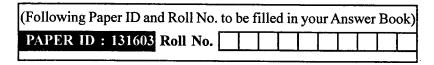
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EEC603



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:

 $(5 \times 4 = 20)$

- (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 × 1 cms transports energy in the TE₁₀ 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 TM₁₀ and TM₀₁ modes in rectangular waveguide do not exist.
- (d) A TE₁₁ mode of 10 GHz is propagating in air filled rectangular waveguide. The magnetic field in the z direction is given by:

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

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

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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 $\varepsilon_r = 2.1$ and $\mu_r = 1$.
- (f) Write short note on microstrip transmission line.
- 2. Attempt any four parts of the following: $(5\times4=20)$
 - (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 it S-matrix.
 - (f) Incident power for a 30 dB coupler is 560 MW. Calculate the power in the main arm and in auxiliary arm.

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- 3. Attempt any two parts of the following:
 - (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:

$$V_0 = 1000 \text{ V}, R_0 = 40 \text{ k}\Omega, I_0 = 25 \text{ mA}, f = 3\text{GHz}$$

Gap spacing in either cavity d = 1 mm

Spacing between the two cavities L = 4 cm

Effective shunt impedance, excluding beam load $R_{sh} = 30 \text{ k}\Omega$

- (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: $(10\times2=20)$
 - (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 $L = 6 \mu m$

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 $(10 \times 2 = 20)$

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

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

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

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: $(10\times2=20)$
 - (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.

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