

Code: AE20

**DECEMBER 2008****Subject: MICROWAVE THEORY  
& TECHNIQUES****Time: 3 Hours****Max. Marks: 100****NOTE: There are 9 Questions in all.**

- Question 1 is compulsory and carries 20 marks. Answer to Q. 1. must be written in the space provided for it in the answer book supplied and nowhere else.
- Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.
- Any required data not explicitly given, may be suitably assumed and stated.

**Q.1 Choose the correct or best alternative in the following: (2x10)**

- a. Which one of the following can be used for amplification of microwave energy?
- (A) Travelling wave tube                      (B) Magnetron  
(C) Reflex klystron                              (D) Gunn diode
- b. Geostationary satellites are placed in equatorial orbits at a height of approximately
- (A) 1,000 Km.                                      (B) 5,000 Km.  
(C) 18,000 Km.                                    (D) 36,000 Km.
- c. The transmission line using two ground planes is
- (A) Coaxial line.                                  (B) Microstrip.  
(C) Strip line                                      (D) Rectangular waveguide.
- d. For a matched load the value of VSWR is
- (A) 0.    (B)  $\infty$ .  
(C) 1.    (D) 0 and 1.
- e. Rat race coupler is a
- (A) 3-port network.                              (B) two port network.  
(C) 4-port network                                (D) 1 port network
- f. The following diode does not use negative resistance in its operation
- (A) Gunn diode                                    (B) Tunnel diode  
(C) Backward diode                              (D) IMPATT diode
- g. In a two hole directional coupler; the distance between two holes in terms of guide wavelength  $\lambda_g$  is

- (A)  $\lambda_g$  (B)  $\lambda_g/2$   
 (C)  $\lambda_g/4$  (D)  $2\lambda_g$
- h. The dominant modes in microwaves for waveguide propagation are  
 (A)  $TE_{10}$  &  $TM_{10}$  (B)  $TE_{10}$  &  $TM_{11}$   
 (C)  $TE_{11}$  &  $TM_{01}$  (D)  $TE_{11}$  &  $TM_{10}$
- i. One of the following material is not used as resistive material for the fabrication of MICS  
 (A) Cr (B) NiCr  
 (C)  $Al_2O_3$  (D) CrSiO
- j. When microwave signals follow the curvature of the earth, this is known as  
 (A) Ducting (B) Faraday effect  
 (C) Tropospheric scatter (D) Ionospheric reflection.

**Answer any FIVE Questions out of EIGHT Questions.  
 Each question carries 16 marks.**

- Q.2** a. Give a table of the position of microwave bands in the entire Radio spectrum giving the frequency-band, wavelength band and designation (IR<sub>CC</sub>) band. (4)
- b. Mention some important applications of microwaves. Briefly explain two of them. (4)
- c. Starting from fundamentals derive the transmission line equations. (8)
- Q.3** a. A shielded strip line has the following parameters:  
 Dielectric constant of the insulator (polystyrene):  $\epsilon_r = 2.56$  strip width:  $w = 25$  mils strip thickness  $t = 14$  mils shield depth:  $d = 70$  mils calculate  
 (i) the k factor  
 (ii) the fringe capacitance  
 (iii) the characteristic impedance of the line. (6)
- b. A Rectangular waveguide of cross-section 5 cm x 2 cm is used to propagate  $TM_{11}$  mode at 10 GHz. Determine the cut-off wavelength and characteristic impedance. (6)
- c. With reference to wave guides, differentiate between group velocity and phase velocity. (4)

- Q.4** a. What are ferrites? Why are these useful in microwaves. Mention their properties. (6)
- b. Using a neat diagram, explain, how can a four port circulator be realized using magic-tees. (4)
- c. Derive the scattering matrix of a directional coupler. (6)
- Q.5** a. Two identical 30 dB directional couplers are used to sample incident and reflected power in a waveguide. VSWR = 2 and the output of the coupler sampling incident power = 4.5 mw. What is the value of reflected power? (4)
- b. Describe how can the power of a microwave generator be measured using calorimeter techniques. (6)
- c. Write a short note on measurement of a cavity resonator. (6)
- Q.6** a. What are MESFETs? Explain the construction, operation, performance characters and their applications. (6)
- b. What is parametric amplifier? How is it different from a normal amplifier? (4)
- c. An up-converter parametric amplifier has the following parameters:  
 Ratio of output frequency over signal frequency :  $f_o/f_s = 25$   
 Figure of merit :  $Y Q = 10$   
 Factor of merit figure :  $Y = 0.4$  Diode temperature :  $T_d = 350^\circ\text{K}$   
 Calculate  
 (i) the power gain in decibels;  
 (ii) the noise figure in decibels;  
 (iii) the band width. (6)
- Q.7** a. How do you distinguish stationary targets and moving targets. Explain the principle and working of an MTI radar. (6)
- b. Derive the radar range equation. Explain the factors that affect the maximum range of a radar. (6)
- c. A 10 GHz radar has the following characteristics, peak transmitted power = 250 kw; power gain of antenna = 2500; minimum detectable peak signal power by receiver =  $10^{-14}$  watts; cross sectional area of the radar antenna =  $10\text{m}^2$ .  
 If this radar were to be used to detect a target of  $2\text{m}^2$  equivalent cross section, find the maximum range possible. (4)
- Q.8** a. What is a waveguide? What are wave guide modes? (4)

b. Why is  $TE_{10}$  mode, considered to be the DOMINANT MODE in rectangular waveguides? What is the dominant mode in circular waveguides? Why is this mode not preferred in circular guides? What are then the preferred modes in circular waveguides? (6)

c. For a dominant mode of operation in an air filled circular waveguide of inner diameter 4 cm, find  
(i) cut-off wavelength.  
(ii) cut-off frequency.  
(iii) wavelength in the guide. (6)

**Q.9** a. Write a short note on Travelling-wave Tube. (4)

b. Explain the construction and principle of working of a two cavity Klystron Amplifier. Also discuss the process of bunching using an “Applegate diagram”. (6)

c. Describe the modes of operation for Gunn Diodes. (6)