

Attempt the following questions. Full Mark 100

Time: 3 Hours

1- Give short answers to the following questions

- What is the range of the characteristic impedance of lines used in actual practice?
- At what point on an open-circuited RF line do voltage peaks occur?
- If the VSWR on a line is infinite, what are the possible values of the load impedance?
- Define the critical angle for the refraction of electromagnetic waves at the boundary between two media. How is it related to the refractive indices of the two media?
- What is the relation between the electric and magnetic fields in a uniform plane transverse electromagnetic TEM wave?

25 Marks

2- A lossless transmission line of characteristic impedance 50Ω and length 45 cm is terminated in a reactive load of $25 + j 25 \Omega$. The line is fed by a 10 V rms source of internal resistance 50Ω . The distance between adjacent voltage minima on the line is 5 cm . Determine:

- The operating frequency.
- The input impedance to the line.
- The voltage standing wave ratio.
- The power delivered to the load.

25 Marks

3- A 3 GHz uniform plane TEM wave is incident from air onto air-water interface at an angle 45° . The constants of water are: $\epsilon_r = 81$ and $\sigma = 0.0$. If the incident electric field is in the plane of incidence (vertical polarization) and its magnitude is 1.0 V/m , find:

- The reflected and transmitted electric and magnetic fields.
- The transmitted power into water per unit area.
- For the present case of incidence from air onto water, can the incident wave be totally reflected?
- For which angle of incidence would total transmission occur?

25 Marks

4- a) Why are microwave waveguides usually designed to support only a single mode?

- Derive expression for the power transmitted through a rectangular waveguide operating in the dominant TE_{10} mode.

10 Marks

5- The inside dimensions of the WR-42 air-filled waveguide are $a = 10.7 \text{ mm}$ and $b = 4.3 \text{ mm}$.

- What is the frequency range within which this waveguide will support a single mode?
- For the TE_{10} mode at 1.2 the cutoff frequency, determine the phase shift constant, the wavelength, the phase and group velocities, and the wave impedance inside the guide.
- If the guide is used to transmit a 2 mW CW , determine the maximum electric field inside the guide.

15 Marks