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Assignment : Sectional

Department : Electrical

Semester : 8th

Subject : Antenna and wave Propagation

Submitted to : Dr- Naeem

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Q1: Design a mm Wave antenna for 5G applications using HFSS or CST software, having return loss less than -10dB and gain around 5dBi or more.

Introduction

Currently, the telecommunications field has taken a big step to achieve the strong demands of population and industry.

1) Among the apprehensions for this area, we have the micro strip antennas which are essential elements to ensure the emission or reception of electromagnetic waves present in wireless communication system.

5G is the next generation of wireless technology systems and will be the first generation to use millimeter waves. Besides, 5G is not only an evolutionary upgrade of the previous cell generation, but it is a promising solution focused on removing the limits of access, bandwidth enhancement, radiation performance and latency limitations on connectivity worldwide.

Also, future 5G wireless communication networks will likely use millimeter wave frequency bands.

2) Namely 28 GHz, 38 GHz, 60 GHz, and 70 GHz. These bands will be considered as operating bands for 5G mobile networks.

3) Experimental tests show that atmospheric absorption at 28 GHz and 38 GHz is relatively small by about 200 meters, while frequencies from 70 GHz to 100 GHz and 125 GHz to 140 GHz also show low attenuation. Even the Federal Communications Commission (FCC) has proposed to authorize mobile operations in the 28 GHz band (27.5 GHz–28.35 GHz), but this band isn't sufficient for 5G applications. 5G band could be suitable for deployment of high-capacity, high-throughput small cells as part of mobile broadband deployments, At the same time, FFC suggested rules that would provide licensees with the flexibility to conduct fixed and mobile operations. In fact, new applications and services will emerge when this technology is available.

4) The 5G wireless network's transmission chain is made up of a key element which is the antenna. Mobile antenna technology for 5G will be subjected to a huge change in coverage and capacity.

5) Furthermore, it is relevant to note that the 5G millimeter wave antenna's radiation performance is significantly better compared to those of other generations (2G, 3G, and

4G) in terms of radiation coverage, power, adaptive, bandwidth, gain and radiation – 1 – 2020 JINST 15 T01003 efficiency.

6) In recent years, many countries have accelerated scientific research on 5G. Indeed, several research studies have been dedicated and intended for the design and realization of antennas for 5G applications in millimeter bands.

7) proposed a new structure of a 5G antenna with a bandwidth of 1.44 GHz, from 27.12 GHz to 28.56 GHz for 28 GHz. Jandi et al.

8) Presented a design of 4 × 4 patch antenna array for 5G applications that provides a reasonable bandwidth of about 0.3 GHz around at 28 GHz. The basic element of this arrangement is a rectangular patch antenna designed on the Rogers RT/Droid 5880 substrate, which provides a bandwidth of about 0.47 GHz.

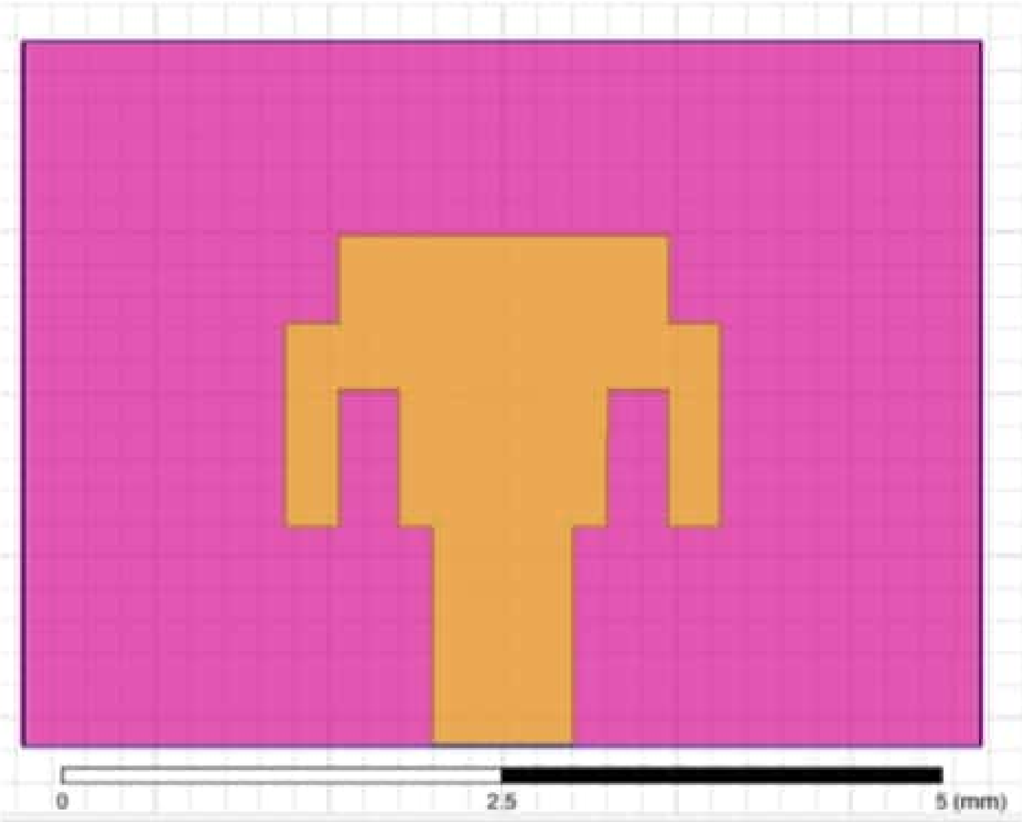
9) Indeed, all the values of the bandwidths found in the references cited above are not sufficient to cover the bandwidth of 5G applications, that's why; we are willing to develop the proposed work.

10) In this work, a new micro strip antenna structure having a wide bandwidth, a relatively standard gain and a small size, dedicated to 5G applications around a resonance frequency of 28 GHz are presented

.

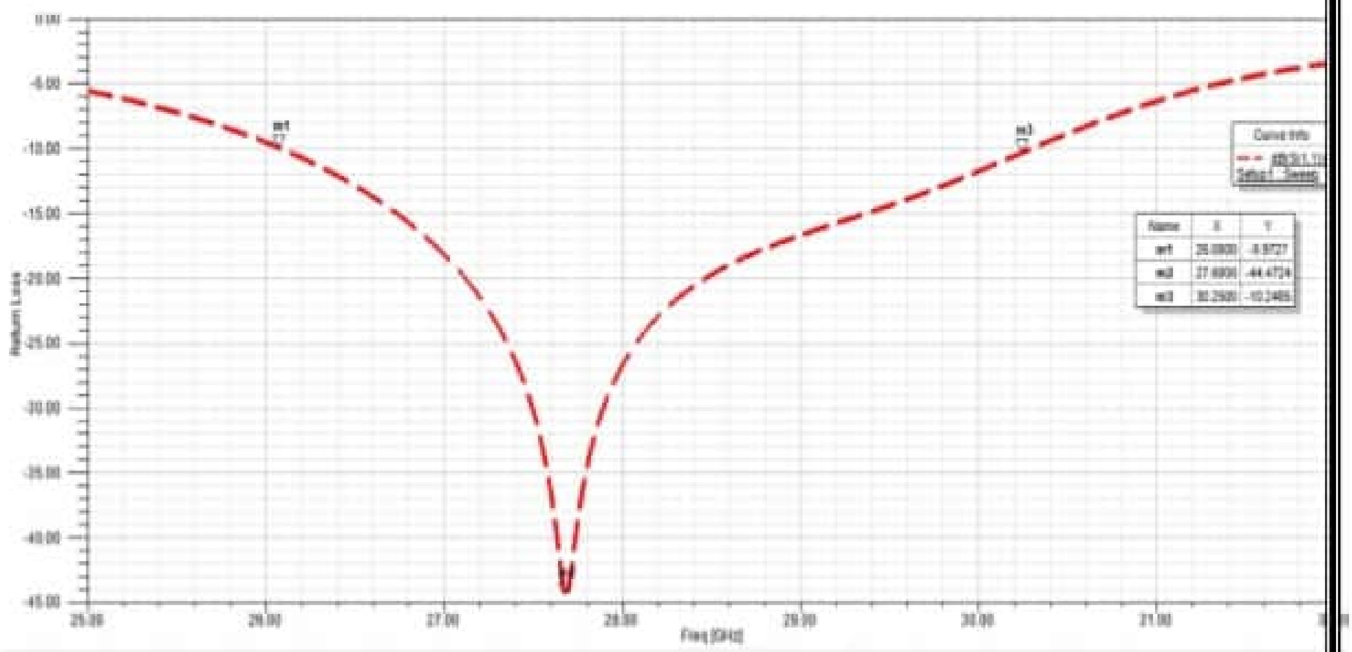
11) The proposed antenna consists of a corner truncated E-shaped rectangular patch, printed on an FR4 type substrate and fed by a micro strip line having a power port adapted to 50 Ω. The assembly is placed on a total ground plane

Antenna Design

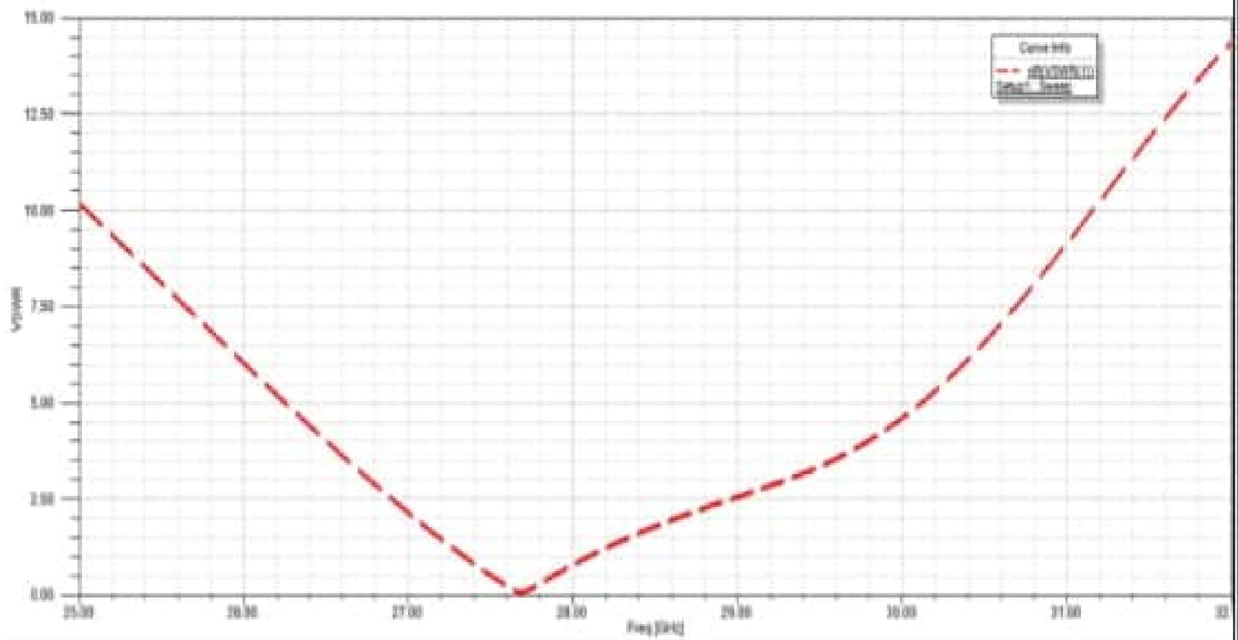


Results:

1) Return loss



2) VSWR



3) Antenna Parameters

Antenna Parameters

Inputs

Setup Name: Infinite Sphere1

Solution: LastAdaptive

Array Setup: None

Intrinsic Variation: Freq='29GHz'

Design Variation:

OK

Export

Export Fields

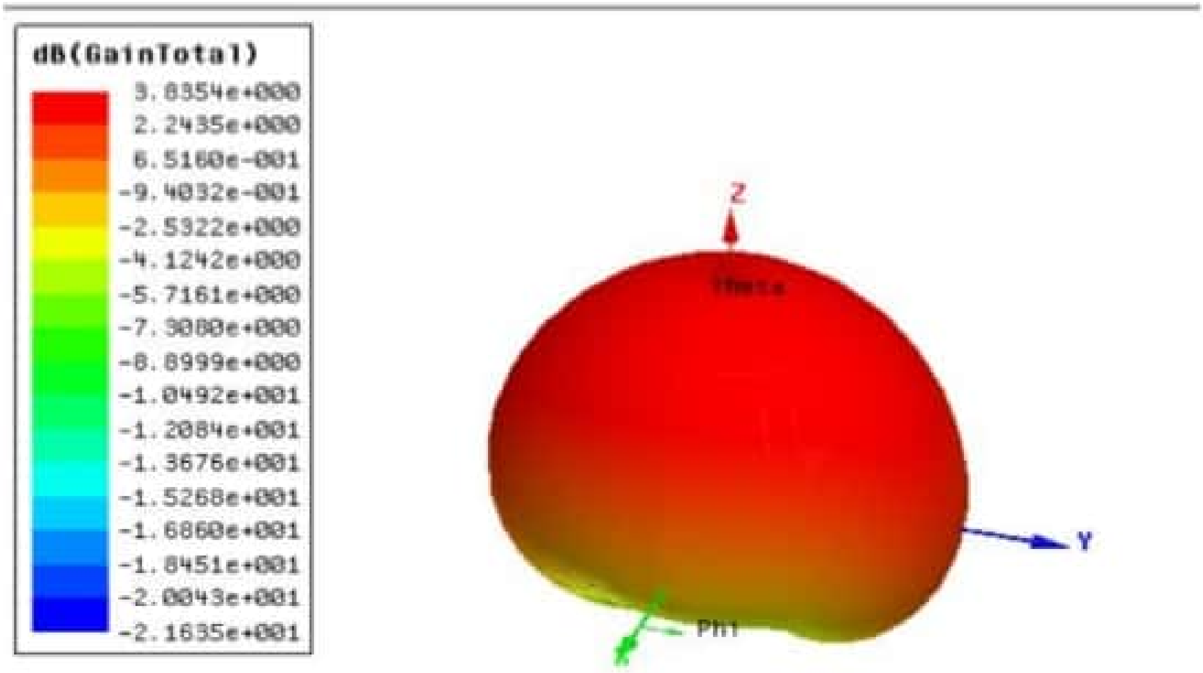
Antenna Parameters:

Quantity	Value	Units
Max U	0.18829	W/sr
Peak Directivity	2.9521	
Peak Gain	2.4185	
Peak Realized Gain	2.3662	
Radiated Power	0.80154	W
Accepted Power	0.97839	W
Incident Power	1	W
Radiation Efficiency	0.81924	
Front to Back Ratio	10.775	
Decay Factor	0	

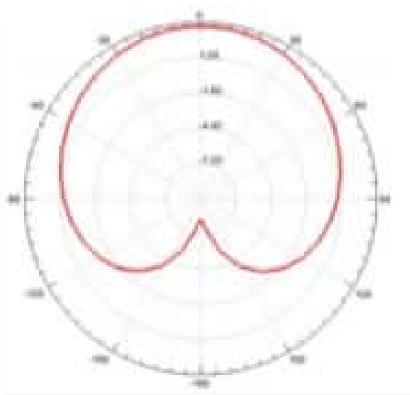
Maximum Field Data:

rE Field	Value	Units	At Phi	At Thet
Total	11.915	V	360deg	10deg
X	11.776	V	80deg	0deg
Y	4.5978	V	40deg	80deg
Z	7.3344	V	360deg	60deg

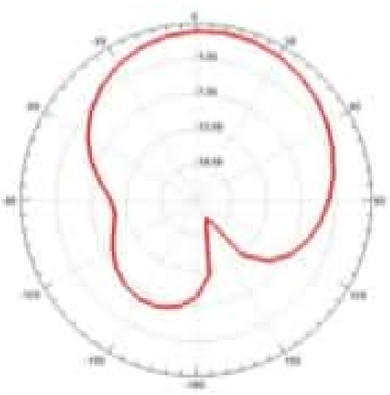
4) 3D polar plot of Gain



5) Radiation pattern (H-Plane) at 29GHz

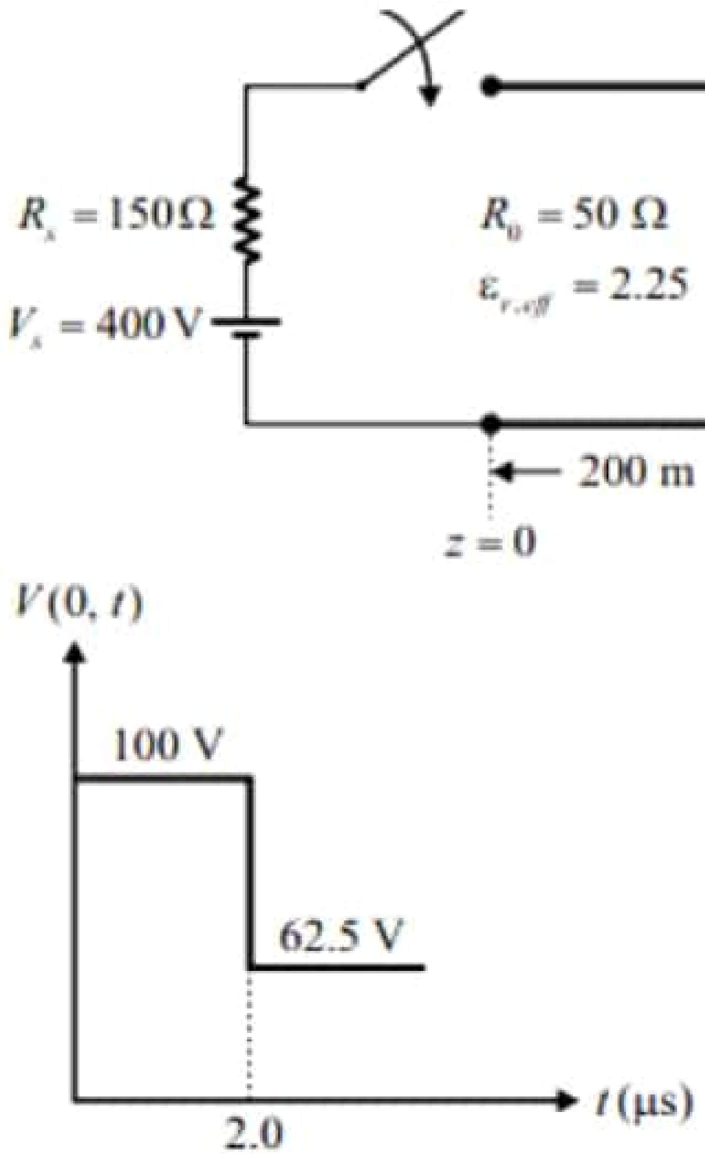


Radiation pattern (E-plane) at 29Ghz



Q2: solve the given diagram below.

A 200 m long transmission line having parameters shown in the figure is terminated with a load RL. The line is connected to a 400 V source having source resistance RS through a switch which is closed at t = 0 . The transient response of the circuit at the input of the line (z = 0) is also drawn in the figure. The value of RL (in Ω) is __________.



Solution :-

$R_s = 150$
$V_s = 400V$
$R_0 = 50\Omega$

Phase velocity is given by

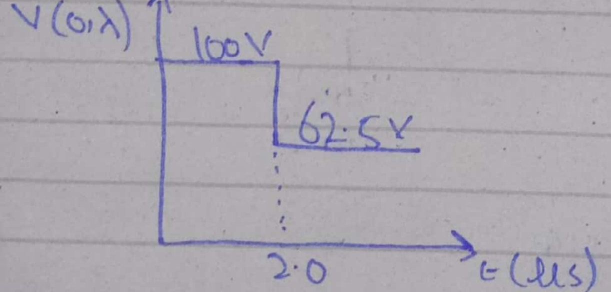
$$V_p = \frac{1}{\sqrt{\mu\epsilon}} = \frac{c}{\sqrt{\mu_r \epsilon_r}}$$

Assuming non- magnetic medium $\mu_r = 1$

$$V_p = \frac{c}{\sqrt{\epsilon_r}} = \frac{(3\times 10^8)}{\sqrt{2.25}}$$

$$= 2\times 10^8 \, m/sec$$

The transcient response of the circuit of the input or source and of the line (Z=0) is shown in the figure.



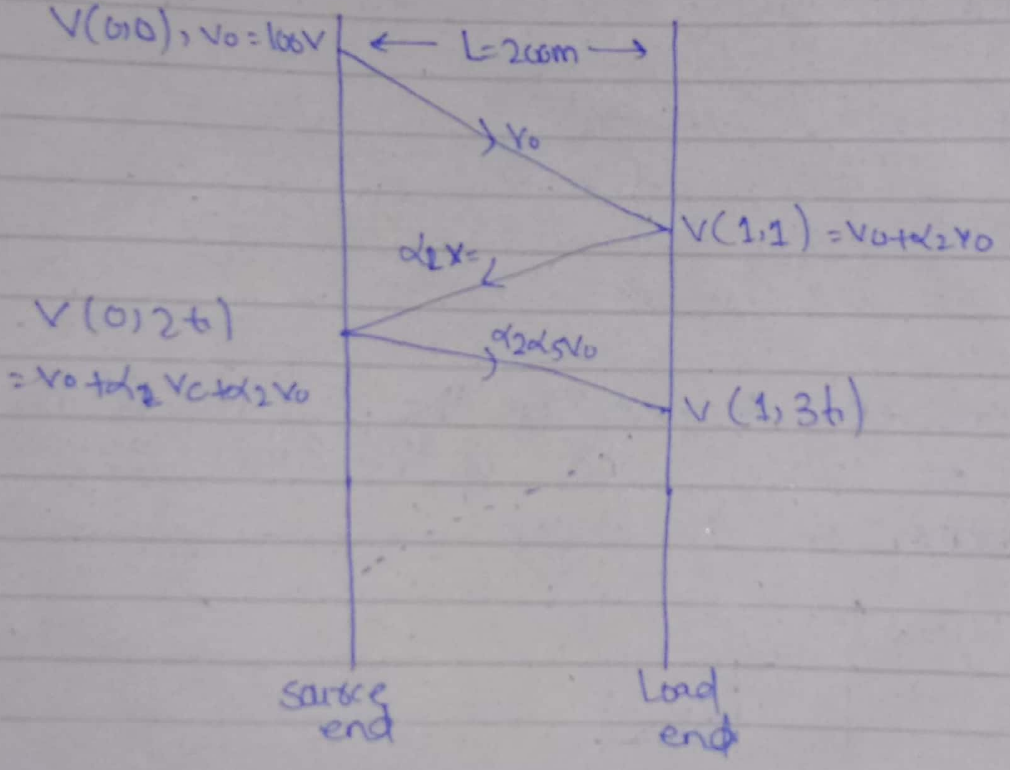
At 2μs the input voltage of transmission line become 62.5V, Time taken by wave to travel from source to load.

$T = l/v_p$

$= \frac{200}{(2 \times 10^8)}$

$= 1 \mu sec$

using voltage bounce diagram



From above figure.

$V_0 + \alpha_L V_0 + \alpha_L \alpha_s V_0 = 62.5V$ —— (a)

$V_0 = 100V$

$$\alpha_L = \frac{R_L - R_0}{R_L + R_0} = \frac{R_L - 50}{R_L + 50} \quad \text{--- (b)}$$

$$\alpha_S = \frac{R_S - R_0}{R_S + R_0} = \frac{150 - 50}{150 + 50}$$

$$\alpha_S = 0.5$$

Substituting these values in equation (a)

$$100(1 + \alpha_L + 0.5\alpha_L)$$

$$= 62.5$$

$$1.5\alpha_L + 1 = \frac{62.5}{100}$$

$$1.5\alpha_L = \frac{-37.5}{100}$$

$$\alpha_L = -0.25$$

From equation (b)

$$\frac{R_L - 50}{R_L + 50} = -0.25$$

$$R_L = 30\Omega$$

Hence, value of $R_L = 30\Omega$