2022

PHYSICS — HONOURS

Paper : SEC-A-1

[Syllabus : 2019-2020]

(Scientific Writing)

Full Marks : 20

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

Answer *any ten* questions. 2×10

1. Which of the following commands for font typesetting is not valid in LaTeX?

   (a) \textsc   (b) \textit

   (c) \textbf   (d) \textmr

2. In a \begin{tabular} environment, what is the correct code for producing a table with 3 columns— first 2 are left-aligned and the third is right-aligned with no vertical lines among them?

   (a) {| l | l | r}   (b) {l l r}

   (c) {| \l | \l | \r}   (d) {\l \l \r}

3. What is the output of the LaTeX command $ \frac{5}{\frac{3}{2} + 1} $?

   (a) $\dfrac{5}{\frac{3}{2}+1}$ (b) $\dfrac{5}{\frac{3}{2}}+1$

   (c) $\dfrac{\frac{3}{2}+1}{5}$ (d) $5\dfrac{3}{2}+1$

4. In a math mode, what is the correct command to write $\sqrt[x]{y^{1/3}}$ in LaTeX?

   (a) \sqrt {y}^{1/3}_x   (b) \xsqrt{y^{1/3}}

   (c) \sqrt[x]{y^{1/3}}   (d) \sqrt{x}{y^{1/3}}

5. How to write $\zeta(2)$ inside math mode in LaTeX?

   (a) \zeta(2)   (b) \zeta{2}

   (c) \xi(2)   (d) \xi{2}

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6. What is the correct output of the LaTeX command $\prod_{i=1}^n i = n!$?

   (a) $\Pi_{i=1}^{ni} = n!$

   (b) $\Pi_{i=1} ni = n!$

   (c) $\Pi_{i=1}^n i = n!$

   (d) $\Pi_{i=1} n^i = n!$

7. What is the correct LaTeX command to write *examinee* inside a text?

   (a) \textit{\textbf{examinee}}

   (b) {\textit \textbf examinee}

   (c) {\it {\bf examinee}}

   (d) {\it \bf examinee}.

8. The symbol $\Rightarrow$ is written inside math mode in LaTeX as

   (a) \Rightarrow

   (b) \rightarrow

   (c) \Doublerightarrow

   (d) \doublerightarrow.

9. What is the use of % symbol inside a text in LaTeX?

   (a) To calculate percentage

   (b) To convert into percentage

   (c) To make rest of the line out of compilation

   (d) To convert into math mode.

10. A block \[\] makes the content inside it to

   (a) surround by square bracket

   (b) keep the section out of compilation

   (c) produce matrix

   (d) present equation in display mode.

11. A paragraph is started with indentation. What is the LaTeX command to make the indentation off?

   (a) \indentoff

   (b) \noindent

   (c) \indent = 0

   (d) \zeroindent

12. What is the LaTeX command to scale up a figure by 30% of its original size inside an appropriate figure environment?

   (a) \includegraphics [scale = 30%] { }

   (b) \includegraphics [scale = 1.3] { }

   (c) \includegraphics [scale = 0.3] { }

   (d) \includegraphics [scale = 130] { }

[Syllabus : 2018-2019]

(Basics of Programming and Scientific Word Processing)

Full Marks : 80

Answer *question no.* **1** and **2**, and *any four* questions from the rest.

1. Answer *any ten* questions : 2×10

(a) Write a program in FORTRAN/C to calculate θ from equation $\frac{y}{x} = \tan\theta$, where $y = 2.0$ and $x = 3.0$.

(b) Find x in the following code :

```
    void  main()
  {
    int  i  =  7,  j  =  2;
    float  x;
    x  =  i/j  +  j/i;
    printf  ("x=",  x);
  }
```

Or,

Write the output of the following code :

```
    i  =  7
    j  =  2
    i  =  i/j  +  j/i
    x  =  float  (i)
    write  (*, *)x
    stop
    end
```

(c) Write the mathematical expression in FORTRAN/C for the following equations :

(i) $x = \ln(a/b)$ (ii) $x = \sin^{-1}a$

(d) Write a program in FORTRAN/C to check whether a given integer is even or odd.

(e) Write the code in FORTRAN/C to swap the values of any two variables x and y.

(f) Write the command in GNUPLOT to plot two functions $y = x$ and $y = x^2$.

(g) Write down the commands to plot y vs. x from a data file containing x and y as first and second columns respectively in GNUPLOT.

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(h) Write the commands in GNUPLOT to plot $y = x \cos(2x)$ for x lying between -4 and 4.

(i) What will be the LaTeX instruction to write : $\vec{E} = \vec{A} \times \vec{B}$?

(j) What will be the command in LaTeX to write : $S = 1 + 3 + 5 + \cdots$?

(k) Which command in LaTeX is required to write the symbol $\int_0^1$ in Math mode?

(l) Write the command in LaTeX to write the following matrix :

$$\begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix}$$

2. Answer *any four* of the following questions : 5×4

(a) Write a code in FORTRAN/C to find the sum of a G.P. series reading the value of first term, common ratio and number of terms from the screen.

(b) Write a code in FORTRAN/C to read the elements of a 3×3 matrix and to determine the trace of the matrix.

(c) Write a program in FORTRAN/C to calculate the value of 5!.

(d) Suppose you are given two functions : $f_1(x) = 5\sin x$ and $f_2(x) = 5\cos x$. Write code in GNUPLOT to draw both functions on the same plot, where the range of x is $-\pi \le x \le \pi$.

(e) Write the LaTeX source code for the equation, $\dfrac{\partial^2 \phi}{\partial x^2} = \dfrac{1}{c^2} \dfrac{\partial^2 \phi}{\partial t^2}$

(f) Write the LaTex code to type the following :

$$M_{12} = \begin{vmatrix} a_{21} & a_{23} \\ a_{31} & a_{33} \end{vmatrix}$$

3. (a) Write a code in FORTRAN/C to sort the following sequence of numbers in descending order by any method : 5, 10, 3, 9, 12, 8

(b) Write a code in FORTRAN/C to calculate the sum $S = 1 + 2 + 3 + ... + 100$. 5+5

4. Write a code in FORTRAN/C to read three real numbers $a = 5$, $b = 4$ and $c = 3$. Then check whether a, b and c form a right angled triangle. Also write the algorithm/flowchart of the program. 5+5

5. (a) B is a 3×3 matrix. Write a FORTRAN/C program to determine the transpose of the matrix, taking the matrix elements as input from the screen.

(b) Given two vectors, $\vec{A}$ and $\vec{B}$ write a FORTRAN/C program to find the resultant of these two vectors, taking the components of these two vectors as input from the screen. 5+5

6. Define the function $f(x) = 3x^2 e^{-x}$ in GNUPLOT. Label the axes as 'X-axis' and 'Y-axis'. Write the command to plot the function $f(x)$ for $x = -2$ to $+10$ and $y = -1$ to $+5$ using GNUPLOT. Write also the systematic commands to get the output in jpg format. 2+2+4+2

7. Write the LaTeX source code for the following equations : 6+4

(a) $dN_c = 4N\pi \left(\dfrac{m}{2\pi kT}\right)^{\frac{3}{2}} c^2 e^{\frac{-mc^2}{2kT}} dc$

(b) $C = \sqrt{\dfrac{1}{\mu_0\, \epsilon_0}}$

8. (a) Write LaTeX code to write $\vec{\nabla}\cdot\vec{E} = \dfrac{\rho}{\epsilon_0}$.

(b) Write LaTeX code to write the following table : 5+5

Group	Topic	Marks
A	Section 1	20
B	Section 2	30
C	Section 3	50

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PHYSICS — HONOURS

Paper : SEC-A-2

[Syllabus : 2019-2020]

(Renewable Energy and Energy Harvesting)

Full Marks : 80

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

1. Answer *any ten* questions : 2×10

    (a) Write down two disadvantages of renewable energy.

    (b) What is photovoltaic effect?

    (c) What is the main composition of biogas? Mention one application of biogas.

    (d) What are the spring and neap tides?

    (e) How is the energy in the wind captured?

    (f) What are the benefits of using biomass for energy generation?

    (g) Write down the working principle of a linear generator.

    (h) What is carbon capture and storage technology?

    (i) Define solar constant.

    (j) What is sustainable development?

    (k) What are the different types of turbines?

    (l) What do you mean by cogeneration?

2. Answer *any four* questions :

    (a) Describe a solar heating system briefly with a neat sketch. 5

    (b) Explain why a tall tower is essential for mounting a horizontal axis wind turbine. What is teethering?
    3+2

    (c) What are the advantages and limitations of wave energy conversion? List some applications of fuel cells.
    3+2

    (d) Explain the performance characteristics of a battery and its equivalent circuit. 5

    (e) What is a nuclear chain reaction? Explain how electricity is generated from a nuclear reactor.
    2+3

    (f) What are the main types of OTEC power plants? Describe their working in brief. 2+3

3. Answer **any four** questions :

   (a) (i) Define vertical axis wind turbine (VAWT).

        (ii) Write and explain the principle and applications of wind electric system.   2+8

   (b) (i) Explain how ocean tides are generated. Discuss the limitations of the ocean energy harvesting methods.

        (ii) Write a short note on bioenergy from agricultural waste.   (2+3)+5

   (c) (i) Discuss on the merits and demerits of primary energy sources.

        (ii) Write a short note on hydroelectric energy.   5+5

   (d) (i) What are wastelands? How do we reclaim the wastelands?

        (ii) Describe the characteristics of biodiesel.   (2+3)+5

   (e) Write short notes on **any two** of the following :   5×2

        (i) Nuclear Fusion

        (ii) Geothermal Resources

        (iii) Ozone layer depletion problem.

   (f) (i) What is piezoelectric effect? What is the importance of piezoelectricity on society?

        (ii) What is caloric value of a fuel? Explain the basic principle of operation of a solar pond.

                              (2+3)+(2+3)

(Syllabus : 2018-2019)

(Electrical Circuits and Network Skills)

Full Marks : 80

2×5

1. Answer *any five* questions :

(a) In a delta connection system, the relationship between the line current (I_L) and phase current (I_{ph}) is

   (i) $I_L = \sqrt{3}I_{ph}$

   (ii) $I_L = 3I_{ph}$

   (iii) $I_L = I_{ph}$

   (iv) $I_L = I_{ph}/\sqrt{3}$.

(b) A galvanometer can be converted to ammeter when

   (i) a high resistance is connected in series

   (ii) a high resistance is connected in parallel

   (iii) a low resistance is connected in series
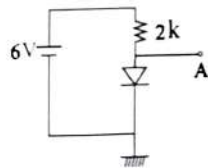
   (iv) a low resistance is connected in parallel.

(c) If the flux/pole of a DC generator is halved but its speed is doubled, then its generator emf will

   (i) be halved

   (ii) be doubled

   (iii) be quadrupled

   (iv) remain the same.

(d) Power in a three phase circuit may be expressed as

   (i) $P = 3 V_{ph} I_{ph} \cos\varphi$

   (ii) $P = \sqrt{3} V_L I_L \cos\varphi$

   (iii) Both (i) and (ii)

   (iv) None of these.

(e) Assuming silicon diode the voltage at the point A is _____ volt.

   (i) 0   (ii) ~ 0.3   (iii) ~ 0.7   (iv) ~ 6.

(f) In an ac circuit with a resistive branch and an inductive branch in parallel, the

   (i) resistive and inductive branch currents have the same phase

   (ii) resistive branch current is 90° out of phase with the inductive branch current

   (iii) resistive and inductive branch currents are 180° out-of-phase

   (iv) voltage across the inductance leads the voltage across the resistance by 90°.

(g) Which of the statements below is not true?

    (i) Voltage source is a passive element

    (ii) Resistor is a linear element

    (iii) Current source is an active element

   (iv) Diode is a non-linear element.

2. Answer **any five** questions :

    2×5

    (a) Why is a transformer core laminated?

    (b) What is the function of insulator in transmission line?

    (c) Find the polar representation of the voltage $\left(\sqrt{3} + j\right) V$.

    (d) Give the schematic representations of

        (i) Tapped resistor

        (ii) photodiode

        (iii) push-button switch

        (iv) overload safety switch.

    (e) Distinguish between Star and Delta connection with reference to line and phase, voltage and current.

    (f) In a bridge rectifier circuit if one of the diodes is open what should be change in the output?

Group - A

3. Answer **any four** questions :

    (a) Derive the emf equation of an ideal single-phase transformer.   5

    (b) In the circuit below, calculate the value of the resistance 'R' when the current through 5Ω resistance is zero.
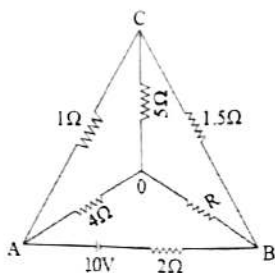
    5

    (c) Write two advantages of induction type wattmeter over dynamo type wattmeter. Explain why a relay is always connected to a circuit breaker.   3+2

    (d) What is the function of poles in DC generator? An 8-pole lap-wound DC generator has 960 conductors and a flux/pole of 40 mWb. Calculate the generated emf when it runs at 400 rpm.   2+3

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(e) (i) Distinguish between AC and DC motors with references to speed control, noise generation, efficiency and practical uses.

(ii) Two supply terminals of a three phase induction motor gets an interchange while regular scheduling work. When the machine switches on what will be the effect?   3+2

Group - B

Answer *any four* questions.

4. (a) Draw the symbols used for lightning arrester, fuse and Zener diode in circuit diagram.

(b) What is ground fault protection?

(c) What is the function of circuit breaker? What is the difference between circuit breaker and isolator?
                                                                                                3+2+(2+3)

5. (a) State the condition for maximum efficiency of a DC generator.

(b) The speed and number of poles of an AC generator are respectively N and P. Derive an expression for the frequency (f) of the generated e.m.f.

(c) Why are AC generators commonly called synchronous generators? What is the difference between an AC generator and a DC generator?   2+3+(2+3)

6. Write short notes on (*any two*) :   5×2

(a) Wattmeter

(b) SF_6 circuit breaker

(c) Merits and demerits of Star and Delta connections.

7. (a) A step down transformer with 10 : 1 turn ratio is connected to 220 V 50 Hz ac supply mains.

(i) What is frequency of the secondary voltage?

(ii) How much is secondary voltage?

(iii) If a secondary load of 100Ω is connected, what will be secondary current and primary current? Assume 100% efficiency of the transformer.

(b) What is barrier potential of a p-n junction diode? How does it vary with the bias applied across the junction?

(c) Determine the output waveform of the network when $V_i = 20 \sin \omega t$.
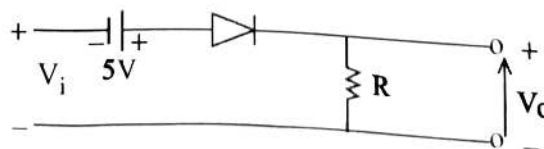
   (1+1+3)+(1+2)+2

8. (a) A DC source of voltage V is connected for a sufficient time to a circuit consisting of resistor R and inductor L in series. The source is now suddenly removed keeping the circuit closed. Find how the current in the circuit decays with time. What do you mean by time constant of the circuit? Show graphically how the voltage across L and R vary with time.

   (b) Show that in wattmeter average deflecting torque is proportional to the average power. How power factor can be measured using wattmeter and voltmeter?   (3+1+2)+(3+1)

9. (a) A 0.5 μF capacitor has voltage waveform v(t) as shown below, sketch i(t) as a function of time.
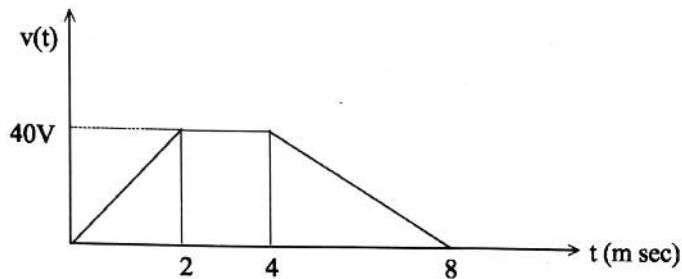
   (b) Considering series RLC circuit and current i(t) waveform shown sketch the voltage waveform across R, L, C. Give a single phasor diagram showing V_R, V_L, V_C and V_S.
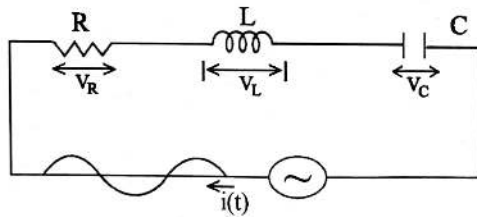
   (c) How would you test a capacitor with ohmmeter?   3+(3+2)+2