SEMESTER V

CST 301	FORMAL LANGUAGES AND AUTOMATA THEORY	Category	L	T	P	Credit	Year of Introduction
		PCC	3	1	0	4	2019

Preamble: This is a core course in theoretical computer science. It covers automata and grammar representations for languages in Chomsky Hierarchy. For regular languages, it also covers representations using regular expression and Myhill-Nerode Relation. The topics covered in this course have applications in various domains including compiler design, decidability and complexity theory, software testing, formal modelling and verification of hardware and software.

Prerequisite: Basic knowledge about the following topic is assumed: sets, relations - equivalence relations, functions, proof by Principle of Mathematical Induction.

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

CO1	Classify a given formal language into Regular, Context-Free, Context Sensitive, Recursive or Recursively Enumerable. **[Cognitive knowledge level: Understand]**
CO2	Explain a formal representation of a given regular language as a finite state automaton, regular grammar, regular expression and Myhill-Nerode relation. [**Cognitive knowledge level: Understand**]
CO3	Design a Pushdown Automaton and a Context-Free Grammar for a given context-free language. [**Cognitive knowledge level** : **Apply**]
CO4	Design Turing machines as language acceptors or transducers. [**Cognitive knowledge level: Apply]**
CO5	Explain the notion of decidability. [**Cognitive knowledge level: Understand]**

Mapping of course outcomes with program outcomes

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

CO2	✔	✔	✔	✔								✔
CO3	✔	✔	✔	✔								✔
CO4	✔	✔	✔	✔								✔
CO5	✔	✔	✔	✔								✔

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

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks**
	Test 1 (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**

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

CST 301 Formal Languages and Automata Theory

Module - 1 (Introduction to Formal Language Theory and Regular Languages)

Introduction to formal language theory– Alphabets, Strings, Concatenation of strings, Languages.

Regular Languages - Deterministic Finite State Automata (DFA) (Proof of correctness of construction not required), Nondeterministic Finite State Automata (NFA), Equivalence of DFA and NFA**,** Regular Grammar (RG), Equivalence of RGs and DFA.

Module - 2 (More on Regular Languages)

Regular Expression (RE), Equivalence of REs and DFA, Homomorphisms, Necessary conditions for regular languages, Closure Properties of Regular Languages, DFA state minimization (No proof required).

Module - 3 (Myhill-Nerode Relations and Context Free Grammars)

Myhill-Nerode Relations (MNR)- MNR for regular languages, Myhill-Nerode Theorem (MNT) (No proof required), Applications of MNT.

Context Free Grammar (CFG)- CFG representation of Context Free Languages (proof of correctness is required), derivation trees and ambiguity, Normal forms for CFGs.

Module - 4 (More on Context-Free Languages)

Nondeterministic Pushdown Automata (PDA), Deterministic Pushdown Automata (DPDA), Equivalence of PDAs and CFGs (Proof not required), Pumping Lemma for Context-Free Languages (Proof not required), Closure Properties of Context Free Languages.

Module - 5 (Context Sensitive Languages, Turing Machines)

Context Sensitive Languages **-** Context Sensitive Grammar (CSG), Linear Bounded Automata.

Turing Machines - Standard Turing Machine, Robustness of Turing Machine, Universal Turing Machine, Halting Problem, Recursive and Recursively Enumerable Languages.

Chomsky classification of formal languages.

Text Book

1. Dexter C. Kozen, Automata and Computability, Springer (1999)

Reference Materials

1. John E Hopcroft, Rajeev Motwani and Jeffrey D Ullman, Introduction to Automata Theory, Languages, and Computation, 3/e, Pearson Education, 2007
2. Michael Sipser, Introduction To Theory of Computation, Cengage Publishers, 2013.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1): Identify the class of the following languages in Chomsky Hierarchy:

- $L_1 = \{a^p | p is\ a\ prime\ number\}$
- $L_2 = \{x\{0,1\}^* | x is\ the\ binary\ representation\ of\ a\ decimal\ number\ which\ is\ a\ multiple\ of 5\}$
- $L_3 = \{a^n b^n c^n | n \geq 0\}$
- $L_4 = \{a^m b^n c^{m+n} | m > 0, n \geq 0\}$
- $L_5 = \{M\#x | M halts\ on x\}$. Here, M is a binary encoding of a Turing Machine and x is a binary input to the Turing Machine.

Course Outcome 2 (CO2):

(i) Design a DFA for the language $L = \{axb | x \in \{a, b\}^*\}$

(ii) Write a Regular Expression for the language: $L = \{x \in \{a, b\}^* | third\ last\ symbol\ in\ x\ is\ b\}$

(iii) Write a Regular Grammar for the language: $L = \{x \in \{0,1\}^* | there\ are\ no\ consecutive\ zeros\ in x\}$

(iv) Show the equivalence classes of the canonical Myhill-Nerode relation induced by the language: $L = \{x \in \{a, b\}^* | x contains\ even\ number\ of a's\ and\ odd\ number\ of b's\}$.

Course Outcome 3 (CO3):

(i) Design a PDA for the language $L = \{ww^R | w \in \{a, b\}^*\}$. Here, the notation w^R represents the reverse of the string w.

(ii) Write a Context-Free Grammar for the language $L = \{a^n b^{2n} | n \geq 0\}$.

Course Outcome 4 (CO4):

(i) Design a Turing Machine for the language $L = \{a^n b^n c^n | n \geq 0\}$

(ii) Design a Turing Machine to compute the square of a natural number. Assume that the input is provided in unary representation.

Course Outcome 5 (CO5): Argue that it is undecidable to check whether a Turing Machine M enters a given state during the computation of a given input x.

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: CST301

Course Name: Formal Languages and Automata Theory

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

PART A

Answer all Questions. Each question carries 3 Marks

1. Design a DFA for the language $L = \{x \in \{a, b\}^* | aba \text{ is not a substring in } x\}$.

2. Write a Regular Grammar for the language: $L = \{axb | x \in \{a, b\}^*\}$

3. Write a Regular Expression for the language:
$L = \{x \in \{0,1\}^* | \text{there are no consecutive } 1\text{'s in } x\}$

4. Prove that the language $L_1 = \{a^{n!} | n \in N\}$ is not regular.

5. List out the applications of Myhill-Nerode Theorem.

6. Write a Context-Free Grammar for the language: $L = \{x \in \{a, b\}^* | \#_a(x) = \#_b(x)\}$. Here, the notation $\#_1(w)$ represents the number of occurrences of the symbol 1 in the string w.

7. Design a PDA for the language of odd length binary palindromes (no explanation is required, just list the transitions in the PDA).

8. Prove that Context Free Languages are closed under set union.

9. Write a Context Sensitive Grammar for the language $L = \{a^n b^n c^n | n \geq 0\}$ (no explanation is required, just write the set of productions in the grammar).

10. Differentiate between Recursive and Recursively Enumerable Languages.

(10x3=30)

Part B

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

11. (a) Draw the state-transition diagram showing an NFA N for the following language L. Obtain the DFAD equivalent to N by applying the subset construction algorithm. **(7)**

$$L = \{x \in \{a, b\}^* | the\ second\ last\ symbol\ in\ x\ is\ b\}$$

(b) Draw the state-transition diagram showing a DFA for recognizing the following language: **(7)**

$$L = \{x \in \{0,1\}^* | x\ is\ a\ binary\ representation\ of\ a\ natural$$

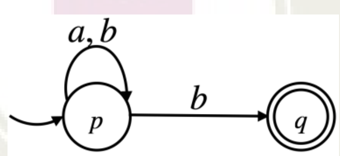
$number\ which\ is\ a$multiple of 5}

OR

12. (a) Write a Regular grammar G for the following language Ldefined as: $L = \{x \in \{a, b\}^* | xdoes\ not\ conatin\ consecutiveb's\}$. **(7)**

(b) Obtain the DFA A_G over the alphabet set $\Sigma = \{a, b\}$, equivalent to the regular grammar G with start symbol S and productions: $S \to aA$ and $A \to aA|bA|b$. **(7)**

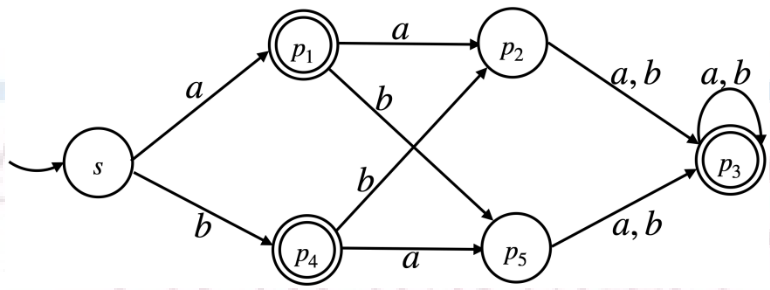
13. (a) Using Kleen's construction, obtain the regular expression for the language represented by the following NFA **(8)**



(b) Using pumping lemma for regular languages, prove that the language $L = \{a^n b^n | n \geq 0\}$ is not regular. **(7)**

OR

14. (a) Obtain the minimum-state DFA from the following DFA. **(8)**



(b) Using ultimate periodicity for regular languages, prove that the language $L = \{a^{n^2} | n \geq 0\}$ is not regular. **(6)**

15. (a) Show the equivalence classes of the canonical Myhill-Nerode relation for the language of binary strings with odd number of 1′s and even number of 0s. **(7)**

(b) With an example, explain ambiguity in Context Free Grammar **(7)**

OR

16. (a) Convert the Context-Free Grammar with productions: $\{S \rightarrow aSb | \epsilon\}$ into Greibach Normal form. **(8)**

(b) Convert the Context-Free Grammar with productions: $\{S \rightarrow aSa | bSb | SS | \epsilon\}$ into Chomsky Normal form. **(6)**

17. (a) Design a PDA for the language $L = \{a^m b^n c^{m+n} | n \geq 0, m \geq 0\}$. Also illustrate the computation of the PDA on a string in the language **(7)**

(b) With an example illustrate how a multi-state PDA can be transformed into an equivalent single-state PDA. **(7)**

OR

18. (a) Using pumping lemma for context-free languages, prove that the language: $L = \{ww | w \in \{a, b\}^*\}$ is not a context-free language. **(6)**

(b) With an example illustrate how a CFG can be converted to a single-state PDA **(8)**

19. (a) Design a Turing machine to obtain the sum of two natural numbers a and b, both represented in unary on the alphabet set $\{1\}$. Assume that initially the tape contains $\vdash 1^a 0 1^b \; \not{b}^{\omega}$. The Turing Machine should halt with $\vdash 1^{a+b} \; \not{b}^{\omega}$ as the tape content. Also, illustrate the computation of your Turing Machine on the input $a = 3$and $b = 2$. **(7)**

(b) With an example illustrate how a CFG can be converted to a single-state PDA. **(7)**

OR

20. (a) Design a Turing machine to obtain the sum of two natural numbers $a$and b, both represented in unary on the alphabet set $\{1\}$. Assume that initially the tape contains $\vdash 1^a 0 1^b \; \not{b}^{\omega}$. The Turing Machine should halt with $\vdash 1^{a+b} \; \not{b}^{\omega}$ as the tape content. Also, illustrate the computation of your Turing Machine on the input $a = 3$and $b = 2$. **(7)**

(b) Write a context sensitive grammar for the language $L = \{a^n b^n c^n | n \geq 0\}$. Also illustrate how the the string $a^2 b^2 c^2$ can be derived from the start symbol of the proposed grammar. **(7)**

Teaching Plan

Sl. No	Topic	No. of Hours (45 hrs)
Module - 1 (Introduction to Formal Language Theory and Regular Languages)		**9 Hours**
1.1	Introduction to formal language theory – Alphabets, strings, concatenation of strings, Languages	1 Hour
1.2	Deterministic Finite State Automata (DFA) – Example DFA (Proof of correctness of construction not required)	1 Hour
1.3	Formal definition of DFA, Language accepted by the class of DFA	1 Hour
1.4	Nondeterministic Finite State Automata (NFA) – Example NFA	1 Hour
1.5	Formal definition of NFA, NFA with □ transitions - examples, formal definition	1 Hour
1.6	Equivalence of DFA and NFA with and without □ transitions - Subset construction	1 Hour
1.7	Regular Grammar (RG) – Example RGs, derivation of sentences	1 Hour
1.8	Formal definition of RG, Language represented by a RG	1 Hour
1.9	Equivalence of RG and DFA	1 Hour
Module - 2 (More on Regular Languages)		**9 Hours**
2.1	Regular Expression (RE) - Example REs and formal definition	1 Hour
2.2	Conversion of RE to NFA with □ transition	1 Hour
2.3	Conversion of NFA with □ transition to RE (Kleen's construction)	1 Hour
2.4	Homomorphisms	1 Hour
2.5	Pumping Lemma for regular languages	1 Hour
2.6	Ultimate periodicity	1 Hour
2.7	Closure Properties of Regular Languages (proof not required)	1 Hour

2.8	DFA state minimization - Quotient construction	1 Hour
2.9	State Minimization Algorithm - Example	1 Hour
Module - 3 (Myhill-Nerode Relations and Context Free Grammars)		**10 Hours**
3.1	Myhill-Nerode Relations (MNR) - Example, Properties of MyhillNerode Relation	1 Hour
3.2	Conversion of DFA to MNR (Proof of correctness not required)	1 Hour
3.3	Conversion of MNR to DFA(Proof of correctness not required)	1 Hour
3.4	Myhill-Nerode Theorem (MNT)	1 Hour
3.5	Applications of MNT	1 Hour
3.6	Context Free Grammar (CFG) - Example CFGs and formal definition	1 Hour
3.7	Proving correctness of CFGs	1 Hour
3.8	Derivation Trees and ambiguity	1 Hour
3.9	Chomsky Normal Form	1 Hour
3.10	Greibach Normal Form	1 Hour
Module - 4 (More on Context-Free Languages)		**8 Hours**
4.1	Nondeterministic Pushdown Automata (PDA) – Example PDAs, formal definition	1 Hour
4.2	Acceptance criteria - equivalence	1 Hour
4.3	Deterministic PDA	1 Hour
4.4	Conversion of CFG to PDA (No proof required)	1 Hour
4.5	Conversion of PDA to CGF - Part I (No proof required)	1 Hour
4.6	Conversion of PDA to CGF - Part II (No proof required)	1 Hour
4.7	Pumping Lemma for context-free languages (No proof required)	1 Hour
4.8	Closure Properties of Context Free Languages	1 Hour

Module - 5 (Context Sensitive Languages, Turing Machines)		**9 Hours**
5.1	Context Sensitive Grammar (CSG) - Examples, formal definition	1 Hour
5.2	Linear Bounded Automata (LBA) - Example LBA, formal definition	1 Hour
5.3	Turing Machine (TM) - TM as language acceptors - examples, formal definition	1 Hour
5.4	TM as transducers - examples	1 Hour
5.5	Robustness of the standard TM model - Multi-tape TMs, Nondeterministic TM	1 Hour
5.6	Universal Turing Machine	1 Hour
5.7	Halting Problem of TM - proof of its undecidability	1 Hour
5.8	Recursive and Recursively Enumerable Languages	1 Hour
5.9	Chomsky classification of formal languages	1 Hour

<table>
<tr><td rowspan="2">CST 303</td><td rowspan="2">COMPUTER NETWORKS</td><td>Category</td><td>L</td><td>T</td><td>P</td><td>Credit</td><td>Year of Introduction</td></tr>
<tr><td>PCC</td><td>3</td><td>1</td><td>0</td><td>4</td><td>2019</td></tr>
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Preamble: Study of this course provides the learners a clear understanding of how computer networks from local area networks to the massive and global Internet are built, how they allow computers to share information and communicate with one another. This course covers the physical aspects of computer networks, layers of OSI Reference model, and inter-networking. The course helps the learners to compare and analyze the existing network technologies and choose a suitable network design for a given system.

Prerequisite: Nil

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

CO#	Course Outcomes
CO1	Explain the features of computer networks, protocols, and network design models **(Cognitive Knowledge: Understand)**
CO2	Describe the fundamental characteristics of the physical layer and identify the usage in network communication **(Cognitive Knowledge: Apply)**
CO3	Explain the design issues of data link layer, link layer protocols, bridges and switches **(Cognitive Knowledge: Understand)**
CO4	Illustrate wired LAN protocols (IEEE 802.3) and wireless LAN protocols (IEEE 802.11) **(Cognitive Knowledge: Understand)**
CO5	Select appropriate routing algorithms, congestion control techniques, and Quality of Service requirements for a network **(Cognitive Knowledge: Apply)**
CO6	Illustrate the functions and protocols of the network layer, transport layer, and application layer in inter-networking **(Cognitive Knowledge: Understand)**

Mapping of course outcomes with program outcomes

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

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and 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	Test 1 (Marks in percentage)	Test 2 (Marks in percentage)	End Semester Examination (Marks in percentage)
Remember	40	30	30

Understand	**50**	**50**	**50**
Apply	**10**	**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 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. 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 anyone. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module - 1 (Introduction and Physical Layer)

Introduction – Uses of computer networks, Network hardware, Network software. Reference models – The OSI reference model, The TCP/IP reference model, Comparison of OSI and TCP/IP reference models.

Physical Layer – Modes of communication, Physical topologies, Signal encoding, Repeaters and hub, Transmission media overview. Performance indicators – Bandwidth, Throughput, Latency, Queuing time, Bandwidth–Delay product.

Module - 2 (Data Link Layer)

Data link layer - Data link layer design issues, Error detection and correction, Sliding window protocols, High-Level Data Link Control(HDLC)protocol. Medium Access Control (MAC) sublayer –Channel allocation problem, Multiple access protocols, Ethernet, Wireless LANs - 802.11, Bridges & switches - Bridges from 802.x to 802.y, Repeaters, Hubs, Bridges, Switches, Routers and Gateways.

Module - 3 (Network Layer)

Network layer design issues. Routing algorithms - The Optimality Principle, Shortest path routing, Flooding, Distance Vector Routing, Link State Routing, Multicast routing, Routing for mobile hosts. Congestion control algorithms. Quality of Service (QoS) - requirements, Techniques for achieving good QoS.

Module - 4 (Network Layer in the Internet)

IP protocol, IP addresses, Internet Control Message Protocol (ICMP), Address Resolution Protocol (ARP), Reverse Address Resolution Protocol (RARP), Bootstrap Protocol (BOOTP), Dynamic Host Configuration Protocol (DHCP). Open Shortest Path First(OSPF) Protocol, Border Gateway Protocol (BGP), Internet multicasting, IPv6, ICMPv6.

Module – 5 (Transport Layer and Application Layer)

Transport service – Services provided to the upper layers, Transport service primitives. User Datagram Protocol (UDP). Transmission Control Protocol (TCP) – Overview of TCP, TCP segment header, Connection establishment &release, Connection management modeling, TCP retransmission policy, TCP congestion control.

Application Layer –File Transfer Protocol (FTP), Domain Name System (DNS), Electronic mail, Multipurpose Internet Mail Extension (MIME), Simple Network Management Protocol

(SNMP), World Wide Web(WWW) – Architectural overview.

Text Books

1. Andrew S. Tanenbaum, Computer Networks, 4/e, PHI (Prentice Hall India).
2. Behrouz A Forouzan, Data Communication and Networking, 4/e, Tata McGraw Hill

Reference Books

1. Larry L Peterson and Bruce S Dave, Computer Networks – A Systems Approach, 5/e, Morgan Kaufmann.
2. Fred Halsall, Computer Networking and the Internet, 5/e.
3. James F. Kurose, Keith W. Ross, Computer Networking: A Top-Down Approach, 6/e.
4. Keshav, An Engineering Approach to Computer Networks, Addison Wesley, 1998.
5. W. Richard Stevens. TCP/IP Illustrated Volume 1, Addison-Wesley, 2005.
6. William Stallings, Computer Networking with Internet Protocols, Prentice-Hall, 2004.
7. Request for Comments (RFC) Pages - IETF -https://www.ietf.org/rfc.html

Course Level Assessment Questions

Course Outcome1 (CO1)

1. Compare TCP/IP and OSI reference model.
2. The purpose of physical layer is to transport a raw bit stream from one machine to another. Justify.

Course Outcome2 (CO2)

1. Write the physical and transmission characteristics of Optical Fibre Cable guided transmission media.
2. The distance between the sender and receiver systems is about 200 KM. The speed of transmission is 2GB/s. Find out the propagation time?

Course Outcome3 (CO3)

1. Ethernet frames must be at least 64 bytes long to ensure that the transmitter is still going in the event of a collision at the far end of the cable. Fast Ethernet has the same 64-byte minimum frame size but can get the bits out ten times faster. How is it possible to maintain the same minimum frame size?
2. What do you mean by bit stuffing?

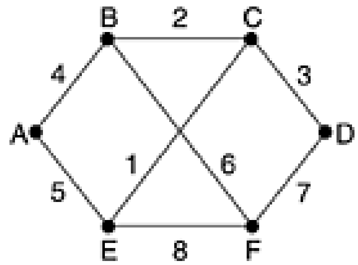
Course Outcome4 (CO4)

1. Draw and explain the frame format for Ethernet.
2. Give the differences between CSMA/CD and CSMA/CA protocol.

Course Outcome5 (CO5)

1. Consider the given subnet in which distance vector routing is used, and the vectors just come in to router C as follows: from B: (5, 0, 8, 12, 6, 2); from D: (16, 12, 6, 0, 9, 10);

and from E: (7, 6, 3, 9, 0, 4). The measured delays from C to B, D, and E, are 6, 3, and 5, respectively. What is C's new routing table? Give both the outgoing line to use and the expected delay.



2. Illustrate the leaky bucket congestion control technique.

Course Outcome 6 (CO6)

1. How do you subnet the Class C IP Address 206.16.2.0 so as to have 30 subnets. What is the subnet mask for the maximum number of hosts? How many hosts can each subnet have?
2. Give the architecture of World Wide Web.

Model Question Paper

QP CODE: **PAGES:**

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Reg No:_______________

Name:_________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST 303

Course Name : Computer Networks

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

PART-A

(Answer All Questions. Each question carries 3 marks)

1. What does "negotiation" mean when discussing network protocols in a layered architecture? Give an example.

2. Define simplex, half-duplex, and full-duplex transmission modes. Give one example for each.

3. Data link protocols almost always put the CRC in a trailer rather than in a header. Why?

4. An 8-bit byte with binary value 10101111 is to be encoded using an even-parity Hamming code. What is the binary value after encoding?

5. Illustrate the Count to Infinity problem in routing.

6. Describe two major differences between the warning bit method and the Random Early Detection (RED) method.

7. The Protocol field used in the IPv4 header is not present in the fixed IPv6 header. Why?

8. How many octets does the smallest possible IPv6 (IP version 6) datagram contain?

9. Can Transmission Control Protocol(TCP) be used directly over a network (e. g. an Ethernet) without using IP? Justify your answer.

10. When Web pages are sent out, they are prefixed by MIME headers. Why?

(10x3=30)

Part B

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

11. (a) With a neat diagram, explain Open Systems Interconnection (OSI) Reference Model. **(8)**

    (b) Compare Twisted Pair, Coaxial Cable and Optical Fibre guided transmission media. **(6)**

OR

12. (a) Consider two networks providing reliable connection-oriented service. One of them offers a reliable byte stream and the other offers a reliable message stream. Are they identical? Justify your answer. **(8)**

    (b) Sketch the waveform in Manchester and Differential Manchester Encoding for the bitstream 11000110010. **(6)**

13. (a) A bit stream 10011101 is transmitted using the standard CRC method. The generator polynomial is $\square^3 + 1$. Show the actual bit string transmitted. Suppose the third bit from the left is inverted during transmission. Show that this error is detected at the receiver's end. **(8)**

(b) Explain the working of High-Level Data Link Control (HDLC) protocol. **(6)**

OR

14. (a) Explain the working of IEEE 802.11 MAC sublayer. **(10)**

(b) Distinguish between Bridges and Switches. **(4)**

15. (a) Illustrate Distance Vector Routing algorithm with an example. **(8)**

(b) Explain the characteristics of Routing Information Protocol (RIP). **(6)**

OR

16. (a) A computer on a 6-Mbps network is regulated by a token bucket. The token bucket is filled at a rate of 1 Mbps. It is initially filled to capacity with 8 megabits. How long can the computer transmit at the full 6 Mbps? **(8)**

(b) Explain how routing is performed for mobile hosts. **(6)**

17. (a) Explain the address resolution problem using Address Resolution Protocol (ARP) and Reverse Address Resolution Protocol (RARP)with an example network. **(10)**

(b) A network on the Internet has a subnet mask of 255.255.240.0. What is the maximum number of hosts it can handle? **(4)**

OR

18. (a) How do you subnet the Class C IP address 195.1.1.0 so as to have 10 subnets with a maximum of 12 hosts in each subnet. **(6)**

(b) Draw IPv6 Datagram format and explain its features. **(8)**

19. (a) Distinguish the header formats of Transmission Control protocol (TCP) and User Datagram Protocol (UDP). **(8)**

(b) Explain the principal Domain Name System (DNS) resource record types for **(6)**

IPv4.

OR

20. (a) What is the role of Simple Mail Transfer Protocol (SMTP) in E- mail? **(6)**

(b) With the help of a basic model, explain the working of World Wide Web (WWW). **(8)**

Teaching Plan

No	Contents	No of Lecture Hrs
	Module – 1 (Introduction and Physical Layer) (10 hrs)	
1.1	Introduction, Uses of computer networks.	1 hour
1.2	Network Hardware, Local Area Networks (LAN), Metropolitan Area Networks (MAN), Wide Area Networks (WAN), Wireless networks, Home networks, Internetworks.	1 hour
1.3	Network Software, Protocol hierarchies, Design issues for the layers.	1 hour
1.4	Connection-oriented and Connectionless services, Service primitives, Relationship of services to protocols.	1 hour
1.5	Reference models, The OSI reference model.	1 hour
1.6	The TCP/IP reference model, Comparisonof OSI and TCP/IP reference models.	1 hour
1.7	Physical layer, Modes of communication, Simplex, Half-duplex, and Full-duplex, Physical topologies, Mesh, Star, Bus, Ring, Hybrid.	1 hour
1.8	Signal encoding, Manchester, Differential Manchester.	1 hour
1.9	Transmission media overview, Guided media (twisted pair, coaxial and fiber optic media), Unguided/wireless media (radio, microwave, and infrared).	1 hour
1.10	Performance indicators, Bandwidth (in Hertz and in Bits per Seconds),	1 hour

	Throughput, Latency (Delay), Queuing time, Bandwidth-Delay product.	
Module 2 – (Data Link Layer) (10 hrs)		
2.1	Data link layer design issues.	1 hour
2.2	Error detection and correction, Error correcting codes	1 hour
2.3	Error detecting codes.	1 hour
2.4	Sliding window protocols.	1 hour
2.5	High-Level Data Link Control(HDLC) protocol.	1 hour
2.6	Medium Access Control (MAC) sublayer, Channel allocation problem, Multiple access protocols.	1 hour
2.7	Ethernet, Ethernet cabling, Manchester encoding, Ethernet MAC sublayer protocol, Binary Exponential Backoff algorithm.	1 hour
2.8	Ethernet performance, Switched Ethernet, Fast Ethernet, Gigabit Ethernet, IEEE 802.2: Logical Link Control.	1 hour
2.9	Wireless LANs, 802.11 protocol stack, Physical layer, MAC Sublayer protocol, Frame structure.	1 hour
2.10	Bridges &switches, Bridges from 802.x to 802.y, Repeaters, Hubs, Bridges, Switches, Routers, and Gateways.	1 hour
Module 3 - (Network Layer) (8 hrs)		
3.1	Network layer design issues.	1 hour
3.2	Routing algorithms, The Optimality Principle, Shortest path routing, Flooding.	1 hour
3.3	Distance Vector Routing.	1 hour
3.4	Link State Routing.	1 hour
3.5	Multicast routing, Routing for mobile hosts.	1 hour

3.6	General principles of congestion control, Congestion prevention policies, Congestion control in virtual circuit subnets.	1 hour
3.7	Congestion control algorithms, Congestion control in Datagram subnets, Load shedding, Jitter control.	1 hour
3.8	Quality of Service, Requirements, Techniques for achieving good Quality of Service.	1 hour
Module 4 – (Network Layer in the Internet) (9 hrs)		
4.1	Network layer in the Internet, Internet Protocol (IP).	1 hour
4.2	IP Addresses, Subnets, Classless Inter-Domain Routing (CIDR).	1 hour
4.3	IP Addresses, Network Address Translation (NAT).	1 hour
4.4	Internet Control Message Protocol (ICMP), Address Resolution Protocol (ARP), Reverse Address Resolution Protocol (RARP).	1 hour
4.5	Bootstrap Protocol (BOOTP), Dynamic Host Configuration Protocol (DHCP).	1 hour
4.6	Open Shortest Path First (OSPF) protocol.	1 hour
4.7	Border Gateway Protocol (BGP).	1 hour
4.8	Internet multicasting.	1 hour
4.9	IPv6, Header format, Extension headers, Internet Control Message Protocol version 6 (ICMPv6).	1 hour
Module 5 - (Transport Layer and Application Layer) (8 hrs)		
5.1	Transport Service, Services provided to the upper layers, Transport service primitives. User Datagram Protocol (UDP).	1 hour
5.2	Transmission Control Protocol (TCP), TCP segment header, Connection establishment &release, Connection management modeling.	1 hour
5.3	TCP retransmission policy, TCP congestion control.	1 hour
5.4	Application layer, File Transfer Protocol (FTP).	1 hour

5.5	Domain Name System (DNS).	1 hour
5.6	Electronic Mail, Multipurpose Internet Mail Extension (MIME).	1 hour
5.7	Simple Network Management Protocol (SNMP).	1 hour
5.8	World Wide Web, Architectural overview.	1 hour

AMT 305	INTRODUCTION TO MACHINE LEARNING	Category	L	T	P	Credit	Year Of Introduction
		PCC	3	1	0	4	2020

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 and classifier performance measures. This course helps the students to provide machine learning based solutions to real world problems.

Prerequisite: Basic understanding of probability theory and linear algebra

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

CO1	Illustrate Machine Learning concepts and basics of supervised learning concepts. (Cognitive Knowledge Level: **Apply)**
CO2	Describe dimensionality reduction techniques and supervised learning concepts (regression, linear classification). **(**Cognitive Knowledge Level: **Apply**)
CO3	Solve real life problems using appropriate machine learning models and evaluate the performance measures and Illustrate the concepts of Multilayer neural network . **(**Cognitive Knowledge Level: **Apply**)
CO4	Illustrate basics of parameter estimation models and the working of classifier SVM classifier model (Cognitive Knowledge Level: **Apply**)
CO5	Describe unsupervised learning concepts (Cognitive Knowledge Level: **Apply**)

Mapping of course outcomes with program outcomes

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

CO3	✔	✔	✔	✔								✔
CO4	✔	✔	✔	✔								✔
CO5	✔	✔	✔	✔								✔

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

Assessment Pattern

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

Evaluate			
Create			

Mark Distribution

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

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

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

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern

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

End Semester Examination Pattern:

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

SYLLABUS

Module-1 (Overview of machine learning)

Introduction to Machine Learning, Machine learning paradigms-supervised, semi-supervised, unsupervised, reinforcement learning.

Supervised learning- Input representation, Hypothesis class, Version space, Vapnik-Chervonenk is (VC) Dimension, Probably Approximately Correct Learning (PAC), Noise, Learning Multiple classes, Model Selection and Generalization

Module-2 (Supervised Learning)

Dimensionality reduction – Subset selection, Principal Component Analysis.

Regression - Linear regression with one variable, Linear regression with multiple variables, solution using gradient descent algorithm and matrix method, basic idea of overfitting in regression. Linear Methods for Classification- Logistic regression, Naive Bayes, Decision tree algorithm ID3.

Case Study: Develop a classifier for face detection.

Module-3 (Classification Assessment and Neural Networks (NN))

Classification Performance measures - Precision, Recall, Accuracy, F-Measure, Receiver Operating Characteristic Curve(ROC), Area Under Curve AUC. Bootstrapping, Cross Validation.

Perceptron, Neural Network - Multilayer feed forward network, Activation functions (Sigmoid, ReLU, Tanh), Back propagation algorithm.

Module-4 (Parameter estimation & SVM Classifier)

Basics of parameter estimation **-** Maximum Likelihood Estimation(MLE) and Maximum a Posteriori estimation(MAP). Bias-Variance decomposition.

Support Vector Machines - Introduction, Maximum Margin hyperplanes, Mathematics behind Maximum Margin Classification, soft margin SVM classifier, non-linear SVM, Kernels for learning non-linear functions, polynomial kernel, Radial Basis Function(RBF), Kernel Trick.

Module-5 (Unsupervised Learning)

Ensemble methods, Voting, Bagging, Boosting.

Unsupervised Learning - Clustering Methods -Similarity measures, K-means clustering, Expectation-Maximization for soft clustering, Hierarchical Clustering Methods , Density based clustering.

Text Book

1. Ethem Alpaydin, Introduction to Machine Learning, 2nd edition, MIT Press 2010.
2. Tom Mitchell, Machine Learning, McGraw-Hill, 1997.

Reference Books

1. Christopher Bishop. Neural Networks for Pattern Recognition, Oxford University Press, 1995.
2. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective, MIT Press 2012.
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements Of Statistical Learning, Second edition Springer 2007.
4. P. Langley, Elements of Machine Learning, Morgan Kaufmann, 1995.
5. Richert and Coelho, Building Machine Learning Systems with Python.
6. Mohammed J. Zaki and Wagner Meira, Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge University Press, First South Asia edition, 2016.
7. Jake VanderPlas, Python Data Science Handbook, O'Reilly Media, 2016
8. Davy Cielen, Arno DB Meysman and Mohamed Ali.Introducing Data Science: Big Data, Machine Learning, and More, Using Python Tools, Dreamtech Press 2016.

Course Level Assessment Questions

Course Outcome1 (CO1):

1. Compare different machine learning paradigms with suitable examples.
2. Explain (a) Hypothesis space (b) Version space (c) Most General hypothesis (d) Most specific hypothesis in the context of a classification problem.
3. Define VC dimension. Show that an axis aligned rectangle can shatter 4 points in 2 dimensions.
4. Explain the concept of PAC learning . Derive an expression for PAC learning in such a way that the selected function will have low generalized error.
5. Distinguish between overfitting and underfitting. How it can affect model generalization?

Course Outcome 2(CO2):

1. 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?

2. Suppose you have a three class problem where class label $\boldsymbol{y} \in \mathbf{0, 1, 2}$ 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?
3. Is principal component analysis a supervised learning problem? Justify your answer
4. Explain feature selection and feature extraction method for dimensionality reduction.
5. Use the ID3 algorithm to construct a decision tree for the data in the following table.

Age	Competition	Type	Class (profit)
Old	Yes	Software	Down
Old	No	Software	Down
Old	No	Hardware	Down
Mid	Yes	Software	Down
Mid	Yes	Hardware	Down
Mid	No	Hardware	Up
Mid	No	Software	Up
New	Yes	Software	Up
New	No	Hardware	Up
New	No	Software	Up

Course Outcome 3(CO3):

1. 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.
2. 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?
3. 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.
4. Briefly explain Perceptron Network.
5. Briefly explain BackPropagation Network.
6. Briefly explain one way in which using tanh instead of logistic activations makes optimization easier.
7. ReLU activation functions are most used in neural networks instead of the tanh activation function. Draw both activation functions and give a) an advantage of the

ReLU function compared to the tanh function. b) a disadvantage of the ReLU function compared to the tanh function.

Course Outcome 4(CO4): .

1. What are support vectors and list any three properties of the support vector classifier solution?
2. Why do you use kernels to model a projection from attributes into a feature space, instead of simply projecting the dataset directly?
3. Describe how Support Vector Machines can be extended to make use of kernels. Illustrate with reference to the Gaussian kernel $K(x, y) = e^{-z}$, where $z = (x-y)^2$.
4. A coin is tossed 100 times and lands heads 62 times. What is the maximum likelihood estimate for θ, the probability of heads.
5. Suppose data $x_1, ..., x_n$ are independent and identically distributed drawn from an exponential distribution $exp(\lambda)$. Find the maximum likelihood for λ.
6. Suppose $x_1, ..., x_n$ are independent and identically distributed(iid) samples from a distribution with density

$$f_X(x \mid \theta) = \begin{cases} \dfrac{\theta x^{\theta-1}}{3^\theta}, & 0 \leq x \leq 3 \\ 0, & \text{otherwise} \end{cases}$$

   Find the maximum likelihood estimate(MLE) for θ.
7. Find the maximum likelihood estimator (MLE) and maximum a posteriori (MAP) estimator for the mean of a univariate normal distribution. Assume that we have N samples, $x_1,..., x_N$ independently drawn from a normal distribution with known variance σ^2 and unknown mean μ and the prior distribution for the mean is itself a normal distribution with mean v and variance β^2. What happens to the MLE and MAP estimators as the number of samples goes to infinity.

Course Outcome 5(CO5): .

1. Illustrate the strength and weakness of the K-means algorithm.
2. 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.

3. 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.

4. What is ensemble learning? Can ensemble learning using linear classifiers learn classification of linearly non-separable sets?
5. Describe boosting. What is the relation between boosting and ensemble learning?

Model Question Paper

QP CODE:

Reg No: _______________

Name: _________________ **PAGES : 4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: AMT305

Course Name: Introduction to Machine Learning

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

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Distinguish between classification and regression with an example.

2. Determine the hypothesis space H and version space with respect to the following data D.

x	2	11	17	0	1	5	7	13	20
Class	0	1	1	0	0	0	0	1	1

3. Is principal component analysis a supervised learning problem? Justify your answer.

4. Specify the basic principle of gradient descent algorithm.

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

6. Mention the primary motivation for using the kernel trick in machine learning algorithms?

7. Suppose that you have a linear support vector machine(SVM) binary classifier. Consider a point that is currently classified correctly, and is far away from the decision boundary. If you remove the point from the training set, and re-train the classifier, will the decision boundary change or stay the same? Justify your answer.

8. Differentiate between bagging and boosting.

9. Illustrate the strength and weakness of the k-means algorithm.

10. Expectation maximization (EM) is designed to find a maximum likelihood setting of the parameters of a model when some of the data is missing. Does the algorithm converge? If so, do you obtain a locally or globally optimal set of parameters?

(10x3=30)

Part B

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

11. (a) Define machine learning. Explain different paradigms of machine learning with examples. **(7)**

(b) Calculate the VC dimension of the following

1)An open internal in R is defined as(a,b) = {x€R | a<x<b}. It has two parameters a and b. Calculate the VC dimension of the set of all open intervals.

2) Suppose the instance space X is the set of real numbers and the hypothesis space H is the set of intervals on the real number line. Here, it is evident that H is the set of hypotheses of the form $a < x < b$, where a and b may be any real constants. What is VC(H)?

OR

12. (a) Let $X = R^2$ and C be the set of all possible rectangles in two dimensional plane which are axis aligned (not rotated). Show that this concept class is PAC learnable. **(7)**

(b) What is meant by noise in data? What are the interpretations of noise? **(7)**

13. (a) Consider the hypothesis for the linear regression $h_\theta(x) = \theta_0 + \theta_1 x$, and the cost function $J(\theta_0, \theta_1) = 1/2m\ \Sigma_1^m(h_\theta(x^{(i)}) - y^{(i)})^2$ where m is the number of training examples. Given the following set of training examples. **(7)**

x	y
3	2
1	2
0	1
4	3

Answer the following questions :

1) Find the value of h_θ (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.

(b) Let $X = R^2$ and C be the set of all possible rectangles in two dimensional plane which are axis aligned (not rotated). Show that this concept class is PAC learnable. **(7)**

OR

14. (a) The following dataset can be used to train a classifier that determines whether a given person is likely to own a car or not. There are three features: education level (primary, secondary, or university); residence (city or country); gender (female, male). **(7)**

education	residence	gender	has car?
sec	country	female	yes
univ	country	female	yes
prim	city	male	no
univ	city	male	no
sec	city	female	no
sec	country	male	yes
prim	country	female	yes
univ	country	male	yes
sec	city	male	yes
prim	city	female	no
univ	city	female	no
prim	country	male	yes

Use ID3 Algorithm and find the best attribute at the root level of the tree

(b) Consider a linear regression problem y = w1x + w0, with a training set having m examples (x1, y1), . . .(xm, ym). Suppose that we wish to minimize the mean 5th degree error (loss function) given by 1/m Σ1m(yi −w1xi − w0)5. **(7)**

1. Calculate the gradient with respect to the parameter w1.

2. Write down pseudo-code for on-line gradient descent on w1.

3. Give one reason in favor of on-line gradient descent compared to batch-gradient descent, and one reason in favor of batch over on-line.

15. (a) Suppose the dataset had 9700 cancer-free images from 10000 images from cancer patients. Find precision, recall and accuracy ? Is it a good classifier? Justify. **(7)**

Actual Class\Predicted class	cancer = yes	cancer = no	Total
cancer = yes	**90**	**210**	300
cancer = no	**140**	**9560**	9700
Total	230	9770	10000

(b) Compare ReLU with Sigmoid function. Consider a neuron with four inputs, and weight of edge connecting the inputs are 1, 2, 3 and 4. Let the bias of the node is zero and inputs are 2, 3, 1, 4. If the activation function is linear f(x)=2x, compute the output of the neuron. **(7)**

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? **(7)**

(b) Discuss with a flowchart ,explain how training and testing is performed in back-propagation neural networks? **(7)**

17. (a) Compute the maximum likelihood estimate for the parameter λ in the Poisson distribution whose probability function is $f(x) = \frac{e^{-\lambda} \lambda^x}{x!}$ **(8)**

(b) Explain the general MLE method for estimating the parameters of a probability distribution **(6)**

OR

18. (a) State the mathematical formulation to express Soft Margin as a constraint optimization problem **(8)**

(b) Explain Kernel Trick in the context of support vector machine. List any two kernel function used in SVM. **(6)**

19. (a) Suppose that we have the following data (one variable). Use single linkage Agglomerative clustering to identify the clusters. **(8)**

Data: (2, 5, 9, 15, 16, 18, 25, 33, 33, 45).

(b) Given two objects represented by the tuples (22, 1, 42, 10) and (20, 0, 36, 8): **(6)**

(i) Compute the Euclidean distance between the two objects.

(ii) Compute the Manhattan distance between the two objects.

(iii) Compute the Minkowski distance between the two objects, using p = 3

OR

20. (a) Suppose that we have the following data: **(8)**

(2, 0), (1, 2), (2, 2), (3, 2), (2, 3), (3, 3), (2, 4), (3, 4), (4, 4), (3, 5)

Identify the cluster by applying the k-means algorithm, with k = 2. Try using initial cluster centers as far apart as possible

(b) Describe EM algorithm for Gaussian Mixtures **(6)**

TEACHING PLAN

No	Contents	No. of Lecture Hours (44 hrs)
Module -1 (Overview of machine learning) (8 hours)		
1.1	Introduction to Machine Learning, Machine learning paradigms-supervised, semi-supervised, unsupervised, reinforcement learning.	1 hour
1.2	Supervised learning- Input representation, Hypothesis class, Version space	2 hours
1.3	Vapnik-Chervonenkis (VC) Dimension	2 hours
1.4	Probably Approximately Correct Learning (PAC)	1 hour
1.5	Noise, Learning Multiple classes	1 hour
1.6	Model Selection and Generalization, Overfitting and Underfitting	1 hour
Module-2 (Supervised Learning) (11 hours)		
2.1	Dimensionality reduction – Subset selection, Principal Component Analysis.	2 hours
2.2	Linear regression with one variable (TB 1: Section 2.6)	1 hour
2.3	Multiple variables, Solution using gradient descent algorithm and matrix method (No derivation required) (TB 1: Section 5.8)	2 hours

2.4	Logistic regression	1 hour
2.5	Naive Bayes (TB 2: Section 18.2)	2 hours
2.6	Decision trees (TB 2: Chapter 19)	1 hour
2.7	Decision trees- ID3 algorithm (TB 2: Chapter 19)	1 hour
2.8	Case Study: Develop a classifier for face detection.	1 hour
Module-3 (Classification Assessment and Neural Networks) (7 hours)		
3.1	Performance measures - Precision, Recall, Accuracy, F-Measure, ROC, AUC. (TB 2: Chapter 22.1)	2 hours
3.2	Bootstrapping, Cross validation	1 hour
3.3	Perceptron, Perceptron Learning	1 hour
3.4	Multilayer Feed forward Network, Activation Functions (Sigmoid, ReLU, Tanh)	1 hour
3.5	Back Propagation Algorithm	1 hour
3.6	Illustrative Example for Back Propagation	1 hour
Module-4 (Parameter estimation & SVM Classifier)) (9 hours)		
4.1	Basics of Parameter estimation	1 hour
4.2	Maximum Likelihood Estimation	1 hour
4.3	Maximum a Posteriori estimation(MAP). Bias-Variance decomposition.	1 hour
4.4	Introduction, Maximum Margin Hyperplane,	1 hour
4.5	Mathematics behind Maximum Margin Classification	1 hour
4.6	Formulation of maximum margin hyperplane and solution	1 hour
4.7	Soft margin SVM, Solution of Soft margin SVM	1 hour
4.8	Non-linear SVM , Kernels for learning non-linear functions, Examples - Linear, RBF, Polynomial, Kernel trick	2 hours
Module-5 (Unsupervised Learning) (9 hours)		
4.1	Ensemble Methods- Voting, Bagging, Boosting	1 hour
4.2	Similarity measures- Minkowski distance measures(Manhattan, Euclidean), Cosine Similarity	1 hour

4.3	K-means clustering (TB 2: Chapter 13)	1 hour
4.4	Clustering - Hierarchical Clustering (TB 2: Chapter 14)	2 hours
4.5	Density based Clustering	2 hours
4.6	Expectation maximization (EM) for soft clustering (TB 2: Chapter 13)	1 hour
4.7	Expectation maximization (EM) for soft clustering (TB 2: Chapter 13)	1 hour

AIT307	INTRODUCTION TO ARTIFICIAL INTELLIGENCE	CATEGORY	L	T	P	CREDITS
		PCC	3	1	0	4

Preamble: The course aims to introduce the fundamental principles of intelligent systems to students. This involves ideas about the characteristics of intelligent systems, knowledge representation schemes, logic and inference mechanisms. The course helps the learner to understand the design of self learning systems along with some of their typical applications in the emerging scenario where the business world is being transformed by the progress made in machine learning.

Prerequisite : NIL

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

CO#	CO
CO1	Explain the fundamental concepts of intelligent systems and their architecture. (**Cognitive Knowledge Level: Understanding)**
CO2	Illustrate uninformed and informed search techniques for problem solving in intelligent systems. **(Cognitive Knowledge Level: Understanding)**
CO3	Solve Constraint Satisfaction Problems using search techniques. (**Cognitive Knowledge Level: Apply**)
CO4	Represent AI domain knowledge using logic systems and use inference techniques for reasoning in intelligent systems. (**Cognitive Knowledge Level: Apply**)
CO5	Illustrate different types of learning techniques used in intelligent systems **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO 1	✔											
CO 2	✔	✔										✔
CO 3	✔	✔	✔	✔								✔
CO 4	✔	✔	✔	✔								✔
CO 5	✔	✔			✔							✔

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test 1 (%)	**Test 2 (%)**	
Remember	30	30	30
Understand	60	30	40
Apply	20	40	30
Analyze			
Evaluate			
Create			

Mark Distribution

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

Continuous Internal Evaluation Pattern:

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

Internal Examination Pattern:

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

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

SYLLABUS

Module – 1 (Introduction)

Introduction – What is Artificial Intelligence(AI) ? The Foundations of AI, History of AI, Applications of AI. Intelligent Agents – Agents and Environments, Good behavior: The concept of rationality, Nature of Environments - Specifying the task environment, Properties of task environments. Structure of Agents - Agent programs, Basic kinds of agent programs.

Module – 2 (Problem Solving)

Solving Problems by searching-Problem solving Agents, Example problems, Searching for solutions, Uninformed search strategies, Informed search strategies, Heuristic functions.

Module - 3 (Search in Complex environments)

Adversarial search - Games, Optimal decisions in games, The Minimax algorithm, Alpha-Beta pruning. Constraint Satisfaction Problems – Defining CSP, Example Problems, Constraint Propagation- inference in CSPs, Backtracking search for CSPs, Structure of CSP problems.

Module - 4 (Knowledge Representation and Reasoning)

Logical Agents – Knowledge based agents, Logic, Propositional Logic, Propositional Theorem proving, Agents based on Propositional Logic. First Order Predicate Logic - Syntax and Semantics of First Order Logic, Using First Order Logic, Knowledge representation in First Order Logic. Inference in First Order Logic – Propositional Vs First Order inference, Unification and Lifting, Forward chaining, Backward chaining, Resolution. Classical Planning - Algorithms for planning state space search, Planning Graphs.

Module - 5 (Machine Learning)

Learning from Examples – Forms of Learning, Supervised Learning. Learning Decision Trees-The decision tree representation, Inducing decision trees from examples, Choosing attribute tests, Generaliztion and overfitting. Evaluating and choosing the best hypothesis, Regression and classification with Linear models.

Text Book

1. Stuart Russell and Peter Norvig. Artificial Intelligence: A Modern Approach, 3rd Edition. Prentice Hall.

References

1. Nilsson N.J., Artificial Intelligence - A New Synthesis, Harcourt Asia Pvt. Ltd.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain about the basic types of agent programs in intelligent systems.
2. For the following activities, give a PEAS description of the task environment and characterize it in terms of the task environment properties.
   a) Playing soccer.
   b) Bidding on an item at an auction.

Course Outcome 2 (CO2):

1. Differentiate between uninformed and informed search strategies in intelligent systems.
2. Illustrate the working of Minimax search procedure.

Course Outcome 3 (CO3):

1. Solve the following crypt arithmetic problem by hand, using the strategy of backtracking with forward checking and the MRV & least-constraining-value heuristics.

$$\begin{array}{r} T\ W\ O \\ +\ T\ W\ O \\ \hline F\ O\ U\ R \end{array}$$

Course Outcome 4 (CO4):

1. Prove, or find a counter example to, the following assertion:
If $\alpha \models \gamma$ or $\beta \models \gamma$ (or both) then $(\alpha \wedge \beta \models \gamma$
2. For each pair of atomic sentences, find the most general unifier if it exists:
a) P (A, B, B), P (x, y, z).
b) Q(y, G(A, B)), Q(G(x, x), y).

Course Outcome 5 (CO5):

1. Consider the following data set comprised of three binary input attributes (A1 , A2 , and A3) and one binary output.

Example	A_1	A_2	A_3	Output y
$\mathbf{x}_1$	1	0	0	0
$\mathbf{x}_2$	1	0	1	0
$\mathbf{x}_3$	0	1	0	0
$\mathbf{x}_4$	1	1	1	1
$\mathbf{x}_5$	1	1	0	1

Use the DECISION-TREE-LEARNING algorithm to learn a decision tree for these data. Show the computations made to determine the attribute to split at each node.

2. What is multivariate linear regression? Explain.

Model Question Paper

QP CODE:

Reg No: _______________

Name: _________________ **PAGES : 4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: AIT307

Course Name: Introduction To Artificial Intelligence

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

PART A

Answer All Questions. Each Question Carries 3 Marks

1 What is a rational agent? Explain.

2 Describe any two ways to represent states and the transitions between them in agent programs.

3 Differentiate between informed search and uninformed search.

4 Define heuristic function? Give two examples.

5 What are the components of a Constraint Satisfaction Problem? Illustrate with an example.

6 Formulate the following problem as a CSP. Class scheduling: There is a fixed number of professors and classrooms, a list of classes to be offered, and a list of possible time slots for classes. Each professor has a set of classes that he or she can teach.

7 What is a knowledge based agent? How does it work?

8. Represent the following assertion in propositional logic:
"A person who is radical (R) is electable (E) if he/she is conservative (C), but otherwise is not electable."

9 Describe the various forms of learning?

10 State and explain Ockham's razor principle? **(10x3=30)**

Part B

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

11. (a) Explain the structure Goal-based agents and Utility-based agents with the help of diagrams. **(8)**

(b) For the following activities, give a PEAS description of the task environment and characterize it in terms of the task environment properties. **(6)**

a) Playing soccer

b) Bidding on an item at an auction.

OR

12. (a) Explain the structure Simple reflex agents and Model-based reflex agents with the help of diagrams. **(8)**

(b) Discuss about any five applications of AI. **(6)**

13. (a) Explain Best First Search algorithm. How does it implement heuristic search? **(6)**

(b) Describe any four uninformed search strategies. **(8)**

OR

14. (a) Write and explain A* search algorithm. **(6)**

(b) Explain the components of a well defined AI problem? Write the standard formulation of 8-puzzle problem. **(8)**

15. (a) (a) Solve the following crypt arithmetic problem by hand, using the strategy of backtracking with forward checking and the MRV and least-constraining-value heuristics. **(8)**

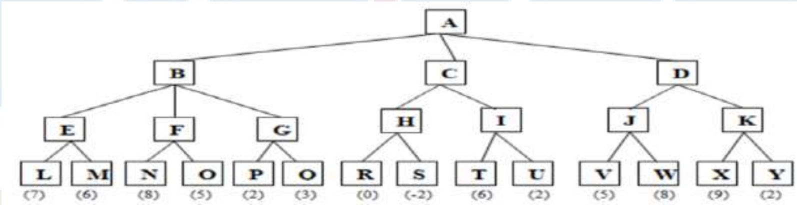
$$\begin{array}{r} T\ W\ O \\ +\ T\ W\ O \\ \hline F\ O\ U\ R \end{array}$$

(b) What is local consistency in CSP constraint propagation? Explain different types local consistencies. **(6)**

OR

16. (a) Illustrate the use of alpha-beta pruning in games. **(6)**

(b) Consider the following game tree in which static evaluation score are all from the players point of view: static evaluation score range is (+10 to -10) **(8)**



Suppose the first player is the maximizing player. What move should be chosen? Justify your answer.

17. (a) Convert the following sentences into first order logic: **(6)**

Everyone who loves all animals is loved by someone.

Anyone who kills an animal is loved by no one.

Jack loves all animals.

Either Jack or Curiosity killed the cat, who is named Tuna.

Did Curiosity kill the cat?

(b) Give a resolution proof to answer the question “Did Curiosity kill the cat? “ **(8)**

OR

18. (a) Draw a planning graph for the "have cake and eat cake too" problem up to level S2. **(6)**

(b) For each pair of atomic sentences, give the most general unifier if it exists: Older (Father (y), y), Older (Father (x), John). **(8)**

19. (a) How is best hypothesis selected from alternatives? **(8)**

(b) Explain Univariate Linear Regression. **(6)**

OR

20. (a) Consider the following data set comprised of two binary input attributes (A1 and A2) and one binary output. **(8)**

Example	A_1	A_2	Output y
x_1	1	1	1
x_2	1	1	1
x_3	1	0	0
x_4	0	0	1
x_5	0	1	0
x_6	0	1	0

Use the DECISION-TREE-LEARNING algorithm to learn a decision tree for these data. Show the computations made to determine the attribute to split at each node.

(b) Explain Linear classification with logistic regression **(6)**

TEACHING PLAN COMPUTER SCIENCE AND ENGINEERING(ARTIFICIAL INTELLIGENCE)

No	Contents	No of Lecture Hrs (44)
	Module – 1 (Introduction) (9 hrs)	
1.1	Introduction, What is Artificial Intelligence(AI)?	1
1.2	The foundations of AI, The history of AI	1
1.3	Applications of AI	1
1.4	Intelligent Agents – Agents and Environments	1
1.5	Good behavior: The concept of rationality	1
1.6	The nature of Environments- - Specifying the task environment	1
1.7	Properties of task environments	1
1.8	The structure of Agents - Agent programs	1
1.9	Basic kinds of agent programs	1
	Module - 2 (Problem Solving by searching) (7 hrs)	
2.1	Solving Problems by searching-Problem solving Agents	1
2.2	Illustration of the problem solving process by agents	1
2.3	Searching for solutions	1
2.4	Uninformed search strategies:BFS, Uniform-cost search, DFS, Depth-limited search, Iterative deepening depth-first search	1
2.5	Informed search strategies: Best First search	1
2.6	Informed search strategies: A* Search	1
2.7	Heuristic functions	1
	Module - 3 (Problem Solving in complex environments) (8 hrs)	
3.1	Adversarial search - Games	1
3.2	Optimal decisions in games, The Minimax algorithm	1
3.3	Alpha-Beta pruning	1
3.4	Constraint Satisfaction Problems – Defining CSP	1
3.5	Example Problem formulations	1
3.6	Constraint Propagation- inference in CSPs	1
3.7	Backtracking search for CSPs	1
3.8	The structure of problems	1

	Module - 4 (Knowledge Representation and Reasoning) (12 hrs)	
4.1	Logical Agents – Knowledge based agents and logic	1
4.2	Propositional Logic	1
4.3	Propositional Theorem proving	1
4.4	Agents based on Propositional Logic	1
4.5	First Order Predicate Logic – Syntax and Semantics of First Order	1

	Logic	
4.6	Using First Order Logic, Knowledge representation in First Order Logic	1
4.7	Inference in First Order Logic – Propositional Vs First Order inference, Unification and Lifting	1
4.8	Forward chaining, Backward chaining	1
4.9	Resolution	1
4.10	Classical Planning	1
4.11	Algorithms for planning state space search	1
4.12	Planning Graphs	1
Module - 5 (Machine Learning)(8 hrs)		
5.1	Learning from Examples – Forms of Learning	1
5.2	Supervised Learning	1
5.3	Learning Decision Trees- The decision tree representation	1
5.4	Inducing decision trees from examples	1
5.5	Choosing attribute tests	1
5.6	Generaliztion and overfitting	1
5.7	Evaluating and choosing the best hypothesis	1
5.8	Regression and classification with Linear models.	1

CST 309	MANAGEMENT OF SOFTWARE SYSTEMS	Category	L	T	P	Credit	Year of Introduction
		PCC	3	0	0	3	2019

Preamble: This course provides fundamental knowledge in the Software Development Process. It covers Software Development, Quality Assurance, Project Management concepts and technology trends. This course enables the learners to apply state of the art industry practices in Software development.

Prerequisite: Basic understanding of Object Oriented Design and Development.

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

CO1	Demonstrate Traditional and Agile Software Development approaches **(Cognitive Knowledge Level: Apply)**
CO2	Prepare Software Requirement Specification and Software Design for a given problem. **(Cognitive Knowledge Level: Apply)**
CO3	Justify the significance of design patterns and licensing terms in software development, prepare testing, maintenance and DevOps strategies for a project. **(Cognitive Knowledge Level: Apply)**
CO4	Make use of software project management concepts while planning, estimation, scheduling, tracking and change management of a project, with a traditional/agile framework. **(Cognitive Knowledge Level: Apply)**
CO5	Utilize SQA practices, Process Improvement techniques and Technology advancements in cloud based software models and containers & microservices. **(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 (Percentage)	Test2 (Percentage)	
Remember	**30**	**30**	**30**
Understand	**40**	**40**	**50**
Apply	**30**	**30**	**20**
Analyse			
Evaluate			
Create			

Mark Distribution

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

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Tests : **25 marks**

Continuous Assessment Assignment : **15 marks** (Each student shall identify a software development problem and prepare Requirements Specification, Design Document, Project Plan and Test case documents for the identified problem as the assignment.)

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 Software Engineering (7 hours)

Introduction to Software Engineering - Professional software development, Software engineering ethics. Software process models - The waterfall model, Incremental development. Process activities - Software specification, Software design and implementation, Software validation, Software evolution. Coping with change - Prototyping, Incremental delivery, Boehm's Spiral Model. Agile software development - Agile methods, agile manifesto - values and principles. Agile development techniques, Agile Project Management. Case studies : An insulin pump control system. Mentcare - a patient information system for mental health care.

Module 2 : Requirement Analysis and Design (8 hours)

Functional and non-functional requirements, Requirements engineering processes. Requirements elicitation, Requirements validation, Requirements change, Traceability Matrix. Developing use cases, Software Requirements Specification Template, Personas, Scenarios, User stories, Feature identification. Design concepts - Design within the context of software engineering, Design Process, Design concepts, Design Model. Architectural Design - Software Architecture, Architectural Styles, Architectural considerations, Architectural Design Component level design - What is a component?, Designing Class-Based Components, Conducting Component level design, Component level design for web-apps. Template of a Design Document as per “IEEE Std 1016-2009 IEEE Standard for Information Technology Systems Design Software Design Descriptions”. Case study: The Ariane 5 launcher failure.

Module 3 : Implementation and Testing (9 hours)

Object-oriented design using the UML, Design patterns, Implementation issues, Open-source development - Open-source licensing - GPL, LGPL, BSD. Review Techniques - Cost impact of Software Defects, Code review and statistical analysis. Informal Review, Formal Technical Reviews, Post-mortem evaluations. Software testing strategies - Unit Testing, Integration Testing, Validation testing, System testing, Debugging, White box testing, Path testing, Control Structure testing, Black box testing, Testing Documentation and Help facilities. Test automation, Test-driven development, Security testing. Overview of DevOps and Code Management - Code management, DevOps automation, Continuous Integration, Delivery, and Deployment (CI/CD/CD). Software Evolution - Evolution processes, Software maintenance.

Module 4 : Software Project Management (6 hours)

Software Project Management - Risk management, Managing people, Teamwork. Project Planning, Software pricing, Plan-driven development, Project scheduling, Agile planning. Estimation techniques, COCOMO cost modeling. Configuration management, Version management, System building, Change management, Release management, Agile software management - SCRUM framework. Kanban methodology and lean approaches.

Module 5 : Software Quality, Process Improvement and Technology trends (6 hours)

Software Quality, Software Quality Dilemma, Achieving Software Quality Elements of Software Quality Assurance, SQA Tasks , Software measurement and metrics. Software Process Improvement(SPI), SPI Process CMMI process improvement framework, ISO 9001:2000 for Software. Cloud-based Software - Virtualisation and containers, Everything as a service(IaaS, PaaS), Software as a service. Microservices Architecture - Microservices, Microservices architecture, Microservice deployment.

Text Books

1. Book 1 - Ian Sommerville, Software Engineering, Pearson Education, Tenth edition, 2015.
2. Book 2 - Roger S. Pressman, Software Engineering : A practitioner's approach, McGraw Hill publication, Eighth edition, 2014
3. Book 3 - Ian Sommerville, Engineering Software Products: An Introduction to Modern Software Engineering, Pearson Education, First Edition, 2020.

References

1. IEEE Std 830-1998 - IEEE Recommended Practice for Software Requirements SpeciÞcations
2. IEEE Std 1016-2009 IEEE Standard for Information Technology—Systems Design—Software Design Descriptions

3. David J. Anderson, Kanban, Blue Hole Press 2010
4. David J. Anderson, Agile Management for Software Engineering, Pearson, 2003
5. Walker Royce, Software Project Management : A unified framework, Pearson Education, 1998
6. Steve. Denning, The age of agile, how smart companies are transforming the way work gets done. New York, Amacom, 2018.
7. Satya Nadella, Hit Refresh: The Quest to Rediscover Microsoft's Soul and Imagine a Better Future for Everyone, Harper Business, 2017
8. Henrico Dolfing, Project Failure Case Studies: Lessons learned from other people's mistakes, Kindle edition
9. Mary Poppendieck, Implementing Lean Software Development: From Concept to Cash, Addison-Wesley Signature Series, 2006
10. StarUML documentation - https://docs.staruml.io/
11. OpenProject documentation - https://docs.openproject.org/
12. BugZilla documentation - https://www.bugzilla.org/docs/
13. GitHub documentation - https://guides.github.com/
14. Jira documentation - https://www.atlassian.com/software/jira

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What are the advantages of an incremental development model over a waterfall model?
2. Illustrate how the process differs in agile software development and traditional software development with a socially relevant case study. (Assignment question)

Course Outcome 2 (CO2):

1. How to prepare a software requirement specification?
2. Differentiate between Architectural design and Component level design.
3. How does agile approaches help software developers to capture and define the user requirements effectively?
4. What is the relevance of the SRS specification in software development?
5. Prepare a use case diagram for a library management system.

Course Outcome 3 (CO3):

1. Differentiate between the different types of software testing strategies.
2. Justify the need for DevOps practices?
3. How do design patterns help software architects communicate the design of a complex system effectively?

4. What are the proactive approaches one can take to optimise efforts in the testing phase?

Course Outcome 4 (CO4):

1. Illustrate the activities involved in software project management for a socially relevant problem?
2. How do SCRUM, Kanban and Lean methodologies help software project management?
3. Is rolling level planning in software project management beneficial? Justify your answer.
4. How would you assess the risks in your software development project? Explain how you can manage identified risks?

Course Outcome 5 (CO5):

1. Justify the importance of Software Process improvement?
2. Explain the benefits of cloud based software development, containers and microservices.
3. Give the role of retrospectives in improving the software development process.
4. Illustrate the use of project history data as a prediction tool to plan future socially relevant projects.

Model Question Paper

QP CODE:

Reg No:______________

Name :______________ **PAGES : 3**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST 309

Course Name: Management of Software Systems

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

PART A

Answer all Questions. Each question carries 3 marks

1. Why professional software that is developed for a customer is not simply the programs that have been developed and delivered.
2. Incremental software development could be very effectively used for customers who do not have a clear idea about the systems needed for their operations. Justify.
3. Identify any four types of requirements that may be defined for a software system
4. Describe software architecture
5. Differentiate between GPL and LGPL?
6. Compare white box testing and black box testing.
7. Specify the importance of risk management in software project management?
8. Describe COCOMO cost estimation model.
9. Discuss the software quality dilemma
10. List the levels of the CMMI model? **(10x3=30)**

Part B

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

11. (a) Compare waterfall model and spiral model **(8)**

(b) Explain Agile ceremonies and Agile manifesto **(6)**

12. (a) Illustrate software process activities with an example. **(8)**

(b) Explain Agile Development techniques and Agile Project Management **(6)**

13. (a) What are functional and nonfunctional requirements? Imagine that you are developing a library management software for your college, list eight functional requirements and four nonfunctional requirements. **(10)**

(b) List the components of a software requirement specification? **(4)**

OR

14. (a) Explain Personas, Scenarios, User stories and Feature identification? **(8)**

(b) Compare Software Architecture design and Component level design **(6)**

15. (a) Explain software testing strategies. **(8)**

(b) Describe the formal and informal review techniques. **(6)**

OR

16. (a) Explain Continuous Integration, Delivery, and Deployment CI/CD/CD) **(8)**

(b) Explain test driven development **(6)**

17. (a) What is a critical path and demonstrate its significance in a project schedule with the help of a sample project schedule. **(8)**

(b) Explain plan driven development and project scheduling. **(6)**

OR

18. (a) Explain elements of Software Quality Assurance and SQA Tasks. **(6)**

(b) What is algorithmic cost modeling? What problems does it suffer from when **(8)** compared with other approaches to cost estimation?

19. (a) Explain elements of Software Quality Assurance and SQA Tasks. **(8)**

(b) Illustrate SPI process with an example. **(6)**

OR

20. (a) Compare CMMI and ISO 9001:2000. **(8)**

(b) How can Software projects benefit from Container deployment and Micro service deployment? **(6)**

Teaching Plan

No	Contents	No of Lecture Hrs
Module 1 : Introduction to Software Engineering (7 hours)		
1.1	Introduction to Software Engineering.[Book 1, Chapter 1]	1 hour
1.2	Software process models [Book 1 - Chapter 2]	1 hour
1.3	Process activities [Book 1 - Chapter 2]	1 hour
1.4	Coping with change [Book 1 - Chapter 2, Book 2 - Chapter 4]	1 hour
1.5	Case studies : An insulin pump control system. Mentcare - a patient information system for mental health care. [Book 1 - Chapter 1]	1 hour
1.6	Agile software development [Book 1 - Chapter 3]	1 hour
1.7	Agile development techniques, Agile Project Management.[Book 1 - Chapter 3]	1 hour
Module 2 : Requirement Analysis and Design (8 hours)		
2.1	Functional and non-functional requirements, Requirements engineering processes [Book 1 - Chapter 4]	1 hour
2.2	Requirements elicitation, Requirements validation, Requirements change, Traceability Matrix [Book 1 - Chapter 4]	1 hour
2.3	Developing use cases, Software Requirements Specification Template [Book 2 - Chapter 8]	1 hour

2.4	Personas, Scenarios, User stories, Feature identification [Book 3 - Chapter 3]	1 hour
2.5	Design concepts [Book 2 - Chapter 12]	1 hour
2.6	Architectural Design [Book 2 - Chapter 13]	1 hour
2.7	Component level design [Book 2 - Chapter 14]	1 hour
2.8	Design Document Template. Case study: The Ariane 5 launcher failure. [Ref - 2, Book 2 - Chapter 16]	1 hour
Module 3 : Implementation and Testing (9 hours)		
3.1	Object-oriented design using the UML, Design patterns [Book 1 - Chapter 7]	1 hour
3.2	Implementation issues, Open-source development - Open-source licensing - GPL, LGPL, BSD [Book 1 - Chapter 7]	1 hour
3.3	Review Techniques - Cost impact of Software Defects, Code review and statistical analysis. [Book 2 - Chapter 20]	1 hour
34	Informal Review, Formal Technical Reviews, Post-mortem evaluations. [Book 2 - Chapter 20]	1 hour
3.5	Software testing strategies - Unit Testing, Integration Testing, Validation testing, System testing and Debugging (basic concepts only). [Book 2 - Chapter 22]	1 hour
3.6	White box testing, Path testing, Control Structure testing, Black box testing. Test documentation [Book 2 - Chapter 23]	1 hour
3.7	Test automation, Test-driven development, Security testing. [Book 3 - Chapter 9]	1 hour
3.8	DevOps and Code Management - Code management, DevOps automation, CI/CD/CD. [Book 3 - Chapter 10]	1 hour
3.9	Software Evolution - Evolution processes, Software maintenance. [Book 1 - Chapter 9]	1 hour
Module 4 : Software Project Management (6 hours)		
4.1	Software Project Management - Risk management, Managing people, Teamwork [Book 1 - Chapter 22]	1 hour
4.2	Project Planning - Software pricing, Plan-driven development, Project scheduling, Agile planning [Book 1 - Chapter 23]	1 hour
4.3	Estimation techniques [Book 1 - Chapter 23]	1 hour
4.4	Configuration management [Book 1 - Chapter 25]	1 hour

4.5	Agile software management - SCRUM framework [Book 2 - Chapter 5]	1 hour
4.6	Kanban methodology and lean approaches.[Ref 9 - Chapter 2]	1 hour
Module 5 : Software Quality, Process Improvement and Technology trends (6 hours)		
5.1	Software Quality, Software Quality Dilemma, Achieving Software Quality. [Book 2 - Chapter 19]	1 hour
5.2	Elements of Software Quality Assurance, SQA Tasks , Software measurement and metrics. [Book 3 - Chapter 21]	1 hour
5.3	Software Process Improvement (SPI), SPI Process [Book 2 - Chapter 37]	1 hour
5.4	CMMI process improvement framework, ISO 9001:2000 for Software. [Book 2 - Chapter 37]	1 hour
5.5	Cloud-based Software - Virtualisation and containers, IaaS, PaaS, SaaS.[Book 3 - Chapter 5]	1 hour
5.6	Microservices Architecture - Microservices, Microservices architecture, Microservice deployment [Book 3 - Chapter 6]	1 hour

AML311	PYTHON AND MACHINE LEARNING LAB	CATEGORY	L	T	P	Credit	Year of Introduction
		PCC	0	0	3	2	2022

Preamble: This course enables the learners to get hands-on experience in most popular supervised learning algorithms (such as linear regression, logistic regression, decision trees, Bayesian learning and Naive Bayes algorithm) and unsupervised learning algorithms (such as basic clustering algorithms). This helps the learners to understand the process of knowledge inference from raw data through dataset preprocessing and analysis.

Prerequisite: Fundamentals of Programming, Python programming fundamentals, Machine learning.

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

CO#	Course Outcomes
CO1	Develop applications in Python programming. **(Cognitive Knowledge Level: Apply)**
CO2	Implement machine learning algorithms using packages and libraries in Python for various applications.**(Cognitive Knowledge Level: Apply)**
CO3	Implement python programs for supervised learning methods through Neural network, Regression and classification.**(Cognitive Knowledge Level: Apply)**
CO4	Implement clustering algorithms.**(Cognitive Knowledge Level: Apply)**
CO5	Apply dimensionality reduction as a dataset preprocessing step. **(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 teamwork
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

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

Mark Distribution

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

Continuous Internal Evaluation Pattern:

Attendance	:	**15 marks**
Continuous Evaluation in Lab	:	**30 marks**
Continuous Assessment Test	:	**15 marks**
Viva voce	:	**15 marks**

Internal Examination Pattern:

The Internal examination shall be conducted for 100 marks, which will be converted to out of 15 while calculating Internal Evaluation marks. The marks will be distributed as, Algorithm - 30 marks, Program - 20 marks, Output - 20 marks and Viva - 30 marks.

End Semester Examination Pattern:

The End Semester Examination shall be conducted for 100 marks, which will be converted to out of 75 while calculating External Evaluation marks. The marks will be distributed as, Algorithm - 30 marks, Program - 20 marks, Output - 20 marks and Viva- 30 marks.

Operating System to use in lab : Ubuntu , Windows

Fair Lab Record:

All the students attending the Python and machine learning lab should have a Fair Record. Every experiment conducted in the lab should be noted in the fair record. For every experiment, in the fair record, the right-hand page should contain experiment heading, experiment number, date of experiment, aim of the experiment, procedure/algorithm followed, other such details of the experiment and final result. The left-hand page should contain a print out of the respective code with sample input and corresponding output obtained. All the experiments noted in the fair record should be verified by the faculty regularly. The fair record, properly certified by the faculty, should be produced during the time of End Semester Examination for the verification by the examiners.

SYLLABUS

***Mandatory**

1. Introduction to Python Programming.
2. Familiarization of basic Python Libraries such as Sklearn, Numpy, Pandas and Matplotlib.*
3. Write a Python program to find the union and intersection of two lists.
4. Design a Python program to count the occurrences of each word in a given sentence.
5. Write a Python program to multiply two matrices.*
6. Write a Python program to find the most frequent words in a text file.*
7. Implement and demonstrate Single, Multi variable and Polynomial Regression for a given set of training data stored in a .CSV file and evaluate the accuracy.*
8. Implement a Python program to perform logistic regression on a dataset.
9. Write a Python program to implement Naive Bayes classifier and calculate the accuracy, precision, and recall for your data set.*
10. Write a Python program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.*
11. Assuming a set of data that need to be classified, use a Support Vector Machine classifier to perform this task and evaluate the accuracy.*
12. Implement K-Nearest Neighbor algorithm to classify any dataset.
13. Implement K-Means Clustering using any given dataset.*
14. Build an Artificial Neural Network using Backpropagation algorithm and test the same with appropriate dataset.*
15. Implement dimensionality reduction using PCA.

(Use socially relevant dataset as far as possible)

Python and Machine Learning Lab-Practice Questions

1. Review of Python programming: Programs using matplotlib / plotly / bokeh / seaborn.
2. Write a program to find words which are greater than a given length k.
3. Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using the standard Heart Disease Dataset.
4. Implementation of Random Forest Classification in Python.
5. Write a program to implement k-Nearest Neighbor algorithm to classify the iris data set. Print both correct and wrong predictions.
6. Program to implement text classification using Support vector machine.
7. The probability that it is Friday and that a student is absent is 3%. Since there are 5 school days in a week, the probability that it is Friday is 20%. What is the probability that a student is absent given that today is Friday? Apply Bayes' rule in python to get the result. (Ans: 15%)

8. Implement Naïve Bayes theorem to classify the English text.
9. Program to implement Mean-Shift algorithm in python.
10. Implement Agglomerative Hierarchical Clustering.
11. Apply K-Means clustering to evaluate Student's performance. The results expected show the profile of a student with criteria for excellent performance, standard performance, and underperformance.

Reference Books:

1. Aurelien Geron, "Hands–On Machine Learning with Scikit–Learn and TensorFlow", O'Relily.
2. Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, 2007.
3. Ian Good fellow and Yoshua Bengio and Aaron Courville, "Deep Learning", MIT Press, 2016.

AIL 333	AI ALGORITHMS LAB	CATEGORY	L	T	P	Credit	Year of Introduction
		PCC	0	0	3	2	2022

Preamble: This laboratory course enables the students to get the fundamental concepts in the area of Artificial Intelligence. This course covers the AI based Algorithms, logical reasoning agents and implementation of these reasoning systems using either backward or forward inference mechanisms. This course helps the learners to apply AI techniques to solve real world problems.

Prerequisite: A sound knowledge of the basics of programming, Discrete Mathematics.

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

CO#	Course Outcomes
CO1	State the basics of learning problems with hypothesis and version spaces **(Cognitive Knowledge Level: Understand).**
CO2	Demonstrate real-world problems as state space problems, optimization problems or constraint satisfaction problems. **(Cognitive Knowledge Level: Apply)**
CO3	Simulate given problem scenario and analyze its performance. **(Cognitive Knowledge Level: Apply)**
CO4	Develop programming solutions for given problem scenario. **(Cognitive Knowledge Level: Apply)**
CO5	Design and develop an expert system by using appropriate tools and techniques. **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

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

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

Assessment Pattern

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

Mark Distribution

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

Continuous Internal Evaluation Pattern:

Attendance : **15 marks**
Continuous Evaluation in Lab : **30 marks**
Continuous Assessment Test : **15 marks**
Viva voce : **15 marks**

Internal Examination Pattern:

The internal examination shall be conducted for 100 marks, which will be converted to out of 15, while calculating internal evaluation marks. The marks will be distributed as, Algorithm - 30 marks, Program - 20 marks, Output - 20 marks and Viva - 30 marks.

End Semester Examination Pattern:

The end semester examination will be conducted for a total of 75 marks and shall be distributed as, Algorithm - 30 marks, Program - 20 marks, Output - 20 marks and Viva- 30 marks.

Operating System to Use in Lab : Linux/Windows

Programming Language to Use in Lab : C++/Java/Python/Prolog

Fair Lab Record:

All the students attending the Artificial Intelligence Algorithms laboratory should have a fair record. Every experiment conducted in the lab should be noted in the fair record. For every experiment, in the fair record, the right-hand page should contain experiment heading, experiment number, date of experiment, aim of the experiment, procedure/algorithm followed, other such details of the experiment and final result. The left-hand page should contain a print out of the respective code with sample input and corresponding output obtained. All the experiments noted in the fair record should be verified by the faculty regularly. The fair record, properly certified by the faculty, should be produced during the time of end semester examination for the verification by the examiners.

SYLLABUS

***Mandatory**

1. Installation and working on various AI tools viz. Python, R, GATE, NLTK, MATLAB etc.*
2. Implement basic search strategies for selected AI applications*.
3. Implement state space search algorithms*
4. Implement informed search algorithms*
5. Implement backtracking algorithms for CSP*
6. Implement local search algorithms for CSP*
7. Implement propositional logic inferences for AI tasks*
8. Implementation of Knowledge representation schemes*
9. Implement travelling salesman problem*
10. Implementation of Game playing (adversarial search)
11. Mini Project that implement a real world application using AI techniques (Group project with a maximum of four students)

PRACTICE QUESTIONS

1. Implementation of Depth-First Search (DFS).
2. Write a program to implement water jug problem.
3. Implement variants of hill-climbing and genetic algorithms.
4. Implement tic tac toe game for 0 and X.
5. Develop a program to construct a pruned game tree using Alpha-Beta pruning. Take the sequence, [5, 3, 2, 4, 1, 3, 6, 2, 8, 7, 5, 1, 3, 4] of MINIMAX values for the nodes at the cutoff depth of 4 plies. Assume that branching factor is 2, MIN makes the first move, and nodes are generated from right to left.
6. Write a program to implement production system.
7. Write a program to implement heuristic search procedure.
8. Write a program to implement Expert system.
9. Write a program to implement search problem of 3 x 3 puzzles.

References:

1. Dan W. Patterson, “Introduction to AI and ES”, Pearson Education, 2007
2. Kevin Night, Elaine Rich, and Nair B., “Artificial Intelligence”, McGraw Hill, 2008
3. Patrick H. Winston, "Artificial Intelligence", Third edition, Pearson Edition, 2006
4. Deepak Khemani, “Artificial Intelligence”, Tata McGraw Hill Education, 2013 (http://nptel.ac.in/)
5. Artificial Intelligence by Example: Develop machine intelligence from scratch using real artificial intelligence use cases -by Dennis Rothman, 2018
6. Padhy, N.P. 2009. Artificial Intelligence and Intelligent Systems, Oxford University Press
7. Brachman, R. and Levesque, H. 2004. Knowledge Representation and Reasoning, Morgan Kaufmann.

SEMESTER V

MINOR

CST 381	CONCEPTS IN SOFTWARE ENGINEERING	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2019

Preamble: This course provides fundamental knowledge in the Software Development Process. It covers Software Development, Quality Assurance and Project Management concepts. This course enables the learners to apply state of the art industry practices in Software development.

Prerequisite: Basic understanding of Object Oriented Design and Development.

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

CO1	Differentiate Traditional and Agile Software Development approaches **(Cognitive Knowledge Level: Understand)**
CO2	Prepare Software Requirement **Specification** and Software Design for a given problem. **(Cognitive Knowledge Level: Apply**)
CO3	Justify the significance of design patterns and licensing terms in software development, prepare testing, maintenance and DevOps strategies for a project. **(Cognitive Knowledge Level: Apply**)
CO4	Make use of software project management concepts while planning, estimation, scheduling, tracking and change management of a project, with proper application of SCRUM, Kanban and Lean frameworks. (**Cognitive Knowledge Level: Apply**)
CO5	Utilize SQA practices, Process Improvement techniques and Technology improvements **namely** cloud based software model and containers & microservices in a Software Development Process. (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 (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** (Each student shall identify a software development problem and prepare Requirements Specification, Design Document, Project Plan and Test case documents for the identified problem as the assignment.)

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 Software Engineering (8 hours)

Introduction to Software Engineering - Professional software development, Software engineering ethics. Software process models - The waterfall model, Incremental development. Process activities - Software specification, Software design and implementation, Software validation, Software evolution. Coping with change - Prototyping, Incremental delivery, Boehm's Spiral Model. Agile software development - Agile methods, agile manifesto - values and principles. Agile development techniques, Agile Project Management. Case studies : An insulin pump control system. Mentcare - a patient information system for mental health care.

Module 2 : Requirement Analysis and Design (10 hours)

Functional and non-functional requirements, Requirements engineering processes. Requirements elicitation, Requirements validation, Requirements change, Traceability Matrix. Developing use cases, Software Requirements Specification Template, Personas, Scenarios, User stories, Feature identification. Design concepts - Design within the context of software engineering, Design Process, Design concepts, Design Model. Architectural Design - Software Architecture, Architectural Styles, Architectural considerations, Architectural Design Component level design - What is a component?, Designing Class-Based Components, Conducting Component level design, Component level design for web-apps. Template of a Design Document as per "IEEE Std 1016-2009 IEEE Standard for Information Technology Systems Design Software Design Descriptions". Case study: The Ariane 5 launcher failure.

Module 3 : Implementation and Testing (12 hours)

Object-oriented design using the UML, Design patterns, Implementation issues, Open-source development - Open-source licensing - GPL, LGPL, BSD. Review Techniques - Cost impact of Software Defects, Code review and statistical analysis. Informal Review, Formal Technical Reviews, Post-mortem evaluations. Software testing strategies - Unit Testing, Integration Testing, Validation testing, System testing, Debugging, White box testing, Path testing, Control Structure testing, Black box testing, Testing Documentation and Help facilities. Test automation, Test-driven development, Security testing. Overview of DevOps and Code Management - Code management, DevOps automation, CI/CD/CD. Software Evolution - Evolution processes, Software maintenance.

Module 4 : Software Project Management (8 hours)

Software Project Management - Risk management, Managing people, Teamwork. Project Planning, Software pricing, Plan-driven development, Project scheduling, Agile planning. Estimation techniques, COCOMO cost modeling. Configuration management, Version management, System building, Change management, Release management, Agile software management - SCRUM framework. Kanban methodology and lean approaches.

Module 5 : Software Quality and Process Improvement (6 hours)

Software Quality, Software Quality Dilemma, Achieving Software Quality Elements of Software Quality Assurance, SQA Tasks , Software measurement and metrics. Software Process Improvement(SPI), SPI Process CMMI process improvement framework, ISO 9001:2000 for Software.

Text Books

1. Book 1 - Ian Sommerville, Software Engineering, Pearson Education, Tenth edition, 2015.
2. Book 2 - Roger S. Pressman, Software Engineering : A practitioner's approach, McGraw Hill publication, Eighth edition, 2014
3. Book 3 - Ian Sommerville, Engineering Software Products: An Introduction to Modern Software Engineering, Pearson Education, First Edition, 2020.

References

1. IEEE Std 830-1998 - IEEE Recommended Practice for Software Requirements Specifications
2. IEEE Std 1016-2009 IEEE Standard for Information Technology—Systems Design—Software Design Descriptions
3. David J. Anderson, Kanban, Blue Hole Press 2010
4. David J. Anderson, Agile Management for Software Engineering, Pearson, 2003
5. Walker Royce, Software Project Management : A unified framework, Pearson Education, 1998
6. Steve. Denning, The age of agile, how smart companies are transforming the way work gets done. New York, Amacom, 2018.
7. Satya Nadella, Hit Refresh: The Quest to Rediscover Microsoft's Soul and Imagine a Better Future for Everyone, Harper Business, 2017
8. Henrico Dolfing, Project Failure Case Studies: Lessons learned from other people's mistakes, Kindle edition
9. Mary Poppendieck, Implementing Lean Software Development: From Concept to Cash, Addison-Wesley Signature Series, 2006
10. StarUML documentation - https://docs.staruml.io/
11. OpenProject documentation - https://docs.openproject.org/

12. BugZilla documentation - https://www.bugzilla.org/docs/
13. GitHub documentation - https://guides.github.com/
14. Jira documentation - https://www.atlassian.com/software/jira

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What are the advantages of an incremental development model over a waterfall model?
2. Compare agile software development with traditional software development?

Course Outcome 2 (CO2):

1. How to prepare a software requirement specification?
2. Differentiate between Architectural design and Component level design.
3. How do agile approaches help software developers to capture and define the user requirements effectively?
4. What is the relevance of the SRS specification in software development?
5. Prepare a use case diagram for a library management system.

Course Outcome 3 (CO3):

1. Differentiate between the different types of software testing strategies.
2. What are the benefits of DevOps?
3. How do design patterns help software architects communicate the design of a complex system effectively?
4. What are the proactive approaches one can take to optimise efforts in the testing phase?

Course Outcome 4 (CO4):

1. What are the activities involved in software project management?
2. What is the need for SCRUM, Kanban and Lean methodologies?
3. What are the benefits of rolling level planning in software project management and how would you implement it?
4. How would you assess the risks in your software development project? How would you plan for risk mitigation and contingency?

Course Outcome 5 (CO5):

1. What is the importance of Software Process improvement?
2. How will retrospectives help in improving the software development process?
3. What are the important skills required for the SQA role?
4. How would you use project history data as a prediction tool to plan future projects?

Model Question Paper

QP CODE:

Reg No:______________

Name :______________

PAGES : 3

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Course Code: CST 381

Course Name: Concepts in Software Engineering

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

PART A

Answer all Questions. Each question carries 3 Marks

1. Explain why professional software that is developed for a customer is not simply the programs that have been developed and delivered

2. Incremental software development could be very effectively used for customers who do not have a clear idea about the systems needed for their operations. Discuss.

3. Identify and briefly describe four types of requirements that may be defined for a computer based system.

4. Describe software architecture in your own words.

5. What are the major differences between GPL and LGPL?

6. Compare between white box testing and black box testing.

7. What is the importance of risk management in software project management?

8. Explain COCOMO cost estimation model

9. Describe the software quality dilemma in your own words

10. Which are the levels of the CMMI model?

(10x3=30)

Part B

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

11.	(a)	Compare between waterfall model and spiral model	**(8)**
	(b)	Explain Agile methods and Agile manifesto	**(6)**
		OR	
12.	(a)	Explain software process activities	**(7)**
	(b)	Explain Agile Development techniques and Agile Project Management.	**(7)**
13.	(a)	What are functional and nonfunctional requirements? Imagine that you are developing a library management software for your college, identify at least 8 functional requirements and 4 nonfunctional requirements.	**(10)**
	(b)	What are the contents of a software requirement specification?	**(4)**
		OR	
14.	(a)	Explain Personas, Scenarios, User stories and Feature identification?	**(8)**
	(b)	Compare between Software Architecture design and Component level design	**(6)**
15.	(a)	Describe the formal and informal review techniques in detail.	**(6)**
	(b)	Explain various software testing strategies.	**(8)**
		OR	
16.	(a)	Explain DevOps CI/CD/CD in detail.	**(8)**
	(b)	Explain test driven development.	**(6)**
17.	(a)	What is a critical path and demonstrate its significance in a project schedule with the help of a sample project schedule.	**(6)**
	(b)	Explain plan driven development and project scheduling	**(6)**

OR

18. (a) Explain the SCRUM framework. **(8)**

(b) What is algorithmic cost modeling? What problems does it suffer from when compared with other approaches to cost estimation? **(6)**

19. (a) Explain elements of Software Quality Assurance and SQA Tasks. **(8)**

(b) Explain the SPI process. **(6)**

OR

20. (a) Compare between CMMI and ISO 9001:2000 **(8)**

(b) Compare Quality Control and Quality Assurance. **(6)**

Teaching Plan [44 hours]		
	Module 1 : Introduction to Software Engineering (8 hours)	**Hours**
1.1	Introduction to Software Engineering. [Book 1, Chapter 1]	1 hour
1.2	Software process models [Book 1 - Chapter 2]	1 hour
1.3	Process activities [Book 1 - Chapter 2]	1 hour
1.4	Coping with change [Book 1 - Chapter 2, Book 2 - Chapter 4]	1 hour
1.5	Agile software development [Book 1 - Chapter 3]	1 hour
1.6	Agile development techniques [Book 1 - Chapter 3]	1 hour
1.7	Agile Project Management.[Book 1 - Chapter 3]	1 hour
1.8	Case studies : An insulin pump control system. Mentcare - a patient information system for mental health care. [Book 1 - Chapter 1]	1 hour
	Module 2 : Requirement Analysis and Design (10 hours)	
2.1	Functional and non-functional requirements, Requirements engineering processes [Book 1 - Chapter 4]	1 hour

2.2	Requirements elicitation, Requirements validation, Requirements change, Traceability Matrix [Book 1 - Chapter 4]	1 hour
2.3	Developing use cases, Software Requirements Specification Template [Book 2 - Chapter 8]	1 hour
2.4	Personas, Scenarios [Book 3 - Chapter 3]	1 hour
2.5	User stories, Feature identification [Book 3 - Chapter 3]	1 hour
2.6	Design concepts [Book 2 - Chapter 12]	1 hour
2.7	Architectural Design [Book 2 - Chapter 13]	1 hour
2.8	Component level design [Book 2 - Chapter 14]	1 hour
2.9	Component level design, Design Document Template. [Book 2 - Chapter 14, Ref - 2]	1 hour
2.10	Case study: The Ariane 5 launcher failure. [Book 2 - Chapter 16]	1 hour
Module 3 : Implementation and Testing (12 hours)		
3.1	Object-oriented design using the UML, Design patterns [Book 1 - Chapter 7]	1 hour
3.2	Implementation issues, Open-source development - Open-source licensing - GPL, LGPL, BSD [Book 1 - Chapter 7]	1 hour
3.3	Review Techniques - Cost impact of Software Defects, Code review. [Book 2 - Chapter 20]	1 hour
34	Informal Review, Formal Technical Reviews, Post-mortem evaluations. [Book 2 - Chapter 20]	1 hour
3.5	Software testing strategies [Book 2 - Chapter 22]	1 hour
3.6	Software testing strategies [Book 2 - Chapter 22]	1 hour
3.7	White box testing, Path testing, Control Structure testing [Book 2 - Chapter 23]	1 hour
3.8	Black box testing. Test documentation [Book 2 - Chapter 23]	1 hour
3.9	Test automation, Test-driven development [Book 3 - Chapter 9]	1 hour
3.10	Security testing. DevOps and Code Management [Book 3 - Chapter 9, Chapter 10]	1 hour
3.11	DevOps and Code Management - Code management, DevOps automation, CI/CD/CD. [Book 3 - Chapter 10]	1 hour

3.12	Software Evolution - Evolution processes, Software maintenance. [Book 1 - Chapter 9]	1 hour
Module 4 : Software Project Management (8 hours)		
4.1	Software Project Management - Risk management, Managing people, Teamwork [Book 1 - Chapter 22]	1 hour
4.2	Project Planning - Software pricing, Plan-driven development, Project scheduling, Agile planning [Book 1 - Chapter 23]	1 hour
4.3	Estimation techniques [Book 1 - Chapter 23]	1 hour
4.4	Configuration management [Book 1 - Chapter 25]	1 hour
4.5	Agile software management - SCRUM framework [Book 2 - Chapter 5]	1 hour
4.6	Agile software management - SCRUM framework [Book 2 - Chapter 5]	1 hour
4.7	Kanban methodology and lean approaches. [Ref 9 - Chapter 2]	1 hour
4.8	Kanban methodology and lean approaches.[Ref 9 - Chapter 2]	1 hour
Module 5 : Software Quality, Process Improvement and Technology trends (6 hours)		
5.1	Software Quality, Software Quality Dilemma, Achieving Software Quality. [Book 2 - Chapter 19]	1 hour
5.2	Elements of Software Quality Assurance, SQA Tasks [Book 3 - Chapter 21]	1 hour
5.3	Software measurement and metrics. [Book 3 - Chapter 21]	1 hour
5.4	Software Process Improvement(SPI), SPI Process[Book 2 - Chapter 37]	1 hour
5.5	Software Process Improvement(SPI), SPI Process[Book 2 - Chapter 37]	1 hour
5.6	CMMI process improvement framework, ISO 9001:2000 for Software. [Book 2 - Chapter 37]	1 hour

CST 383	CONCEPTS 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 fundamental 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 & the naive Bayes algorithm, support vector machines& kernels, basic clustering algorithms and dimensionality reduction methods. This course helps the students to provide machine learning based solutions to real world problems.

Prerequisite: Familiarity with basics in linear algebra, probability and Python programming.

	Course Outcomes
CO1	Illustrate Machine Learning concepts and basic parameter estimation methods.**(Cognitive Knowledge Level: Apply)**
CO2	Demonstrate supervised learning concepts (regression, linear classification). **(Cognitive Knowledge Level**: **Apply**)
CO3	Illustrate the concepts of Multilayer neural network and Support Vector Machine **(Cognitive Knowledge Level: Apply**)
CO4	Describe unsupervised learning concepts and dimensionality reduction techniques. (**Cognitive Knowledge Level**: **Apply**)
CO5	Solve real life problems using appropriate machine learning models and evaluate the performance measures (**Cognitive Knowledge Level: Apply**)

Mapping of course outcomes with program outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO 7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO1 2**
CO1	✓	✓	✓	✓	✓							✓
CO2	✓	✓	✓	✓	✓							✓
CO3	✓	✓	✓	✓	✓							✓

CO4	✓	✓	✓	✓	✓							✓
CO5	✓	✓	✓	✓	✓	✓						✓

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

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks**
	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 maximum 2 sub-divisions and carry 14 marks.

Syllabus

Module-1 (Overview of machine learning)

Machine learning paradigms-supervised, semi-supervised, unsupervised, reinforcement learning. Basics of parameter estimation - maximum likelihood estimation(MLE) and maximum a posteriori estimation(MAP). Introduction to Bayesian formulation.

Module-2 (Supervised Learning)

Regression - Linear regression with one variable, Linear regression with multiple variables, solution using gradient descent algorithm and matrix method, basic idea of overfitting in regression. Linear Methods for Classification- Logistic regression, Perceptron, Naive Bayes, Decision tree algorithm ID3.

Module-3 (Neural Networks (NN) and Support Vector Machines (SVM))

NN - Multilayer feed forward network, Activation functions (Sigmoid, ReLU, Tanh), Backpropagation algorithm.

SVM - Introduction, Maximum Margin Classification, Mathematics behind Maximum Margin Classification, Maximum Margin linear separators, soft margin SVM classifier, non-linear SVM, Kernels for learning non-linear functions, polynomial kernel, Radial Basis Function(RBF).

Module-4 (Unsupervised Learning)

Clustering - Similarity measures, Hierarchical Agglomerative Clustering, K-means partitional clustering, Expectation maximization (EM) for soft clustering. Dimensionality reduction – Principal Component Analysis, factor Analysis, Multidimensional scaling, Linear Discriminant Analysis.

Module-5 (Classification Assessment)

Classification Performance measures - Precision, Recall, Accuracy, F-Measure, Receiver Operating Characteristic Curve(ROC), Area Under Curve(AUC. Bootstrapping, Cross Validation, Ensemble methods, Bias-Variance decomposition. Case Study: Develop a classifier for face detection.

Text Book

1. Ethem Alpaydin, Introduction to Machine Learning, 2nd edition, MIT Press 2010.
2. Mohammed J. Zaki and Wagner Meira, Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge University Press, First South Asia edition, 2016.
3. Jake VanderPlas, Python Data Science Handbook, O'Reilly Media, 2016
4. Tom Mitchell, Machine Learning, McGraw-Hill, 1997.

Reference Books

1. Christopher Bishop. Neural Networks for Pattern Recognition, Oxford University Press, 1995.
2. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective, MIT Press 2012.
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements Of Statistical Learning, Second edition Springer 2007.
4. P. Langley, Elements of Machine Learning, Morgan Kaufmann, 1995.
5. Richert and Coelho, Building Machine Learning Systems with Python.
6. Davy Cielen, Arno DB Meysman and Mohamed Ali. Introducing Data Science: Big Data, Machine Learning, and More, Using Python Tools, Dreamtech Press 2016.

Sample Course Level Assessment Questions

Course Outcome1(CO1):

1. A coin is tossed 100 times and lands heads 62 times. What is the maximum likelihood estimate for θ, the probability of heads.
2. Suppose data $x_1, ..., x_n$are independent and identically distributed drawn from an exponential distribution $exp(\lambda)$. Find the maximum likelihood for λ.
3. Suppose $x_1, ..., x_n$ are independent and identically distributed(iid) samples from a distribution with density

$$f_X(x \mid \theta) = \begin{cases} \dfrac{\theta x^{\theta-1}}{3^\theta}, & 0 \leq x \leq 3 \\ 0, & \text{otherwise} \end{cases}$$

   Find the maximum likelihood estimate(MLE) for θ.
4. Find the maximum likelihood estimator (MLE) and maximum a posteriori (MAP) estimator for the mean of a univariate normal distribution. Assume that we have N samples, $x_1,..., x_N$ independently drawn from a normal distribution with known variance σ^2 and unknown mean μ and the prior distribution for the mean is itself a normal distribution with mean v and variance β^2. What happens to the MLE and MAP estimators as the number of samples goes to infinity.

Course Outcome 2 (CO2):

1. Explain the difference between (batch) gradient descent and stochastic gradient descent. Give an example of when you might prefer one over the other.
2. 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?
3. Suppose you have a three class problem where class label $y \in 0, 1, 2$ and each training example X has 3 binary attributes $X_1, X_2, X_3 \in 0, 1$. How many parameters (probability distribution) do you need to know to classify an example using the Naive Bayes classifier?

Course Outcome 3 (CO3):

1. What are support vectors and list any three properties of the support vector classifier solution?
2. Why do you use kernels to model a projection from attributes into a feature space, instead of simply projecting the dataset directly?
3. Describe how Support Vector Machines can be extended to make use of kernels. Illustrate with reference to the Gaussian kernel $K(x, y) = e^{-z}$,where $z = (x-y)^2$.

4. Briefly explain one way in which using tanh instead of logistic activations makes optimization easier.
5. ReLU activation functions are most used in neural networks instead of the tanh activation function. Draw both activation functions and give a) an advantage of the ReLU function compared to the tanh function. b) a disadvantage of the ReLU function compared to the tanh function.

Course Outcome 4(CO4):

1. Describe cluster analysis? Identify two applications where cluster analysis can be applied to multimedia data?
2. 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.

3. Use PCA to reduce the dimension from 2 to 1 for the design matrix ***X***.

$$X = \begin{bmatrix} 6 & -4 \\ -3 & 5 \\ -2 & 6 \\ 7 & -3 \end{bmatrix}$$

4. What is Principal Component Analysis (PCA)? Which eigen value indicates the direction of largest variance?
5. Suppose that one runs a principal component analysis on a data set and tells that the percentage of variance explained by the first 3 components is 80%. How is this percentage of variance explained?

Course Outcome 5 (CO5):

1. Suppose that you are contacted by a food processing company that wants you to develop a classifier that detects whether a rat is present in an image. You collect a large dataset of images by crawling the web, and have annotators determine which images contain rats. This set of images can then be used as the training set for your classifier.
    a. Suggest a machine learning method to use for this classification task and evaluate its performance.
    b. After you have delivered your solution to the company, they get back to you and complain that when they evaluate on a new test set, they get precision and recall values that are much lower than what you reported to them. Explain what might have gone wrong and propose remedial measures .
2. A real estate firm would like to build a system that predicts the sale prices of a house. They create a spreadsheet containing information about 1,500 house sales in the Kochi

area. In addition to the price, there are 10 features describing the house, such as number of bedrooms, total indoor area, lot area, a swimming pool, location, etc. Explain how you would implement a machine learning model that would solve this prediction task. Give all steps you would carry out when developing it. Explain why the model you built is probably useless in the long run.

3. For a classifier, the confusion matrix is given by:

	+	-
+	9	9
-	1	5

What is the precision, recall and accuracy of that classifier?

Model Question Paper

QP CODE: PAGES:3

Reg No:________________

Name:__________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Course Code: CST 383

Course Name: CONCEPTS IN MACHINE LEARNING

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

PART A

Answer all Questions. Each question carries 3 Marks

1. Define supervised learning? Name special cases of supervised learning depending on whether the inputs/outputs are categorical, or continuous.
2. Differentiate between Maximum Likelihood estimation (MLE) and Maximum a Posteriori (MAP) estimation?
3. What is overfitting and why is it a problem? Give an example of a method to reduce the risk of overfitting.
4. Specify the basic principle of gradient descent algorithm.
5. Suppose that you have a linear support vector machine(SVM) binary classifier. Consider a point that is currently classified correctly, and is far away from the decision boundary. If you

remove the point from the training set, and re-train the classifier, will the decision boundary change or stay the same? Justify your answer.

6. Mention the primary motivation for using the kernel trick in machine learning algorithms?
7. Expectation maximization (EM) is designed to find a maximum likelihood setting of the parameters of a model when some of the data is missing. Does the algorithm converge? If so, do you obtain a locally or globally optimal set of parameters?
8. Illustrate the strength and weakness of k-means algorithm.
9. 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.
10. How does bias and variance trade-off affect machine learning algorithms?

(10x3=30)

Part B

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

11. a) Suppose that X is a discrete random variable with the following probability mass function: where $0 \leq \theta \leq 1$ is a parameter. The following 10 independent observations

X	0	1	2	3
$P(X)$	$2\theta/3$	$\theta/3$	$2(1-\theta)/3$	$(1-\theta)/3$

were taken from such a distribution: ***(3, 0, 2, 1, 3, 2, 1, 0, 2, 1)***. What is the maximum likelihood estimate of θ. **(6)**

b) A gamma distribution with parameters α, β has the following density function, where $\Gamma(t)$ is the gamma function.

$$p(x) = \frac{\beta^\alpha}{\Gamma(\alpha)} x^{\alpha-1} e^{-\beta x}$$

If the posterior distribution is in the same family as the prior distribution, then we say that the prior distribution is the conjugate prior for the likelihood function. Using the Gamma distribution as a prior, show that the Exponential distribution is a conjugate prior of the Gamma distribution. Also, find the maximum a posteriori estimator for the parameter of the Exponential distribution as a function of α and β. **(8)**

OR

12. a) Traffic between 8AM and 9AM at a certain place was measured by counting the number of vehicles that passed at that time. Suppose the counts follow a Poisson process. A random sample of 9 observations was collected, having observed the following number of vehicles: (95, 100, 80, 70, 110, 98, 97, 90, 70). Derive the maximum likelihood estimator for the

average number of vehicles that pass by that place between 8 AM and 9 AM, and compute the corresponding estimate using the given sample. **(7)**

b) Find the maximum a posteriori (MAP) estimator for the mean of a univariate normal distribution. Assume that we have N samples, $x_1,..., x_N$ independently drawn from a normal distribution with known variance σ^2 and unknown mean μ and the prior distribution for the mean is itself a normal distribution with mean ν and variance β^2. **(7)**

13.a) Derive the gradient descent training rule assuming for the target function $o_d = w_0 + w_1x_1 + ... + w_nx_n$. Define explicitly the squared cost/error function E, assuming that a set of training examples D is provided, where each training example $d \in D$ is associated with the target output t_d. **(10)**

b) How can we interpret the output of a two-class logistic regression classifier as a probability? **(4)**

OR

14. a) In a two-class logistic regression model, the weight vector $w = [4, 3, 2, 1, 0]$. We apply it to some object that we would like to classify; the vectorized feature representation of this object is $x = [-2, 0, -3, 0.5, 3]$. What is the probability, according to the model, that this instance belongs to the positive class? **(6)**

b) The following dataset can be used to train a classifier that determines whether a given person is likely to own a car or not. There are three features: education level (primary, secondary, or university); residence (city or country); gender (female, male).

education	residence	gender	has car?
sec	country	female	yes
univ	country	female	yes
prim	city	male	no
univ	city	male	no
sec	city	female	no
sec	country	male	yes
prim	country	female	yes
univ	country	male	yes
sec	city	male	yes
prim	city	female	no
univ	city	female	no
prim	country	male	yes

Find the root attribute and justify your answer **(8)**

15. a) Consider a support vector machine whose input space is 2-D, and the inner products are computed by means of the kernel ***K(x, y) = (x.y + 1)²-1***, where ***x.y*** denotes the ordinary inner product. Show that the mapping to feature space that is implicitly defined by this kernel is the mapping to 5-D given by **(10)**

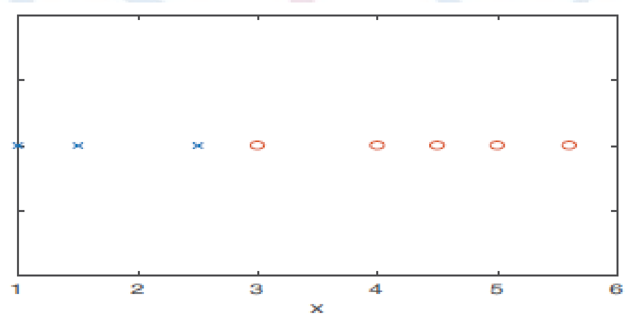
$$\mathbf{x} = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \rightarrow \phi(\mathbf{x}) = \begin{bmatrix} x_1^2 \\ x_2^2 \\ \sqrt{2}\, x_1 x_2 \\ \sqrt{2}\, x_1 \\ \sqrt{2}\, x_2 \end{bmatrix}.$$

b) What is the basic idea of a Support Vector Machine? **(4)**

OR

16. a) Explain how back propagation can be used to solve XOR problem which is not linearly separable. **(8)**

b) Consider the following one dimensional training data set, 'x' denotes negative examples and 'o' positive examples. The exact data points and their labels are given in the table. Suppose a SVM is used to classify this data. Indicate which are the support vectors and mark the decision boundary. Find the equation of the hyperplane. (6)



x	1	1.5	2.5	3	4	4.5	5	5.6
y	-1	-1	-1	1	1	1	1	1

17. a)Suppose that we have the following data (one variable). Use single linkage Agglomerative clustering to identify the clusters.
Daa: (2, 5, 9, 15, 16, 18, 25, 33, 33, 45). **(8)**

b) 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.

(iii) Compute the Minkowski distance between the two objects, using p = 3 **(6)**

OR

18. a) Suppose that we have the following data:

a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*
(2,0)	(1,2)	(2,2)	(3,2)	(2,3)	(3,3)	(2,4)	(3,4)	(4,4)	(3,5)

Identify the cluster by applying the k-means algorithm, with k = 2. Try using initial cluster centers as far apart as possible. **(10)**

b) List the steps involved in Principal Component Analysis. **(4)**

19. a) Suppose the dataset had 9700 cancer-free images from 10000 images from cancer patients. Find precision, recall and accuracy ? Is it a good classifier? Justify. **(8)**

Actual Class\ Predicted class	**cancer = yes**	**cancer = no**	**Total**
cancer = yes	90	210	300
cancer = no	140	9560	9700
Total	230	9770	10000

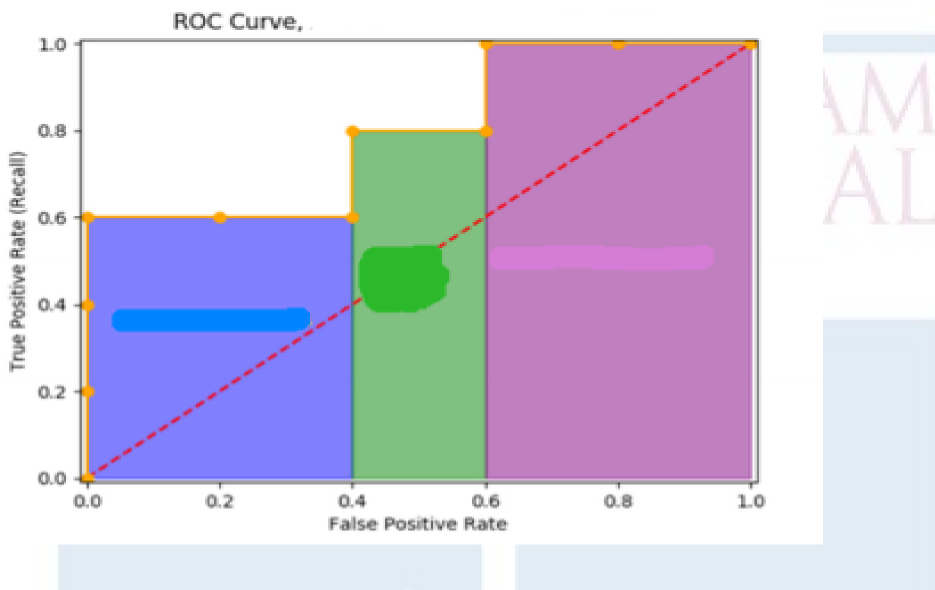
b) Suppose that you have a classification problem where our feature representation contains about 10,000,000 features. We would like to develop a classifier that can be deployed in a mobile phone, so preferably it should have a small memory footprint. Discuss one solution for how this can be done. **(6)**

OR

20. 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? **(6)**

b)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. **(4)**

c) Given the following ROC Curve? Find the AUC? **(4)**



Teaching Plan

No	Contents	No of Lecture Hrs
Module 1 :Overview of machine learning (7 hours)		
1.1	Supervised, semi-supervised, unsupervised learning, reinforcement learning (Text Book (TB) 1: Chapter 1)	1hour
1.2	Maximum likelihood estimation(MLE) (TB 1: Section 4.2)	1hour
1.3	Maximum likelihood estimation (MLE)- example (TB 1: Section 4.2)	1hour
1.4	Maximum a posteriori estimation(MAP) (TB 4: Section 6.2)	1hour
1.5	Maximum a posteriori estimation(MAP)-example (TB 4: Section 6.2)	1hour
1.6	Bayesian formulation (TB 1: Section 14.1, 14.2)	1hour
1.7	Bayesian formulation -example (TB 1: Section 14.1, 14.2)	1hour
Module 2 : Supervised Learning (8 hours)		

2.1	Linear regression with one variable (TB 1: Section 2.6)	1hour
2.2	Multiple variables, Solution using gradient descent algorithm and matrix method (No derivation required) (TB 1: Section 5.8)	1hour
2.3	Overfitting in regression, Lasso and Ridge regularization	1hour
2.4	Logistic regression	1hour
2.5	Perceptron	1hour
2.6	Naive Bayes (TB 2: Section 18.2)	1hour
2.7	Decision trees (TB 2: Chapter 19)	1hour
2.8	Decision trees- ID3 algorithm (TB 2: Chapter 19)	1hour
Module 3 : Neural Networks and Support Vector Machines (TB 2: Chapter 21) (11 hours)		
3.1	Multilayer Feed forward Network, Activation Functions (Sigmoid, ReLU, Tanh)	1hour
3.2	Back Propagation Algorithm	1hour
3.3	Illustrative Example for Back Propagation	1hour
3.4	Introduction, Maximum Margin Hyperplane,	1hour
3.5	Mathematics behind Maximum Margin Classification	1hour
3.6	Formulation of maximum margin hyperplane and solution	1hour
3.7	Soft margin SVM	1hour
3.8	Solution of Soft margin SVM	1hour
3.9	Non-linear SVM	1hour
3.10	Kernels for learning non-linear functions and properties of kernel functions.	1hour
3.11	Example Kernels functions- Linear, RBF, Polynomial.	1hour
Module 4 : Unsupervised Learning (10 hours)		
4.1	Similarity measures- Minkowski distance measures(Manhattan, Euclidean), Cosine Similarity	1hour
4.2	Clustering - Hierarchical Clustering (TB 2: Chapter 14)	1hour
4.3	K-means partitional clustering (TB 2: Chapter 13)	1hour
4.4	Expectation maximization (EM) for soft clustering (TB 2: Chapter 13)	1hour
4.5	Expectation maximization (EM) for soft clustering (TB 2: Chapter 13)	1hour

4.6	Dimensionality reduction – Principal Component Analysis (TB 1: Section 6.3)	1hour
4.7	Dimensionality reduction – Principal Component Analysis (TB 1: Section 6.3)	1hour
4.8	Factor Analysis (TB 1: Section 6.4)	1hour
4.9	Multidimensional scaling (TB 1: Section 6.5)	1hour
4.10	Linear Discriminant Analysis (TB 1: Section 6.6)	1hour
Module 5 : Classification Assessment (8 hours)		
5.1	Performance measures - Precision, Recall, Accuracy, F-Measure, ROC, AUC. (TB 2: Chapter 22.1)	1hour
5.2	Boot strapping, Cross validation	1hour
5.3	Ensemble methods- bagging	1hour
5.4	Ensemble methods- boosting	1hour
5.5	Bias-Variance decomposition (TB 2: Chapter 22.3)	1hour
5.6	Bias-Variance decomposition (TB 2: Chapter 22.3)	1hour
5.7	Face detection (TB 3: Chapter 5 Section Application: A Face Detection Pipeline)	1hour
5.8	Face detection (TB 3: Chapter 5 Section Application: A Face Detection Pipeline)	1hour

CST 385	CLIENT SERVER SYSTEMS	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2019

Preamble:

The syllabus is prepared with the view of preparing the Engineering Graduates to build effective Client/Server applications. This course aims at providing a foundation in decentralized computer systems, using the client/server model. The course content is decided to cover the essential fundamentals which can be taught within the given slots in the curriculum.

Prerequisite: **Basic knowledge in Computer**

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

	Course Outcomes
CO 1	Identify the basics of client/server systems and the driving force behind the development of client/server systems**(Cognitive Knowledge Level: Understand)**
CO 2	Outline the architecture and classifications of client/server systems**(Cognitive Knowledge Level: Understand)**
CO 3	Summarize the client/server network services for an application**(Cognitive Knowledge Level: Understand)**
CO 4	Identify management services and issues in network **(Cognitive Knowledge Level: Understand)**
CO 5	Outline the Client/Server technology in respect of databases and Client/Server database architecture **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔										✔
CO2	✔	✔										✔
CO3	✔	✔										✔
CO4	✔											✔
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 (Percentage)	Test 2 (Percentage)	
Remember	40	40	40
Understand	40	40	40
Apply	20	20	20
Analyse			
Evaluate			
Create			

Mark distribution

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

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Test 1 (for theory, for 2 hrs) : **20 marks**

Continuous Assessment Test 2 (for lab, internal examination, for 2hrs) : **20 marks**

Internal Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 5 questions with 2 questions from each module (2.5 modules x 2 = 5), having 3 marks for each question. Students should answer all questions. Part B also contains 5 questions with 2 questions from each module (2.5 modules x 2 = 5), of which a student should answer any one. The questions should not have sub-divisions and each one carries 7 marks.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A 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.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Computing in client server architecture over Mainframe architecture has certain advantages and disadvantages. Describe at least three advantages and disadvantages for each architecture.

Course Outcome 2 (CO2):

1. Explain the role of mainframe-centric model in Client/Server computing?

Course Outcome 3(CO3):

1. Describe the client server system development methodology? Explain different phases of System Integration Life-Cycle.

Course Outcome 4 (CO4):

1. Explain about network management and remote system management. How can security be provided to the network?

Course Outcome 5 (CO5):

1. Explain various types of Client/Server Database Architecture

Syllabus

Module – 1 (Introduction)

Introduction to Client/Server computing - Basic Client/Server Computing Model, Server for Every Client- File Server, Print Server, Application Server, Mail Server, Directory Services Server, Web Server, Database Server, Transaction Servers. Client/Server-Fat or Thin, Stateless or Stateful, Servers and Mainframes, Client/Server Functions. Driving Forces behind Client/Server Computing- Business Perspective, Technology Perspective.

Module -2 (Client/Server Classification)

Client/Server Types-Single Client/Single Server, Multiple Clients/Single Server, Multiple Clients/Multiple Servers, Integration With Distributed Computing, Alternatives To Client/Server Systems. Classification of Client/Server Systems- Two-Tier Computing, Middleware, Three-Tier Computing- Model View Controller (MVC), Principles behind Client/Server Systems.Client/Server Topologies. Existing Client/Server Architecture. Architecture for Business Information System.

Module -3 (Client/Server Application Components)

Client- Services, Request for services, RPC, Windows services, Print services, Remote boot services, other remote services, Utility Services. Server- Detailed server functionality, Network operating system, Available platforms, Server operating system. Organizational Expectations, Improving performance of client/server applications, Single system image, Downsizing and Rightsizing, Advantages and disadvantages of Client/Server computing, Applications of Client/Server.

Module -4 (Client/ Server Systems Services and Support)

Services and Support- System administration, Availability, Reliability, Scalability, Observability, Agility, Serviceability. Software Distribution, Performance, Network management. Remote Systems Management- RDP, Telnet, SSH, Security. LAN and Network Management issues.

Module -5(Client/Server Technology and Databases)

Client/Server Technology and Databases **-** Storing Data, Database System Architectures. Client/Server In Respect Of Databases- Client/Server Databases, Client/Server Database Computing, Database Computing Vs. Mainframe, PC/File Server Computing. Client/Server Database Architecture - Process-Per-Client Architecture, Multi-Threaded Architecture, Hybrid Architecture. Database Middleware Component - Application Programming Interface, Database Translator, Network Translator.

Text Book

1. Patrick Smith &Steve Guengerich, Client / Server Computing, PHI

2. Subhash Chandra Yadav, Sanjay Kumar Singh, An Introduction to Client/Server Computing, New Age International Publishers

Reference Books

1. Jeffrey D.Schank, "Novell's Guide to Client-Server Application & Architecture" Novell Press

2. Robert Orfali, Dan Harkey, Jeri Edwards, Client/Server Survival Guide, Wiley-India Edition, Third Edition

3. Dawna Travis Dewire, Client Server Computing — McGraw Hill

4. W.H.Inman, Developing Client Server Applications, BPB

Model Question Paper

QP CODE: **PAGES: ___**

Reg No:_______________

Name:_________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Course Code: CST 385

Course Name : Client Server Systems

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

PART-A

(Answer All Questions. Each question carries 3 marks)

1. Differentiate between Stateful and Stateless servers

2. List the different phases and activities of client/server system development methodology.

3. How does transmission protocol work in client/server applications?

4. List any six services in single system image environment.

5. Specify the role of the client in Client/Server computing and also list any six services provided by the client.

6. Why do most RPC system support call by value semantics for parameter passing?

7. What do you mean by a thin client network? List three advantages of the Thin

Client Network system.

8. How are connectivity and interoperability between .client/server achieved?

9. One disadvantage of the Client/Server system is lack of control in a Database Management environment. Justify.

10. Explain the DBMS concept in client/server architecture.

(10x3=30)

Part B

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

11. (a) Differentiate between Transaction server and Data server system with examples. **(7)**

(b) Computing in client server architecture over Mainframe architecture has certain advantages and disadvantages. Describe at least three advantages and disadvantages for each architecture. **(7)**

OR

12. (a) Explain various Clients/Server system development tools. **(6)**

(b) Classify and describe the driving forces that drive the move to Client/Server computing. **(8)**

13. (a) Explain the role of mainframe-centric model in Client/Server computing? **(5)**

(b) Describe the three types of Client/Server systems in existence **(9)**

OR

14. (a) List and explain the general forces behind the architecture for business information systems **(7)**

(b) Explain the different distribution styles. **(7)**

15. (a) Illustrate the concept of rightsizing and downsizing in Client/Server Computing **(7)**

(b) What is client server system development methodology? Explain the **(7)** different phases of System Integration Life-Cycle.

OR

16. (a) In Client/Server computing, explain the following with examples **(10)**
    i. Dynamic Data Exchange
    ii. RPC, Remote Procedure Call
    iii. Remote Boot Service
    iv. Diskless Computer
    v. Object-linking and embedding

    (b) Explain the functions and features of Network Operating System **(4)**

17. (a) Explain about network management and remote system management. How can security be provided to the network ? **(10)**

    (b) In client server architecture, what do you mean by Availability, Reliability, Serviceability and Security? Explain with examples. **(4)**

OR

18. (a) Client server is modular infrastructure, this is intended to improve Usability, Flexibility, Interoperability and Scalability. Explain each term with an example, in each case how it helps to improve the functionality of client server architecture. **(7)**

    (b) Explain about network management and remote system management. How can security be provided to network? **(7)**

19. (a) Explain the different types of Client/Server Database Architecture **(9)**

    (b) List and explain the main components of Database middleware **(5)**

OR

20. (a) Discuss types of database utilities, tools and their functions **(7)**

    (b) Discuss about the role of traditional and web databases in handling client/server based applications. **(7)**

Teaching Plan

Module- 1(Introduction)		**(10 hours)**
1.1	Basic Client/Server Computing Model	1 hour
1.2	Server for Every Client- File Server, Print Server	1 hour
1.3	Application Server, Mail Server, Directory Services Server	1 hour
1.4	Web Server, Database Server	1 hour
1.5	Transaction Servers	1 hour
1.6	Client/Server-Fat or Thin	1 hour
1.7	Stateless or Stateful	1 hour
1.8	Servers and Mainframes	1 hour
1.9	Client/Server Functions	1 hour
1.10	Driving Forces behind Client/Server Computing- Business Perspective, Technology Perspective	1 hour
Module- 2 (Client/Server Classification)		**(10 hours)**
2.1	Client/Server Types-Single Client/Single Server	1 hour
2.2	Multiple Clients/Single Server, Multiple Clients/Multiple Servers	1 hour
2.3	Integration With Distributed Computing	1 hour
2.4	Alternatives To Client/Server Systems	1 hour
2.5	Classification of Client/Server Systems- Two-Tier Computing, Middleware	1 hour
2.6	Three-Tier Computing- Model View Controller (MVC)	1 hour
2.7	Principles behind Client/Server Systems.	1 hour
2.8	Client/Server Topologies	1 hour
2.9	Existing Client/Server Architecture	1 hour
2.10	Architecture for Business Information System	1 hour
Module -3 (Client/Server Application Components)		**(9 hours)**
3.1	The client: Services, Request for services, RPC	1 hour
3.2	Windows services, Print services, Remote boot services	1 hour

3.3	Utility Services & Other Services	1 hour
3.4	Server- Detailed server functionality, Network operating system	1 hour
3.5	Available platforms, Server operating system	1 hour
3.6	Organizational Expectations, Improving performance of client/server applications	1 hour
3.7	Single system image, Downsizing and Rightsizing	1 hour
3.8	Advantages and disadvantages of Client/Server computing	1 hour
3.9	Applications of Client/Server	1 hour
Module -4 (Client/ Server Systems Services and Support)		**(8 hours)**
4.1	Services and Support, System administration	1 hour
4.2	Availability, Reliability	1 hour
4.3	Scalability, Observability, Agility	1 hour
4.4	Serviceability, Software Distribution	1 hour
4.5	Performance	1 hour
4.6	Network management	1 hour
4.7	Remote Systems Management- RDP, Telnet, SSH	1 hour
4.8	Security, LAN and Network Management issues	1 hour
Module -5(Client/Server Technology and Databases)		**(8 hours)**
5.1	Client/Server Technology and Databases - Storing Data	1 hour
5.2	Database System Architectures	1 hour
5.3	Client/Server In Respect Of Databases- Client/Server Databases	1 hour
5.4	Client/Server Database Computing	1 hour
5.5	Database Computing Vs. Mainframe, PC/File Server Computing	1 hour
5.	Client/Server Database Architecture - Process-Per-Client Architecture	1 hour
5.7	Multi-Threaded Architecture, Hybrid Architecture	1 hour
5.8	Database Middleware Component - Application Programming Interface, Database Translator, Network Translator	1 hour

SEMESTER V

HONOURS

CST 393	CRYPTOGRAPHIC ALGORITHMS	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2019

Preamble:

The course on Cryptographic Algorithms aims at exploring various algorithms deployed in offering confidentiality, integrity, authentication and non-repudiation services. This course covers classical encryption techniques, symmetric and public key crypto-system, key exchange and management, and authentication functions. The concepts covered in this course enable the learners in effective use of cryptographic algorithms for real life applications.

Prerequisite: A sound background in Number Theory**.**

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

CO1	Identify the security services provided for different types of security attacks. (**Cognitive Knowledge Level : Understand**)
CO2	Summarize the classical encryption techniques for information hiding. (**Cognitive Knowledge Level: Apply**)
CO3	Illustrate symmetric / asymmetric key cryptographic algorithms for secure communication.(**Cognitive Knowledge Level: Apply**)
CO4	Interpret key management techniques for secure communication.(**Cognitive Knowledge Level: Understand)**
CO5	Summarize message authentication functions in a secure communication scenario.(**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
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks**
	Test1 (Percentage)	**Test2 (Percent**	

		age)	
Remember	**30**	**30**	**30**
Understand	**30**	**30**	**30**
Apply	**40**	**40**	**40**
Analyze			
Evaluate			
Create			

Mark Distribution

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

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Tests : **25 marks**

Continuous Assessment Assignment : **15 marks**

Internal Examination Pattern:

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

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

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

End Semester Examination Pattern:

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

Syllabus

Module-1 (Introduction to the Concepts of Security)

Need for security, Security approaches, Principles of security, Types of attacks, OSI Security Architecture, Classical encryption techniques - Substitution techniques, Transposition techniques. Stream cipher, Block cipher, Public key cryptosystems vs. Symmetric key cryptosystems, Encrypting communication channels.

Module-2 (Symmetric Key Cryptosystems)

Overview of symmetric key cryptography, Block cipher principles, Data Encryption Standard (DES), Differential and Linear cryptanalysis, Double DES, Triple DES, International Data Encryption Algorithm (IDEA), Advanced Encryption Algorithm (AES),Block cipher modes of operation, Stream cipher, RC4.

Module-3 (Public Key Cryptosystems)

Principles of public key cryptosystems, RSA algorithm, RSA illustration, Attacks, ElGamal cryptographic system, Knapsack algorithm, Diffie-Hellman key exchange algorithm, Elliptical curve cryptosystems.

Module-4 (Key Management)

Symmetric key distribution using symmetric encryption, Symmetric key distribution using asymmetric encryption, Distribution of public keys, Generating keys, transferring keys, Verifying keys, Updating keys, Storing keys, Backup keys, Compromised keys, Public key infrastructure.

Module – 5 (Authentication)

Authentication requirements, Authentication functions, Message authentication codes (MAC), Hash functions, Security of Hash functions and MAC, Message Digest 5 (MD5), Secure Hash Algorithm (SHA)-512, Hash-based Message Authentication Code (HMAC), Cipher-based Message Authentication Code (CMAC), X.509 Authentication services.

Text Books

1. William Stallings, Cryptography and Network Security Principles and Practice, Pearson Edu, 6e.
2. Bruice Schneier, Applied Cryptography Protocols, Algorithms and source code in C, Wiley,2e.

References

1. Behrouz A. Forouzan, Cryptography and Network Security, McGraw Hill, 2e.

2. Johannes A. Buchmann, Introduction to Cryptography, Springer, 2e.

3. DouglasR. Stinson, Cryptography Theory and Practice, 3e,Chapman & Hall/CRC, 2006.

4. Bernard Menezes, Network Security and Cryptography, Cengage Learning, 2011.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Consider an automated teller machine (ATM) in which users provide a personal identification number (PIN) and a card for account access. Give examples of confidentiality, integrity, and availability requirements associated with the system and, in each case, indicate the degree of importance of the requirement.

2. Discuss the different security services provided for preventing security attacks.

Course Outcome 2 (CO2):

1. The encryption key in a transposition cipher is (3,2,6,1,5,4). Find the decryption key

2.Discuss the process of encryption in Vernam cipher

Course Outcome 3 (CO3):

1. Devise a meet-in-the-middle attack for a triple DES.

2. Write an algorithm for the InvSubBytes transformation and implement using python (**Assignment**)
3. Consider the following elliptic curve signature scheme. We have a global elliptic curve, prime *p*, and "generator" G. Alice picks a private signing key X_A and forms the public verifying $Y_A = X_A G$. To sign a message *M*:
   - Alice picks a value k
   - Alice sends Bob *M*, k and the signature $S = M - kX_A G$.
   - Bob verifies that $M = S + kY_A$.

   Show that the verification process produces an equality if the signature is valid.
4. Write an algorithm to add two points on an elliptic curve over GF(*p*) and implement using Python. **(Assignment)**
5. Write an algorithm for encryption using knapsack cryptosystem and implement using Java. **(Assignment)**

Course Outcome4 (CO4):

1. List four general categories of schemes for the distribution of public keys.
2. What are the essential ingredients of a public-key directory?

Course Outcome 5 (CO5):

1. State the value of the length field in SHA-512 if the length of the message is 1919 bits and 1920 bits.
2. Write an algorithm in pseudo code for HMAC and implement using Python (**Assignment**)

Model Question Paper

QP CODE:

Reg No:_______________

Name :_______________ **PAGES : 3**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Course Code: CST393

Course Name: Cryptographic Algorithms

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

PART A

Answer all Questions. Each question carries 3 Marks

1. State the two approaches in attacking a cipher.
2. Define Substitution Cipher. Encrypt using one time pad M = HONORS and K = CIPHER.
3. Specify the purpose of S-Boxes in Data Encryption Standard (DES).
4. Differentiate between diffusion and confusion.
5. Perform encryption using RSA Algorithm for the following p=7; q=11; e=13; M=5.
6. Is Diffie-Hellman key exchange protocol vulnerable? Justify.
7. List the techniques for distribution of public keys.
8. Define a certificate authority and its relation to public key cryptography.
9. Distinguish between integrity and message authentication.
10. What types of attacks are addressed by message authentication?

(10x3=30)

Part B

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

11. (a) With a neat sketch, Explain OSI Security architecture model. **(8)**

(b) How does link encryption differ from end-to-end encryption? Explain. **(6)**

OR

12. (a) Encrypt the text "cryptography" using the Hill Cipher with the key $\begin{pmatrix} 9 & 4 \\ 5 & 7 \end{pmatrix}$. Show the calculations. **(8)**

(b) Illustrate the steps involved in encrypting a plain text using playfair cipher with an example. **(6)**

13. (a) With a neat sketch, explain a single round in DES. **10**

(b) Explain encryption and decryption using 2 keys and 3 keys of triple DES. **(4)**

OR

14. (a) Explain the block cipher modes i) Cipher feedback mode ii) Output feedback mode. **(8)**

(b) Describe the four types of transformations in AES. **(6)**

15. (a) Write an algorithm for generating public and private key using Elliptical curve cryptography. **(10)**

(b) The equation $y^2=x^3+x+1$, the calculation is done modulo 13. Add two points R= P+Q, where P= (4,2) and Q= (10,6). **(4)**

OR

16. User A and B use the Diffie-Hellman key exchange technique with a common prime q=71 and primitive root alpha=7.

(a) If user A has private key X_A =3, What is A's public key Y_A? **(7)**

(b) If user B has private key X_B =6, What is A's public key Y_B? **(7)**

17. (a) Define a session key and show how a KDC can create can create a session key between Alice and Bob. **(7)**

(b) What are the requirements for the use of a public-key certificate scheme? **(7)**

OR

18. (a) What are the core components of a PKI? Briefly describe each component. **(8)**

(b) Describe the following (i) Updating keys (ii) Compromised Keys. **(6)**

19. (a) Describe how SHA-512 logic produce message digest **(10)**

(b) Distinguish between HMAC and CMAC **(4)**

OR

20. (a) Specify the format for X.509 certificate. Explain the steps required to obtain user's certificate. **(7)**

(b) With suitable block diagrams, explain the types of functions that may be used to produce an authenticator. **(8)**

Teaching Plan

No	Contents	No of Lecture Hrs
Module - 1 (Introduction to the Concepts of Security) (9 hrs)		
1.1	Need for security, Security approaches	1 hour
1.2	Principles of security, Types of attacks	1 hour
1.3	OSI Security Architecture	1 hour
1.4	Classical encryption techniques: Substitution techniques(Caesar cipher, Monoalphabetic cipher, Playfair cipher)	1 hour
1.5	Classical encryption techniques: Substitution techniques (Hill cipher, Polyalphabetic cipher, One-time pad)	1 hour
1.6	Classical encryption techniques: Transposition techniques	1 hour
1.7	Stream cipher, Block cipher	1 hour
1.8	Public- key cryptosystems vs. Symmetric key cryptosystems	1 hour
1.9	Encrypting communication channels	1 hour
Module - 2 (Symmetric key cryptosystems) (11 hrs)		
2.1	Overview of symmetric key cryptography	1 hour
2.2	Block cipher principles	1 hour
2.3	Data Encryption Standard (DES)	1 hour
2.4	DES design criteria	1 hour
2.5	Differential and Linear cryptanalysis	1 hour
2.6	Double DES, Triple DES	1 hour

2.7	IDEA	1 hour
2.8	Advanced Encryption Algorithm (AES structure)	1 hour
2.9	Advanced Encryption Algorithm (Transformations)	1 hour
2.10	Block cipher modes of operation	1 hour
2.11	Stream cipher, RC4	1 hour
Module - 3 (Public key cryptosystems) (8 hrs)		
3.1	Principles of public key cryptosystems	1 hour
3.2	RSA algorithm	1 hour
3.3	RSA illustration, Attacks	1 hour
3.4	ElGamal cryptographic system	1 hour
3.5	Knapsack algorithm	1 hour
3.6	Diffie-Hellman key exchange algorithm	1 hour
3.7	Elliptical curve cryptosystems(Elliptical curve arithmetic)	1 hour
3.8	Elliptical curve cryptosystems (Elliptical curve algorithm)	1 hour
Module - 4 (Key Management) (8 hrs) [Text book-2]		
4.1	Symmetric key distribution using symmetric encryption	1 hour
4.2	Symmetric key distribution using asymmetric encryption	1 hour
4.3	Distribution of public keys	1 hour
4.4	Generating keys, Transferring keys	1 hour

4.5	Verifying keys, Updating keys	1 hour
4.6	Storing keys, Backup keys	1 hour
4.7	Compromised keys	1 hour
4.8	Public key infrastructure	1 hour
Module - 5 (Authentication) (9 hrs)		
5.1	Authentication requirements	1 hour
5.2	Authentication functions	1 hour
5.3	Message Authentication Codes (MAC)	1 hour
5.4	Hash functions	1 hour
5.5	Security of Hash functions and MAC	1 hour
5.6	MD5	1 hour
5.7	SHA-512	1 hour
5.8	HMAC, CMAC	1 hour
5.9	X.509 Authentication services	1 hour

AIT395	COMPUTATIONAL BIOLOGY	CATEGORY	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2020

Preamble: This course helps the learners to understand concepts in Genomics, Proteomics Computational Biology, Next Generation Sequencing, NGS Data Analysis and Systems biology. It enables the learners to understand various Next Generation Sequencing Techniques, analysis and interpretation of the NGS Data. Also, course introduces computational and mathematical analysis and modeling of complex biological systems and Systems Biology

Prerequisite: Basic background in Bioinformatics

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

CO 1	Describe the basic concepts of genomics, microarray, protein structure determination and prediction(**Cognitive knowledge level: Understand**)
CO 2	Explain the fundamental aspects drug discovery and molecular modelling (**Cognitive knowledge level: Apply)**
CO 3	Demonstrate Networks in Biology, types of networks and its representation (**Cognitive knowledge level : Apply)**
CO 4	Explain Next Generation sequencing Technologies and DNA Protein interaction analysis(**Cognitive knowledge level: Understand)**
CO 5	Illustrate Next Generation sequence analysis, Mapping approaches and algorithms (**Cognitive knowledge level: Understand**)

Mapping of course outcomes with program outcomes

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

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

Assessment Pattern

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

Mark Distribution

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

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

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

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern:

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

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

SYLLABUS`

Module -01 (Genomics and Proteomics)

Genes, Genes in genomes, Genomes of prokaryotes and Eukaryotes, Protein-coding genes, RNA, Single-nucleotide polymorphisms, Microarray, Analysis of microarray data, Proteins and peptides, Experimental Protein structure identification, computational methods for protein structure prediction, Homology modelling, Protein folding and fold recognition.

Module-02 (Computer Aided Drug Discovery)

Drug discovery pipeline, Drug target identification & validation, Active site identification, pharmacophore, Lead/Ligand identification, lead compound optimization, Binding energy calculation, Energy Minimization. Molecular modelling in drug discovery, concept of Molecular Dynamics, concept of Absorption, Distribution, Metabolism and Excretion (ADME), Quantitative Structure-Activity Relationships.

Module-03 (Network Biology)

Transcriptional Regulatory Networks, Genes and DNA Regulatory Regions, Genetic Interaction Map, Protein Interaction Networks, Experimental methodologies to obtain Protein Interaction Data, Computational methods to Predict Protein-Protein Interactions, Visualization of Protein Interaction Networks,Metabolic Networks, Interacting Partners, Mathematical Representation

Module-04 (Next Generation Sequencing and analysis)

A Typical NGS Experimental Workflow, Next-Generation Sequencing (NGS) Technologies, Illumina Reversible Dye-Terminator Sequencing, Ion Torrent Semiconductor Sequencing, Pacific Biosciences Single Molecule Real-Time (SMRT) Sequencing, RNA-sequencing (RNA Seq), Protein-DNA Interaction Analysis (ChIP-Seq)

Module-05 (NGS Data Analysis)

Base Calling, FASTQ File Format, and Base Quality Score, NGS Data Quality Control and Preprocessing, Reads Mapping, Mapping Approaches and Algorithms, Selection of Mapping Algorithms and Reference Genome Sequences, SAM/BAM as the Standard Mapping File Format, Mapping File Examination and Operation, Tertiary Analysis

Books

1. Lesk, Arthur M. Introduction to Bioinformatics. United Kingdom, Oxford University Press, 2019.
2. Biological Networks. Singapore, World Scientific Publishing Company, 2007.
3. Wang, Xinkun. Next-Generation Sequencing Data Analysis. United States, CRC Press, 2016.

References

1. Tiwary, Basant K.. Bioinformatics and Computational Biology: A Primer for Biologists. Singapore, Springer Singapore, 2021.
2. Benfey, Philip N.. Quickstart Molecular Biology: An Introductory Course for Mathematicians, Physicists, and Computational Scientists. United States, Cold Spring Harbor Laboratory Press, 2014.
3. Baxevanis, Andreas D., Gary D. Bader, and David S. Wishart, eds. *Bioinformatics*. John Wiley & Sons, 2020.
4. Shaik, Noor Ahmad, et al. *Essentials of Bioinformatics, Volume I.* Springer, 2019
5. Selzer, Paul M., Richard J. Marhöfer, and Andreas Rohwer, *Applied bioinformatics. An introduction–Springer, Verlag,*, 2008.
6. S C Rastogi, N Mendiratta and P Rastogi, *Bioinformatics: Methods and Applications* , PHI Learning Private Limited, New Delhi, 2015.
7. D E Krane and M L Raymer, *Fundamental Concepts of Bioinformatics*, Pearson Education, 2006.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Compare and contrast the genomes of Prokaryotes and Eukaryotes
2. Summarize the method of DNA microarray and its analysis.
3. Using the online tool SWISS-MODEL, develop model of Homo sapiens (Human) Leptin protein and interpret your result

Course Outcome 2 (CO2):

1. Explain the process of computer aided drug discovery and various step involved in it
2. Explain the process of molecular modelling in drug discovery

Course Outcome 3 (CO3):

1. Differentiate between Transcriptional and protein interaction networks
2. From the STRING database identify the interactions of Homo sapiens TP53 protein and interpret your result

Course Outcome 4 (CO4):

1. Summarize Next Generation Sequencing methods.
2. Explain The Protein- DNA interaction analysis with the help of ChIP-Seq
3. What can RNA-seq reveal?

Course Outcome 5 (CO5):

1. Illustrate the process involved in Data Quality control and preprocessing in Next Generation Sequencing
2. Explain the mapping algorithms and reference genome sequences

TEACHING PLAN

No	Contents	No of Lecture (45Hrs)
	Module -01 (Genomics and Phylogenetics) (9hrs)	
1.1	Genes, Genes in genomes.	1
1.2	Genomes of prokaryotes and Eukaryotes	1
1.3	Protein-coding genes, RNA, Single-nucleotide polymorphisms	1
1.4	Microarrays	1
1.5	Analysis of microarray data	1
1.6	Proteins and peptides	1
1.7	Experimental Protein structure identification	1
1.8	Computational methods for protein structure prediction	1
1.9	Homology modelling, Protein folding and fold recognition	1
	Module-02 (Computer Aided Drug Discovery)(9hrs)	
2.1	Drug discovery pipeline	1
2.2	Drug target identification & validation	1
2.3	Active site identification, pharmacophore	1
2.4	Lead/Ligand identification	1
2.5	lead compound optimization, Binding energy calculation, Energy Minimization	1
2.6	Molecular modelling in drug discovery	1

2.7	Concept of Molecular Dynamics	1
2.8	Concept of Absorption, Distribution, Metabolism and Excretion (ADME)	1
2.9	Quantitative Structure-Activity Relationship	1
Module-03 (Network Biology)(9hrs)		
3.1	Transcriptional Regulatory Networks	1
3.2	Genes and DNA Regulatory Regions,	1
3.3	Genetic Interaction Map,	1
3.4	Protein Interaction Networks	1
3.5	Experimental methodologies to obtain Protein Interaction Data	1
3.6	Computational methods to Predict Protein-Protein Interactions	1
3.7	Visualization of Protein Interaction Networks	1
3.8	Metabolic Networks- Interacting Partners	
3.9	Metabolic Networks- Mathematical Representation	

Module-04 (Next Generation Sequencing and analysis) (8hrs)		
4.1	A Typical NGS Experimental Workflow	1
4.2	Next-Generation Sequencing (NGS) Technologies	1
4.3	Next-Generation Sequencing (NGS) Technologies	1
4.4	Illumina Reversible Dye-Terminator Sequencing	1
4.5	Ion Torrent Semiconductor Sequencing	1
4.6	Pacific Biosciences Single Molecule Real-Time (SMRT) Sequencing	1
4.7	RNA-sequencing (RNA Seq)	1
4.8	Protein-DNA Interaction Analysis (ChIP-Seq)	1
Module-05 (NGS Data Analysis)(10hrs)		
5.1	NGS data,FASTQ File Format	1
5.2	Base Calling, Base Quality Score	1
5.3	NGS Data Quality Control	1
5.4	NGS data Preprocessing	1
5.5	Reads Mapping, Mapping Approaches and Algorithms,	1

5.6	Selection of Mapping Algorithms and Reference Genome Sequences	1
5.7	SAM/BAM as the Standard Mapping	1
5.8	Mapping File Examination and Operation	1
5.9	Tertiary Analysis	1
5.10	Demonstration of NGS Data Analysis	1

Model Question Paper

QP CODE:

Reg No: _______________

Name: _________________ **PAGES: 4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: AIT395

Course Name: COMPUTATIONAL BIOLOGY

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

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Distinguish between Genes, Genes in genomes.
2. What are the structural features of Eukaryotic cells?
3. What are SNPs and why are they important?
4. How do you identify the active site of a protein?
5. What is protein energy minimization?
6. List any three types of biochemical networks with one line description
7. What are reversible Dye-Terminators in NGS sequencing?
8. What is the difference between the DNA sent for Whole Exome sequencing vs ChIP sequencing?
9. List any three features of FastQ file format.
10. What is SAM format? How is BAM different from SAM? **(10x3=30)**

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

11. (a) With the help of a neat diagram, explain a prokaryotic gene structure. Is a promoter at the upstream or downstream of a transcription unit? **(7)**

    (b) What is homology modeling? Discuss the steps involved in the same **(7)**

OR

12. (a) Explain the design of a microarray experiment, detailing the various phases. **(7)**

    (b) What experimental method is used to determine the tertiary protein structure? What are the computational methods? **(7)**

13. (a) Illustrate the computational drug discovery pipeline with a suitable flowchart **(7)**

    (b) What is Molecular modeling in drug discovery? Explain the process of molecular modelling. **(7)**

OR

14. (a) Explain the scoring functions in molecular docking. **(7)**

    (b) Explain lead compound optimization, Binding energy calculation, Energy Minimization in the process of Computer aided drug discovery **(7)**

15. (a) What is transcriptional control and why is it important? Explain how transcriptional regulatory networks plays an important role in gene expression and control? **(7)**

    (b) Explain how the computational methods helps in identifying the Protein–Protein Interactions **(7)**

OR

16. (a) How the Protein–Protein Interactions are identified by using experimental methods. **(7)**

    (b) What is metabolic network? What are type of data are needed for metabolic network reconstruction? **(7)**

17. (a) Explain any two next-generation sequencing techniques with their steps. **(7)**

    (b) How do you interpret a FastQC report? **(7)**

OR

18. (a) What are the steps in RNA sequencing?Why is RNA-seq better than microarrays? **(7)**

    (b) illustrate the steps involved in mapping protein-DNA interactions using ChIP-sequencing **(7)**

19. (a) How do you interpret per base sequence quality?What is the purpose of mapping reads to a reference genome? **(7)**

    (b) Explain any three mapping algorithms for the NGS. **(7)**

OR

20. (a) Illustrate steps involved in the NGS data Preprocessing and Quality Control **(7)**

(b) Discuss the significance of NGS in clinical diagnosis. **(7)**

AIT397	ADVANCED CONCEPTS IN COMPUTER VISION	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2020

Preamble: This course enables the learners to understand the advanced concepts in computer vision. The course covers the basics of image processing, imaging geometry, image segmentation, feature extraction, object recognition and classification and common applications of computer vision. This course helps the students to design solutions for complex real-life problems.

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

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

CO1	Illustrate the concepts of image formation and image model. **(Cognitive Knowledge Level: Understand)**
CO2	Demonstrate various feature extraction and edge detection techniques. **(Cognitive Knowledge Level: Apply**
CO3	Apply edge-based and region-based image segmentation techniques. **(Cognitive Knowledge Level: Apply)**
CO4	Understand and implement image recognition and classification methods. **(Cognitive Knowledge Level: Apply)**
CO5	Explain the various applications of computer vision. **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

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

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

Assessment Pattern

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

Analyze			
Evaluate			
Create			

Mark Distribution

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

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

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

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing 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 (Image Formation and Processing)

Image formation and Image model- Components of a vision system- Cameras- camera model and camera calibration-Radiometry- Light in space- Light in surface - Sources, shadows and shading.

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

Module - 2(Feature Extraction)

Points and Patches – Feature detectors, feature descriptors, feature matching, feature tracking. **Edges –** edge detection, edge linking. **Lines** - Successive approximation, Hough transforms, Vanishing points.

Module - 3 **(Image Segmentation)**

Classification of segmentation techniques, Edge detection, Edge linking, Thresholding, Region growing, Region splitting and merging, Watershed based segmentation. Shadow detection and removal. Image processing using OpenCV - blending, smoothing, and reshaping.

Module - 4 (**Image Recognition and Classification**)

Shape based object classification, Motion based object classification, Viola Jones Object Detection Framework, Object classification using CNNs, use of RCNN for object classification.

Module - 5 (**Applications**)

Speech and Handwriting Recognition, Automatic Face Recognition, Video Segmentation and Keyframe Extraction, Real-Time Hand Pose Recognition.

Text 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.

Reference Books

1. Reinhard Klette, “Concise Computer Vision: An Introduction into Theory and Algorithms”, Springer London, 2014.

2. Olivier Faugeras, “Three-Dimensional Computer Vision”, The MIT Press, 1993.

Course Level Assessment Questions

Course Outcome1 (CO1):

1.Explain the components of a visual system.

2.Elaborate on the image formation model.

Course Outcome 2(CO2):

1. Explain edge linking through Hough Transform.
2. Discuss how feature extraction is done in image processing.

Course Outcome 3(CO3):

1. Compare the following methods for image segmentation: a) multiple thresholding, b) global thresholding c) local thresholding.
2. Justify the role of region growing, region splitting and region merging operations in any of the computer vision applications.

Course Outcome 4(CO4): .

1. Explain convolution stage and pooling stage of a typical CNN layer.
2. Illustrate Viola Jones object detection framework.

Course Outcome 5(CO5):

1. Elaborate on how computer vision helps in automatic face recognition applications.
2. Discuss how computer vision helps in tackling complex real world problems.

Model Question Paper

QP CODE:

Reg No: _______________

Name: _________________ **PAGES : 3**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: AIT397

Course Name: Advanced Concepts in Computer Vision

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

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Explain the working of a pinhole camera, Derive the expression for pinhole perspective projection.

2. Illustrate "foreshortening" with a neat diagram.

3. Explain edge linking through Hough Transform.

4. Illustrate any two techniques for vanishing point detection in an image.

5. Compare following methods for image segmentation
   a, multiple thresholding, b, global thresholding c, local thresholding.

6. Draw the flowchart of foreground-pixel extraction by edge-based shadow removal

7. Why is a convolutional neural network preferred over a dense neural network for an image classification task?

8. Assess the relevance of selective search algorithm in RCNN for object classification

9. Draw the diagram which shows the general scheme of a recognition system.

10. Illustrate steps in feature extraction from handwritten images.

(10x3=30)

Part B

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

11. (a) State different limitations of pinhole cameras and how to overcome these limitations. **(9)**

(b) What are shadows? Differentiate umbra from penumbra. How is a self shadow different from a cast shadow? **(5)**

OR

12. (a) Explain the local shading model.How are area sources different from line sources? **(7)**

(b) Define Camera Calibration. Explain intrinsic and extrinsic parameters of a camera. **(7)**

13. (a) Assess the role of adaptive non-maximal suppression (ANMS) in feature detection. **(4)**

(b) Illustrate following techniques: **(10)**

i) Bias and gain normalization (MOPS).

ii) Gradient location-orientation histogram (GLOH)

OR

14. (a) Illustrate any 2 techniques in Successive approximation. **(4)**

(b) Compare Scale invariant feature transform (SIFT) and PCA-SIFT. **(5)**

15. (a) Illustrate Gradient operator and Laplacian operator with one example for each. **(10)**

(b) Illustrate Watershed Algorithms. **(4)**

OR

16. (a) With the help of a diagram illustrate region splitting and merging. **(7)**

(b) Compare blending, smoothing, and reshaping functions using OpenCV. **(7)**

17. (a) Differentiate between convolution stage and pooling stage of a typical CNN layer. **(8)**

(b) Assess the role of dispersedness in shape based object classification. **(6)**

OR

18. (a) Illustrate Viola Jones object detection framework. **(8)**

(b) Explain the steps in motion based object classification. **(6)**

19. (a) Illustrate shot boundary detection through pixel-based approaches and block-based approaches . **(7)**

(b) Explain different approaches in keyframe extraction problems. **(7)**

OR

20. (a) Illustrate shot boundary detection through histogram-based approaches and clustering-based approaches. **(6)**

(b) Illustrate HMM training in speech and handwriting recognition. **(8)**

TEACHING PLAN

No	Contents	No. of Lecture Hours (42 hrs)
	Module – 1 (Image Formation and Processing) (8 hours)	
1.1	Image formation and Image model-Introduction	1 hour
1.2	Components of a vision system- Cameras-Camera model	1 hour
1.3	Camera calibration	1 hour
1.4	Radiometry- Light in space-Light in surface	1 hour
1.5	Sources-Shadows and shading	1 hour
1.6	Fundamentals of Image processing: Basic steps of Image processing system	1 hour
1.7	Sampling and quantization of an Image	1 hour
1.8	Basic relationship between pixels.	1 hour
	Module-2(Feature Extraction) (8 hours)	
2.1	**Points and Patches** – Feature detectors	1 hour
2.2	Feature descriptors	1 hour
2.3	Feature matching	1 hour
2.4	Feature tracking.	1 hour
2.5	**Edges –** edge detection, edge linking.	1 hour
2.6	**Lines** - Successive approximation	1 hour
2.7	Hough transforms	1 hour
2.8	Vanishing points	1 hour

Module-3(Image Segmentation)(9 hours)		
3.1	Classification of segmentation techniques, Edge detection	1 hour
3.2	Edge linking	1 hour
3.3	Thresholding, Region growing	2 hours
3.4	Region splitting and merging	1 hour
3.5	Watershed based segmentation.	1 hour
3.6	Shadow detection and removal	1 hour
3.7	Image processing using OpenCV - blending	1 hour
3.8	Smoothing, and reshaping	1 hour
Module-4(Image Recognition and Classification) (9 hours)		
4.1	Shape based object classification	1 hour
4.2	Motion based object classification	2 hours
4.3	Viola Jones Object Detection Framework	2 hours
4.4	Object classification using CNNs	2 hours
4.6	Use of RCNN for object classification.	2 hours
Module-5(Applications)(8 hours)		
5.1	Speech and Handwriting Recognition	1 hour
5.2	Handwriting Recognition	1 hour
5.3	Automatic Face Recognition	2 hours
5.4	Video Segmentation	2 hours
5.5	Keyframe Extraction	1 hour
5.6	Real-Time Hand Pose Recognition.	1 hour

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.

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

Course Outcome 3 (CO3):

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

   $E \rightarrow E + T \mid T$

   $T \rightarrow T*F \mid F$

   $F \rightarrow (E) \mid id$

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

   $S \rightarrow L = R$

   $S \rightarrow R$

   $L \rightarrow * R$

   $L \rightarrow id$

   $R \rightarrow L$

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

Course Outcome 4 (CO4):

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

   R1 = C * D

   R2 = B + R1

   A = R2

   B[0] = A

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

Course Outcome 5 (CO5):

1. List out the examples of function preserving transformations.
2. What are the actions performed by a simple code generator for a typical three-address statement of the form x: = y 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 **(7)**

S→ CC

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

AIT304	**ROBOTICS AND INTELLIGENT SYSTEM**	**Category**	**L**	**T**	**P**	**Credit**	**Year of Introduction**
		PCC	**3**	**1**	**0**	**4**	**2022**

Preamble: This course enables the learners to understand the fundamental concepts and algorithms in Robotics and Intelligent systems. The course covers the standard hardware and kinematic concepts for robot design. Standard algorithms for localization, mapping, path planning, navigation and obstacle avoidance, to incorporate intelligence in robots are included in the course. This course helps the students to design robots with intelligence in a real world environment.

Prerequisite: Basic understanding of probability theory, linear algebra, machine learning, artificial intelligence

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

CO1	Understand the concepts of manipulator and mobile robotics. **(Cognitive Knowledge Level: Understand)**
CO2	Choose the suitable sensors, actuators and control for robot design. **(Cognitive Knowledge Level: Apply)**
CO3	Developing kinematic model of mobile robot and understand robotic vision intelligence. **(Cognitive Knowledge Level: Apply)**
CO4	Discover the localization and mapping methods in robotics. **(Cognitive Knowledge Level: Apply)**
CO5	Plan the path and navigation of robot by applying artificial intelligence algorithm. **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

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

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

Assessment Pattern

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

Mark Distribution

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

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

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

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern

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

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

SYLLABUS

Module – 1 (Introduction to robotics)

Introduction to robotics – Degrees of freedom, Robot types- Manipulators- Anatomy of a robotic manipulator-links, joints, actuators, sensors, controllers. Robot configurations-PPP, RPP, RRP, RRR. Mobile robots- wheeled, legged, aerial robots, underwater robots, surface water robots . Dynamic characteristics- speed of motion, load carrying capacity & speed of response. Introduction to End effectors - mechanical grippers, special tools, Magnetic grippers, Vacuum grippers, adhesive grippers, Active and Passive grippers. Ethics in robotics - 3 laws - applications of robots.

Module - 2(Sensors, Actuators and Control)

Sensor classification- touch, force, proximity, vision sensors. Internal sensors-Position sensors, velocity sensors, acceleration sensors, Force sensors; External sensors-contact type, non contact type; Digital Camera - CCD camera - CMOS camera - Omnidirectional cameras
Sensor characteristics. Actuators - DC Motors - H-Bridge - Pulse Width Modulation - Stepper Motors – Servos, Hydraulic & pneumatic actuators. Control - On-Off Control - PID Control - Velocity Control and Position Control

Module – 3 (Robotic vision & Kinematics)

Robotic Vision: Sensing, Pre-processing, Segmentation, Description, Recognition, Interpretation, Feature extraction -Camera sensor hardware interfacing. Representation of Transformations - Representation of a Pure Translation - - Pure Rotation about an Axis - Combined Transformations - Transformations Relative to the Rotating Frame.

Basic understanding of Differential-Drive Wheeled Mobile Robot, Car-Like Wheeled Mobile Robot. Kinematic model of a differential drive and a steered mobile robot, Degree of freedom and manoeuvrability, Degree of steerability, Degree of mobility - different wheel configurations, holonomic and nonholonomic robots. Omnidirectional Wheeled Mobile Robots.

Module - 4 (Localization and Mapping)

Position and Orientation - Representing robot position. Basics of reactive navigation; Robot Localization, Challenges in localization - An error model for odometric position estimation

Map Representation - Continuous representations - Decomposition strategies - Current challenges in map representation. Probabilistic map-based localization (only Kalman method), Autonomous map building, Simultaneous localization and mapping (SLAM) - Mathematical definition of SLAM - Visual SLAM with a single camera - Graph-based SLAM - Particle filter SLAM - Open challenges in SLAM

Module - 5 (Path Planning and Navigation)

Path Planning- Graph search, deterministic graph search - , breadth first search - depth first search- Dijkstra' s algorithm, A*, D* algorithms, Potential field based path planning. Obstacle avoidance - Bug algorithm - Vector Field Histogram - Dynamic window approaches. Navigation Architectures - Modularity for code reuse and sharing - Control localization - Techniques for decomposition. Alternatives for navigation - Neural networks - Processing the image - Training the neural network for navigation - Convolutional neural network robot control implementation

Text Books

1. R Siegwart, IR Nourbakhsh, D Scaramuzza, Introduction to Autonomous Mobile Robots ,, MIT Press, USA, 2011
2. Thomas Bräunl - Embedded Robotics,Mobile Robot Design and Applications with Embedded Systems-Springer (2006)
3. S.G. Tzafestas - Introduction to Mobile Robot Control-Elsevier (2014)
4. Francis X. Govers - Artificial Intelligence for Robotics-Packt Publishing (2018)
5. Saeed B. Niku - Introduction to Robotics_ Analysis, Control, Applications

Reference Books

1. John J. Craig, Introduction to Robotics, Pearson Education Inc., Asia, 3rd Edition, 2005
2. S. K. Saha, Introduction to Robotics 2e, TATA McGraw Hills Education (2014)
3. Peter Corke - Robotics, Vision and Control_ Fundamental Algorithms in MATLAB® - Springer-Verlag Berlin Heidelberg (2021)

Course Level Assessment Questions

Course Outcome1 (CO1):

1. Categorise the various types of Grippers used in robot manipulators.
2. Differentiate between active and passive grippers.
3. Explain speed of motion and load carrying capacity of a mobile robot.
4. You wish to build a dynamically stable robot with a single wheel only. For each of the four basic wheel types, explain whether or not it may be used for such a robot.

Course Outcome 2(CO2):

1. Categorise the sensors used in robotics
2. Explain any four characteristics of a sensor
3. Illustrate the sensor performance measuring parameters
4. Suggest any two mechanism to realise 360^{o} Camera

Course Outcome 3(CO3):

1. Determine the degrees of mobility, steerability, and maneuverability for each of the following: (a) bicycle; (b) dynamically balanced robot with a single spherical wheel (c) automobile.
2. A frame F was rotated about the y-axis 90^{o}, followed by a rotation about the o-axis of 30^{o}, followed by a translation of 5 units along the n-axis, and finally, a translation of 4 units along the x-axis. Find the total transformation matrix.
3. Explain the camera sensor hardware interfacing.
4. What is an omni directional robot? Explain two configurations to set up an omni directional robot.

Course Outcome 4(CO4): .

1. Explain the challenges of localization
2. How Kalman method can be used in localization of mobile robots
3. What are the Decomposition strategies in map representation
4. How Visual SLAM can be performed with a single camera

Course Outcome 5(CO5):

1. Explain Dijkstra's algorithm with a suitable example.
2. Identify the steps of Generic temporal decomposition of a navigation architecture.
3. What is meant by control decomposition? Explain two types of control decomposition.
4. Why does SLAM work better with wheel odometer data available?

5. In the Floor Finder algorithm, what does the Gaussian blur function does to improve the results?

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: AIT304

Course Name: ROBOTICS AND INTELLIGENT SYSTEM

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

PART A

Answer All Questions. Each Question Carries 3 Marks

1. What do you mean by degrees of freedom? How many degrees of freedom are required for a drone to achieve any position in 3D space? And how many more DOF required for achieving any orientation as well.
2. Explain how leg configuration affects the stability of mobile robot.
3. Explain Dynamic range, Linearity and Resolution of a Sensor.
4. Explain the working of a Mechanical accelerometer with a block diagram
5. Differentiate between holonomic and nonholonomic robots.
6. What is the significance of differential drive in mobile robot?
7. How will you represent the position and orientation of a wheeled mobile robot?

8. Identify the 2 mobile robot localization problems.

9. Explain the Bug algorithm for obstacle avoidance. .

10. What is Voronoi diagram method and its advantages? **(10x3=30)**

Part B

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

11. (a) Explain the general features of wheeled, legged and aerial robots. **(9)**

(b) Explain the anatomy of a robotic manipulator with a neat diagram. **(5)**

OR

12. (a) Briefly explain the dynamic characteristics of robots. **(9)**

(b) Assume an object of mass 140 kg is to be lifted up with an acceleration of 10 m/s2. Calculate the gripper force required for the operation, if coefficient of friction between contact surfaces is 0.2, number of fingers in gripper is 2 and acceleration due to gravity is 9.8 m/s2 **(5)**

13. (a) Explain the working of an Optical Encoder. **(5)**

(b) A mobile robot is designed for unidirectional motion with constant velocity. Illustrate the mechanism to make the robot move in forward and reverse direction with variable speed. Support with necessary diagrams **(9)**

OR

14. (a) Compare and contrast the working of CCD and CMOS camera **(9)**

(b) Illustrate the significance of the PID controller with a neat block diagram **(5)**

15. (a) Outline the seven stages of robot vision. **(14)**

OR

16. (a) Derive the kinematic model of a differential drive mobile robot. **(7)**

(b) A frame B was rotated about the x-axis 90^o, then it was translated about the current a-axis 3 inches before it was rotated about the z-axis 90^o. Finally, it was translated about the current o–axis 5 inches. **(7)**

(a) Write an equation that describes the motions.

(b) Find the final location of a point p(1,5,4)T attached to the frame relative to the reference frame.

17. (a) Derive error model for odometric position estimation **(8)**

(b) Illustrate the SLAM problem with suitable diagrams **(6)**

OR

18. (a) Compare and Contrast graph based and particle SLAM **(8)**

(b) Describe the concept of mobile robot localization with suitable Block diagrams **(6)**

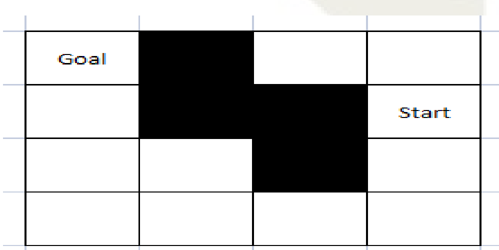
19. (a) Compare and contrast local and global Dynamic window approaches in obstacle avoidance. **(7)**

(b) Explain the concepts of floor finding Algorithm **(7)**

OR

20. (a) Illustrate the Incorporation of Neural network approach in Robot navigation? List its advantages **(6)**

(b) Make the robot to run from start position to goal position in the Following diagram using A* Algorithm **(8)**



TEACHING PLAN

No	Contents	No. of Lecture Hours (45 hrs)
	Module-1 (Introduction to robotics) (8 hours)	
1.1	Introduction to robotics – Degrees of freedom - Robot types	1 hour
1.2	Manipulators- Anatomy of a robotic manipulator-links, joints, actuators, sensors, controller	1 hour
1.3	Robot configurations-PPP, RPP, RRP, RRR- Mobile robots- wheeled	1 hour
1.4	Legged robots, Aerial robots, underwater robots, surface water robots -	1 hour
1.5	Dynamic characteristics of robot- speed of motion, load carrying capacity & speed of response	1 hour
1.6	Introduction to End effectors - mechanical grippers, special tools, Magnetic grippers	1 hour
1.7	Vacuum grippers, adhesive grippers, Active and Passive grippers	1 hour
1.8	Ethics in robotics - 3 laws - applications of robots	1 hour
	Module-2 (Sensors, Actuators and Control) (9 hours)	
2.1	Sensor classification- touch, force, proximity, vision sensors.	1 hour
2.2	Internal sensors-Position sensors, velocity sensors	1 hour
2.3	Acceleration sensors, Force sensors;	1 hour
2.4	External sensors-contact type, non-contact type	1 hour

2.5	Digital Camera - CCD camera - CMOS camera	1 hour
2.6	Omnidirectional cameras - Sensor characteristics	1 hour
2.7	Actuators - DC Motors - H-Bridge - Pulse Width Modulation	1 hour
2.8	Stepper Motors – Servos - Control - On-Off Control	1 hour
2.9	PID Control - Velocity Control and Position Control	1 hour
Module-3 (Robotic vision & Kinematics) (9 hours)		
3.1	Robot Vision: Sensing, Pre-processing, Segmentation, Description	1 hour
3.2	Recognition, Interpretation, Feature extraction -Camera sensor hardware interfacing	1 hour
3.3	Representation of Transformations - Representation of a Pure Translation - Pure Rotation about an Axis	1 hour
3.4	Combined Transformations - Transformations Relative to the Rotating Frame	1 hour
3.5	Basic understanding of Differential Drive Wheeled Mobile Robot - Car Like Wheeled Mobile Robot	1 hour
3.6	Kinematic model of a differential drive and a steered mobile robot.	1 hour
3.7	Degree of freedom and manoeuvrability, Degree of steerability	1 hour
3.8	Degree of mobility, Different wheel configurations	1 hour
3.9	Holonomic and Nonholonomic robots, Omnidirectional Wheeled Mobile Robots	1 hour
Module-4 (Localization and Mapping) (9 hours)		

4.1	Position and Orientation - Representing robot position, Basics of reactive navigation	1 hour
4.2	Robot Localization, Challenges in localization	1 hour
4.3	An error model for odometric position estimation	1 hour
4.4	Map Representation - Continuous representations - Decomposition strategies	1 hour
4.5	Current challenges in map representation, Probabilistic map-based localization (only Kalman method)	1 hour
4.6	Probabilistic map-based localization (only Kalman method)	1 hour
4.7	Autonomous map building, Simultaneous localization and mapping (SLAM) - Mathematical definition of SLAM	1 hour
4.8	Visual SLAM with a single camera - Graph-based SLAM	1 hour
4.9	Particle filter SLAM - Open challenges in SLAM	1 hour
Module-5 (Path Planning and Navigation) (10 hours)		
5.1	Path Planning- Graph search	1 hour
5.2	Deterministic graph search - breadth first search - depth first search- Dijkstra's algorithm	1 hour
5.3	A*, D* algorithms, Potential field based path planning	1.5 hour
5.4	Obstacle avoidance - Bug algorithm - Vector Field Histogram - Dynamic window approaches	1.5 hour

5.5	Navigation Architectures - Modularity for code reuse and sharing - Control localization - Techniques for decomposition	1 hour
5.6	Alternatives for navigation - Neural networks	1 hour
5.7	Processing the image - Training the neural network for navigation	1.5 hour
5.8	Training the neural network for navigation - Convolutional neural network robot control implementation	1.5 hour

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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):

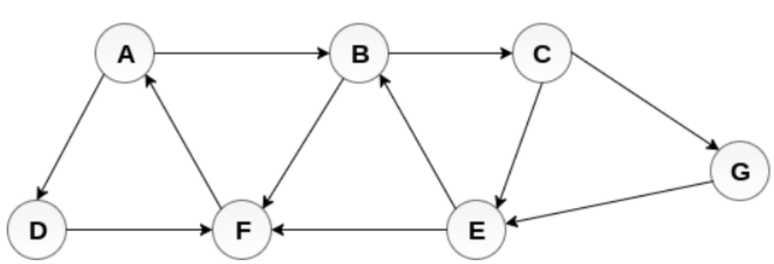
1. Is $2^{n+1} = O(2^n)$? Is $2^{2n} = O(2^n)$? Justify your answer.
2. What is the need of asymptotic analysis in calculating time complexity? What are the notations
   used for asymptotic analysis?
3. Calculate the time complexity for addition of two matrices.
4. Define time complexity and space complexity.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

Course Outcome 2 (CO2):

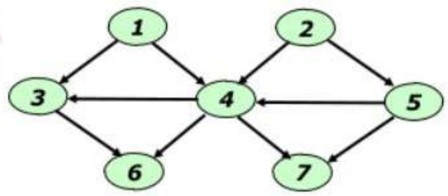
1. State Master's theorem for solving recurrences.
2. Solve the recurrence T(n) = 3T(n-2), using iteration method
3. State the conditions in recurrences where Master Theorem is not applicable.
4. Solve the following recurrence equations using Master's theorem.
   a) $T(n) = 8T(n/2) + 100\, n^2$
   b)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

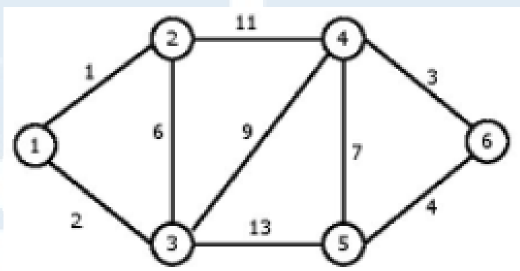


3. Find the minimum and maximum height of any AVL-tree with 7 nodes? Assume that the height of a tree with a single node is 0. (3)
4. Find any three topological orderings of the given graph.

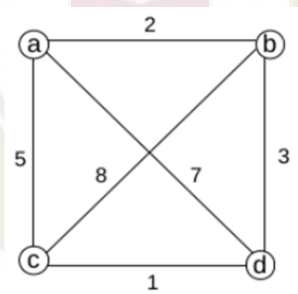


Course Outcome 4 (CO4):

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

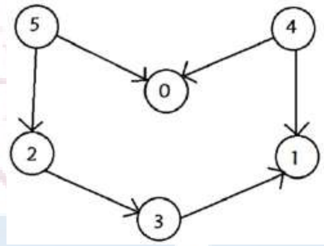
Answer All Questions. Each Question Carries 3 Marks

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)**

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

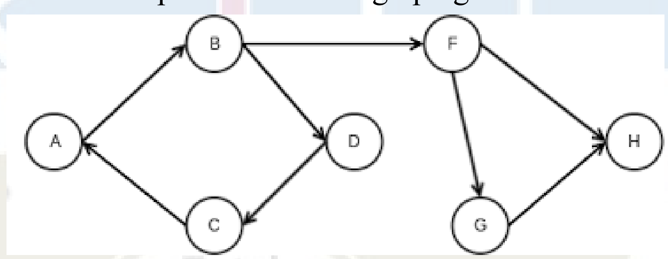
(b) Determine the time complexities of the following two functions fun1( ) and fun2( ). **(7)**

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)**



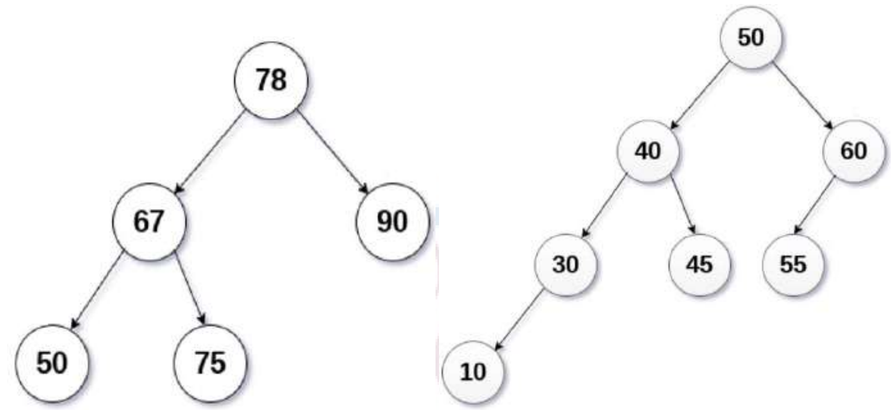
OR

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



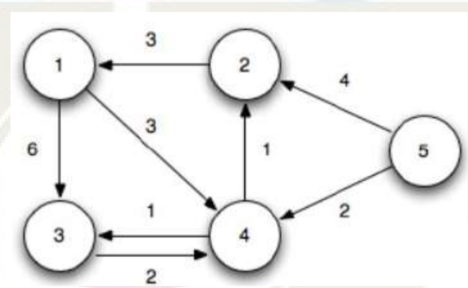
15. (a) State Fractional Knapsack Problem and write Greedy Algorithm for Fractional Knapsack Problem. **(7)**

(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)**



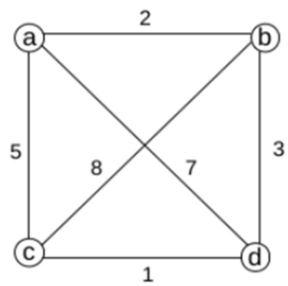
17. (a) Write Floyd-Warshall algorithm and analyse its complexity. **(5)**

(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

CAT308	COMPREHENSIVE COURSE WORK	Category	L	T	P	Credit	Year of Introduction
		PCC	1	0	0	1	2019

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

Prerequisite:

1. **Computer Organization and Architecture**
2. **Data Structures**
3. **Operating Systems**
4. **Introduction to Artificial Intelligence**
5. **Database Management Systems**

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

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

Mapping of course outcomes with program outcomes

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

Assessment Pattern

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

Mark distribution

Total Marks	CIE	ESE	ESE Duration
50	0	50	1 hour

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

SYLLABUS

Full Syllabus of all five selected Courses.

1. **Computer Organization and Architecture**
2. **Data Structures**
3. **Operating Systems**
4. **Introduction to Artificial Intelligence**
5. **Database Management Systems**

Course Contents and Lecture Schedule

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

4.2	Mock Test on Module 4 and Module 5	1 hour
4.3	Feedback and Remedial class	
5	**DATABASE MANAGEMENT SYSTEMS**	
5.1	Mock Test on Module 1, Module 2 and Module 3	1 hour
5.2	Mock Test on Module 4 and Module 5	1 hour
5.3	Feedback and Remedial class	1 hour

Model Question Paper

QP CODE:

Reg No: _______________

Name: _________________ **PAGES : 9**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CAT308

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 processor design characteristics.
   I. Register-to-register arithmetic operations only
   II. Variable instruction format
   III. Hardwired control unit
   Which of the characteristics above are used in the design of a RISC processor?

   (A) I only (B) I and II only (C) I and III only (D) I, II and III

2. A 64-bit processor can support a maximum memory of 8 GB, where the memory is word-addressable (one word is of 64 bits). The size of the address bus of the processor is atleast ____ bits.
   (A) 30 (B) 31 (C) 32 (D) None

3. The stage delays in a 4-stage pipeline are 900, 450, 400 and 350 picoseconds. The first stage (with delay 900 picoseconds) is replaced with a functionally equivalent design involving two stages with respective delays 600 and 550 picoseconds. The throughput increase of the pipeline is _______ percent.
   (A) 38 (B) 30 (C) 58 (D) 50

4. Consider a direct mapped cache of size 256 Kilo words with block size 512 words. There are 6 bits in the tag. The number of bits in block (index) and word (offset) fields of physical address are is:
   (A) block (index) field = 6 bits, word (offset) field = 9 bits
   (B) block (index) field = 7 bits, word (offset) field = 8 bits
   (C) block (index) field = 9 bits, word (offset) field = 9 bits
   (D) block (index) field = 8 bits, word (offset) field = 8 bits

5. The memory unit of a computer has 1 Giga words of 64 bits each. The computer has instruction format, with 4 fields: an opcode field; a mode field to specify one of 12 addressing modes; a register address field to specify one of 48 registers; and a memory address field. If an instruction is 64 bits long, how large is the opcode field?
   (A) 34 bits (B) 24 bits (C) 20 bits (D) 14 bits

6. A computer has 64-bit instructions and 28-bit address. Suppose there are 252 two-address instructions. How many 1-address instructions can be formulated?
   (A) 2^24 (B) 2^26 (C) 2^28 (D) 2^30

7. Determine the number of clock cycles required to process 200 tasks in a six-segment pipeline.(Assume there were no stalls),each segment takes 1 cycle.
   (A) 1200 cycles (B) 206 cycles (C) 207 cycles (D) 205 cycles

8. Match the following Lists:

P.DMA	1.Priority Interrupt
Q. Processor status Word	2.I/O Transfer
R. Daisy chaining	3.CPU
S. Handshaking	4.Asynchronous Data Transfer

   (A) P-1, Q-3, R-4, S-2 (B) P-2, Q-3, R-1, S-4
   (C) P-2, Q-1, R-3, S-4 (D) P-4, Q-3, R-1, S-2

9. Pipelining improves performance by:
   (A) decreasing instruction latency
   (B) eliminating data hazards
   (C) exploiting instruction level parallelism
   (D) decreasing the cache miss rate

10. The advantage of .... is that it can reference memory without paying the price of having a full memory address in the instruction.
(A) Direct addressing (B) Indexed addressing
(C) Register addressing (D) Register Indirect addressing

11. 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

12. A B-tree of order (degree)5 and of height 3 will have a minimum of ___ keys.
A. 624
B. 249
C. 124
D. 250

13. 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

14. 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

15. 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/*+

16. 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

17. 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. $O(n^2 logn)$
B. $O(n \log^2 n)$
C. $O(n^3)$
D. $O(n \log n^2)$

18. How many distinct binary search trees can be created out of 6 distinct keys?
 (A) 7 (B) 36 (C) 140 (D) 132

19. 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

20. 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

21. 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

22. 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

23. Calculate the internal fragmentation if page size is 4KB and process size is 103KB.
 (A) 3KB (B) 4KB (C) 1KB (D) 2KB

24. Which of the following scheduling policy is likely to improve interactiveness?

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

25. 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

26. 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

27. 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

28. 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.

29. 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

30. 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

31. Artificial Intelligence is about_____.
    (A)Playing a game on Computer
    (B)Making a machine Intelligent
    (C)Programming on Machine with your Own Intelligence
    (D)Putting your intelligence in Machine

32.Select the most appropriate situation for that a blind search can be used.
    (A)Real-life situation
    (B)Small Search Space
    (C)Complex game
    (D)All of the above

33.The application/applications of Artificial Intelligence is/are
    (A)Expert Systems
    (B)Gaming
    (C)Vision Systems
    (D)All of the above

34. Among the given options, which search algorithm requires less memory?
    (A)Optimal Search
    (B)Depth First Search
    (C)Breadth-First Search
    (D)Linear Search

35. The component of an Expert system is_________.
    (A)Knowledge Base
    (B)Inference Engine
    (C)User Interface
    (D)All of the above

36. Which algorithm is used in the Game tree to make decisions of Win/Lose?
    (A)Heuristic Search Algorithm
    (B)DFS/BFS algorithm
    (C)Greedy Search Algorithm

(D)Min/Max algorithm

37. Among the given options, which is not the required property of Knowledge representation?
    (A)Inferential Efficiency
    (B)Inferential Adequacy
    (C)Representational Verification
    (D)Representational Adequacy

38. Which of the given language is not commonly used for AI?
    (A)LISP
    (B)PROLOG
    (C)Python
    (D)Perl

39. A technique that was developed to determine whether a machine could or could not demonstrate the artificial intelligence known as the___
    (A)Boolean Algebra
    (B)Turing Test
    (C)Logarithm
    (D)Algorithm

40. The available ways to solve a problem of state-space-search.
    (A)1 (B)2 (C)3 (D)4

41. Let E1, E2 and E3 be three entities in an E/R diagram with simple single-valued attributes. R1 and R2 are two relationships between E1 and E2, where R1 is one-to-many, R2 is many-to-many. R3 is another relationship between E2 and E3 which is many-to-many. R1, R2 and R3 do not have any attributes of their own. What is the minimum number of tables required to represent this situation in the relational model?
    (A) 3 (B) 4 (C) 5 (D) 6

42. 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

43. 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)

44. 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.

45. 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

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

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

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

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

48. 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

49. Specialization is __________ process.

(A) top-down (B) bottom up

(C) Both (A) and (B) (D) none of these

50. 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

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

AIL332	ROBOTICS LAB	Category	L	T	P	Credit	Year of Introduction
		PCC	0	0	3	2	2022

Preamble: Robotics lab provides students with exposure to the common sensor and actuator interfacing, setting up mobile robots and familiarising intelligent systems.

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

CO 1	Interface different peripherals to arduino board
CO 2	Assemble a mobile robot with different sensors and actuators..
CO 3	Familiarise about localisation of mobile robots
CO 4	Impart intelligence to robot using standard algorithms.
CO 5	Familiarise the robot navigation

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	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 Test (Internal Exam) Marks in percentage	End Semester Examination Marks in percentage
Remember	**20**	**20**
Understand	**20**	**20**
Apply	**60**	**60**
Analyze		
Evaluate		
Create		

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**75**	**75**	**2.5**

Continuous Internal Evaluation Pattern:

Attendance : **15 marks**

Continuous Evaluation in Lab : **30 marks**

Continuous Assessment Test : **15 marks**

Viva voce : **15 marks**

Internal Examination Pattern: The Internal examination shall be conducted for 75 marks, which will be converted to out of 15 while calculating Internal Evaluation marks. The marks will be distributed as,
Preliminary work : 15 Marks,
Implementing the work/Conducting the experiment : 10 Marks
Performance, result and inference (usage of equipment and troubleshooting) : 25 Marks,
Viva voce : 25 Marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks
(a) Preliminary work : 15 Marks
(b) Implementing the work/Conducting the experiment : 10 Marks
(c) Performance, result and inference (usage of equipment and troubleshooting) : 25 Marks
(d) Viva voce : 25 Marks

General instructions:

Practical examination to be conducted immediately after the second series test covering the entire syllabus given below. Evaluation is a serious process that is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the University examination only on submitting the duly certified record. The external examiner shall endorse the record.

ROS Essentials

• Installing and Configuring Your ROS Environment—ROS Kinetic/Melodic/Compatible versions
• Familiarisation with ROS (Master, nodes, topics, messages, services, parameters and actions)
• Familiarisation with ROS Tools – Gazebo , Moveit , Rviz
• Creating Workspace and Package in ROS

LIST OF EXPERIMENTS
Any 4 experiments from each group are mandatory

Part A: Interfacing sensors and actuators

1. Familiarisation of Arduino IDE,Arduino microcontroller I/O interfacing(LED, LCD,Serial Monitor)
2. Interfacing IR and Ultrasonic sensor with Arduino
3. Interfacing DC motors with arduino - speed and direction control
4. Interfacing Servo Motors with Arduino - angle of rotation
5. Calibration of sensors-sonar, IR sensors and obtain the calibration curve
6. Mobile Robot assembly
7. Networking with Arduino: GSM and Bluetooth

Part B: Intelligent systems

8. Writing a Simple Publisher and Subscriber, Simple Service and Client,Recording and playing back data, Reading messages from a bag file(Python/C++)
9. Localization of a mobile robot using LIDAR (ROS)
10. Touch Sensors interfacing and feedback system
11. Line following Robot using IR sensor
12. Obstacle avoidance of a mobile robot while moving to a point.
13. Object detection using any one standard algorithm
14. Navigation simulation using turtlebot using ROS

Reference Books

1. Siegwart, Roland, Introduction to Autonomous Mobile Robots, Cambridge, Mass. : MIT Press, 2nd ed.
2. Peter Corke, Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Springer 2021
3. John. J. Craig, Introduction to Robotics (Mechanics and control), Pearson Education Asia 2002.
4. S K Saha, Introduction to Robotics by Mc Graw Hill Education, 2014.
5. R K Mittal and I J Nagrath, “Robotics and Control”, Tata McGraw Hill, New Delhi,2003.
6. Dahiya, Ravinder S., Valle, Maurizio, Robotic Tactile Sensing, Springer, 2013.
7. https://emanual.robotis.com/docs/en/platform/turtlebot3/simulation/

CAD334	MINI PROJECT	CATEGORY	L	T	P	CREDITS
		PWS	0	0	3	2

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

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

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

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

Mapping of course outcomes with program outcomes

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

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

Assessment Pattern

Mark Distribution

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

Split-up of Continuous Internal Evaluation :

Attendance **10 marks**

Project Guide **15 marks**

Project Report **10 marks**

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

Split-up of End Semester Examination:

The marks will be distributed as

Presentation : 30 marks

Demonstration : 20 marks

Viva : 25 marks.

Total : 75 marks.

Course Plan

Student Groups with 3 or 4 members should identify a topic of interest in consultation with Faculty/Advisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design/fabrication or develop codes/programs to achieve the objectives. Innovative design concepts, performance, scalability, reliability considerations, aesthetics/ergonomic, user experience and security aspects taken care of in the project shall be given due weight.

The progress of the mini project is evaluated based on a minimum of two reviews. The review committee may be constituted with the Head of the Department or a senior faculty, Mini Project coordinator and project guide as the members. Innovative design concepts, reliability considerations, aesthetics/ergonomic aspects taken care of in the project shall be given due weight. The internal evaluation shall be made based on the progress/outcome of the project, reports and a viva-voce examination, conducted internally by a 3-member committee. A project report is required at the end of the semester. The product/application has to be demonstrated for its full design specifications.

Guidelines for the Report preparation

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

- Use Times New Roman font for the entire Report – Chapter / Section Title –Times New Roman 18, Bold; Heading 2 – Times New Roman 16, Bold; Heading 3 – Times New Roman 14,Bold; Body- Times New Roman12, Normal.
- Line Spacing – Between Heading 2 – 3 lines, between lines in paragraph 1.5 lines.
- Alignments – Chapter / Section Title – Center, Heading 2 & 3 should be LeftAligned. Ensure that all body text is paragraph justified.
- Figures & Tables – Ensure that all Figures and Tables are suitably numbered and given proper names/headings. Write figure title under the figure and table title above the table
- Suggestive order of documentation:
    i. Top Cover

SEMESTER VI

PROGRAM ELECTIVE I

CAT312	CONCEPTS IN GRAPH THEORY	Category	L	T	P	Credit	Year of Introduction
		PEC	2	1	0	3	2020

Preamble: This course introduces fundamental concepts in Graph Theory, including properties and characterisation of graph/trees and graph theoretic algorithms, which are widely used in Mathematical modelling and has got applications across Computer Science and other branches in Engineering

Prerequisite: Basic understanding of Discrete Mathematical Structures

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

CO1	Explain vertices and their properties, types of paths, classification of graphs and trees & their properties. **(Cognitive Knowledge Level: Understand)**
CO2	Demonstrate the fundamental theorems on Eulerian and Hamiltonian graphs. **(Cognitive Knowledge Level: Understand)**
CO3	Illustrate the working of Prim's and Kruskal's algorithms for finding minimum cost spanning tree and Dijkstra's algorithm for finding shortest paths. **(Cognitive Knowledge Level: Apply)**
CO4	Explain planar graphs, their properties and an application for planar graphs. **(Cognitive Knowledge Level: Apply)**
CO5	Illustrate how one can represent a graph in a computer. **(Cognitive Knowledge Level: Apply)**
CO6	Explain the Vertex Color problem in graphs and illustrate an example application for vertex coloring. **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

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

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

Assessment Pattern

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

Mark Distribution

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

Continuous Internal Evaluation Pattern:

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

Internal Examination Pattern

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

End Semester Examination Pattern:

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

SYLLABUS

Module – 1 (Introduction to Graphs)

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

Module - 2 (Eulerian and Hamiltonian graphs)

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

Module - 3 (**Trees and Graph Algorithms**)

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

Module - 4 (**Connectivity and Planar Graphs**)

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

Module - 5 (**Graph Representations and VertexColourin**g)

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

Text Books

1. Narsingh Deo, Graph theory, PHI,1979

Reference Books

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

Course Level Assessment Questions

Course Outcome1 (CO1):

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

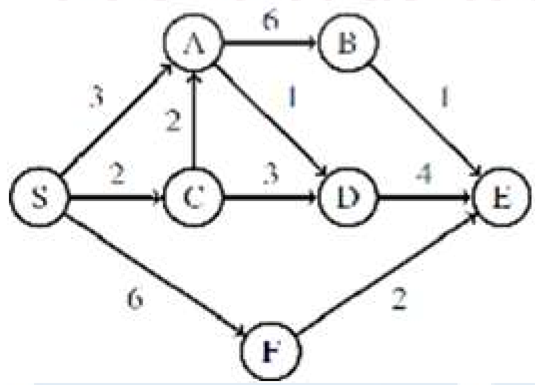
Course Outcome 2(CO2):

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

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

Course Outcome 3(CO3):

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



Course Outcome 4(CO4): .

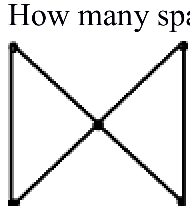
1. Define edge connectivity, vertex connectivity and separable graphs. Give an example for each.
2. Prove the statement: Every cut set in a connected graph G must also contain at least one branch of every spanning tree of G.

Course Outcome 5(CO5):

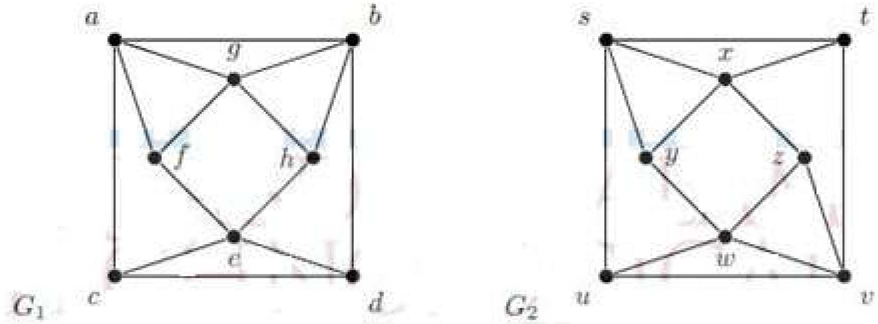
1. Show that if ***A(G)*** is an incidence matrix of a connected graph ***G*** with ***n*** vertices, then rank of ***A(G)*** is $n-1$.
2. Show that if ***B*** is a cycle matrix of a connected graph ***G*** with ***n*** vertices and ***m*** edges, then rank ***B*** $= m-n+1$.
3. Derive the relations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

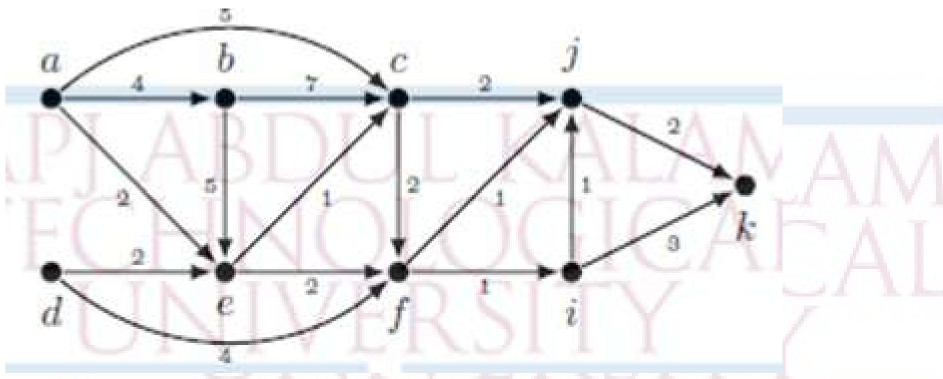
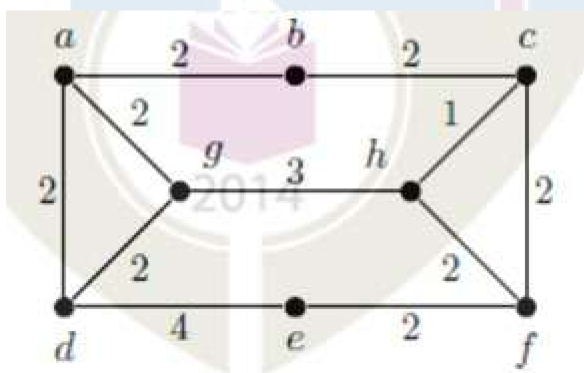
Course Outcome 6 (CO6):

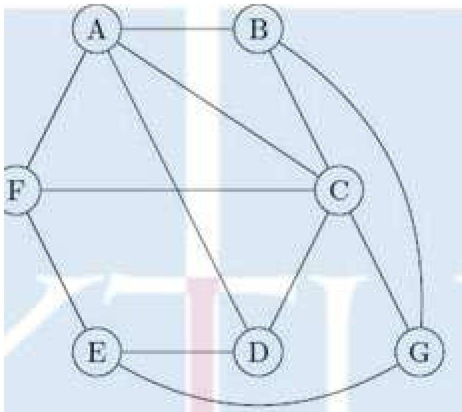
1. Show that an n vertex graph is a tree iff its chromatic polynomial is $P_n(\lambda) = \lambda(\lambda-1)^{n-1}$
2. Define Path matrix and Circuit matrix with an example each.

Model Question Paper		
QP CODE:		
Reg No: _______________		
Name: _________________ **PAGES : 4**		
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY		
SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR		
Course Code: CAT312		
Course Name: Concepts in Graph Theory		
Max. Marks : 100 **Duration: 3 Hours**		
PART A		
Answer All Questions. Each Question Carries 3 Marks		
1.	Construct a simple graph of 12 vertices with two of them having degree 1, three having degree 3 and the remaining seven having degree10.	**(3)**
2.	What is the largest number of vertices in a graph with 35 edges, if all vertices are of degree at least 3 ?	**(3)**
3.	Define a Euler graph. Give an example of Eulerian graph which is not Hamiltonian	**(3)**
4.	Give an example of a strongly connected simple digraph without a directed Hamiltonianpath.	**(3)**
5.	What is the sum of the degrees of any tree of***n*** vertices?	**(3)**
6.	How many spanning trees are there for thefollowinggraph 	**(3)**

7.		Show that in a simple connected planar graph ***G*** having ***V***-vertices, ***E***-edges, and no triangles $E <= 3V - 6$	**(3)**
8.		Let G be the following disconnected planar graph. Draw its dual G*,andthe dual of the dual (G*)*.  G	**(3)**
9.		Consider the circuit matrix ***B*** and incidence matrix ***A*** of a simple connected graph whose columns are arranged using the same order of edges. Prove that every row of ***B*** is orthogonal to every row of ***A***?	**(3)**
10.		A graph is *critical* if the removal of any one of its vertices (and the edgesadjacent to that vertex) results in a graph with a lower chromatic number. how that ***Kn*** is critical for all $n > 1$.	**(10x3=30)**
		Part B **(Answer any one question from each module. Each question carries 14 Marks)**	
11.	(a)	Prove that for any simple graph with at least two vertices has two vertices of the same degree.	**(6)**
	(b)	Prove that in a complete graph with ***n*** vertices there are **(n-1)/2** edge disjoint Hamiltonian circuits and $n >= 3$	**(8)**
		OR	
12.	(a)	Determine whether the following graphs ***G1 = (V1, E1)*** and ***G2 = (V2, E2)*** are isomorphic or not. Give justification.	**(6)**

			
	(b)	Prove that a simple graph with n vertices and k components can have atmost (n-k)(n-k+1)/2 edges.	**(8)**
13.	(a)	Let***S***beasetof5elements.Constructagraph***G***whoseverticesaresubsets of ***S*** of size 2 and two such subsets are adjacent in ***G*** if they are disjoint. i. Draw the graph***G***. ii. How many edges must be added to ***G*** in order for ***G*** to have a Hamiltoniancycle?	**(8)**
	(b)	Let ***G*** be a graph with exactly two connected components, both being Eulerian. What is the minimum number of edges that need to be added to ***G*** to obtain an Eulerian graph?	**(6)**
OR			
14.	(a)	Show that a ***k***-connected graph with no hamiltonian cycle has an independent set of size ***k +1***.	**(8)**
	(b)	i. Let ***G*** be a graph that has exactly two connected components, both being Hamiltonian graphs. Find the minimum number of edges that one needs to add to ***G*** to obtain a Hamiltoniangraph. **i.** For which values of ***n*** the graph ***Qn*** (hyper-cube on ***n*** vertices) is Eulerian.	**(6)**
15.	(a)	A tree ***T*** has at least one vertex ***v*** of degree 4, and at least one vertex ***w*** of degree 3. Prove that ***T*** has at least 5leaves.	**(5)**
	(b)	Write Dijkstra's shortest path algorithm. Consider the following weighted directed graph ***G.*** Find the shortest path	**(9)**

		between ***a*** and every other vertices in ***G*** using Dijkstra’s shortest path algorithm. 	
		OR	
16.	(a)	Define pendent vertices in a binary tree? Prove that the number of pendent vertices in a binary tree with ***n*** vertices is ***(n+1)/2***	**(5)**
	(b)	Write Prim’s algorithm for finding minimum spanning tree. Find a minim um spanning tree in the following weighted graph, using Prim'salgorithm. Determine the number of minimum spanning trees for the given graph. 	**(9)**
17.	(a)	i.State and prove Euler's Theorem relating the number of faces, edges and vertices for a planar graph. **ii.**If ***G*** is a 5-regular simple graph and **|*V*| = 10**, prove that ***G*** is non-planar.	**(9)**
	(b)	Let ***G*** be a connected graph and ***e*** an edge of ***G***. Show that ***e*** is a cut-edge if and only if ***e*** belongs to every spanning tree.	**(5)**
		OR	

18.	(a)	State Kuratowski's theorem, and use it to show that the graph G below is not planar. Draw G on the plane without edges crossing. Your drawing should use the labelling of the vertices given.  	**(9)**
	(b)	Let ***G*** be a connected graph and ***e*** an edge of ***G***. Show that ***e*** belongs to a loop if and only if ***e*** belongs to no spanningtree.	**(5)**
19.	(a)	Definethecircuitmatrix***B(G)***ofaconnectedgraph***G***with***n***verticesand***e*** edges with an example. Prove that the rank of ***B(G)*** is ***e-n+1***	**(7)**
	(b)	Give the definition of the chromatic polynomial ***PG(k)***. Directly from the definition, prove that the chromatic polynomials of ***Wn*** and ***Cn*** satisfy the identity ***PWn(k) = k PCn-1 (k – 1).***	**(7)**
		OR	
20.	(a)	Prove that the rank of an incidence matrix of a connected graph with ***n*** vertices is***n-1.***	**(3)**
	(b)	i. A graph ***G*** has chromatic polynomial ***PG(k) = k4-4k3+5k2-2k***. How many vertices and edges does ***G*** have? Is ***G*** bipartite? Justify your answers. i. State and prove Five Color Theorem.	**(11)**

Teaching Plan

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

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

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

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

Prerequisite: A sound knowledge of Mathematics and a programming language.

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

CO#	CO
CO1	Describe the working principles of graphics devices**(Cognitive Knowledge level: Understand)**
CO2	Illustrate line drawing, circle drawing and polygon filling algorithms(Cognitive Knowledge level: Apply)
CO3	Demonstrate geometric representations, transformations on 2D & 3D objects, clipping algorithms and projection algorithms(Cognitive Knowledge level: Apply)
CO4	Summarize visible surface detection methods(Cognitive Knowledge level: Understand)
CO5	Summarize the concepts of digital image representation, processing and demonstrate pixel relationships(Cognitive Knowledge level: Apply)
CO6	Solve image enhancement and segmentation problems using spatial domain techniques(Cognitive Knowledge level: Apply)

Mapping of course outcomes with program outcomes

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

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

Assessment Pattern

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

Analyze			
Evaluate			
Create			

Mark Distribution

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

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

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

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern:

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

End Semester Examination Pattern:

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

SYLLABUS

Module – 1 (Basics of Computer graphics and Algorithms)

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

Module – 2 (Filled Area Primitives and transformations)

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

Module - 3 (Clipping and Projections)

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

Module - 4 (Fundamentals of Digital Image Processing)

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

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

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

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

Text Book

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

References

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

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

Course Level Assessment Questions

Course Outcome 1 (CO1):

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

Course Outcome 2 (CO2):

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

Course Outcome 3 (CO3):

1. Rotate a triangle ABC 45 degree counter clockwise about the pivot point (10,3), where the position vector of the coordinate ABC is given as A(4,1), B(5,2) and C(4,3).
2. Given a clipping window A(20,20), B(60,20), C(60,40) and D(20,40). Using Cohen Sutherland algorithm, find the visible portion of the line segment joining the points P(40,80) and Q(120,30)

Course Outcome 4 (CO4):

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

Course Outcome 5 (CO5):

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

   3 1 2 1 (q)

   2 2 0 2

   1 2 1 1

   (p) 1 0 1 2

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

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

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

Course Outcome 6 (CO6):

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

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

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

$$\begin{pmatrix} 10 & 12 & 8 & 9 \\ 10 & 12 & 12 & 14 \\ 12 & 13 & 10 & 9 \\ 14 & 12 & 10 & 12 \end{pmatrix}$$

   (a) Apply histogram equalisation to the image by rounding the resulting image pixels to integers
   (b) Sketch the histogram of the original image and the histogram-equalised image.

3. You have Sobel operator and Laplacian operator for edge detection. Which operator will you select for edge detection in the case of noisy image? Explain.**(Assignment)**

Model Question Paper

QP CODE:

Reg No: _______________

Name: _________________ **PAGES : 4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: AIT322

Course Name: Concepts in Computer Graphics and Image Processing

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

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Justify the approach of using integer arithmetic in Bresenham's line drawing algorithm.

2. Consider a raster system with a resolution of 1024*1024. What is the size of the raster needed to store 4 bits per pixel? How much storage is needed if 8 bits per pixel are to be stored?

3. Show that two successive reflections about either of the coordinate axes is equivalent to a single rotation about the coordinate origin.

4. Determine a sequence of basic transformations that are equivalent to the x-direction shearing matrix.

5. Find the window to viewport normalization transformation with window lower left corner at (1,1) and upper right corner at (2,6).

6. Find the orthographic projection of a unit cube onto the x=0, y=0 and z=0 plane.

7. Define Sampling and Quantization of an image.

8. Give any three applications of digital image processing.

9. A captured image appears very dark because of wrong lens aperture setting. Describe an enhancement technique which is appropriate to enhance such an image.

10. Suggest an approach of thresholding that should be used in case of uniform illumination.

(10x3=30)

Part B

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

11. (a) Write Midpoint circle drawing algorithm and use it to plot a circle with radius=20 and center is (50,30). **(10)**

(b) Draw the architecture of raster scan display systems and explain its working principle. **(4)**

OR

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

(b) Explain the working principle of color CRT monitors with suitable illustrations. **(4)**

13. (a) Compare boundary fill algorithm and flood fill algorithm. **(5)**

(b) Reflect a triangle ABC about the line 3x-4y+8=0. The position vector of the coordinate ABC is given as A(4,1), B(5,2) and C(4,3). **(9)**

OR

14. (a) Explain the need of using vanishing points in projections. **(4)**

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

15. (a) Describe Sutherland Hodegman polygon clipping algorithm and what are its limitations. **(7)**

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

OR

16. (a) Describe Sutherland Hodegman polygon clipping algorithm and what are its limitations. **(7)**

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

17. (a) Explain the components of an image processing system with suitable diagram **(9)**

(b) Define Resolution of an image. Explain the spatial and gray level resolution of an image with an example. **(5)**

OR

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

4 2 3 2 (q)
3 3 1 3
2 3 2 2
(p) 2 1 2 3

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

(b) Using any one application, explain the steps involved in image processing. **(7)**

19. (a) A 5x5 image patch is shown below. Compute the value of the marked pixel if it is smoothened by a 3x3 average filterand median filter. **(4)**

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

(b) Define Image segmentation and describe in detail method of edge and region **(10)** based segmentation technique.

OR

20. (a) Distinguish between smoothing and sharpening filters in terms of **(10)**
    - **(i)** Functionality
    - **(ii)** Types
    - **(iii)** Applications
    - **(iv)** Mask Coefficients

    (b) Describe how an image is segmented using split and merge technique in association with the region adjacency graph. **(8)**

TEACHING PLAN

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

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

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

<table>
<tr><td rowspan="2">CST 332</td><td rowspan="2">FOUNDATIONS OF SECURITY IN COMPUTING</td><td>Category</td><td>L</td><td>T</td><td>P</td><td>Credit</td><td>Year Of Introduction</td></tr>
<tr><td>PEC</td><td>2</td><td>1</td><td>0</td><td>3</td><td>2019</td></tr>
</table>

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

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

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

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

Mapping of course outcomes with program outcomes

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

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

Assessment Pattern

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

Evaluate			
Create			

Mark Distribution

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

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Test : **25 marks**

Continuous Assessment Assignment : **15 marks**

Internal Examination Pattern:

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

End Semester Examination Pattern:

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

Syllabus

Module-1 (Modular Arithmetic)

Integer arithmetic - Integer division, Divisibility, Greatest Common Divisor (GCD), Euclid's algorithm for GCD, Extended Euclid's algorithm, Linear Diophantine Equations. Modular arithmetic - Operations, Properties. Algebraic structures - Groups, Rings, Fields, Finite fields, GF(p), GF (2^n).

Module-2 (Prime Numbers and Factorization)

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

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

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

Module-4 (Computer and Program Security)

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

Module-5 (Operating System and Database Security)

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

Text Books

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

References

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

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

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

Course Outcome 2 (CO2):

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

Course Outcome 3 (CO3):

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

Course Outcome 4 (CO4):

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

Course Outcome 5 (CO5):

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

Model Question Paper

QP CODE: **PAGES: ___**

Reg No:_______________
Name:_________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST 332
Course Name : FOUNDATIONS OF SECURITY IN COMPUTING

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

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

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

(10x3=30)

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

11. (a) For the group $G = < Z_6^*, x>$, prove that it is an Abelian group. Also show the result of 5 x 1 and 1 ÷ 5. **(6)**

(b) Find a particular and the general solution to the following linear Diophantine equations. **(8)**
i) $19x+13y = 20$ ii) $40x + 16y = 88$

OR

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

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

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

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

OR

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

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

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

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

OR

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

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

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

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

OR

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

(b) Explain the four aspects of malicious code infection. **(10)**

19. (a) List any six computer security related functions addressed by operating systems. **(6)**

(b) How does a kernelized design support in enforcing security mechanisms? **(8)**

OR

20. (a) Explain any four security requirements of databases. **(4)**

(b) How can database disclosure be prevented? With the help of suitable examples, explain any six types of disclosure. **(10)**

Teaching Plan

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

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

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

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

AIT352	ARTIFICIAL NEURAL NETWORKS TECHNIQUES	Category	L	T	P	Credit	Year of Introduction
		PEC	2	1	0	3	2019

Preamble: This course enables the learners to understand the fundamental concepts regarding Artificial Neural networks. The course covers basic analogy between ANN and human brain, the basic learning laws, fundamental ANN algorithms, Back Propagation Feed Forward Network, Self Organising Maps, RBF net, BAM and ART networks. This course enables the students to apply techniques and methods to solve real-world problems involving the application of ANN.

Prerequisite: Nil.

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

CO1	Summarize the basic concepts and the learning rules of ANN. **(Cognitive Knowledge Level: Understand)**
CO2	Utilize the fundamental learning algorithms namely, Mc-Culloch Pitts, Hebb Perceptron and Adaline to solve real world problems.**(Cognitive Knowledge Level: Apply)**
CO3	Implement Back propagation learning algorithm, Generic Radial Basis Function network. **(Cognitive Knowledge Level: Apply)**
CO4	Demonstrate Self Organizing Maps and Adaptive Resonance Theory.**(Cognitive Knowledge Level: Understand)**
CO5	Implement training algorithms for pattern association. **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

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

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

Assessment Pattern

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

Mark Distribution

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

Continuous Internal Evaluation Pattern:

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

Internal Examination Pattern

Two internal examinations of two hours duration 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 (Basics of Artificial Neural Network and Learning Methods)

Characteristics of the human brain, Neurons, Introduction to Artificial Neural Networks, Terminology, Models of ANN, Topology, Network Architectures, Knowledge Representation, Learning Process, Learning Tasks. Categories of learning - Hebbian learning, Perceptron Learning Rule, Delta Learning Rule, Generalized Delta Learning Rule, Competitive learning, Error-correction learning, Reinforcement learning, Stability and Convergence.

Module – 2(Basic ANN Models)

McCulloch-Pitts Neuron, Architecture, Algorithm and Applications. Biases and Thresholds, Linear Separability. Hebb Net - Algorithm, Applications. Perceptron - Architecture, Algorithm, Applications. Perceptron Learning Rule Convergence Theorem. Adaline - Architecture, Algorithm, Applications.

Module - 3 (Multilayer Perceptrons)

Multi-Layered network architecture, Back propagation Algorithm, Applications, XOR problem, Replacing and Modifying Back propagation Algorithms Using Heuristics.

Cover's Theorem on the Separability of patterns, The Interpolation Problem, Radial Basis Function Networks, Comparison of MLP and RBF Networks(Theory only).

Module – 4 (SOMs and ART Networks)

Self-organizing maps - Building, Training, Evaluating, Interpreting and Visualizing a Self-organizing Map. Applications of Self Organizing Maps.

Adaptive Resonance Theory -Stability Plasticity Dilemma, ART-1-Architeture, Algorithm, Applications. ART-2 – Architeture, Algorithm, Applications.

Module – 5 (Training Algorithms for Pattern Association)

Introduction, Hetero associative neural network- Architecture, Applications. Auto Associative Net -Architecture, Applications. Iterative Auto Associative Net – Architecture, Applications. Discrete Hopfield Network. Bidirectional Auto-associative Memory – Architecture, Applications.

Text Books

1. Simon Haykin, "Neural Networks, A comprehensive Foundation"(2nd edition), Pearson Education (Module - 4)
2. Laurene Faucett, "Fundamentals of Artificial Neural Networks, architecture algorithm and applications"(Modules – 2,3,5)
3. Yegnanarayana, "Artificial Neural Networks", Phi Learning (Module -1)

Reference Books

1. Christopher M Bishop," Neural networks for Pattern Recognition
2. Mohammad H Hassoun, "Fundamentals of Artificial Neural Networks"

Course Level Assessment Questions

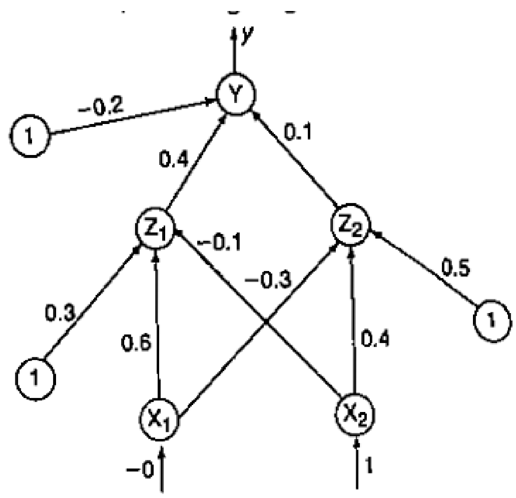
Course Outcome1 (CO1):

1. What are the different types of competitive learning?
2. Demonstrate the significance of different Activation functions.
3. Explain the terms cell body, axon, synapse, dendrite and neuron with reference to abiological neural network.
4. Illustrate examples of pattern recognition tasks to demonstrate the superiority of the biological neural network over a conventional computer system. (Assignment Question)

Course Outcome 2 (CO2):

1. How is training adopted in Adaline network and state the characteristics of weighted interconnections in Adaline .
2. How is the linear separability concept implemented using Perceptron Network training?
3. Implement NAND logical function using Perceptron Network in Python language(Assignment Question)

Course Outcome 3(CO3):



1. Find the new weights of Back propagation net shown in the figure for the input pattern (0,-1) and the target output 1, Use 0.25 as learning rate.
2. Why is gradient descent method adopted to minimize error? Explain in relation to Back propagation of error phase of BPNN?
3. Implement RBF network using Python language. (Assignment Question)

Course Outcome 4(CO4): .

1. Design an ART1 used to cluster four vectors with low vigilance. The values and description of the parameters are given in the table. Cluster the vectors, (1,1,0,0), (0,0,0,1), (1,0,0,0), (0,0,1,1) in at most three clusters.

n=4	Number of components in the input vector
m=3	It was an excellent game.
P=0.4	Vigilence parameter
L=2	Parameter used in update of bottom-up weights
$b_{ij}(0)=1/n+1$	Initial bottom-up weights
$t_{ij}(0)=1$	Initial top-down weights

2. Use NeuPy library of Python to implement Adaptive Resonance Theory (ART1) Network for binary data clustering.
3. Implement Self Organizing Map in Python to demonstrate how does the grid automatically arrange, using colour patterns and evaluate the effect of Learning Rate and Radius. (Assignment Question)

Course Outcome 5(CO5):

1. Compare and contrast auto associative and hetero associative networks with examples.

2. Implement Bidirectional Associative Memory using Python without using specific libraries. (Assignment Question)

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: AIT352

Course Name: Artificial Neural Networks Techniques

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

PART A

Answer All Questions. Each Question Carries 3 Marks

1.	What are the main differences among the three models of artificial neurons, namely, McCulloch-Pitts, Perceptron and Adaline?	**3**
2.	Compare the stability and convergence of ANN	**3**
3.	Design a Mc-Culloch Pitts neural network to implement AND function.	**3**
4.	Define Perceptron Learning Rule Convergence theorem.	**3**
5.	What is the significance of momentum factor in backpropagation learning?	**3**
6.	Compare RBF network and Multilayer Perceptron network.	**3**
7.	Illustrate the feature mapping models.	**3**
8.	What is the significance of 'resonance' in ART network?	**3**

9. Explain the hebb rule for pattern association **3**

10. Interpret cross talk and perfect recall using suitable examples **3**

Part B

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

11. (a) Describe any four attractive features of the biological neural network that make it superior to the most sophisticated Artificial Intelligence computer system for pattern recognition tasks. **(8)**

(b) Compare LMS, Perceptron and Delta learning laws. **(6)**

OR

12. (a) Compare the performance of a computer and that of a biological neural network in terms of speed of processing, size and complexity, storage, fault tolerance and control mechanism. **(8)**

(b) What is reinforcement learning? In what way it is different from supervised learning? **(6)**

13. (a) Explain Hebb net algorithm and implement logical AND function using bipolar inputs. **(4)**

(b) Use Adaline nerwork to train AND NOT function with bipolar inputs and targets. Perform one epoch of training. **(10)**

OR

14. (a) Using the Perceptron Learning rule find the weights required to perform the following classifications. Vectors (1,1,1,1) and (-1,1,-1,-1) are members of the class and hence target value 1; vectors (1,1,1,-1) and (1, -1, -1, 1) are not the members of the class and hence target value -1. Use learning rate of 1 and starting value of weights as 0, test the response of the net. **(10)**

(b) XOR function is non·linearly separable by a single decision boundary line. Justify. **(4)**

15. (a) Analyse Cover's theorem based on XOR problem. **(10)**

(b) Explain the learning factors of of Back propagation network algorithm **(4)**

OR

16. (a) Relate Hidden layer and Output layer error terms with back propagation of error term phase in Back Propagation Network algorithm. **(10)**

(b) Explain the architecture and algorithm of RBF network . **(8)**

17. (a) Explain the statistical properties exhibited by SOM after convergence. **(10)**

(b) Interpret stability-plasticity dilemma in relation with ART network. **(4)**

OR

18. (a) Show the architecture of Kohonen's Self Organising Map and demonstrate the competitive process in Kohonen's self organising Map. **(8)**

(b) Explain the basic architecture of ART-2 and its algorithm. **(6)**

19. (a) Describe the architecture and algorithm of Discrete Bidirectional Associative Memory **(5)**

(b) Use the Hebb rule to store the vetors (1,1,1,1)and (1,1,-1,-1) in an auto associative neural net. **i.(9)**

a. Fnd the weight matrix(Do not set the diagonal terms to zero)

b. Test the net, using the following vectors as input

i. (1,1,1,1)

ii. (1,1,-1,-1)

iii. (1,1,1,0)

Repeat parts a and b with diagonal weight matrix set to zero. Identify the differences in the response.

OR

20. (a) Design a BAM net to associate the letters"A" and "C" given in bipolar 5X3 vectors to the bipolar codes (-1,1) and (1,1) respectively. **(10)**

(b) Compare Iterative Autoassocative with Discrete Hopfield Net. **(4)**

TEACHING PLAN

No	Contents	No of Lecture Hrs: 35
Module -1 : Basics of Artificial Neural Network and Learning methods (7 hours)		
1.1	Introduction to Neural Network, The human brain - Characteristics of Neural Network.	1
1.2	Artificial Neural Network - Terminology, Models of a neuron, Topology	1
1.3	Network architectures, Knowledge representation.	1
1.4	Learning Process, Learning tasks.Categories of learning- Hebbian learning, Competitive learning.	1
1.5	Error-correction learning.	1
1.6	Reinforcement learning.	1
1.7	Stability and Convergence.	1
Module - 2 : Basic ANN Models(7 hours)		
2.1	McCulloch-Pitts Neuron - Architecture, Algorithm and Applications.	1
2.2	Biases and thresholds, Linear separability.	1
2.3	Hebb net - Algorithm , Applications	1
2.4	Perceptron -Architecture, Algorithm	1
2.5	Perceptron -Applications, Perceptron learning rule convergence theorem.	1
2.6	Perceptron learning rule convergence theorem. Adaline - Architecture, Algorithm	1
2.7	Adaline - Applications	1
Module 3 : Multilayer Perceptrons (7 hours)		
3.1	Multilayered Feed Forward Network Architecture,	1

3.2	Back propagation algorithm, Activation functions, Rate of learning, Stopping criteria	1
3.3	Applications, XOR problem, Heuristics for making the Back propagation algorthm perform better.	1
3.4	Cover's Theorem on the separability of patterns.	1
3.5	Cover's Theorem on the separability of patterns, XOR problem.	1
3.6	The interpolation problem, Radial Basis Function networks.	1
3.7	The interpolation problem, Radial Basis function networks, Comparison of RBF network and Multi-Layer perceptrons.	1
Module 4 : SOMs and ART networks (7 hours)		
4.1	Two basic feature mapping methods.	1
4.2	Self Organizing Map, Competitive process, Cooperative process, Adaptive process.	1
4.3	Properties of the feature map.	1
4.4	Stability Plasticity Dilemma, ART-1-Architeture**.**	1
4.5	ART-1 - Algorithm, Applications.	1
4.6	ART-2 - Architeture-Algorithm	1
4.7	ART-2 - Applications.	1
Module 5 : Training Algorithms for pattern Association (7 hours)		
5.1	Introduction, Hebb rule for pattern association, Delta rule for pattern association	1
5.2	Hetero Associative Neural Network-Architecture , Applications,	1
5.3	Auto-associative Net - Architecture, Algorithm, Applications, Storage capacity.	1
5.4	Iterative Auto Associative Net - Architecture, Applications	1
5.5	Discrete Hopfield network - Architecture, Algorithm, Applications**.**	1
5.6	Bidirectional Auto-associative Memory-Architecture, Algorithm.	1
5.7	Bidirectional Auto-associative Memory – Applications.	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	PO1 0	PO1 1	PO1 2
CO1	✔	✔	✔		✔							✔
CO2	✔	✔	✔		✔							✔
CO3	✔	✔	✔	✔	✔							✔
CO4	✔	✔	✔	✔	✔							✔
CO5	✔	✔			✔							✔

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

Assessment Pattern

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

Mark distribution

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

Continuous Internal Evaluation Pattern:

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

Internal Examination Pattern:

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

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

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

End Semester Examination Pattern:

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

SYLLABUS

Module -1 (Introduction to R)

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

Module -2(Reading and writing data)

Importing data from Text files and other software, Exporting data, importing data from databases- Database Connection packages, Missing Data - NA, NULL

Combining data sets, Transformations, Binning Data, Subsets, summarizing functions. Data Cleaning, Finding and removing Duplicates, Sorting.

Module -3 (Statistics with R)

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

Module -4(Data Visualization)

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

Module - 5 (Regression Models)

Building linear models - model fitting, Predict values using models, Analyzing the fit, Refining the model, Regression- types, Unusual observation and corrective measures, Comparison of models, Generalized linear models - Logistic Regression, Poisson Regression, Nonlinear least squares

Text Book

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

Reference Books

1. Jared P Lander, R for Everyone- Advanced analytics and graphics, Addison Wesley data analytics series, Pearson
2. Norman matloff, The art of R programming, A Tour of Statistical, Software Design, O'reilly
3. Robert Kabacoff, R in action, Data analysis and graphics with R, Manning
4. Garret 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: **AIT362**

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

AIT372	AUGMENTED REALITY	Category	L	T	P	Credit	Year of Introduction
		PEC	2	1	0	3	2020

Preamble: This course enables the learners to understand the concepts augmented reality. The course covers the applications of augmented reality, analyse the hardware requirement of AR, use computer vision concepts for AR, introduction to mixed reality. This course helps the students to understand and analyse the use of augmented reality.

Prerequisite: Nil.

Mapping of course outcomes with program outcomes

CO1	Describe how AR systems work and list the applications of AR. **(Cognitive Knowledge Level: Understand)**
CO2	Understand and analyse the hardware requirement of AR **(Cognitive Knowledge Level: Understand)**
CO3	Use computer vision concepts for AR and describe AR techniques **(Cognitive Knowledge Level: Apply)**
CO4	Analyse and understand the working of various state of the art AR devices **(Cognitive Knowledge Level: Apply)**
CO5	Describe the applications of mixed reality **(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	30	30	30
Understand	30	30	30
Apply	40	40	40
Analyze			
Evaluate			
Create			

Mark Distribution

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

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

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

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern

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

End Semester Examination Pattern:

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

SYLLABUS

Module – 1 (Introduction to Augmented Reality: A.R)

Defining augmented reality, history of augmented reality. Timeline of evolution of AR from VR. Relationship between AR and other technologies- Media, technologies, other ideas related to the spectrum between real and virtual worlds. Applications of augmented reality.

Concepts related to augmented reality. How does augmented reality work? Ingredients of an augmented reality experience.

Module – 2 (Augmented Reality Hardware)

Augmented Reality Hardware – Displays – audio displays, haptic displays, visual displays, other sensory displays, visual perception, requirements and characteristics, Spatial Display Model.

Processors – Role of processors, processor system architecture, processor specifications.

Tracking & Sensors - Tracking, calibration, and registration, characteristics of tracking technology, stationary tracking systems, mobile sensors, optical tracking, and sensor fusion.

Module - 3 (Computer Vision for Augmented Reality & A R Software)

Computer Vision for Augmented Reality - Marker tracking, Multiple-Camera Infrared Tracking, Natural Feature Tracking by Detection, Simultaneous Localization and Mapping, outdoor tracking.

Augmented Reality Software - Introduction, major software components for augmented reality systems, software used to create content for the augmented reality application.

Module - 4 (AR Techniques - Marker based & Markerless tracking)

Marker Based Approach - Introduction to marker-based tracking, types of markers, marker camera pose and identification, visual tracking.

Marker Types - Template markers, 2D barcode markers, imperceptible markers.

Markerless Approach - Localization based augmentation, real world examples.

Tracking methods - Visual tracking, feature based tracking, hybrid tracking, and initialisation and recovery.

Module - 5 (AR Devices, Components, and Mixed Reality)

AR Components – Scene generator, tracking system, monitoring system, display, Game scene

AR Devices – Optical see - through HMD, virtual retinal systems, monitor bases systems, projection, displays, video see-through systems.

Introduction to mixed reality - Applications of mixed reality, input and output in mixed reality, Computer Vision and Mixed Reality.

Text Books

1. Allan Fowler-AR Game Development‖, 1st Edition, A press Publications, 2018, ISBN 978-1484236178
2. Augmented Reality: Principles & Practice by Schmalstieg / Hollerer, Pearson Education India; First edition (12 October 2016),ISBN-10: 9332578494

Reference Books

1. Designing for Mixed Reality, Kharis O'Connell Published by O'Reilly Media, Inc., 2016, ISBN: 9781491962381
2. Sanni Siltanen- Theory and applications of marker-based augmented reality. Julkaisija –
3. Utgivare Publisher. 2012. ISBN 978-951-38-7449-0..

Course Level Assessment Questions

Course Outcome1 (CO1):

1. How does augmented reality work? Ingredients of an augmented reality experience.

Course Outcome1 (CO2):

1. With a neat a diagram write a short on augmented reality processor system architecture

Course Outcome1 (CO3):

1. Discuss the major software components for augmented reality systems

Course Outcome1 (CO4):

1. Explain different tracking methods

Course Outcome1 (CO5):

1. Compare feature based tracking and hybrid tracking.
2. Explain in detail about AR devices?

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 372

Course Name: Augmented Reality

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

PART A

Answer All Questions. Each Question Carries 3 Marks

1. What are relationship between augmented reality and other technologies

2. Write a short note about applications of augmented reality

3. With a neat a diagram write a short on augmented reality processor system architecture

4. What do you mean by sensor fusion of augmented reality

5. Describe marker tracking?

6. What do you mean by computer vision for augmented reality?

7. Illustrate the different marker types of AR?

8. Explain AR tracking methods

9. Discuss about virtual retinal systems?

10. Write a short note on input and output in mixed reality? **(10x3=30)**

Part B

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

11. (a) How does augmented reality works, Explain? **(10)**

(b) Compare augmented reality and virtual reality. **(4)**

OR

12. (a) Write a note on history of augmented reality. **(7)**

(b) Explain in detail about ingredients of augmented reality experience? **(7)**

13. (a) Explain in detail about augmented reality hardware displays? **(10)**

(b) Write a short note on role of processors in augmented reality? **(4)**

OR

14. (a) Explain in detail about characteristic of tracking technology? **(8)**

(b) Write a note on Mobile sensors in augmented reality? **(6)**

15. (a) What are major software components for augmented reality, explain? **(8)**

(b) Explain about multiple-camera infrared tracking? **(6)**

OR

16. (a) Explain about augmented reality software? **(9)**

(b) Explain about natural feature tracking by detection? **(5)**

17. (a) Explain in detail about marker-based and marker-less tracking approaches of AR **(8)**

(b) What is visual tracking, explain? **(6)**

OR

18. (a) Compare feature based tracking and hybrid tracking? **(8)**

(b) Design and explain real world example of location based augmentation **(6)**

19. (a) Explain in detail about AR components? **(10)**

(b) What do you mean by mixed reality? **(4)**

OR

20. (a) Explain in detail about AR devices? **(10)**

(b) What are applications of mixed reality? **(4)**

TEACHING PLAN

No	Contents	No. of Lecture Hours (37 hrs)
Module-1 (Introduction to Augmented Reality) (7 hours)		
1.1	Defining augmented reality, history of augmented reality.	1 hour
1.2	Timeline of evolution of AR from VR.	1 hour
1.3	Relationship between AR and other technologies- Media, technologies, other ideas related to the spectrum between real and virtual worlds.	1 hour
1.4	Applications of augmented reality.	1 hour
1.5	Concepts related to augmented reality.	1 hour
1.6	How does augmented reality work?	1 hour
1.7	Ingredients of an augmented reality experience.	1 hour
Module-2 (Augmented Reality Hardware) (7 hours)		
2.1	Augmented Reality Hardware – Displays – audio displays, haptic displays.	1 hour
2.2	Visual displays, Other sensory displays.	1 hour
2.3	Visual perception, requirements and characteristics, Spatial Display Model.	1 hour
2.4	Processors – Role of processors, processor system architecture, processor specifications.	1 hour
2.5	Tracking & Sensors - Tracking, calibration, and registration.	1 hour
2.6	Characteristics of tracking technology, stationary tracking systems.	1 hour
2.7	Mobile sensors, optical tracking, and sensor fusion.	1 hour
Module-3 (Computer Vision for Augmented Reality & A R Software) (7 hours)		
3.1	Computer Vision for Augmented Reality	1 hour
3.2	Marker Tracking, Multiple-Camera Infrared Tracking.	1 hour
3.3	Natural Feature Tracking by Detection.	1 hour

3.4	Simultaneous Localization and Mapping, Outdoor Tracking.	1 hour
3.5	Augmented Reality Software – Introduction.	1 hour
3.6	Major software components for augmented reality systems.	1 hour
3.7	Software used to create content for the augmented reality application.	1 hour
Module-4 (AR Techniques - Marker based & Markerless tracking) (7 hours)		
4.1	Marker Based Approach - Introduction to marker-based tracking.	1 hour
4.2	Types of markers, marker camera pose and identification, visual tracking.	1 hour
4.3	Marker Types - Template markers, 2D barcode markers, imperceptible markers.	1 hour
4.4	Markerless Approach - Localization based augmentation.	1 hour
4.5	Real world examples of Markerless Approach.	1 hour
4.6	Tracking methods - Visual tracking, feature based tracking.	1 hour
4.7	Hybrid tracking, initialisation and recovery.	1 hour
Module-5 (AR Devices, Components, and Mixed Reality) (9 hours)		
5.1	AR Components – Scene generator.	1 hour
5.2	Tracking system, monitoring system.	1 hour
5.3	Display, Game scene.	1 hour
5.4	AR Devices.	1 hour
5.5	Optical see - through HMD, virtual retinal systems, monitor bases systems.	1 hour
5.6	Projection, displays, video see-through systems.	1 hour
5.7	Introduction to mixed reality - Applications of mixed reality.	1 hour
5.8	Input and output in mixed reality.	1 hour
5.9	Computer Vision and Mixed Reality.	1 hour

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)**

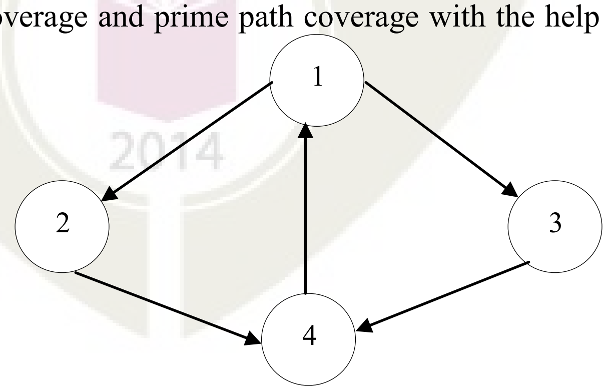
(b) Explain the major difference between control flow testing and data flow testing. **(6)**

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):

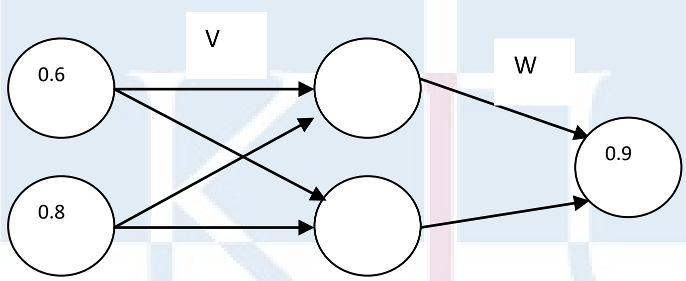
1. Compare regression and classification.
2. Define supervised learning? Distinguish between regression and classification.
3. Discuss the different learning approaches used in machine learning.

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)**

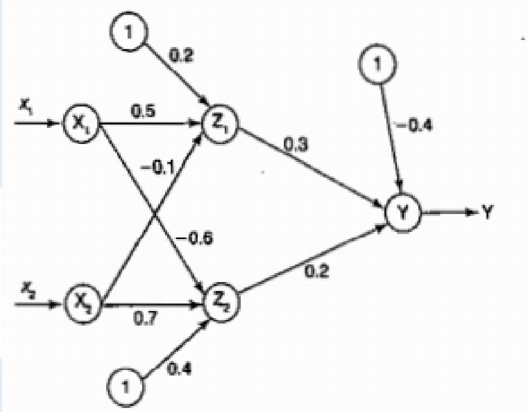
(b) List and discuss the different hyper parameters used in fine tuning the **(4)** traditional machine learning models

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

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

Preamble:

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

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

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

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

Mapping of course outcomes with program outcomes

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

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

Assessment Pattern

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

Mark Distribution

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

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Tests : **25 marks**

Continuous Assessment Assignment : **15 marks**

Internal Examination Pattern:

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

End Semester Examination Pattern:

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

Syllabus

Module – 1 (Network Security Basics)

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

Module – 2 (Network Security Standards)

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

Module – 3 (Email Security)

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

Module – 4 (Web Security)

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

Module – 5 (Wireless Network Security and Firewalls)

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

Text Books

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

Education Asia.

References

1. Behrouz A. Forouzan, Debdeep Mukhopadhyay, "Cryptography and Network Security", 3/e, Tata McGraw Hill.
2. Tyler Wrightson, "Wireless Network Security A Beginner's Guide", 2012, Tata McGraw Hill.
3. William Stallings, "Network Security Essentials: Applications and Standards", 4/e, Prentice Hall.
4. Schiller J., Mobile Communications, 2/e, Pearson Education.
5. Roberta Bragg et. al., "Network Security: The Complete Reference", Tata McGraw Hill.

Course Level Assessment Questions

Course Outcome 1 (CO1):

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

Course Outcome 2 (CO2):

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

Course Outcome 3 (CO3):

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

Course Outcome 4 (CO4):

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

Course Outcome 5 (CO5):

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

Model Question Paper

QP CODE:
Reg. No:______________
Name:________________ **PAGES : 3**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH. DEGREE (HONORS) EXAMINATION, MONTH &YEAR
Course Code: CST 394

Course Name: Network Security

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

PART A

Answer all Questions. Each question carries 3 Marks

1. Distinguish between signature-based and anomaly-based intrusion detection techniques.

2. A trusted third party is considered as a main component in a network security model. Why?

3. How is endpoint identifier hiding achieved in real-time communication?

4. Show how encryption is used to provide privacy and integrity in Kerberos v5.

5. End-to-end privacy is essential for e-mail security. How is this achieved?

6. List the four steps for preparing an EnvelopedData MIME entity.

7. Show the operation of a Secure Sockets Layer (SSL) Record protocol.

8. For Secure Shell (SSH) packets, what is the advantage of not including the MAC in the scope of packet encryption?

9. List the three security services provided by IEEE 802.11i.

10. Define the terms Access Point, Basic Service Set, Extended Service Set.

(10x3=30)

Part B

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

11\. (a) Using the ElGamal scheme, let p = 881 and d = 700, find values for e1 and e2. Choose r = 17. Find the value of S1 and S2 if M = 400. **(8)**

(b) Explain the requirements and challenges of network security. **(6)**

OR

12\. (a) In ElGamal, Schnorr and DSS, what happens if an attacker can find the value of random secret key used by the signer? Also, what happens if a user uses the same value of random secret key to sign two messages? Explain your answer for each scheme separately. **(8)**

(b) Explain the network security model with the help of a neat diagram. **(6)**

13\. (a) Alice wishes to log into Bob's workstation remotely. List the steps involved in this communication if Kerberos v4 is used. **(7)**

(b) How does Diffie-Hellman technique provide perfect forward secrecy using signature keys? **(7)**

OR

14\. (a) Explain the algorithm for Message Authentication Code (MAC) calculation and verification in Kerberos v5 rsa-md5-des. **(8)**

(b) Compare the aggressive mode and main mode of Phase 1 Internet Key Exchange (IKE). **(6)**

15\. (a) Describe the different methods by which authentication of source is performed in email communication. **(7)**

(b) Explain the Signed data and Clear-signed data functions provided by S/MIME. **(7)**

OR

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

(b) Define non-repudiation. Describe the different ways by which it is implemented in email communication. **(7)**

17. (a) Describe the significance of pseudo-random function of Transport Layer Security. **(7)**

(b) Explain the four different phases of Secure Sockets Layer (SSL) HandshakeProtocol. **(7)**

OR

18. (a) Describe how connection initiation and connection closure is done in Hyper Text Transfer Protocol Secure (HTTPS). **(7)**

(b) Illustrate the sequence of events in Secure Shell (SSH) transport layer protocol packet exchanges. **(7)**

19. (a) Explain the Discovery phase and Authentication phase of IEEE 802.11i operation. **(7)**

(b) Why are firewalls needed? Compare the features of packet filters and circuit level firewalls. **(7)**

OR

20. (a) Explain the two authentication methods used in Wired Equivalent Privacy (WEP). **(7)**

(b) Describe the three transaction classes provided by Wireless Transaction Protocol. **(7)**

Teaching Plan

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

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

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

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

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

Prerequisite: Basic background in Bioinformatics and Machine Leaning

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

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

Mapping of course outcomes with program outcomes

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

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

Assessment Pattern

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

Mark Distribution

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

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

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

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern:

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

End Semester Examination Pattern:

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

Machine Learning in Computational Biology

Module 1 (Overview of Machine Learning)

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

Module 2 (Clustering problems Computational Biology)

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

Module 3 (Supervised techniques for Computational Biology)

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

Module 4 (Machine-Learning Algorithms for Computational Biology)

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

Module 5 (Scope of Machine Learning in Computational Biology)

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

Text Books

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

References

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

Course Level Assessment Questions

Course Outcome 1 (CO1):

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

Course Outcome 2 (CO2):

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

Course Outcome 3 (CO3):

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

Course Outcome 4 (CO4):

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

Course Outcome 5 (CO5):

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

Model Question Paper

QP CODE:

Reg No: _______________

Name: ________________ **PAGES: 3**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Course Code: AIT 396

Course Name: MACHINE LEARNING IN COMPUTATIONAL BIOLOGY

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

PART A

Answer All Questions. Each Question Carries 3 Marks

1.	What does the regression line equation tell you?	**(3)**
2.	How do you create a predictive data model using machine learning?	**(3)**
3.	Write the major differences between K-means clustering and hierarchical clustering	**(3)**
4.	List any three resources of Proteomics Datasets	**(3)**
5.	What is the importance of using PCA before applying Machine learning method?	**(3)**
6.	Draw example of an ANN architecture including 4 independent variables, one hidden layer with 3 hidden neurons and 2 dependent variables	**(3)**
7.	What is the role of the Activation functions in Neural Networks?	**(3)**
8.	What is Hinge Loss in SVM?	**(3)**
9.	What is mean square error? how will you evaluate it?	**(3)**
10.	What are discriminative machine learning models?	**(10x3=30)**

Part B

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

11.	(a)	With example, differentiate Supervised and unsupervised learning	**(7)**

	(b)	What is loss function and cost function in machine Learning. write the difference and example of loss function and cost function	(7)
	OR		
12.	(a)	Define Train, Validation, and Test Datasets. how do you divide the data into Train, Validation, and Test Datasets.	(7)
	(b)	Explain Classification, regression and clustering methods with examples of each	(7)
13.	(a)	Use K Means clustering to cluster the following data into two groups. Assume cluster centroid are m1=2 and m2=4. The distance function used is Euclidean distance. { 2, 4, 10, 12, 3, 20, 30, 11, 25 }	(7)
	(b)	Illustrate with a toy example the application of clustering algorithms on gene expression data	(7)
OR			
14.	(a)	Explain the advantages, disadvantages of k-Means clustering	(7)
	(b)	What is the advantage of using hierarchical clustering over K means clustering? When to use the hierarchical clustering?	(7)
15.	(a)	Explain Dimension and Feature Subset Selection	(7)
	(b)	20 physicochemical properties of 100 set of proteins were given with the help of PCA, explain how will you reduce 20x100 in to Five properties (5x100) for the next level analysis	(7)
OR			
16.	(a)	Explain how Linear Discriminant Analysis can be used for the dimensionality reduction with the help of a scenario in computational biology	(7)
	(b)	How do decision tree classifiers work? what types of problems can they solve in Computational Biology	(7)
17.	(a)	Explain the process of Feature Extraction and Pattern recognition from sequence data	(7)
	(b)	Illustrate the design of Artificial Neural Network for solving Computational Biology question	(7)
OR			
18.	(a)	Explain crossover and mutation in genetic algorithm with an example	(7)
	(b)	Explain how to construct a support vector machine (SVM) to classify ovarian	(7)

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

TEACHING PLAN

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

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

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

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

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

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

Prerequisite: Advanced Computer Graphics, Advanced Concepts in Computer Vision

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

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

Mapping of course outcomes with program outcomes

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

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

Assessment Pattern

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

Mark Distribution

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

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

(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