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Subject: MICROWAVE THEORY & TECHNIQUES

December 2005

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. If a 50-ohm loss-less transmission line is terminated in a pure reactance of 25 ohms, then the VSWR produced on the line is
 - (A) zero.

(B) 1/2.

(C) 2.

- (D) infinity.
- b. Transverse electric wave travelling in Z-direction satisfies
 - **(A)** Ez = 0: Hz = 0

(B) $Ez = 0 : Hz \neq 0$

(C) $Ez \neq 0$: Hz = 0

(D) Ez \neq 0: Hz \neq 0

- c. Reflex klystron is a
 - (A) Low power oscillator
- (B) High power oscillator
- (C) Amplifier used in Receiver
- (D) A mixer device
- d. Which one is not ATTD, (Avalanche Transit Time Device)
 - (A) BARITT

(B) IMPATT

(C) TRAPATT

- **(D)** PIN
- e. The expression for f_{o} in a rectangular cavity resonator is given by

(A)
$$f_0 = \frac{C}{2} \left((m/a)^2 + (n/b)^2 + (p/d)^2 \right)^{1/2}$$

(B)
$$f_o = \frac{2}{C} \left((m/a)^2 + (n/b)^2 + (p/d)^2 \right)^{1/2}$$

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(C)
$$f_o = \frac{2}{C} \left((a/m)^2 + (b/n)^2 + (d/p)^2 \right)^{1/2}$$

(D)
$$f_0 = \frac{C}{2} \left\{ (a/m)^2 + (b/n)^2 + (d/p)^2 \right\}^{1/2}$$

where the parameters/symbols have usual meaning.

A T.V. transmitter antenna has a height of 144 meters (AMSL) and the receiving antenna has a height of 25 m (AMSL). What is the maximum distance along the earth through which the T.V. signal could be received by space propagation?

(A) 68 km

(B) 68 mt

(C) 680 km

(D) 680 mt

Bandwidth for a power-up converter is given by (Y, fo, fs have their usual meanings)

(A) BW =
$$2\gamma \sqrt{\text{fo } | \text{fs}}$$

(B)
$$BW = 2\gamma \sqrt{fs \mid fo}$$

(A)
$$BW = 2\gamma \sqrt{f \circ | f \circ |}$$
 (B) $BW = 2\gamma \sqrt{f \circ | f \circ |}$ (C) $BW = \left(\gamma/2 \sqrt{f \circ | f \circ |}\right) \sqrt{f \circ | f \circ |}$ (D) $BW = \gamma/2 \sqrt{f \circ | f \circ |}$

BW =
$$\gamma/2\sqrt{f \circ |f \circ |}$$

Two identical directional couplers are used in waveguide to sample the incident and reflected powers. The output of the two couplers is found to be 2.5 mw and 0.15 mw. The value of VSWR in the waveguide is given by

(A) 1.64

(B) 1.63

(C) 10.64

(D) 10.63

When the phase velocity of an EM wave depend on frequency in any medium, the phenomenon is called

(A) Scattering.

(B) Polarisation.

(C) Absorption.

(D) Dispersion.

On the smith chart, a loss less line is represented by

- (A) the diameter along real axis.
- **(B)** the diameter along imaginary axis.
- (C) the diameter equally inclined to the real and imaginary axis.
- **(D)** a circle with its centre at the origin.

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

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Q.2	 a. A certain transmission line has a characteristic impedance of 75 + j0.01 Ω and is terminated in a load impedance of 70 + j50 Ω. Compute reflection coefficient and transmission coefficient. (7) 					
	b. List the drawbacks of single-stub matching.	(4)				
	c. A Lossless transmission line with characteristic impedance voltage 10∠0° volts at 1.2 MHz. If the line is terminated by input impedance of open circuit line and input impedance (5)	Z_L at a distance 1 km, calculate				
Q.3	a. Bring out the similarities and dis-similarities between waveguline.(8)	uide and 2-wire transmission				
	b. Derive the wave equation for a TE wave.	(8)				
Q.4	a. Derive an expression for resonant frequency $f_{\rm o}$ in a rectangular	cavity resonator. (6)				
	b. A circular waveguide has a radius of 3 cms and is used as a GHz by placing two perfectly conducting plates at its two ends between the two end resonance.					
	c. Explain Loop coupling and aperture coupling.	(4)				
Q.5	 a. Prove that it is impossible to construct a perfectly matched, lossless reciprocal three-port junction. (6) 					
	b. In a H-plane T-junction, compute power delivered to the load to arm 1 and 2 when 10 mw power is delivered to the load (6)					
	c. Explain how, magic-tee can be used as a balanced microwave i	mixer. (4)				
Q.6	a. Write short notes on waveguide bend corners and twists.	(8)				
	b. A symmetric directional coupler with infinite directivity and used to monitor the power delivered to a load ${}^{\mathbb{Z}}_{\mathbb{L}}$. If Bolom on arm 4. Bolometer 2 is matched to arm 3. If Bolometer 1 rd 2 mw, find the amount of power dissipated in ${}^{\mathbb{Z}}_{\mathbb{L}}$.	neter1 introduces a VSWR of 2.0				
Q.7	a. Discuss the high frequency limitation of conventional tubes.	(8)				
n for Notice 12 /	b. By carrying out detailed mathematical analysis for reflex k maximum power output. (8)	clystron, obtain the expression for				

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Q.8

a. Explain in detail the operation of PIN diode.

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b. A negativ	ve resistance parar	netric ampli	fier has a si	ignal frequency of 2	GHz, pum	p frequency of
12 GHz, o	output resistance of	of signal gen	erator of	1 K ∩ Determine	(i) Power	gain in dB (ii)
Dorron	~~	:c	:4	*******	0.0	LICD

gain Power 1**†** 1t work as USB **(6)** converter.

(6)

c. Write a short note on varactor diode. **(4)**

- **Q.9** a. A typical SI BARITT diode has the following specifications. Relative dielectric constant = 12.5Donor concentration = $3.2 \times 10^{22} / \text{m}^3$ Length = $8 \mu m$ Calculate (i) Critical voltage (ii) breakdown voltage (iii) breakdown electric field. **(8)**
 - Mention the performance characteristics, applications and disadvantages of b. MASERS. **(8)**