels and their sustainability for different application environments	**(10 Marks)**
	b) Compare integrated and modular storage systems.	**(4 Marks)**
15)	a) What are the components of NAS? Explain NAS Implementations.	**(7 Marks)**
	b) Briefly explain the architecture and components of networked storage.	**(7 Marks)**
	OR	
16)	a) Explain the topologies used in networked storage management.	**(7 Marks)**
	b) What are the benefits of different network storage devices?	**(7 Marks)**
17)	a) List the reasons for planned or unplanned outages.	**(10 Marks)**
	b) Explain disaster recovery(DR)-RTO-RPO.	**(4 Marks)**
	OR	**(6 Marks)**
18)	a) Explain industry standards for data monitoring and management	**(8 Marks)**
	b) Explain the key metrics and key task for storage management	
19)	a) Explain Critical security attributes in storage.	**(8 Marks)**
	b) Explain the storage security domains in storage management.	**(6 Marks)**
	OR	
20)	a) What isStorage Virtualization? Explain how it can be done.	**(8 Marks)**

b) List and analyzes the common threats in security storage management **(6 Marks)**

TEACHING PLAN

No	Contents	No of Lecture Hrs
Module-1(Introduction)(5 hrs)		
1.1	Introduction to Information Storage Management –Evolution of Storage Technology	1
1.2	Data Centre Infrastructure-Key Challenges in managing Information	1
1.3	Solutions available for data storage	1
1.4	Core elements of a data center infrastructure	1
1.5	Role of each element in supporting business activities	1
Module-2(Storage system architecture)(9 hrs)		
2.1	Hardware and software components of the host environment	1
2.2	Key protocols and concepts used by each component	1
2.3	Physical and logical components of a connectivity environment	1
2.4	Major physical components of a disk drive and their function	1
2.5	Logical constructs of a physical disk-Access characteristics-Performance implications	1
2.6	Concept of RAID and its components	1

2.7	Different RAID levels and their sustainability for different application environments	1
2.8	Compare and contrast integrated and modular storage systems-	1
2.9	High-level architecture and working of an intelligent storage system.	1
Module-3(Network Storage)(8 hrs)		
3.1	Evolution of networked storage	1
3.2	Architecture-Components	1
3.3	Topologies of FC- SAN- NAS	1
3.4	Topologies of IP- SAN	1
3.5	Benefits of the different networked storage options	1
3.6	Understand the need for long- Term archiving solutions	1
3.7	Describe how CAS fulfill the need- Understand the appropriateness	1
3.8	Different networked storage options-Different application environments.	1
Module-4(Management of Information)(8hrs)		
4.1	List reasons for planned or unplanned outages- Impact of downtime-Business continuity(BC)	1
4.2	Disaster recovery(DR)-RTO-RPO-Identify single points of failure	1
4.3	Identify single points of failure- List solutions to mitigate failures – Architecture of backup/recovery systems	1

4.4	Different backup or recovery topologies-Replication technologies	1
4.5	Role in ensuring information availability and business continuity	1
4.6	Remote replication technologies-Role in providing disaster recovery and business continuity capabilities	1
4.7	Identify key areas to monitor in a data center	1
4.8	Industry standards for data monitoring and management-key metrics-key management tasks.	1
Module-5(Storage Security)(5hrs)		
5.1	Information security- Critical security attributes	1
5.2	Storage security domains –List and analyzes the common threats in each domain	1
5.3	Virtualization technologies	1
5.4	Block-level virtualization technologies and processes	1
5.5	File-levelvirtualization technologies and processes	1

CST 342	AUTOMATED VERIFICATION	Category	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PEC	2	1	0	3	2019

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

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

CCT352	MALWARE FORENSICS	CATEGORY	L	T	P	CREDITS
		PEC	2	1	0	3

Preamble: The courseenables the learners to understand malware forensics, use of manual and automated tools to analyzevarious malicious activity. During the course students will learn to identify and analyze various types of malware. It helps the learners to understand static and dynamic malware analysis techniques and malware behavior monitoring tools.

Prerequisite: Knowledge in Fundamental concepts of security.

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

CO#	Course Outcomes
CO1	Identify the nature of malware and its capabilities. (**Cognitive Knowledge Level:Understand**)
CO2	Explain the types of malware anddifferent types of Malware analysis. (**Cognitive Knowledge Level: Understand)**
CO3	Identify the different malware detection techniques.**(Cognitive Knowledge Level: Understand)**
CO4	Explain the methods of data collection and examination in Windows and Linux Systems **(Cognitive Knowledge Level:Understand)**
CO5	Demonstrate tools and skills needed to conduct malware attacks against Windows and Linux System.**(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

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

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

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks(%)**
	Test1 (%)	**Test2 (%)**	
Remember	30	30	30
Understand	50	50	50
Apply	20	20	20
Analyze			
Evaluate			
Create			

Mark Distribution

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

Continuous Internal Evaluation Pattern:

Attendance 10 marks

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

Continuous Assessment Assignment 15 marks

Internal Examination Pattern:

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

Introduction to malware, OS security concepts, malwarethreats, evolution of malware, malware typesviruses,worms, rootkits,Trojans,bots, spyware, adware,logicbombs.

Types of malware Analysis – Static Analysis, Dynamic Analysis, Malware Analysis Techniques - Obfuscated, Deobfuscated, Malware Analysis Tools - Static Analysis Tools, Dynamic Analysis Tools. AntivirusScanning, FingerprintforMalware.

Module-2 (Malware Analysis)

Dynamic analysis: Live malware analysis, dead malware analysis, analyzing traces of malware-system-calls, api-calls, registries, network activities. Anti-dynamic analysis techniques anti-vm, runtime-evasion techniques, Malware Sandbox, Monitoring with Process Monitor, Packet Sniffing with Wireshark, Kernelvs. User-Mode Debugging, OllyDbg, Breakpoints, Tracing, Exception Handling, Patching.

Module-3 (Malware Detection)

Malware Detection Techniques: Signature-based techniques: malware signatures, packed malware signature,metamorphic and polymorphicmal ware signature Non-signature based techniques: similarity-based techniques, machine-learning methods, invariant inferences.

Module-4 (Incident Response)

Malware Incident response: Volatile Data Collection and Examination on a Live Windows Systems - Volatile Data collection methodology from Windows systems- Preservation of Volatile data, Collecting Subject System details, Identifying users Logged into the System, Inspect Network Connections and Activity, Current and Recent Network Connections, Collecting Process Information, Correlate Open Ports with Running Processes and Programs, Identifying Services and Drivers, Determining Scheduled Tasks, Collecting Clipboard Contents, Non-Volatile Data Collection from a Live Windows System, Volatile Data collection methodology from Linux systems, Non-volatile Datacollectionfromalive Linuxsystem.

Module – 5(OS Forensics)

Post-Mortem Forensics - Malware Discovery and Extraction from a Windows and Linux system, Examine Windows and Linux file system, Examine application traces, Examine Windows registry, keyword searching from Windows and Linux systems, Forensic reconstruction of compromised Linux and Windows system.

Text Books

1. James M.Aquilina, Cameron H.Malin ,Eoghan Casey,“Malware Forensics Field Guide for Windows Systems: Digital ForensicsFieldGuides”,Syngress Publishing, First Edition,2012
2. JamesM.Aquilina,CameronH.Malin,EoghanCasey,“Malware ForensicsField Guide for LinuxSystems:Digital ForensicsField Guides”,Syngress Publishing, Second Edition,2014
3. EoghanCasey,James M.Aquilina,CameronH.Malin,“Malware ForensicsInvestigatingandAnalyzingMalicious code”,Syngress Publishing, First Edition,2008

References

1.Michael Sikorski and Andrew Honig,"PracticalmalwareanalysisTheHands-OnGuide to Dissecting Malicious Software", No starch press, First Edition,2012.
2.Michael Davis,SeanBodmer, AaronLemasters,"Malware&rootkits:malware&rootkitssecurity secrets&Solutions",McGraw Hill,Second Edition,2010
3.VictorMarak,"WindowsMalwareAnalysisEssentials"PacktPublishing,First Edition, 2015

Course Level Assessment Questions

CourseOutcome1(CO1):

1. Discuss the different types of Malware Analysis.

CourseOutcome2(CO2):

1. Explain the various Anti-dynamic malware analysis techniques?

CourseOutcome3 (CO3):

1. Compare and contrast Signature-based malware detection technique and Non-signature based malware detection technique

CourseOutcome4 (CO4):

1. Explain how the volatile data from a Windows systembe collected.

Course Outcome 5 (CO5):

1. With a Suitable tool, extract the contents of Hive Files in a Windows registry.

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: CCT 352
Course Name: Malware Forensics

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

PART A

Answer all Questions. Each question carries 3 Marks

1. Compare Static and Dynamic analysis.
2. List the different types of malware threats.
3. How to perform packetsniffing using wireshark? Explain.
4. What are the different types of Anti-dynamic analysis techniques?
5. What is the difference between polymorphic and metamorphic malware?
6. Write the different techniques used for malware detection.
7. "Performing live response and collecting information from a system is vital". Justify.
8. Explain the process of collecting Non-volatile data from a Windows system.
9. Discuss the significance of performing Post- Mortem Forensics.
10. Explain the methodology for uncovering trace evidence of malware on Linux.

(10x3=30 Marks)

PART B

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

11. (a)Explainviruses,worms, rootkits,Trojans,bots, spyware, adware and Logic bombs. **(8 Marks)**
    (b)Discuss the different tools used for Static and Dynamic Analysis. **(6 Marks)**

OR

12. (a)Explain in detail the different types of Malware Analysis Techniques. **(8 Marks)**
    (b)What is antivirus scanning? **(6 Marks)**
13. (a)Compare the live and dead malware analysis. **(8 Marks)**

(b)What are the different methods of Anti-dynamic analysis techniques? **(6 Marks)**

OR

14. (a)Explain the process of analyzing traces of malware. **(8 Marks)**
    (b) What is User mode debugging? **(6 Marks)**

15. (a)Discuss how Signature-based techniques are used for malware detection. **(8 Marks)**
    (b) How the machine learning techniques are used for malware detection? **(6 Marks)**

OR

16. (a)Compare Similarity-basedtechniques andMachine-learning methods with illustrations. **(8 Marks)**
    (b)What are the characteristics of signature based analysis of malware? **(6 Marks)**

17. (a)Explain the process of collecting non-volatile data from a windows system. **(8 Marks)**
    (b)How to gather volatile data such as subject system details, logged on users, process information, open ports, open files from a Linux system? **(6 Marks)**

OR

18. (a)Explain the different steps involved in collecting volatile data from a Linux system. **(8 Marks)**
    (b) With Illustrations, Correlate Open Ports with Running Processes and Programs. **(6 Marks)**

19. (a)What are the tools required for searching known malware in Linux system? **(10 Marks)**

    (b) Explain Real time data and protected data with examples. **(4 Marks)**

OR

20. (a)Explain the methodology for discovering and extracting malware from Windows system. **(7 Marks)**
    (b) How the artifacts from a windows registry be extracted? **(7 Marks)**

TEACHING PLAN

No	Contents	No of Lecture Hrs
Module-1 (Introduction) (7hrs)		
1.1	Introduction to malware, OS security concepts	1
1.2	Malware threats, Evolution of malware	1
1.3	Malware types- viruses,worms, rootkits	1
1.4	Trojans, bots, spyware, adware,logicbombs	1
1.5	Types of malware Analysis – Static Analysis, Dynamic Analysis	1
1.6	Malware Analysis Techniques –1. Obfuscated, Deobfuscated	1

1.7	Malware Analysis Tools - Static Analysis Tools, Dynamic Analysis Tools	1
Module-2 (Malware Analysis)(9hrs)		
2.1	Dynamic analysis: Live malware analysis	1
2.2	Dead malware analysis	1
2.3	Analyzing traces of malware- system-calls, api-calls	1
2.4	Analyzing traces of malware- registries, network activities	1
2.5	Anti-dynamic analysis techniques anti-vm,	1
2.6	Runtime-evasiontechniques	1
2.7	Malware Sandbox, Monitoring with Process Monitor	1
2.8	Packet Sniffing with Wireshark	1
2.9	Kernelvs.User-ModeDebugging	1
Module–3(Malware Detection) (6hrs)		
3.1	Malware Detection Techniques: Signature-based techniques: malware signatures	1
3.2	Signature-based techniques: packed malware signature	1
3.3	Signature-based techniques: metamorphic and polymorphic malwaresignature	1
3.4	Malware Detection Techniques: Non-signaturebasedtechniques	1
3.5	Non-signaturebasedtechniques:similarity-based and machine learning techniques	1
3.6	Non-signaturebasedtechniques:invariant inferences	1
Module- 4 (Incident Response)(7hrs)		
4.1	Malware Incident response: Volatile Data Collection and Examination on a Live Windows Systems	1
4.2	Preservation of Volatile data, Collecting Subject System details, Identifying users Logged into the System	1

4.3	Inspect Network Connections and Activity, Current and Recent Network Connections	1
4.4	Collecting Process Information, Correlate Open Ports with Running Processes and Programs, Identifying Services and Drivers	1
4.5	Determining Scheduled Tasks, Collecting Clipboard Contents	1
4.6	Non-Volatile Data Collection from a Live Windows System	1
4.7	Volatile Data collection methodology from Linux systems	1
Module - 5 (OS Forensics)(6 hrs)		
5.1	Post-Mortem Forensics	1
5.2	Post-Mortem Forensics - Malware Discovery and Extraction from a Windows system	1
5.3	Malware Discovery and Extraction from a Linux system	1
5.4	ExamineWindowsfilesystem	1
5.5	ExamineLinuxfilesystem and application traces	1
5.6	ExamineWindowsregistry	1

AIT362	PROGRAMMING IN R	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PEC	2	1	0	3	2019

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	PO10	PO11	PO12
CO1	✓	✓	✓		✓							✓
CO2	✓	✓	✓		✓							✓
CO3	✓	✓	✓	✓	✓							✓
CO4	✓	✓	✓	✓	✓							✓
CO5	✓	✓			✓							✓

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

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks**
	Test1 (percentage)	**Test2 (percentage)**	
Remember	20	20	20
Understand	40	40	40
Apply	40	40	40
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 Grolemund, 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 display the duplicate elements and unique rows of the said data frame. (7 marks)

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 and 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

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

CST 372	DATA AND COMPUTER COMMUNICATION	Category	L	T	P	Credits	Year of Introduction
		PEC	2	1	0	3	2019

Preamble:

The purpose of this course is to prepare learners to understand the communication entities and the associated issues in data transmission. This course covers fundamental concepts of data transmission in digital and analog form, transmission media, concepts of encoding, multiplexing, spread spectrum and switching methods. This course helps the learner to gain insight into the important aspects of data communication and computer networking systems and enables to apply in practical applications.

Prerequisite: NIL

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

CO#	Course Outcomes
CO1	Identify the characteristics of signals for analog and digital transmissions (**Cognitive knowledge: Apply**)
CO2	Identify the issues in data transmission (**Cognitive knowledge: Apply**)
CO3	Select transmission media based on characteristics and propagation modes (**Cognitive knowledge: Apply**)
CO4	Choose appropriate signal encoding techniques for a given scenario (**Cognitive knowledge: Apply**)
CO5	Illustrate multiplexing and spread spectrum technologies (**Cognitive knowledge: Apply**)
CO6	Use error detection, correction and switching techniques in data communication (**Cognitive knowledge: 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**	Lifelong learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination (%)
	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 Test : **25 marks**

Continuous Assessment Assignment : **15 marks**

Internal Examination Pattern:

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

End Semester Examination Pattern:

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

Syllabus

Module-1 (Data Transmission Basics)

Communication model - Simplex, Half duplex, Full duplex transmission. Periodic analog signals - Sine wave, Amplitude, Phase, Wavelength, Time and frequency domain, Bandwidth. Analog & digital data and signals. Transmission impairments - Attenuation, Delay distortion, Noise. Data rate limits - Noiseless channel, Nyquist bandwidth, Noisy channel, Shannon's capacity formula.

Module-2 (Transmission Media)

Guided transmission media - Twisted pair, Coaxial cable, Optical fiber. Unguided media - Radio waves, Terrestrial microwave, Satellite microwave, Infrared. Wireless propagation - Ground wave propagation, Sky wave propagation, Line-of-Sight (LoS) propagation.

Module-3 (Digital Transmission and Analog Transmission)

Digital data to digital signal – Non-Return-to-Zero (NRZ), Return-to-Zero (RZ), Multilevel binary, Biphase. Analog data to digital signal - Sampling theorem, Pulse Code Modulation (PCM), Delta Modulation (DM). Digital data to analog signal - Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK). Analog data to analog signal - Amplitude Modulation (AM), Frequency Modulation (FM), Phase Modulation (PM).

Module-4 (Multiplexing and Spread Spectrum)

Multiplexing - Frequency Division Multiplexing (FDM), Wavelength Division Multiplexing (WDM), Time Division Multiplexing (TDM), Characteristics, Synchronous TDM, Statistical TDM. Spread spectrum techniques - Direct Sequence Spread Spectrum (DSSS), Frequency Hopping Spread Spectrum (FHSS), Code Division Multiplexing, Code Division Multiple Access (CDMA).

Module-5 (Error Detection, Correction and Switching)

Digital data communication techniques - Asynchronous transmission, Synchronous transmission. Detecting and correcting errors - Types of errors, Parity check, Checksum, Cyclic Redundancy Check (CRC), Forward Error Correction (FEC), Hamming distance, Hamming code. Basic principles of switching - Circuit switching, Packet switching, Message switching.

Text Books

1. Forouzan B. A., Data Communications and Networking, 5/e, McGraw Hill, 2013.

2. William Stallings, Data and Computer Communication 9/e, Pearson Education, Inc.

References

1. Schiller J., Mobile Communications, 2/e, Pearson Education, 2009.
2. Curt M. White, Fundamentals of Networking and Communication 7/e, Cengage learning.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. If the spectrum of a channel is between 3 MHz and 4 MHz and SNR_{dB} = 24 dB, calculate the Shannon capacity.
2. Assume that a periodic signal is composed of five sine waves with frequencies 200, 400, 600, 800 and 1000 Hz. Determine the bandwidth. Draw the spectrum assuming all components have a maximum amplitude of 5 V.

Course Outcome 2 (CO2):

1. Given a receiver with an effective noise temperature of 294 K and a bandwidth of 10 MHz. Find the thermal noise level at the receiver side in dBW.
2. The loss in a cable is usually defined in decibels per kilometer (dB/km). If the signal at the beginning of a cable with -0.3 db/km has a power of 2 mW, determine the power of the signal at 5 km.

Course Outcome 3 (CO3):

1. Explain the reflective property of a parabolic antenna.
2. Two separate frequencies are used for uplink and downlink transmission in satellite communication. Give reason.

Course Outcome 4 (CO4):

1. Encode the data sequence 101011100 using Multilevel binary and Biphase schemes.
2. Encode the data bits 00101101110001 using 2B1Q encoding scheme. Assume negative original level.

Course Outcome 5 (CO5):

1. The frequency spectrum of input signals will move to high frequency bands by the FDM process. Justify.
2. Four channels are multiplexed using TDM. If each channel sends 100 bytes/sec and we multiplex one byte per channel, determine the frame size, duration of a frame, frame rate and bit rate of link.

Course Outcome 6 (CO6):

1. Using the divisor polynomial $x^4 + x + 1$, determine the Cyclic Redundancy Check (CRC) for the dataword 10110100. Also, perform the checking at the receiver side.
2. How many redundancy bits are required to generate the Hamming code for a 7-bit data? Assuming even parity, generate the Hamming code for the 7-bit dataword 1001101. If the fifth bit from the left of the received codeword is changed to 0, can

this be detected? Give reasons for your answer.

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: CST 372

Course Name : Data and Computer Communication

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

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

1. Define bandwidth. Find the lowest frequency, if a periodic signal has a bandwidth of 20 Hz and the highest frequency is 60 Hz. Draw the spectrum if the signal contains all frequencies of the same amplitude.
2. Assume that a TV picture is to be transmitted over a channel with 4.5 MHz bandwidth and a 35 dB Signal-to-Noise-Ratio. Find the capacity of the channel.
3. How does twisting affect the performance in a twisted pair cable?
4. Which wireless propagation method is suitable for satellite communication? Justify your answer.
5. Explain the two main distortions that can occur in a delta modulated waveform. How can it be avoided?
6. Illustrate the equivalent square wave pattern of the bit string 01001101 using Non-Return-to-Zero (NRZ) - Level and NRZ-Invert encoding schemes.
7. Apply Direct Sequence Spread Spectrum to the data 101 using the Barker sequence 10110111000. Show the encoding and decoding steps.
8. Compare synchronous and statistical time division multiplexing.
9. Find the minimum hamming distance for the following cases:
    a) Detection of two errors

b) Correction of two errors
c) Detection of three errors

10. Find the parity bit for simple even parity check for the following. **(10x3=30)**
    a) 1001010
    b) 0001100
    c) 1000000

Part B

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

11. (a) With the help of suitable figures, distinguish between time and frequency domain representations. **(4)**

    (b) Describe the different types of transmission impairments. **(10)**

OR

12. (a) Calculate the bandwidth, if a periodic signal is decomposed into 4 sine waves with frequencies 50 Hz, 100 Hz, 150 Hz and 200 Hz. Draw the spectrum, assuming all components having an amplitude in the range 6-12 V and all are multiples of two in the increasing order. **(6)**

    (b) Distinguish between Nyquist bandwidth and Shannon capacity. Consider a noiseless channel with a bandwidth of 3000 Hz transmitting a signal with (i) Two signal levels (ii) Four signal levels. Determine the maximum bit rate in both cases. **(8)**

13. (a) For a parabolic reflective antenna operating at 12 GHz with a diameter of 2 m, calculate the effective area and the antenna gain. **(6)**

    (b) List any four advantages and disadvantages of twisted pair, coaxial cable and fiber optic cable. **(8)**

OR

14. (a) Compare the features of terrestrial microwave and satellite microwave. **(6)**

    (b) With the help of suitable diagrams, differentiate Multi-mode and Single-mode optical fibres. How are the rays propagated in Step-index and Graded-index Multi-mode fibres? **(8)**

15. (a) Distinguish between data rate and signal rate. **(4)**

(b) How is polar encoding done? Encode the pattern 010011001110 using the two Biphase schemes. **(10)**

OR

16. (a) Show the equivalent analog sine wave pattern of the bit string 010011010 using Amplitude Shift Keying, Frequency Shift Keying and Phase Shift Keying. **(4)**

(b) State Sampling theorem. Explain Pulse Code Modulation with suitable figures. **(10)**

17. (a) Four channels are multiplexed using Time Division Multiplexing. If each channel sends 100 bytes/sec and we multiplex one byte per channel, determine the frame size, duration of a frame, frame rate and bit rate of the link. **(6)**

(b) Explain the working of Frequency Hopping Spread Spectrum with an example. **(8)**

OR

18. (a) Explain any three techniques by which the disparity in input data rate is handled by Time Division Multiplexing. Give examples. **(4)**

(b) Suppose Alice and Bob are communicating using Code Division Multiple Access. Alice uses the code [+1 +1] and Bob uses the code [+1 -1]. Alice sends a data bit 0 and Bob sends a data bit 1. Show the data in the channel and how they can detect what the other person has sent. **(10)**

19. (a) Explain two-dimensional parity check with examples. **(4)**

(b) Describe the need for a switch in a communication system. What are the different phases in circuit switching? **(10)**

OR

20. (a) Explain the virtual circuit approach of packet switching with a suitable example. **(6)**

(b) Find the Hamming code for the data word 1011001. Assume odd parity. **(8)**

Teaching Plan

No	Contents	No.of Lecture Hrs (35 hrs)
Module-1 (Data Transmission Basics) (6 hrs)		
1.1	Introduction, Communication model, Simplex, Half duplex, Full duplex transmission, Periodic analog signals, Sine wave, Amplitude, Phase, Wavelength	1
1.2	Time and frequency domain, Bandwidth	1
1.3	Analog & digital data and signals	1
1.4	Transmission impairments, Attenuation, Delay distortion, Noise	1
1.5	Data rate limits, Noiseless channel, Nyquist bandwidth	1
1.6	Noisy channel, Shannon's capacity formula	1
Module-2 (Transmission Media) (6 hrs)		
2.1	Guided transmission media, Twisted pair, Coaxial cable	1
2.2	Optical fiber	1
2.3	Unguided media, Radio waves	1
2.4	Terrestrial microwave, Satellite microwave	1
2.5	Infrared	1
2.6	Wireless Propagation, Ground wave, Sky wave, Line-of-Sight (LoS) propagation	1
Module-3 (Digital Transmission and Analog Transmission) (8 hrs)		
3.1	Digital data to digital signal, Non-Return-to-Zero (NRZ), Return-to-Zero (RZ)	1
3.2	Multilevel binary and Biphase	1
3.3	Analog data to digital signal, Sampling theorem, Pulse Code Modulation (PCM)	1

3.4	Delta Modulation (DM)	1
3.5	Digital data to analog signal, Amplitude Shift Keying (ASK)	1
3.6	Frequency Shift Keying (FSK), Phase Shift Keying (PSK)	1
3.7	Analog data to analog signal, Amplitude Modulation (AM)	1
3.8	Frequency Modulation (FM), Phase Modulation (PM)	1
Module-4 (Multiplexing and Spread Spectrum) (7 hrs)		
4.1	Multiplexing, Frequency Division Multiplexing (FDM), Wavelength Division Multiplexing (WDM)	1
4.2	Time Division Multiplexing (TDM), Characteristics, Synchronous TDM, Statistical TDM	1
4.3	Spread spectrum techniques, Direct Sequence Spread Spectrum (DSSS)	1
4.4	Frequency Hopping Spread Spectrum (FHSS)	1
4.5	Code Division Multiplexing	1
4.6	Code Division Multiple Access (CDMA) (Lecture 1)	1
4.7	CDMA (Lecture 2)	1
Module-5 (Error Detection, Correction and Switching) (8 hrs)		
5.1	Digital data communication techniques, Asynchronous & Synchronous transmission	1
5.2	Detecting and correcting errors, Types of errors, Parity check, Checksum	1
5.3	Cyclic Redundancy Check (CRC)	1
5.4	Forward Error Correction (FEC), Hamming distance	1
5.5	Hamming code	1
5.6	Basic principles of switching, Circuit switching	1
5.7	Packet switching	1
5.8	Message switching	1

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 Marks**
	Test 1 (Marks)	**Test 2 (Marks)**	
Remember	**30**	**30**	**30**
Understand	**40**	**40**	**40**
Apply	**30**	**30**	**30**
Analyze			
Evaluate			
Create			

Mark Distribution

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

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment - 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 inputdomain - All Combinations Coverage (ACoC), Each Choice Coverage (ECC), Pair-wise Coverage, T-wise Coverage, Base Choice Coverage, Multiple Base Choices Coverage. TriTyp example. Functional Testing - Functional Testing Concepts of Howden. Functional testing - Important Steps. Types of Functional testing - Equivalence Class Partitioning, Boundary Value Analysis, Decision Tables, Random Testing. Case Study - Black Box testing approaches using JUnit.

Module - 5 (Grey Box Testing Approaches)

Introduction to Grey Box testing - Why Grey Box testing, Gray Box Methodology, Advantages and Disadvantages. Techniques of Grey Box Testing - Matrix Testing, Regression Testing, Orthogonal Array Testing or OAT, Pattern Testing. An Introduction to PEX - Parameterized Unit Testing, The Testing Problem. Symbolic Execution – Example, Symbolic execution tree. PEX application Case Study – PEX.

Text Books

1. Paul Ammann and JeffOffutt ,Introduction to Software Testing.
2. KshirasagarNaik and PriyadarshiTripathy, 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) Balck-box testing.

(ii) White-box testing.

(iii) Grey-box testing.

Course Outcome 2 (CO2): Define 12 mutants for the following method *power*() using effective mutation operators. Try to use each mutation operator at least once. Approximately, how many mutants do you think there would be, if all mutants for *power*() were created?

```
public static int power (int left, int right)
{
//*************************************
// Raises Left to the power of Right
// precondition : Right >= 0
// postcondition: Returns Left**Right
//*************************************
        intrslt;
        rslt = Left;
```

```
if (Right == 0)
{
        rslt = 1;
}
else
{
        for (int i = 2; i <= Right; i++)
        rslt = rslt * Left;
}
return (rslt);
}
```

Course Outcome 3 (CO3): Draw the control flow graph and data flow graph of given piece of code.

```
public static double ReturnAverage(int value[],int AS, int MIN, int MAX){
/*
Function: ReturnAverageComputes the averageof all those numbers in the input array in
the positive range [MIN, MAX]. The 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 (α1, α2).

```
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)**

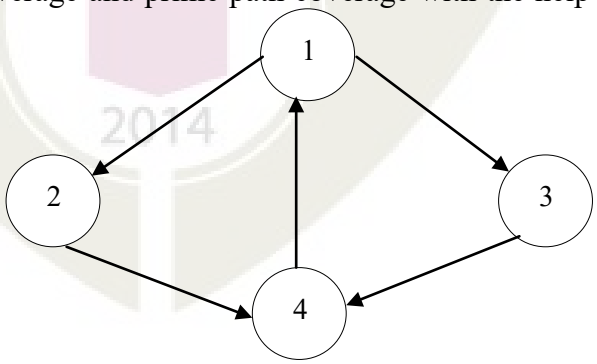
(b) Explain the major difference between control flow testing and data flow testing. **(6)**

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 ← 1;
3. J ← 1;
4. LAB: IF Y ≥ J THEN

5. DO; Z← Z * X;
6. J ← J + 1;
7. GO TO LAB; END;
8. RETURN (Z) ;
9. END;

a) Explain Symbolic execution of POWER (αl, α2).

(b) Explain Execution tree for POWER (αl, α2) 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):

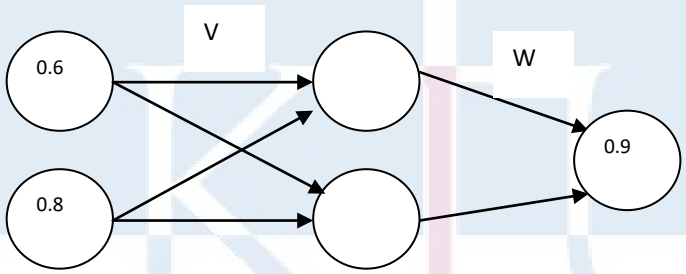
1. Compare regression and classification.
2. Define supervised learning? Distinguish between regression and classification.
3. Discuss the different learning approaches used in machine learning.

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 Ct-1 to Ct
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 Ct-1 to Ct
2. Show the steps involved in an LSTM to predict stock prices.
3. Illustrate the workings of the RNN with an example of a single sequence defined on a vocabulary of four words.

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)**

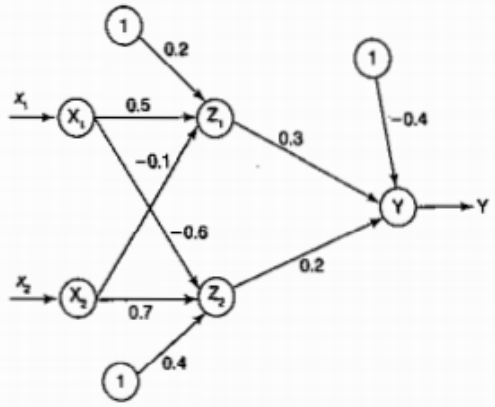
traditional machine learning models

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



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

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

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

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

OR

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

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

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

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

OR

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

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

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

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

OR

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

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

Teaching Plan

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

CST 386	WIRELESS NETWORKS AND IoT APPLICATIONS	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2019

Preamble:

This course equips the learners with fundamental wireless technologies for the Internet of Things(IoT) and the IoT ecosystem. It covers the underlying concepts in wireless networks, communication mechanisms, protocols, hardware, software, and the cloud platforms for IoT. The students will be able to design smart IoT applications for real world problems..

Prerequisite: Sound knowledge in Data Communication, Computer Networks and Programming in C

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

CO1	Recognize wireless technologies required for IoT ecosystem **(Cognitive Knowledge Level : Understand)**
CO2	Perceive the concept of IoT and M2M architecture, IoT examples, and Data Management in IoT **(Cognitive Knowledge Level :Apply)**
CO3	Outline the hardware components used in IoT including Sensors, Actuators and development boards **(Cognitive Knowledge Level : understand)**
CO4	Explain the software components of IoT **(Cognitive Knowledge Level :Understand)**
CO5	Demonstrate the protocols used in IoT and build IoT Programs **(Cognitive Knowledge Level : Apply)**
CO6	Build IoT-based smart real-time applications such as Smart Healthcare, Smart Agriculture, Smart Environment and Smart Home **(Cognitive Knowledge Level : Apply)**

Mapping of course outcomes with program outcomes

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

CO3	✓	✓	✓	✓	✓							✓
CO4	✓	✓	✓	✓	✓							✓
CO5	✓	✓	✓	✓	✓							✓
CO6	✓	✓	✓	✓	✓	✓						

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

Assessment Pattern

Blooms Category	Continuous Assessment Tests		End Semester Examination Marks
	Test 1 (Percentage)	Test 2 (Percentage)	
Remember	**30**	**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 Sevices- 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 DeviceSoftware- 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 Madisetti, "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

SEMESTER VI

HONOURS

CCT394	WIRELESS AND EMAIL SECURITY	CATEGORY	L	T	P	CREDITS
		VAC	4	0	0	4

Preamble: The course on Wireless and Email Security aims at understanding basics of Wireless security and different techniques to secure wireless networks. The course helps the learners to understand the various Email security protocols and different techniques to secure the Email communication. The course ensures that the learners get a better understanding of Domain Name System authentication Framework.

Prerequisite: A Sound knowledge in Computer Networks and Network Security

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

CO#	Course Outcomes
CO1	Summarize the basics of wireless networking.(**Cognitive Knowledge Level: Understand**)
CO2	Explain the different ways by which wireless networks can be secured. (**Cognitive Knowledge Level: Understand)**
CO3	Describe the cryptographic methods used for authentication in wireless networks **(Cognitive Knowledge Level: Understand)**
CO4	Extract the headers of different Email security protocols **(Cognitive Knowledge Level: Understand)**
CO5	Identify the methods used to secure DNS based communication in Wireless environment **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

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

CO5	✓	✓	✓									✓

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

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks (%)**
	Test 1 (%)	**Test 2 (%)**	
Remember	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

Continuous Internal Evaluation Pattern:

Attendance	10 marks
Continuous Assessment Tests (Average of SeriesTests1& 2)	25 marks
Continuous Assessment Assignment	15 marks

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

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

Syllabus

Module-1 (Wireless Networking Basics)
802.11 a/b/g/n, Access Points: DD-WRT, WRT54G, Mini access points, Mobile Hotspots, Enterprise Grade Access Points. SSID, BSSID, MAC Address, Beacons and Broadcasts, Associating and Authenticating, Encryption, Antennas

Module-2 (Securing Wireless Networks)
Phases of Wireless Deployment: New Deployments, Existing Wireless Networks, Wireless Refresh. Secure Design Principles for Wireless Networks: Defense in Depth, Least Privilege, Network Segmentation, Wireless Assessments, Secure the Infrastructure, Rogue AP Detection, Physical Security, Change the default configuration, CIA. Good Wireless Defenses

Module-3 (Wireless Authentication)
Introduction to WPA2 Enterprise with Digital Certificates, Public Key Infrastructure and Digital Certificates: Public Key Cryptography, Digital Certificates, Microsoft Certificate Services. Remote Authentication Dial-in User Service, WPA Enterprise Architecture.

Module–4 (Email Security)
Internet Mail Architecture: Email Components, Email Protocols. Email Formats: RFC 5322, Multipurpose Internet Mail Extensions. Email Threats and Comprehensive Email Security,

S/MIME: Operational Description, S/MIME Message Content Types, Approved Cryptographic Algorithms, S/MIME Messages, S/MIME Certificate Processing, Enhanced Security Services. Pretty Good Privacy, Analysis of Email headers

Module–5 (DNS Security)

DNSSEC, DNS Based Authentication of Named Entities: TLSA Record,Use of DANE for SMTP, Use of DNSSEC for S/MIME. Sender Policy Framework, Domainkeys Identified Mail, Domain Based Message Authentication, Reporting and Conformance.

Text Books

1. Tylor Wrightson, “Wireless Network Security A Beginner's Guide”, McGraw-Hill Education, First Edition, 2016
2. William Stallings “Cryptography and Network Security: Principles and Practice”, Pearson, 7th Global Edition, 2017

References

1. Jonathan LeBlanc & Tim Messerschmidt ,”Identity and Data Security for Web Development”, O’Reilly, First Edition,2016
2. Bryan Sullivan, Vincent Liu “Web Application Security, A Beginners Guide” , McGraw-Hill, First Edition, 2012

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the characteristics and functionalities of Access points, hotspots and Antennas.

Course Outcome 2 (CO2):

1. Explain the different ways by which Wireless networks be secured.

Course Outcome 3 (CO3):

1.Write down the different authentication mechanisms provided by Wireless Networks

Course Outcome 4 (CO4):

1.Apply suitable techniques/tools to examine a Email header and write down the artifacts extracted.

Course Outcome 5 (CO5):

1.Explain the methods used for Domain Name System (DNS) security.

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Model Question Paper

QP CODE: **PAGES: ___**

Reg No:_____
Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FIFTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR
Course Code: CST 394
Course Name : WIRELESS AND EMAIL SECURITY

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

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

1. What are the different types of antenna?
2. What do you mean by DD-WRT?
3. Explain briefly the concept of Least Privilege.
4. Differentiate routers and switches.
5. Explain the components of Public Key Infrastructure (PKI).
6. What are the benefits of using digital certificates?
7. How is email security threats classified?
8. What are the different S/MIME message content types?
9. What is a DNS Database?
10. What is Domain Keys Identified Mail (DKIM)? **(10x3=30 Marks)**

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

11. (a) Define the following terminologies **(8 Marks)**
    (i) SSID, BSSID, MAC Address (ii) Beacons and Broadcasts

    (iii) Associating and Authenticating (iv) Encryption

(b) What does 802.11a/b/g/n mean? **(6 Marks)**

OR

12. (a) Describe (i) Autonomous vs. Controller Based (ii)Access Points **(6 Marks)**

(b) Explain the different security principles. **(8 Marks)**

13. (a) Explain the different ways of Wireless deployment. **(6 Marks)**

(b) Describe (i)Pre-shared Key (PSK)(ii)Protected extensible Authentication Protocol (PeAP) (iii)extensible Authentication Protocol–Transport Layer Security (eAP-TLS). **(8 Marks)**

OR

14. (a) What are the different wireless defenses? Explain any three. **(7 Marks)**

(b) Explain (i)Faraday cage (ii)SSID cloaking (iii)WEP Cloaking **(7 Marks)**

15. (a) Explain the different possible attacks on public key crypto-secured system **(7 Marks)**

(b) Explain the significance of Digital Certificates. **(7 Marks)**

OR

16. (a) What is public key cryptography? Explain. **(6 Marks)**

(b) Explain Certificate Authority Server Structure? **(8 Marks)**

17. (a) How confidentiality is achieved in S/MIME? **(4 Marks)**

(b) With a neat diagram explain the Interrelationship of DNSSEC, SPF, DKIM, DMARC, DANE, and S/MIME for Assuring Message Authenticity and Integrity. **(10 Marks)**

OR

18. (a) Describe the key components of the Internet mail architecture. **(7 Marks)**

(b) Apply using any inbuilt tool of OS and Analyze the Email headers to find the artefacts present in it. **(7 Marks)**

19. (a) Explain the four certification usage models of TLSA RR. **(6 Marks)**

(b) Explain the Sender Policy Framework Operation. **(8 Marks)**

OR

20. (a) Explain the functional flow of DMARC. **(8 Marks)**

(b) What are the different elements of DNS? **(6 Marks)**

TEACHING PLAN

No	Contents	No.of Lecture Hrs
Module - 1 (Wireless Networking Basics) (7 hrs)		
1.1	802.11 a/b/g/n, Access Points	1
1.2	DD-WRT, WRT54G, Mini access points	1
1.3	Mobile Hotspots	1
1.4	Enterprise Grade Access Points.	1
1.5	SSID, BSSID, MAC Address	
1.6	Beacons and Broadcasts, Associating and Authenticating	1
1.7	Encryption, Antennas	1
Module - 2 (Securing Wireless Networks) (8 hrs)		
2.1	Phases of Wireless Deployment: New Deployments	1
2.2	Existing Wireless Networks, Wireless Refresh	1
2.3	Secure Design Principles for Wireless Networks: Defense in Depth, Least Privilege	1
2.4	Network Segmentation, Wireless Assessments	1
2.5	Secure the Infrastructure	1
2.6	Rogue AP Detection	1
2.7	Physical Security	1
2.8	Change the default configuration, CIA. Good Wireless Defenses	1

Module - 3 (Wireless Authentication) (9 hrs)		
3.1	Introduction to WPA2 Enterprise with Digital Certificates	1
3.2	Public Key Infrastructure and Digital Certificates-Lecture 1	1
3.3	Public Key Infrastructure and Digital Certificates-Lecture 2	1
3.4	Public Key Cryptography	1
3.5	Digital Certificates	1
3.6	Microsoft Certificate Services	1
3.7	Remote Authentication	1
3.8	Dial-in User Service	1
3.9	WPA Enterprise Architecture	1
Module – 4 (Email Security) (12 hrs)		
4.1	Internet Mail Architecture: Email Components	1
4.2	Email Protocols	1
4.3	Email Formats: RFC 5322	1
4.4	Multipurpose Internet Mail Extensions	
4.5	Email Threats and Comprehensive Email Security	1
4.6	S/MIME: Operational Description	1
4.7	S/MIME Message Content Types	1
4.8	Approved Cryptographic Algorithms	1
4.9	S/MIME Messages	1
4.10	S/MIME Certificate Processing	1
4.11	Enhanced Security Services, Pretty Good Privacy	1
4.12	Analysis of Email headers	1
Module – 5 (DNS Security) (9 hrs)		
5.1	DNSSEC	1

5.2	DNS Based Authentication of Named Entities	1
5.3	TLSA Record	1
5.4	Use of DANE for SMTP	1
5.5	Use of DNSSEC for S/MIME	1
5.6	Sender Policy Framework	1
5.7	Domain keys Identified Mail	1
5.8	Domain Based Message Authentication	1
5.9	Reporting and Conformance	1

CST 396	ADVANCED TOPICS IN MACHINE LEARNING	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2019

Preamble:

This course enables the learners to understand the advanced concepts and algorithms in machine learning. The course covers the standard and most popular supervised learning algorithms such as linear regression, logistic regression, decision trees, Bayesian learning and the naive Bayes algorithm, basic clustering algorithms, auto encoders, sampling methods and PAC learning. This course helps the students to provide machine learning based solutions to real world problems.

Prerequisite: Basic understanding of probability theory, linear algebra, multivariate calculus and multivariate probability theory.

CO1	Illustrate the concepts of regression and classification techniques **(Cognitive Knowledge Level: Apply)**
CO2	Demonstrate various unsupervised learning techniques **(Cognitive Knowledge Level: Apply)**
CO3	Choose suitable model parameters for different machine learning techniques and to evaluate a model performance **(Cognitive Knowledge Level: Apply)**
CO4	Explain the framework of PAC learning, basic concepts of VC dimension and non-uniform learnability **(Cognitive Knowledge Level: Understand)**
CO5	Construct Bayesian models for data and apply computational techniques to draw inferences **(Cognitive Knowledge Level: Apply)**
CO6	Illustrate the concepts of sampling algorithms, auto encoder, generative adversarial networks **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO1 2
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
	Test1 (Percentage)	Test2 (Percentage)	
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 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 a maximum 2 sub-divisions and carry 14 marks.

Syllabus

Module -1 (Supervised Learning)

Overview of machine learning - supervised, semi-supervised, unsupervised learning, reinforcement learning Regression algorithms: least squares linear regression, gradient descent, closed form, normal equations, regularization techniques (LASSO, RIDGE), polynomial regression. Discriminative Methods - Logistic Regression, Decision Tree Learning. Generative Methods - Naive Bayes Classifier, Gaussian Discriminant Analysis (GDA).

Module -2 (Unsupervised Learning)

Clustering - Similarity measures, Hierarchical Agglomerative Clustering, K-means partitional clustering, K-medoids clustering, Gaussian mixture models: Expectation Maximization (EM) algorithm for Gaussian mixture model.

Module -3 (Practical aspects in machine learning)

Classification Performance measures - Precision, Recall, Accuracy, F-Measure, ROC, AUC, generalisation and overfitting, cross-validation, bias-variance tradeoff, error estimation, parameter and model selection. Ensemble Methods - Bagging, Boosting, Adaboost, Random Forests.

Module -4 (Statistical Learning Theory)

Models of learnability- learning in the limit, probably approximately correct (PAC) learning. Sample complexity- quantifying the number of examples needed to PAC learn, Computational complexity of training, Sample complexity for finite hypothesis spaces, PAC results for learning conjunctions, Sample complexity for infinite hypothesis spaces, Vapnik-Chervonenkis(VC) dimension.

Module -5 (Advanced Machine Learning Topics)

Graphical models - Bayesian belief networks, Markov random fields(MRFs), Inference on chains and factor graphs, inference on clique trees. Monte Carlo methods – Basic sampling algorithms, rejection sampling, importance sampling, Markov chain Monte Carlo(MCMC), Gibbs sampling. Variational methods. Auto Encoder, Variational AutoEncoder, Generative Adversarial Networks

Textbook

1. Christopher M. Bishop. Pattern recognition and machine learning. Springer 2006.
2. Ethem Alpaydin, Introduction to Machine Learning, 2nd edition, MIT Press 2010.
3. Mohammed J. Zaki and Wagner Meira, Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge University Press, First South Asia edition, 2016.
4. Ian Goodfellow, Yoshua Bengio and Aaron Courville. Deep Learning. MIT Press 2016.
5. Mehryar Mohri, Afshin Rostamizadeh and Ameet Talwalkar. Foundations of Machine Learning. Second edition. MIT Press 2018.
6. Tom Mitchell. Machine Learning. McGraw Hill 1997.
7. Richard O. Duda, Peter E . Hart, David G. Stork. Pattern classification, Second Edition. Wiley.
8. Jiawei Han, Micheline Kamber, Jian Pei. Data Mining Concepts and Techniques, Third Edition. Morgan Kaufmann.
9. David Foster. Generative Deep Learning - Teaching Machines to Paint, Write, Compose, and Play. O'Reilly Media, Inc., June 2019.

Reference Books

1. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective. MIT Press 2012
2. Carl Edward Rasmussen and Christopher K. I. Williams. Gaussian Processes for Machine Learning. MIT Press 2005.

Sample Course Level Assessment Questions

Course Outcome1 (CO1):

1. Consider a naive Bayes classifier with 3 boolean input variables, $\mathbf{X_1}$, $\mathbf{X_2}$ and $\mathbf{X_3}$, and one boolean output, **Y**. How many parameters must be estimated to train such a naive Bayes classifier? How many parameters would have to be estimated to learn the above classifier if we do not make the naive Bayes conditional independence assumption?
2. Describe the ID3 algorithm. Is the order of attributes identical in all branches of the decision tree?
3. Explain the difference between (batch) gradient descent and stochastic gradient descent. Give an example of when you might prefer one over the other.
4. Suppose that you are asked to perform linear regression to learn the function that outputs y, given the D-dimensional input x. You are given N independent data points, and that all the D attributes are linearly independent. Assuming that D is around 100, would you prefer the closed form solution or gradient descent to estimate the regressor?
5. Suppose you have a three class problem where class label y $\in$ 0, 1, 2 and each training example $\boldsymbol{X}$ has 3 binary attributes $\boldsymbol{X_1, X_2, X_3} \in \mathbf{0, 1}$. How many parameters (probability distribution) do you need to know to classify an example using the Naive Bayes classifier?

Course Outcome 2(CO2):

1. Which similarity measure could be used to compare feature vectors of two images? Justify your answer.
2. Illustrate the strength and weakness of k-means algorithm.
3. Suppose you want to cluster the eight points shown below using **k**-means

	A_1	A_2
x_1	2	10
x_2	2	5
x_3	8	4
x_4	5	8
x_5	7	5
x_6	6	4
x_7	1	2
x_8	4	9

Assume that **k = 3** and that initially the points are assigned to clusters as follows:

$C_1 = \{x_1, x_2, x_3\}$, $C_2 = \{x_4, x_5, x_6\}$, $C_3 = \{x_7, x_8\}$. Apply the **k**-means algorithm until convergence, using the Manhattan distance.

4. Cluster the following eight points representing locations into three clusters: $A_1(2, 10)$, $A_2(2, 5)$, $A_3(8, 4)$, $A_4(5, 8)$, $A_5(7, 5)$, $A_6(6, 4)$, $A_7(1, 2)$, $A_8(4, 9)$.

   Initial cluster centers are: $A_1(2, 10)$, $A_4(5, 8)$ and $A_7(1, 2)$.

   The distance function between two points $a = (x_1, y_1)$ and $b = (x_2, y_2)$ is defined as $D(a, b) = |x_2 - x_1| + |y_2 - y_1|$

   Use **k**-Means Algorithm to find the three cluster centers after the second iteration.

Course Outcome 3(CO3):

1. What is ensemble learning? Can ensemble learning using linear classifiers learn classification of linearly non-separable sets?
2. Describe boosting. What is the relation between boosting and ensemble learning?
3. Classifier A attains 100% accuracy on the training set and 70% accuracy on the test set. Classifier B attains 70% accuracy on the training set and 75% accuracy on the test set. Which one is a better classifier. Justify your answer.
4. What are ROC space and ROC curve in machine learning? In ROC space, which points correspond to perfect prediction, always positive prediction and always negative prediction? Why?
5. Suppose there are three classifiers A,B and C. The (FPR, TPR) measures of the three classifiers are as follows – A (0, 1), B (1, 1) , C (1,0.5). Which can be considered as a perfect classifier? Justify your answer.

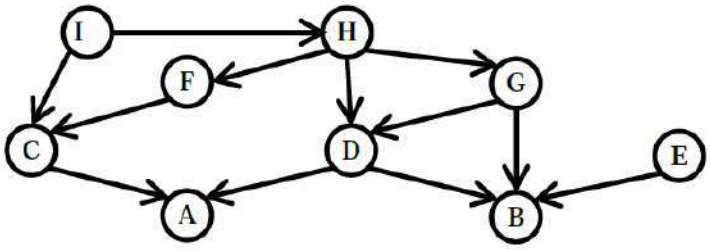
Course Outcome 4(CO4): .

1. A monotone conjunction is a conjunction of the variables such that no variable is negated. Show that the concept class of monotone conjunction is probably approximately correct (PAC)-learnable.
2. Consider a Boolean classification problem with n binary variables and a hypothesis space H, where each hypothesis is a decision tree of depth 2, using only two variables. How many training examples, m suffice to assure that with probability at least 0.99, any consistent learner using H will output a hypothesis with true error at most 0.05
3. Show that the concept class C containing the set of all boolean functions on n variable is not PAC-learnable.

4. What is the Vapnik-Chervonenkis(VC)-dimension of a circle centered at the origin.
5. A hypothesis space that has a high VC dimension is good, bad, or neither? Explain in terms of both (a) richness or expressive power of the hypotheses, and (b) sample complexity.

Course Outcome 5(CO5):

1. Write down the factored conditional probability expression that corresponds to the graphical Bayesian Network shown below.



2. How do we learn the conditional probability tables(CPT) in Bayesian networks if information about some variables is missing? How are these variables called?

Course Outcome 6 (CO6):

1. Derive an algorithm using the inverse transform method to generate a random sample from the exponential distribution.
2. Explain the pros and cons of importance sampling versus rejection sampling.
3. Sketch the core idea of the Monte Carlo method. What is a sample? What is a direct sampling method? Why can't it be used directly to do any inference? What is rejection sampling? What is its major disadvantage?
4. Generative Adversarial Networks(GANs) include a generator and a discriminator. Sketch a basic GAN using those elements, a source of real images, and a source of randomness.
5. The word “adversarial” in the acronym for GANs suggests a two-player game. What are the two players, and what are their respective goals?

Model Question Paper

QP CODE:

Reg No: _____

Name: _____ **PAGES : 5**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Course Code: CST 396

Course Name: Advanced Topics in Machine Learning

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

PART A

Answer All Questions. Each Question Carries 3 Marks

1.	Suppose you have a dataset with m = 1000000 examples and n = 200000 features for each example. You want to use multivariate linear regression to fit the parameters to our data. Should you prefer gradient descent or the normal equation? Justify your answer.	
2.	Define Information gain? How is that different from Gain ratio? Give the advantage of using Gain ratio measure?	
3.	What is cluster analysis? Identify two applications where cluster analysis can be applied to multimedia data?	
4.	Given two objects represented by the tuples (22, 1, 42, 10) and (20, 0, 36, 8): (i) Compute the Euclidean distance between the two objects. (ii) Compute the Manhattan distance between the two objects.	
5.	Suppose there are three classifiers A,B and C. The (FPR, TPR) measures of the three classifiers are as follows – A (0, 1), B (1, 1) , C (1,0.5). Which can be considered as a perfect classifier? Justify your answer.	
6.	How Bias-Variance Tradeoff affects machine learning algorithms?	
7.	For a particular learning task, if the requirement of error parameter ε changes from 0.1 to 0.01. How many more samples will be required for probably approximately correct(PAC) learning?	

8.		Suppose we have a hypothesis set that labels all points inside an interval ***[a, b]*** as class 1. Find its Vapnik-Chervonenkis(VC)- dimension?	
9.		Given a density function ***f(x)***, the rejection sampling is a method that can generate data points from the density function ***f***. List the three steps to generate a random sample from f using rejection sampling.	
10.		How does the variational auto-encoder(VAE) architecture allow it to generate new data points, compared to auto-encoder, which cannot generate new data points?	**(10x3=30)**
		Part B **(Answer any one question from each module. Each question carries 14 Marks)**	
11.	(a)	Consider the hypothesis for the linear regression $h_\theta(x) = \theta_0 + \theta_1 x$, and the cost function $J(\theta_0, \theta_1) = 1/2m \sum_{i=1}^{m} (h_\theta(x^{(i)}) - y^{(i)})^2$ where m is the number of training examples. Given the following set of training examples. x | y 3 | 2 1 | 2 0 | 1 4 | 3 Answer the following questions : 1) Find the value of $h_\theta(2)$ if $\theta_0 = 0$ and $\theta_1 = 1.5$ 2) Find the value of J(0,1) 3) Suppose the value of $J(\theta_0, \theta_1) = 0$. What can be inferred from this.	**(5)**
	(b)	Write a gradient descent algorithm for multivariate regression? Compare the gradient and analytical solution to the multivariate regression?	**(9)**
		OR	
12.	(a)	Consider the collection of training samples (S) in the Figure given below. Drug is the target attribute which describes the Drug suggested for each patient. Find the value of the following . i) Gain(S, Sex) ii) Gain (S, Cholesterol)	**(9)**

		<table><tr><th>Patient ID</th><th>Age</th><th>Sex</th><th>BP</th><th>Cholesterol</th><th>Drug</th></tr><tr><td>p1</td><td>Young</td><td>F</td><td>High</td><td>Normal</td><td>Drug A</td></tr><tr><td>p2</td><td>Young</td><td>F</td><td>High</td><td>High</td><td>Drug A</td></tr><tr><td>p3</td><td>Middle-age</td><td>F</td><td>Hiigh</td><td>Normal</td><td>Drug B</td></tr><tr><td>p4</td><td>Senior</td><td>F</td><td>Normal</td><td>Normal</td><td>Drug B</td></tr><tr><td>p5</td><td>Senior</td><td>M</td><td>Low</td><td>Normal</td><td>Drug B</td></tr><tr><td>p6</td><td>Senior</td><td>M</td><td>Low</td><td>High</td><td>Drug A</td></tr><tr><td>p7</td><td>Middle-age</td><td>M</td><td>Low</td><td>High</td><td>Drug B</td></tr><tr><td>p8</td><td>Young</td><td>F</td><td>Normal</td><td>Normal</td><td>Drug A</td></tr><tr><td>p9</td><td>Young</td><td>M</td><td>Low</td><td>Normal</td><td>Drug B</td></tr><tr><td>p10</td><td>Senior</td><td>M</td><td>Normal</td><td>Normal</td><td>Drug B</td></tr><tr><td>p11</td><td>Young</td><td>M</td><td>Normal</td><td>High</td><td>Drug B</td></tr><tr><td>p12</td><td>Middle-age</td><td>F</td><td>Normal</td><td>High</td><td>Drug B</td></tr><tr><td>p13</td><td>Middle-age</td><td>M</td><td>High</td><td>Normal</td><td>Drug B</td></tr><tr><td>p14</td><td>Senior</td><td>F</td><td>Normal</td><td>High</td><td>Drug A</td></tr></table>	
	(b)	Explain how LASSO regression helps to reduce the overfitting problem?	**(5)**
13.	(a)	Suppose that we have the following data: <table><tr><th>a</th><th>b</th><th>c</th><th>d</th><th>e</th><th>f</th><th>g</th><th>h</th><th>i</th><th>j</th></tr><tr><td>(2,0)</td><td>(1,2)</td><td>(2,2)</td><td>(3,2)</td><td>(2,3)</td><td>(3,3)</td><td>(2,4)</td><td>(3,4)</td><td>(4,4)</td><td>(3,5)</td></tr></table> Identify the cluster by applying the k-means algorithm, with k = 2. Try using initial cluster centers as far apart as possible.	**(9)**
	(b)	Describe EM algorithm for Gaussian mixtures.	**(5)**
		OR	
14.	(a)	Illustrate the strength and weakness of k-means in comparison with the k-medoids algorithm.	**(4)**
	(b)	Suppose that we have the following data . Use single linkage Agglomerative clustering to identify the clusters. Draw the Dendogram. Use Euclidean distance measure	**(10)**

	X	Y
P1	0.4	0.53
P2	0.22	0.38
P3	0.35	0.32
P4	0.26	0.19
P5	0.08	0.41
P6	0.45	0.30

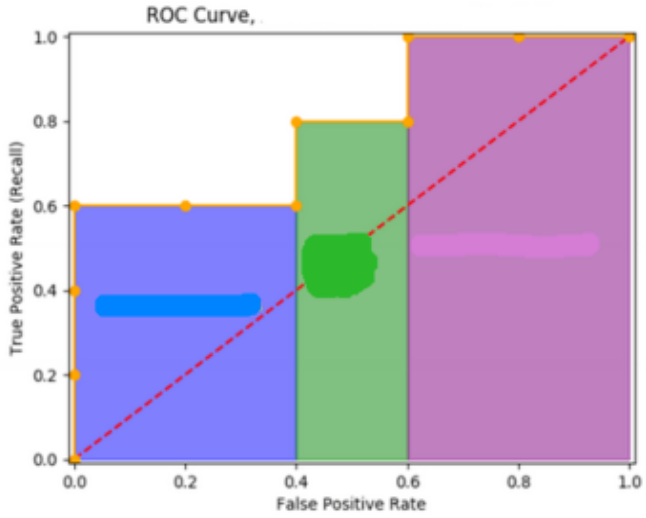
15. (a) Define Precision, Recall, Accuracy and F-measure? **(4)**

(b) What does it mean for a classifier to have a high precision but low recall? **(3)**

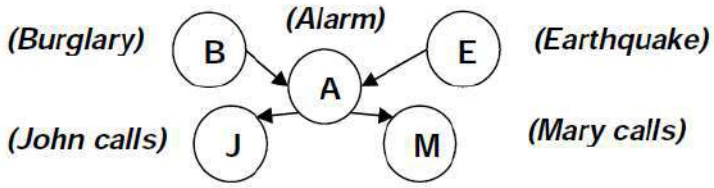
(c) Fill in the missing values in the accompanying three class confusion matrix. Given that model accuracy is 72% and classification error for class 2 is 20%. Find also the precision and recall for class1 **(7)**

		Predicted		
		Class 1	**Class 2**	**Class 3**
Actual	**Class 1**	14	2	5
	Class 2	?(X)	40	2
	Class 3	1	?(Y)	18

OR

16.	(a)	What are ROC space and ROC curve in machine learning? In ROC space, which points correspond to perfect prediction, always positive prediction and always negative prediction? Why?	**(4)**
	(b)	Given the following ROC Curve? Find the AUC? 	**(3)**
	(c)	How does random forest classifier work? Why is a random forest better than a decision tree?	**(7)**
17.	(a)	Show that the concept class Cn of the conjunction of boolean literals up to n variables is probably approximately correct(PAC)-learnable.	**(8)**
	(b)	Explain the concept of Vapnik-Chervonenkis (VC) dimension using shattering. How the number of training examples required to train the model is related to the VC dimension and what is its relation with training and test errors.	**(6)**
		OR	
18.	(a)	Consider a Boolean classification problem with ***n*** binary variables and a hypothesis space ***H***, where each hypothesis is a decision tree of depth 1. How many training examples, ***m*** suffice to assure that with probability at least 0.99, any consistent learner using ***H*** will output a hypothesis with true error at most 0.05?	**(7)**
	(b)	Prove that VC(H) ≤ log2 |H|, where H is a hypothesis space. (|H| denotes the	**(7)**

		cardinality of the hypothesis space)	
19.	(a)	Shown below is the Bayesian network corresponding to the Burglar Alarm problem, P(J | A) P(M | A) P(A | B, E) P(B) P(E). The probability tables show the probability that variable is True, e.g., P(M) means P(M = t). Find P(J = t ∧ M = f ∧ A = f ∧ B = f ∧ E = t).	**(7)**
	(b)	Derive an algorithm using the inverse transform method to generate a random sample from the distribution with density $f_X(x) = 3x^2,\ 0 < x < 1$.	**(7)**
		OR	
20.	(a)	Draw the Bayesian Network that corresponds to this conditional probability: ***P(A | B,C,E) P(B | D,E) P(C | F,H) P(D | G) P(E| G,H) P(F | H) P(G) P(H)***	**(6)**
	(b)	What is effective sample size (ESS)? Why is a large ESS necessary but not sufficient for good MCMC mixing?	**(3)**
	(c)	Describe the overall Gibbs sampling algorithm briefly	**(5)**



P(E)
.002

A	P(M)
t	.70
f	.01

P(B)
.001

A	P(J)
t	.90
f	.05

B	E	P(A)
t	t	.95
t	f	.94
f	t	.29
f	f	.001

Teaching Plan

Module 1 : (Supervised Learning)(10 hours)		
1.1	Supervised, semi-supervised, unsupervised learning, reinforcement learning (TB 2: Ch 1)	1 hour
1.2	Least squares linear regression (TB 2: Section 2.6)	1 hour
1.3	Gradient descent, closed form, normal equations (TB 2: Section 5.8)	1 hour
1.4	Regularization techniques (LASSO, RIDGE) (TB 4: Section 7.1)	1 hour
1.5	Polynomial regression (TB 2: Section 2.6)	1 hour
1.6	Logistic Regression (TB 6: Section 3.3)	1 hour
1.7	Decision Tree Learning (ID3) (TB 8: Section 8.2)	1 hour
1.8	Decision Tree Learning (C4.5) (TB 8: Section 8.2)	1 hour
1.9	Naive Bayes Classifier (TB 8: Section 8.3)	1 hour
1.10	Gaussian Discriminant Analysis (GDA) (TB 7: Section 5.2,5.3)	1 hour
Module 2 : (Unsupervised Learning)(8 hours)		
2.1	Similarity measures (TB 8: Section 2.4)	1 hour
2.2	Hierarchical Agglomerative Clustering (TB 3: Chapter 14)	1 hour
2.3	Hierarchical Agglomerative Clustering (TB 3: Chapter 14)	
2.4	K-means partitional clustering (TB 3: Chapter 13)	1 hour
2.5	K-medoids partitional clustering	
2.6	Gaussian mixture models (TB 3: Chapter 13)	1 hour
2.7	Expectation Maximization (EM) algorithm for Gaussian mixture model Lecture-1 (TB 3: Chapter 13)	1 hour
2.8	Expectation Maximization (EM) algorithm for Gaussian mixture model Lecture-2 (TB 3: Chapter 13)	1 hour
Module 3 : (Practical aspects in machine learning) (6 hours)		

3.1	Precision, Recall, Accuracy, F-Measure, ROC, AUC (TB8.5/TB 3: Chapter 22.1)	1 hour
3.2	Generalisation and overfitting, cross-validation (TB 2: Section 2.7,4.8)	1 hour
3.3	Bias-variance tradeoff (TB 2: Chapter 22.3)	1 hour
3.4	Error estimation, parameter and model selection (TB 3: Chapter 8.5)	1 hour
3.5	Bagging, Boosting (TB 8: Chapter 8.6)	1 hour
3.6	Adaboost, Random Forests (TB 8: Chapter 8.6)	1 hour
Module 4 : (Statistical Learning Theory) (TB 5 – Chapter 2, 3.3)(7 hours)		
4.1	Learning in the limit, probably approximately correct (PAC) learning	1 hour
4.2	Quantifying the number of examples needed to PAC learn	1 hour
4.3	Computational complexity of training	1 hour
4.4	Sample complexity for finite hypothesis spaces	1 hour
4.5	PAC results for learning conjunctions	1 hour
4.6	Sample complexity for infinite hypothesis spaces	1 hour
4.7	Vapnik-Chervonenkis(VC) dimension	1 hour
Module 5 : (Advanced Machine Learning Topics) (13 hours)		
5.1	Bayesian belief networks (TB 1 – Chapter 8)	1 hour
5.2	Markov random fields (TB 1 – Chapter 8)	1 hour
5.3	Inference on chains and factor graphs (TB 1 – Chapter 8)	1 hour
5.4	Inference on clique trees (TB 1 – Chapter 8)	1 hour
5.5	Basic sampling algorithms (TB 1 – Chapter 11)	1 hour
5.6	Rejection sampling (TB 1 – Chapter 11)	1 hour
5.7	Importance sampling (TB 1 – Chapter 11)	1 hour
5.8	Markov chain Monte Carlo(MCMC) (TB 1 – Chapter 11)	1 hour
5.9	Gibbs sampling (TB 1 – Chapter 11)	1 hour

5.10	Variational method (TB 1 – Chapter 10)	1 hour
5.11	Auto Encoder (TB 4 – Chapter 14)	1 hour
5.12	Variational AutoEncoder (TB 9 – Chapter 3)	1 hour
5.13	Generative Adversarial Networks (TB 9 – Chapter 4)	1 hour

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	PO 10	PO11	PO 12
CO1	✓	✓	✓	✓	✓							✓
CO2	✓	✓	✓	✓	✓	✓						✓
CO3	✓	✓	✓	✓	✓	✓						✓
CO4	✓	✓	✓	✓	✓	✓						✓
CO5	✓											✓

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test 1 (%)	Test 2 (%)	
Remember	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

COMMON COURSES

(S5 & S6)

MCN 301	DISASTER MANAGEMENT	Category	L	T	P	CREDIT	YEAR OF INTRODUCTION
		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	PO 9	PO1 0	PO1 1	PO1 2
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. Sulphey, 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 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.

    i. If the monthly sales is Rs. 120000 estimate contribution and break-even sales.
    ii. 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, 3 rd 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 Outcome1 (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 Modem 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)**

Teaching Plan

Sl.No	TOPIC	SESSION
	Module I	
1.1	Introduction to management	1
1.2	Levels of managers and skill required	2
1.3	Classical management theories	3
1.4	neo-classical management theories	4
1.5	modern management theories	5
1.6	System approaches to Management,	6
1.7	Task and Responsibilities of a professional Manager	7
	Module 2	
2.1	Management process – planning	8
2.2	Mission – objectives – goals – strategy – policies – programmes – procedures	9
2.3	Organizing, principles of organizing, organization structures	10
2.4	Directing, Leadership	11
2.5	Motivation, Controlling	12
	Module III	
3.1	Concept of productivity and its measurement Competitiveness	13
3.2	Decision making process;	14
3.3	Models in decision making	15
3.4	Decision making under certainty and risk	16
3.5	Decision making under uncertainty	17
3.6	Decision trees	18
3.7	Models of decision making.	19
	Module IV	
4.1	Project Management	20

Sl.No	TOPIC	SESSION
	Module I	
4.2	Network construction	21
4.3	Arrow diagram, Redundancy	22
4.4	CPM and PERT Networks	23
4.5	Scheduling computations	24
4.6	PERT time estimates	25
4.7	Probability of completion of project	26
4.8	Introduction to crashing	
	Module V	
5.1	Introduction to functional areas of management,	28
5.2	Operations management	29
5.3	Human resources management ,	30
5.4	Marketing management	31
5.5	Financial management	32
5.6	Entrepreneurship,	33
5.7	Business plans	34
5.8	Corporate social responsibility, Patents and Intellectual property rights	35

SEMESTER VII

SCHEME : 2019

PROGRAMME: CSE (CYBER SECURITY)

CCT 401	ETHICAL HACKING	CATEGORY	L	T	P	Credits	Year of Introduction
		PCC	2	1	0	3	2019

Preamble:

The course enables students to learn ethical hacking and security challenges in computer networking. It addresses the data security issues, types of attacks including malwares, viruses, sniffer and denial of service. Students will also learn how to protect the network system using firewalls and filters, about the legal, professional and ethical issues.

Prerequisite: Knowledge in Cryptography, System and Network Security, Computer Networks**.**

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

CO#	Course Outcomes
CO1	Explain the basic concepts of Ethical hacking. (**Cognitive Knowledge Level: Understand**)
CO2	Utilize the tools to conduct competitive intelligence and social engineering. (**Cognitive Knowledge Level: Apply**)
CO3	Examine the different types of cyber and network attack vectors and players. (**Cognitive Knowledge Level: Apply**)
CO4	Use different security techniques to protect system and user data. (**Cognitive Knowledge Level: Apply**)
CO5	Infer the basic concepts of logging and safeguard controls/measures. (**Cognitive Knowledge Level: Understand**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO8	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**	Lifelong learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	Test1 (%)	**Test2 (%)**	**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 Tests	**:** 25 marks
Continuous Assessment Assignment	**:** 15 marks

Internal Examination Pattern:

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

End Semester Examination Pattern:

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

Syllabus

Module 1(Introduction to Ethical Hacking)

Elements of Information Security, Authenticity and Non-Repudiation, Security Challenges, Effects of Hacking, Hacker – Types of Hacker, Ethical Hacker ,Role of Security and Penetration Tester, Penetration Testing Methodologies :– OSSTMM, NIST, OWASP, Categories of Penetration Test, Types of Penetration Tests, Vulnerability Assessment.

Module 2(Foot Printing and Social Engineering)

Tools for Foot Printing, Conducting Competitive Intelligence, Google Hacking, Scanning, Enumeration, Trojans & Backdoors, Virus & Worms, Proxy & Packet Filtering, Denial of Service, Sniffer, Social Engineering–shoulder surfing, Dumpster Diving, Piggybacking.

Module 3(Network attacks)

Vulnerability Data Resources – Exploit Databases – Network Sniffing – Types of Sniffing – MITM Attacks – ARP Attacks – Denial of Service Attacks - Hijacking Session with MITM Attack -DNS Spoofing – ARP Spoofing Attack Manipulating the DNS Records – DHCP Spoofing -Remote

Exploitation – Attacking Network Remote Services – Overview of Brute Force Attacks – Traditional Brute Force – Attacking SMTP – Attacking SQL Servers – Testing for Weak Authentication.

Module 4(Network Protection System & Hacking Web servers)

Routers, Firewall & Honey pots, IDS &IPS, Web Filtering, Vulnerability, Penetration Testing, Session Hijacking, Web Server, SQL Injection, Cross Site Scripting, Exploit Writing, Buffer Overflow, Reverse Engineering, Email Hacking, Incident Handling & Response, Bluetooth Hacking, Mobiles Phone Hacking.

Module 5(Event Logging)

Covering tracks and hiding-Event Logging, Hiding evidence by altering event log. Defenses against log and accounting file attacks, Hiding evidence on the network. System hacking: Password Cracking, Escalating Privileges, and Hiding Files

Textbooks

1. Michael T Simpson, Kent Back man, James Corley, "Hands on ethical hacking and network defense", Cengage Learning, 2nd edition, 2010.
2. Ed Skoudis and Tom Liston, "Counter Hack Reloaded: A step-by-step guide to computer attacks and effective defenses", Prentice Hall Series in Computer Networking and security, 2nd edition, 2006.
3. Rafay Baloch, "Ethical Hacking and Penetration Testing Guide", CRC Press, 2014.

References

1. Kimberly Graves, "Certified Ethical Hacker: A Study Guide", Wiley Publishing, Inc., 2010.
2. Stuart Mc Clure, Joel Scambray, "Hacking Exposed 7 :Network Security Secrets & Solutions", McGraw-Hill publishing, edition 7, 2012

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the different stages in Ethical hacking.
2. The role of penetration testers in the current scenario is inevitable. Justify.

Course Outcome 2 (CO2):

1. Use a suitable tool to perform any of the social engineering attack. What are its inferences?

Course Outcome 3 (CO3):

1. Describe how session hijacking is performed by using MITM attack.
2. Use a suitable tool to perform brute force attack.

Course Outcome 4 (CO4):

1. Explain how vulnerability is assessed using penetration testing.
2. Cross site scripting can be prevented. Explain.

Course Outcome 5 (CO5):

1. Explain the different safeguard measures used to hide evidence.
2. Password cracking a boon or bane. Explain both contexts.

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: CCT 401

Course Name: Ethical Hacking

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

PART A

Answer all Questions. Each question carries 3 Marks

1. What are the different stages involved in hacking?
2. Define the basic elements of information security.
3. What is foot printing? How is it done?
4. How Distributed DoS is different from DoS?
5. Explain network sniffing.
6. How is Brute-force attack performed?
7. What is SQL injection? How can you find whether the website is affected by SQL injection?
8. What is cross-site scripting and what are its different variations?

9. List out the challenges in password cracking.
10. Define Event logging.

(10*3=30 Marks)

PART B

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

11(a) Write down the security challenges in information security. **(6 marks)**

(b) Describe the different types of penetration testing**.** **(8 marks)**

OR

12(a) Explain the role of a penetration tester in ethical hacking. **(8 marks)**

(b) Describe how vulnerability assessment is done**.** **(6 marks)**

13(a) Explain any one method to showcase dumpster diving social engineering attack. **(8marks)**

(b)What are the results obtained by the usage of foot printing tools? **(6 marks)**

OR

14(a) Explain how social enumeration is performed. **(6marks)**

(b) Illustrate the working of network sniffers. **(8 marks)**

15(a) How DNS records can be manipulated using ARP spoofing? **(6 marks)**

(b) Explain network sniffing and its different types? **(8marks)**

OR

16(a) Describe DHCP Spoofing. **(6marks)**

(b) How SQL Servers are vulnerable attacked? **(8marks)**

17(a) Compare and contrast Session Hijacking & SQL Injection. **(8marks)**

(b)Explain how Reverse Engineering is done. **(6marks)**

OR

18(a) Differentiate Bluetooth Hacking & Mobile Phone Hacking. **(6marks)**

(b) Explain the concept of Incident Handling & Response. **(8 marks)**

19(a) How can we hide evidence by altering event logs? **(6marks)**

(b) What are the defense methods taken against log and accounting file attacks? **(8marks)**

OR

20(a) Explain how Password cracking method is used for system hacking? Explain any one tool used for cracking usernames and passwords. **(8marks)**

(b) Evidence on network can be hidden. Justify? **(6 marks)**

TEACHING PLAN

Sl.No	Contents	No. of Lecture Hrs (37)
	Module 1(Introduction to Ethical Hacking) (8 hrs)	
1.1	Elements of Information Security, Authenticity and Non-Repudiation	1
1.2	Security Challenges, Effects of Hacking	1
1.3	Hacker – Types of Hacker, Ethical Hacker- Explanation	1
1.4	Role of Security and Penetration Tester	1
1.5	Penetration Testing Methodologies:–OSSTMM, NIST	1
1.6	OWASP	1
1.7	Categories of Penetration Test, Types of Penetration Tests	1
1.8	Vulnerability Assessment	1
	Module 2(Foot Printing and Social Engineering) (6 hrs)	
2.1	Tools for Foot Printing, Conducting Competitive Intelligence	1
2.2	Google Hacking, Scanning, Enumeration	1
2.3	Trojans & Backdoors, Virus & Worms	1
2.4	Proxy & Packet Filtering	1
2.5	Denial of Service, Sniffer	1
2.6	Social Engineering – shoulder surfing, Dumpster Diving, Piggybacking	1
	Module 3(Network attacks) (9 hrs)	
3.1	Vulnerability Data Resources – Exploit Databases	1
3.2	Network Sniffing – Types of Sniffing	1
3.3	MITM Attacks – ARP Attacks, Denial of Service Attacks	1
3.4	Hijacking Session with MITM Attack	1
3.5	DNS Spoofing – ARP Spoofing Attack	1
3.6	Manipulating the DNS Records – DHCP Spoofing	1
3.7	Remote Exploitation – Attacking Network Remote Services	1
3.8	Overview of Brute Force Attacks – Traditional Brute Force	1
3.9	Attacking SMTP – Attacking SQL Servers, Testing for Weak Authentication	1
	Module 4(Network Protection System & Hacking Web servers) (8 hrs)	
4.1	Routers, Firewall & Honeypots	1
4.2	IDS & IPS, Web Filtering, Vulnerability	1

4.3	Penetration Testing, Session Hijacking, Web Server	1
4.4	SQL Injection	1
4.5	Cross-Site-Scripting, Exploit Writing, Buffer-Overflow	1
4.6	Reverse Engineering, Email Hacking	1
4.7	Incident Handling & Response, Bluetooth Hacking	1
4.8	Mobiles Phone Hacking	1
Module 5(Event Logging) (6 hrs)		
5.1	Covering tracks and hiding-Event-Logging	1
5.2	Hidingevidence by altering event log	1
5.3	Defenses against log and accounting file attacks	1
5.4	Hiding evidence on the network.	1
5.5	System hacking: Password Cracking,	1
5.6	Escalating Privileges, and Hiding Files	1

CCL 411	ETHICAL HACKING LAB	CATEGORY	L	T	P	CREDITS	Year of Introduction
		PCC	0	0	3	2	2019

Preamble: The aim of the course is to give practical exposure on various methods used in Ethical Hacking and to trace out vulnerabilities.

Prerequisite: Topics covered under the course Ethical Hacking.

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

CO1	Use the tools available in Kali Linux to perform Reconnaissance (**Cognitive Knowledge Level: Apply**)
CO2	Use the tools available online or in Kali Linux to perform Configuration and deployment testing (**Cognitive Knowledge Level: Apply**)
CO3	Compute Infrastructure and Application Admin Interface **(Cognitive Knowledge Level: Apply)**
CO4	Use the tools available online or in Kali Linux to perform identity management testing (**Cognitive Knowledge Level :Apply**)
CO5	Use the tools available online or in Kali Linux to perform authorization and authentication testing (**Cognitive Knowledge Level: Apply**)
CO6	Use the tools available online or in Kali Linux to perform input validation and client side testing (**Cognitive Knowledge Level : Apply**)

Mapping of course outcomes with program outcomes

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

CO6	✓	✓	✓		✓						✓

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

Assessment Pattern

Bloom's Category	Continuous Assessment Test (Internal Exam)(%)	End Semester Examination (%)
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 : 15marks

Internal Examination Pattern:

The marks will be distributed as Algorithm 30 marks, Program20 marks, Output 20 marks and Viva 30 marks. Total 100 marks which will be converted out of 75 while calculating Internal Evaluation marks.

End Semester Examination Pattern:

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

Operating System to Use in Lab **:** Kali Linux/Windows 7/8/10

Software to Use in Lab **:** Penetration Testing Softwares/Tools- Open Source

Fair Lab Record:

All Students attending the Lab should have a Fair Record. The fair record should be produced in the University Lab Examination. Every experiment conducted in the lab should be noted in the fair record. For every experiment in the fair record the right hand page should contain Experiment Heading, Experiment Number, Date of Experiment, Aim of Experiment, Data Structure used 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 the experiment and sample output obtained for a set of input.

Syllabus

1. Application Penetration Testing for Network Foot printing (Reconnaissance) and Vulnerability Assessment

2. Test for Configuration and deployment
   Checking for known server vulnerabilities using scanning ' ZAP' or wpscan , NVD database
   Sensitive files using spidering or crawling
   Using robots. txt file finding unreferenced directories

3. Enumerate Infrastructure and Application Admin Interface

Using Google dorks, Hydra tool and ZAP, Finding sub domain info, The harvestor tool, Recon-ng, DDnsrecon, Dig

4. Identity Management Testing
   Test Role Definitions
   Test User Registration Process
   Testing for Account Enumeration and Guessable User Account
   Testing for Weak or Unenforced Username Policy

5. Authentication and Authorization Testing
   Testing for Default Credentials
   Testing for Weak Lock out Mechanism
   Testing for Browser Cache Weaknesses
   Testing for Weak Password Policy
   Testing for Weak Password Change or Reset Functionalities

6. Input Validation Testing
   Testing for SQL Injection

7. Client-side Testing
   Testing for Cross Site Scripting
   Testing for JavaScript Execution
   Testing for HTML Injection

PRACTICE QUESTIONS

List of Exercises/ Experiments

1. Using any reconnaissance tool perform active reconaissance
2. Check for known server vulnerabilities using scanning ' ZAP' or wpscan or NVD database.
3. Use the following tools to Enumerate Infrastructure and Application Admin Interface Google dorks, Hydra tool and ZAP, Finding sub domain info, The harvestor tool, Recon-ng, Dnsrecon, Dig
4. Perform Identity Management Testing
5. Perform Authentication and Authorization Testing
6. Perform Input Validation Testing
7. Perform Client side testing

CCQ 413	SEMINAR	CATEGORY	L	T	P	Credits	Year of Introduction
		PWS	0	0	3	2	2019

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

Course Objectives:

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

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

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

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1		**2**	1					3

CO2	3	3	2	3		2	1					3
CO3	3	2			3			1		2		3
CO4	3				2			1		3		3
CO5	3	3	3	3	2	2		2		3		3

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

General Guidelines

- The Department shall form an Internal Evaluation Committee (IEC) for the seminar with academic coordinator for that program as the Chairperson/Chairman and seminar coordinator & seminar guide as members. During the seminar presentation of a student, all members of IEC shall be present.
- Formation of IEC and guide allotment shall be completed within a week after the University examination (or last working day) of the previous semester.
- Guide shall provide required input to their students regarding the selection of topic/ paper.
- Choosing a seminar topic: The topic for a UG seminar should be current and broad based rather than a very specific research work. It's advisable to choose a topic for the Seminar to be closely linked to the final year project area. Every member of the project team could choose or

be assigned Seminar topics that covers various aspects linked to the Project area.

- A topic/paper relevant to the discipline shall be selected by the student during the semester break.
- Topic/Paper shall be finalized in the first week of the semester and shall be submitted to the IEC.
- The IEC shall approve the selected topic/paper by the second week of the semester.
- Accurate references from genuine peer reviewed published material to be given in the report and to be verified.

Evaluation pattern

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

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

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

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

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

CCD 415	PROJECT PHASE I	CATEGORY	L	T	P	Credits	Year of Introduction
		PWS	0	0	6	2	2019

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

Course Objectives:

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

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

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

Mapping of course outcomes with program outcomes

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

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

PROJECT PHASE I

Phase 1 Target

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

Evaluation Guidelines & Rubrics

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

- Project progress evaluation by guide: 30 Marks.
- Interim evaluation by the Evaluation Committee: 20 Marks.
- Final Evaluation by the Evaluation Committee: 30 Marks.
- Project Phase - I Report (By Evaluation Committee): 20Marks.

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

Evaluation by the Guide

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

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

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

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

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

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

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

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

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

EVALUATION RUBRICS for PROJECT Phase I: Interim Evaluation

No.	Parameters	Marks	Poor	Fair	Very Good	Outstanding
1-a	Topic identification, selection, formulation of objectives and/or literature survey. (Group assessment) [CO1]	10	The team has failed to come with a relevant topic in time. Needed full assistance to find a topic from the guide. They do not respond to suggestions from the evaluation committee and/or the guide. No literature review was conducted. The team tried to gather easy information without verifying the authenticity. No objectives formed yet.	The team has identified a topic. The originally selected topic lacks substance and needs to be revised. There were suggestions given to improve the relevance and quality of the project topic. Only a few relevant references were consulted/ studied and there is no clear evidence to show the team's understanding on the same. Some objectives identified, but not clear enough.	Good evidence of the group thinking and brainstorming on what they are going to build. The results of the brainstorming are documented and the selection of topic is relevant. The review of related references was good, but there is scope of improvement. Objectives formed with good clarity, however some objectives are not realistic enough.	The group has brainstormed in an excellent manner on what they were going to build. The topic selected is highly relevant, real world problem and is potentially innovative. The group shows extreme interest in the topic and has conducted extensive literature survey in connection with the topic. The team has come up with clear objectives which are feasible.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
1-b	Project Planning, Scheduling and Resource/ Tasks Identification and allocation. (Group assessment) [CO4]	10	No evidence of planning or scheduling of the project. The students did not plan what they were going to build or plan on what materials / resources to use in the project. The students do not have any idea on the budget required. The team has not yet decided on who does what. No project journal kept.	Some evidence of a primary plan. There were some ideas on the materials /resources required, but not really thought out. The students have some idea on the finances required, but they have not formalized a budget plan. Schedules were not prepared. The project journal has no details. Some evidence on task allocation among the team members.	Good evidence of planning done. Materials were listed and thought out, but the plan wasn't quite complete. Schedules were prepared, but not detailed, and needs improvement. Project journal is presented but it is not complete in all respect / detailed. There is better task allocation and individual members understand about their tasks. There is room for improvement.	Excellent evidence of enterprising and extensive project planning. Gantt charts were used to depict detailed project scheduling. A project management/version control tool is used to track the project, which shows familiarity with modern tools. All materials / resources were identified and listed and anticipation of procuring time is done. Detailed budgeting is done. All tasks were identified and incorporated in the schedule. A well-kept project journal shows evidence for all the above, in addition to the interaction with the project guide. Each member knows well about their individual tasks.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
Phase 1 Interim Evaluation Total Marks: 20						

EVALUATION RUBRICS for PROJECT Phase I: Final Evaluation

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

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

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