

21-805-0204: OPERATING SYSTEMS

Answer any 4 questions (Total 20 Marks, 5 marks per question)

1. Compare temporal and spatial locality in cache policy. Explain these concepts with a real world computation example.
2. Distinguish between circuit switching, packet switching.
3. What is virtual memory and how is swap space maintained.
4. Explain steps in performing a context switch between processes.
5. Write a program to create 100 threads which generate 1 random number each, having value between 1-10, and print it on screen. Once all threads completes its function, print "job ends" on screen.

SFI DCS



Cochin University of Science and Technology

Department of Computer Science

21-805-0201 Linear Algebra

I Term, Date: July 12, 2023

Timing: 10:00 to 12:00 Noon

II Semester

Max mark: 20

Attempt ALL Questions

1. (a) Let $\mathbf{v} = \begin{pmatrix} 3 \\ -1 \end{pmatrix}$ and $\mathbf{w} = \begin{pmatrix} 1 \\ 1 \end{pmatrix}$. (i) Illustrate how vector $\mathbf{v}+2\mathbf{w}$ is obtained geometrically. (ii) Compute the angle θ between the vectors \mathbf{v} and \mathbf{w} . (3)
- (b) Let A be an $m \times n$ matrix and vector $\mathbf{x} \in \mathbb{R}^n$. Give the definition of product $A\mathbf{x}$. What is the dimension of the product? (2)
2. (a) Solve the system of equations and interpret the same geometrically.
$$\begin{cases} x + 2y = 1 \\ -4x - 3y = 6 \end{cases}$$
 (4)
(b) Is the above solution unique? comment (1)
3. (a) Express the vector $\mathbf{v} = [-1, 1, 2]$ as a linear combination of vectors $\mathbf{v}_1 = [1, -1, 0]$, $\mathbf{v}_2 = [0, 1, -1]$ and $\mathbf{v}_3 = [0, 1, 0]$ (3)
(b) When a system of linear equations are of the form $A\mathbf{x}=0$; what can you say about the columns and A when (i) it has many solutions (ii) it has only one solution? (2)
4. (a) Find the matrix P that multiplies (x, y, z) to give (y, z, x) . Find the matrix Q that brings back (x, y, z) from (y, z, x) . Show all steps. (3)
(b) Given $A = \begin{bmatrix} 1 & 2 \\ 0 & 0 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & 0 \\ 3 & 0 \end{bmatrix}$, Is $(A+B)^2$ different from $A^2+2AB+B^2$? If so, what is the correct formula? (2)



Cochin University of Science and Technology
Department of Computer Science

21-805-0205 Java Programming

Timing: 9:30 AM to 12:30 PM

II Semester

Max mark: 50

Attempt ALL Questions

1. (a) Explain the keyword *final* in following context.
 - i. Variable
 - ii. Function
 - iii. Class(5)
- (b) Explain the concept of overloading methods with an example Java program. (5)

OR

2. (a) Write a Java program that calculates the binomial coefficient (n choose k) using a recursive approach.

Hint : The binomial coefficient is defined as follows:

$$C(n, k) = \begin{cases} 1 & \text{if } k = 0 \text{ or } k = n \\ C(n - 1, k - 1) + C(n - 1, k) & \text{if } n > 0 \text{ and } k > 0 \end{cases}$$

for all non-negative integers n and k. (5)

- (b) Explain any five features of Java programming language. (5)
3. (a) Write a Java program that showcases multiple inheritance and method overriding.
(Hint: Create two parent classes, **InternalExam** and **ExternalExam**, for managing different exam scores, each with grading and display methods. Then, create a child class, **FinalExam**, inheriting from both parent classes, to display final exam scores and calculate the final grade. Demonstrate method overriding by displaying final exam results and calculating the final grade in the **main** method.) (10)

OR

4. (a) Distinguish between an interface and an abstract class. (5)
(b) Explain the concept of multidimensional array in Java with the example. (5)
5. (a) Explain the user defined exception handling in Java with examples (10)

OR

6. (a) Write a Java program to solve the producer-consumer problem. (10)
7. (a) Write a Java program to open and read 'n' numbers from an input file. Then write the odd numbers to an output file named 'odd.txt' and the even numbers to another output file named 'even.txt'. (10)

OR

8. (a) Explain the different Java Database drivers. (10)
9. (a) Write a program to find all its unique elements in an Integer ArrayList.
(b) Explain boxing and unboxing in Java. (5)
(5)

OR DCS

10. (a) Explain the following.
i. varargs
ii. subtyping
iii. wildcards
iv. reifiable types
v. reflected types

(10)

21-805-0204: OPERATING SYSTEMS

Section I: Choose the best answer among the options given (4 marks)

1. Which among the following is always a static-priority scheduling algorithm?

 - a) Shortest Time Remaining
 - b) Shortest Job First with pre-emption
 - c) Rate monotonic
 - d) Earliest Deadline First

2. A lower priority thread gets CPU time, but does not get access to shared resource for execution. This state is called ____?

 - a) Deadlock
 - b) Starvation
 - c) Aging
 - d) Exception

3. A portion of code is making modifications on video where the same computation is being done on each pixel stored sequentially in memory. It is advisable that the nearby locations of the latest referenced memory be moved into cache. This feature is called....?

 - a) Temporal locality
 - b) Local storage
 - c) Spatial locality
 - d) Nearby locality

4. Response time (R_j) is the difference between these two measurements

 - a) Finishing time and arrival time
 - b) Computation time and arrival time
 - c) Finishing time and start time
 - d) Absolute deadline and start time

Section II: Answer the following (Total 16 Marks)

5. For a memory with 48 blocks, a cache with total of 12 lines is being designed. Draw the mapping diagram for the following and answer where the memory lines 3, 12, 22, 30 will be mapped

 - For a direct mapped cache
 - For a 3-way set associative cache

(4 marks)

6. Consider an RTOS with two processes P1 and P2. The period p and execution time t in milliseconds for P1 and P2 are as follows: p(P1) is 80ms, t(P1) is 40ms; p(P2) is 50ms, t(P2) is 20ms. For this RTOS, answer these questions when pre-emption is allowed.

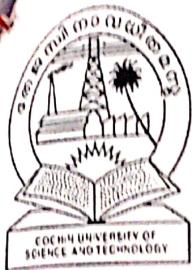
 - Draw and explain the schedule using Rate Monotonic algorithm.
 - Draw and explain the schedule using Earliest Deadline First algorithm.

(4 marks)

7. Explain the UNIX file structure? (4 marks)

8. Consider a 4 processes with following characteristics (ProcessName, Arrival time, Burst time) => (P1, 1, 3), (P2, 0, 4), (P3, 3, 8), (P4, 1, 2). Draw Gantt Charts with with Shortest Job First and Shortest Time Remaining algorithms. Calculate their average waiting times? (4 marks)

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Cochin University of Science and Technology
Department of Computer Science
21-805-0201 Linear Algebra
I Term, Date: July 12, 2023

Timing: 10:00 to 12:00 Noon

II Semester

Max mark: 20

Attempt ALL Questions

1. (a) Let $\mathbf{v} = \begin{pmatrix} 3 \\ -1 \end{pmatrix}$ and $\mathbf{w} = \begin{pmatrix} 1 \\ 1 \end{pmatrix}$. (i) Illustrate how vector $\mathbf{v}+2\mathbf{w}$ is obtained geometrically. (ii) Compute the angle θ between the vectors \mathbf{v} and \mathbf{w} . (3)

- (b) Let A be an $m \times n$ matrix and vector $\mathbf{x} \in \mathbb{R}^n$. Give the definition of product $A\mathbf{x}$. What is the dimension of the product? (2)

2. (a) Solve the system of equations and interpret the same geometrically.

$$\begin{cases} x + 2y = 1 \\ -4x - 3y = 6 \end{cases} \quad (4)$$

SFI DCS (1)

- (b) Is the above solution unique? comment

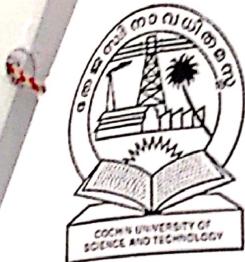
3. (a) Express the vector $\mathbf{v} = [-1, 1, 2]$ as a linear combination of vectors $\mathbf{v}_1 = [1, -1, 0]$, $\mathbf{v}_2 = [0, 1, -1]$ and $\mathbf{v}_3 = [0, 1, 0]$ (3)

- (b) When a system of linear equations are of the form $A\mathbf{x}=0$; what can you say about the columns and A when (i) it has many solutions (ii) it has only one

solution? (2)

4. (a) Find the matrix P that multiplies (x, y, z) to give (y, z, x) . Find the matrix Q that brings back (x, y, z) from (y, z, x) . Show all steps. (3)

- (b) Given $A = \begin{bmatrix} 1 & 2 \\ 0 & 0 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & 0 \\ 3 & 0 \end{bmatrix}$, Is $(A+B)^2$ different from $A^2+2AB+B^2$? If so, what is the correct formula? (2)



Cochin University of Science and Technology

Department of Computer Science

21-805-0201 Linear Algebra

II Term, Date: August 16, 2023

Timing: 10:00 to 12:00 Noon

II Semester

Max mark: 20

Attempt ALL Questions

1. (a) Given a matrix with three rows where $\text{row}3 = \text{row}1 + \text{row}2$. Is this matrix invertible? Prove or disprove. (2)

- (b) Using Gauss-Jordan Method, find inverse of $A = \begin{bmatrix} 1 & 0 & 0 \\ -1 & 1 & 0 \\ 0 & -1 & 1 \end{bmatrix}$, Suppose a_{13} is -1 in the original A matrix, would it be invertible? and why? (3)

2. (a) Reduce the system of linear equations to upper triangular form. Circle the pivots and give solution.

$$\begin{cases} 2x + 3y + z = 8 \\ 4x + 7y + 5z = 20 \\ -2y - 2z = 0 \end{cases}$$

SFI DCS

(3)

- (b) A matrix $\begin{bmatrix} 2 & 2 \\ 4 & 9 \end{bmatrix}$ is decomposed to L and U; if the diagonal elements of U are both 1, then find the lower diagonal entry l_{22} . (2)

3. (a) Find the eigenvalues and eigenvectors of Pauli's matrix $\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$. Show all steps. (3)

- (b) Prove that (R, \times) is a group. (2)

4. (a) Define a subspace, basis and dimension of a vector space.

- (b) Verify set of all quadratic polynomials of the form $px^2 + qx + r$ where $p, q, r \in R$ over integer field is a vector space. (3)

Department of Computer Science,
Cochin University of Science and Technology, Kochi

**M.Sc (Five Year Integrated) Programme in Computer Science
Second Internal Examination, August 2023**

21-805-0202: Data Structures

Total marks: 20

Time: 2 hrs

1. Write the algorithm to perform bubble sort on a given array of integers.
Trace the steps in sorting the array [2, 8, 4, 3, 1] in ascending order. [5 marks]

2. What are Linked Lists? Give the pseudo-code and discuss the time complexity of the following operations on a Singly Linked List (SLL):
 - a. Insert a node at the beginning
 - b. Delete a node at the beginning
 - c. Insert a node at the end
 - d. Delete a node at the ~~begin~~^{end} [5 marks]

3. Given a pointer **ptr** to a node with an element **E** in a doubly linked list (DLL), write the pseudo code to delete **E** from the list. Can you do the same operation in an SLL in O(1) time? Justify your answer. [3 marks]

4. Implement a circular queue using an array with the following 5 operations:
enqueue, dequeue, isEmpty, IsFull, size. [5 marks]

5. Evaluate the given postfix expression using a stack data structure. Trace the steps: a b 5 * + c 3 2 / ^ 9 + [2 marks]

Department of Computer Science,
Cochin University of Science and Technology, Kochi

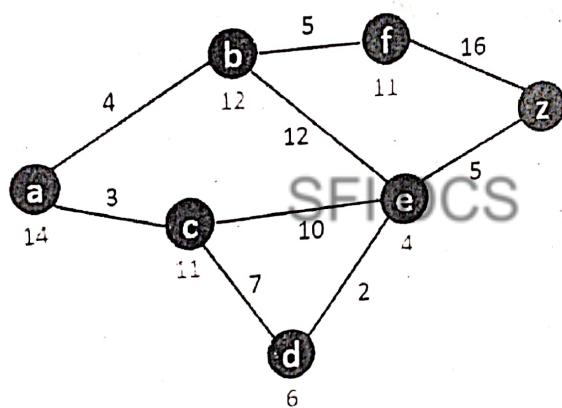
M.Sc(Five Year Integrated) Programme in Computer Science
Second Internal Examination, August 2023

Introduction to Artificial Intelligence

Duration: 2 hour

Max Marks: 20

1. What are different types of uninformed search strategies? 5 marks
2. Find the shortest path between initial (a) and final state (z) using A* Algorithm.



3. Explain Hill climbing Algorithm with a suitable example. 5 marks
4. Write detailed note on the limits of AI. 5 marks

Cochin University of Science and Technology
Department of Computer Science

Second Semester M.Sc. (Five-Year Integrated) in Computer Science
(Artificial Intelligence & Data Science)

End Semester Examination - September 2023

21-805-0202: Data Structures

Duration : 3 Hrs

Maximum Marks : 50

Answer all questions. From each question fully answer either (a) or (b)

1. (a) (i) What is the worst-case asymptotic time complexity of the given code snippet
(5 marks)
in terms of n :

```
l = 0; sum = 10;  
r = n - 1;  
while (l < r) {  
    if (A[l] + A[r] == sum)  
        return 1;  
    else if (A[l] + A[r] < sum)  
        l++;  
    else  
        r--;  
}
```

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- (ii) Give a recursive algorithm to find the sum of the first n numbers. Trace the
(5 marks)
steps using an example

OR

- (b) Define asymptotic analysis of algorithms. Explain the best-case, worst-case, and
(10 marks)
average-case complexity using the linear search algorithm.

2. (a) Write an algorithm for binary search in an array of size n . What is the worst-case
(10 marks)
time complexity of your algorithm? Justify your answer.

OR

- (b) Write an algorithm to do merge sort on an array of size n . What is the worst-case
(10 marks)
time complexity of your algorithm? Justify your answer.

3. (a) (i) Define Linked list. With neat diagrams, explain the data organization and
(6 marks)
various operations on Linked List

- (ii) Compare the time complexity of the following operations: (Insertion & deletion at front, rear, and deletion of a node whose pointer is given, insertion after a given node) on the Singly Linked List and Doubly Linked List. (4 marks)

OR

- (b) Write an algorithm to add two polynomials represented by two linked lists with head pointers $HEAD1$ and $HEAD2$. (10 marks)

4. (a) Write the pseudo code to implement a stack using a linked list with the following operations: PUSH, POP, ISEMPTY (10 marks)

OR

- (b) (i) Write the pseudo code to implement a DEQUEUE using array with the following operation: PUSH_REAR, POP_FRONT, POP_REAR (6 marks)

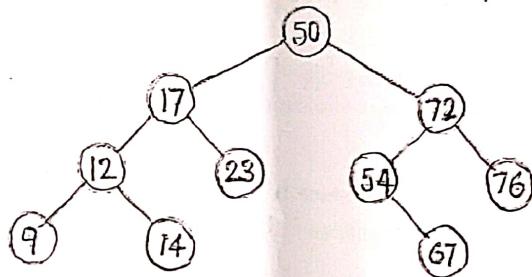
- (ii) Discuss any two applications of stack data structures. (4 marks)

5. (a) (i) Create a Binary Search Tree (BST) using the keys 25, 2, 30, 1, 10, 8, 11, 40, and 48. Write an algorithm to find an element $elem$ in a given Binary Search Tree (BST) with root T . What would be the worst-case time complexity for your search in a BST with n nodes? (7 marks)
- (ii) Insert the following keys: 29, 37, 38, 15, 22, 58, 30, and 28 into a Hash table of size 7. Use division method for hashing and linear probing for resolving collision. (3 marks)

OR

- (b) (i) Illustrate using the given keys: 29, 37, 38, 15, 22, 58, 30, and 28 to be stored in a hash table of size 10, the three different techniques for open addressing to resolve collisions. (Use $HASH1(x) = x \bmod 10$, and $HASH2(x) = x \bmod 7$) (7 marks)

- (ii) Write down the pre-order, in-order, and post-order traversal for the binary tree given below: (3 marks)



(ition & deletion
tion after a
marks)

Cochin University of Science and Technology, Kochi
Department of Computer Science

Fourth Semester M.Sc (Five Year Integrated) in Computer Science
Artificial Intelligence and Data Science
End Semester Examination, September 2023

21-805-0203: Introduction to Artificial Intelligence

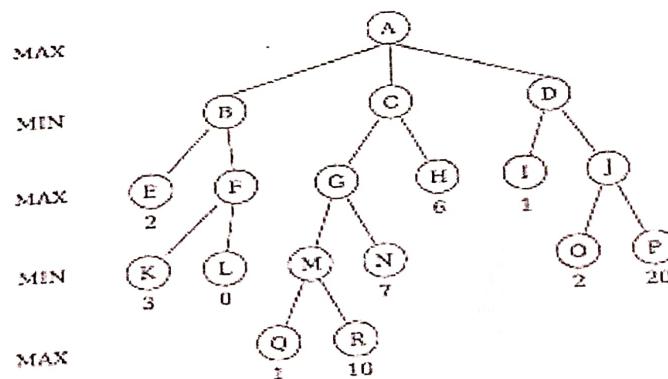
Duration: 3 Hrs

Maximum marks: 50

1. A) Define Artificial Intelligence. Analyze the Turing test in AI. [5 marks]
- B) What are the three different types of AI? Compare the advantages and disadvantages of AI. [5 marks]

OR

2. A) Explain the water Jug problem in AI along with a sample solution. [5 marks]
 - B) What is problem space? Explain the different steps in problem solving using AI? [5 marks]
- SFTDCS
3. A) What do you mean by searching in AI? Explain different types of search algorithms used in AI. [5 marks]
 - B) Discuss Alpha Beta Pruning. Do Alpha Beta Pruning on the given tree. [5 marks]



OR

4. State and explain A* algorithm with a suitable example. Write down its advantages and disadvantages. Also analyze its time and space complexity. [10 marks]

5. A) What are agents in AI? Explain different types of agents in AI. [6 marks]
B) Explain the different components of agents. [4 marks]

OR

6. What is knowledge? Compare different types of knowledge. Also explain the semantic representation of knowledge. [10 marks]
7. What is planning? Explain how it is different from problem solving along with a suitable planning problem example and its solution. [10 marks]

OR

8. A) Write a detailed note on Constraint Satisfaction Problem. Demonstrate with the help of a suitable example. [6 marks]
B) Explain Hill climbing Algorithm with a suitable example. [4 marks]
9. A) Write a detailed note on the Limits of AI. [5 marks]
B) Write a detailed note on the Ethics of AI. [5 marks]

OR

10. A) Write a detailed note on the Safety of AI. [5 marks]
B) Write a detailed note on AI architectures with necessary block diagrams. [5 marks]



Cochin University of Science and Technology
Department of Computer Science
21-805-0201 Linear Algebra
Final Exam, Date: September 05, 2023

Timing: 9:30 AM to 12:30 PM

II Semester

Max mark: 50

Attempt ALL Questions

1. (a) The linear combinations of $v = (1, 1, 0)$ and $w = (0, 1, 1)$ fill a plane. Describe that plane. Find a vector that is not a combination of v and w . (3)

(b) Given $A = \begin{bmatrix} -4 & 0 & 5 \\ -3 & 5 & 5 \\ -1 & 2 & 2 \end{bmatrix}$. Use Gauss-Jordan elimination to find A^{-1} . (7)

OR

2. (a) Express b as linear combinations of vectors $v = (2, -1)$ and $w = (-1, 2)$. Find the unknowns in the above equation. (3)

(b) Given $A = \begin{bmatrix} 1 & 2 & 0 & 1 \\ 2 & 4 & 1 & 4 \\ 3 & 6 & 3 & 9 \end{bmatrix}$. Find the row reduced echelon form of A . How many independent columns are there in A ? (7)

3. (a) Define a vector space. (3)
(b) Prove that the set of all real diagonal 2×2 matrices form a vector space under matrix addition and scalar multiplication. (7)

OR

4. (a) Explain what is a subspace, basis, and dimension in connection with vector space. (4)

(b) Determine whether following set is a basis for R^3 : $S = \left\{ \begin{bmatrix} 1 \\ 0 \\ -1 \end{bmatrix}, \begin{bmatrix} 2 \\ 1 \\ -1 \end{bmatrix}, \begin{bmatrix} -2 \\ 1 \\ 4 \end{bmatrix} \right\}$ (6)

5. (a) Given $A = \begin{bmatrix} 1 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 1 \end{bmatrix}$, Perform QR decomposition. Show all steps. (7)

(b) What is the goal of Gram-Schmidt Algorithm? Explain. (3)

OR

6. (a) Find the eigenvalues and eigenvectors of the matrix $\begin{bmatrix} 5 & -2 & 3 \\ 0 & 1 & 0 \\ 6 & 7 & 2 \end{bmatrix}$ (7)

(b) What is meant by *eigenspace* of a matrix? Explain. (3)

7. Matrix A can be decomposed into $P D P^{-1}$, where P is a matrix with eigen vectors as its columns, D is a diagonal matrix with eigen values as its diagonals. Given $A = \begin{bmatrix} -2 & 12 \\ -1 & 5 \end{bmatrix}$, Represent $A = P D P^{-1}$. What will be A^{10} ? (10)

OR

8. (a) Given $u_1 = (3, -3, 0)$, $u_2 = (2, 2, -1)$, and $u_3 = (1, 1, 4)$. Show that they are orthogonal in \mathbb{R}^3 . Also express the vector $x = (5, -3, 1)$ as a linear combination of u (7)
- (b) Define orthogonal matrices. If P and Q are orthogonal matrices, show that PQ is also orthogonal. (3)

9. Explain how linear algebra is utilized in Search Engines (10)

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10. Explain translation, rotation, and reflection operations on points in R^2 (10)



Cochin University of Science and Technology
Department of Computer Science
21-805-0201 Linear Algebra
Final Exam. Date: September 05, 2023

Timing: 9:30 AM to 12:30 PM

II Semester

Max mark: 50

Attempt ALL Questions

1. (a) The linear combinations of $v = (1, 1, 0)$ and $w = (0, 1, 1)$ fill a plane. Describe that plane. Find a vector that is not a combination of v and w . (3)
(b) Given $A = \begin{bmatrix} -4 & 0 & 5 \\ -3 & 5 & 5 \\ -1 & 2 & 2 \end{bmatrix}$, Use Gauss-Jordan elimination to find A^{-1} . (7)

OR

2. (a) Express b as linear combinations of vectors $v = (2, -1)$ and $w = (-1, 2)$. Find the unknowns in the above equation. (3)
(b) Given $A = \begin{bmatrix} 1 & 2 & 0 & 1 \\ 2 & 4 & 1 & 1 \\ 3 & 6 & 3 & 9 \end{bmatrix}$, Find the row reduced echelon form of A . How many independent columns are there in A ? (7)

3. (a) Define a vector space. (3)
(b) Prove that the set of all real diagonal 2×2 matrices form a vector space under matrix addition and scalar multiplication. (7)

OR

4. (a) Explain what is a subspace, basis, and dimension in connection with vector space. (4)
(b) Determine whether following set is a basis for R^3 , $S = \left\{ \begin{bmatrix} 1 \\ 0 \\ -1 \end{bmatrix}, \begin{bmatrix} 2 \\ 1 \\ -1 \end{bmatrix}, \begin{bmatrix} -2 \\ 1 \\ 4 \end{bmatrix} \right\}$ (6)

5. (a) Given $A' = \begin{bmatrix} 1 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 1 \end{bmatrix}$. Perform QR decomposition. Show all steps. (7)

(b) What is the goal of Gram-Schmidt Algorithm? Explain. (3)

OR

6. (a) Find the eigenvalues and eigenvectors of the matrix $\begin{bmatrix} 5 & -2 & 3 \\ 0 & 1 & 0 \\ 6 & 7 & 2 \end{bmatrix}$ (7)

(b) What is meant by *eigenspace* of a matrix? Explain. (3)

7. Matrix A can be decomposed into $P D P^{-1}$, where P is a matrix with eigen vectors as its columns, D is a diagonal matrix with eigen values as its diagonals. Given $A = \begin{bmatrix} -2 & 12 \\ -1 & 5 \end{bmatrix}$. Represent $A = P D P^{-1}$. What will be A^{10} ? (10)

OR

8. (a) Given $u_1 = (3, -3, 0)$, $u_2 = (2, 2, -1)$, and $u_3 = (1, 1, 4)$. Show that they are orthogonal in \mathbb{R}^3 . Also express the vector $x = (5, -3, 1)$ as a linear combination of u . (7)

(b) Define orthogonal matrices. If P and Q are orthogonal matrices, show that PQ is also orthogonal. (3)

9. Explain how linear algebra is utilized in Search Engines (10)

OR

SFI DCS

10. Explain translation, rotation, and reflection operations on points in R^2 (10)

Department of Computer Science, Cochin University of Science & Technology
M. Sc. Computer Science (Artificial Intelligence and Data Science)

21-805-0204: OPERATING SYSTEMS

Final Examination

September 2023

Total: 50 marks

Time: 3 hours

Module 1

I A.

- (i) Draw the process life cycle and explain the allowed transitions between states. (6 marks)
(ii) What are privilege rings in an Operating System? (4 marks)

I B.

OR

- (i) What is user mode and kernel mode in an Operating System. How do they interact with each other? (6 marks)
(ii) Explain the following: a) Text memory b) Data memory c) Stack d) Heap (4 marks)

Module 2

II A.

- (i) Consider an RTOS 'OS1' with two processes P1 and P2. The period p and execution time t for P1 and P2 are as follows. p(P1) is 50ms, t(P1) is 25ms; p(P2) is 80ms, t(P2) is 35ms. Calculate the CPU utilization ratio.

For the system 'OS1', draw and explain scheduling activity if P2 has higher priority over P1.
For the system 'OS1', draw and explain the schedule when Rate Monotonic scheduling is used. (10 marks)

OR

II B.

- (i) Consider a 4 processes with following characteristics (ProcessName, Arrival time, Burst time) => (P1, 0, 8), (P2, 1, 4), (P3, 2, 9), (P4, 3, 5). Draw Gantt Charts with Shortest Job First and Shortest Time Remaining algorithms. Calculate their average waiting times? (10 marks)

Module 3

III A.

- (i) What are critical sections? Give an example for why mutex or semaphores are required to protect a multi-threaded program. (10 marks)

OR

III B.

- (i) What are the different methods to terminate a thread using pthreads library. (6 marks)
(ii) Explain steps in performing a context switch between processes. (4 marks)

PTO