

**MAX MARKS: 90**

**Duration: 180 MINUTES**

- 1. ATTEMPT ALL QUESTIONS. ALL QUESTIONS CONTAIN EQUAL MARKS.**
- 2. ATTEMPT THE QUESTIONS IN THE SEQUENTIAL ORDER AND WRITE NEATLY.**

**Qus 1(a):** Draw a Binary Search Tree using the following data:

[26 05 77 01 61 11 59 15 48 19]

**1(b):** Using the BST, write the data in ascending order. Is the BST balanced?

**1(c):** Draw the AVL Tree using the following data:

[26 05 77 01 61 11 59 15 48 19]

Start from the first data and make suitable rotations as and when required.

**(20 Marks) (4-5 Pages)**

**Qus 2(a):** Make a complete Binary Tree using the following data and convert it to the Maxheap algorithm discuss in the class (BuildMaxHeap(A,size)):

[26 05 77 01 61 11 59 15 48 19]

**2(b):** Use the Heap Sort algorithm (HeapSort(A,size)) to sort the array.

**(15 Marks) (4-5 Pages)**

**Qus 3(a):** In a machine scheduling example of three machines and 10 jobs, the jobs times are given as follows:

[26 05 77 01 61 11 59 15 48 19]

Find the processing time with random possible schedule discussed in the class

**3(b):** Find the processing time with largest processing time (LPT) first schedule discussed in the class.

**3(c):** What did you observe in the timing distributions of these two schedules? What is the time complexities of the schedules for a n number of jobs and m number of machines?

**(15 Marks) (4-5 Pages)**

**Qus 4:** Mention clearly the difference between Array, ArrayList, OrderedArrayList, and LinkedList data structure using the following table.

Feature/Data structure	Array		ArrayList		OrderedArrayList	LinkedList	
<b>Insertion/Deletion Cost</b> <b>( Write the cost O() )</b>	Not Last Element	O()	Not Last Element	O()	O()	First Element	O()
	Last Element	O()	Last Element	O()		Not First Element	O()
<b>Search Cost</b> <b>( Write the cost O() )</b>	O()		O()		O()	O()	

**(10 Marks) (1 Page)**

**Qus 5:** Take the following code for towerOfHanoi() function:

```
void towerOfHanoi(int n, char source, char auxiliary, char destination)
{
    if (n == 1) {
        printf("Move disk from %c to %c\n", source, destination);
    }
    else {
        towerOfHanoi(n-1, source, destination, auxiliary);
        printf("Move disk from %c to %c\n", source, destination);
        towerOfHanoi(n-1, auxiliary, source, destination);
    }
}
```

Write the output for towerOfHanoi(4, 'A', 'B', 'C') function with the help of the binary tree discussed in the class (no marks without binary tree) **(10 Marks) (1-2 Pages)**

**Qus 6:** Applying the following steps to convert an input expression to an output expression:

- (1) Initialize an empty stack to hold operators temporarily during the conversion process.
- (2) Initialize an empty list to hold the output expression.
- (3) Scan the infix expression from left to right, one token (operator or operand) at a time.
- (4) For each token, do the following:
  - a. If it is an operand (a number or a variable), add it to the output expression list.
  - b. If it is an operator, do the following:
    - i. While the stack is not empty and the precedence of the operator at the top of the stack is greater than or equal to the precedence of the current operator, pop operators from the stack and add them to the output expression list.
    - ii. Push the current operator onto the stack.
  - c. If it is an opening parenthesis '(', push it onto the stack.
  - d. If it is a closing parenthesis ')', pop operators from the stack and add them to the output expression list until an opening parenthesis is encountered. Pop and discard the opening parenthesis.
- (5) After scanning the entire input expression, pop any remaining operators from the stack and add them to the output expression list.
- (6) The resulting postfix expression, stored in the list, will be the equivalent expression to the original infix expression.

**6(a):** Find the output expression using step by step for the following input expression:

$$\text{Input expression} = (50 + 20) * (70 - 10) / (25 - 15)$$

Also draw the binary tree for the problem.

**6(b):** Using algorithm discuss in the class, process the output expression obtained in 6(a) from the input expression to get the output value.

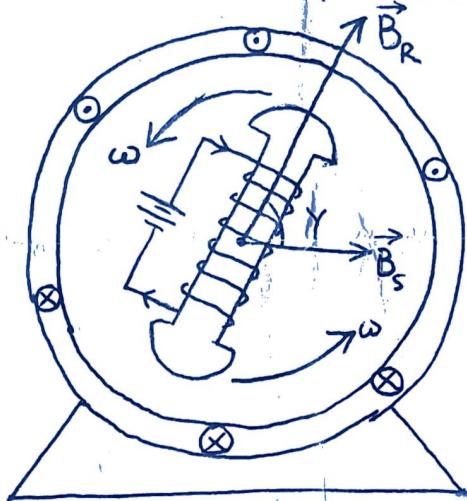
**(20 Marks) (2-3 Pages)**

**Instructions:**

1. The exam is a closed book/resource.
2. Attempt ALL the questions.
3. Each question carries 10 marks.
4. Answer each question sequentially beginning on a new page.
5. Only a scientific calculator is permitted to use.

**Ques. 1:** Show that a three-phase set of currents, each of equal magnitude and differing in phase by  $120^\circ$ , flows in a three-phase winding of the machine, will produce a rotating magnetic field. [Assume that the three-phase winding consisting of three separate windings are spaced  $120^\circ$  apart around the surface of the machine.]

**Ques. 2:** If an ac machine has the rotor and stator magnetic fields shown below, what is the magnitude and direction of the induced torque in the machine? Is the machine acting as a motor or generator?



**Ques. 3:** In the early days of ac motor development, machine designers had great difficulty controlling the core losses (hysteresis and eddy currents) in machines. They had not yet developed steels with low hysteresis, and were not making laminations as thin as the ones used today. To help control these losses, early ac motors were run from a 25 Hz ac power supply, while lighting systems were run from a separate 50 Hz ac power supply.

- a) Develop a table showing the speed of magnetic field rotation in ac machines of 2, 4, 6, 8, 10, 12, and 14 poles operating at 25 Hz. What was the fastest rotational speed available to these early motors?
- b) For a given motor operating at a constant flux density B, how would the core losses of the motor running at 25 Hz compare to the core losses of the motor running at 50 Hz?
- c) Why did the early engineers provide a separate 50 Hz power system for lighting?

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**Ques. 4:** A three-phase Y-connected synchronous generator is rated 120 MVA, 13.2 kV, 0.8 PF lagging, and 60 Hz. Its synchronous reactance is  $0.9 \Omega$ , and its resistance may be ignored.

- What is its voltage regulation?
- What would the voltage and apparent power rating of this generator be if it were operated at 50 Hz with the same armature and field losses as it had at 60 Hz?

**Ques. 5:** Answer the following briefly:

- Name the two different types of rotor in the Induction Motor.
- Draw a schematic diagram of both the rotors and describe their design principle.
- Which one of the two are widely used. Give reasons to support your answer.
- Define *slip speed* and *slip*. How does the resulting rotor voltage and rotor frequency depend on the *slip*?

**Ques. 6:** A three-phase, 60-Hz, four-pole induction motor runs at a no-load speed of 1790 r/min and a full-load speed of 1720 r/min. Calculate the *slip* and the electrical frequency of the rotor at no-load and full-load conditions. What is the speed regulation of this motor?

**Ques. 7:** Consider a simple machine having a single loop of wire, rectangular in shape, is rotating with angular speed  $\omega$  between the curved pole faces of a permanent magnet.

- Determine the magnitude and shape of the total induced voltage in the loop of wire.
- Plot the induced voltage as a function of time.
- How can this machine be made to produce a dc voltage? Describe the design principle.

**Ques. 8:** Show Wye-Delta connection in a three-phase transformer. Develop a relationship between the line voltage on the primary side to the line voltage on the secondary side.

# End Semester Exam

HS 102

## Science, Technology and Society

Marks- 100

### Answer the following questions-

- ✓ 1. Write a short note on Nehruvian Science? (5)
- ✓ 2. How do Sigmund Freud's concepts of the Id, Ego, and Superego explain the dynamics of human behaviour and the formation of personality? (5) M.S
- ✓ 3. George Bernard Shaw said that science never solves a problem without creating ten more. Illustrate. (5)
- ✓ 4. What is postcolonialism? What do you understand by Eurocentric view of history? (5)
- ✓ 5. Sam was stuck in traffic. He just wanted his vehicle to move! Enraged at the situation, Sam pulled his car onto the shoulder and sped forward, not caring that he was clipping people's side mirrors as he tried to get ahead of the cars in front of him. M.S  
Which personality theory made Sam behave in such a manner in the traffic? Explain the theory. (5)
- ✓ 6. What is the concept of social class according to Karl Marx? (5) M.S
- ✓ 7. Explain Positivism and Logical Positivism? (5) M.S
- ✓ 8. The inherent vice of capitalism is the unequal sharing of blessings; the inherent virtue of socialism is the equal sharing of miseries. Comment. (5) M.S
- ✓ 9. We live in a society exquisitely dependent on science and technology and yet have cleverly arranged things so that almost no one understands science and technology. Elaborate. (5)
- ✓ 10. What is the role of gender in the issues related to digital divide in India? (5)
- ✓ 11. Ruth couldn't remember the answer to test question no.12, even though she had studied. Bert was the smartest kid in the class, and from where Ruth sat, she could

see his answers if she turned her head slightly. When Mrs. Lawrence turned her back, Ruth almost cheated, but her conscience stopped her because she knew it was wrong. Instead, Ruth took a guess at the answer and then turned in her paper. Name the personality theory of Ruth and also explain the same. (5)

12. What is FRS? Write about any three Indian Scientists who received the FRS before 1950. (5)

13. Rohini's mom had given her \$ 50 to purchase groceries for dinner that night. At the mall, Rohini saw shoes that she really wanted, and was tempted to use the money from her mom to make the purchase. However, if she spent the money on shoes, she wouldn't have enough to buy the groceries, so she decided she better not buy the shoes.

Name the personality theory of Rohini and also explain the same. (5)

14. What is BC/AD and BCE/CE? Why have some people adopted BCE/CE in place of BC/AD? (5)

15. What is Freudianism? Write a short note on Interpretation of Dreams. (5)

16. What is the Oedipus Complex? Write a short note on the Greek mythology on Oedipus. (5)

17. What is Falsificationism theory? How can the hypothesis that "all swans are white" be falsified? (5)

18. What is Electra Complex? Illustrate. (5)

19. What was the chemical found in the water and why was it a problem? How would you evaluate/justify the efforts by PG&E to "bury" the facts of what they were doing to the water in Hinckley? Was it done on purpose? (5)

20. In India, I personally believe yes, there is a clear fear of unknown; there's a lot of risk aversions in science and technology. They want predictability in everything they do, and it starts from people. It starts from investors. It starts from the regulators. You see that mindset across the society. Comment. (5)

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**Indian Institute of Information Technology Vadodara**  
**Winter 2023 End Semester Examination of PH 110 Electrodynamics**

The exam duration is 3 hrs. Access to internet/phone/book/notes is not allowed.  
Through out the paper the convention and notation of the textbook is followed.  
All the questions are 5 marks each.

1. Write down the four Maxwell's equations in terms of  $\vec{E}$  and  $\vec{B}$  fields. Clearly explain the reason behind the new term added by Maxwell in the Ampere's law. Using the divergence and Stokes theorem write the integral forms of these equations.
2. a) Write down the integral form of Gauss Law. b) Using it find the electric field at a distance  $z$  from an infinite planar sheet that has surface charge density  $\sigma$ . c) Further suppose if the infinite planar sheet is replaced by a grounded planar metallic sheet, and a point charge  $Q$  is placed at a distance  $z$  from the sheet, then find out the electric field at any point above and below the sheet.
3. Suppose a bar magnet is place inside a cubical box. What is the net magnetic flux  $\oint \vec{B} \cdot d\vec{a}$  that passes through the surface of the box ? Suppose if one deforms the box to change its surface and volume, then would the flux change ? Justify your answer. Next suppose you are given an electric dipole with dipole moment  $\vec{p}$  and it is place inside a metallic spherical container. What would be the electric field outside the container ? What would happen if instead of a dipole an isolated fixed charge is placed ?
4. Explain what is a) dielectric material b) paramagnetic material c) ferromagnetic material d) diamagnetic material. What is relation between  $\vec{D}$  and  $\vec{E}$  in a linear dielectric ?
5. Find the following:
- Calculate the divergence of vector field  $\lambda \vec{r}$ .
  - Calculate the curl of vector field  $\vec{F} = 3 \hat{r}$ .
  - What is gradient of the field  $V = \frac{\alpha}{r^\beta}$  ? Consider all the possible scenarios.
  - Find the formula for  $r, \theta, \phi$  in terms of Cartesian coordinates  $x, y, z$ . Using this find the expression for  $\hat{r}, \hat{\theta}, \hat{\phi}$  in terms of  $\hat{i}, \hat{j}, \hat{k}$ .
  - An electric dipole consists of equal and opposite charges separated by distance  $d$ . Find the approximate form of electric potential far away from it.

Indian Institute of Information Technology Vadodara  
 MA 102: Mathematics II (Linear Algebra and Matrices)  
 Endsemester Examination (Winter 2022-23)

Name: Kavishit Agarwal

Instructions:

Student id: S1053

Total: 55 marks

0) DO NOT WRITE ANYTHING ON THE QUESTION PAPER EXCEPT YOUR NAME AND ROLL NO.

- 1) Write down answer of each question on new page.
- 2) Use of any electronic gadget is not allowed.
- 3) Each question has 5 marks.

✓ Answer True/False to following statements:

(a) ✓ The set  $\{[a_1 \ a_2 \ a_3]^T \in \mathbb{R}^3 | a_1 a_2 = 0\}$  is a vector subspace of  $\mathbb{R}^3$ .

(b) ✓ Every non-zero matrix can be written as a product of elementary matrices.

(c) ✓ For  $A = \begin{bmatrix} 1 & 2 & x \\ 2 & 1 & 10 \end{bmatrix}$  with  $x = \text{last digit of your id}$ , there exists a matrix  $B$  of size  $3 \times 2$  such that  $AB$  is zero matrix. ✓

(d) ✓ Every  $5 \times 5$  matrix with entries from  $\mathbb{Q}$  has at least one real eigenvalue and eigenvector.

(e) ✓  $A \in M(n, \mathbb{R})$  is diagonalizable over  $\mathbb{R}$  if and only if  $A^2$  is diagonalizable over  $\mathbb{R}$ .

2. Fill in the blanks:

(a) If  $W$  is a subspace of  $\mathbb{R}^3$  of dimension 3 then  $W = \dots$

(b) Let  $T : \mathbb{R}^3 \rightarrow \mathbb{R}^3$  be such that  $T((x_1, x_2, x_3)) = (x_1 + 3x_2 - 2x_3, x_1 - 4x_3, x_1 + 6x_2)$ . Then kernel of  $T$  is a ..... of  $\mathbb{R}^3$  and is given by the equation(s) .....

(c) The rank of a non-invertible, non-zero  $2 \times 2$  matrix is .....

(d) Homogeneous linear system is always .....

(e) Every positive semidefinite matrix has ..... eigenvalues.

3. Find a matrix  $A$  with real entries of size  $4 \times 4$  with eigenvalues  $1, 2, 1+i, 1-i$ . Find its determinant, rank and nullity. Is  $A$  diagonalizable over  $\mathbb{R}$ ? Give reason.

4. Find characteristic and minimal polynomial of following matrix. Is it similar to triangular matrix? Find  $A^{100}$

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

$$\begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix} = \begin{bmatrix} x_1 + x_2 + x_3 + x_4 \\ x_1 + x_2 + x_3 + x_4 \\ x_1 + x_2 + x_3 + x_4 \\ x_1 + x_2 + x_3 + x_4 \end{bmatrix}$$

5. Let  $T : \mathbb{R}^4 \rightarrow \mathbb{R}^4$  be a function defined as  $T\left(\begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix}\right) = \begin{bmatrix} x_1 + x_2 + x_3 + x_4 \\ x_1 + x_2 + x_3 + x_4 \\ x_1 + x_2 + x_3 + x_4 \\ x_1 + x_2 + x_3 + x_4 \end{bmatrix}$ . Is  $T$  a linear transformation? If yes then find its matrix representation. Does there exist a diagonal matrix representation of  $T$ ?

- ✓ 6. What is the fastest method to find the inverse of following matrix. Apply it to find its inverse.

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

- ✓ 7. Find all solutions of following linear system. Does there exists a non-negative solution, i.e.,  $x_i \geq 0$  for all  $i$ ? Is the set of all solutions a vector space?

$$\begin{aligned} 2x_1 - 3x_2 - 7x_3 + 5x_4 + 2x_5 &= -2 \\ x_1 - 2x_2 - 4x_3 + 3x_4 + x_5 &= -2 \\ 2x_1 - 4x_3 + 2x_4 + x_5 &= 3 \\ x_1 - 5x_2 - 7x_3 + 6x_4 + 2x_5 &= -7 \end{aligned}$$

- ✓ 8. Let  $V$  be the set of all polynomials of degree less than or equal 4. Consider a function  $T : V \rightarrow V$  defined as  $T(f(X)) = \int_0^X \left(\frac{d}{dX}\right)^2 f(X) dX$ . Is  $T$  linear, one-to-one, onto? Find  $T(1 + X^2)$  using linear algebra.

- ✓ 9. Find singular value decomposition of the following matrix. Use it to find orthonormal basis of null space and column space of  $A$ .

$$A = \begin{bmatrix} 1 & -1 \\ -2 & 2 \\ 2 & -2 \end{bmatrix}$$

- ✓ 10. Describe three iterative methods to solve linear systems. Compare them. What is the convergence criteria for each method?

- ✓ 11. Use linear algebra to find the plane of best fit for the points  $(1, 5, 1)$ ,  $(3, 3, 0)$  and  $(4, 0, 5)$

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$$\begin{pmatrix} 1 & 5 & 1 \\ 3 & 3 & 0 \\ 4 & 0 & 5 \end{pmatrix}$$