Printed Pages—4 **EEC603**

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

PAPER ID : 131603 Roll No. | | | | | | | | | | |

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 × 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 :

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

The phase constant $\beta = 1.0475 \frac{rad}{cm}$ (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 : **(5×4=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 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 : **(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, $R_o = 40$ kΩ, $I_o = 25$ mA, f = 3GHz

Gap spacing in either cavity d = 1 mm

Spacing between the two cavities L = 4 cm

Effective shunt impedance, excluding beam load $R_{sh} = 30$ kΩ

(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 μm

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

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

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