

Seat No. : _____

DC-119

December-2018

M.Sc., Sem.-I

403 : Physics

**Electrodynamics and Programming in C
(New Course)**

Time : 2.30 Hours]

[Max. Marks : 70

- Instructions :**
- (1) **All** symbols carry their usual meanings.
 - (2) Attempt **all** questions.
 - (3) Scientific calculators are allowed.

1. (A) (i) Explain the concept of reflection from the surface of metal and obtain the equation for reflection 7

$$R = 1 - 2 \sqrt{\frac{2\omega\epsilon_1}{\sigma}}$$
. Use propagation vector K_T for conducting medium as

$$K_T^2 = \epsilon_2 \mu_2 \omega^2 \left[1 + \frac{i\sigma}{\omega\epsilon_2} \right] = (\alpha + i\beta)^2.$$

- (ii) Calculate the exact reflection and transmission co-efficients at normal incidence without assuming $\mu_0 = \mu_1 = \mu_2$. Confirm that $R + T = 1$. 7

OR

- (i) (1) Express all equations for wave propagation through linear media. 3
- (2) Write boundary conditions at oblique incidence and use it to obtain the Fresnel's equation. 4
- (ii) Silver is an excellent conductor, but it's very expensive. Suppose you are designing a microwave experiment to operate at a frequency of 10^{10} Hz. How thick would you make the silver coatings ? [Take : $\rho_{\text{silver}} = 1.59 \times 10^{-8} \Omega\text{m}$, $\epsilon_0 = 8.85 \times 10^{-12}$ Farad/m, $\omega = 2\pi f$ and $\mu_0 = 4\pi \times 10^{-7}$ Henry/m] 7

(B) Answer any **four** from the following : (**one** mark each) **4**

- (i) If $n_1 = 1.11$ and $n_2 = 1.46$, then what will be the values of reflection co-efficient and transmission co-efficient ? (Assume, $\mu_1 = \mu_2 = \mu_0$)
- (ii) What is Brewster's angle ?
- (iii) Consider a wave propagates from glass to air. The refractive index of glass is 1.5, the critical angle for glass is $\theta_c = 42^\circ$. If the light is incident internally from the glass at an angle of 45° , then find out it's skin depth.
- (iv) What are Dispersion and Dispersive ?
- (v) What is plane of incidence ?
- (vi) Under which of the following conditions the α diverges ?
 - (a) normal incidence
 - (b) oblique incidence
 - (c) grazing incidence
 - (d) None of the above

2. (A) (i) Obtain the wave equation (E_{OT}) for waves in guides of arbitrary cross-section. Discuss the conditions of wave number and cut-off frequency for TEM waves. **7**

- (ii) Consider a rectangular waveguide with dimension 2.28×1.01 cm. If the driving frequency is 1.70×10^{10} Hz, which TE modes will propagate in this waveguide ? What range of frequency has to be used to excite only one TE mode ? What are the corresponding wavelengths (in open space) ? **7**

OR

- (i) Discuss the Resonant cavities when a perfect conductor is placed at half infinite space in the direction of propagating wave. Explain Q-factor and write some applications of cavities in waveguide. **7**
- (ii) Find the modes of 3 cm wavelength radar waves that would be propagated in a waveguide of rectangular cross. section with $a = 1$ cm, $b = 2$ cm. Find also the group velocity of the waves. **7**

(B) Answer any **three** from the following : (**one** mark each) **3**

- (i) Write the principal or dominant mode rectangular waveguides ?
- (ii) What is the requirement for exciting a particular mode of oscillation in a resonant cavity ?

(iii) In the case of dielectric waveguide, $\tan(kd) = k(\gamma + \delta) / (k^2 - \gamma\delta)$. Which condition is responsible for the loss of total internal reflection at the lower boundary condition (means the mode will no longer be guided) ?

(a) $\gamma = 1$, (b) $\delta = 1$, (c) $k^2 = 1$, (d) $\gamma = 0$

(iv) Find the shortest length of a simplest cavity resonator to be made from a rectangular waveguide with $a = 10.16$ mm and $b = 22.86$ mm which will resonate at 10 GHz.

[Take $C = 3 \times 10^8$ m/s, m & $n = 1$]

(v) Write an expression for cut-off frequency in case of rectangular waveguide.

3. (A) (i) With examples discuss various data types and different categories of operators available in C language. 7

(ii) Write a program to read a positive integer number, generate a number which should be in the reversed order of the given number and then check the reversed and the original numbers are same or not. Program should print proper message. 7

OR

(i) Write a single program to read a number n and then calculate and print the following :

(1) sum of the squares of all even numbers upto n .

(2) product of all numbers upto n , which are divisible by 5.

(3) factorial of that number. 7

(ii) For a number, if the sum of the cubes of its all individual digits is equal to that number itself, then that number is known as Armstrong number (Eg. 153). Write a program to check the given number is an Armstrong number or not. 7

(B) Answer any **four** from the following : 4

(i) Write down the output of the following program segment

```
printf("%d %d", 5*4/3+2, 2*3%4+5);
```

(ii) Write any four header files used in C language.

(iii) Draw block diagram of do while loop.

- (iv) Write output of the following program segment


```
int x 100;
if (x)
    printf("AAA");
else
    printf("BBB");
```
- (v) How can we come out of a nested loop ?
- (vi) Write a statement to assign largest of a and b to c using conditional operator.

4. (A) (i) Write a program to read 50 values, find out and print values greater than average. The program also should find out and print the highest value in the series. 7
- (ii) Write a program to accept a string from user and check whether it is a palindrome or not. A word is said to be a palindrome, if it spells same forward and backward. 7

OR

- (i) Accept roll numbers of 50 students and their marks obtained in 6 different subjects out of 100 each. Find out and print percentage marks of all individual students and average marks for all individual papers. Program should print results with original data. 7
 - (ii) Write a program to read a string and a character, generate a new string by deleting the specified character from the string. Print both strings. Program also should print length of both strings. 7
- (B) Answer any **three** from the following : 3
- (i) Declare a two dimensional array which can store 10 values.
 - (ii) What will be output of the following program segment


```
double x[10];
printf("%d", sizeof(x));
```
 - (iii) What is a string in C language ?
 - (iv) Write C language functions (1) to get square root of 25.6 (2) to read a string containing two words.
 - (v) Write a statement to store PHYSICS in a variable.

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- Instructions :**
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1. (A) (i) Derive expressions for electric field and magnetic field of the electric dipole radiation ? 7

- (ii) Find the radiation resistance of the oscillating magnetic dipole where $d = 5 \text{ cm}$ and $a = \text{radius of loop of wire}$. Express the answer in terms of λ and a , and compare it with the radiation resistance of the electric dipole ($R(\text{ele}) = 790 \left(\frac{d}{\lambda}\right)^2 \Omega$) 7

OR

- (i) Derive expressions for electric field and magnetic field of the radiation from an arbitrary distribution of charges and currents. 7

- (ii) Prove that radiation resistance of a wire joining the two ends of an electric dipole is $R(\text{ele}) = 790 \left(\frac{d}{\lambda}\right)^2 \Omega$ (where d is distance between two ends of a dipole). 7

- (B) Answer any **four** from the following : (**one** mark each) 4

- (i) What is advance time in retarded potential theory ?
- (ii) Write inhomogeneous wave equations for retarded potential.
- (iii) What is radiation zone ?

- (iv) Find the ratio of total radiated power ($p_{\text{mag}} / p_{\text{ele}}$) ? Which one is greater for configuration with comparable dimensions ? [Assume, $m_0 = \pi a^2 I_0$ and $p_0 = q_0 s$, & the amplitude of the current in the electrical case is $I_0 = q_0 \omega$ at $s = \pi a$.]
- (v) Write the Poisson equations ?
- (vi) Write equation of pointing vector in terms of electric field and magnetic field.

2. (A) (i) Discuss the Abraham-Lorentz formula in detail. 7
- (ii) Show that the electric field of a point charge in motion can be expressed as,
- $$\mathbf{E} = \frac{q}{4\pi\epsilon_0} \frac{1}{(R \cdot \mathbf{u})} \frac{\partial}{\partial t_r} \left(\frac{\mathbf{R}\mathbf{u}}{R \cdot \mathbf{u}} \right) \quad [\text{NOTE : } r \text{ and } t \text{ are treated as constant}] . \quad 7$$

OR

- (i) Explain “ theory of Lienard-Wiechert potentials” with appropriate example. 7
- (ii) Consider a particle of charge q moves in a circle of radius R at constant angular velocity ω (assume the circle lies in the xy plane at time $t=0$, the charge is at $(R, 0)$ on the $+x$ axis). Find out the Lienard-Wiechert potentials for point on the Z -axis. 7
- (B) Answer any **three** from the following : (**one** mark each) 3
- (i) The current density of a rigid object for radiation from a point charge is ____.
- (i) ρv , (ii) $\rho \epsilon$, (iii) $\rho \mu$, (iv) μv
- (ii) Distinguish between Radiation reaction and Field reaction.
- (iii) For the moving point charge, the retarded potentials $V(r, t_r)$ and $A(r, t_r)$ are depends upon the ____ at the time t_r . (a) field, (b) motion of charge, (c) high acceleration, (d) recoil force.

- (iv) The power radiated by a point charge, $P = \frac{1}{4\pi\epsilon_0} \frac{2}{3} \frac{q^2}{c^2} \gamma^6 \left[a^2 - \left(\frac{v}{c} \times a \right)^2 \right]$

This is Lienard’s generalization of Larmor formula (to which it reduces when $v = 0$). The factor γ^6 indicates that

- (a) the radiated power increases enormously as the particle velocity approaches the speed of light.
- (b) the radiated power decreases enormously as the particle velocity approaches the speed of light.
- (c) the radiated power increases enormously as the particle charge greater than γ .
- (d) None of above
- (v) For the caboose train, the observer watching the leaving train looks like little longer then the real train by the factor of ____.
- (i) $(1 - v / c)^{-1}$ (iii) $(1 + v / c)^{-1}$
- (iii) $(1 - v^2 / c^2)^{-1}$ (iv) $(1 + v^2 / c^2)^{-1}$

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- (v) What is the difference between a global variable and a static variable ?
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