

M.TECH/ECE/1ST SEM/ECEN 5103/2016
ADVANCED MICROWAVE COMMUNICATION
(ECEN 5103)

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 × 1 = 10**
- (i) When the port of a network is mismatched, its reflection coefficient is
(a) still equal to S_{11}
(b) not equal to S_{11} but independent of Γ_2
(c) not equal to S_{11} but dependent of Γ_2
(d) none of these.
- (ii) Microwave Lens antenna is made of
(a) dielectric
(b) metal
(c) semiconducting material
(d) gaseous medium.
- (iii) A Gunn diode of length 10 μm is operating at 10 GHz. The electron drift velocity is
(a) 10^5 cm/sec
(b) 10^7 cm/sec
(c) 10^6 cm/sec
(d) 10^8 cm/sec.
- (iv) The most serious drawback of an IMPATT diode is
(a) high noise
(b) low efficiency
(c) low power handling capacity
(d) inability to provide pulses operation.
- (v) Aperture for parabolic dish antenna is
(a) circular
(b) rectangular
(c) elliptical
(d) without any regular shape.
- (vi) Half wave dipole antenna has a beam width equal to
(a) 78°
(b) 120°
(c) 90°
(d) 45° .

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- (vii) Wave propagation velocity through a medium of dielectric constant 100 is
(a) 3×10^9 cm/sec
(b) 3×10^8 cm/sec
(c) 3×10^7 cm/sec
(d) 10^9 cm/sec.
- (viii) A ground wave gradually disappears as one moves away from the transmitter because of
(a) interference from sky wave
(b) finite conductivity of the earth's surface
(c) loss of LOS communication
(d) maximum single hop distance limitation.
- (ix) Received signal strength for a radio communication system is proportional to
(a) $G_T + G_R$
(b) $G_T \cdot G_R$
(c) G_T / G_R
(d) G_R / G_T .
- (x) Ionospheric propagation occurs at which of the following band of frequencies?
(a) VHF
(b) UHF
(c) SHF
(d) HF.

Group - B

2. (a) What is the origin of negative resistance in GUNN diode oscillator operation? How does microwave cavity support oscillation? What is LSA mode of operation?
(b) Write the physical principle of HEMT device?
6 + 6 = 12
3. (a) Explain the operation of microwave diode as a detector. Describe its role in slotted line measurement and spectrum analyzer.
(b) Describe with a schematic diagram the physical structure of IMPATT diode. Describe the principle of oscillation employing IMPATT diode.
6 + 6 = 12

Group - C

4. (a) Define with the help of a diagram the scattering parameters of a two port microwave network. What do you understand by reciprocal network and lossless networks? Give an expression for input and output voltage in terms of Scattering Matrix for a generalized n port network.

- (b) In a two port microwave network $S_{11}=0.1\angle 0$ $S_{12}=0.8\angle 90^\circ$
 $S_{21}=0.8\angle 90^\circ$ $S_{22}=0.2\angle 0$
 Determine whether the network is reciprocal or lossless.

7 + 5 = 12

5. (a) With a suitable figure, describe the operation of a single ended mixer.
- (b) The S parameter of a certain FET at 3 GHz with a bias voltage $V_{gs} = 0V$ and $Z_0 = 50 \Omega$ are as follows: $S_{11} = 0.87 \angle -57^\circ$, $S_{12} = 0.015 \angle 60^\circ$, $S_{21} = 3.2 \angle 125^\circ$ and $S_{22} = 0.75 \angle -30^\circ$. Determine the stability of the transistor and plot the stability circle using Smith Chart.

6 + 6 = 12

Group - D

6. (a) Deduce the array pattern of two point sources equally spaced with uniform excitation for broadside case.
- (b) Assume that the radial component of the radiated power density of an antenna can be expressed as $A_0 \sin(\theta)/r^2$, where A_0 is the peak power density. Determine (a) total radiated power (b) directivity and (c) directive gain.
7. (a) Explain the following with respect to antenna array
 (i) Pattern Multiplication (ii) Ground effect of antenna radiation.
- (b) Calculate the width and length of a microstrip line for a 50 ohm characteristic impedance and a 90° phase shift at 2.5 GHz. The substrate thickness is $d = 0.127$ cm with dielectric constant 2.20.

6 + 6 = 12

Group - E

8. (a) What is fading? Describe different types of fading. Describe the methods that can be used to reduce fading.
- (b) Derive Friis power transmission equation for satellite communication.

6 + 6 = 12

9. (a) Give a short account of characteristics, frequency of operation and application areas of the following modes of propagation of radio waves.
 (i) Surface Wave propagation (ii) Tropospheric propagation and (iii) Ionospheric propagation.
- (b) Elucidate the mechanism involved in Duct propagation and Troposcatter propagation.

7 + 5 = 12