SEMESTER IV

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
A	MAT 266	MATHEMATICAL FOUNDATIONS FOR SECURITY SYSTEMS	3-1-0	4	4
B	CST 202	COMPUTER ORGANISATION AND ARCHITECTURE	3-1-0	4	4
C	CST 204	DATABASE MANAGEMENT SYSTEMS	3-1-0	4	4
D	CST 206	OPERATING SYSTEMS	3-1-0	4	4
E (1/2)	EST 200	DESIGN & ENGINEERING	2-0-0	2	2
	HUT 200	PROFESSIONAL ETHICS	2-0-0	2	2
F	MCN 202	CONSTITUTION OF INDIA	2-0-0	2	--
S	CCL 202	SCRIPTING LANGUAGES FOR SECURITY	0-0-3	3	2
T	CCL 204	OS AND DBMS LAB	0-0-3	3	2
R/M/H	VAC	Remedial/Minor/Honours course	3-1-0	4	4
TOTAL				**26***	**22/26**

* Excluding Hours to be engaged for Remedial/Minor/Honours course.

NOTE:

1. Design & Engineering and Professional Ethics shall be offered in both S3 and S4. Institutions can advise students belonging to about 50% of the number of branches in the Institution to opt for Design & Engineering in S3 and Professional Ethics in S4 & vice versa.

2. *All Institutions should keep 4 hours exclusively for Remedial class/Minor course (Thursdays from 3 to 5 PM and Fridays from 2 to 4 PM). If a student does not opt for minor programme, he/she can be given remedial class.

SEMESTER IV

MAT 266	MATHEMATICAL FOUNDATIONS FOR SECURITY SYSTEMS	Category	L	T	P	Credit	Year of Introduction
		BSC	3	1	0	4	2021

Preamble: This course helps the learners to understand the concepts of algebraic structures, number theory and random variables. The topics covered include rings, finite field, properties of numbers, primality test, factorization, vector space and discrete random variables. These concepts will help them to develop security model and analyse them before being used in many commercial, industrial as well as web application.

Prerequisite: A sound knowledge in elementary algebraic and probability concepts.

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

CO1	Illustrate the basic concepts of various algebraic structures like rings, finite fields and construction of Galois fields.**(Cognitive Knowledge Level: Apply)**
CO2	Make use of concepts of vector space and its operations.**(Cognitive Knowledge Level: Apply)**
CO3	Identify and apply the properties of integers including divisibility, congruence, primality testing, prime factorization, modulo operations.**(Cognitive Knowledge Level: Apply)**
CO4	Recognize the concepts and properties of discrete random variables and use them to model and analyse random phenomena.**(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

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

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

Assessment Pattern

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

Mark Distribution

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

Continuous Internal Evaluation Pattern:

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

Internal Examination Pattern

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

End Semester Examination Pattern:

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

Syllabus

Module – 1 (Algebraic Structures)

Rings – Definition, Rings of Polynomial. Quotient Rings. Fields – Finite field, Galois Field Construction – Illustration. Applications in LFSR, Properties of Galois fields. Subfields of Galois Fields. (All theorems without proofs.).

Module– 2(Linear Algebra)

Irreducible and Primitive Polynomials. Conjugate Elements and Minimal Polynomials.
Vector space – Linear combination of the vectors, Spanning set for vector space, Row space, column space, linearly dependent and independent vectors, Basis, Vector subspace, Inner product, Orthogonality, dual space. (All theorems without proofs.)

Module - 3 (Number Theory I)

Divisibility, Greatest Common Divisor, Euclidean Algorithm, The Extended Euclidean Algorithm. Congruence, Residue Classes. Primes, Cardinality of Primes, Checking for Primeness, Euler's phi function, Fermat's Little Theorem, Euler's Theorem, Generating Primes.

Module - 4 (Number Theory II)

Primality Testing – Fermat's Test, Divisibility Test, Miller – Rabin Test, Combination of Divisibility Test and Miller – Rabin Test. Factorization – Fundamental Theorem of Arithmetic, Fermat method, Pollard p-1 method, Pollard rho method. The Chinese Remainder Theorem. Quadratic Congruence - Quadratic Congruence Modulo a Prime, Quadratic Congruence Modulo a Composite. Order of an element, Primitive Roots.

Module - 5 (Probability Theory)

Discrete random variable, Probability distributions, Expected value, Variance, Sum and Product of Random Variable, Independent Random variables. Binomial distribution, Mean and Variance. Markov's inequality, Chebysheff's inequality. Law of Large Numbers. Entropy – Entropy of a sample space, Joint entropy and conditional entropy.

Text Books

1. Todd K. Moon, 'Error Correction Coding, Mathematical Methods and Algorithms', Second Edition, John Wiley & Sons, 2021.
2. Behrouz A. Forouzan, 'Cryptography and Network Security', McGraw-Hill.
3. Paul Garrett, 'The Mathematics of Coding Theory', Prentice-Hall. Inc., 2004.

ReferenceBooks

1. Thomas Koshy, 'Elementary Number Theory with Applications', Second Edition, Elsevier Inc., 2007.
2. David c. Lay, Linear Algebra and its Applications, 3rd edition.
3. Stephen Andrilli and David Hecker, 'Elementary Linear Algebra', Fifth edition, Elsevier Inc, 2016.
4. Fraleigh J. B., 'A first course in abstract algebra', Narosa, 1990.
5. Sheldon M. Ross, "Introduction to Probability Models", Academic Press, 2003
6. Niven, H. S. Zuckerman and H. L. Montgomery, An introduction to the theory of numbers, John Wiley and Sons, 2004.
7. Jay L. Devore, Probability and Statistics for Engineering and the Sciences, 8th edition, Cengage, 2012.

Course Level Assessment Questions

Course Outcome1 (CO1):

1. Check whether the set of 2 x 2 matrices under usual definitions of addition and multiplication form a ring?
2. Is every field a ring? Does the converse hold? Justify your answer.
3. Check whether 242 a Galois field.
4. Illustrate the subfields of $GF(2^{24})$.

Course Outcome 2(CO2):

1. Does $(x^3 + x + 1)$divides$(x^7 + 1)$ in $GF\ (2)$?
2. If $f(x) \epsilon\ GF(q)[x]$ is irreducible, then is it possible for all the roots of f(x) to have the same order?
3. Determine the minimal polynomial for each conjugacy class in GF(8) with respect to GF(2).
4. Is it true that if x, y and z are linearly independent vectors over GF(q) then so also are x + y, y + z and z + x?

Course Outcome 3(CO3):

1. Using the Euclidean algorithm, find the greatest common divisor of 88 and 220.
2. Find the result of 6^{10} mod 11.
3. Specify the formula for a Fermat number? Is F_5 a prime?
4. The number 4033 is a composite (33 x 109). Does it pass the Miller – Rabin test?
5. Use The Pollard p – 1 method to find a factor of 57247159 with the bound B = 8.
6. Find an integer that has a remainder of 3 when divided by 7 and 13, but is divisible by 12.
7. For the group $G = \langle Z_{19}^*\ ,\ \times \rangle$: find the order of each element in the group. Also find the primitive roots in the group.
8. Implement primality test (Programming Assignment)

Course Outcome 4 (CO4):

1. Let X denote the number that show up when an unfair die is tossed. Faces 1 to 5 of the die are equally likely, while face 6 is twice as likely as any other. Find the probability distribution, mean and variance of X.
2. An equipment consists of 5 components each of which may fail independently with probability 0.15. If the equipment is able to function properly when at least three of the components are operational, what is the probability that it functions properly?
3. Compute the expected value and variance of the random variable which tells the sum of the result of the roll of two fair dice.
4. Determine the entropy of the random variable which counts the sum of three dice.

Model Question Paper

QP CODE:

Reg No: _____

Name: _____ **PAGES: 4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FOURTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: MAT266

Course Name: MATHEMATICAL FOUNDATIONS FOR SECURITY SYSTEMS

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

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Define a ring with a suitable example.
2. Is$GF(12)$ a Galois field? Justify.
3. Show that $x^5 + x^3 + 1$ is irreducible over GF (2).
4. Using an example show that the intersection oftwo subspaces is also a subspace of a vector space.
5. Find the greatest common divisor of 25 and 60.
6. Define Mersenne primes.Are all Mersenne primesprimes? Justify.
7. Find the order of all elements in $G = \langle Z_{10}^*, \times \rangle$.
8. Test whether the number 561 pass the Miller – Rabin Test?
9. Let X and Y be two independent random variables with $Var(2X - Y) = 6$ and $Var(X + 2Y) = 9$. Find Var (X) and Var (Y).

10. Find the probability of exactly 3 heads out of 10 flips of a fair coin?

(10x3=30)

Part B

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

11. (a) Construct the ring $R_4 = GF(2)[x]/(x^3+1)$. Is R_4a field? **(7)**

    (b) In $GF(2^4)$, find the product of the Galois field numbers $1+\alpha+\alpha^3$ and $\alpha+\alpha^2$. **(7)**

OR

12. (a) Prove that the characteristic of a field must be either 0 or a prime number. **(7)**

    (b) The field GF (4) is a subfield of GF (256). Let α be primitive in GF (256). Find an element in GF(4) $\subset$ GF(256). **(7)**

13. (a) Determine whether each of the following polynomials in $GF(2)[x]$ is irreducible. If irreducible, determine if it is also primitive.
    (i) x^2+1 (ii) x^3+x+1. **(7)**

    (b) Find all conjugacy classes in $GF(2^4)$ with respect to GF (4). **(7)**

OR

14. (a) Check that $V = \left\{\binom{x}{y} : x, y \epsilon \mathbb{R}\right\}$ with the usual addition and scalar multiplication is a vector space. **(7)**

    (b) Find a basis for the dual space to the vector space spanned by $\{(1,1,1,0,0),(0,1,1,1,0),(0,0,1,1,1)\}$. **(7)**

15. (a) Given a = 161 and b = 28, find gcd (a, b) using Extended Euclidean Algorithm and also find the integers s and t such that $sa+tb = \gcd(a,b)$ **(7)**

    (b) Find the results of the following using Fermat's little theorem:
    (i) $5^{-1} \bmod 13$ (ii) $5^{15} \bmod 13$. **(7)**

OR

16. (a) Define Euler's totient function. What are the values of $\varphi(13), \varphi(240)$. Determine the number of elements in Z_{14}^*? **(7)**

(b) Find the results of the following using Euler's theorem: **(7)**
(i) $20^{62} \bmod 77$ (ii) $71^{-1} \bmod 100$.

17. (a) Use any primality test to determine whether any of the following integers are primes: 271, 3149, 9673. **(7)**

(b) Assume that there is a computer that can perform 2^{30} (almost 1 billion) bit operations per second. What is the approximation time required to factor an integer of size (i) 60 decimal digits? (ii) 100 decimal digits? (using Pollard rho method). **(7)**

OR

18. (a) State Chinese Remainder Theorem. Find the solution to the simultaneous equations: **(7)**

$$x \equiv 2 \, mod \, 3$$
$$x \equiv 3 \, mod \, 5$$
$$x \equiv 2 \, mod \, 7.$$

(b) Solve the following quadratic equations: **(7)**
(i) $x^2 \equiv 3(mod\ 23)$(ii) $x^2 \equiv 2(mod\ 11)$ (iii) $x^2 \equiv 7(mod\ 19)$.

19. (a) The probability mass function of a discrete random variable is $p(x) = kx, x = 1,2,3$, where 'k' is a positive constant. Find **(7)**
(i) the value of 'k' (ii) $P(X \leq 2)$ (iii) E[X] and (iv) Var (1 – X).

(b) Find the mean and variance of a binomial distribution. **(7)**

OR

20. (a) With a coin that has probability only $\frac{1}{10}$ of coming up heads, show that the probability is less than $\frac{1}{900}$ that in 10,000 flips the number of heads will be **(7)**

less than 2000.

(b) Determine the entropy of the random variable which counts the number of heads in flipping three fair coins. **(7)**

Teaching Plan

No	Contents	No. of Lecture Hours (45 hrs)
	Module-1(Algebraic Structures) (9 hours) **(Text 1: Relevant topics from sections 4.3, 4.4, 5.4, 5.5, 5.7)** **(Section 5.4.1 is excluded)**	
1.1	Rings – Definition.	1 hour
1.2	Rings of Polynomial	1 hour
1.3	Quotient Rings.	1 hour
1.4	Fields – Finite field	1 hour
1.5	Galois Field Construction	1 hour
1.6	Galois Field Construction – Illustration	1 hour
1.7	Applications in LFSR.	1 hour
1.8	Properties of Galois Fields.	1 hour
1.9	Subfields of Galois Fields.	1 hour
	Module-2(Linear Algebra)(11 hours) **(Text 1: Relevant topics from sections 5.8, 5.9, 2.4)**	
2.1	Irreducible Polynomials.	1 hour
2.2	Primitive Polynomials.	1 hour
2.3	Conjugate Elements.	1 hour
2.4	Minimal Polynomials.	1 hour
2.5	Vector space.	1 hour

2.6	Linear combination of the vectors, Spanning set for vector space.	1 hour
2.7	Row space, Column space.	1 hour
2.8	Linearly dependent and independent vectors, Basis.	1 hour
2.9	Vector subspace.	1 hour
2.10	Inner product.	1 hour
2.11	Orthogonality, dual space	1 hour
Module-3(Number Theory I) (9 hours) (Text 2: Relevant topics from sections 2.1, 2.2, 9.1)		
3.1	Divisibility, Greatest Common Divisor.	1 hour
3.2	Euclidean Algorithm.	1 hour
3.3	The Extended Euclidean Algorithm.	1 hour
3.4	Congruence, Residue Classes.	1 hour
3.5	Primes, Cardinality of Primes, Checking for Primeness.	1 hour
3.6	Euler's phi function	1 hour
3.7	Fermat's Little Theorem.	1 hour
3.8	Euler's Theorem.	1 hour
3.9	Generating Primes.	1 hour
Module-4 (Number Theory II) (8 hours) (Text 2: Relevant topics from sections 9.2, 9.3, 9.4, 9.5, 9.6)		
4.1	Fundamental Theorem of Arithmetic, Primality Testing – Fermat's Test, Divisibility Test.	1 hour
4.2	Miller – Rabin Test.	1 hour
4.3	Combination of Divisibility Test and Miller – RabinTest.	1 hour
4.4	Fermat method.	1 hour
4.5	Pollard p-1 method, Pollard rho method.	1 hour
4.6	The Chinese Remainder Theorem.	1 hour
4.7	Quadratic Congruence Modulo a Prime, Quadratic Congruence Modulo a	1 hour

	Composite.	
4.8	Order of an element, Primitive Roots.	1 hour
Module-5(Probability Theory)(8 hours) (Text 3: Relevant topics from sections 1.5, 1.6, 1.7, 2.2)		
5.1	Discrete random variable, Probability distributions, Expectation, Variance.	1 hour
5.2	Independent Random variables, Sum and Product of random Variables.	1 hour
5.3	Binomial distribution, Mean and Variance.	1 hour
5.4	Binomial distribution – Problems.	1 hour
5.5	Markov's inequality, Chebysheff's inequality.	1 hour
5.6	Law of Large Numbers.	1 hour
5.7	Entropy of a sample space, Joint entropy and conditional entropy.	1 hour
5.8	Entropy of a sample space – Problems.	1 hour

CST202	COMPUTER ORGANISATION AND ARCHITECTURE	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	3	1	0	4	2019

Preamble:

The course is prepared with the view of enabling the learners capable of understanding the fundamental architecture of a digital computer. Study of Computer Organization and Architecture is essential to understand the hardware behind the code and its execution at physical level by interacting with existing memory and I/O structure. It helps the learners to understand the fundamentals about computer system design so that they can extend the features of computer organization to detect and solve problems occurring in computer architecture.

Prerequisite : Topics covered under the course Logic System Design (CST 203)

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

CO#	CO
CO1	Recognize and express the relevance of basic components, I/O organization and pipelining schemes in a digital computer **(Cognitive knowledge: Understand)**
CO2	Explain the types of memory systems and mapping functions used in memory systems **(Cognitive Knowledge Level: Understand)**
CO3	Demonstrate the control signals required for the execution of a given instruction **(Cognitive Knowledge Level: Apply))**
CO4	Illustrate the design of Arithmetic Logic Unit and explain the usage of registers in it (**Cognitive Knowledge Level: Apply**)
CO5	Explain the implementation aspects of arithmetic algorithms in a digital computer **(Cognitive Knowledge Level:Apply)**
CO6	Develop the control logic for a given arithmetic problem (**Cognitive Knowledge Level: Apply**)

Mapping of course outcomes with program outcomes

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

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test1 (%)	Test2 (%)	
Remember	20	20	30
Understand	40	40	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

Basic Structure of computers – functional units - basic operational concepts - bus structures. Memory locations and addresses - memory operations,Instructions and instruction sequencing , addressing modes.

Basic processing unit – fundamental concepts – instruction cycle – execution of a complete instruction - single bus and multiple bus organization

Module 2

Register transfer logic: inter register transfer – arithmetic, logic and shift micro operations.

Processor logic design: - processor organization – Arithmetic logic unit - design of arithmetic circuit - design of logic circuit - Design of arithmetic logic unit - status register – design of shifter - processor unit – design of accumulator.

Module 3

Arithmetic algorithms: Algorithms for multiplication and division (restoring method) of binary numbers. Array multiplier , Booth's multiplication algorithm.

Pipelining: Basic principles**,** classification of pipeline processors, instruction and arithmetic pipelines (Design examples not required), hazard detection and resolution.

Module 4

Control Logic Design: Control organization – Hard_wired control-microprogram control – control of processor unit - Microprogram sequencer,micro programmed CPU organization - horizontal and vertical micro instructions.

Module 5

I/O organization: accessing of I/O devices – interrupts, interrupt hardware -Direct memory access.

Memory system: basic concepts – semiconductor RAMs. memory system considerations – ROMs, Content addressable memory, cache memories - mapping functions.

Text Books

1. Hamacher C., Z. Vranesic and S. Zaky, Computer Organization ,5/e, McGraw Hill, 2011
2. Mano M. M., Digital Logic & Computer Design, PHI, 2004
3. KaiHwang, Faye Alye Briggs, Computer architecture and parallel processing McGraw-Hill, 1984

Reference Books

1. Mano M. M., Digital Logic & Computer Design, 3/e, Pearson Education, 2013.
2. Patterson D.A. and J. L. Hennessy, Computer Organization and Design, 5/e, Morgan Kaufmann Publishers, 2013.
3. William Stallings, Computer Organization and Architecture: Designing for Performance, Pearson, 9/e, 2013.
4. Chaudhuri P., Computer Organization and Design, 2/e, Prentice Hall, 2008.
5. Rajaraman V. and T. Radhakrishnan, Computer Organization and Architecture, Prentice Hall, 2011

Sample Course Level Assessment Questions

Course Outcome1(CO1): Which are the registers involved in a memory access operation and how are they involved in it?

Course Outcome 2(CO2): Explain the steps taken by the system to handle a write miss condition inside the cache memory.

Course Outcome 3(CO3): Generate the sequence of control signals required for the execution of the instruction MOV [R1],R2 in a threebus organization.

Course Outcome 4(CO4): Design a 4-bit combinational logic shifter with 2 control signals H0 and H1 that perform the following operations :

H1	H0	Operation
0	0	Transfer 1's to all output line
0	1	No shift operation
1	0	Shift left
1	1	Shift right

Course Outcome 5(CO5): Explain the restoring algorithm for binary division. Also trace the algorithm to divide $(1001)_2$ by $(11)_2$

Course Outcome 6(CO6): Design a software control logic based on microprogramed control to perform the addition of 2 signed numbers represented in sign magnitude form.

Model Question Paper

QP CODE: PAGES:2

Reg No:_____

Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST 202

Course Name: Computer organisation and architecture

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

PART A

Answer all Questions. Each question carries 3 Marks

1. Give the significance of instruction cycle.
2. Distinguish between big endian and little endian notations. Also give the significance of these notations.
3. Compare I/O mapped I/O and memory mapped I/O.
4. Give the importance of interrupts in I/O interconnection.
5. Justify the significance of status register.
6. How does the arithmetic circuitry perform logical operations in an ALU.
7. Illustrate divide overflow with an example.
8. Write notes on arithmetic pipeline.
9. Briefly explain the role of micro program sequence.
10. Differentiate between horizontal and vertical micro instructions.

Part B

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

11.

11.(a) What is the significance of addressing modes in computer architecture.

(4)

11.(b) Write the control sequence for the instruction DIV R1,[R2] in a three bus structure.

(10)

OR

12. Explain the concept of a single bus organization with help of a diagram. Write the control sequence for the instruction ADD [R1],[R2].

(14)

13. Explain various register transfer logics.

(14)

OR

14.

14.(a) Design a 4 bit combinational logic shifter with 2 control signals H1 and H2 that perform the following operations (bit values given in parenthesis are the values of control variable H1 and H2 respectively.) : Transfer of 0's to S (00), shift right (01), shift left (10), no shift (11).

(5)

14.(b) Design an ALU unit which will perform arithmetic and logic operation with a given binary adder.

(9)

15.

15.(a) Give the logic used behind Booth's multiplication algorithm.

(4)

15.(b) Identify the appropriate algorithm available inside the system to perform the multiplication between -14 and -9. Also trace the algorithm for the above input.

(10)

OR

16.

16.(a) List and explain the different pipeline hazards and their possible solutions

(10)

16.(b) Design a combinational circuit for 3x2 multiplication. (4)

17. Design a hardwared control unit used to perform addition/subtraction of 2 numbers represented in sign magnitude form. (14)

OR

18. Give the structure of the micro program sequencer and its role in sequencing the micro instructions. (14)

19.

19.(a) Explain the different ways in which interrupt priority schemes can be implemented (10)

19.(b) Give the structure of SRAM cell. (4)

OR

20.

20.(a) Explain the various mapping functions available in cache memory. (9)

20.(b) Briefly explain content addressable memory. (5)

TEACHING PLAN		
No	**Contents**	**No of Lecture Hrs**
Module 1 : (Basic Structure of computers) (9 hours)		
1.1	Functional units,basic operational concepts,bus structures (introduction)	1
1.2	Memory locations and addresses , memory operations	1
1.3	Instructions and instruction sequencing	1
1.4	Addressing modes	1
1.5	Fundamental concepts of instruction execution, instruction cycle	1
1.6	Execution of a complete instruction - single bus organization (Lecture 1)	1
1.7	Execution of a complete instruction - single bus organization (Lecture 2)	1
1.8	Execution of a complete instruction - multiple bus organization (Lecture 1)	1
1.9	Execution of a complete instruction - multiple bus organization (Lecture 2)	1
Module 2 :(Register transfer logic and Processor logic design) (10 hours)		
2.1	Inter register transfer – arithmetic micro operations	1
2.2	Inter register transfer – logic and shift micro operations	1
2.3	Processor organization	1
2.4	Design of arithmetic circuit	1
2.5	Design of logic circuit	1
2.6	Design of arithmetic logic unit	1
2.7	Design of status register	1
2.8	Design of shifter - processor unit	1

2.9	Design of accumulator (Lecture 1)	1
2.10	Design of accumulator (Lecture 2)	1
Module 3 : (Arithmetic algorithms and Pipelining) (9 hours)		
3.1	Algorithm for multiplication of binary numbers	1
3.2	Algorithm for division (restoring method) of binary numbers	1
3.3	Array multiplier	1
3.4	Booth's multiplication algorithm	1
3.5	Pipelining: Basic principles	1
3.6	Classification of pipeline processors (Lecture 1)	1
3.7	Classification of pipeline processors (Lecture 2)	1
3.8	Instruction and arithmetic pipelines (Design examples not required)	1
3.9	Hazard detection and resolution	1
Module 4 :(Control Logic Design) (9 hours)		
4.1	Control organization –design of hardwired control logic (Lecture 1)	1
4.2	Control organization –design of hardwired control logic (Lecture 2)	1
4.3	Control organization –design of hardwired control logic (Lecture 3)	1
4.4	Design of microprogram control logic–control of processor unit (Lecture1)	1
4.5	Design of microprogram control logic–control of processor unit (Lecture2)	1
4.6	Design of microprogram control logic–control of processor unit (Lecture3)	1
4.7	Microprogram sequencer	1
4.8	Micro programmed CPU organization	1
4.9	Microinstructions –horizontal and vertical micro instructions	1
Module 5 : (Basic processing units, I/O and memory) (8 hours)		
5.1	Accessing of I/O devices –interrupts	1
5.2	Interrupt hardware	1

5.3	Direct memory access	1
5.4	Memory system: basic concepts –semiconductor RAMs	1
5.5	Memory system considerations – ROMs	1
5.6	Content addressable memory	1
5.7	Cache memories -mapping functions (Lecture 1)	1
5.8	Cache memories -mapping functions (Lecture 2)	1

CST 204	DATABASE MANAGEMENT SYSTEMS	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	3	1	0	4	2019

Preamble: This course provides a clear understanding of fundamental principles of Database Management Systems (DBMS) with special focus on relational databases to the learners. The topics covered in this course are basic concepts of DBMS, Entity Relationship (ER) model, Relational Database principles, Relational Algebra, Structured Query Language (SQL), Physical Data Organization, Normalization and Transaction Processing Concepts. The course also gives a glimpse of the alternative data management model, NoSQL. This course helps the learners to manage data efficiently by identifying suitable structures to maintain data assets of organizations and to develop applications that utilize database technologies.

Prerequisite: Topics covered under the course Data Structures (CST 201), Exposure to a High Level Language like C/python.

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

CO1	Summarize and exemplify fundamental nature and characteristics of database systems (**Cognitive Knowledge Level: Understand)**
CO2	Model real word scenarios given as informal descriptions, using Entity Relationship diagrams. **(Cognitive Knowledge Level: Apply**)
CO3	Model and design solutions for efficiently representing and querying data using relational model (**Cognitive Knowledge Level: Analyze**)
CO4	Demonstrate the features of indexing and hashing in database applications **(Cognitive Knowledge Level: Apply**)
CO5	Discuss and compare the aspects of Concurrency Control and Recovery in Database systems **(Cognitive Knowledge Level: Apply**)
CO6	Explain various types of NoSQL databases (**Cognitive Knowledge Level: Understand**)

Mapping of course outcomes with program outcomes

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

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

Assessment Pattern

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

Analyze			
Evaluate			
Create			

Mark Distribution

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

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

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

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing 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 & Entity Relationship (ER) Model

Concept & Overview of Database Management Systems (DBMS) - Characteristics of Database system, Database Users, structured, semi-structured and unstructured data. Data Models and Schema - Three Schema architecture. Database Languages, Database architectures and classification.

ER model - Basic concepts, entity set & attributes, notations, Relationships and constraints, cardinality, participation, notations, weak entities, relationships of degree 3.

Module 2: Relational Model

Structure of Relational Databases - Integrity Constraints, Synthesizing ER diagram to relational schema

Introduction to Relational Algebra - select, project, cartesian product operations, join - Equi-join, natural join. query examples, introduction to Structured Query Language (SQL), Data Definition Language (DDL), Table definitions and operations – CREATE, DROP, ALTER, INSERT, DELETE, UPDATE.

Module 3: SQL DML (Data Manipulation Language), Physical Data Organization

SQL DML (Data Manipulation Language) - SQL queries on single and multiple tables, Nested queries (correlated and non-correlated), Aggregation and grouping, Views, assertions, Triggers, SQL data types.

Physical Data Organization - Review of terms: physical and logical records, blocking factor, pinned and unpinned organization. Heap files, Indexing, Singe level indices, numerical examples, Multi-level-indices, numerical examples, B-Trees & B+-Trees (structure only, algorithms not required), Extendible Hashing, Indexing on multiple keys – grid files.

Module 4: Normalization

Different anomalies in designing a database, The idea of normalization, Functional dependency, Armstrong's Axioms (proofs not required), Closures and their computation, Equivalence of Functional Dependencies (FD), Minimal Cover (proofs not required). First Normal Form (1NF), Second Normal Form (2NF), Third Normal Form (3NF), Boyce Codd Normal Form (BCNF), Lossless join and dependency preserving decomposition, Algorithms for checking Lossless Join (LJ) and Dependency Preserving (DP) properties.

Module 5: Transactions, Concurrency and Recovery, Recent Topics

Transaction Processing Concepts - overview of concurrency control, Transaction Model, Significance of concurrency Control & Recovery, Transaction States, System Log, Desirable Properties of transactions.

Serial schedules, Concurrent and Serializable Schedules, Conflict equivalence and conflict serializability, Recoverable and cascade-less schedules, Locking, Two-phase locking and its variations. Log-based recovery, Deferred database modification, check-pointing.

Introduction to NoSQL Databases, Main characteristics of Key-value DB (examples from: Redis), Document DB (examples from: MongoDB)

Main characteristics of Column - Family DB (examples from: Cassandra) and Graph DB (examples from : ArangoDB)

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.

Reference Books:

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
3. Web Resource: https://www.w3resource.com/redis/
4. web Resource: https://www.w3schools.in/category/mongodb/
5. Web Resource: https://www.tutorialspoint.com/cassandra/cassandra_introduction.htm
6. Web Resource : https://www.tutorialspoint.com/arangodb/index.htm

Sample Course Level Assessment Questions

Course Outcome1 (CO1):

1. List out any three salient features of database systems, which distinguish it from a file system.
2. Give one example each for logical and physical data independence.

Course Outcome 2(CO2):

1. What facts about the relationships between entities EMPLOYEE and PROJECT are conveyed by the following ER diagram?

1. Design an ER diagram for the following scenario:
   There is a set of teams, each team has an ID (unique identifier), name, main stadium, and to which city this team belongs. Each team has many players, and each player belongs to one team. Each player has a number (unique identifier), name, DoB, start year, and shirt number that he uses. Teams play matches, in each match there is a host team and a guest team.

Course Outcome 3(CO3):

1. For the SQL query, SELECT *A, B FROM R WHERE B='apple' AND C = 'orange'* on the table R(A, B, C, D), where A is a key, write any three equivalent relational algebra expressions.
2. Given the FDs P→Q, P→R, QR→S, Q→T, QR→U, PR→U, write the sequence of *Armstrong's Axioms* needed to arrive at the following FDs: (a) P → T (b) PR → S (c) QR → SU
3. Consider a relation PLAYER (PLAYER-NO, PLAYER-NAME, PLAYER-POSN, TEAM, TEAM-COLOR, COACH-NO, COACH-NAME, TEAM-CAPTAIN). Assume that PLAYER-NO is the *only* key of the relation and that the following dependencies hold:

   TEAM→{TEAM-COLOR, COACH-NO, TEAM-CAPTAIN}
   COACH-NO→COACH-NAME.

   i. Is the relation in 2NF? If not, decompose to 2NF.
   ii. Is the relation in 3NF? If not, decompose to 3NF.

4. In the following tables foreign keys have the same name as primary keys except DIRECTED-BY, which refers to the primary key ARTIST-ID. Consider only *single-director* movies.
   MOVIES(MOVIE-ID, MNAME, GENRE, LENGTH, DIRECTED-BY)
   ARTIST(ARTIST-ID, ANAME)
   ACTING(ARTIST-ID, MOVIE-ID)
   Write SQL expressions for the following queries:
   (a) *Name(s) and director name(s) of movie(s) acted by 'Jenny'.*
   (b) *Names of actors who have never acted with 'Rony'*
   (c) *Count of movies genre-wise.*
   (d) *Name(s) of movies with maximum length.*

Course Outcome 4(CO4):

1. Consider an EMPLOYEE file with 10000 records where each record is of size 80 bytes. The file is sorted on employee number (15 bytes long), which is the primary key. Assuming un-spanned organization, block size of 512 bytes and block pointer size of 5 bytes. Compute the number of block accesses needed for retrieving an employee record based on employee number if (i) No index is used (ii) Multi-level primary index is used.

Course Outcome 5(CO5):

1. Determine if the following schedule is *recoverable*. Is the schedule *cascade-less*? Justify your answer. *r1(X), r2(Z), r1(Z), r3(X), r3(Y), w1(X), c1, w3(Y), c3, r2(Y), w2(Z), w2(Y), c2*. (*Note: ri(X)/wi(X)* means transaction *Ti* issues read/write on item X; *ci* means transaction *Ti* commits.)
2. Two-phase locking protocol ensures serializability. Justify.

Course Outcome 6(CO6):

1. List out any three salient features of NoSQL databases. Give example of a document in MongoDB.

Model Question paper

QPCODE

Reg No:_____

Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FOURTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST 204

Course Name: **Database Management Systems**

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

PART A

Answer all Questions. Each question carries 3 Marks

1 List out any three salient features of a database systems.

2 When is multi-valued composite attribute used in ER modelling?

3 For the SQL query, SELECT *A, B FROM R WHERE B='apple' AND C = 'orange'* on the table R(A, B, C, D), where A is a key, write any two equivalent relational algebra expressions.

4 Outline the concept of *theta*-join.

5 How is the purpose of *where* clause is different from that of having clause?

6 What is the use of a trigger?

7 When do you say that a relation is not in 1NF?

8 Given the FDs P→Q, P→R, QR→S, Q→T, QR→U, PR→U, write the sequence of Armstrong's Axioms needed to arrive at a. P → T b. PR → S

9 What is meant by the lost update problem?

10 What is meant by check pointing?

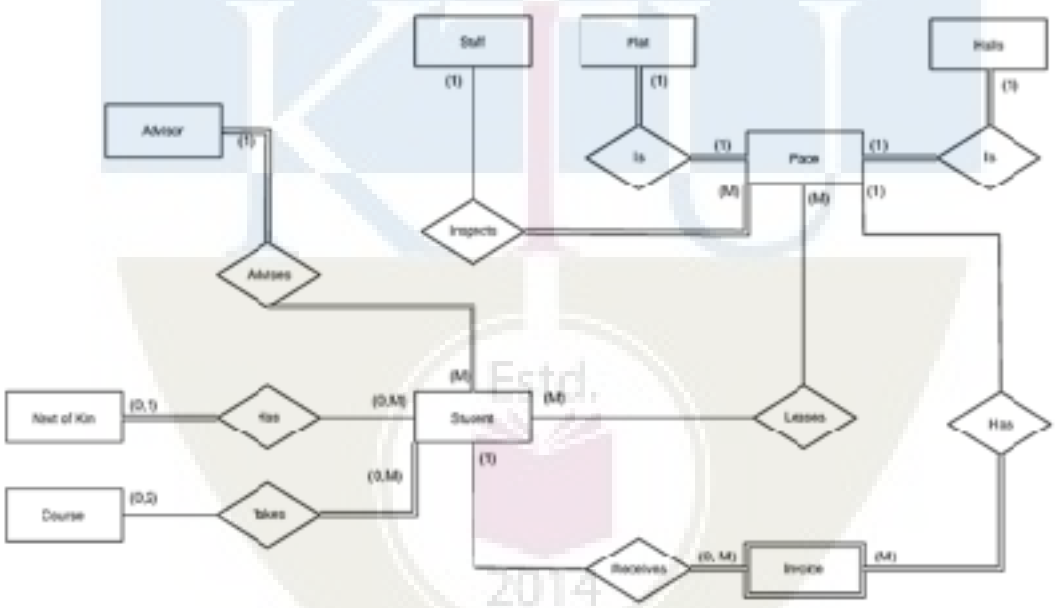
PART B

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

11 a. Design an ER diagram for the following scenario: There is a set of teams, each team has an ID (unique identifier), name, main stadium, and to which city this team belongs. Each team has many players, and each player belongs to one team. Each player has a number (unique identifier), name, DoB, start year, and shirt number that he uses. Teams play matches, in each match there is a host team and a guest team. The match takes place in the stadium of the host team. For each match we need to keep track of the following: The date on which the game is played The final result of the match. The players participated in the match. For each player, how many goals he scored, whether or not he took yellow card, and whether or not he took red card. During the match, one player may substitute another player. We want to capture this substitution and the time at which it took place. Each match has exactly three referees. For each referee we have an ID (unique identifier), name, DoB, years of experience. One referee is the main referee and the other two are assistant referee. (14)

OR

12 a. Interpret the the following ER diagram. (8)



b. Distinguish between physical data independence and logical data independence with suitable examples. (6)

13 **EMPLOYEE(ENO, NAME, ADDRESS, DOB, AGE, GENDER, SALARY, DNUM, SUPERENO)**
DEPARTMENT(DNO, DNAME, DLOCATION, DPHONE, MGRENO)
PROJECT(PNO, PNAME, PLOCATION, PCOST, CDNO) (14)

DNUM is a foreign key that identifies the department to which an employee belongs. MGRENO is a foreign key identifying the employee who manages the department. CDNO is a foreign key identifying the department that controls the project. SUPERENO is a foreign key identifying the supervisor of each employee.

Write relational algebra expressions for the following queries:-

(a) Names of female employees whose salary is more than 20000.
(b) Salaries of employee from 'Accounts' department
(c) Names of employees along with his/her superviser's name
(d) For each employee return name of the employee along with his department name and the names of projects in which he/she works
(e) Names of employees working in all the departments

OR

14 a. Write SQL DDL statements for the the following (Assume suitable domain types): (10)

i. Create the tables STUDENT(ROLLNO, NAME, CLASS, SEM, ADVISER), FACULTY(FID, NAME, SALARY, DEPT). Assume that ADVISER is a foreign key referring FACUTY table.

ii. Delete department with name 'CS' and all employees of the department.

iii. Increment salary of every faculty by 10%.

b. Illustrate foreign key constraint with a typical example. (4)

15 For the relation schema below, give an expression in SQL for each of the queries that follows: (14)

employee(<u>employee-name</u>, street, city)
works(<u>employee-name, company-name</u>, salary)
company(<u>company-name</u>, city)
manages(<u>employee-name, manager-name</u>)

a) Find the names, street address, and cities of residence for all employees who work for the Company 'RIL Inc.' and earn more than $10,000.
b) Find the names of all employees who live in the same cities as the companies for which they work.
c) Find the names of all employees who do not work for 'KYS Inc.'. Assume that all people work for exactly one company.
d) Find the names of all employees who earn more than every employee of 'SB Corporation'. Assume that all people work for at most one company.
e) List out number of employees company-wise in the decreasing order of number of employees.

OR

16 a. Consider an EMPLOYEE file with 10000 records where each record is of size 80 bytes. The file is sorted on employee number (15 bytes long), which is the primary key. Assuming un-spanned organization and block size of 512 bytes compute the number of block accesses needed for selecting records based on employee number if, (9)

i. No index is used
ii. Single level primary index is used
iii. Multi-level primary index is used

Assume a block pointer size of 6 bytes.

b. Illustrate correlated and non-correlated nested queries with real examples. (5)

17 a. Illstrate3NF and BCNF with suitable real examples. (6)

b. Given a relation R(A1,A2,A3,A4,A5) with functional dependencies A1→A2A4 and A4→A5, check if the decomposition R1(A1,A2,A3), R2(A1,A4), R3(A2,A4,A5) is lossless. (8)

OR

18 a. Consider the un-normalized relation R(A, B, C, D, E, F, G) with the FDs A→B , AC→G, AD→EF, EF→G, CDE→AB. Trace the normalization process to reach 3NF relations. (7)

b. Illustrate Lossless Join Decomposition and Dependency Preserving Decomposition with typical examples. (7)

19 a. Discuss the four ACID properties and their importance. (7)

b. Determine if the following schedule is conflict serializable. Is the schedule recoverable? Is the schedule cascade-less? Justify your answers. (7)

r1(X), r2(Z), r1(Z), r3(X), r3(Y), w1(X), c1, w3(Y), c3, r2(Y), w2(Z), w2(Y), c2

(Note: ri(X)/wi(X) means transaction Ti issues read/write on item X; ci means transaction Ti commits.)

OR

20 a. Discuss the main characteristics of Key-value DB and Graph DB. (7)

b. Illustrate two-phase locking with a schedule containing three transactions. Argue that 2PL ensures serializability. Also argue that 2Pl can lead to deadlock. (7)

Teaching Plan

	Course Name	Hours (48)
	Module 1: Introduction & ER Model	**8**
1.1	Concept & Overview of DBMS, Characteristics of DB system, Database Users.	1
1.2	Structured, semi-structured and unstructured data. Data Models and Schema	1
1.3	Three-Schema-architecture. Database Languages	1
1.4	Database architectures and classification	1
1.5	ER model: basic concepts, entity set & attributes, notations	1
1.6	Relationships and constraints – cardinality, participation, notations	1
1.7	Weak entities, relationships of degree 3	1
1.8	ER diagram – exercises	1
	Module 2: Relational Model	**7**
2.1	Structure of relational Databases, Integrity Constraints	1
2.2	Synthesizing ER diagram to relational schema, Introduction to relational algebra.	1
2.3	Relational algebra: select, project, Cartesian product operations	1
2.4	Relational Algebra: join - Equi-join, Natural join	1
2.5	Query examples	1
2.6	Introduction to SQL, important data types	1
2.7	DDL, Table definitions and operations – CREATE, DROP, ALTER, INSERT, DELETE, UPDATE	1
	Module 3: SQL DML, Physical Data Organization	**11**
3.1	SQL DML, SQL queries on single and multiple tables	1
3.2	Nested queries (correlated and non-correlated)	1
3.3	Aggregation and grouping	1

	Course Name	Hours (48)
3.4	Views, assertions (with examples)	1
3.5	Triggers (with examples), SQL data types	1
3.6	Review of terms: physical and logical records, blocking factor, pinned and unpinned organization. Heap files, Indexing	1
3.7	Singe level indices, numerical examples	1
3.8	Multi-level-indices, numerical examples	1
3.9	B-Trees and B+Trees (structure only, algorithms not required)	1
3.10	Extendible Hashing	1
3.11	Indexing on multiple keys – grid files	1
	Module 4: Normalization	**8**
4.1	Different anomalies in designing a database, The idea of normalization	1
4.2	Functional dependency, Armstrong's Axioms (proofs not required)	1
4.3	Closures and their computation, Equivalence of FDs, minimal Cover (proofs not required).	1
4.4	1NF, 2NF	1
4.5	3NF, BCNF	1
4.6	Lossless join and dependency preserving decomposition	1
4.7	Algorithms for checking Lossless Join and Dependency preserving properties (Lecture 1)	1
4.8	Algorithms for checking Lossless Join and Dependency preserving properties (Lecture 2)	1
	Module 5: Transactions, Concurrency and Recovery, Recent Topics	**14**
5.1	Transaction Processing Concepts: Transaction Model	1
5.2	Overview of concurrency control, Significance of concurrency Control & Recovery	1
5.3	Transaction States, System Log	1

	Course Name	Hours (48)
5.4	Desirable Properties of transactions, Serial schedules	1
5.5	Concurrent and Serializable Schedules	1
5.6	Conflict equivalence and conflict serializability	1
5.7	Recoverable and cascade-less schedules	1
5.8	Locking, Two-phase locking, strict 2PL.	1
5.9	Log-based recovery	1
5.10	Deferred database modification (serial schedule), example	1
5.11	Deferred database modification (concurrent schedule) example, check-pointing	1
5.12	Introduction to NoSQL Databases	1
5.13	Main characteristics of Key-value DB (examples from: Redis), Document DB (examples from: MongoDB) [detailed study not expected]	1
5.14	Main characteristics of Column-Family DB (examples from: Cassandra) and Graph DB (examples from : ArangoDB) [detailed study not expected]	1

CST 206	OPERATING SYSTEMS	Category	L	T	P	Credit	Year of Introduction
		PCC	3	1	0	4	2019

Preamble: Study of operating system is an essential to understand the overall working of computer system, tradeoffs between performance and functionality and the division of jobs between hardware and software. This course introduces the concepts of memory management, device management, process management, file management and security & protection mechanisms available in an operating system. The course helps the learner to understand the fundamentals about any operating system design so that they can extend the features of operating system to detect and solve many problems occurring in operating system and to manage the computer resources appropriately.

Prerequisite: Topics covered in the courses are **Data Structures (CST 201)** and **Programming in C (EST 102)**

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

CO1	Explain the relevance, structure and functions of Operating Systems in computing devices. (**Cognitive knowledge: Understand**)
CO2	Illustrate the concepts of process management and process scheduling mechanisms employed in Operating Systems. (**Cognitive knowledge: Understand**)
CO3	Explain process synchronization in Operating Systems and illustrate process synchronization mechanisms using Mutex Locks, Semaphores and Monitors (**Cognitive knowledge: Understand**)
CO4	Explain any one method for detection, prevention, avoidance and recovery for managing deadlocks in Operating Systems. (**Cognitive knowledge: Understand**)
CO5	Explain the memory management algorithms in Operating Systems. (**Cognitive knowledge: Understand**)
CO6	Explain the security aspects and algorithms for file and storage management in Operating Systems. **(Cognitive knowledge: Understand)**

Mapping of course outcomes with program outcomes

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

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

Assessment Pattern

Bloom's Category	Test 1 (Marks in percentage)	Test 2 (Marks in percentage)	End Semester Examination (Marks in 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

Continuous Internal Evaluation Pattern:
Attendance : 10 marks
Continuous Assessment Test : 25 marks
Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

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

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

Syllabus

Module I

Introduction: Operating system overview – Operations, Functions, Service – System calls, Types – Operating System structure - Simple structure, Layered approach, Microkernel, Modules – System boot process.

Module II

Processes - Process states, Process control block, threads, scheduling, Operations on processes - process creation and termination – Inter-process communication - shared memory systems, Message passing systems.

Process Scheduling – Basic concepts- Scheduling criteria -scheduling algorithms- First come First Served, Shortest Job Firs, Priority scheduling, Round robin scheduling

Module III

Process synchronization- Race conditions – Critical section problem – Peterson's solution, Synchronization hardware, Mutex Locks, Semaphores, Monitors – Synchronization problems - Producer Consumer, Dining Philosophers and Readers-Writers.

Deadlocks: Necessary conditions, Resource allocation graphs, Deadlock prevention, Deadlock avoidance – Banker's algorithms, Deadlock detection, Recovery from deadlock.

Module IV

Memory Management: Concept of address spaces, Swapping, Contiguous memory allocation, fixed and variable partitions, Segmentation, Paging. Virtual memory, Demand paging, Page replacement algorithms.

Module V

File System: File concept - Attributes, Operations, types, structure – Access methods, Protection. File-system implementation, Directory implementation. Allocation methods.
Storage Management: Magnetic disks, Solid-state disks, Disk Structure, Disk scheduling, Disk formatting.

Text Book

Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, ' Operating System Concepts' 9th Edition, Wiley India 2015.

Reference Books:

1. Andrew S Tanenbaum, "Modern Operating Systems" , 4th Edition, Prentice Hall, 2015.
2. William Stallings, "Operating systems", 6th Edition, Pearson, Global Edition, 2015.
3. Garry Nutt, Nabendu Chaki, Sarmistha Neogy, "Operating Systems", 3rd Edition, Pearson Education.
4. D.M.Dhamdhere, "Operating Systems", 2nd Edition, Tata McGraw Hill, 2011.
5. Sibsankar Haldar, Alex A Aravind, "Operating Systems", Pearson Education.

Sample Course Level Assessment Questions

Course Outcome1 (CO1): What is the main advantage of the micro kernel approach to system design? How do user program and system program interact in a microkernel architecture?

Course Outcome 2 (CO2): Define process. With the help of a neat diagram explain different states of process.

Course Outcome 3 (CO3): What do you mean by binary semaphore and counting semaphore? With C, explain implementation of wait () and signal().

Course Outcome 4 (CO4): Describe resource allocation graph for the following. a) with a deadlock b) with a cycle but no deadlock.

Course Outcome 5 (CO5): Consider the following page reference string 1, 2, 3, 4, 2, 1, 5, 6, 2, 1, 2, 3, 7, 6, 3, 2, 1, 2, 3, 6. Find out the number of page faults if there are 4 page frames, using the following page replacement algorithms. i) LRU ii) FIFO iii) Optimal

Course Outcome 6 (CO6): Explain the different file allocation methods with advantages and disadvantages.

Model Question Paper

QP CODE: PAGES: ___

Reg No:_____
Name:_____

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

Course Code: CST 206

Course name : OPERATING SYSTEMS

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

PART-A

(Answer All Questions. Each question carries 3 marks)

1. How does hardware find the Operating System kernel after system switch-on?
2. What is the purpose of system call in operating system?
3. Why is context switching considered as an overhead to the system?

4. How is inter process communication implement using shared memory?

5. Describe resource allocation graph for the following.

   a) with a deadlock b)with a cycle but no deadlock.

6. What is critical section? What requirement should be satisfied by a solution to the critical section problem?

7. Consider the reference string 1, 2, 3, 4, 2, 1, 5, 6, 2, 1, 2, 3, 7, 6, 3, 2, 1, 2, 3, 6. How many page faults occur while using FCFS for the following cases.

   a) frame=2 b)frame=3

8. Differentiate between internal and external fragmentations.

9. Compare sequential access and direct access methods of storage devices.

10. Define the terms (i) Disk bandwidth (ii) Seek time.

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

11. a) Explain the following structures of operating system (i) Monolithic systems (ii) Layered Systems (iii) Micro Kernel (iv) Modular approach. **(12)**

    b) Under what circumstances would a user be better of using a time sharing system than a PC or a single user workstation? **(2)**

OR

12. a) What is the main advantage of the micro kernel approach to system design? How do user program and system program interact in a microkernel architecture? **(8)**

    b) Describe the differences between symmetric and asymmetric multiprocessing? What are the advantages and disadvantages of multiprocessor systems? **(6)**

13. a) Define process. With the help of a neat diagram explain different states of process. **(8)**

    b) Explain how a new process can be created in Unix using fork system call. **(6)**

OR

14 a) Find the average waiting time and average turnaround time for the processes given in the table below using:- i) SRT scheduling algorithm ii) Priority scheduling algorithm **(9)**

Process	Arrival Time (ms)	CPU Burst Time (ms)	Priority
P1	0	5	3
P2	2	4	1
P3	3	1	2
P4	5	2	4

b) What is a Process Control Block? Explain the fields used in a Process Control Block. **(5)**

15. Consider a system with five processes P_0 through P_4 and three resources of type A, B, C. Resource type A has 10 instances, B has 5 instances and C has 7 instances. Suppose at time t_0 following snapshot of the system has been taken:

Process	Allocation	Max	Available
	A B C	A B C	A B C
P_0	0 1 0	7 5 3	3 3 2
P_1	2 0 0	3 2 2	
P_2	3 0 2	9 0 2	
P_3	2 1 1	2 2 2	
P_4	0 0 2	4 3 3	

i) What will be the content of the Need matrix? Is the system in a safe state? If Yes, then what is the safe sequence? **(8)**

iii)What will happen if process P_1 requests one additional instance of resource type A and two instances of resource type C? **(6)**

OR

16. a) State dining philosopher's problem and give a solution using semaphores. **(7)**

b) What do you mean by binary semaphore and counting semaphore? With C struct, explain implementation of wait () and signal() **(7)**

17. a) Consider the following page reference string 1, 2, 3, 4, 2, 1, 5, 6, 2, 1, 2, 3, 7, 6, 3, 2, 1, 2, 3, 6. Find out the number of page faults if there are 4 page frames, using the following page replacement algorithms i) LRU ii) FIFO iii) Optimal **(9)**

b) Explain the steps involved in handling a page fault. **(5)**

OR

18. a) With a diagram, explain how paging is done with TLB. **(5)**

b) Memory partitions of sizes 100 kb, 500 kb, 200 kb, 300 kb, 600 kb are available, how would best ,worst and first fit algorithms place processes of size 212 kb, 417 kb, 112 kb, 426 kb in order. Rank the algorithms in terms of how efficiently they uses memory. **(9)**

19. a) Suppose that a disk drive has 5000 cylinders, numbered 0 to 4999. the drive currently services a request at cylinder 143, and the previous request was at cylinder 125. the queue of pending request in FIFO order is 86, 1470, 913, 1774, 948, 1509, 1022, 1750, 130. Starting from the current position, what is the total distance (in cylinders) that the disk arm moves to satisfy all pending requests for each of the following algorithms

i) FCFS ii) SSFT iii) SCAN iv) LOOK v) C-SCAN **(10)**

b) What is the use of access matrix in protection mechanism? **(4)**

OR

20. a) Explain the different file allocation operations with advantages and disadvantages. **(8)**

b) Explain the following i) file types ii) file operation iii) file attributes **(6)**

Teaching Plan

	Module 1 - Introduction	**5 Hours**
1.1	Introduction to Operating System	1
1.2	Operating System operations, functions, service	1
1.3	System calls, Types	1
1.4	Operating System Structure: Simple, Layered, Microkernel, Modules	1
1.5	System Boot Process	1
	Module 2 – Processes and Process Scheduling	**9 Hours**
2.1	Processes, Process states	1
2.2	Process Control Block, Threads	1

2.3	Scheduling	1
2.4	Operations on processes: process creation and termination	1
2.5	Inter-process communication: Shared memory systems, Message Passing	1
2.6	Process Scheduling – Basic concepts, Scheduling Criteria	1
2.7	Scheduling algorithms - Basics	1
2.8	First come First Served, Shortest Job First	1
2.9	Priority scheduling, Round Robin Scheduling	1
	Module 3 - Process synchronization and Dead locks	**13 Hours**
3.1	Process synchronization, Race conditions	1
3.2	Critical Section problem, Peterson's solution	1
3.3	Synchronization hardware, Mutex Locks	1
3.4	Semaphores	1
3.5	Monitors	1
3.6	Synchronization problem examples (Lecture 1)	1
3.7	Synchronization problem examples (Lecture 2)	1
3.8	Deadlocks: Necessary conditions, Resource Allocation Graphs	1
3.9	Deadlock prevention	1
3.10	Deadlock avoidance	1
3.11	Banker's algorithm	1
3.12	Deadlock detection	1
3.13	Deadlock recovery	1
	Module 4 - Memory Management	**9 Hours**
4.1	Memory Management: Concept of Address spaces	1
4.2	Swapping	1
4.3	Contiguous memory allocation, fixed and variable partitions	1
4.4	Segmentation.	1
4.5	Paging (Lecture 1)	1
4.6	Paging (Lecture 2)	1
4.7	Virtual memory, Demand Paging	1

4.8	Page replacement algorithms (Lecture 1)	1
4.9	Page replacement algorithms (Lecture 2)	1
	Module 5 - File and Disk management	**9 Hours**
5.1	File concept, Attributes, Operations, types, structure	1
5.2	Access methods	1
5.3	Protection	1
5.4	File-System implementation	1
5.5	Directory implementation	1
5.6	Allocation methods	1
5.7	Magnetic disks, Solid-state disks, Disk structure	1
5.8	Disk scheduling	1
5.9	Disk formatting	1

CCL202	SCRIPTING LANGUAGES FOR SECURITY	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	0	0	3	2	2020

Preamble: The course aims to offer hands-on experience for learners in Python programming and Shell Scripting for security implementations. It covers basic shell commands, shell scripting, python programming constructs and its use in security applications. The course helps the learners to get practical exposure on security related issues and its solutions.

Prerequisite: Basic concepts in any Programming Language

Course Outcomes:

At the end of the course, the student should be able to

CO1	Develop simple applications and file operations in shell script (**Cognitive Knowledge Level: Apply**)
CO2	Illustrate the use of shell scripting in security applications (**Cognitive Knowledge Level: Apply**)
CO3	Implement control structures, iterations, string operations and recursive functions in Python (**Cognitive Knowledge Level: Apply**)
CO4	Implement security operations on files using python (**Cognitive Knowledge Level: Apply**)
CO5	Develop security related programs using python libraries(**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) Mark in Percentage**	**End Semester Examination Mark 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**	**3hours**

Continuous Internal Evaluation Pattern:

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

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

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

Operating System to Use in Lab :Unix/Linux

Compiler/Software to Use in Lab : Bash Shell / Python

Interpreter Language to Use in Lab : Shell Script / Python

Fair Lab Record:

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

SYLLABUS

Shell Scripting

Programs using Basic Linux Shell Commands : Interactive shell script, Positional parameters, Arithmetic operators, Logical operators, Selection and Iterative Control statements, Meta characters

Programs using Basic Unix Shell Commands: Creation of class directory, User file creation, User log history, Script escalation, Hash for files, Denial of Execution.

Python

Variables, Expressions Decision making, Branching, Conditional statements, Iterative statements.

Function: Function calls, Math functions,Parameters and arguments, Adding new functions, Recursion

Files: Operations, Access Privileges

MD5 Hash, Primality Testing: Miller-Rabin Method, Pseudo Random number Generation, Packet Capture

PRACTICAL QUESTIONS IN SHELL SCRIPTING

1. Write a shell script to create a file in $USER/class/batch directory
2. Write a shell script to display the list of files in a directory?
3. Write shell script for showing the count of users logged in.
4. Write a shell script to print file names in directory showing date of creation & serial number of file.
5. Write a shell script to count lines, words & characters in its input.(do not use wc)
6. Write a shell script to print end of a Glossary file in reverse order using array.
7. Write a shell script to check whether a user has logged in, continue checking further after every 30 seconds till success.
8. Write a shell script to check access to root and stop escalation to root from another script.
9. Write a shell script to test file integrity. Create hash for files and check changes.
10. Write a shell script to check access from users other than in white list
11. Write a shell script to check any shell script running.
12. Write a shell script to deny exec right to another program.

PRACTICAL QUESTIONS IN PYTHON

(Implement minimum of 6 experiments from Part B)

PART A

1. Write a program to print the factors of a given number.
2. Write a program to check whether a given number is prime or not
3. Write a program to check whether a number is palindrome or not
4. Write a Python program to read a list of numbers and sort the list in a non-decreasing order without using any built-in functions. Separate function should be written to sort the list where in the name of the list is passed as the parameter.
5. Find the factorial of a given Natural Number ***n*** using recursive functions.

PART B

6. Write a program to check the complexity of a password.
7. Write a program to implement Primality testing using Miller-Rabin Method
8. Write a program to implement MD5 hash
9. Write a program to search for deleted files in python
10. Write a program to check for presence of dark web.
11. Write a program to implement privilege escalation and evasion
12. Write a Key logger / key logger detection tool program using python
13. Write a program to detect access from invalid IP address using packet capture.
14. Write a program to implement pseudo random number generation
15. Write a program to list images, pdf in a file given.

Micro Project: Students are expected to do a micro project preferably related to the security aspects(Python).

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CCL204	OS AND DBMS LAB	CATEGORY	L	T	P	CREDITS
		PCC	0	0	3	2

Preamble: The course aims to offer students a hands-on experience on Operating System concepts and Database design.This course helps the learners to get practical exposure on Process synchronization, CPU scheduling, deadlock, memory allocation, memory management, database creation, SQL queries creation and PL/SQL. The course enables the students to develop real world application involving OS and Database constructs.

Prerequisite: A sound knowledge of the basics of relational DBMS and Operating Systems.

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

CO1	Implement Process Creation, Inter Process Communication and CPU Scheduling algorithms in Operating Systems. **(Cognitive knowledge: Apply)**
CO2	Illustrate the performance of First In First Out, Least Recently Used and Least Frequently Used Page Replacement Algorithms.
C03	Implement modules for Deadlock Detection and Deadlock Avoidance in Operating Systems. **(Cognitive knowledge: Apply)**
C04	Construct queries using SQL for database creation, interaction, modification, and updation. **(Cognitive Knowledge Level: Apply)**
CO5	Implement procedures, functions, and control structures using PL/SQL. **(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) 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 marks will be distributed as Algorithm 30 marks, 20 marks for program, 20 marks for output and 30 marks for viva. In DBMS experiments, marks will be distributed as Schema/Form Design/Queries 50 marks, 20 marks for output, and 30 marks for viva. Total 100 marks which will be converted out of 15 while calculating Internal Evaluation marks.

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

Operating System to Use in Lab : Linux/Windows
Compiler/Software to Use in Lab : gcc
Progamming Language to Use in Lab : Ansi C
DBMS software: Oracle, MySQL
Front end Tool: Java

Fair Lab Record:

All Students attending the OS AND 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.

In the case Operating System experiments, the right hand page also contains aim, algorithm and output. The left hand page should contain a print out of the code used for experiment and sample output obtained for a set of input.

In the case of DBMS Lab, the right hand page also contains 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

Operating System

1. Implement programs for Inter Process Communication using Shared Memory.
2. Implement Semaphores.
3. Implementation of CPU scheduling algorithms. a) Round Robin b) SJF c) FCFS d)Priority
4. Implementation of the Memory Allocation Methods for fixed partition.
   i. First Fit b) Worst Fit c) Best Fit
5. Implement page replacement algorithms a) FIFO b) LRU c) LFU
6. Implement the Banker's algorithm for deadlock avoidance.
7. Implementation of Deadlock detection algorithm.

Database Management System

8. Creation, modification, configuration, and deletion of databases using UI and SQL Commands.
9. DDL and DML commands -(insertion, updating, set constraints, altering, deletion of data, and viewing/querying records based on condition in databases) .
10. Implementation of built-in functions in RDBMS .
11. Implementation of Order By, Group By & Having clause .
12. Implementation of various control structures like IF-THEN, IF-THEN-ELSE, IF-THEN-ELSIF, CASE, WHILE using PL/SQL .
13. Implementation of set operators nested queries, and join queries

14. Design a database application using any front end tool for any problem selected. The application constructed should have five or more tables.

OS AND DBMS LAB-PRACTICE QUESTIONS
(Minimum six experiments from Operating Systems)

1. Given the list of processes, their CPU burst times and arrival times, print the Gantt chart for FCFS and SJF. For each of the scheduling policies, compute and print the average waiting time and average turnaround time
2. Write a C program to simulate following non-pre-emptive CPU scheduling algorithms tofind turnaround time and waiting time.
   a) FCFS b) SJF c) Round Robin (pre-emptive) d) Priority
3. Write a C program to simulate following contiguous memory allocation techniques
   a) Worst-fit b) Best-fit c) First-fit
4. Write a C program to simulate paging technique of memory management.
5. Write a C program to simulate Bankers algorithm for the purpose of deadlock avoidance.
6. Write a C program to simulate disk scheduling algorithms a) FCFS b) SCAN c) C-SCAN
7. Write a C program to simulate page replacement algorithms a) FIFO b) LRU c) LFU
8. Write a C program to simulate producer-consumer problem using semaphores.
9. Write a C program to simulate algorithm for deadlock prevention.
10. Creation of a database using DDL commands and write DQL queries to retrieve information from the database.
11. Performing DML commands like Insertion, Deletion, Modifying, Altering, and Updating records based on conditions.
12. Creating a database to set various constraints.
13. Practice of SQL TCL commands like Rollback, Commit, Savepoint.
14. Creation of Views and Assertions
15. Implementation of Built-in functions in RDBMS
16. Implementation of various aggregate functions in SQL
17. Implementation of Order By, Group By& Having clause.
18. Implementation of set operators, nested queries and Join queries
19. Implementation of various control structures using PL/SQL
20. Mini project (Application Development using Oracle/ MySQL using Database connectivity like)
    a. Hospital Management System.
    b. Railway Reservation System.
    c. Personal Information System.
    d. Web Based User Identification System.
    e. Timetable Management System.
    f. Hotel Management System.

SEMESTER IV

HONOURS

CCT292	SECURE MOBILE APPLICATION DEVELOPMENT	CATEGORY	L	T	P	CREDITS
		VAC	3	1	0	4

Preamble: This course helps the learners to make awareness about strong theoretical concept in the development of mobile applications and its challenges. It covers the concepts of Mobile App and Mobile Interface, key concepts of Android, 2D graphics and multimedia in Android, User interface design, SQLite database, mobile embedded system architecture and mobile cloud. This course enables the learners to develop the ability to create Android based applications for different domains.

Prerequisite: A sound knowledge in Java.

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

CO#	CO
CO1	Describe the concepts, security challenges in mobile system and mobile applications **(Cognitive Knowledge level: Understand)**
CO2	Implement 2D graphics, Graphical User Interface and incorporate multimedia in Android applications **(Cognitive Knowledge level: Apply)**
CO3	Explain the concepts of general and Android based mobile embedded systems and its application, processor technology and scheduling algorithms**(Cognitive Knowledge level: Understand)**
CO4	Illustrate the storage of data from mobile applications to a mobile device **(Cognitive Knowledge level: Apply)**
CO5	Describe the techniques employed in mobile cloud**(Cognitive Knowledge level: Understand)**

Mapping of course outcomes with program outcomes

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

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

Assessment Pattern

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

Mark Distribution

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

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

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

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern:

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

End Semester Examination Pattern:

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

SYLLABUS

Module – 1(Overview of Mobile App and Mobile Interface)

Mobile Systems. Mobile Interface and Applications - Optimizations in Mobile Systems, Mobile Embedded System. Mobile Cloud - Big Data Application in Mobile Systems, Data Security and Privacy Protection in Mobile Systems, Concept of Mobile Apps, Brief Introduction of Android and its Framework. Installation and creation of Android application. Introduction to Key Concepts of Android- App Components, App Resources, App Manifest.

Module - 2(2D Graphics and Multimedia in Android)

Introduction to 2-D Graphics Techniques. Advanced UI Design. Overview of Multimedia in Android. Audio Implementation in Android. Executing Video in Android.

Module - 3 (Mobile Embedded System Architecture)

Embedded Systems. Scheduling algorithms – FCFS, SJF, Multiprocessors, Priority scheduling, As-Soon-As-Possible(ASAP) and As-Late-As-Possible(ALAP). Memory Technology. Mobile Embedded systems. Messaging and Communication mechanisms.

Module - 4 (Data storage and SQLite Operations)

Local Data - Internal and External Storage, Save a File on Internal Storage, Save a File on External Storage, Delete a File, Query the Space. SQLite Database - Table Structure, CRUD Operations, Usage of SQLite Techniques. Content Provider.

Module - 5 (Mobile Cloud Computing in Mobile Applications Deployment)

Concepts of mobile cloud computing - Technological Structure, Differences between Cloud Computing and Mobile Cloud, Mobile Computing, Wireless LAN, Wireless, WAN and Cellular

networks. Main techniques of mobile cloud computing – Virtualization, Parallel Programming Model, Mass Distributed Storage. Mobile Cloud Computing Architecture.

Text Books

1. Meikang Qiu, Wenyun Dai, and Keke Gai, Mobile Applications Development with Android Technologies and Algorithms, Taylor and Francis, 2017

References

1) Corinne Hoisington, Android Boot Camp for Developers using JavaTM, Comprehensive: A Beginner's Guide to Creating Your First Android Apps, 3e,2017
2) James C. Sheusi, Android Application Development for Java, 2013

Course Level Assessment Questions

Course Outcome 1 (CO1):

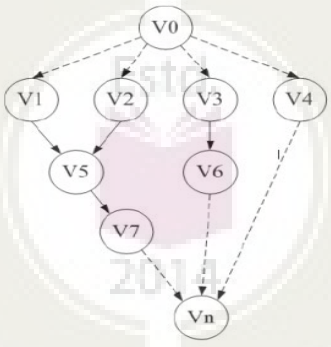
1. Explain the process of producing an Android app in mobile.
2. Illustrate the importance of look and feel of on screen system in mobile applications.

Course Outcome 2 (CO2):

1. Implement an Android project named "Rock-Paper-Scissors" Game (Programming Assignment). The basic function may cover the following aspects:
   a. Basic UI of this Android Project
   b. Basic functions of this Android Project

Course Outcome 3 (CO3):

1. Consider the figure given below and use the ASAP and ALAP algorithms to analyze them, and draw charts to explain them.



A DAG G-(V, E, D) and
d1=d2=d3=d4=d5=d6=d7=1; d0=dn=0

2. Consider that there are six jobs with different completion times and arrival times, as shown in below. Use the FCFS scheduling algorithm to schedule these jobs. You can draw a chart to answer this question.

Jobs	Arrival Time	Processing Time
j1	0.0	7
j2	2.0	4
j3	3.0	1
j4	5.0	4
j5	6.0	5
j6	8.0	3

Course Outcome 4 (CO4):

1. Implement the CRUD operations possible in SQLite in an Android application (Programming Assignment).
2. Illustrate data sharing concepts among multiple applications in Android.

Course Outcome 5 (CO5):

1. Explain mobile cloud computing architecture with proper illustrations.
2. Compare any five wireless network types with respect to various possible parameters.

Model Question Paper

QP CODE:

Reg No: _____

Name: _____ **PAGES : 4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FOURTH SEMESTER B.TECH DEGREE(HONOURS) EXAMINATION, MONTH & YEAR

Course Code: CCT292

Course Name: Secure Mobile Application Development

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

PART A

Answer All Questions. Each Question Carries 3 Marks

1. List any three constraints in a mobile system.
2. Differentiate between an App and Application.
3. List three key functions of *Action bar* design element of Android.
4. Mention four basic properties of a well designed Custom view.
5. Give three reasons that justify the importance of Embedded system in Mobile applications.
6. What are the key metrics used to measure the memory performance of an Embedded system?

7. Specify common methods for reading and writing data provided by the *Context* class?

8. Write an Android code snippet to get the current available space and total space in the internal storage

9. Specify two main workload migrations of implementing mobile cloud computing.

10. Define cloud mass storage.

(10x3=30)

Part B

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

11. (a) Explain the process of developing an Android App. **(5)**

    (b) Describe the structure of Android system architecture. **(9)**

OR

12. (a) Explain the need of data security and privacy protection in mobile systems. **(7)**

    (b) Describe the main structure of mobile cloud computing and their challenges. **(7)**

13. (a) Describe different types of drawables supported by Android. **(7)**

    (b) Explain the life cycle of a Media player with a state diagram. **(7)**

OR

14. (a) Explain the steps involved in developing a program to execute a video in Android application. **(9)**

    (b) Explain persistent application data storage in Android. **(5)**

15. (a) Illustrate ASAP and ALAP scheduling algorithms. **(10)**

    (b) List five criteria that should be considered for developing a scheduling algorithm **(4)**

OR

16. (a) Illustrate the working of the kernel inside the Android. **(7)**

(b) Explain various Android message mechanisms. **(7)**

17. (a) Explain how a file can be saved in internal storage and external storage in an Android application. **(10)**

(b) Describe the mechanism used in Android to delete a file. **(4)**

OR

18. (a) Illustrate the CRUD operations possible in SQLite. **(8)**

(b) Explain how data sharing is achieved among multiple applications in Android. **(6)**

19. (a) Differentiate between mobile cloud and cloud computing with proper illustrations. **(4)**

(b) Compare any five wireless network types in terms of type, performance and coverage capability. **(10)**

OR

20. (a) Differentiate between Wimax and Wifi. **(4)**

(b) Describe three schemas in mobile cloud computing architecture. **(10)**

TEACHING PLAN

No	Contents	No of Lecture Hrs (45 Hours)
Module – 1 (Overview of Mobile App and Mobile Interface) (10 hrs)		
1.1	Mobile Systems. Mobile Interface And Applications- Optimizations in Mobile Systems, Mobile Embedded System.	1
1.2	Mobile Cloud- Big Data Application in Mobile Systems, Data Security and Privacy Protection in Mobile Systems	1
1.3	Concept of Mobile Apps, Brief Introduction of Android	1
1.4	Android Device distribution	1
1.5	Android SDK	1
1.6	Installation and creation of Android application	1

1.7	Introduction to Key Concepts of Android- App Components, App Resources	1
1.8	Introduction to App Manifest	1
1.9	Illustration of App Manifest	1
1.10	Illustration of App Manifest	1
Module - 2 (2D graphics techniques and Multimedia in Android) (10 hrs)		
2.1	Introduction of 2D graphics techniques	1
2.2	Illustration of usage of graphics tool to draw the screen	1
2.3	Illustration of usage of graphics tool to draw the screen	1
2.4	Advanced UI design-Multiple screens	1
2.5	Advanced UI design-Action bar and Custom view	1
2.6	Developing UI design of an Android system	1
2.7	Overview of multimedia in Android	1
2.8	Audio implementation in Android	1
2.9	Executing video in Android	1
2.10	Developing program to execute multimedia in Android	1
Module - 3 (Mobile Embedded System Architecture) (10 hrs)		
3.1	Embedded system Overview, Introduction to scheduling algorithm	1
3.2	FCFS,SJF	1
3.3	Multiprocessor scheduling algorithm, priority scheduling	1
3.4	As Soon As Possible(ASAP)	1
3.5	As Late As Possible(ALAP)	1
3.6	Embedded system in Mobile devices	1
3.7	Embedded Systems in Android	1
3.8	Power Management of Android	1
3.9	Embedded Systems in Mobile Apps	1
3.10	Messaging and Communication Mechanisms	1
Module - 4 (Data storage and SQLite Operations (9 hrs)		
4.1	Local Data - Internal and External Storage-Save a file	1
4.2	Local Data - Delete file, Query the space	1
4.3	SQLite Database - Table Structure	1
4.4	SQLite Database - CRUD Operations	1
4.5	Illustration of CRUD Operations in SQLite Database	1
4.6	Usage of SQLite Techniques	1
4.7	Illustration of the usage of SQLite Techniques	1

4.8	Content Provider	1
4.9	Content Provider	1
Module - 5 (Mobile Cloud Computing in Mobile Applications Deployment)(6 hrs)		
5.1	Introduction of mobile cloud computing - Technological Structure, Differences between Cloud Computing and Mobile Cloud	1
5.2	Concepts of mobile cloud computing and mobile computing	1
5.3	Wireless LAN, Wireless WAN and Cellular networks	1
5.4	Main techniques of mobile cloud computing – Virtualization	1
5.5	Parallel Programming Model, Mass Distributed Storage	1
5.6	Mobile Cloud Computing Architecture	1

CODE CST294	COMPUTATIONAL FUNDAMENTALS FOR MACHINE LEARNING	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: This is the foundational course for awarding B. Tech. Honours in Computer Science and Engineering with specialization in ***Machine Learning***. The purpose of this course is to introduce mathematical foundations of basic Machine Learning concepts among learners, on which Machine Learning systems are built. This course covers Linear Algebra, Vector Calculus, Probability and Distributions, Optimization and Machine Learning problems. Concepts in this course help the learners to understand the mathematical principles in Machine Learning and aid in the creation of new Machine Learning solutions, understand & debug existing ones, and learn about the inherent assumptions & limitations of the current methodologies.

Prerequisite: A sound background in higher secondary school Mathematics.

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

CO 1	Make use of the concepts, rules and results about linear equations, matrix algebra, vector spaces, eigenvalues & eigenvectors and orthogonality & diagonalization to solve computational problems (Cognitive Knowledge Level: **Apply**)
CO 2	Perform calculus operations on functions of several variables and matrices, including partial derivatives and gradients (Cognitive Knowledge Level: **Apply**)
CO 3	Utilize the concepts, rules and results about probability, random variables, additive & multiplicative rules, conditional probability, probability distributions and Bayes' theorem to find solutions of computational problems (Cognitive Knowledge Level: **Apply**)
CO 4	Train Machine Learning Models using unconstrained and constrained optimization methods (Cognitive Knowledge Level: **Apply**)
CO 5	Illustrate how the mathematical objects - linear algebra, probability, and calculus can be used to design machine learning algorithms (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	PO 10	PO 11	PO 12
CO 1	√	√	√	√								√
CO 2	√	√	√									√
CO 3	√	√	√	√								√
CO 4	√	√	√	√		√						√
CO 5	√	√	√	√	√	√				√		√

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

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	20%	20%	20%
Understand	40%	40%	40%
Apply	40%	40%	40%
Analyse			
Evaluate			
Create			

Mark Distribution

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

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

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

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

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

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

Syllabus

Module 1

LINEAR ALGEBRA : Systems of Linear Equations – Matrices, Solving Systems of Linear Equations. Vector Spaces - Linear Independence, Basis and Rank, Linear Mappings, Norms, - Inner Products - Lengths and Distances - Angles and Orthogonality - Orthonormal Basis - Orthogonal Complement - Orthogonal Projections. Matrix Decompositions - Determinant and Trace, Eigenvalues and Eigenvectors, Cholesky Decomposition, Eigen decomposition and Diagonalization, Singular Value Decomposition, Matrix Approximation.

Module 2

VECTOR CALCULUS : Differentiation of Univariate Functions - Partial Differentiation and Gradients, Gradients of Vector Valued Functions, Gradients of Matrices, Useful Identities for Computing Gradients. Back propagation and Automatic Differentiation - Higher Order Derivatives- Linearization and Multivariate Taylor Series.

Module 3

Probability and Distributions : Construction of a Probability Space - Discrete and Continuous Probabilities, Sum Rule, Product Rule, and Bayes' Theorem. Summary Statistics and Independence – Important Probability distributions - Conjugacy and the Exponential Family - Change of Variables/Inverse Transform.

Module 4

Optimization : Optimization Using Gradient Descent - Gradient Descent With Momentum, Stochastic Gradient Descent. Constrained Optimization and Lagrange Multipliers - Convex Optimization - Linear Programming - Quadratic Programming.

Module 5

CENTRAL MACHINE LEARNING PROBLEMS : Data and Learning Model- Empirical Risk Minimization - Parameter Estimation - Directed Graphical Models.

Linear Regression - Bayesian Linear Regression - Maximum Likelihood as Orthogonal Projection.

Dimensionality Reduction with Principal Component Analysis - Maximum Variance Perspective, Projection Perspective. Eigenvector Computation and Low Rank Approximations.

Density Estimation with Gaussian Mixture Models - Gaussian Mixture Model, Parameter Learning via Maximum Likelihood, EM Algorithm.

Classification with Support Vector Machines - Separating Hyperplanes, Primal Support Vector Machine, Dual Support Vector Machine, Kernels.

Text book:

1.Mathematics for Machine Learning by Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong published by Cambridge University Press (freely available at https:// mml - book.github.io)

Reference books:

1. Linear Algebra and Its Applications, 4th Edition by Gilbert Strang

2. Linear Algebra Done Right by Axler, Sheldon, 2015 published by Springer

3. Introduction to Applied Linear Algebra by Stephen Boyd and Lieven Vandenberghe, 2018 published by Cambridge University Press

4. Convex Optimization by Stephen Boyd and Lieven Vandenberghe, 2004 published by Cambridge University Press

5. Pattern Recognition and Machine Learning by Christopher M Bishop, 2006, published by Springer

6. Learning with Kernels – Support Vector Machines, Regularization, Optimization, and Beyond by Bernhard Scholkopf and Smola, Alexander J Smola, 2002, bublished by MIT Press

7. Information Theory, Inference, and Learning Algorithms by David J. C MacKay, 2003 published by Cambridge University Press

8. Machine Learning: A Probabilistic Perspective by Kevin P Murphy, 2012 published by MIT Press.

9. The Nature of Statistical Learning Theory by Vladimir N Vapnik, 2000, published by Springer

Sample Course Level Assessment Questions.

Course Outcome 1 (CO1):

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

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

2. Determine the inverses of the following matrix if possible

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

3. Are the following sets of vectors linearly independent?

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

4. A set of ***n*** linearly independent vectors in R^n forms a basis. Does the set of vectors **(2, 4,−3)** , **(0, 1, 1)** , **(0, 1,−1**) form a basis for R^3? Explain your reasons.
5. Consider the transformation ***T (x, y) = (x + y, x + 2y, 2x + 3y)***. Obtain ***ker T*** and use this to calculate the nullity. Also find the transformation matrix for ***T***.

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

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

7. Diagonalize the following matrix, if possible

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

8. Find the singular value decomposition (SVD) of the following matrix

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

Course Outcome 2 (CO2):

1. For a scalar function $f(x, y, z) = x^2 + 3y^2 + 2z^2$, find the gradient and its magnitude at the point **(1, 2, -1)**.
2. Find the maximum and minimum values of the function $f(x, y) = 4x + 4y - x^2 - y^2$ subject to the condition $x^2 + y^2 <= 2$.
3. Suppose you were trying to minimize $f(x, y) = x^2 + 2y + 2y^2$. Along what vector should you travel from (5, 12)?
4. Find the second order Taylor series expansion for $f(x, y) = (x + y)^2$ about **(0 , 0)**.
5. Find the critical points of $f(x, y) = x^2 - 3xy + 5x - 2y + 6y^2 + 8$.
6. Compute the gradient of the Rectified Linear Unit (ReLU) function $ReLU(z) = max(0 , z)$.
7. Let $L = ||Ax - b||^2_2$, where A is a matrix and x and b are vectors. Derive dL in terms of dx.

Course Outcome 3 (CO3):

1. Let ***J*** and ***T*** be independent events, where ***P(J)=0.4*** and ***P(T)=0.7***.
   - ***i.*** Find ***P(J∩T)***
   - ***ii.*** Find ***P(J∪T)***
   - ***iii.*** Find ***P(J∩T')***
2. Let ***A*** and ***B*** be events such that ***P(A)=0.45*** , ***P(B)=0.35*** and ***P(A∪B)=0.5***. Find ***P(A|B)***.
3. A random variable **R** has the probability distribution as shown in the following table:

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

   i. Given that ***E(R)=2.85***, find ***a*** and ***b***.

   ii. Find ***P(R>2)***.

4. A biased coin (with probability of obtaining a head equal to $p > 0$) is tossed repeatedly and independently until the first head is observed. Compute the probability that the first head appears at an even numbered toss.
5. Two players A and B are competing at a trivia quiz game involving a series of questions. On any individual question, the probabilities that A and B give the correct answer are ***p*** and ***q*** respectively, for all questions, with outcomes for different questions being independent. The game finishes when a player wins by answering a question correctly. Compute the probability that A wins if

   i. A answers the first question,

   ii. B answers the first question.

6. A coin for which ***P(heads) = p*** is tossed until two successive tails are obtained. Find the probability that the experiment is completed on the n^{th} toss.
7. You roll a fair dice twice. Let the random variable ***X*** be the product of the outcomes of the two rolls. What is the probability mass function of ***X***? What are the expected value and the standard deviation of ***X***?

8. While watching a game of Cricket, you observe someone who is clearly supporting Mumbai Indians. What is the probability that they were actually born within 25KM of Mumbai? Assume that:
    - the probability that a randomly selected person is born within 25KM of Mumbai is 1/20;
    - the chance that a person born within 25KMs of Mumbai actually supports MI is 7/10 ;
    - the probability that a person not born within 25KM of Mumbai supports MI with probability 1/10.
9. What is an exponential family? Why are exponential families useful?
10. Let Z_1 and Z_2 be independent random variables each having the standard normal distribution. Define the random variables X and Y by $X = Z_1 + 3Z_2$ and $Y = Z_1 + Z_2$. Argue that the joint distribution of (X, Y) is a bivariate normal distribution. What are the parameters of this distribution?
11. Given a continuous random variable x, with cumulative distribution function $F_x(x)$, show that the random variable $y = F_x(x)$ is uniformly distributed.
12. Explain Normal distribution, Binomial distribution and Poisson distribution in the exponential family form.

Course Outcome 4(CO4):

1. Find the extrema of $f(x, y) = x$ subject to $g(x, y) = x^2 + 2y^2 = 3$.
2. Maximize the function $f(x, y, z) = xy + yz + xz$ on the unit sphere $g(x, y, z) = x^2 + y^2 + z^2 = 1$.
3. Provide necessary and suffcient conditions under which a quadratic optimization problem be written as a linear least squares problem.
4. Consider the univariate function $f(x) = x^3 + 6x^2 - 3x - 5$. Find its stationary points and indicate whether they are maximum, minimum, or saddle points.
5. Consider the update equation for stochastic gradient descent. Write down the update when we use a mini-batch size of one.

6. Consider the function

$$f(x) = (x_1 - x_2)^2 + \frac{1}{1 + x_1^2 + x_2^2}.$$

   i. Is ***f(x)*** a convex function? Justify your answer.

   ii. Is (1 , -1) a local/global minimum? Justify your answer.

7. Is the function ***f(x, y) = 2x² + y² + 6xy - x + 3y - 7*** convex, concave, or neither? Justify your answer.

8. Consider the following convex optimization problem

$$\text{minimize } \frac{x^2}{2} + x + 4y^2 - 2y$$

   Subject to the constraint ***x + y >= 4, x, y >= 1***.

   Derive an explicit form of the Lagrangian dual problem.

9. Solve the following LP problem with the simplex method.

$$max\ 5x_1 + 6x_2 + 9x_3 + 8x_4$$

   subject to the constraints

$$\begin{aligned} x_1 + 2x_2 + 3x_3 + x_4 &\leq 5 \\ x_1 + x_2 + 2x_3 + 3x_4 &\leq 3 \\ x_1, x_2, x_3, x_4 &\geq 0 \end{aligned}$$

Course Outcome 5 (CO5):

1. What is a loss function? Give examples.
2. What are training/validation/test sets? What is cross-validation? Name one or two examples of cross-validation methods.
3. Explain generalization, overfitting, model selection, kernel trick, Bayesian learning

4. Distinguish between Maximum Likelihood Estimation (MLE) and Maximum A Posteriori Estimation (MAP)?
5. What is the link between structural risk minimization and regularization?
6. What is a kernel? What is a dot product? Give examples of kernels that are valid dot products.
7. What is ridge regression? How can one train a ridge regression linear model?
8. What is Principal Component Analysis (PCA)? Which eigen value indicates the direction of largest variance? In what sense is the representation obtained from a projection onto the eigen directions corresponding the the largest eigen values optimal for data reconstruction?
9. 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? Explain your answer in one sentence.
10. Suppose you have n independent and identically distributed (i.i.d) sample data points $x_1, \ldots, x_n$. These data points come from a distribution where the probability of a given datapoint x is

$$P(x) = \frac{1}{\theta} e^{-\frac{1}{\theta}x}.$$

    Prove that the MLE estimate of parameter is the sample mean.
11. Suppose the data set $y_1,\ldots,y_n$ is a drawn from a random sample consisting of i.i.d. discrete uniform distributions with range 1 to N. Find the maximum likelihood estimate of N.
12. Ram has two coins: one fair coin and one biased coin which lands heads with probability 3/4. He picks one coin at random (50-50) and flips it repeatedly until he gets a tails. Given that he observes 3 heads before the first tails, find the posterior probability that he picked each coin.
    i. What are the prior and posterior odds for the fair coin?
    ii. What are the prior and posterior predictive probabilities of heads on the next flip? Here prior predictive means prior to considering the data of the first four flips.

Model Question paper

QP Code : **Total Pages: 4**

Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

IV SEMESTER B.TECH (HONOURS) DEGREE EXAMINATION, MONTH and YEAR

Course Code: CST 294

Course Name: COMPUTATIONAL FUNDAMENTALS FOR MACHINE LEARNING

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks. Marks

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

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

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

3 Let $f(x, y, z) = xye^r$, where $r = x^2+z^2-5$. Calculate the gradient of f at the point **(1, 3, -2)**.

4 Compute the Taylor polynomials $T_n, n = 0, \ldots, 5$ of $f(x) = sin(x) + cos(x)$ at $x_0 = 0$.

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

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

7 Explain the principle of the gradient descent algorithm.

8 Briey explain the difference between (batch) gradient descent and stochastic gradient descent. Give an example of when you might prefer one over the other.

9 What is the empirical risk? What is “empirical risk minimization”?

10 Explain the concept of a Kernel function in Support Vector Machines. Why are kernels so useful? What properties a kernel should posses to be used in an SVM?

PART B

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

11 a) i. Find all solutions to the system of linear equations (6)

$$-4x + 5z = -2$$
$$-3x - 3y + 5z = 3$$
$$-x + 2y + 2z = -1$$

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

b) Use the Gramm-Schmidt process to find an orthogonal basis for the column space of the following matrix (8)

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

OR

12 a) i. Let L be the line through the origin in R^2 that is parallel to the vector (6)

$[3, 4]^T$. Find the standard matrix of the orthogonal projection onto L. Also find the point on L which is closest to the point **(7 , 1)** and find the point on L which is closest to the point ***(-3 , 5)***.

ii. Find the rank-1 approximation of

$$\begin{bmatrix} 3 & 2 & 2 \\ 2 & 3 & -2 \end{bmatrix}$$

b) i. Find an orthonormal basis of R^3 consisting of eigenvectors for the following matrix (8)

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

ii. Find a 3 × 3 orthogonal matrix S and a 3 × 3 diagonal matrix D such that $A = SDS^T$.

13 a) A skier is on a mountain with equation $z = 100 - 0.4x^2 - 0.3y^2$, where z denotes height. (8)

i. The skier is located at the point with xy-coordinates **(1 , 1)**, and wants to ski downhill along the steepest possible path. In which direction (indicated by a vector **(a , b)** in the xy-plane) should the skier begin skiing.

ii. The skier begins skiing in the direction given by the xy-vector **(a , b)** you found in part (i), so the skier heads in a direction in space given by the vector **(a , b , c)**. Find the value of **c**.

b) Find the linear approximation to the function $f(x,y) = 2 - \sin(-x - 3y)$ at the point **(0 , π)**, and then use your answer to estimate $f(0.001 , \pi)$. (6)

OR

14 a) Let ***g*** be the function given by (8)

$$g(x,y) = \begin{cases} \dfrac{x^2 y}{x^2+y^2} & \text{if } (x,y) \neq (0,0); \\ 0 & \text{if } (x,y) = (0,0). \end{cases}$$

i. Calculate the partial derivatives of ***g*** at **(0 , 0)**.

ii. Show that ***g*** is not differentiable at **(0 , 0)**.

b) Find the second order Taylor series expansion for $f(x,y) = e^{-(x^2+y^2)} \cos(xy)$ about **(0 , 0)**. (6)

15 a) There are two bags. The first bag contains four mangos and two apples; the second bag contains four mangos and four apples. We also have a biased coin, which shows "heads" with probability 0.6 and "tails" with probability 0.4. If the coin shows "heads". we pick a fruit at random from bag 1; otherwise we pick a fruit at random from bag 2. Your friend flips the coin (you cannot see the result), picks a fruit at random from the corresponding bag, and presents you a mango. What is the probability that the mango was picked from bag 2? (6)

b) Suppose that one has written a computer program that sometimes compiles and sometimes not (code does not change). You decide to model the apparent stochasticity (success vs. no success) ***x*** of the compiler using a Bernoulli distribution with parameter μ: (8)

$$p(x \mid \mu) = \mu^x (1-\mu)^{1-x}, \quad x \in \{0,1\}$$

Choose a conjugate prior for the Bernoulli likelihood and compute the posterior distribution $p(\mu \mid x_1, \ldots, x_N)$.

OR

16 a) Consider a mixture of two Gaussian distributions (8)

$$0.4\mathcal{N}\left(\begin{bmatrix}10\\2\end{bmatrix}, \begin{bmatrix}1 & 0\\0 & 1\end{bmatrix}\right) + 0.6\mathcal{N}\left(\begin{bmatrix}0\\0\end{bmatrix}, \begin{bmatrix}8.4 & 2.0\\2.0 & 1.7\end{bmatrix}\right)$$

i. Compute the marginal distributions for each dimension.

ii. Compute the mean, mode and median for each marginal distribution.

iii. Compute the mean and mode for the two-dimensional distribution.

b) Express the Binomial distribution as an exponential family distribution. Also express the Beta distribution is an exponential family distribution. Show that the product of the Beta and the Binomial distribution is also a member of the exponential family. (6)

17 a) Find the extrema of $f(x,y,z) = x - y + z$ subject to $g(x,y,z) = x^2 + y^2 + z^2 = 2$. (8)

b) Let

$$P = \begin{bmatrix} 13 & 12 & -2 \\ 12 & 17 & 6 \\ -2 & 6 & 12 \end{bmatrix}, \; q = \begin{bmatrix} -22.0 \\ -14.5 \\ 13.0 \end{bmatrix}, \; \text{and} \; \; r = 1.$$

Show that $x^* = (1 , 1/2 , -1)$ is optimal for the optimization problem

$$\begin{array}{ll} \min & \frac{1}{2}x^T P x + q^T x + r \\ \text{s.t.} & -1 \leq x_i \leq 1, \; i = 1, 2, 3. \end{array}$$

(6)

OR

18 a) Derive the gradient descent training rule assuming that the target function is represented as $o_d = w_0 + w_1x_1 + \ldots + w_nx_n$. Define explicitly the 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. (8)

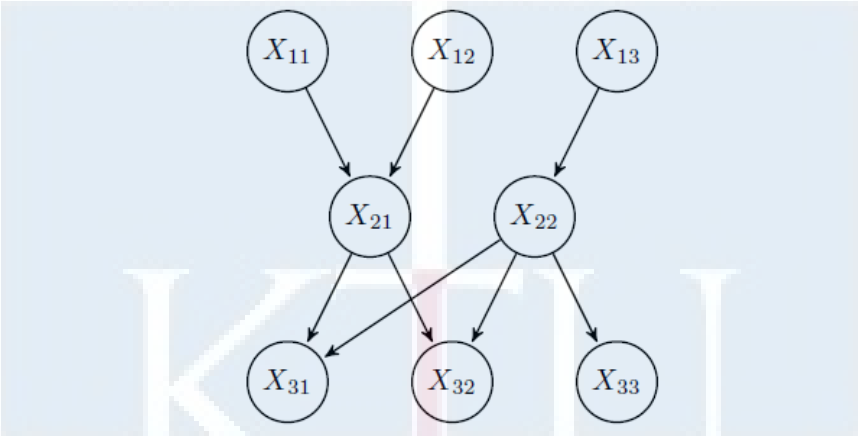
b) Find the maximum value of $f(x,y,z) = xyz$ given that $g(x,y,z) = x + y + z = 3$ and $x,y,z >= 0$. (6)

19 a) Consider the following probability distribution (7)

$$P_\theta(x) = 2\theta x e^{-\theta x^2}$$

where θ is a parameter and x is a positive real number. Suppose you get m i.i.d. samples x_i drawn from this distribution. Compute the maximum likelihood estimator for θ based on these samples.

b) Consider the following Bayesian network with boolean variables. (7)



i. List variable(s) conditionally independent of X_{33} given X_{11} and X_{12}

ii. List variable(s) conditionally independent of X_{33} and X_{22}

iii. Write the joint probability $P(X_{11}, X_{12}, X_{13}, X_{21}, X_{22}, X_{31}, X_{32}, X_{33})$ factored according to the Bayes net. How many parameters are necessary to define the conditional probability distributions for this Bayesian network?

iv. Write an expression for $P(X_{13} = 0, X_{22} = 1, X_{33} = 0)$ in terms of the conditional probability distributions given in your answer to part (iii). Justify your answer.

OR

20 a) 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 below. Suppose a SVM is used to classify this data. (6)

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

i. Indicate which are the support vectors and mark the decision boundary.

ii. Give the value of the cost function and the model parameter after training.

b) Suppose that we are fitting a Gaussian mixture model for data items consisting of a single real value, x, using $K = 2$ components. We have $N = 5$ training cases, in which the values of x are as **5, 15, 25, 30, 40**. Using the EM algorithm to find the maximum likeihood estimates for the model parameters, what are the mixing proportions for the two components, π_1 and π_2, and the means for the two components, μ_1 and μ_2. The standard deviations for the two components are fixed at 10. (8)

Suppose that at some point in the EM algorithm, the **E** step found that the responsibilities of the two components for the five data items were as follows:

r_{i1}	r_{i2}
0.2	0.8
0.2	0.8
0.8	0.2
0.9	0.1
0.9	0.1

What values for the parameters π_1, π_2 , μ_1, and μ_2 will be found in the next **M** step of the algorithm?

****

Teaching Plan		
No	**Topic**	**No. of Lectures (45)**
1	**Module-I (LINEAR ALGEBRA)**	**8**
1.	Systems of Linear Equations – Matrices, Solving Systems of Linear Equations. Vector Spaces - Linear Independence.	1
2.	Vector Spaces - Basis and Rank	1
3.	Linear Mappings	1
4.	Norms, Inner Products, Lengths and Distances, Angles and Orthogonality, Orthonormal Basis, Orthogonal Complement	1
5.	Orthogonal Projections, Matrix Decompositions, Determinant and Trace.	1
6.	Eigenvalues and Eigenvectors	1
7.	Cholesky Decomposition, Eigen decomposition and Diagonalization	1
8.	Singular Value Decomposition - Matrix Approximation	1
	Module-II (VECTOR CALCULUS)	**6**
1	Differentiation of Univariate Functions, Partial Differentiation and Gradients	1
2	Gradients of Vector Valued Functions, Gradients of Matrices	1
3	Useful Identities for Computing Gradients	1
4	Backpropagation and Automatic Differentiation	1
5	Higher Order Derivatives	1
6	Linearization and Multivariate Taylor Series	1
3	**Module-III (Probability and Distributions)**	**10**
1	Construction of a Probability Space - Discrete and Continuous Probabilities (Lecture 1)	1

2	Construction of a Probability Space - Discrete and Continuous Probabilities (Lecture 2)	1
3	Sum Rule, Product Rule	1
4	Bayes' Theorem	1
5	Summary Statistics and Independence	1
6	Important probability Distributions (Lecture 1)	1
7	Important probability Distributions (Lecture 2)	1
8	Conjugacy and the Exponential Family (Lecture 1)	1
9	Conjugacy and the Exponential Family (Lecture 2)	1
10	Change of Variables/Inverse Transform	1
4	**Module-IV (Optimization)**	**7**
1	Optimization Using Gradient Descent.	1
2	Gradient Descent With Momentum, Stochastic Gradient Descent	1
3	Constrained Optimization and Lagrange Multipliers (Lecture 1)	1
4	Constrained Optimization and Lagrange Multipliers (Lecture 2)	1
5	Convex Optimization	1
6.	Linear Programming	1
7.	Quadratic Programming	1
5	**Module-V (CENTRAL MACHINE LEARNING PROBLEMS)**	**14**
1.	Data and Learning models - Empirical Risk Minimization,	1
2.	Parameter Estimation	1
3.	Directed Graphical Models	1
4.	Linear Regression	1
5.	Bayesian Linear Regression	1
6.	Maximum Likelihood as Orthogonal Projection	1
7.	Dimensionality Reduction with Principal Component Analysis - Maximum Variance Perspective, Projection Perspective.	1
8.	Eigenvector Computation and Low Rank Approximations	1
9.	Density Estimation with Gaussian Mixture Models	1

10.	Parameter Learning via Maximum Likelihood	1
11.	EM Algorithm	1
12.	Classification with Support Vector Machines - Separating Hyperplanes	1
13.	Primal Support Vector Machines, Dual Support Vector Machines	1
14.	Kernels	1
*Assignments may include applications of the above theory. With respect to module V, programming assignments may be given.		

ADT296	ADVANCED TOPICS IN COMPUTER GRAPHICS	CATEGORY	L	T	P	CREDITS
		VAC	3	1	0	4

Preamble: This course helps the learners to make awareness about strong theoretical concept in computer graphics. It covers the three-dimensional environment representation in a computer, transformation of 2D/3D objects, basic mathematical techniques and algorithms used to build useful applications. This course enables the learners to develop the ability to create image processing frameworks for different domains and develops algorithms for emerging display technologies.

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

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

CO#	CO
CO1	Describe the working principles of graphics devices**(Cognitive Knowledge level: Understand)**
CO2	Illustrate line drawing, circle drawing and polygon filling algorithms**(Cognitive Knowledge level: Apply)**
CO3	Demonstrate geometric representations and transformations on 2D & 3D objects. **(Cognitive Knowledge level: Apply)**
CO4	Demonstrate the working of various clipping algorithms and projection algorithms. **(Cognitive Knowledge level: Apply)**
CO5	Summarize visible surface detection methods**(Cognitive Knowledge level: Understand)**
CO6	Explain the concept of realism in a scene and its performance preservation**(Cognitive Knowledge level: Understand)**

Mapping of course outcomes with program outcomes

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

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

Assessment Pattern

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

Mark Distribution

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

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

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

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern:

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

End Semester Examination Pattern:

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

SYLLABUS

Module – 1(Line and Circle drawing algorithms)

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

Module - 2(Filled Area Primitives and Two dimensional transformations)

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

Module - 3 (Clipping and 3D transformations)

Window to viewport transformation. Cohen Sutherland and Midpoint subdivision line clipping algorithms, Sutherland Hodgeman and Weiler Atherton Polygon clipping algorithms. Three dimensional viewing pipeline. Basic 3D transformations.

Module - 4 (Projections and Visible Surface detection)

Projections- Parallel and Perspective projections. Visible surface detection algorithms- Back face detection, Depth buffer algorithm, Scan line algorithm, A buffer algorithm

Module - 5 (Realism and performance)

Realism - Illumination Shading, Shadows, Texture mapping, Bump mapping, Environment mapping, Transparency, Accumulation Buffer, Back face Culling, Visibility Culling.

Text Books

1. Donald Hearn and M. Pauline Baker, Computer Graphics, PHI, 2e, 1996
2. Aditi Majumder and M.Gopi , Introduction to VISUAL COMPUTING Core Concepts in Computer Vision, Graphics, and Image Processing, 2018

References

1) William M. Newman and Robert F. Sproull, Principles of Interactive Computer Graphics. McGraw Hill, 2001
2) Zhigang Xiang and Roy Plastock, Computer Graphics (Schaum's outline Series), McGraw Hill, 2019.
3) David F. Rogers , Procedural Elements for Computer Graphics, Tata McGraw Hill,2001.
4) Donald Hearn, M. Pauline Baker and Warren Carithers, Computer Graphics with OpenGL, PHI, 4e, 2013

Course Level Assessment Questions

Course Outcome 1 (CO1):

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

Course Outcome 2 (CO2):

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

Course Outcome 3 (CO3):

1. Rotate a triangle ABC 45 degree counter clockwise about the pivot point (10,3) , where the position vector of the coordinate ABC is given as A(4,1), B(5,2) and C(4,3).
2. Implement the above transformation using any appropriate programming language with user inputs. (Assignment)

Course Outcome 4 (CO4):

1. Given a clipping window A(20,20), B(60,20), C(60,40) and D(20,40). Using Cohen Sutherland algorithm, find the visible portion of the line segment joining the points P(40,80) and Q(120,30).
2. Implement Cohen Sutherland clipping algorithm using any appropriate programming language with user inputs. (Assignment)

Course Outcome 5 (CO5):

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

Course Outcome 6 (CO6):

1. You are rendering a black and white checkered tiled floor using a single texture mapped polygon. The view is simulating a person standing on the floor and looking at a point far away from him on the floor. (1)Artifacts at the distant end of the floor can be seen. How would you remove these artifacts? (2) How can you explain why this method works using the sampling theorem?
2. You are seeing an object which is either texture mapped, bump mapped or displacement mapped but you don't know which one. However, you have the liberty to move the light and the viewpoint of an object and see it from different angles and for different positions of the light. How will you figure out which technique was used?

Model Question Paper

QP CODE:

Reg No: _____

Name: _____ **PAGES : 4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FOURTH SEMESTER B.TECH DEGREE (HONOURS) EXAMINATION, MONTH & YEAR

Course Code:ADT296

Course Name: Advanced Topics in Computer Graphics

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

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Consider a raster system with a resolution of 1024*1024. Compute the size of the raster needed to store 4 bits per pixel? How much storage is needed if 8 bits per pixel are to be stored?
2. How 8-way symmetry of circle can be used for writing circle drawing algorithms? Write the symmetric points if (x, y) is a point on the circle with centre at origin.
3. Show that two successive reflections about either of the coordinate axes is equivalent to a single rotation about the coordinate origin.
4. Determine a sequence of basic transformations that are equivalent to the x-direction shearing matrix.

5. Find the window to viewport normalization transformation with window lower left corner at (1,1) and upper right corner at (2,6).

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

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

8. Differentiate between the object space and image space method for the hidden surface removal of an image.

9. Describe the steps used to convert the normal map to bump mapping.

10. One artifact of Gouraud shading is that it can miss specular highlights in the interior of the triangles. How can this be explained as an aliasing artifact? **(10x3=30)**

Part B

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

11. (a) Derive the initial decision parameter of Bresenham's line drawing algorithm and rasterize a line with endpoints (2,2) and (10,10). **(8)**

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

OR

12. (a) Explain the working principle of a Refresh CRT monitor with suitable diagrams. **(7)**

(b) Write Midpoint circle drawing algorithm and plot a circle with radius=20 and center (50,30) using the algorithm. **(7)**

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

(b) Reflect a triangle ABC about the line 3x-4y+8=0, where the position vector of the coordinate ABC is given as A(4,1), B(5,2) and C(4,3). **(9)**

OR

14. (a) A diamond shaped polygon is located at P(-1,0), Q(0,-2), R(1,0) and S(0,2). Find the transformation matrix which would rotate the triangle by 90 degree counter clockwise about the point Q. Using the transformation matrix, find the coordinates of the rotated polygon. **(7)**

(b) Illustrate the working principle of scan line polygon filling algorithm **(7)**

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

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

OR

16. (a) Describe the steps required for a general 3D rotation if the rotation axis is not parallel to any one of the principal axis. The rotation axis is defined by the points P1(x1,y1,z1) and P2(x2,y2,z2). Give its composite matrix representation **(6)**

(b) Describe Sutherland Hodgeman polygon clipping algorithm and list out its limitations **(8)**

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

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

OR

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

(b) Explain the steps involved in performing perspective projections **(7)**

19. (a) Specify any three shading algorithms used in interactive graphics. **(6)**

(b) Explain the procedure of texture to object space mapping. **(8)**

OR

20. (a) Explain the mapping scheme in which the effects of small bumps on the surface of an object can be simulate without changing the number of primitives **(8)**

(b) Describe about object to screen space mapping. **(6)**

TEACHING PLAN

No	Contents	No of Lecture Hrs
	Module – 1 (Line and Circle drawing algorithms) (10 hrs)	
1.1	Basics of Computer Graphics and applications	1
1.2	Refresh Cathode Ray Tubes	1
1.3	Random and Raster Scan Displays and systems,	1
1.4	Color CRT displays	1
1.5	Flat panel display and its categories.	1
1.6	DDA Line drawing Algorithm	1
1.7	Bresenham's line drawing algorithm	1
1.8	Midpoint Circle generation algorithm	1
1.9	Bresenham's Circle generation algorithm	1
1.10	Illustration of line and circle drawing algorithms	1
	Module - 2 (Filled Area Primitives and Two dimensional transformations) (9 hrs)	
2.1	Scan line polygon filling	1
2.2	Boundary filling and flood filling	1
2.3	Basic 2D transformations-Translation	1
2.4	Basic 2D transformations- Rotation	1
2.5	Basic 2D transformations- Scaling	1
2.6	Reflection and Shearing	1
2.7	Illustration of Basic 2D Transformations	1
2.8	Composite transformations	1
2.9	Matrix representations and homogeneous coordinates	1
	Module - 3 (Clipping and 3D transformations) (8 hrs)	
3.1	Window to viewport transformation	1
3.2	Cohen Sutherland Line clipping algorithm	1
3.3	Midpoint subdivision Line clipping algorithm	1
3.4	Sutherland Hodgeman Polygon clipping algorithm	1
3.5	Weiler Atherton Polygon clipping algorithm	1
3.6	Three dimensional viewing pipeline	1

3.7	Basic 3D transformation-Translation and scaling	1
3.8	Basic 3D transformation-Rotation	1
Module - 4 (Projections and Visible Surface detection) (7 hrs)		
4.1	Projections-Parallel projections	1
4.2	Projections- Perspective projections	1
4.3	Illustration of projection methods	1
4.4	Visible surface detection algorithms- Back face detection	1
4.5	Depth buffer algorithm	1
4.6	Scan line visible surface detection algorithm	1
4.7	*A buffer* algorithm	1
Module - 5 (Realism and performance)(10 hrs)		
5.1	Illumination	1
5.2	Shading and Shadows	1
5.3	Texture mapping-Texture to object space mapping	1
5.4	Texture mapping-Object to screen space mapping and Mip Mapping	1
5.5	Bump mapping	1
5.6	Bump mapping-Illustration	1
5.7	Environment mapping and Transparency	1
5.8	Accumulation Buffer and Back face Culling	1
5.9	Visibility Culling	1
5.10	Visibility Culling	1