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ENGINEERING & MANAGEMENT EXAMINATIONS, JUNE – 2007

ELECTROMAGNETIC WAVES & RADIATING SYSTEMS

SEMESTER – 4

Time : 3 Hours] [Full Marks : 70

Group – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

i) The magnetic flux density $\vec{B}$ and vector potential $\vec{A}$ are related as

a) $\vec{B} = \nabla \times \vec{A}$ b) $\vec{A} = \nabla \times \vec{B}$

c) $\vec{B} = \nabla \cdot \vec{A}$ d) $\vec{A} = \nabla \cdot \vec{B}$.

ii) A potential field is given by $V = 3x^2 y - yz$. The electric field at $P(2, -1, 4)$ is

a) $12\vec{i} - 8\vec{j}$ V/m b) $12\vec{i} - \vec{j}$ V/m

c) $12\vec{i} + 8\vec{j} + \vec{k}$ V/m d) $-12\vec{i} - 8\vec{j} - \vec{k}$ V/m.

iii) The electric field lines & equipotential lines

a) are parallel to each other

b) are one and the same

c) cut each other orthogonally

d) can be inclined to each other at any angle.

iv) A transmission line of length $\frac{\lambda}{4}$ shorted at far end behaves like

a) series resonant circuit b) parallel resonant circuit

c) pure inductor d) pure capacitor.

v) Maxwell's equation $\nabla \times \vec{H} = \vec{J} + \dot{\vec{D}}$ represents

a) Gauss's law in magnetism

b) Kirchhoff's current law for direct current

c) Biot-Savart law

d) Generalized Ampere's circuital law.

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vi) In a two region system, a plane wave is arriving at a normal incidence in air with amplitude $E_1 = 100\ V/m$ and frequency 100 MHz. The slab is Teflon ($\varepsilon_r = 2{\cdot}1$, $\varepsilon^{11}/\varepsilon^{1} = 0$). The amplitude of the reflected wave is

a) 18·34 V/m
b) 36·68 V/m
c) – 18·34 V/m
d) – 36·68 V/m.

vii) If the frequency of the incident wave increases by a factor of 4, the depth to which a wave penetrates a conducting material

a) increases by a factor of 2
b) increases by a factor of 4
c) decreases by a factor of 2
d) decreases by a factor of 4.

viii) The MUF of transmission between two stations 500 km apart at f_{crit} = 9 MHz and minimum value of incident angle $i = 45°$ is

a) 0·7 MHz
b) 25·4 MHz
c) 12·7 MHz
d) 18 MHz.

ix) A quarter-wave monopole antenna operating in air at a frequncy of 1 MHz must have an overall length (l) of

a) $l >> \lambda$
b) 150 m
c) 75 m
d) $l << \lambda$.

x) The radiation resistance of a dipole, having a length of 4 cm, radiating 50 W of power at a frequency of 500 MHz is

a) 3·5 Ω
b) 0·82 Ω
c) 1·75 Ω
d) 7·0 Ω .

xi) Ohm's law is obeyed by

a) conduction current
b) convection current
c) conduction & convection current
d) none of these.

xii) The direction of propagation of EM wave is obtained from

a) E × H
b) E . H
c) E
d) H.

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Group - B

(Short Answer Type Questions)

Answer any *three* questions. $3 \times 5 = 15$

2. Define the term i) VSWR and ii) 'Reflection co-efficient' for transmission line.

   Explain the relationship between them.

3. Prove that $\nabla \times \vec{H} = \vec{J} + \frac{\partial \vec{D}}{\partial t}$. The symbols have usual meaning.

4. A 2m long lossless transmission line has an impedance of 300Ω. The velocity of propagation is $2 \cdot 5 \times 10^{8}$ m/s. The load has an impedance of 300Ω with sending end voltage being 60V at 100 MHz. Find :

   a) The phase constant

   b) The load voltage

   c) The load current

   d) The load reflection coefficient &

   e) Standing wave ratio.

5. Why is ionosphere important for radiowave propagation ? Describe the different layers of ionosphere.

6. What do you mean by magnetic vector potential ? Write down the Maxwell's equations for time varying electromagnetic fields, when the medium is lossless, linear, isotropic, homogeneous and source free. 3 + 2

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Group - C

(Long Answer Type Questions)

Answer any *three* questions. $3 \times 15 = 45$

7. a) Find the expression of Radiation resistance of a short electric dipole with uniform current distribution. 7

   b) Define complex Poynting vector. 3

   c) Explain the concept of skin depth & find out an expression for that. 5

8. a) Derive an expression for the input impedance Z_{in} of a lossless transmission line, in terms of relevant parameters, when the line is terminated in load impedance Z_L. 6

   b) Show that for a lossless transmission line the impedance of a line repeats over every $\frac{\lambda}{2}$ distance. 5

   c) A transmission line with air as dielectric has $Z_0 = 50\Omega$ and a phase constant of 3 rad/m at 10 MHz. Find the inductance & capacitance of the line. 4

9. a) What is electromagnetic interference ? 2

   b) Why does the short wave radio signal propagate with very low attenuation at night ? Describe the sky-wave propagation of EM waves. 3 + 6

   c) What is fading ? Briefly describe the diversity techniques to reduce the effect of fading. 1 + 3

10. a) Obtain the Poynting theorem for the conservation of energy in an electromagnetic field and discuss the physical significance of each term in resulting equation. 6

    b) In free space $E(z, t) = 50 \cos(\omega t - \beta z)$ V/m. Find the average power crossing a circular area of radius 5m in the plane x = constant. 5

    c) Derive the equation of continuity for time varying fields. 4

11. a) State & explain Faraday's law. 4

    b) Derive the induced *emf* when a stationary loop is in the time varying B fields. 4

    c) Determine the magnetic field intensity at a point P due to a current carrying filamentary conductor AB carrying current I along Z axis with its upper and lower ends subtending angles α_1 and α_2 respectively. 7

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