Experiment - 4: Design of Rectangular Waveguide using EM Simulation Software

1. **Aim:** To design, simulate and analyze a WR-90 Rectangular Waveguide using Ansys 2022 R1
2. **Objectives:**
   a) To implement and simulate an air filled WR-90 Rectangular Waveguide in HFSS.
   b) To study field pattern for the first three modes (TE10, TE20, TM11).
   c) To generate β vs. frequency graph for each mode.
3. **Requirements**
   ANSYS Software

4. Pre-experiment Exercise

Brief Theory

5. Laboratory Exercise:

5.1 Procedure

1. Implement a WR-90 Rectangular waveguide in HFSS.
2. Simulate the designed waveguide and observe field patterns for the dominant mode.
3. Observe the S11 and S12 graph
4. For first three modes in a rectangular waveguide, plot Beta/ko vs frequency response and obtain the cutoff frequency for each mode using the plot.
5. Compute the cutoff frequencies for the modes using the analytical approach.
6. Compare the results obtained from step 3 and step 4.

5.2 Observations

Sr. No.	Type of Modes	Simulation	Theoretical
1.	Mode1(TE10)	f_{cTE10} = _____	f_{cTE10} = _____
2.	Mode 2 (TE20)	f_{cTE20} = _____	f_{cTE20} = _____
3.	Mode 3(TM11)	f_{cTE01} = _____	f_{cTE01} = _____

Other Observations:

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Post Experiment Exercise:

6.1 Conclusion/Comments

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6.2 Questions

1. Define a dominant mode and which mode is a dominant in rectangular waveguide? Give reason? Which modes are not possible in a rectangular waveguide and why?
2. Derive field equations for TE and TM modes in rectangular waveguides
3. A rectangular waveguide is designed to propagate the dominant mode at 5 GHz. The cut-off frequency is 0.8 of the signal frequency. The ratio of the guide height to width is 2. The time average power flow through the waveguide is 1kW. Determine the magnitudes of electric and magnetic fields inside the guide and indicate where these occur in the guide.
4. A rectangular waveguide operating at 3.5 GHz in the dominant TE10 mode has inside dimensions a=7 cm b=3.5 cm. Calculate cut-off frequency, phase velocity and guided wavelength.