



CONFIDENTIAL

HERITAGE INSTITUTE OF TECHNOLOGY

M.Tech. 1st Semester Examination. 2014

Session : 2014-15

Discipline : ECE

Paper Code : ECEN5103

Paper Name : Advanced Microwave Communication Engineering

Time Allotted : 3 hrs

Full Marks : 70

*Figures out of the right margin indicate full marks.
Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.
Candidates are required to give answer in their own words as far as practicable.*

Group – A

(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: 10 x 1=10
- (i) For an aperture antenna of aperture dimension D and wavelength of radiation from the antenna λ , the far-field is at a distance greater than
- (a) D^2/λ (b) $D^2/2\lambda$
(c) $2D^2/\lambda$ (d) $(2D/\lambda)^2$
- (ii) For its S matrix to be unitary, the circuit should be
- (a) reciprocal (b) lossless
(c) both (d) none of these
- (iii) The expression for phase velocity in lossless line is
- (a) $v_p = \sqrt{LC}$ (b) $v_p = 1/\sqrt{LC}$
(c) $v_p = \omega/\sqrt{LC}$ (d) $v_p = 0$
- (iv) A quarter wave line open circuited at far end behaves as
- (a) L (b) L and C in parallel
(c) C (d) L and C in series
- (v) The wavelength measured along a microstrip line is measured as 15 mm for a 10 GHz signal. What is the effective dielectric constant of the substrate
- (a) 1 (b) 2
(c) 3 (d) 4
- (vi) The Centre of the Smith chart represents
- (a) Matched Load (b) Short Circuit
(c) Open Circuit (d) none of these
- (vii) A TRAPATT diode is fabricated with doping concentration $N_a = 2 \times 10^{15} \text{ cm}^{-3}$ and $J = 20 \text{ kAcm}^{-2}$, the drift velocity will be:
- (a) $6.25 \times 10^7 \text{ cm/s}$ (b) $6.25 \times 10^4 \text{ cm/s}$
(c) $1 \times 10^7 \text{ cm/s}$ (d) $1 \times 10^4 \text{ cm/s}$



HERITAGE INSTITUTE OF TECHNOLOGY

M.Tech. 1st Semester Examination. 2014

Session : 2014-15

Discipline : ECE

Paper Code : ECEN5103

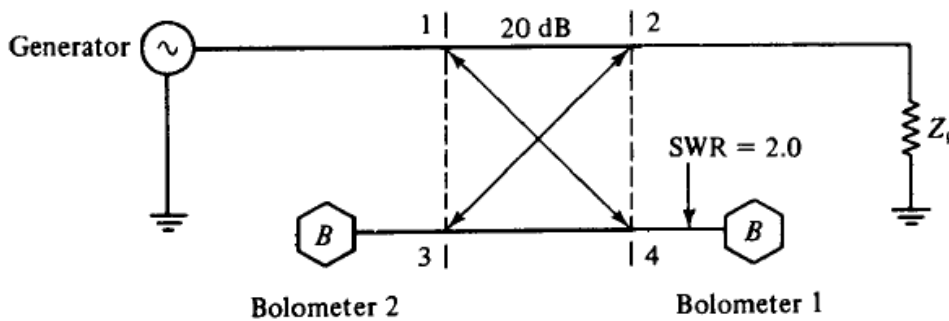
Paper Name : Advanced Microwave Communication Engineering

- (viii) Duct propagation is similar to
 - (a) free space propagation
 - (b) propagation in waveguides
 - (c) propagation in water
 - (d) uniform plane wave
- (ix) Beam steering in antenna array can be achieved by
 - (a) changing relative time delay
 - (b) changing relative phase shifts
 - (c) both (a) and (b)
 - (d) none of these
- (x) The directive gain of a transmitting antenna is proportional to
 - (a) its cross sectional area
 - (b) square of cross sectional area
 - (c) square root of cross sectional area
 - (d) cube root of cross sectional area

Group - B

- 2. (a) Explain the concept of pattern multiplication in antenna array with suitable examples.
- (b) A four element linear array of isotropic radiators has uniform amplitude and uniform spacing of 0.5λ and zero progressive phase shift. Find i) the array factor and ii) all the null positions. 5 + 7 = 12

- 3. (a) A symmetric directional coupler with infinite directivity and forward attenuation of 20 dB is used to monitor the power delivered to load Z_L . Bolometer 1 connected to port 4 introduces a VSWR of 2. Bolometer 2 however is matched to port 3. If bolometer 1 reads 8 mW and bolometer 1 reads 2 mW. Calculate:
 - i) The amount of power dissipated in the load Z_L .
 - ii) VSWR on arm 2



- (b) Explain the tunnelling action of a tunnel diode. (4+4)+4=12

**HERITAGE INSTITUTE OF TECHNOLOGY**M.Tech. 1st Semester Examination. 2014

Session : 2014-15

Discipline : ECE

Paper Code : ECEN5103

Paper Name : Advanced Microwave Communication Engineering

Group - C

4. (a) Prove that a 3-port matched, lossless network does not exist.
- (b) In the circuit shown below a $Z_L = 200 + j100 \Omega$ is to be matched a 40Ω line using a length l of lossless transmission of characteristic impedance Z_1 . Find l and Z_1 . Determine, in general, what type of load impedances can be matched using such a circuit.
- (c) What is quarter wave impedance transformer? 5+5+2 = 12
5. (a) Explain the V-I characteristics of a Gunn Diode. What is the main advantage of using the Gunn diode compared with the IMPATT diode?
- (b) A Gunn diode with 3.5V critical threshold potential and 25Ω resistance is connected to 3V dc. If the diode is connected to a tank circuit where $L = 0.1$ nH and $C = 2.5$ pF, what is the period of oscillation? Also find the frequency of oscillation.
- (c) An IMPATT has the following parameters: pulse operating current is 1A and a pulse operating voltage is 200 V. The efficiency is 15%. If the pulse width is 0.02 ns and the frequency is 20 GHz, determine the power output and the duty cycle. 6+3+3 = 12

Group - D

6. (a) Establish Frii's Transmission formula.
- (b) What is fading and what is its effect on propagation?
- (c) The transmitting and receiving radar are separated by a distance of 600 m and have directive gains of 25 dB and 18 dB, respectively. If 5 mW of power is to be received, calculate the minimum transmitted power if the operating frequency of the radar is 100 MHz. 3+2+7 = 12
- 7.(a) What is an isolator? Mention some applications of isolators. What is the role of ferrite in isolators?
- (b) Find the S matrix for a matched isolator having an insertion loss of 0.5 dB and an isolation of 25 dB. (1+2+2) + 5+2
- (c) Write differences between circulators and isolators. = 12



CONFIDENTIAL

HERITAGE INSTITUTE OF TECHNOLOGY

M.Tech. 1st Semester Examination. 2014

Session : 2014-15

Discipline : ECE

Paper Code : ECEN5103

Paper Name : Advanced Microwave Communication Engineering

Group - E

8.(a) Define the S-parameters. What are the different S-parameters associated with a two port network?

(b) The S- matrix of a two port is given below:

$$\begin{bmatrix} 0.1\angle 0^\circ & 0.8\angle 90^\circ \\ 0.8\angle 90^\circ & 0.2\angle 0^\circ \end{bmatrix}$$

a) Determine whether the network is reciprocal or lossless.

b) If a short circuit is placed at port 2, what will be the resulting return loss at port 1?

(c) Derive the S matrix for a – 3dB directional coupler.

(2+2)+(2+2)+4
= 12

9. Write short notes on:

a) Duct propagation

b) Skip distance

c) Link budget

(3x4)= 12