B.Sc. (Honours) in Physics, Sem: III - 2023

Subject/Papers: [SECC-1] - Computational Physics Skills

Time: 2 Hours, Maximum Marks: 25

Questions are of equal marks or as indicated in the margins

Answer question 1 and any three others

1.

(a) Match left hand side with the corresponding right hand side:

expert	SQL
query	OpenSCAD
$fn=5	CLIPS
importance	concurrent
whenever	salience

(5 × 1)

(b) In your own words, describe what is implied by a *view* in SQL.(2)

(c) Describe the syntax of an STL file (ascii version, not binary). (2)

(d) Indicate the line number for the syntactically wrong line:

i. {assert(Hermione Granger is a cry-baby, but very brave)}

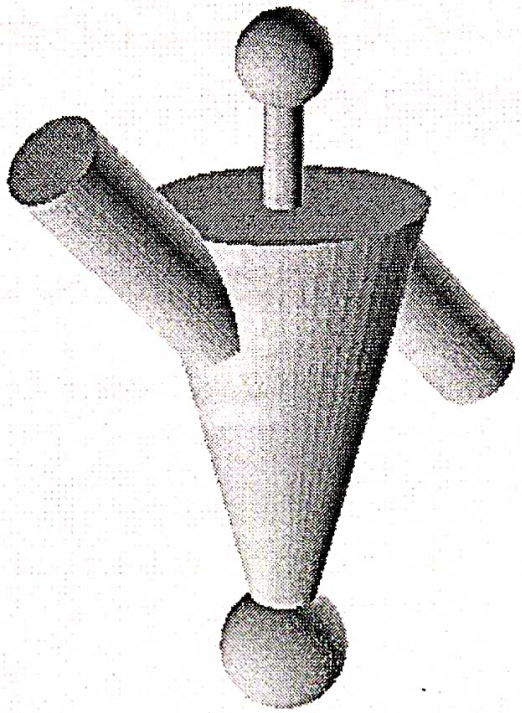
ii. select *,1 froom bhoot

iii. cylinder(r1=5, r2=7, h=10, $fn=50);

(1)

2. What does the *build* command do in CLIPS? Write a CLIPS programme which creates decision stumps (learns) given facts of the form (sekho ?x ?y ?z)
Describe how your programme works clearly in your own words. (5)

3. Try to reverse-engineer (find) the OpenSCAD code which created the object shown below:



(5)

4. Set up CLIPS code to recursively expand *[a + b] * [a - b]* into *a ^ 2 - b ^ 2* from a given fact. Remember that *a* and *b* can be any single word, i.e your code should work for *[x + y] * [x - y] + [bhoot + poot] * [bhoot - poot] + sheora gach* also. (5)

5.

   (a) There is a table containing the following data for students: *id (integer), name (text), gender (single character), semester (integer).* Form a query which increases the semester of a student with a given *id* by one. Keep in mind that the maximum semester number can be six. (2)

   (b) Explain clearly, in your own words, how an SQL query can be used to extract data from multiple tables and present it as a single resultant output. (3)

6.

(a) What does *$fn=50* mean in OpenSCAD?

(b) What does *implode* and *gensym** do in CLIPS?

(c) How does *between* work in SQL?

(d) What is meant by *prefix form*; demonstrate with an *neq* clause in CLIPS. $(1+2+1+1)$

B.Sc. (Honours) in Physics Examination, 2023
Semester-III (CBCS)
Core Course: CC-5
Mathematical Physics II (Theory)

Time : 3 Hours **Full Marks : 40**

Questions are of value as indicated in the margin

Symbols bear their usual meanings

*Answer **any four** questions*

1. a) Obtain the Fourier series representation of $f(x) = x^2$ in the interval $-\pi \leq x \leq \pi$.

b) Using the result obtained in (a), find out the sum of the series

$$\frac{1}{1^2}+\frac{1}{2^2}+\frac{1}{3^2}+\frac{1}{4^2}+ \ldots\ldots\ldots\ldots$$

c) Using the result obtained in (a), find out the series representation of $g(x) = x$ in the same interval.

d) Evaluate

$$\int_0^{\frac{\pi}{2}} sin^4\theta \; d\theta$$

4+2+2+2=10

2. a) Obtain the series solution for the following differential equation (only for the first root) about the point $x = 0$ by Frobenius method:

$$(2x + x^3)\frac{d^2y}{dx^2} + 3\frac{dy}{dx} - 2xy = 0$$

b) Prove that

$$\sum_{n=0}^{\infty} P_n(x) = \frac{1}{\sqrt{2-2x}}$$

8+2=10

3. a) The differential equation for heat flow through an insulated one-dimensional bar is given by

$$\frac{\partial\theta}{\partial t} = h\frac{\partial^2\theta}{\partial x^2}$$

where h is the material constant of the rod. Find a general solution of this equation using the separation of variable technique with the boundary conditions:

$$\theta(0,t) = \theta(l,t) = 0$$

$$\theta(x,0) = \frac{x(l-x)}{l^2}, \quad 0 < x < l$$

b) Starting from the Hermite differential equation

$$\frac{\partial^2 y}{\partial x^2} - 2x\frac{\partial y}{\partial x} + 2ny = 0$$

establish the orthogonality relation for the Hermite polynomials given by

$$\int_{-\infty}^{+\infty} e^{-x^2} H_m(x) H_n(x) dx = 0 \quad \text{for } m \neq n$$

7+3=10

4. a) The generating function for Legendre polynomials is given by

$$(1 - 2xt + t^2)^{-\frac{1}{2}} = \sum_{n=0}^{\infty} P_n(x)\, t^n$$

From this, show that

$$n\, P_n(x) = xP_n'(x) - P_{n-1}'(x)$$

b) Show that

$$J_{\frac{1}{2}}(x) = \sqrt{\left(\frac{2}{\pi x}\right)} \sin x$$

c) Show that for an even function, the Fourier series is a cosine series.

d) Evaluate $\beta\left(\frac{1}{2}, 2\right)$

3+3+2+2=10

5. a) Given

$$J_n(x) = \sum_{r=0}^{\infty} \frac{(-1)^r}{r!\, \Gamma(n + r + 1)} \left(\frac{x}{2}\right)^{n+2r}$$

From this, establish the relation

$$xJ_n'(x) = -nJ_n(x) + xJ_{n-1}(x)$$

b) Express $f(x) = 4x^3 - 2x^2 + x - 2$ in terms of Legendre polynomials.

c) Using the properties of Gamma function show that

$$\int_0^{\infty} x^n e^{-ax} dx = \frac{n!}{a^{n+1}}$$

d) The voltage across a wire is (100 ± 5) V and the current passing through it is (10 ± 0.2) A. Find the resistance of the wire and the error therein.

3+2+3+2=10

6. a) Fit the given set of data in a straight line using the least square method. Obtain the values of slope and intercept of the fitted line.

x	1	2	3	4	5	6
y	1	2	2	5	6	5

b) Hence find the error on the slope and intercept of the fitted line.

c) Consider an elastic string of length l fixed at two ends under a constant tension T. Show that the transverse vibrations of the string lead to the one-dimensional wave equation.

4+2+4=10

Visva-Bharati

B.Sc (Hons) ExaminationSEM-III -2023

Subject: Physics — PAPER: Thermal Physics (CC-6)

Time: 3 hours — Full Marks: 40

Answer any four (4) Questions. Marks are indicated in the margin.

1. (a) Derive the Maxwell's thermodynamic relations. 3.5

(b) Prove that $C_P - C_V = -T\left(\frac{\partial V}{\partial T}\right)_P^2 \left(\frac{\partial P}{\partial V}\right)_T$, where the terms are of usual meaning. Is $C_P - C_V$ a negative quantity? Explain properly. For water, mention the temperature with proper reason at which $C_P - C_V$ is zero. 3.5

(c) What do you mean by 'heat', 'work' and 'internal energy'? Distinguish between them. 3

2. (a) What do you mean by thermal diffusivity of a material? Is the term meaningful at steady state? 1.5

(b) Set the Fourier equation of one dimensional heat flow. Find out the solution of the equation at steady state. 2+2=4

(c) What will be temperature at a distance '*l*' from the hot end of lagged bar. 1.5

(d) Calculate the time for the formation of '*3 cm*' thick ice on the surface of a lake when the surrounding air temperature drops to '*-20° C*'. Given, density of ice *0.917 g/c.c*, latent heat *80 cal/gm*, thermal conductivity *0.005 cal* $cm^{-1}sec^{-1}°C^{-1}$. 3

3. (a)State the 'Kelvin-Plank' and 'Clausius' statements of second law of thermodynamics. 2

(b) Prove the Carnot's theorem 'Working between the same temperature limit no irreversible engine will be more efficient than a reversible one'. 3

(c) A Carnot engine whose low temperature reservoir is at 7°C has an efficiency of 40%. It is desired to increase the efficiency to 50%. By how many degrees should the temperature of the source be increased? 3

(d) State the 'zeroth law of thermodynamics' and explain that this law is the basis of measuring temperature by a thermometer. 2

4. (a) Neatly draw the theoretical curves of van der Waals equation for real gases for different temperatures '*T*'. On the curves show the locus of maxima and minima points and locus of the three different real roots of the equation for a particular '*p*'. Properly mark the collapsible state of the on particular isothermal. 4

(b) Assuming the critical state corresponds to a point of inflexion of an isothermal, find out the critical volume, temperature and pressure for a gas obeying the equation $p=(RT/V-b)\times e^{-(a/RTV)}$, where '*e*' is the exponential, '*a*', '*b*', '*R*' are constants and all other symbols have their usual meaning. 3

(c) Find out Boyle temperature T_B in terms of T_C. 2

(d)Describe the characteristics of critical state. 1

5. (a) Write down the assumptions of the kinetic theory. 2

(b) The energy distribution law of a system of ideal gas molecules at a temperature $T\,K$ is given by

$$n(\varepsilon)d\varepsilon = AN\exp(-\varepsilon/KT)\varepsilon\sqrt{\varepsilon}d\varepsilon$$

where 'A' is a constant and 'N' is the total number of molecules. Find out the (i) value of the constant 'A', (ii) Hence find the most probable energy and (iii) the average energy of the molecules. 2+1+1=4

(c) Show graphically how the distribution of velocities of Maxwell's gas changes with absolute temperature and the mass of the gas molecules 2

(d) Find the ratio of the molar specific heats for diatomic gas. Is this value match with experimental value Cl_2 gas at room temperature? 2

6. (a) Explain what is meant by 'mean free path' of molecules in a gas. Find out the expression of 'survival equation'. 1+2=3

(b) Show that the mean free path of the gas molecules in thermal equilibrium in an enclosure is approximately $1/\pi n\sigma^2$, where 'n' and 'σ' are density and diameter of the gas molecules. 2

(c) A shower of 5000 molecules, each originally moving with a same velocity, traverses a gas. Find the number of molecules which will remain undeflected even after traversing a distance equal 0.5 and 1 time the mean free path. 2

(d) Find out the expression of adiabatic work-done. 3

7. (a) What is meant by 'thermodynamic equilibrium' of a system? 1.5

(b) What do you mean by quasistatic process? Justify the statement "All reversible processes are quasistatic, but all the quasistatic processes are not reversible". 2

(c) Show that heat change 'dQ' and change in entropy 'dS' are inexact and exact differential respectively. 2.5

(d) Find out the change in entropy when two gases diffuse into one another. Show that this change is always positive for two different gases. In this context explain the Gibb's paradox. 2.5

(e) Why specific heat of saturated vapour pressure is negative? 1.5

B.Sc. (Honours) Examination, 2023
Semester III (CBCS)
Physics (Core)
Core Course: CC-7
(Digital Systems and Applications)

Time: Three Hours **Full Marks: 40**

Questions are of value as indicated in the margin
Answer **any four** questions

1. a) Find the value of $32B_{16} + B23_{16}$ and present in Octal number system

   b) Represent -30 in signed 2's complement form. Add the following signed numbers given in 2's complement and also show its equivalent decimal number

   (i) 00011010 and 11101100 (ii) 11100010 and 11101111

   c) Find Binary equivalent of a BCD number 1001 1000

   d) Generate 9's complement of $(75)_{10}$ using Excess-3 code

   2+4+2+2

2. a) Design a two input NAND gate using discrete electronic components.

   b) Consider the truth table given below (with three variables A, B, C and Y_1, Y_2 are outputs). Design the circuits using only NOR ICs.

A	B	C	Y_1	Y_2
0	0	0	1	0
0	0	1	0	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	1	0
1	1	1	0	1

   c) Design a 2-input digital system whose outputs generate the square value of the input.

   3+4+3

3. a) Implement the Boolean expression $F = \Sigma m\ (1, 3\text{-}4, 6, 7, 9, 11\text{-}14)$ using

   (i) minimum number of 8:1 MUX

   (ii) only NOR gates

b) Design a full adder using only NAND 7400 ICs.

3+3+4

4. a) Explain what is meant by 'race around' problem in a JK flip flop. How this problem is eliminated? .

   b) How can you construct an SR-flip flop from D-flip flop with the help of excitation table?

   c) Design a counter with the following sequence of states

A	B	C
0	0	0
0	1	0
1	1	0
1	1	1
1	0	0

3+3+4

5. b) Draw the internal block diagram of 555 Timer. How can you add the external circuit elements to make it functional as an astable multivibrator.

   c) Show the internal structure of a 16 bit (4X4) PROM? What is Mask-ROM?

4+2+2+2

6. a) Draw the internal block diagram of a typical 8- bit microprocessor.

   b) State the function of the following instructions used in 8085 microprocessor

   i) LDA 7200 ii) INR C iii) MOV H, B iv) ORI 25H

   c) Write an assembly language program for 8085 microprocessor to perform the following operation. Store the result at memory location 5300H

   5AH+25H-3CH

5+2+3

7. Write Notes on (***any two***)

   a) BCD ADDER

   b) Ring Counter

   c) PISO shift Register

   d) One-bit RAM cell

5+5

B.Sc. (Hons.) Examination, 2023

(Semester-III)

PHYSICS

Paper: GEC-3

Thermal Physics & Statistical Mechanics

TIME: 3 HRS. FULL MARKS: 40

Attempt *four* questions. **Question No. 1 is compulsory.**
Questions are of value as indicated in the margin.

1. (a) Does the gas do any work during adiabatic process? If yes, what is the source of this energy?

   (b) What are the state functions? Name any two such functions.

   (c) Define the entropy. What is its significance?

   (d) Write down the basic postulates of kinetic theory of gases.

   (e) What do you mean by the degree of freedom. Calculate the number of degrees of freedom for the monoatomic, diatomic gas molecules. [5×2]

2. (a) State the first law of thermodynamics using mathematical form. [2]

   (b) Show that the slope of the adiabatic curve is γ times more than the slope of the isothermal curve. [2]

   (c) A perfect gas at 27^0C is suddenly compressed to 8 times of its original pressure. Find the rise in temperature (if $\gamma = 1.5$). [2]

   (d) Calculate the work done during the isothermal expansion by 1 mole of (i) perfect gas, and (ii) van der Waals' gas. [2+2]

3. (a) What is a Carnot's engine? Explain Carnot's cycle on the p-V diagram for an ideal gas. Derive an expression for the work done in a cycle of operation and hence calculate its efficiency. [1+4]

   (b) Calculate the efficiency of Carnot's engine working between the temperature 300^0C and 15^0C. If 100 Calories of heat are absorbed by the engine at the temperature, find the work done by the engine in Joules. [3]

   (c) State the conditions of the reversibility of a thermodynamic process. [2]

4. Derive Maxwell's distribution law of speed for a gas in thermal equilibrium. Deduce the expressions for the most probable velocity and average speed. [6+2+2]

5. (a) What is the mean free path? Calculate the mean free path of a gas molecule if the temperature of the gas becomes twice of its initial temperature. [1+2]

   (b) Define the collision frequency? Find the number of collisions by a H_2 molecule in one second if $T = 300K, p = 1atm$ and the radius of the H_2 molecule is $0.95 \times 10^{-8} cm$. [1+2]

   (c) Define the coefficient of viscosity. Deduce the expression of coefficient of viscosity in terms of microscopic collision cress-section. [1+3]

6. (a) What is a perfect black body? How can one achieve a perfect body in practice? [2]

(b) Write down the Plank's radiation formula. Using this formula, derive the expressions of Rayleigh-Jeans and Wein's formula. [3]

(c) What do you mean by internal energy and enthalpy of a system? Using these functions, derive the Maxwell's third and fourth thermodynamic relations. [1+2+2]