

RF & MICROWAVE ENGINEERING
(ECEN 4101)

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) The phase velocity of a wave within a waveguide
(a) equal to the free space velocity
(b) less than the free space velocity
(c) greater than the free space velocity
(d) is not related with free space velocity.
- (ii) An electromagnetic wave of frequency 5 GHz is propagating through a medium having $\sigma = 10^1$, $\mu_r = 1$, $\epsilon_r = 4$. The intrinsic impedance of the medium can be found approximately as
(a) $\frac{\eta_0}{2} \angle 15^\circ$ (b) $\frac{\eta_0}{2} \angle 25^\circ$
(c) $\frac{\eta_0}{2} \angle 10^\circ$ (d) $\frac{\eta_0}{2} \angle 20^\circ$
- (iii) For a rectangular waveguide excited with TM mode the fundamental modes is
(a) TM₀₁ (b) TM₁₀
(c) TM₁₁ (d) TM₀₀
- (iv) For lossless network which of the followings is correct?
(a) $[S]^t [S]^* = 1$ (b) $[S]^t [S]^* = 0$
(c) $[S]^t [S]^* = [I]$ (d) $[S]^t [S]^* = [0]$

(v) Given an S matrix as $\begin{matrix} & 0 & 0 & 1 \\ 1 & 0 & 0 & \\ & 0 & 1 & 0 \end{matrix}$. Identify the type of device.

- (a) A T-junction (b) A directional coupler
(c) A clockwise circulator (d) A counter clockwise circulator

(vi) TEM mode exist in waveguides made of
(a) closed conductor
(b) solid dielectric
(c) two conductors separated by dielectric
(d) two dielectrics separated by conductors.

(vii) For reciprocal network which of the followings is correct?
(a) $[S]^t = [S]$ (b) $[S]^t [S]^{-1} = [I]$
(c) $[S] = [S]^{-1}$ (d) (a) and (b) are correct

(viii) The relation between incident voltage matrix , reflected voltage matrix and S matrix for a microwave network:
(a) $[V^-] = [S][V^+]$ (b) $[V^+] = [S][V^-]$
(c) $[V^-][V^+] = [S]$ (d) $[V^-][V] = [S]$

(ix) For lossless network which of the followings is correct?
(a) $[S]^t [S]^* = 1$ (b) $[S]^t [S]^* = 0$
(c) $[S]^t [S]^* = [I]$ (d) $[S]^t [S]^* = [0]$

(x) Given an S matrix as $\begin{matrix} & 0 & 0 & 1 \\ 1 & 0 & 0 & \\ & 0 & 1 & 0 \end{matrix}$. Identify the type of device.

- (a) A T-junction (b) A directional coupler
(c) A clockwise circulator (d) A counter clockwise circulator

Group - B

2. (a) Consider an EM wave is propagating along z direction. Express the transverse electric and magnetic field component in terms of the z component.
- (b) A rectangular waveguide of dimension 22.86 mm x 10.16 mm is filled with a dielectric of dielectric constant 4.3. Calculate the cut-off frequency.

8 + 4 = 12

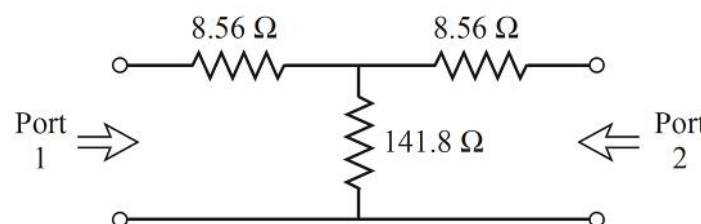
3. (a) Consider a rectangular waveguide is oriented along the z direction. Find general expression of all the field components for TM mode. Hence, show that the dominant mode is TM_1 .
- (b) Consider a rectangular waveguide is to be designed to guide a 12 GHz signal under dominant mode. Calculate the cross-sectional dimension of the waveguide.

(8+1) + (3) = 12

Group - C

4. (a) Given an E-plane Tee with port 3 perfectly matched. Find the S-matrix of E-plane Tee.
- (b) Explain briefly: i) Four-port circulator ii) Isolator.
5. (a) Why KVL and KCL are not suitable for microwave network? Why the Z parameters and Y parameters are not useful for microwave network? Write the conditions for reciprocal and lossless network in the case of Z and Y parameter.
- (b) Write the conditions for reciprocal and lossless network associated with the S parameter. Find the scattering parameter for the circuit when port 2 is terminated at a load 50Ω .

4+(4 + 4)= 12



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

Group - D

6. Write short note on
 i. GUNN Diode
 ii. PIN Diode
 iii. IMPATT Diode

4+4+4= 12

7. Explain the following with proper diagram:
 (i) Two-cavity Klystron amplifier
 (ii) Reflex Klystron
 (iii) Magnetron

4+ 4 + 4 = 12

Group - E

8. (a) Discuss construction and operation of Gunn-effect diode.
 (b) Discuss construction and operation of MESFET

6 + 6 = 12

- 9 (a) Define i) Power gain ii) Available power gain and iii) Transducer power gain with respect to microwave amplifier.
 (b) How to design a prototype of a maximally flat response filter of 2nd order?

(2+ 2 + 2) + 6 = 12

Department & Section	Submission Link
ECE A	https://classroom.google.com/u/0/w/MTIyMjAyNDE0MDEy/tc/MjY0OTAxMTc5NzMz
ECE B	https://classroom.google.com/u/2/w/MTIyNzg2MDIwNzI3/tc/Mjc0NDEyNDEzNTg5
ECE C	https://classroom.google.com/w/MTU3MDA4ODUxMTk1/tc/Mjc0NzkyNjk3MzQx

Department & Section	Submission Link (For Backlog)
ECE	https://classroom.google.com/u/0/w/MTIyMjAyNDE0MDEy/tc/MjY0OTAxMTc5NzMz