

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

PAPER ID : 2489

Roll No.

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B. Tech.

(SEM. VI) THEORY EXAMINATION 2010-11

MICROWAVE ENGINEERING

Time : 3 Hours

Total Marks : 100

Note : (1) Attempt **ALL** questions.

(2) Each question carries equal marks.

1. Attempt any **four** parts of the following : (5×4=20)
- (a) Use Maxwell's equations to show that it is impossible for TEM wave to exist within any conductor wave guide.
 - (b) An air filled hollow rectangular conducting wave guide has cross-section dimensions of 8×10 cms. How many TE mode will this wave guide transmit at frequencies below 4 GHz ?
 - (c) For circular wave guide having an internal diameter of 15 cm calculate the cut-off frequencies for (i) $TE_{2,1}$ mode when the roots of the bessel function is 3.05 (ii) $TM_{1,2}$ mode when the roots of the bessel function is 7.02.
 - (d) An air dielectric rectangular wave guide has inner dimensions of 2 cm by 1 cm. Calculate cut-off frequency for the dominant $TE_{1,0}$ mode and wave impedance, phase constant and wave velocity at a frequency 1.5 times cut-off frequency.

- (e) A lossless parallel strip line has a conducting strip width w . The substrate dielectric separating the two conducting strips has a relative dielectric constant ϵ_{rd} of 6 (beryllia or beryllium oxide BeO) and a thickness d of 4 mm. Find out the required width w of the conducting strip in order to have a characteristic impedance of 50Ω and also calculate the strip-line capacitance.
- (f) What do you mean by microwave cavities? Describe the Rectangular Cavity Resonator.
2. Attempt any four parts of the following : (5×4=20)
- (a) A two-port network with given scattering parameters is terminated in a load Z_L . Obtain the scattering parameters of the new system.
- (b) Classify terminators. Explain each of them with relevant figures.
- (c) Explain the working of E Plane Tee. Derive its [S] matrix when the main arm is perfectly matched and Power P is fed from Auxiliary Arm.
- (d) Explain the working of Directional coupler and define its four coupling parameters.
- (e) Explain the working and applications of circulator. Are they reciprocal or Non reciprocal device?
- (f) What is Faraday Rotation? How it is used in designing Microwave components?

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

(a) What is velocity modulation ? How is it achieved in a two cavity klystron ? Describe the construction and working of a reflex klystron.

(b) A two-cavity klystron amplifier has the following parameters :

$V_0 = 800 \text{ V}$, $L = 1.5 \text{ mm}$, $R_{sh} = 15 \text{ k } \Omega$ $f = 10 \text{ GHz}$,
 $d = 1 \text{ mm}$, $L = 4 \text{ cm}$, $R_{sh} = 30 \text{ k } \Omega$. Calculate : (i) the input voltage for maximum output voltage; (ii) the voltage gain in decibels (iii) efficiency.

(c) An X-band pulsed cylindrical magnetron has the following operating parameters :

Anode voltage : $V_0 = 26 \text{ kV}$

Beam current : $I_0 = 27 \text{ A}$

Magnetic flux density : $B_0 = 0.336 \text{ Wb/m}^2$

Radius of cathode cylinder : $a = 5 \text{ cm}$

Radius off vane edge

to center : $b = 0 \text{ cm}$

Compute : (i) the cyclotron angular frequency (ii) the cutoff voltage for a fixed B_0 (c) the cutoff magnetic flux density for a fixed V_0 .

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

(a) Explain the working of IMPATT Diode. An IMPATT diode has the following parameters :

Carrier drift velocity : $V_d = 2 \times 10^7 \text{ cm/s}$

Drift-region length : $L = 6 \text{ } \mu\text{m}$

Maximum operating voltage :	$V_{omax} = 100 \text{ V}$
Maximum operating current :	$I_{omax} = 200 \text{ mA}$
Efficiency :	$\eta = 15\%$
Breakdown voltage :	$V_{bd} = 90 \text{ V}$

Compute : (i) the maximum CW output power in watts; (ii) the resonant frequency in gigahertz.

- (b) What are transferréd electron devices ? Explain the working of any one of them.
- (c) Explain the operating principle and working of the following :
- Microwave Bipolar Transistor
 - Microwave tunnel diode.
5. Attempt any four part of the following : (5×4=20)
- Working and Application of slotted wave carriage.
 - One technique to measure Micro Wave Power.
 - With the help of Microwave test bench how to measure the unknown Load.
 - How Insertion and attenuation loss of Isolator is measured experimentally.
 - Working principle of Crystal detector.
 - Working of Frequency meter.