Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/M.TECH (ECE)/SEM-1/MCE-104/2011-12

2011
ADVANCED MICROWAVE COMMUNICATION ENGINEERING

Time Allotted : 3 Hours *Full Marks* : 70

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

GROUP – A
(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following : $10 \times 1 = 10$

   i) In a magic tee
      (a) E-arm and H-arm are isolated from each other
      b) one of the collinear arms is isolated from H-arm
      c) one of the collinear arms is isolated from E-arm
      d) none of these.

   ii) In microwave power measurements using bolometers, the working principle is
      a) variation of inductance with absorption of power
      b) variation of capacitance with absorption of power
      c) variation of resistance with absorption of power
      d) none of these.

iii) The dominant mode in a waveguide is characterized by

a) longest cutoff wavelength

b) shortest cutoff wavelength

c) infinite attenuation

d) zero attenuation.

iv) When the polarization of the receiving antenna is unknown, to ensure that it receives at least half the power (except in particular situation), the transmitted wave should be

a) horizonatally polarization

b) vertically polarization

c) circularly polarization

d) elliptically polarization.

v) Cassegrain feed is used with a parabolic reflector to

a) increase the gain of the system

b) increase the bandwith of the system

c) adjust the feed to be placed at a convenient point

d) none of these.

vi) The transit time (in cycles) for the electrons in the repeller-space of a reflex klystron oscillator for sustaining oscillations is (n is any integer including zero)

a) $3\ (n-2)$, b) $5\ (n-1)$

c) $2n + 3/4$ d) $n + 3/4$.

vii) Which one of the following can be used for amplification of microwave energy ?

a) Magnetron b) Two cavity klystron

c) TWT d) Tunnel diode.

viii) The semiconductor diode which can be used in switching circuits at microwave range is

a) PIN diode b) varactor diode

c) tunnel diode d) Gunn diode.

ix) The antenna most commonly used for TV broadcasting in the UHF band is

a) turnstile antenna b) dipole antenna

c) Yagi antenna d) Rhombic antenna.

x) Waveguide section in a microwave circuit will act as a

a) high pass filter b) low pass filter

c) band pass filter d) none of these.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. Calculate maximum usable frequency of transmission between two stations of 500km if electron density is 10^{12} electron per cubic metre and height = 240 km.

3. Calculate the ratio of circular waveguide cross-section area to rectangular waveguide cross-section having similar cut-off wavelengths for the dominant mode in TE. Assume suitable data. Given both have (X_{11} = 1.841).
4. A transmission line has the following parameters r = 0.5 Ω/m, G = 0.5 m-mho/m, f = 1GHz, L = 8mH/m, and C = 0.23pf. Calculate the propagation constant of the line.
5. A TE_{11} mode is propagating in a rectangular waveguide of dimensions a = 6cm, b = 4cm, the distance between maximum and minimum points is found to be 4.55 cm. find the frequency of the wave.
6. Discuss applications of magic Tee.
7. Derive Friis transmission formula for radio communication link.
8. Explain the industrial applications of microwave.
9. What are the limitations of microwave vacuum tubes.
10. Define (a) Antenna gain, (b) Directivity, (c) Radiation pattern.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

11. Explain the operation principle and find out the scattering matrix of a directional coupler.
12. Discuss the operation principle of a magic tee. Find out its scattering matrix.

13. Derive the cut-off magnetic field and cut-off voltage of magnetron.

14. a) Derive the flare angle and horn length of a pyramidal horn antenna.

    b) a pyramidal horn antenna having E-plane aperture a_E = 10λ, path length difference δ = 0.2λ in the *E*-plane and 0.32λ in the *H*-plane. Calculate the (i) horn length, (ii) H-plane aperture, (iii) flare angles θ_E and θ_H, (iv) Directivity.

15. Write short notes on any four of the following :

    a) Energy band diagram of Tunnel diode

    b) Waveguide excitation

    c) Quarter wavelength transformer

    d) Dfferential negative resistance of GUNN diode

    e) Dominant mode

    f) Degenerate mode

    g) Phase velocity

    h) Group velocity.

16. a) Derive the Friis power transmission formula for Microwave communication systems.

b) The Direct Broadcast System (DBS) operates at 12.2-12.7 GHz with a transmit carrier power 5 of 120 watt, a transmit antenna gain of 34dB, an IF bandwidth of 20 MHz, and a worstcase slant angle (30°) distance from the geosynchronous satellite to earth of 39000 km. The 18″ receiving dish antenna has a gain of 33.5 dB and sees an average background brightness temperature of T_b = 50K with a receiver, low noise block having a noise figure of 1.1 dB. The overall system is shown in fig1.

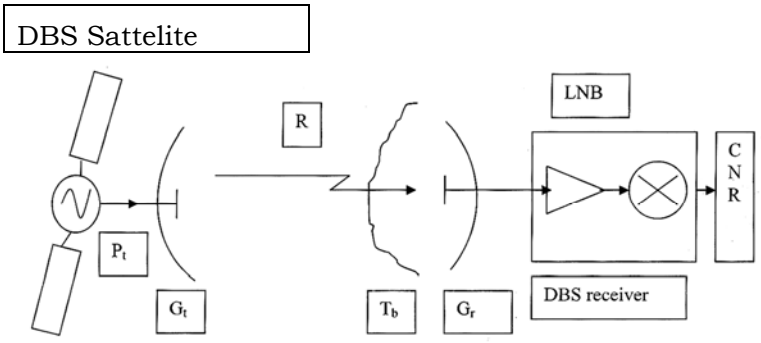

Fig. 1

Find out (i) the EIRP of the transmitter,

(ii) the received carrier power at the receive antenna terminals.

17. What is Faraday rotation ? Explain the working principle of isolator.

18. Explain the working principle of TRAPATT diode.

19. The frequency of a wave propagating in a parallel plate waveguide (Rectangular waveguide) is 6 GHz & plane of separation is 3 cm. Calculate –

    i) the cut-off wavelength for dominant mode.

    ii) phase velocity of the waveguide.

20. Derive the electric and magnetic field equations of TM mode in rectangular waveguide. What is the cut-off frequency of a rectangular waveguide ?