UNIVERSITY OF NORTH BENGAL

B.Sc. Honours 3rd Semester Examination, 2023

SEC1-P1-PHYSICS

Time Allotted: 2 Hours   Full Marks: 60

The figures in the margin indicate full marks.

The question paper contains SEC-1A and SEC-1B. Candidates are required to answer any *one* from the *two* papers and they should mention it clearly on the Answer Book.

SEC-1A
COMPUTATIONAL PHYSICS

GROUP-A

1.   Answer any *four* questions from the following: 3×4 = 12

   (a) Write an algorithm to find *n*!.
   (b) Write three advantages of Linux.
   (c) What is a flowchart? Why is it useful?
   (d) Discuss three rules of defining a correct FORTRAN variable.
   (e) Write a FORTRAN program to input "All Day I Dream About Sports" and print its abbreviation.
   (f) Suppose a folder in a computer contains many kinds of files. Write the DOS commands to navigate to the directory, list the contents of the folder and delete the image files.

GROUP-B
Answer any *four* questions from the following   6×4 = 24

2. (a) Describe the SELECT CASE statement in FORTRAN.   2

   (b) Given a positive integer *n*, write an algorithm to find sum of the series $1^2 - 2^2 + 3^2 - 4^2 + ... \pm n$.   4

3. (a) Suppose there is a data file "data.txt" which contains two columns *x* and *y*. Write Gnuplot commands to plot *x* vs. $\log(y^2)$ along with proper axes labels and legend.   3

   (b) Write the Latex statements to create the following numbered list: 3
   (i) Programming Languages
       (A) BASIC
       (B) FORTRAN
       (C) C
   (ii) Object Oriented Programming languages
       (A) C++
       (B) Java
       (C) Python

4. Using a Subroutine, calculate the sum of the following series up to $n = 10$.   3+3

$$e^x = \sum_{n=0}^{\infty} \frac{x^n}{n!}$$

Use this subroutine to calculate $\sinh x = \dfrac{e^x - e^{-x}}{2}$ for $x = -1$ to 1 in increments of 0.1.

5. Construct the following output in Latex assuming that "Reference.bib" file contains details of all references required and the required bibliography style is defined by "Bibstyle". The bibliography should be in font size 10. Ignore the preamble of code. Assume that the four references are defined in the Reference.bib file by the labels 'ref1', 'ref2', 'ref3' and 'ref4'.   6

At the outset of the present decade a new 114 ferrimagnet was discovered showing strong electric polarization [1]. The compound was derived from yet another newly discovered 114 oxide system, Lanthanides based cobaltates, of the last decade [2-4]. Both of these are characterized by quite distinctive alternate stacking of triangular layers of corner sharing Cobalt tetrahedra [3].

References

(i)   K. Singh, *et. al.*, Phys. Rev. B **86** (2012), 024410.

(ii)   M. Valldor, J. Phys. Condens. Matter **16** (2004) 9209.

(iii) M. Valldor, M. Andersson, Solid State Sci. **4** (2002) 923.

(iv)   L. C. Chapon, *et, al.*, Phys. Rev. B **74** (2006), 172401.

6. A data file "Data.dat" has four columns. The first two columns are x, y data of an experiment and the 3rd and 4th columns are data for x and y error bars. Write a set of GNUPlot commands that will plot the experimental data as points plot with x and y error bars, fit the data to the equation $f(x) = ax^2 + bx$ and plot the fitted data as a line plot with auto-scale. Display legend in the plot, give a title "Fitting of experimental data", x-label "Time (s)", y-label "Speed (m/s)".   6

7. Sketch a flowchart to calculate the product of a $n \times m$ and $m \times n$ matrix and then calculate trace of the resulting matrix.   6

GROUP-C
Answer any *two* questions from the following $12 \times 2 = 24$

8. (a) Write down LaTeX code to display the following set of numbered equations.   8

$$\epsilon' = \epsilon_\infty + (\sigma_0/\epsilon_0)\,\omega^{s-1}\tan(s\pi/2) \qquad (1)$$

$$\sigma_{tot} = \sigma_{dc} + \sigma_0\omega^s + \sigma_1\omega^n \qquad (2)$$

(b) Write down specific LaTeX commands to do the following tasks: 4
   (i)   Write an article in double column format.
   (ii)   Write text in colour.
   (iii) Write text in italics.
   (iv) Write roman style text within equation environment.

9. (a) You have a data file "exp.dat" which contains three columns x, y and z. Write GNUPlot commands to plot $\ln(y^2)$ and $\ln(z^3/100)$ against $1/x$ in the same plot with plot title, axes labels and legend. Use 'line + symbols' style of graph.   4

(b) Describe the basic components of Linux? 4

(c) State the functions of the following Linux commands. 4

    $ pwd

    $ ls

    $ cd <C:\Documents>

    $ mkdir <D:\Latex\Documents>

10.(a) Given a function $f(x)$, write a FORTRAN program to compute the area under the curve between $x = L_1$ and $x = L_2$. 6

(b) The x and y components of a force are given by X and Y. Write a program that reads X and Y, calculates the magnitude $R = (X^2 + Y^2)$ and angle $= \tan^{-1}(Y/X)$ of the force. 6

11. Write a FORTRAN program to input n data of Temperature (T) vs. Voltage (V) of an experiment with a semiconductor and store it in arrays. Calculate resistivity from it using the formula 3+2+4+3

$$Rho = \frac{0.22 \times 2\pi V}{0.005 \times 4.2}.$$

Then create a data file named "exp-data.dat" with the following column names separated by tab-spacing — "Temp", "Voltage", "Resistivity", "Inverse T" and "logRho". This line should start with '#' character. Now write the following data values in the data file — T, V, Rho, $1/T$, $\ln(Rho)$;

arranged in respective columns.

Write GNUPlot code to plot $\ln(Rho)$ vs. $1/T$ from the data file using 'line+points' style with proper axes labels and title. Then fit the data to a straight line to find the fitting parameters.

SEC-1B

ELECTRICAL CIRCUITS AND NETWORK SKILLS

GROUP-A

1. Answer any *four* questions from the following: $3 \times 4 = 12$

(a) Distinguish between single phase and three-phase AC sources.

(b) What are real, imaginary and complex power components of AC source?

(c) A sinusoidal e.m.f. is applied to a circuit containing a capacitor and a resistor in series. Show that the power is dissipated only in resistance.

(d) What are the advantages of using inductive and capacitive circuits over resistive circuits?

(e) What will be the speed of a motor having 4 pole, energized by the supply of 50 Hz frequency?

(f) Draw the electrical circuits symbols of (i) Relay, (ii) Circuit breaker and (iii) Volt-meter.

GROUP-B

Answer any *four* questions from the following $6 \times 4 = 24$

2. What is conduit wiring system? Discuss its advantages and disadvantages. 2+4

3. (a) What do you mean by sensitivity of an electrical instrument? Explain the advantages of electronic voltmeter over conventional type voltmeter with respect to sensitivity.   1+3

   (b) Explain how can one construct a voltmeter using an ammeter.   2

4. Describe the theory of rotating magnetic field generation using a three-phase line.   6

5. For an alternating current $I = I_0 \sin \omega t$, deduce r.m.s. and average values of the current. Which one does an AC ammeter measure?   5+1

6. Describe star and delta connection. Discuss the properties of power available in each connection type.   6

7. (a) What are impedance, admittance, capacitive and inductive reactance of an AC circuit?   4

   (b) Discuss the phase differences of current and voltage in a capacitor and an inductor.   2

GROUP-C
Answer any *two* questions from the following $12 \times 2 = 24$

8. (a) Discuss the working principle of a DC motor and give significance of the Back e.m.f.   6

   (b) Find voltage equation of a DC motor and establish the condition for maximum power.   3

   (c) A 440-V shunt motor has armature resistance of $0.8\,\Omega$ and field resistance of $200\,\Omega$. Determine the back e.m.f. when giving an output of 7.46 kW at 85% efficiency.   3

9. (a) Explain the working principle of an ideal transformer. Find e.m.f. equation of an ideal transformer.   5+3

   (b) A single-phase transformer has 500 turns and 1200 turns in the primary and secondary respectively. The cross-sectional area of the core is 80 sq. cm. If the primary winding is connected to a 50 Hz supply of 500 V, calculate
(i) Peak flux density.
(ii) Voltage induced in the secondary.   4

10.(a) Define time constant of an RC circuit. Find out the time constant and charge stored at $t = 0.005$ sec for a series RC circuit connected across 10 Volt source. [Given $R = 200\,\Omega$, $C = 0.5\,\mu F$].   2+4

   (b) Calculate the equivalent resistance of the circuit (between terminals A and B).   6
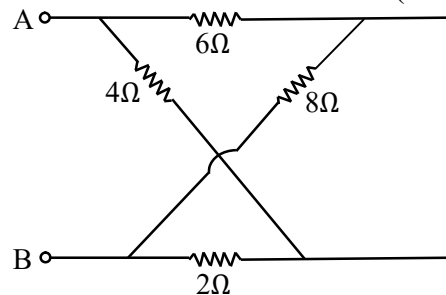
11.(a) Find expressions for (i) Resonant frequency, (ii) Quality factor and (iii) Impedance of a parallel LCR circuit.   6

   (b) Why a parallel LCR circuit is called a rejector circuit?   2

   (c) A coil of inductance 0.7 H and resistance $R = 50\,\Omega$ is connected to 220 V, 50 Hz AC supply. Find the wattless and power components of current.   4

——×——