



## Microwave Lab Report

### Part I:

#### Answer the following theoretical questions:

- 1- How can we make a short circuit in the microwave lab? How can we make an open circuit?
- 2- What is the meaning of the scattering matrix for a waveguide?
- 3- What are the main differences between the E-plane T and the H-plane T microwave components?
- 4- Define the "Insertion Loss" and the "Isolation" for a hybrid-T.
- 5- How can we use the Hybrid-T microwave component to measure an unknown impedance?
- 6- How can we measure the frequency of the wave in the lab?
- 7- How can we measure the SWR of a load using a directional coupler and other microwave components?

### Part II:

In this part you can choose only ONE of the following two alternatives. Choose whichever alternative is more suitable for you.

#### Alternative 1: HFSS Simulation

1. Simulate the E-Plane T and the H-plane T using HFSS showing the field vector distribution and propagation if the field was excited from the middle arm.
2. Simulate the magic T and prove that the  $\Delta$  and  $\Sigma$  ports are decoupled by drawing the field inside (choose the suitable excitation ports to prove your point).

#### Alternative 2: Theoretical Questions

##### - E17:

- 1- Prove that the element  $S_{xy}$  in a scattering matrix could be given by:

$$S_{xy} = \sqrt{(S_{xx} - \Gamma_{xy})(S_{yy} + 1)}$$

Where  $\Gamma_{xy}$  is the reflection coefficient when port X is input, port Y is short circuit and other ports are matched.

- 2- Prove the unitary property for the scattering matrix of a lossless microwave network.

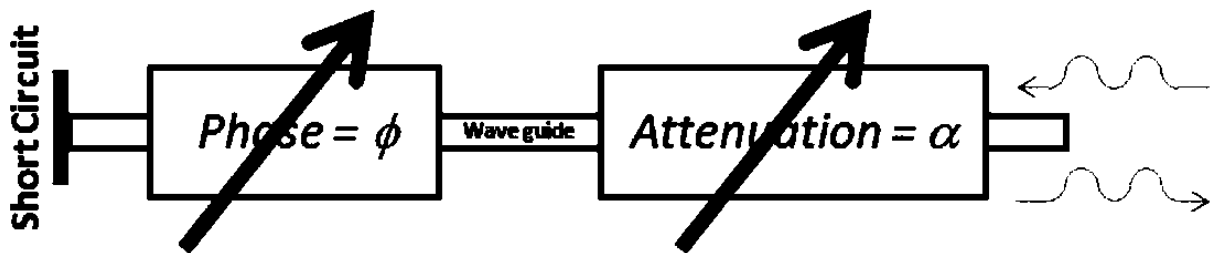
$$|S_{1i}|^2 + |S_{2i}|^2 + |S_{3i}|^2 + \dots + |S_{Ni}|^2 = 1$$

$$i. e. \sum_{n=1}^N |S_{ni}|^2 = 1$$

- 3- If a rectangular waveguide is designed such that ( $a = b$ ). How can we slightly modify the waveguide such that to prevent the excitation of the  $TE_{01}$  mode to be able to use it as a single-mode waveguide (without changing  $a$  or  $b$ ).
- 4- What is meant by “reciprocity” in a microwave network? Mention two non-reciprocal microwave components and their applications.

- **E18:**

- 1- Get the equivalent Impedance of the shown microwave network.



- 2- How can we implement a matched load in the lab?
- 3- What is the function of calibrating the impedance measurement using a movable short first in measuring an unknown impedance using the magic T?
- 4- Describe the functionality of the directional coupler (function, figure showing what is inside and theory of operation). State how can we use the same device for a wide band of input frequencies?

## **Delivery Rules:**

- 1- Copied reports will get **ZERO** marks.
- 2- This is a **group** report.
- 3- Each student will be **asked** in the report while delivering it.
- 4- The deadline of the report is after **one week after your last MW lab.**