SEMESTER V

ADT301	FOUNDATIONS OF DATA SCIENCE	Category	L	T	P	Credit	Year of Introduction
		PCC	3	1	0	4	2022

Preamble: This course enables the learners to understand the basic concepts of data science including data preprocessing, missing value management and data visualization. It discusses different models that can be used in classification and prediction. It also includes an introduction to Association mining and Cluster analysis. It also introduces the basics of model evaluation.

Prerequisite: Basic understanding of probability theory, linear algebra and basic programming knowledge.

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

CO1	Recall the fundamental concepts and applications of data science, and make inferences on key important points **(Cognitive Knowledge Level: Understand)**
CO2	Identify the concepts in data mining and analyze the different steps in data preprocessing**(Cognitive Knowledge Level: Apply)**
CO3	Illustrate the concepts of classification methods **(Cognitive Knowledge Level: Apply)**
CO4	Perform association mining and analyze clusters using different methods **(Cognitive Knowledge Level: Apply)**
CO5	Evaluate & improve the performance of machine learning classification models **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

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

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test1 (%)	Test 2(%)	
Remember	**40**	**40**	**40**
Understand	**40**	**40**	**40**
Apply	**20**	**20**	**20**
Analyze			
Evaluate			
Create			

Mark Distribution

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

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Continuous Assessment Tests (Average of 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 (Introduction to Data Science)

A brief introduction to data – structured, unstructured, semi-structured, data sets & patterns, Brief history of Data Science, Introduction to Data Science, Importance of Data Science, Differences between AI, ML, DL, Data Science & Data Analytics, Real world applications of data science, Steps in data science process

Simple case study based on real life applications such as - Market research case, tracking disease outbreaks, business predictions, (for example, Rating a product design) etc., Ethical and privacy implications of Data Science.

Tools and Skills Needed – brief introduction of platforms, tools, frameworks, languages, databases and libraries, Current trends & major research challenges in data science.

Module – 2 (Data Mining & Preprocessing)

Data Mining, Kinds of data - mining, Data Preprocessing. An Overview - Data Quality, Need to preprocess the data. Major Tasks in Data Preprocessing.

Data cleaning - Missing Values Noisy Data, Data Cleaning as a Process, Data Integration, Data Reduction, Data transformation and Data Discretization. Introduction to Data Visualization

Module - 3 (Classification Models)

Classification - Basic Concepts, Decision Tree Induction, Bayes Classification Methods- Naıve Bayesian Classification, Rule-Based Classification

Classification Advanced Methods - Bayesian Belief Networks, Classification by Back propagation, A Multilayer Feed-Forward Neural Network, Back propagation, Support Vector Machines, Lazy Learners, K-Nearest-Neighbour Classifiers, Case-Based Reasoning

Module - 4 (Association Mining and Cluster Analysis)

Mining Frequent Patterns, Associations, and Correlations. Basic Concepts Frequent Itemset Mining Methods, Apriori Algorithm, Generating Association Rules from Frequent Itemsets Cluster Analysis, Partitioning Methods, Hierarchical Methods, Agglomerative versus Divisive Hierarchical Clustering, Distance Measures in Algorithmic Methods. Density-Based Methods - DBSCAN

Module - 5 (Evaluation)

Evaluating model performance-Confusion matrices, Precision and recall, Sensitivity and specificity, F-measure, ROC curves, Cross validation, K-fold cross validation, Bootstrap sampling. Improving model performance - Bagging, Boosting, Random forests.

Text Books

1. Sanjeev J. Wagh, Manisha S. Bhende, and Anuradha D. Thakare, *Fundamentals of Data Science,* CRC press
2. Jiawei Han, Michelin Kamber, Jian Pei, *Data mining Concepts and Techniques*, Third Edition, 2012 , Morgan Kaufmann Publishers
3. Brett Lantz, *Machine Learning with R*, Second edition, PackT publishing 2015

Reference Books

1. Arun K. Pujari, *Data Mining Techniques*, Universities Press
2. Foster Provost, Tom Fawcett, *Data Science for Business*, O'Reilly Media
3. Margaret H Dunham, *Data Mining: Introductory And Advanced Topics,* Pearson Education
4. Nina Zumel and John Mount, *Practical Data Science with R*, Manning Publications

Sample Course Level Assessment Questions

Course Outcome1 (CO1):

1. What is data science? Why is data science required?
2. How data science is used in a real life application to enhance business management?
3. Explain the different domains of data science where data science plays an active role
4. Explain the different stages in data science process
5. List and briefly explain various tools and skills required for data science

Course Outcome 2(CO2):

1. Given the following data (in increasing order) for the attribute age: 13, 15, 16, 16, 19, 20, 20, 21, 22, 22, 25, 25, 25, 25, 30, 33, 33, 35, 35, 35, 35, 36, 40, 45, 46, 52, 70.

   (a) Use binning methods to smooth these data, using a bin depth of 3.

   Illustrate your steps. Comment on the effect of this technique for the given data.

2. Use these methods to normalize the following group of data: 200,300,400,600,1000

   (a) min-max normalization by setting min = 0 and max = 1

   (b) z-score normalization

   (c) z-score normalization using the mean absolute deviation instead of standard deviation

   (d) normalization by decimal scaling

Course Outcome 3 (CO3):

1. Given a 5-GB data set with 50 attributes (each containing 100 distinct values) and 512 MB of main memory in your laptop, outline an efficient method that constructs decision trees in such large data sets. Justify your answer by rough calculation of your main memory usage.
2. SVM classifiers suffer from slow processing when training with a large set of data tuples. Discuss how to overcome this difficulty and develop a scalable SVM algorithm for efficient SVM classification in large data sets.
3. Write an algorithm for k-nearest-neighbor classification given k, the nearest number of neighbors, and n, the number of attributes describing each tuple.

Course Outcome 4 (CO4): .

1. Suppose the data containing frequent itemset X is {I1, I2, I5}. What are the association rules that can be generated from X if the nonempty subsets of X are {I1, I2}, {I1, I5}, {I2, I5}, {I1}, {I2}, and {I5} and minimum confidence threshold is 70%? Output the strong association rules.
2. Find the frequent itemsets and generate the association rules using the Apriori algorithm if minimum support is 2 and minimum confidence is 50%.

TID	ITEMSETS
T1	A, B
T2	B, D
T3	B, C
T4	A, B, D
T5	A, C
T6	B, C
T7	A, C
T8	A, B, C, E
T9	A, B, C

3. Mention the general characteristics of different clustering methods.
4. Differentiate between Agglomerative and Divisive Hierarchical Clustering.

5. How can we find dense regions in density-based clustering? How does DBSCAN quantify the neighborhood of an object? How can we assemble a large dense region using small dense regions centered by core objects?

Course Outcome 5 (CO5):

1. Explain the various matrices used to measure the performance of classification algorithms.
2. Explain the concepts of bagging and boosting.
3. Suppose 10000 patients get tested for flu; out of them, 9000 are actually healthy and 1000 are actually sick. For the sick people, a test was positive for 620 and negative for 380. For the healthy people, the same test was positive for 180 and negative for 8820. Construct a confusion matrix for the data and compute the precision and recall for the data.

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: ADT301

Course Name: Foundations of Data Science

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

PART A

Answer All Questions. Each Question Carries 3 Marks

1. List out three ethical issues in data science?

2. Differentiate between Data Analytics and Data Science.

3. Define binning?

4. Demonstrate various data reduction strategies?

5. Discuss the classification processes using Bayesian Belief Networks.

6. Illustrate the strength and weakness of KNN classifiers.

7. Infer the conditions to be satisfied for an association rule to be strong? Illustrate with an example.

8. Cite the orthogonal aspects with which clustering methods can be compared?

9. Compare and contrast precision, recall and F-measure.

10. How can you summarize bootstrap sampling? **(10x3=30)**

Part B

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

11. (a) How data science is used in a real life application to enhance business management? **(9)**

(b) Demonstrate the different stages in the data science process. **(5)**

OR

12. (a) List and briefly explain various tools and skills required for data science. **(7)**

(b) Identify the different domains where data science plays an active role. **(7)**

13. (a) Explain the procedures in data reduction strategy using PCA. **(6)**

(b) Briefly explain the preprocessing techniques available in data mining. **(8)**

OR

14. (a) Discover the value ranges of the following normalization methods? **(6)**

(a) min-max normalization

(b) z-score normalization

(b) Briefly explain the terms data reduction and data transformation with an example. **(8)**

15. (a) Why is naıve Bayesian classification called "naıve"? Briefly outline the major ideas of naıve Bayesian classification. **(6)**

(b) Compare the advantages and disadvantages of eager classification (e.g., decision tree, Bayesian, neural network) versus lazy classification (e.g., k-nearest neighbor, case-based reasoning). **(8)**

OR

16. (a) Illustrate the major steps of decision tree classification. **(6)**

(b) Briefly describe the classification processes using (i) Support Vector machine (ii) Back Propagation. **(8)**

17. (a) What is the Apriori algorithm used for? Give the steps used in the Apriori algorithm to find the most frequent itemsets. **(4)**

(b) Consider the following dataset and find frequent itemsets and generate association rules for them. Let minimum support count be 2 and minimum confidence be 60%. **(10)**

TID	items
T1	I1, I2 , I5
T2	I2,I4
T3	I2,I3
T4	I1,I2,I4
T5	I1,I3
T6	I2,I3
T7	I1,I3
T8	I1,I2,I3,I5
T9	I1,I2,I3

OR

18. (a) How does the k-means algorithm work? Clearly state the k-means partitioning algorithm with the help of an example. **(8)**

(b) Explain the requirements for clustering as a data mining tool and aspects that can be used for comparing clustering methods. **(6)**

19. (a) Suppose 10000 patients get tested for flu; out of them, 9000 are actually healthy and 1000 are actually sick. For the sick people, a test was positive for 620 and negative for 380. For the healthy people, the same test was positive for 180 and negative for 8820. Construct a confusion matrix for the data and compute the precision and recall for the data. **(7)**

(b) Explain the various Performance evaluation parameters. **(7)**

OR

20. (a) Assume the following: A database contains 80 records on a particular topic of which 55 are relevant to a certain investigation. A search was conducted on that topic and 50 records were retrieved. Of the 50 records retrieved, 40 were relevant. Construct the confusion matrix for the search and calculate the precision and recall scores for the search. **(6)**

(b) Explain the different methods for improving the model performance. **(8)**

Teaching Plan

No	Contents	No. of Lecture Hours (45 hrs)
	Module-1 (Introduction) (8 hours)	
1.1	A brief introduction to data –structured, unstructured,semi-structured, data sets & patterns, Brief history of data science, Introduction to Data Science	1 hour
1.2	Importance of data science, Differences between AI, ML, DL, Data Science & Data Analytics, Real world applications of data science	1 hour
1.3	Steps in data science process- framing the problem, collecting raw data, data preprocessing, model designing	1 hour
1.4	Steps in data science process- model building, in-depth analysis, communicating results.	1 hour
1.5	Simple case study based on real life applications such as - Market research case, tracking disease outbreaks, business predictions, (for example, rating a product design),etc.	1 hour
1.6	Ethical and privacy implications of Data Science.	1 hour
1.7	Tools and Skills Needed – brief introduction of platforms, tools, frameworks,	1 hour

	languages, databases and libraries	
1.8	Current trends & major research challenges in data science.	1 hour
Module-2 (Data Preprocessing) (8 hours)		
2.1	Data mining and Data Preprocessing: An Overview	1 hour
2.2	Data Cleaning- Missing Values, Noisy Data,Data Cleaning as a Process	1 hour
2.3	Integration - Entity Identification Problem, Redundancy and Correlation Analysis	1 hour
2.4	Tuple Duplication, Data Value Conflict Detection and Resolution	1 hour
2.5	Data Reduction- PCA, Regression and Log-Linear Models: Parametric Data Reduction	1 hour
2.6	Data Reduction- Clustering, Data cube aggregation.	1 hour
2.7	Data Transformation and Data Discretization - Data Transformation by Normalization	1 hour
2.8	Data Visualization - An overview	1 hour
Module-3 (Classification Models) (10 hours)		
3.1	Classification: Basic Concepts (TB2 8.1)	1 hour
3.2	Decision Tree Induction (TB2 8.2.1)	1 hour
3.3	Bayes Classification Methods - Naıve Bayesian Classification (TB2 8.3)	1 hour
3.4	Rule-Based Classification (TB2 8.4)	1 hour
3.5	Classification: Advanced Methods - Bayesian Belief Networks (TB2 9.1)	1 hour
3.6	Classification by Backpropagation - A Multilayer Feed-Forward NN (TB2 9.1)	1 hour
3.7	Backpropagation (TB2 9.2.3)	1 hour
3.8	Support Vector Machines (TB2 9.3)	2 hours
3.9	Lazy Learners - k-Nearest-Neighbor Classifiers - Case-Based Reasoning (TB2 9.5)	1 hour
Module-4 (Association Mining and Cluster Analysis) (10 hours)		
4.1	Mining Frequent Patterns, Associations, and Correlations: Basic Concepts (TB2 6.1)	1 hour
4.2	Frequent Itemset Mining Methods : Apriori Algorithm (TB2 6.2.1)	2 hours
4.3	Generating Association Rules from Frequent Itemsets (TB2 6.2.2)	1 hour
4.4	Cluster Analysis (TB2 10.1)	1 hour
4.5	Partitioning Methods (TB2 10.2)	1 hour

4.6	Agglomerative versus Divisive Hierarchical Clustering (TB2 10.3.1)	1 hour
4.7	Distance Measures in Algorithmic Methods (TB2 10.3.2)	1 hour
4.8	Density-Based Methods: DBSCAN (TB2 10.4.1)	2 hours
Module-5 (Evaluation) (9 hours)		
5.1	Evaluating model performance: Confusion matrices	1 hour
5.2	Precision and recall, Sensitivity and specificity	1 hour
5.3	F-measure, ROC curves	1 hour
5.4	Problems on Evaluating Model performance	1 hour
5.5	Cross validation: K-fold cross validation	1 hour
5.6	Bootstrap sampling	1 hour
5.7	Improving model performance: Bagging	1 hour
5.8	Boosting, Random forests	2 hours

CST 303	COMPUTER NETWORKS	Category	L	T	P	Credit	Year of Introduction
		PCC	3	1	0	4	2019

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?

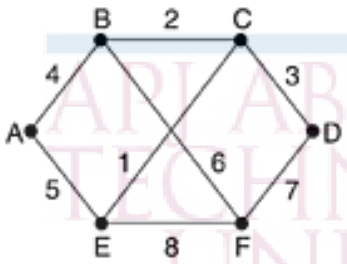
Course Outcome4 (CO4)

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 $□^3 + 1$. 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

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓								✓
CO2	✓	✓	✓	✓	✓							✓

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

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

Assessment Pattern

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

Evaluate			
Create			

Mark Distribution

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

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 $\boldsymbol{y}$, given the $\boldsymbol{D}$-dimensional input $\boldsymbol{x}$. You are given $\boldsymbol{N}$ independent data points, and that all the $\boldsymbol{D}$ attributes are linearly independent. Assuming that $\boldsymbol{D}$ 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 $y \in 0, 1, 2$ 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?
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 $x_1, \ldots, x_n$ are independent and identically distributed drawn from an exponential distribution $exp(\lambda)$. Find the maximum likelihood for λ.
6. Suppose $x_1, \ldots, x_n$ are independent and identically distributed(iid) samples from a distribution with density

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

   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, $x_1, \ldots, x_N$ 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. 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	PO10	PO11	PO12
CO 1	✓											
CO 2	✓	✓										✓
CO 3	✓	✓	✓	✓								✓
CO 4	✓	✓	✓	✓								✓
CO 5	✓	✓			✓							✓

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

Assessment Pattern

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

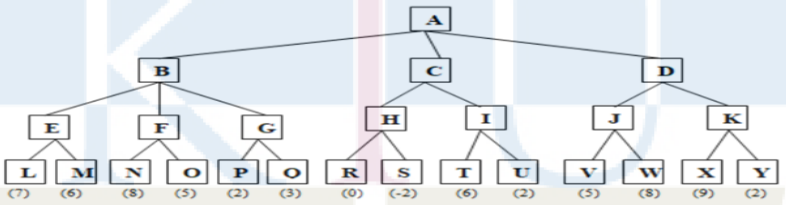
$$\begin{array}{r} T\ W\ O \\ +\ T\ W\ O \\ \hline F\ O\ U\ R \end{array}$$

(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

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

ADL331	AI & DATA SCIENCE LAB	CATEGORY	L	T	P	Credit	Year of Introduction
		PCC	0	0	3	2	2020

Preamble: The course enables the learners to get hands-on experience in AI and data science using Python programming. It covers implementation of various predictive and descriptive analysis measures, 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 develop, implement algorithms and evaluate its performance for real world data.

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	Implement various predictive and descriptive analysis measures using Python. Use various packages and libraries in Python for data handling. **(Cognitive Knowledge Level: Apply)**
CO2	Implement different Regression methods such as Linear and Logistic regression to interpret the given dataset. **(Cognitive Knowledge Level: Apply)**
CO3	Implement various supervised learning models like k-Nearest Neighbour, Support Vector Machine, Naïve Bayesian Classifier and Decision Tree algorithms. **(Cognitive Knowledge Level: Apply)**
CO4	Implement mathematical optimization method like the Hill Climbing algorithm and Deep Learning method like Convolutional Neural Network algorithm. **(Cognitive Knowledge Level: Apply)**
CO5	Implement different methods (like Correlation and Covariance) to determine the dependence between features in the dataset and apply dimensionality reduction 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 : Python

Fair Lab Record:

All the students attending the AI & Data Science 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. Implement a program to perform operations like mean, median, mode, standard deviation, percentile and various data distributions.
2. Review of python programming, Matrix operations, Programs using matplotlib / plotly / bokeh / seaborn for data visualisation and programs to handle data using pandas*
3. Try to open a csv file and sort the content with respect to one column using python.
4. Implement a program to perform linear regression for a dataset that prevails in csv format*
5. Implement a program to perform logistic regression to classify a dataset. Print feature importance after building model*
6. Implement k-Nearest Neighbour algorithm to classify any dataset. Print both correct and wrong predictions. ML library classes can be used for this problem. Assume K=3.*
7. Write a program to construct a Support Vector Machine considering medical data. Use this model to demonstrate the diagnosis of heart patients using the standard Heart Disease Data Set*
8. Assuming a set of documents that need to be classified, use the naïve Bayesian Classifier model to perform this task. Calculate the accuracy, precision, and recall for your data set*
9. Assuming a set of data that need to be classified, use a decision tree model to perform this task. Preferably use any dataset like medical or others to evaluate the accuracy.*
10. Implement a program to perform Hill climbing algorithm.*
11. Implement convolutional neural network to classify images from any standard dataset in the public domain using Keras framework. Reading and writing different types of dataset.
12. Write a program to find Correlation and Covariance between different features of a dataset in csv format.*
13. Write a program to implement feature reduction using PCA. Calculate the covariance between features to find the optimal number of PCA components.*

Practice Questions

1. Write a Python script to generate a list of random numbers and find their mean and standard deviation.
2. Consider the river temperature data available at https://catalogue.ceh.ac.uk/documents/b8a985f5-30b5-4234-9a62-03de60bf31f7. Create a Python script to select only the data from "Swale at Catterick Bridge" location, and find the mean temperature and median dissolved oxygen. Also plot a histogram showing the distribution of temperature over the time period of study.

3. Consider the river temperature data available at https://catalogue.ceh.ac.uk/documents/b8a985f5-30b5-4234-9a62-03de60bf31f7. Create a Python script to perform linear regression to establish how temperature affects dissolved oxygen levels. Test the model on the whole dataset and find the RMSE.
4. Perform logistic regression to classify Cleveland heart disease dataset. Print the feature importance and accuracy. Drop least important attributes one by one and assess how the accuracy and feature importance changes.
5. Find the correlation and covariance between different attributes of Cleveland heart disease dataset. Which are the top 5 attributes closely related to the predicted attribute?
6. Perform Naive Bayes classification on the "glass" dataset from Kaggle. Interpret the performance of the classifier, and evaluate why the accuracy value is what you obtained.
7. Use the "Car Evaluation Dataset" from UCI Machine Learning repository to generate a decision tree and measure the performance.
8. Implement KNN algorithm to classify iris dataset. Print all necessary performance measures.
9. Implement appropriate CNNs to classify (i) MNIST dataset, and (ii) Fashion MNIST dataset. Redesign the CNN with different hyperparameters and evaluate the performance.
10. Implement dimensionality reduction on Car Evaluation dataset from UCI Machine Learning repository using PCA. Try setting number of PCA components from 2 to 5, and identify the composition that gives the best performance among all of them. Find covariance among all features in the original dataset and try to justify the performance.

Reference Books:

1. Aurelien Geron, “Hands–On Machine Learning with Scikit–Learn and TensorFlow”, O’Relily.
2. David dietrich, “EMC education service’s, data science and big data analytics, discovering, analyzing, visualizing, and presenting data”, John Wiley and sons
3. Stuart J. Russell, Peter Norvig, “Artificial Intelligence: A Modern Approach”, Pearson Education.

CSL 333	DATABASE MANAGEMENT SYSTEMS LAB	Category	L	T	P	Credits	Year of introduction
		PCC	0	0	4	2	2019

Preamble:

The Database Management Systems course is intended to impart the elementary concepts of a database management system to students and equip them to design and implement a database application based on those concepts. This course helps the learners to get practical exposure on database creation, SQL queries creation, transaction processing and NoSQL & MongoDB based operations. The course enables the students to create, manage and administer the databases, develop necessary tools for the design and development of the databases, and to understand emerging technologies to handle Big Data.

Prerequisite: A sound knowledge of the basics of relational DBMS.

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

CO#	Course Outcomes
CO1	Design database schema for a given real world problem-domain using standard design and modeling approaches. **(Cognitive Knowledge Level: Apply)**
CO2	Construct queries using SQL for database creation, interaction, modification, and updation. **(Cognitive Knowledge Level: Apply)**
C03	Design and implement triggers and cursors. (Cognitive Knowledge Level: **Apply**)
C04	Implement procedures, functions, and control structures using PL/SQL**. (Cognitive Knowledge Level: Apply)**
CO5	Perform CRUD operations in NoSQL Databases. **(Cognitive Knowledge Level: Apply)**
C06	Develop database applications using front-end tools and back-end DBMS. **(Cognitive Knowledge Level: Create)**

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 Test (Internal Exam)Percentage**	**End Semester Examination Percentage**
Remember	**20**	**20**
Understand	**20**	**20**
Apply	**60**	**60**
Analyse		
Evaluate		
Create		

Mark Distribution

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

Continuous Internal Evaluation Pattern:

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

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

End Semester Examination Pattern:

The marks will be distributed as Schema/Logic: 30 marks,
Program/Queries: 20 marks, Output: 20 marks, and Viva: 30 marks. Total 100 marks will be converted out of 75 for the End Semester Examination.

DBMS software: Oracle, MySQL, SQL Server, PostgreSQL, MongoDB.
Front end Tool: Java

Fair Lab Record:

All Students attending the DBMS Lab should have a Fair Record. The fair record should be produced in the University Lab Examination. Every experiment conducted in the lab should be noted in the fair record. For every experiment in the fair record, the right hand page should contain Experiment Heading, Experiment Number, Date of Experiment, Aim of Experiment, Schemas/Menu & Form Design, and Query questions. The left hand page should contain Queries and sample output(relations created, Form, and Menu Output) obtained for a set of input.

Syllabus

1. Design a database schema for an application with ER diagram from a problem description **.
2. Creation, modification, configuration, and deletion of databases using UI and SQL Commands **.
3. Creation of database schema - DDL (create tables, set constraints, enforce relationships, create indices, delete and modify tables). Export ER diagram from the database and verify relationships** (with the ER diagram designed in step 1).

4. Database initialization - Data insert, Data import to a database (bulk import using UI and SQL Commands)**.
5. Practice SQL commands for DML (insertion, updating, altering, deletion of data, and viewing/querying records based on condition in databases)**.
6. Implementation of built-in functions in RDBMS**.
7. Implementation of various aggregate functions in SQL**.
8. Implementation of Order By, Group By & Having clause **.
9. Implementation of set operators nested queries, and join queries **.
10. Implementation of queries using temp tables.
11. Practice of SQL TCL commands like Rollback, Commit, Savepoint **.
12. Practice of SQL DCL commands for granting and revoking user privileges **.
13. Practice of SQL commands for creation of views and assertions ** .
14. Implementation of various control structures like IF-THEN, IF-THEN-ELSE, IF-THEN-ELSIF, CASE, WHILE using PL/SQL **.
15. Creation of Procedures, Triggers and Functions**.
16. Creation of Packages **.
17. Creation of Cursors **.
18. Creation of PL/SQL blocks for exception handling **.
19. Database backup and restore using commands.
20. Query analysis using Query Plan/Show Plan.
21. Familiarization of NoSQL Databases and CRUD operations**.
22. Design a database application using any front end tool for any problem selected. The application constructed should have five or more tables**.

** mandatory

Text Books

1. Elmasri R. and S. Navathe, Database Systems: Models, Languages, Design and Application Programming, Pearson Education, 2013.
2. Sliberschatz A., H. F. Korth and S. Sudarshan, Database System Concepts, 6/e, McGraw Hill, 2011.

References

1. Adam Fowler, NoSQL for Dummies, John Wiley & Sons, 2015
2. NoSQL Data Models: Trends and Challenges (Computer Engineering: Databases and Big Data), Wiley, 2018

Practice Questions

Design a normalized database schema for the following requirement.

The requirement: A library wants to maintain the record of books, members, book issue, book return, and fines collected for late returns, in a database. The database can be loaded with book information. Students can register with the library to be a member. Books can be issued to students with a valid library membership. A student can keep an issued book with him/her for a maximum period of two weeks from the date of issue, beyond which a fine will be charged. Fine is calculated based on the delay in days of return. For 0-7 days: Rs 10, For 7 – 30 days: Rs 100, and for days above 30 days: Rs 10 will be charged per day.

Sample Database Design

BOOK (**Book_Id**, Title, Language_Id, MRP, Publisher_Id, Published_Date, Volume, Status) // Language_Id, Publisher_Id are FK (Foreign Key)

AUTHOR(Author_Id, Name, Email, Phone_Number, Status)

BOOK_AUTHOR(Book_Id, Author_Id) // many-to-many relationship, both columns are PKFK (Primary Key and Foreign Key)

PUBLISHER(Publisher_id, Name, Address)

MEMBER(Member_Id, Name, Branch_Code, Roll_Number, Phone_Number, Email_Id, Date_of_Join, Status)

BOOK_ISSUE(Issue_Id, Date_Of_Issue, Book_Id, Member_Id, Expected_Date_Of_Return, Status) // Book+Id and Member_Id are FKs

BOOK_RETURN(Issue_Id, Actual_Date_Of_Return, LateDays, LateFee) // Issue_Id is PK and FK

LANGUAGE(Language_id, Name) //Static Table for storing permanent data

LATE_FEE_RULE(FromDays, ToDays, Amount) // Composite Key

EXERCISES

1. Create a normalized database design with proper tables, columns, column types, and constraints
2. Create an ER diagram for the above database design.
3. Write SQL commands to
    a. Create a database by name *Library.* Drop the database and re-create it.
    b. Create DDL statements and create the tables and constraints (from the design) in the database created in step-a (*Library*)

Notes: [Create a script file and execute it. Create the script file in such a way that,,if the table exists, drop the tables and recreate)]

c. Create and execute DROP TABLE command in tables with and without FOREIGN KEY constraints.
d. Create and execute ALTER TABLE command in tables with data and without data.
e. Create and execute SQL commands to build indices on Member_Id and Book_Id on table Book_Issue.
f. Create and execute GRANT/REVOKE commands on tables.
g. Create and execute SQL commands to insert data into each of the tables designed
h. Learn and execute bulk import of data to tables from CSV files (insert 1000 records of books into the BOOK table from a CSV file).
i. Create and execute UPDATE/DELETE commands on tables. Try to update/delete rows with Primary and Foreign Keys. Try bulk updates or deletes using SQL UPDATE statement

4. Write SQLQuery to retrieve the following information
   a. Get the number of books written by a given author
   b. Get the list of publishers and the number of books published by each publisher
   c. Get the names of authors who jointly wrote more than one book.
   d. Get the list of books that are issued but not returned
   e. Get the list of students who reads only ‘Malayalam’ books
   f. Get the total fine collected for the current month and current quarter
   g. Get the list of students who have overdue (not returned the books even on due date)
   h. Calculate the fine (as of today) to be collected from each overdue book.
   i. Members who joined after Jan 1 2021 but has not taken any books
5. Book return should insert an entry into the Book_Return table and also update the status in Book_Issue table as ‘Returned’. Create a database *TRANSACTION* to do this operation (stored procedure).
6. Create a database view ‘Available_Books’, which will list out books that are currently available in the library
7. Create a database procedure to add, update and delete a book to the Library database (use parameters).
8. Use cursors and create a procedure to print Books Issue Register (page wise – 20 rows in a page)
9. Create a history table (you may use the same structure without any keys) for the MEMBER table and copy the original values of the row being updated to the history table using a TRIGGER.
10. NoSQL Exercise
    a. Practice Mongo DB CRUD operations. Refer: https://docs.mongodb.com/manual/crud/

b. You may use a MongoDB local installation or cloud MongoDB services like MongoDB Atlas for this exercise
c. For documentation: Refer: https://docs.mongodb.com/manual/introduction/

11. Application Development Problem examples:
    1) Inventory Control System.
    2) Material Requirement Processing.
    3) Hospital Management System.
    4) Railway Reservation System.
    5) Personal Information System.
    6) Web Based User Identification System.
    7) Timetable Management System.
    8) Hotel Management System.

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 $x_1, \ldots, x_n$ are independent and identically distributed drawn from an exponential distribution $exp(\lambda)$. Find the maximum likelihood for λ.
3. Suppose $x_1, \ldots, x_n$ are independent and identically distributed(iid) samples from a distribution with density

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

   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, $x_1, \ldots, x_N$ 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 ≤ θ ≤ 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 ***Γ(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, $x_1,\ldots, x_N$ 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 $o_d = w_0 + w_1x_1 + \ldots + w_nx_n$. 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)**

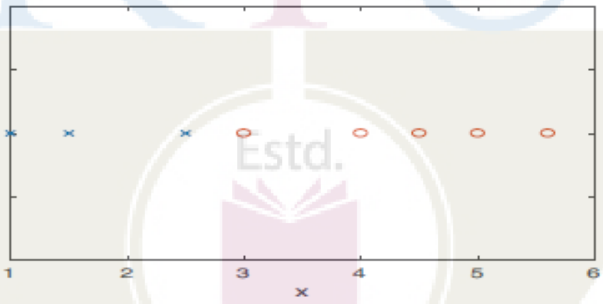
$$\mathbf{x} = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \rightarrow \phi(\mathbf{x}) = \begin{bmatrix} x_1^2 \\ x_2^2 \\ \sqrt{2}\, x_1 x_2 \\ \sqrt{2}\, x_1 \\ \sqrt{2}\, x_2 \end{bmatrix}.$$

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

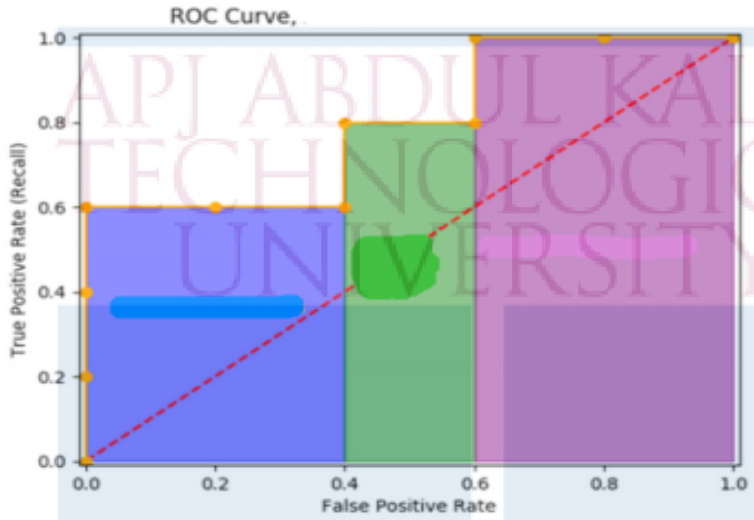
b) Suppose that you have a classification problem where our feature representation contains about 10,000,000 features. We would like to develop a classifier that can be deployed in a mobile phone, so preferably it should have a small memory footprint. Discuss one solution for how this can be done. **(6)**

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	PO 9	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
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 $Y_A = X_AG$. To sign a message *M*:
    - Alice picks a value k
    - Alice sends Bob *M*, k and the signature $S = M - kX_AG$.
    - 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: CST 393

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