

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 131603 Roll No. 

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**B.Tech.****(SEM. VI) THEORY EXAMINATION 2013-14****MICROWAVE ENGINEERING***Time : 3 Hours**Total Marks : 100***Note :-** Attempt all questions. Each question carries equal marks.

1. Attempt any four parts of the following : (5×4=20)
- (a) Use Maxwell's equations to show that TEM mode cannot exist in the hollow waveguide.
  - (b) An airfilled rectangular waveguide with a cross section  $2 \times 1$  cms transports energy in the  $TE_{10}$  mode at a rate of 0.5 hp. The impressed frequency is 30 GHz. What is the peak value of electric field in the guide ?
  - (c) Show that  $TM_{10}$  and  $TM_{01}$  modes in rectangular waveguide do not exist.
  - (d) A  $TE_{11}$  mode of 10 GHz is propagating in air filled rectangular waveguide. The magnetic field in the z direction is given by :

$$H_z = H_0 \cos\left(\frac{\pi x}{\sqrt{6}}\right) \cos\left(\frac{\pi y}{\sqrt{6}}\right) \frac{A}{m}$$

The phase constant  $\beta = 1.0475 \frac{\text{rad}}{\text{cm}}$  (x, y, a and b are in cms).

Find– Cutoff frequency, phase velocity in guide, guided wavelength and magnetic field intensity in the y direction.

- (e) A circular waveguide has a cutoff frequency of 7 GHz in the dominant mode ( $X'_{11} = 1.841$ ), find –
- (i) inside diameter of guide if it is airfilled
  - (ii) inside dimension of guide if it is filled with a dielectric of dielectric constant  $\epsilon_r = 2.1$  and  $\mu_r = 1$ .
- (f) Write short note on microstrip transmission line.
2. Attempt any four parts of the following : (5×4=20)
- (a) Show that a rectangular cavity may be viewed as a rectangular waveguide shorted at both ends. Also find the resonance condition.
  - (b) A rectangular cavity resonator has dimension  $a = 7.5$  cm,  $b = 4$  cm and  $d = 16$  cm, calculate – the resonant frequency of dominant mode, cutoff wave number and phase constant.
  - (c) Prove that it is impossible for a general three-port junction (for example E-plane tee) of arbitrary symmetry to present matched impedance at all three arms.
  - (d) What is Faraday Rotation ? How it is used in designing microwave components ?
  - (e) Derive the schematic diagram of four port microwave circulator and derive its S-matrix.
  - (f) Incident power for a 30 dB coupler is 560 MW. Calculate the power in the main arm and in auxiliary arm.

3. Attempt any two parts of the following : (10×2=20)

- (a) What are the limitations of conventional active devices at microwave frequencies ? Explain in detail.
- (b) What is Travelling Wave Tube ? Explain the principle of operation and construction of T.W.T. Also write its limitations.
- (c) A two cavity Klystron amplifier has the following parameters :  
 $V_o = 1000$  V,  $R_o = 40$  k $\Omega$ ,  $I_o = 25$  mA,  $f = 3$  GHz  
Gap spacing in either cavity  $d = 1$  mm  
Spacing between the two cavities  $L = 4$  cm  
Effective shunt impedance, excluding beam load  $R_{sh} = 30$  k $\Omega$ 
  - (i) Find the input gap voltage to give maximum voltage  $V$ .
  - (ii) Find the voltage gain, neglecting the beam loading in the output cavity.
  - (iii) Find the efficiency of the amplifier, neglecting beam loading.
  - (iv) Calculate the beam loading conductance.

4. Attempt any two parts of the following : (10×2=20)

- (a) Draw the physical structure and explain principle of operation of IMPATT diode.  
An IMPATT diode has the following parameters :  
Carrier drift velocity  $V_d = 2 \times 10^7$  cm/sec  
Drift region length  $L = 6$   $\mu$ m

Maximum operating voltage  $V_{o\max} = 100\text{ V}$

Maximum operating current  $I_{o\max} = 200\text{ nA}$

Efficiency  $\eta = 15\%$ , Breakdown voltage  $V_{bd} = 90\text{ V}$

Calculate :

- (i) maximum CW output power in watts
  - (ii) the resonant frequency in GHz.
  - (b) With neat sketch explain microwave characteristics of tunnel diode. Also explain tunneling phenomenon.
  - (c) Write short notes on :
    - (i) Microwave Bipolar Junction Transistor
    - (ii) Transferred electron devices.
5. Attempt any two parts of the following : (10×2=20)
- (a) How Insertion and Attenuation loss of Isolator are measured ? Explain in detail.
  - (b) Explain in detail measurement of antenna characteristics.
  - (c) How frequency of source is measured using microwave test bench ? Explain in detail.