Faculty of Engineering
Electrical Engineering
Communication Department

2^{nd} Year Communication Department
Electromagnetic fields Lab

LAB Assignment

Introduction

ElecNet v7 is a 2D/3D electric field simulation software, based on the Finite Element Method (FEM). It is developed by the Canadian company Infolytica. ElecNet solves static, AC (time-harmonic) and transient electric field and current flow problems. Using ElecNet, the designers can model complicated devices and accurately predict their behavior.

ElecNet can analyze the performance of many electrical engineering devices, e.g.:

- Shielding
- Cables
- Capacitive Sensors
- High Voltage Components
- Insulation Systems
- Transformers

On the other hand, MagNet v7 is a 2D/3D magnetic field simulation which can perform the same tasks as ElecNet.

In this assignment, we study & analyze the Electric and Magnetic field of some important microwave components used widely in RF systems.

Submission regulations

1. The project should be submitted no later than 24/12/2021 at 23:59.
2. Each team should contain one or two or maximum three students.
3. Each team should submit a PDF report including:
   - Students names and IDs.
   - Screenshots for the software numerical results
   - Analytical results (if required)
   - Comments.
4. The report has to be submitted online to: https://forms.office.com/r/3Xc2Bsdz8q
5. Copied reports will take zero for both teams.
6. Any student may be asked to explain any step in his/her report.

Experiment 1
MIM capacitor

Description

A Metal-insulator-metal (MIM) capacitor consists of parallel plates formed by two metal planes separated by a thin dielectric. MIM capacitors are used in RF circuits for oscillators. Its structure is as shown in fig 1. 1.

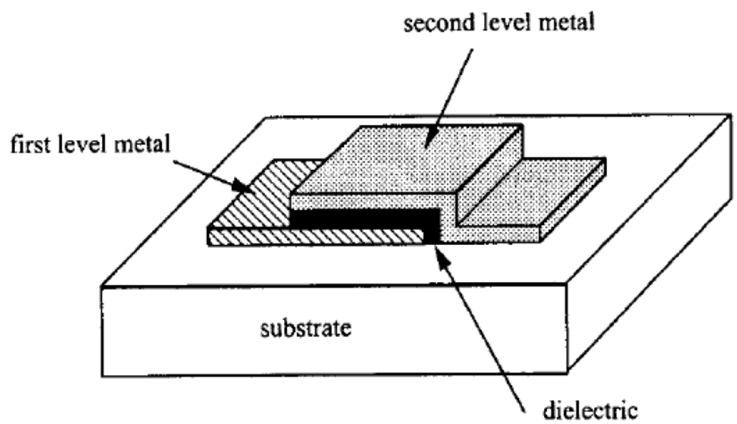


fig 1. 1 MIM capacitor Structure

Experimental Procedure

1. fig 1. 2 shows the elevation view of the device. All dimensions in μm (a=1μm).

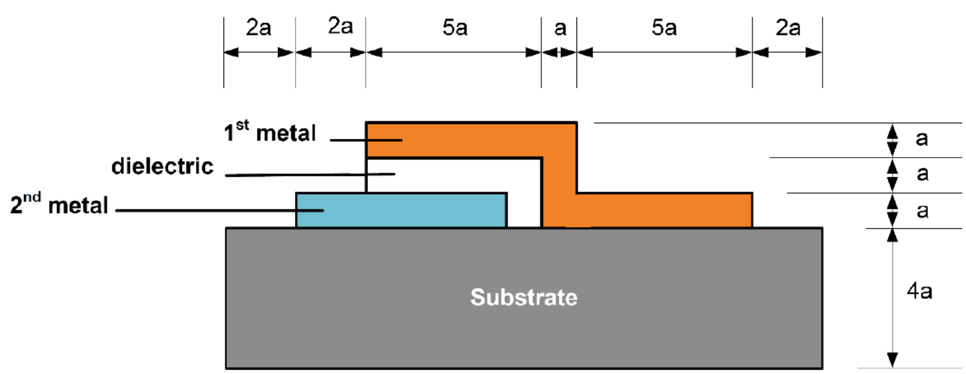


fig 1. 2 elevation view

2. The material of each component is given in the next table

1st metal	**Copper: 5.77e7 Siemens/meter** **Voltage = $2v$**
Dielectric	**Relative permittivity = 2**
2nd metal	**Aluminum: 3.8e7 Siemens/meter** **Voltage = $0v$**
Substrate	**Silicon steel**

3. Sweep the design in rectangular shape with a length of 10 μm.
4. Draw the air box (center = (0,0) and radius 50 μm).
5. Set the options for solving, with the following changes from the default settings:

- Solver Options:
  CG tolerance 0.01%
  Polynomial order 2
- Adaption Options:
  Use h-adaption 1%,
  Tolerance 1%

Requirements

1. Using the internet, write short notes about different types of capacitors used in RF circuits.
2. Plot the contour plot & shaded plot of the Volt & comment on the graphs.
3. Calculate the Stored Energy of this device.
4. Change the relative permittivity of dielectric as shown in the following table. For each value, compute the corresponding capacitance

Relative permittivity	2	2.5	3	3.5	4	4.5
Capacitance						

5. Plot an X-Y graph showing how capacitance varies as a function of Relative permittivity and comment on the results.
6. Now, set the relative permittivity of dielectric =2, and change the 1st metal voltage as shown in the following table. For each value, compute the corresponding capacitance

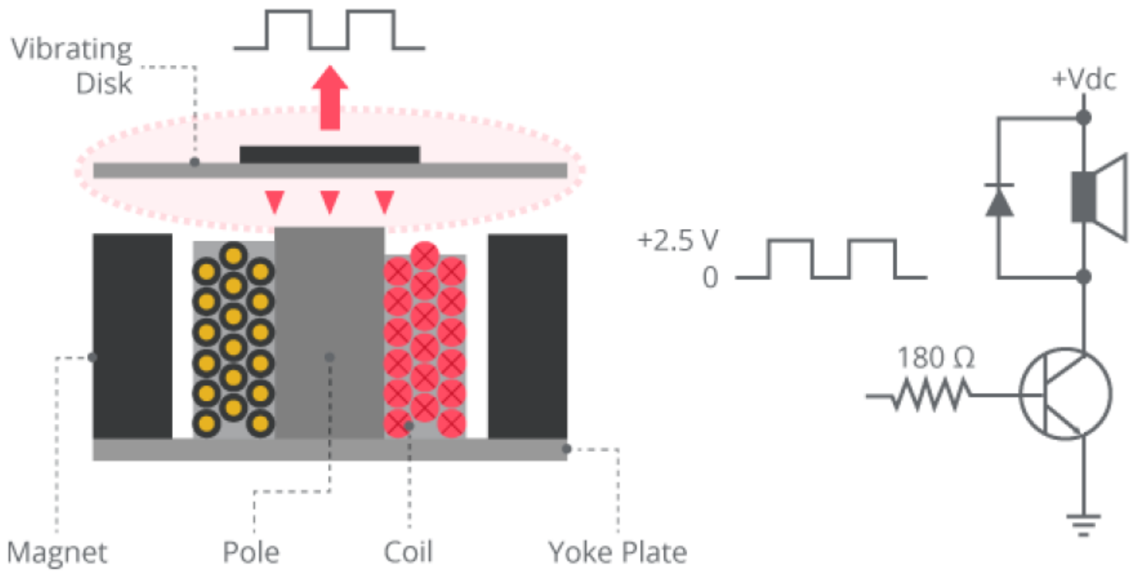
Voltage (v)	0.8	1.2	1.6	2	2.4
Capacitance					

7. Plot an X-Y graph showing how capacitance varies as a function of voltage and comment on the results.

Experiment 2
Magnetic buzzer

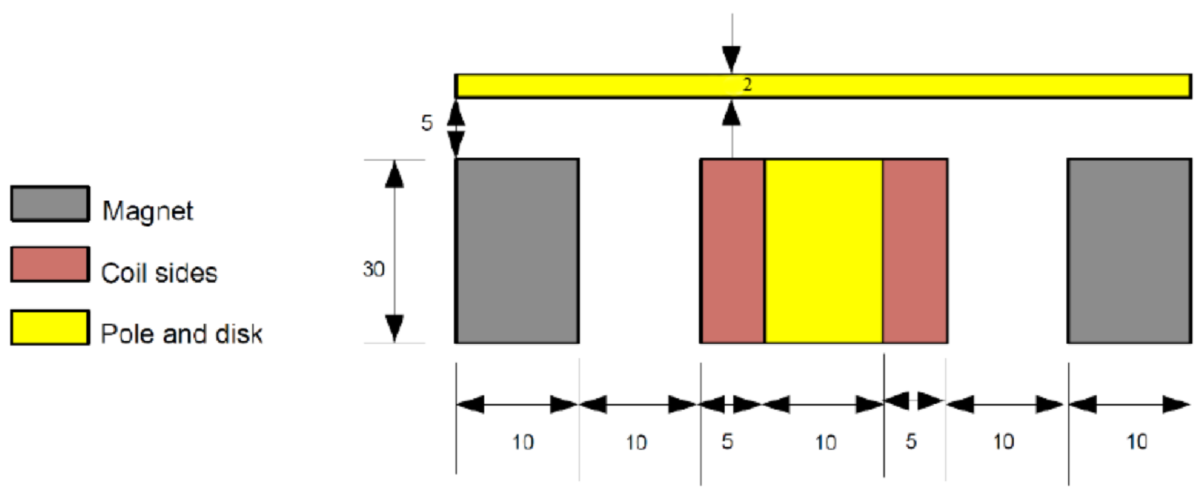
Description

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric (piezo for short). Typical uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke. The following figure shows the structure of Magnetic buzzers.



Experimental Procedure

1. The following figure shows the elevation view of the device. All dimensions in mm.



2. The material of each component is given in the next table.

Magnet	**Cold rolled 1010 steel**
Coil sides	**• Copper: 5.77e7** **• 200 turns** **• Total current: 2.0 A**
Pole and disk	**Relative permeability 10**

3. Sweep the design in rectangular shape with a length of 4 mm.
4. Draw the air box (center = (0,0) and radius 500 mm).
5. Set the options for solving, with the following changes from the default settings:

- Solver Options:
  CG tolerance 0.01%
  Polynomial order 2
- Adaption Options:
  Use h-adaption 1%,
  Tolerance 1%

Requirements

1. Explain How the magnetic buzzer works.
2. Compare between different types of buzzers, showing their advantages and disadvantages.
3. Sketch the contour plot & shaded plot of the magnetic field intensity (|B| smoothed).
4. Compute the Stored magnetic energy.