Seat No. : _____

DO-131

December-2017

M.Sc., Sem.-I

403 : Physics
(Electrodynamics and Programming in C)
(OLD)

Time : 3 Hours] **[Max. Marks : 70**

Instructions : (1) **All** symbols carry their usual meanings.
(2) Attempt **all** questions.
(3) Maximum Marks : 70
(4) Scientific calculators are allowed.

1. (A) Based on retarded potential theory, derive equations for electric field and magnetic field of the radiation of a dipole. **7**

OR

Derive expressions for both magnetic field and electric field for radiation from an arbitrary distribution of charges and currents.

(B) Confirm that the retarded potentials satisfy the Lorentz gauge condition. **7**

(a) Show that,

$$\nabla\left(\frac{J}{\Re}\right)=\left(\frac{1}{\Re}\right)(\nabla\cdot J)+\left(\frac{1}{\Re}\right)(\nabla'\cdot J)-(\nabla'\cdot\left(\frac{J}{\Re}\right))$$

Where, ∇ & ∇' denotes derivatives with respect to r & r'.

Noting that J (r', t- $\Re$/c) depends on r' both explicitly and through $\Re$ whereas it depends on r only through $\Re$, confirm that, [where, $\Re$ = (r – r')]

$$\nabla\cdot J=-\left(\frac{1}{c}\right)\left(\frac{\partial J}{\partial t_r}\right)(\nabla\cdot\Re),\quad \nabla'\cdot J=-\left(\frac{\partial\rho}{\partial t}\right)-\left(\frac{1}{c}\right)\left(\frac{\partial J}{\partial t_r}\right)(\nabla'\cdot\Re)$$

(b) Use results of (a) to calculate the divergence of potential A(r, t).

OR

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

2. (A) Discuss the Lienard-Wiechert potentials theory with necessary example, and derive the famous Lienard-Wiechert potentials formula for a moving point charge. **7**

OR

Discuss the Abraham-Lorentz formula in detail.

(B) If a point charge ***q*** is constrained to move along the *x* axis, show that the field at points on the axis to the *RIGHT* of the charge are given by

$$\mathrm{E} = \left(\frac{q}{4\pi\varepsilon_\circ}\right)\left(\frac{1}{r^2}\right)\left(\frac{c+v}{c-v}\right)\ \hat{i}, \mathrm{B} = 0.$$

Then obtain the fields on the axis to the *LEFT* of the charge. **7**

OR

Consider a particle of charge q moves in a circle of radius R at constant angular velocity ω (assume the circle lies in the x-y plane at time t = 0, the charge is at (R,0) on the +ve x axis). Find out the Lienard-Wiechart potentials for point on the z-axis.

3. (A) With examples, discuss the following

(a) Character set of C language (b) keywords

(c) identifiers (d) precedence of operators **7**

OR

(i) Distance between two points (x_1, y_1) and (x_2, y_2) is given by the formula

$$D^2 = (x_2 - x_1)^2 - (y_2 - y_1)^2.$$ **3**

Write a program to read coordinates of two points and calculate and print the distance.

(ii) For a certain electrical circuit with resistance R, capacitance C and inductance L, the damped natural frequency is given by **4**

$$f = \sqrt{\frac{1}{LC} - \frac{R^2}{4C^2}}$$

Write a program to read resistance in KΩ, capacitance in μF and inductance in mH, calculate frequency and print frequency along with input parameters.

(B) Write a program to read a decimal number and then obtain binary number corresponding to that. Program should print both decimal number and the binary number. **7**

OR

Write a program to read a number, check whether the number is a prime number or not. (A number is said to be prime number if it is not divisible by any other number except by one and the number itself).

4. (A) With help of a block diagram, explain **nested if**

Write a program to read weight and height of 75 students and check how many students have

weight less than 45 and height less than 160

weight more than 70 and height more than 170

weight more than 75 or height more than 185

Program should print a proper message. **7**

OR

(i) Write a program to read two strings, generate a third string by appending (attaching) second string on the first string (without using string handling functions). Program should print all the three strings. **4**

(ii) Write down the syntax for the following string handling functions : **3**

Copying one string to another string

Appending one string on another string

Comparing two strings

(B) Write a program to read a 10 by 10 matrix, transpose the matrix and then check whether the given matrix is symmetric or not. (A matrix is said to be symmetric if the transposed matrix is same as the original matrix). **7**

OR

Write a program to read a string, generate a second string by rearranging all characters in the string in alphabetical order. Program should print original string and the string in the alphabetical order.

5. Answer the following : (**one** mark each) **14**

(i) If retarded time = $(t - \tau/c)$, then $(t + \tau/c)$ is known as ———— [where, $(\tau = r\text{-}r')$]

(ii) Write down Poisson equations.

(iii) Express ratio between power radiated by magnetic dipole (Pmag) and electric dipole (Pele).

(iv) What is radiation zone?

(v) What is the Lienard generalization of Larmor formula (to which it reduces when v=0).

(vi) For the moving point charge, the retarded potentials V(r, t) and A(r, t) depend upon the _____ at the time t ?

(vii) What is meant by field reaction?

(viii) The _____ header file contains all character related functions.

(ix) Mention any two escape sequence (backslash) characters.

(x) Give an example of define statement.

(xi) Write down output of the following program statement

```
int x = 5, y = 2;
printf("%d" ,  x/y + x%y);
```

(xii) If a = 10 and b = 100, what will be output of following program statement ?

```
printf("%d", a++ * – – b);
```

(xiii) Write output of the following program segment :

```
char str[15] = "string";
printf("%d %d", sizeof(str), strlen(str));
```

(xiv) Declare a variable which can store names of 50 students.

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1. (A) Write in detail 'the theory of reflection from the surface of metal'. **7**

OR

Derive the equation for total internal reflection and obtain expression for the skin depth (the penetrating distance).

(B) The index of refraction of air and sapphire (a type of diamond) are 1.0 and 1.76 respectively. Draw a graph of amplitudes of reflected and transmitted waves versus the angle of incidence at air to sapphire interface. (Assume $\mu_1 = \mu_2 = \mu_0$). Calculate (a) the amplitudes at normal incidence, (b) Brewster's angle, (c) the crossover angle at which the reflected and transmitted amplitudes are equal. **7**

OR

(a) Silver is an excellent conductor, but it is very expensive. Suppose you were designing a microwave experiment to operate at a frequency of $\mathbf{10^{10}}$ Hz. What should be the thickness of the silver coatings ?

[Consider : $\rho_{silver} = 1.59 \times 10^{-8}$ Ωm, $\varepsilon = 8.85 \times 10^{-12}$ Farad/m, $\omega = 2\pi \times 10^{10}$ s^{-1} and $\mu = 4\pi \times 10^{-7}$ Henry/m].

(b) Find the wavelength and propagation speed of radio waves in copper at 1 MHz . Compare with the corresponding values in air (or vacuum).

[Consider : $\rho_{copper} = 1.68 \times 10^{-8}$ Ωm, $\varepsilon = 8.85 \times 10^{-12}$ Farad/m, $\omega = 2\pi \times 10^{10}$ s^{-1} and $\mu = 4\pi \times 10^{-7}$ Henry/m].

2. (A) Discuss the propagation of waves between two conducting planes. Obtain the equation of **guide wavelength** (λ_g). **7**

OR

Discuss the dielectric waveguides and obtain equation for **H** field.

(B) 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

Find the modes of **3 cm** wavelength radar waves that would be propagated in waveguide of rectangular cross section with **a = 1 cm, b = 2 cm.** Find also the group velocity of the waves.

3. (A). With examples, discuss the following : **7**

(a) character set of C language (b) keywords

(c) identifiers (d) precedence of operators

OR

(i) Distance between two points (x_1, y_1) and (x_2, y_2) is given by the formula

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4. (A) With help of a block diagram explain **nested if**

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5. Answer the following : (**one** mark each) **14**

(i) When the EM waves propagating through linear media, express the energy density equation.

(ii) What is the plane of incidence ?

(iii) What is critical angle ?

(iv) If $n_1 = 1.2$ and $n_2 = 1.4$, then what are the values of reflection coefficient and transmission coefficient ? (Consider $\mu_1 = \mu_2 = \mu_0$)

(v) What is the requirement for exciting a particular mode of oscillation in a resonant cavity ?

(vi) Write down the expression for cut-off frequency in the case of waveguides.

(vii) 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. [$C = 3 \times 10^8$ m/s, m & n = 1]

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