REV-00
MSE/09/14

2016/12

M.Sc. ELECTRONICS
Third Semester
ELECTROMAGNETIC THEORY & MICROWAVE TECHNOLOGY
(MSE - 302)

Duration: 3Hrs. **Full Marks: 70**

Part-A (Objective) =20
Part-B (Descriptive) =50

(PART-B: Descriptive)

Duration: 2 hrs. 40 mins. **Marks: 50**

Answer any *four* from *Question no.* 2 to 8
***Question no.* 1 is compulsory.**

1. (a) Explain with diagram the basic operation of RADAR.

   (b) Derive RADAR range equation explaining meaning of each term.

   (5+5=10)

2. (a) Write Poynting Theorem. Derive the mathematical expression using Maxwell's equation.

   (b) The magnetic field intensity of uniform plane wave in air is 20 A/m in $\hat{a}_y$ direction. The wave is propagating in $\hat{a}_z$ direction at an angular frequency of 2×10^9 *rad* / sec.

   Find: a) wavelength b) frequency c) period and d) amplitude

   (5+5=10)

3. (a) Derive voltage and current equations for transmission line.

   (b) Calculate the series impedance and shunt admittance of a transmission line at $\omega = 5.5\times10^3$ *rad* / sec. The primary parameters of line are $R = 10.4\ ohm, L = 3.64\ mH, C = 0.00825\mu F$ *and* $G = 0.08\mu mho$.

   (5+5=10)

4. (a) Find the greatest number of half waves of electric intensity with which it may be possible to propagate a signal of 10 GHz in a waveguide whose wall separation is 0.05m. Calculate the guide wavelength for this mode of propagation.

   (b) Obtain expressions for phase velocity and group velocity between parallel planes. Prove that $\frac{1}{\lambda_0^2} = \frac{1}{\lambda_c^2} + \frac{1}{\lambda_g^2}$

   (6+4=10)

5. (a) Derive wave equation for conducting medium.

   (b) Find the value of attenuation constant(α) and phase constant (β) for conducting medium.

   (5+5=10)

6. (a) Explain the operation of magnetron with the aid of suitable schematic diagram.

   (b) Write short notes on:

   (i) Velocity modulation (ii) TWT

   (5+5=10)

7. (a) Explain the working principle of reflex klystron with suitable diagram. Also mention its different applications.

   (b) The characteristic impedance of a uniform transmission line is $2040\,\Omega$ at the frequency of $800\,Hz$. At this frequency, propagation constant is $0.054\angle 87.9^{\circ}$. Determine R, L, G and C.

   (5+5=10)

8. (a) What is antenna? Explain different parameters involved in measurement of antenna performance.

   (b) Write short notes on:

   (i) IMPATT diode (ii) Varactor diode

   (6+4=10)

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Duration: 20 minutes **Marks – 20**

(PART A - Objective Type)

I. Choose the correct answer: **1×20=20**

1. The wave equation for free space in terms of E is:

   a) $\nabla^2 E = \mu_0 \varepsilon_0 \frac{\partial^2 E}{\partial t^2}$ b) $\bar{\nabla}^2 E = \mu_0 \varepsilon_0 \frac{\partial^2 E}{\partial t^2}$

   c) $\nabla^2 E = \frac{1}{\mu_0 \varepsilon_0} \frac{\partial^2 E}{\partial t^2}$ d) $\nabla^2 E = \mu_0 \varepsilon_0 \frac{\partial E}{\partial t}$

2. Velocity of wave in free space is

   a) $\frac{1}{\sqrt{\mu\varepsilon}}$ b) $\sqrt{\mu\varepsilon}$ c) $\frac{1}{\sqrt{\mu_0 \varepsilon_0}}$ d) $\sqrt{\mu_0 \varepsilon_0}$

3. The characteristics of good conductor is

   a) $\frac{\sigma}{\omega\varepsilon} \rangle\rangle 1$ b) $\frac{\sigma}{\omega\varepsilon} \langle\langle 1$ c) $\frac{\omega}{\sigma\varepsilon} \rangle\rangle 1$ d) $\frac{\omega}{\sigma\varepsilon} \langle\langle 1$

4. The Poynting vector is equal to

   a) $E \cdot H$ b) $E \times H$ c) E/H d) H/E

5. Which of the following statements are true for a transmission line parameters *R*, *L*, *G* and *C*?
   a) *R* and *L* are series elements.
   b) *G* and *C* are shunt elements.
   c) both*R* and *G* depend on conductivity of the conductors forming the line.
   d) only*R* depends explicitly on frequency.

6. The voltage reflection coefficient at the load end is

   a) $\Gamma_L = \left(\frac{Z_L - Z_0}{Z_L + Z_0}\right)$ b) $\Gamma_L = \left(\frac{Z_0 - Z_L}{Z_0 + Z_L}\right)$ c) $\Gamma_L = \left(\frac{Z_L + Z_0}{Z_L - Z_0}\right)$ d) $\Gamma_L = \left(\frac{Z_L - Z_0}{Z_L + Z_0}\right)^2$

7. Attenuation constant (α) for wave propagating in conducting medium is given by

   a) $\omega \sqrt{\left(\frac{\mu\omega}{2}\right)\left[\sqrt{1+\left(\frac{\sigma}{\omega\varepsilon}\right)^2} - 1\right]}$ b) $\omega \sqrt{\left(\frac{\mu\omega}{2}\right)\left[\sqrt{1+\left(\frac{\sigma}{\omega\varepsilon}\right)^2} + 1\right]}$

   c) $\sqrt{\left(\frac{\mu\omega}{2}\right)\left[\sqrt{1+\left(\frac{\sigma}{\omega\varepsilon}\right)^2} - 1\right]}$ d) $\sqrt{\left(\frac{\mu\omega}{2}\right)\left[\sqrt{1+\left(\frac{\sigma}{\omega\varepsilon}\right)^2} + 1\right]}$

8. Which of the followings is a mathematically incorrect expression?
   a) grad div b) div grad c) curl grad d) grad div

9. An antenna is terminating device which converts..... to E/H wave
   a) V/I b) V c) I d) P

10. In PIN diode, layer between PN junction is
   a) intrinsic layer b) insulator layer
   c) impedance layer d) none of the above

11. The conduction current density in a conducting medium is given by
   a) $J = \sigma E$ b) $J = \sigma / E$ c) $J = E / \sigma$ d) $J = \sigma^2 / E$

12. Klystron is a microwave
   a) oscillator b) amplifier c) switch d) none of the above

13. The variation in electron velocity in drift space is known as
   a) velocity modulation b) speed modulation
   c) space modulation d) none of the above

14. Which among the following is a valid form of Maxwell's equation?
   a) $\nabla \cdot B = \rho_v$ b) $\nabla \cdot E = \rho_v$ c) $\nabla \times B = J$ d) $\nabla \cdot D = \rho_v$

15. If a plane wave satisfies the equation $\frac{\partial^2 E_x}{\partial z^2} = \frac{1}{c^2}\frac{\partial E_x}{\partial t^2}$, the wave propagates in
   a) x direction b) z direction c) both a) and b) d) y direction

16. Negative resistance effect is observed in
   a) TRAPATT b) IMPATT c) Gunn diode d) Magnetron

17. Intrinsic impedance of free space is
   a) 376Ω b) 377Ω c) 375Ω d) none of the above

18. What is the major factor for determining whether a medium is free space, lossless dielectric, lossy dielectric or good conductor?
   a) attenuation constant b) constitutive parameters $(\alpha, \varepsilon, \mu)$
   c) loss tangent d) intrinsic impedance

19. Characteristic impedance Z_0 of a transmission line at microwave frequencies is
   a) $\sqrt{\frac{L}{C}}$ b) $\sqrt{\frac{C}{L}}$ c) $\sqrt{LC}$ d) $\sqrt{\frac{1}{LC}}$

20. Signals coming back from RADAR target is known as
   a) echos b) reflected signal c) pulse d) none of the above

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