JALPAIGURI GOVERNMENT ENGINEERING COLLEGE
[A GOVERNMENT AUTONOMOUS COLLEGE]
JGEC/B.TECH/ CE/EE/ME/ BS-PH101/ 2023-24
2023
PHYSICS

Full Marks: 70

Times: 3 Hours

The figures in the margin indicate full marks.
Candidates are instructed to write the answers in their own words as far as practicable.

GROUP-A
[OBJECTIVE TYPE QUESTIONS]

Answer *all* questions   5x2=10

1. Show that $y = A sin(kx - bt)$ satisfy the 1-D wave equation. Here A, k and b are constant.   2

2. In Fraunhofer diffraction if the width of the single slit is slightly less than the wavelength of the light which is falling on it, comment on the position of the minima.   2

3. Define **group velocity** and **phase velocity**.   2

4. The wave function for a particle is given by $\psi(x) = ce^{-\alpha^2 x^2}$, $-\infty < x < \infty$, where C and α are constant. Calculate the probability of finding the particle in the region $0 < x < \infty$.   2

5. State and explain Malus's law.   2

GROUP-B
[LONG ANSWER TYPE QUESTIONS]

Answer any *four* questions   4x15 = 60

6. A particle of mass $5\ gm$ moves along x-axis under the influence of two forces: (a) a force of attraction to the origin O which in dyne is numerically equal to 40 times the instantaneous distance from O and (b) a damping force proportional to the instantaneous speed such that when the speed is $10\ cm/s$ the damping force is $200\ dyne$. Assuming that the particle starts from rest at a distance $20\ cm$ from O

   i)   set up the differential equation and conditions describing the motion,   2
   ii) find the position of the particle at any time,   3
   iii) determine the amplitude, period and frequency of the damped oscillations,   3
   iv) graph of the motion,   2
   v)   find the logarithmic decrement,   2
   vi) determine the natural period and frequency of the particle, for what range of values the damping constant will the motion be over-damped, under-damped or damped oscillatory and critically damped.   3

7. i) State Planck's law of black body radiation. Find out the two limits where Planck's formula reduces to (a) **Wien's law** and (b) **Raleigh-Jeans law**.   4
   ii) X-rays of wavelength $10.0\ pm$ are scattered from a target. a) Find the **wavelength** of the x-rays scattered through $45"$. Find the **maximum wavelength** present in the scattered rays.   3
   iii) State and explain **Heisenberg's uncertainty principle**. Justify that an atomic nucleus cannot harbour a free electron.   5
   iv) Find the de Broglie wavelength of $1.00\ MeV$ proton.   3

8. i) Find the **Volume** of the parallelopiped whose edges are represented by $\vec{A} = 2\hat{\imath} - 3\hat{\jmath} + 4\widehat{k}, \vec{B} = \hat{\imath} + 2\hat{\jmath} - \widehat{k}, \vec{C} = 3\hat{\imath} - \hat{\jmath} + 2\widehat{k}$.   3
   ii) A particle moves so that its position vector is given by $\vec{r} = cos\omega t\hat{\imath} + sin\omega t\hat{\jmath}$, where ω is a constant. Show that a) the velocity $\vec{v}$ is **perpendicular** to $\vec{r}$, b) $\vec{r} \times \vec{v}$ is a **constant vector**.   4
   iii) A particle moves in the force field given by $\vec{F} = 2xz(1 - 6xyz)\hat{\imath} + 2yz(1 - 6xyz)\hat{\jmath} + 2xy(1 - 6xyz)\widehat{k}$. Can you define a potential function $V(x, y, z)$ for this force field?   4
   iv) Evaluate $\int \vec{A}.d\vec{r}$ along the curve $x^2 + y^2 = 1$ and $z = 1$ in the positive direction from $(0, 1, 1)$ to $(1, 0, 1)$ if $\vec{A} = 4x\hat{\imath} - 2y^2\hat{\jmath} + z^2\widehat{k}$.   4

9. i) Write down the Maxwell's equation of electrodynamic theory in free space. Show that both $\vec{E}$ and $\vec{B}$ satisfy the wave equation. Hence find the speed of light in free space.   2+3+1

ii) The electric field of a plane electromagnetic wave propagating in free space is described by: 2+3

$\vec{E} = E_0 \cos(kx - \omega t)\hat{j}$. Determine the corresponding magnetic field and the time average Poynting vector for the wave.

iii) Write a short note on **displacement current density vector** in connection with 4th Maxwell's Equation in EM theory.   4

10. i) Describe the **state of polarization** of the wave represented by $\vec{E}(z,t) = E_0 \cos\left(\omega t - kz + \frac{\pi}{2}\right)\hat{i} - E_0 \cos(\omega t - kz)\hat{j}$.   3

ii) Calculate the **thickness** of a **half-wave plate** for a light of wavelength **500 nm**. Given $n_0 = 1.5442, n_e = 1.5533$.   3

iii) A **right circularly** polarized beam of light ($\lambda = 525\ nm$) is incident normally on doubly refracting crystal with optic axis parallel to the surface. The thickness of the crystal is **0.003 mm**. It is also given that $n_0 - n_e = 0.175$. Find the **state of polarization** of the emergent light beam.   3

iv) Find an expression for the intensity of **Fraunhoffer diffraction** pattern due to a **single slit**. Discuss the conditions for **maxima** and **minima**.   6

11. i) Show that the wave functions given by $\psi_n(x) = \sqrt{2/L}\ \sin(n\pi x/L)$ are **orthonormal**.   4

ii) If **p** denotes momentum, then find $\langle p \rangle$ as well as $\langle p^2 \rangle$ in a quantum state $\varphi(x) = \sqrt{\frac{2}{L}}\ \sin\frac{n\pi x}{L}$, L is a constant.   3+3

iii) Show that <E> is real.   3

iv) Calculate $\left[x, \frac{\partial}{\partial x}\right]$.   2

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FM: 70   Time Allotted: 3 hours

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Group – A
[Objective Type Questions]

Answer **all** questions   5 X 2 = 10

1.   What do you mean by bitwise operators?

2.   ```c
     #include<stdio.h>
     #define SQ(x) (x*x)
     void main( ) {
         int a=4, b;
         b= SQ(a + 2);
         printf("\n %d",b);
     }
     ```
     What will be the output?

3.   Convert the hexadecimal number $(73AF.6B)_{16}$ into equivalent binary number.

4.   What will be the output of following code snippet:
     ```c
     int i;
     for(i=1;i<=10;i++);
     { printf("\n i=%d",i); }
     ```

5.   Which of the following is the correct way to declare a float pointer
     a) float ptr   b) float *ptr   c) *float ptr   d) None of the above

Group – B
[Long Answer Type Questions]

Answer any **four** of the following   4 X 15 = 60

6. a.   What is flowchart? Draw a flow chart to determine the greatest number among three numbers?

    b.   What do you mean by conditional operators? Write a program in C Language to check whether a given year is leap year or not using conditional operators.

    c.   Explain the different types of control statements available in C language.

                                                                          (1+4) + (1+5) + 4

7. a.   Define a structure? Explain the differences between structure and union.

    b.   Create a structure to specify data on students given below:
         Roll Number, Name, Department
         Assuming that there are not more than 500 students in the college. Write a program in C language to print the details of a student whose roll number is given.

    c.   Calculate the total required memory of the structure student that you have created.

    d.   Write a program in C language to find out the largest and smallest element in an array.

                                                                          (1+2) + 5 + 2 + 5

P.T.O

8. a. What do you mean by a pointer variable? Are the expression **ptr++** and ***ptr ++** same? Explain.
   b. Write a C function that will act as *strlen()* function .
   c. Compare call by value and call by address with examples.

   (2+3) + 5 + 5

9. a. What do you mean by function? State the advantages of function.
   b. Write a program in C language to find out all roots of a quadratic equation.
   c. Write a program in C to find the frequency (number of occurrences) of a character in a string.

   (1+4) + 5 + 5

10. a. What is the difference between malloc and calloc?
    b. What is the memory leak in C?
    c. What is a dangling pointer?
    d. Explain different storage classes in C.

    5 + 3 + 2 + 5

11. a. Explain different opening mode of files.
    b. Explain conditional operator with an example. What is system software? Give an example
    c. Write a C program to print day of week name using switch case.(If input =2, output : Tuesday)

    (3+1+1) + 5 + 5

12. a. What is recursive function? Compare recursion and iteration with examples.
    b. Write a user-friendly program in C to calculate the factorial of a number using recursion
    c. Write a program in C language to check whether a given string is palindrome string or not.

    (1+4) + 5 + 5

..........END..........