KALINGA INSTITUTE OF INDUSTRIAL TECHNOLOGY (KIIT)

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LABORATORY RECORD – AUTUMN 2020

MICROWAVE ENGINEERING LAB (EC 3015)

DEBAGNIK KAR

ROLL NO: 1804373

Section: ETC-06

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Experiment Number	01
Date of Experiment	12/08/2020
Date of Submission	16/08/2020
Name of the student	Debagnik Kar
Roll Number	1804373
Section	ETC – 06

Aim of The Experiment :-

To design a quarter wave transformer for matching a 50 Ω microstrip line with a load of 173Ω

Equipment / Software Required:-

CST Studio Suite 2019 (Student Edition)

Theory:

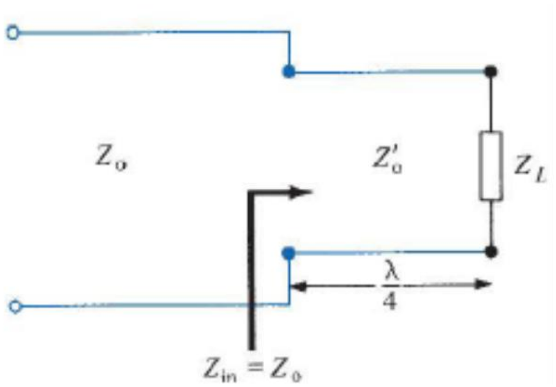

Fig 1.1: Load matching using a quarter wave transformer

When $Z_0 \neq Z_L$, the load is said to be mismatched and a reflected wave exist. So we use quarter wave transformer for impedance matching.

When $l = \frac{\lambda}{4}$,

$$Z_{in} = Z_0 \left[\frac{Z_L + \frac{jZ_0 \tan \pi}{2}}{Z_0 + \frac{jZ_L \tan \pi}{2}} \right] = \frac{Z_0^2}{Z_L}$$

(1)

A mismatched load can be properly matched to a line (with characteristic impedance Z_0) by inserting prior to the transmission line λ/4 long (with characteristic impedance Z'_0) as depicted in Fig.1.

From (1), $Z^{|}_{0}$ is selected such that (Z_{in}=Z_0)

Therefore,

$$Z_0^{|} = \sqrt{Z_0 Z_L} \qquad (2)$$

Note: When microstrip line is used, then guided wavelength must be used ,i.e,

$$\lambda_g = \frac{\lambda_0}{\sqrt{\varepsilon_{eff}}}$$

(3)

where, λ_g= guided wavelength.

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$$Z_{in} = Z_0 \left[\frac{Z_L + \frac{jZ_0 \tan \pi}{2}}{Z_0 + \frac{jZ_L \tan \pi}{2}} \right] = \frac{Z_0^2}{Z_L}$$

(1)

A mismatched load can be properly matched to a line (with characteristic impedance Z_0) by inserting prior to the transmission line λ/4 long (with characteristic impedance Z'_0) as depicted in Fig.1.

From (1), $Z^{|}_{0}$ is selected such that (Z_{in}=Z_0)

Therefore,

$$Z_0' = \sqrt{(Z_0 Z_L)}$$

Z_0 = 50

Z_L = 173

$Z_0' = \sqrt{(50 \times 173)}$

$Z_0' = 93.01\ \Omega$ (2)

Note: When microstrip line is used, then guided wavelength must be used ,i.e,

$$\lambda_g = \frac{\lambda_0}{\sqrt{\varepsilon_{eff}}} \qquad (3)$$

where, λ_g= guided wavelength.

Substrate: FR4 (Lossless) (ε_r = 4.3)

Width of the substrate is 50 mm and the length is 100 mm

h = 1.6 mm

t = 0.2 mm

W = 2.93 mm (determined using Analysis and synthesis of transmission lines)

ε_{eff} = 3.204

$Z_0^{'} =$ 93.01 Ω length = 17 mm

Therefore, width of the quarter wave line is 0.87mm

Design:

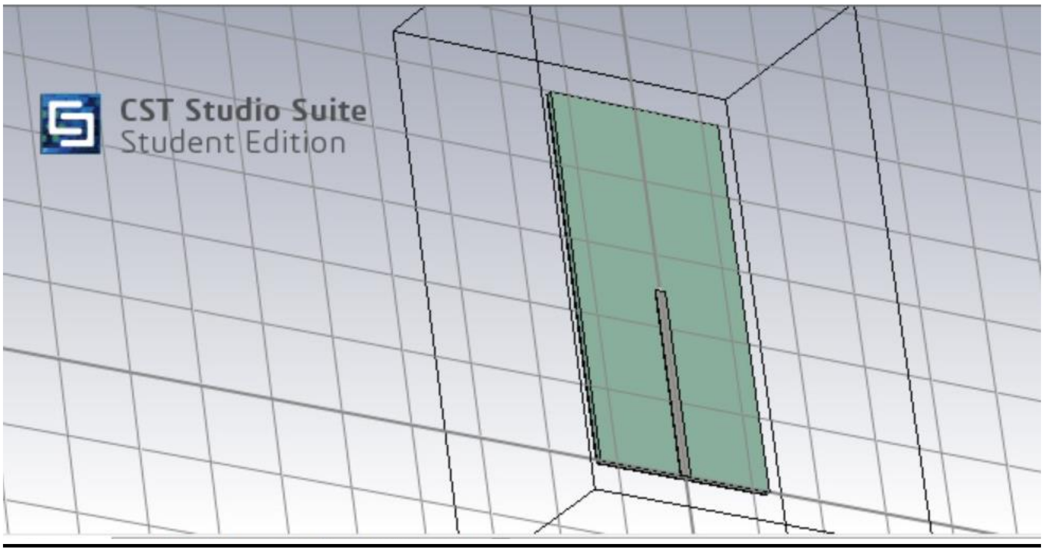

Fig 1.2: Design of microstrip line terminated with the desired load.

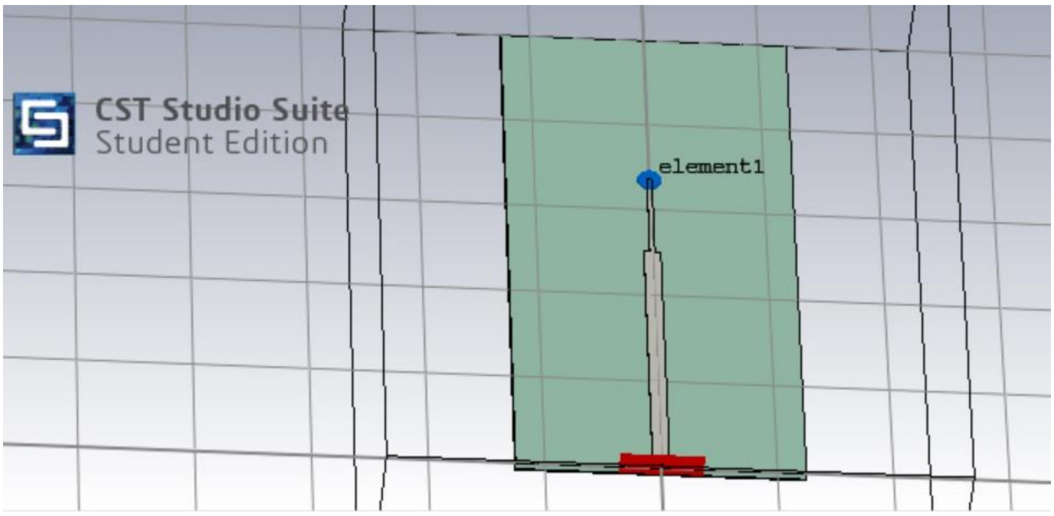

Fig 1.3: Design of microstrip line terminated with quarter wave line and desired load

Output/Graph:-

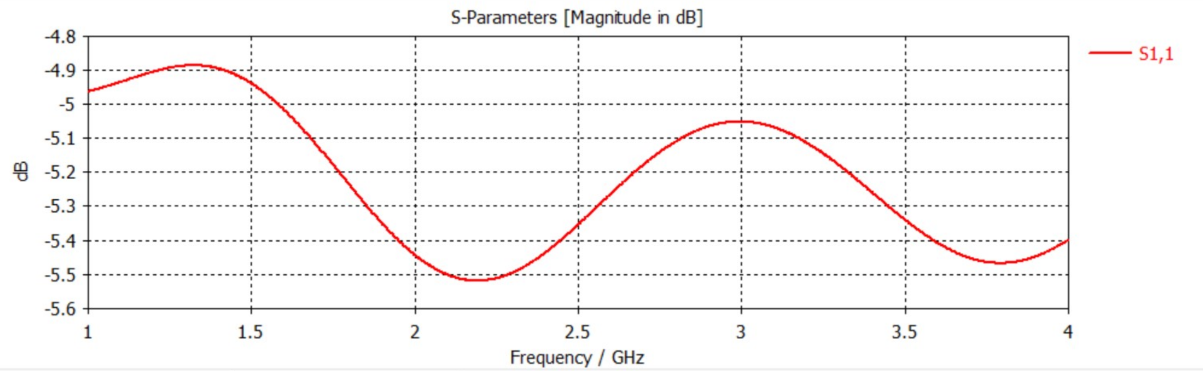

Fig 1.4: Result of the design of the microstrip line

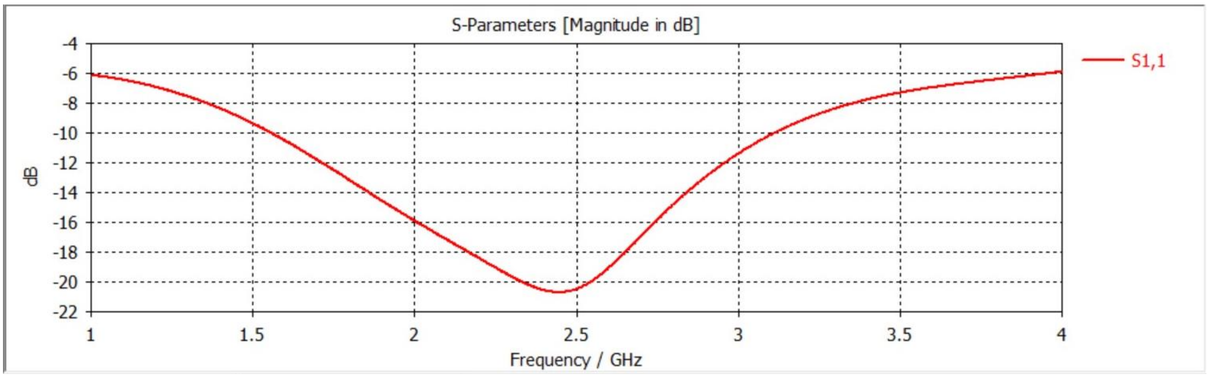

Fig 1.5: Result of the design of the microstrip line terminated by quarter wave line.

Observation of the experiment:

- For fig 4, No resonance is observed around 2.4 GHz which implies impedance mismatch.
- For fig 5, an impedance is achieved at 2.4 GHz by using a quarter wave transformer.

Conclusion:-

The designing of a quarter wave transformer for matching a 50 Ω microstrip line with a load od 173 Ω is successfully achieved.

Experiment Number	02
Date of Experiment	19/08/2020
Date of Submission	24/08/2020
Name of the student	Debagnik Kar
Roll Number	1804373
Section	ETC - 06

<u>Aim of The Experiment :-</u>

To design a wire dipole antenna operating at 373 MHz and to find the directive gain and half power beam width from the radiation pattern.

<u>Software Required:-</u>

CST Studio Suite 2019 (Student Edition)

<u>Theory</u>

The length of the Dipole Antenna is given by the formula:

$$L = \frac{\lambda}{2} = \frac{c}{2f}$$

f = 373 MHz
The length of the dipole is 0.402 m = 0.402 mm

For the 402 mm length, we have got , 0.373 GHz which is far from our desired result, so we cant consider it as our result.

We know, the input impedance = (73± 40j)

To cancel the complex part we have to use a shorter length.
I am taking 360 mm to get a value which is nearly equal to the desired result 0.373 GHz

Design:-

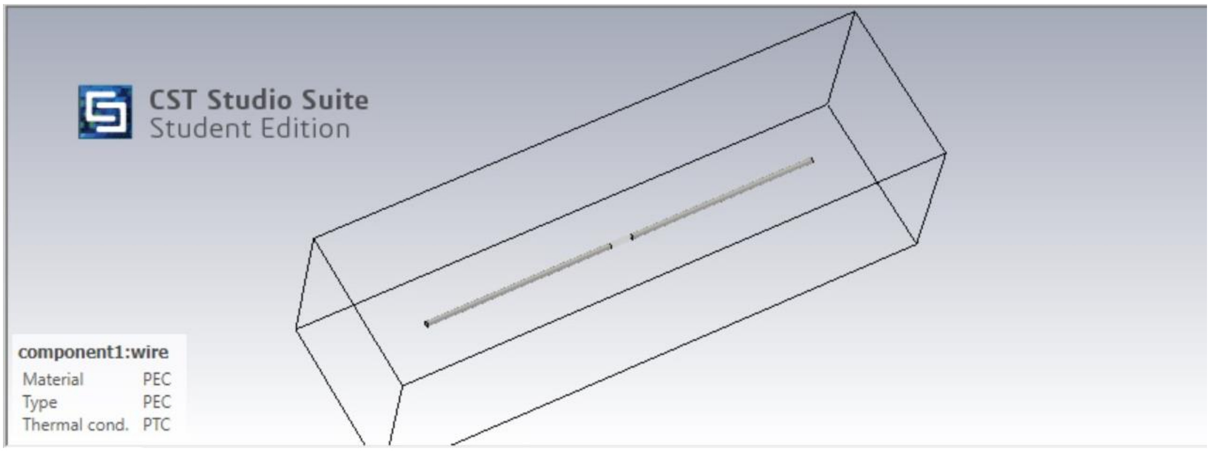

Fig 2.1: Design of wire dipole antenna

Observation:-

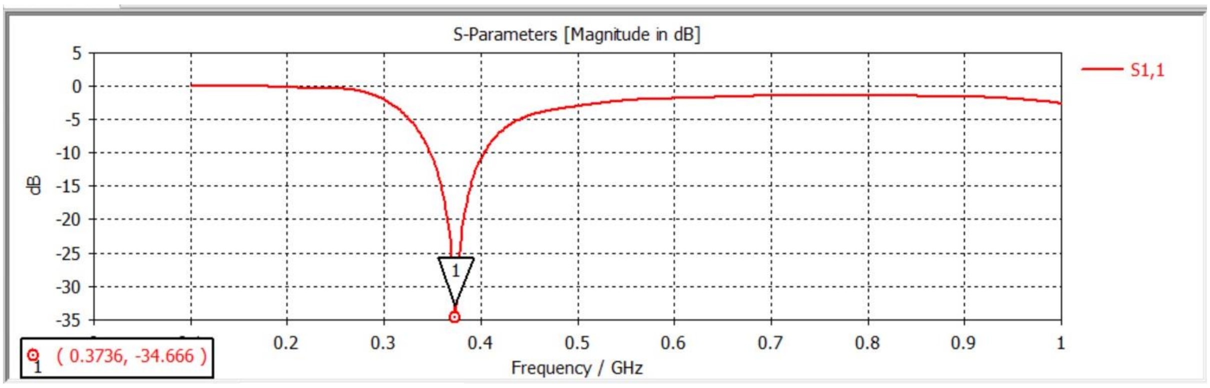

Fig 2.2: S11 Charecteristics

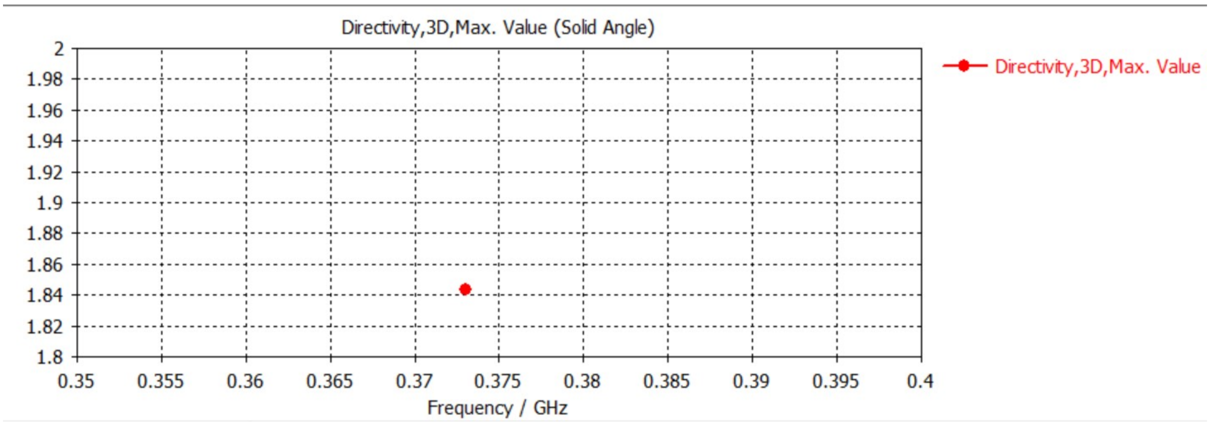

Fig 2.3: Directive Gain

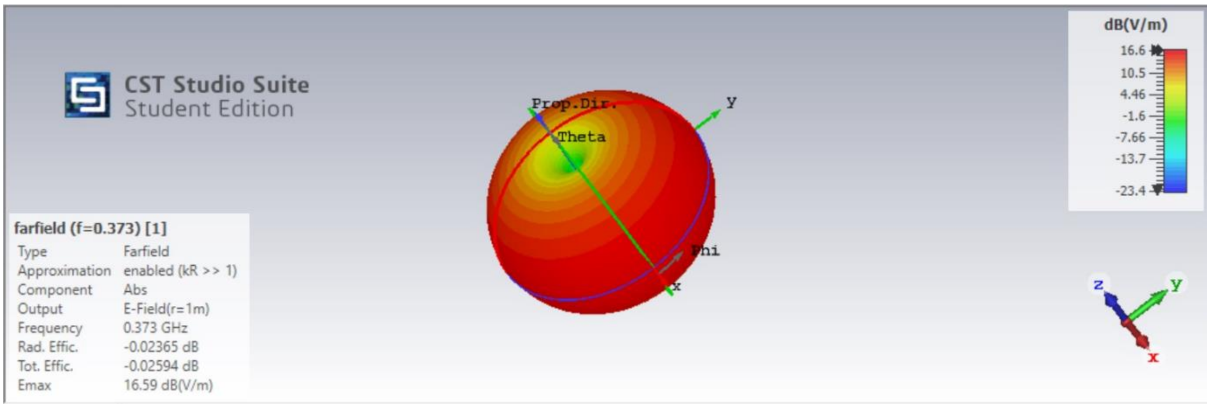

Fig 2.4:Radiation Pattern in X-Z and X-Y plane

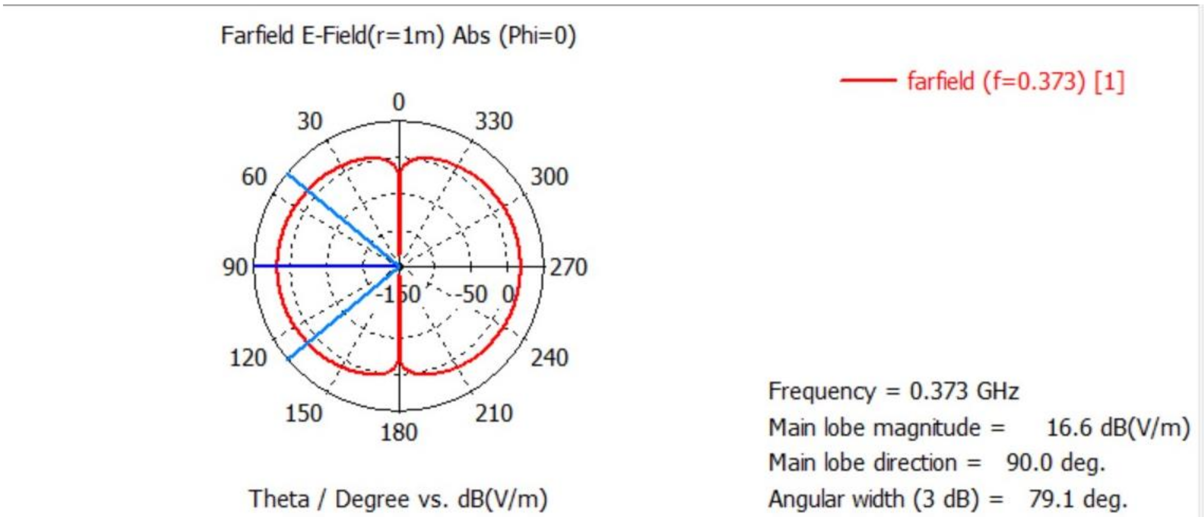

Fig 2.5: Plane radiation pattern and half powered beam width

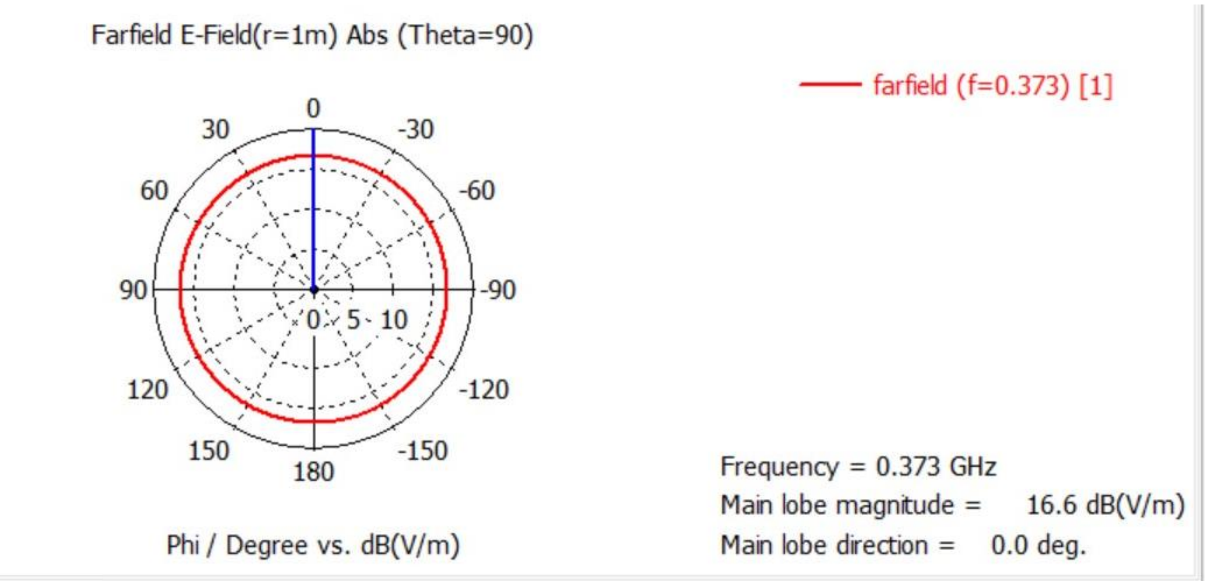

Fig 2.6: H-plane omni-directional Radiation Pattern

Inference of the experiment:

From this experiment, we learnt how to design a wire dipole antenna using CST Studio Suite. We also got to learn about the concept of radiation pattern after performing the experiment

Conclusion:-

A successful design of a wire dipole antenna operating at 373 MHz is successfully simulated on a virtual platform.