

End-semester Examination 2022-23  
PH100: Mechanics and Thermodynamics

Time: 180 Minutes

Marks: 60

- All questions are compulsory and their marks are indicated in square brackets.
- All questions need to be answered sequentially without fail. Non-compliance with instructions will invite a deduction in marks.
- In case you feel any question/s is/are incorrect or have insufficient instruction then write in the answer book with your justification without wasting any time.

1. Answer the following questions briefly (not more than 10 lines) otherwise marks will be deducted.

- (a) Differentiate between the inertial and non-inertial frame of reference with examples.
- (b) If the work integral  $\int_a^b \mathbf{F} \cdot d\mathbf{l}$  is path-independent, then  $\mathbf{F}$  must be a non-conservative force. (True/False) Under what conditions,  $\mathbf{F}$  can be a conservative force?
- (c) What is the quality factor of an oscillator? Estimate its magnitude for a lightly damped oscillator.
- (d) State Kepler's laws of planetary motion.
- (e) How Planck's radiation formula explains the black-body intensity spectrum in both low and high-frequency regions.
- (f) State Heisenberg uncertainty principle. A hydrogen atom is  $5.3 \times 10^{-11} \text{ m}$  in radius. Use the uncertainty principle to estimate the minimum energy an electron can have in this atom.
- (g) How Einstein showed that the stimulated emission has the same probability as stimulated absorption?
- (h) Write down the time-dependent and time-independent form of the Schrodinger equation for a particle. How the steady state wavefunction of a particle is connected with the space- and time-dependent form of wavefunction. Justify.
- (i) What are the conditions for a well-behaved wavefunction? Is  $Ae^{-x}$  a well-behaved wavefunction? Justify.
- (j) State zeroth law of thermodynamics. [2 × 10 = 20 Marks]

2. (a) A particle of mass  $m$  and velocity  $v_0$  collides elastically with a particle of mass  $M$  initially at rest and is scattered through angle  $\theta$  in the center of the mass system. (i) Find the final velocity of  $m$  in the laboratory system. (ii) Find the fractional loss of kinetic energy of  $m$ .

(b) The logarithmic decrement  $\delta$  is defined to be the natural logarithm of the ratio of successive maximum displacements (in the same direction) of a free damped oscillator. Show that  $\delta = \pi / Q$ . Find the spring constant  $k$  and damping constant  $b$  of a damped oscillator having a mass of 5 kg, frequency of oscillation 0.5 Hz, and logarithmic decrement 0.02.

[2 × 5 = 10 Marks]

3. (a) State the postulates of quantum mechanics.
- (b) Find the energy functions in a potential box problem using  $e^{\pm ikx}$  instead of  $\sin kx$  and  $\cos kx$ . Does the eigen energy remain same for both cases. Further, write down Schrodinger wavefunction solution for particle in a box problem and plot it for  $n=1, 2, 3, 4$ .
- (b) Electron with energy 1.0 eV is incident on a barrier 10.0 eV high and 0.50 nm wide. Find the approximate transmission probability. How is it impacted if the barrier is doubled in width?
- [3 × 5 = 15 Marks]**
4. (a) (i) Discuss how experimental results of Photoelectric effect experiment is explained by the particle nature of light. (ii) In a photoelectric experiment it is found that a stopping potential of 1.00 V is needed to stop all the electrons when incident light of wavelength 260 nm is used and 2.30 V is needed for light of wavelength 207 nm. From these data determine Planck's constant and the work function of the metal.
- (b) (i) Discuss how the particle nature of wave is explained by Compton experiment. (ii) An x-ray photon of initial frequency  $3.0 \times 10^{19}$  Hz collides with an electron and is scattered through  $90^\circ$ . Find its new frequency.
- [2 × 5 = 10 Marks]**
5. A block of copper at a pressure of 1 atm (approximately 100 kPa) and a temperature of  $5^\circ\text{C}$  is kept at constant volume. If the temperature is raised to  $10^\circ\text{C}$ , what will be the final pressure? If the vessel holding the block of copper has a negligibly small thermal expansivity and can withstand a maximum pressure of 1000 atm, what is the highest temperature to which the system may be raised? Here, volume expansivity and isothermal compressibility of copper are  $4.95 \times 10^{-5} \text{ K}^{-1}$  and  $6.17 \times 10^{-12} \text{ Pa}^{-1}$ , respectively.

OR

Find out the work done by an ideal gas during quasi-static isothermal expansion or compression of an ideal gas. Further, calculate the work in compressing 2 mol of an ideal gas kept at a constant temperature of  $20^\circ\text{C}$  from a volume of 4 liters to 1 liter.

**[1 × 5 = 5 Marks]**



**End Semester Exam**  
**Spoken and Written Communication (HS 101)**  
**Marks-45**  
**Duration- 3 hrs**

**Answer the following questions (Word Limit: Min. 110- Max. 200 each)-**

1. What is lateral communication? Why is it important in an organization? (2)
2. Draw a diagram of the organs of speech and label the same. (2)
3. What is the difference between Assertive and Aggressive communication? Give examples. (2)
4. How does "An Astrologer's Day" bring out the religious hypocrisy embedded in Indian culture? (2)
5. Write a short note on air-stream mechanisms in the study of Phonetics. (1)
6. What according to you are the characteristics of Grapevine communication in an organization? State the advantages and disadvantages of the same. (2)
7. Write a short note on the topic- "Kinesics-The Art of Body Language". (2)
8. What is an IPA Chart used for? (2)
9. How is the story "The Monkey's Paw" a constant struggle between Fate and Free will? (2)
10. Write a short note on the importance of paralinguistics in successful communication? (2)
11. What is the purpose of Vertical communication in an organization? Explain your answer with examples. (2)
12. The Accents of our Bodies: Proxemics as Communication. Comment on this title in your own words. (2)
13. State the manner of articulation for the sound /p/. (1)
14. What is the significance of Persuasive communication? Give examples. (2)
15. Distinguish between phonetics and phonology. (2)
16. What is a Fishbone diagram? Draw the diagram and explain the same. (2)
17. What do you understand by diphthongs and monophthongs? Give examples of both. (2)  
*(combination of 2 sounds)*
18. Why does Pi give Richard Parker credit for his survival? (1)
19. Explore Mr. John Keating's influence on his students and how his encouragement of originality and "carpe diem" affect them. (1)
20. With an increasing population communicating via the internet and text messages, will face-to-face communication be a thing of the past? Comment. (1)
21. Describe how and why O' Henry compared Della's hair to Queen Sheba's Jewels and Jim's watch to King Solomon's treasure? (2)

**Indian Institute of Information Technology Vadodara**  
**End Semester Examination (Autumn, 2022-23)**  
**Course: EC100 Basic Electronic Circuits**

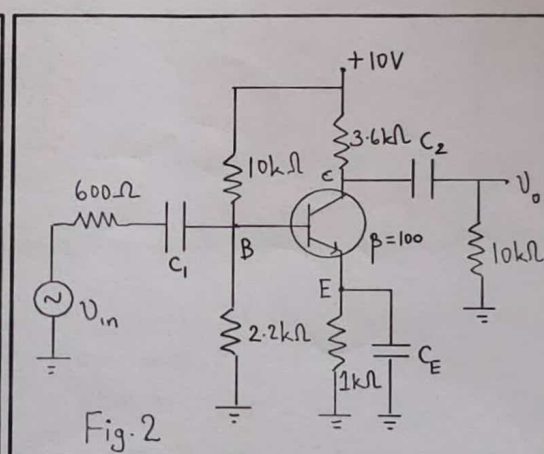
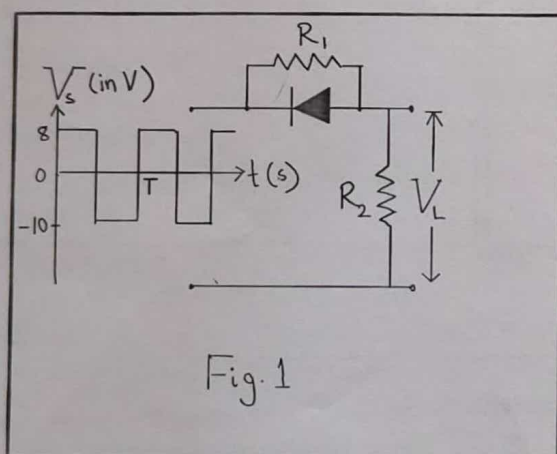
**Full Marks: 120**

**Date: 16/03/2023**  
**Time: 2:00-5:00 PM**

**Instructions:**

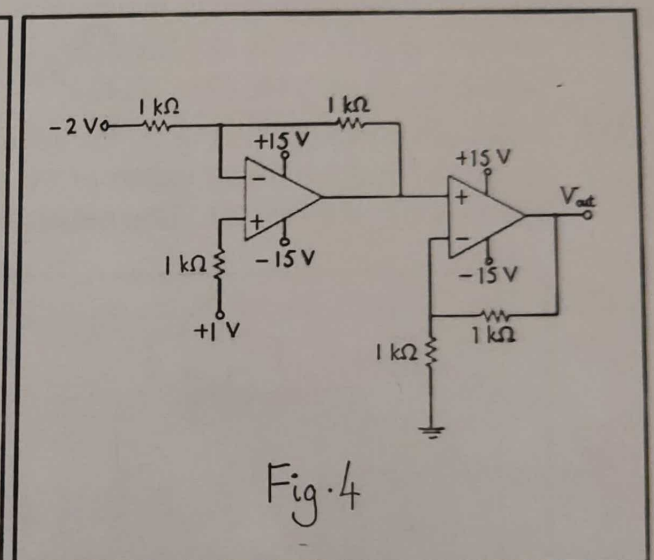
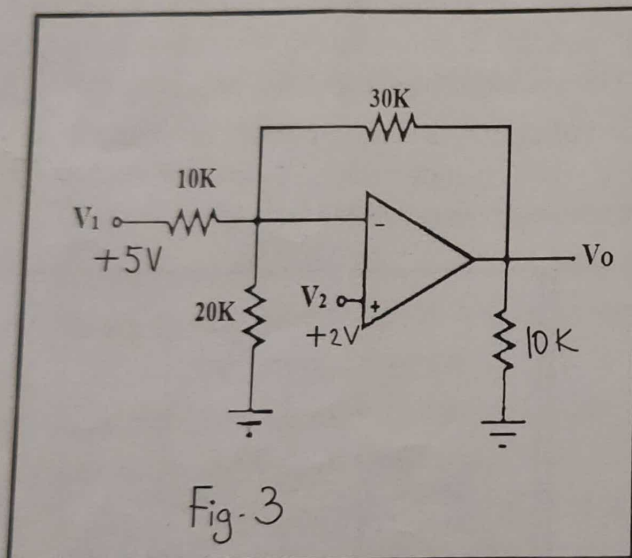
1. Attempt **ALL** the questions. Each question carries 10 marks.
2. Answer each question sequentially beginning on a new page.
3. It is permitted to use a scientific calculator.

- Q1.** State superposition theorem in any linear and bilateral electronic circuits. With a suitable circuit, as an example, prove the theorem.
- Q2.** Determine the approximate expression of the concentration of electrons in the conduction band of a semiconductor in equilibrium and at temperature  $T$ . The Fermi distribution function is  $f(E) = [1 + \exp\{(E-E_F)/k_B T\}]^{-1}$  and the density of energy states in the conduction band is  $D_C(E) = 8\pi m_n [2m_n(E-E_C)]^{1/2}$ . The symbols have the usual meaning.
- Q3.** In the circuit shown in Fig. 1, the source voltage  $V_s$  is a square wave of time period  $T$  with maximum and minimum values of 8V and -10V, respectively. Assume the diode is an ideal diode and  $R_1 = R_2 = 75\Omega$ . Determine the average value of load voltage  $V_L$ .



- Q4.** You are assigned to design a regulated dc-power supply which can be connected to 220V, 50 Hz for inputs and can supply regulated 5V at the output. Propose a circuit with suitable values of the circuit elements to meet the given specifications.
- Q5.** Write down four differences between bipolar junction transistors and field effect transistors. Draw the schematic device structure of (i)  $n-p-n$  bipolar junction transistor, (ii)  $p$ -channel junction field effect transistor and (iii)  $n$ -channel enhancement metal-oxide semiconductor field effect transistor.
- Q6.** For the circuit shown in Fig. 2, draw (i) dc-equivalent circuit and (ii) ac-equivalent circuit using  $\pi$ -model of the transistor.

- Q7. In the circuit shown in Fig. 2, assume the base-to-emitter voltage = 0.8 V. Plot the dc load line on the output characteristics of the transistor and locate the operating point.
- Q8. Plot a typical voltage gain (in dB) versus frequency response of a voltage divider bias common-emitter bipolar junction transistor. Locate the lower and upper cut-off frequencies.
- Q9. What is an operational amplifier (Op-Amp)? Write down typical values (both ideal and practical) of its following characteristics (i) Open-loop Voltage Gain, (ii) Input Impedance, (iii) Output Impedance.
- Q10. For a given circuit in Fig. 3, determine  $V_o$ , assuming that the Op-Amp to be ideal.
- Q11. For a given circuit in Fig. 4, determine  $V_o$ , assuming that both the Op-Amps are ideal.
- Q12. The device parameters of an  $n$ -channel junction field effect transistor are: maximum drain current is 15mA, Pinch-off voltage is 4V. Calculate the drain current for (i) Gate to Source voltage = 0V (ii) Gate to Source voltage = -2V and (iii) Gate to Source voltage = -4V





Date of Exam - 15.03.2023

INDIAN INSTITUTE OF INFORMATION TECHNOLOGY VADODARA  
END-SEMESTER EXAM

IT101: Introduction to Programming and Problem Solving

MAX MARKS: 45

Duration: 180 MINUTES

INSTRUCTIONS -

- 7.5
- Any six
1. Attempt ~~all nine~~ questions. Every question has 8 marks each.
  2. Write the programs using important comments in a neat and structured way. Marks will be deducted for untidy and unstructured code without useful comments.
  3. Be brief, precise and clear in writing the definitions and other useful concepts.

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**Qus 1:** What are the different sections of a C program? Write a program that input a four digits unsigned integer number 1234 from a keyboard and convert it to a number 4321 (reversing the digit positions of a four digits input number) Mention the different sections of the program. (5 Marks)

**Qus 2:** What is an algorithm? Write a program to find the LCM of two unsigned numbers using Euclidean algorithm for GCD. Show the iteration using table for a = 60, b = 9; Why Euclidean algorithm is a better algorithm than the traditional approach (5 Marks)

**Qus 3:** What is data type? Write two main differences between int and float primitive data types. Write a C program to find the sum S of the following series:

$$S = 1 - \frac{1}{1!} + \frac{1}{2!} - \frac{1}{3!} + \dots$$

Stop the program to calculate the sum S to the accuracy of 3 decimal places. What do you think should be output of the program should be analytically? (5 Marks)

**Qus 4:** What is pointer in C programming? State one important advantage and disadvantage of using pointer in C. Write a program to solve the Quadratic equation  $ax^2 + bx + c = 0$ . Take the input a, b, and c using keyboard. The main function calls Quad() that returns the two roots. (5 Marks)

**Qus 5:** What is an array data type and why is it useful? State one important advantage and disadvantage of using array in C. Write a C function to sort an array using insertion sort. The definition of the function is given as follows:

void InsertionSort(int Arr[], int ArrSize)

(5 Marks)

**Qus 6:** What is a bit operator in C. Mention all the bit operators in C programming. State one important advantage of bit operator. Write a C program to count the number of set bits in a given integer using bitwise operators. For example, the number of set bits in number = 10101011 is 5. **(5 Marks)**

**Qus 7:** What is the use of stack memory and stack data structure in the computer? What is recursion? Write a C function to find the factorial of a natural number using recursion. Use the function to find  $N!P_K$ . **(5 Marks)**

**Qus 8:** What is dynamic memory allocation? State one important advantage and disadvantage of using dynamic memory allocation. Write a C program to dynamically allocate memory for an integer array of n elements and then input n and the array using fscanf() and print its average value using fprintf(). Do not forget to free the allocated memory at the end of the program. **(5 Marks)**

**Qus 9:** What is a structure data type and why is it useful? Write a C program to define a structure named Student with fields for name, roll number, marks in three subjects, and calculate the average marks of each student. Then sort the students in ascending order based on their marks in Hindi. You can initialize the following data inside the program instead of using the following data: Use the function InsertionSort(int Arr[], int ArrSize) for sorting the students based on their average marks. **(5 Marks)**

Index	Name	Mathematics	Hindi	English
0	Diya	2	7	6
1	Bhupendra	9	5	1
2	Preeti	4	3	8

**Note:** Students are advised to write the programs using comments in a neat and structured way. Marks will be deducted for untidy and unstructured code without useful comments.



Name:

Roll No.:

MA101: MATHEMATICS I: INTRODUCTION TO DISCRETE MATHEMATICS  
ENDSEMESTER EXAMINATION

TIME: 3 HRS, MARKS: 60

Instructions: 1. Write your name and roll number on the top of question paper and Answersheet.

2. New question should start on new page and solutions must be written clearly.

3. Do not write anything on question paper.

4. Use last page of your answersheet for rough work.

5. No electronic device is allowed.

1. Answer True/False to the following sentences.

5 Marks

(a) Let  $R$  be a reflexive relation on a set  $A$ . Then  $R \subseteq R^2$ .

(b)  $K_4$  is a planar graph.

(c)  $\forall x(P(x) \Rightarrow Q(x))$  and  $\exists x(P(x) \wedge \neg Q(x))$  are logically equivalent.

(d)  $P(A \times B) = P(A) \times P(B)$ , for any sets  $A, B$ .

(e)  $|[1, 2]| = |(5, 10)|$

2. Write down the final answer for each of the question given below.

6 Marks

(a) Find no. of ways to select 5 fruits from a basket of 10 mangoes, 5 bananas, 7 oranges and 5 apples.

(b) What will be the output of following pseudo-code:

$A = 0$ ,

for  $j = 1, j \leq 5, j++$

{

for  $i = 0, i \leq 6, i++$

{

$A = A + i^2 j^3$

}

}

Print (A);

(c) Find  $|\{0, 1, 2, 3, 4, 5\} \times \mathbb{N}|$ .

(d) Find the number of bit strings of length 5 with two consecutive zeros.

(e) How many natural numbers  $< 1000$  are there which do not contain a digit twice.

(f) Find last two digits of  $333^{2023}$ .

(g) What will be day and date on 1000th day after today. For example, 7th day will be Monday with date: 20/03/2023. 2024 is a leap year.

3. Find  $6^{2023} \bmod (715)$ .

4 Marks

4. Using generating function, find the number of ways to make change for Rs 200, using notes of 10, 20 and 50 if at least one note of each denomination is used. Can you solve this problem using another technique?

5 Marks

5. Find  $f(n)$ , when  $n = 2^k$  and  $f(n) = 8f(n/2) + n^2$  with  $f(1) = 1$ .

5 Marks



6. Write down Dijkstra's algorithm for finding shortest distance and path between a pair of vertices in a connected simple weighted graph. **5 Marks**

7. Is the following relation transitive? If not then use Warshall's algorithm to find the transitive closure of the relation on the set  $\{1, 2, 3, 4\}$  **5 Marks**

$$R = \{(2, 1), (2, 3), (3, 1), (3, 4), (4, 1), (4, 3)\}$$

8. Consider the set  $P(\mathbb{N})$ . Define a relation  $R$  on  $P(\mathbb{N})$  as  $ARB$  iff  $A \subseteq B$  for any sets  $A, B \subseteq \mathbb{N}$ . What are the properties of this relation? Does it have minimal and maximal elements? If yes then list them. **5 Marks**

9. Consider the following graph- $G$ . Give justification for each argument. **10 Marks**

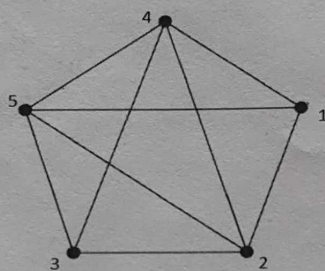
(a) Represent it using a matrix. Can we get two different matrices which will represent  $G$ ?

(b) Is  $G$  bipartite? *partial*

(c) Can you draw  $G$  without lifting your pen and without retracing an edge twice?

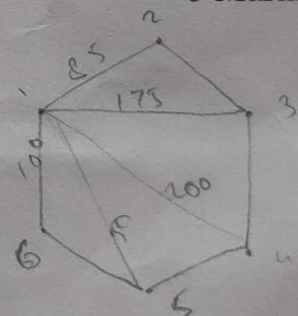
(d) What is the chromatic number and edge chromatic number of  $G$ ?

(e) Is  $G$  planar?



10. How many different channels are needed for six stations located at the distances shown in the table, if two stations cannot use the same channel when they are within 150 miles of each other? Give justification. **5 Marks**

	1	2	3	4	5	6
1	—	85	175	200	50	100
2	85	—	125	175	100	160
3	175	125	—	100	200	250
4	200	175	100	—	210	220
5	50	100	200	210	—	100
6	100	160	250	220	100	—



11. Prove or disprove there exists integers  $x, y$  such that  $x^2 - 5y^2 = 2$ . Which method did you use? **5 Marks**