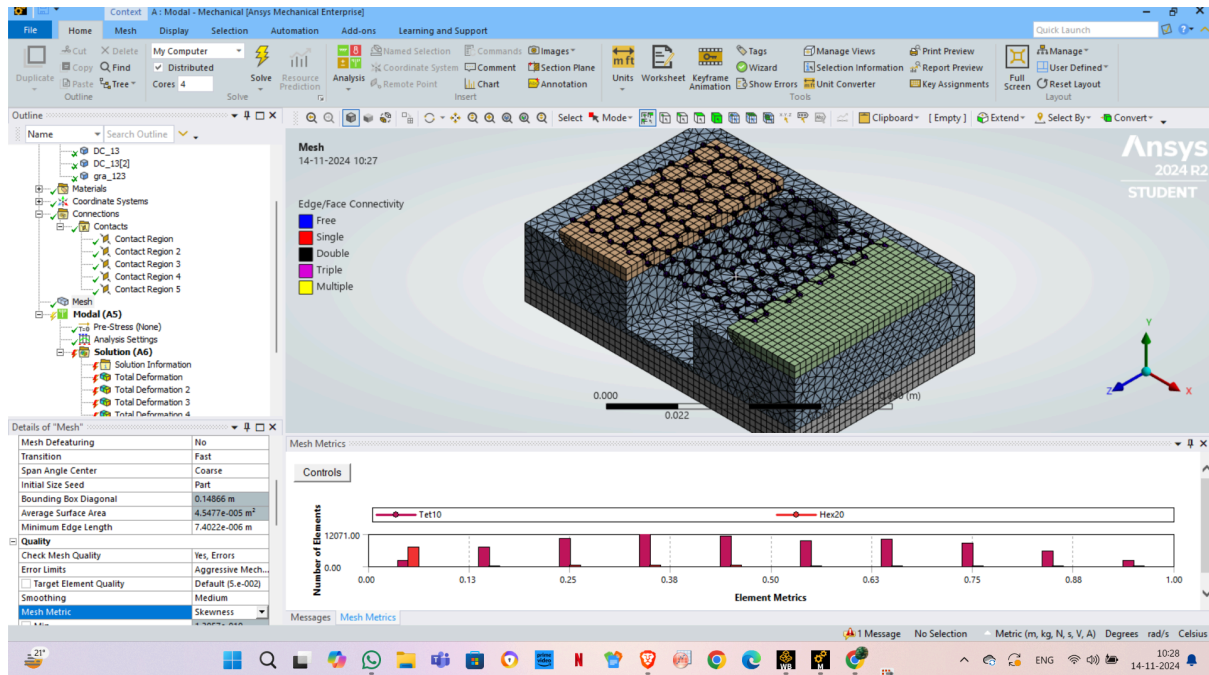# Graphene resonator

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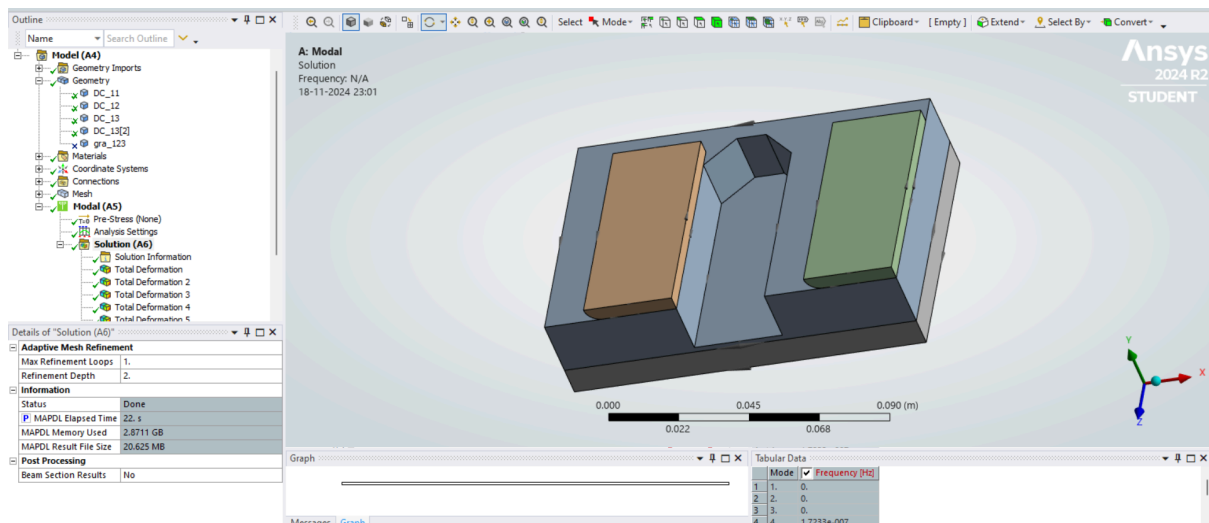## Ansys modal analysis :

1)Materials taken are silicon,silicon dioxide, gold and graphene with their required engineering data.

2)With this model meshing is possible.but,when we have started solving the model it reflects the licence problem with the graphene model because of its small size.

Substrate model without graphene:

1. Introduction

Resonant frequencies play a crucial role in determining the vibrational characteristics of materials and structures. This report presents a detailed study on the calculation of the resonant frequency of a graphene-based structure using a theoretical model and compares the results with values obtained from ANSYS Modal Analysis. The objective is to validate the theoretical approach and identify factors influencing the results.

2. Methodology

2.1 Theoretical Calculation

The fundamental resonant frequency (f0f_0f0) was calculated using the formula:

$$f_0 = \frac{2.404}{\pi d} \sqrt{\gamma_{300K} - \frac{E_Y t}{\rho} \int_{300}^{T_{avg}} \alpha(T) dT}$$

Parameters used:

- **Coefficient of thermal expansion ($\alpha(T)$))**: -2 × 10^-6 K^{-1}
- **Young's modulus (E_Y)**: 1 × 10^6 Pa
- **Poisson's ratio (v)**: 0.165
- **Mass density (ρ)**: 2250 kg/m^3
- **Thickness (t)**: 1 mm
- **Diameter (d)**: 5 mm
- **Average temperature (T avg)**: 400 K

2.2 ANSYS Modal Analysis

The same graphene-based structure was analysed in ANSYS Workbench to calculate resonant frequencies for different modes. A modal analysis simulation was conducted using the following setup:

- Material properties and geometry matching theoretical assumptions.
- Boundary conditions applied based on standard analysis protocols.

3. Results

3.1 Theoretical Calculation Results
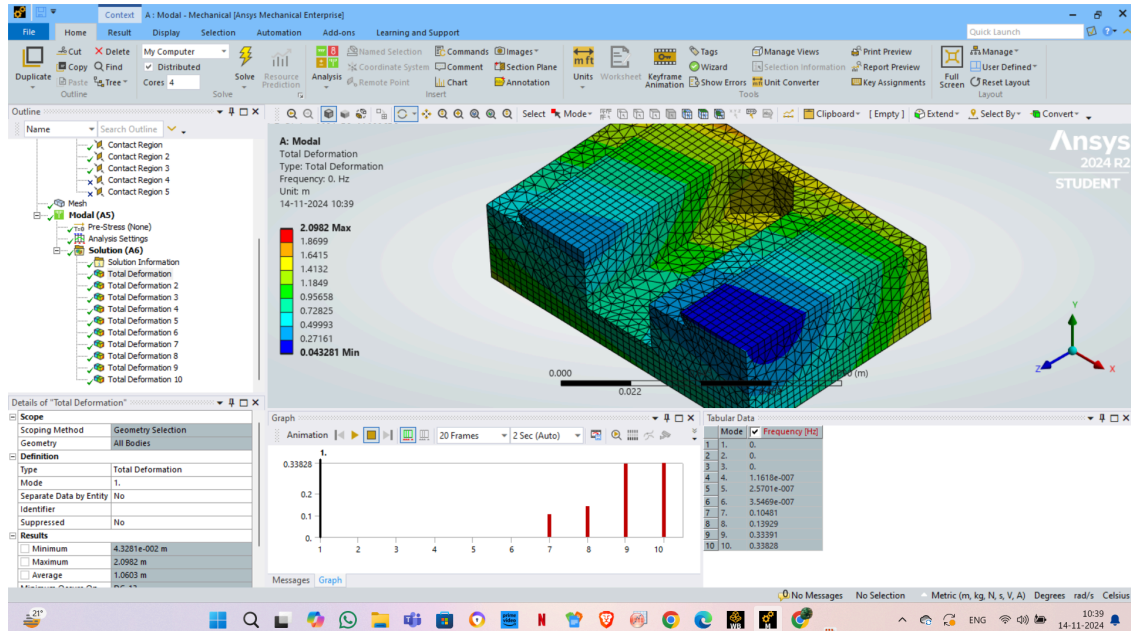The calculated fundamental resonant frequency is:

f_0 = 111.77 Hz

3.2 ANSYS Results
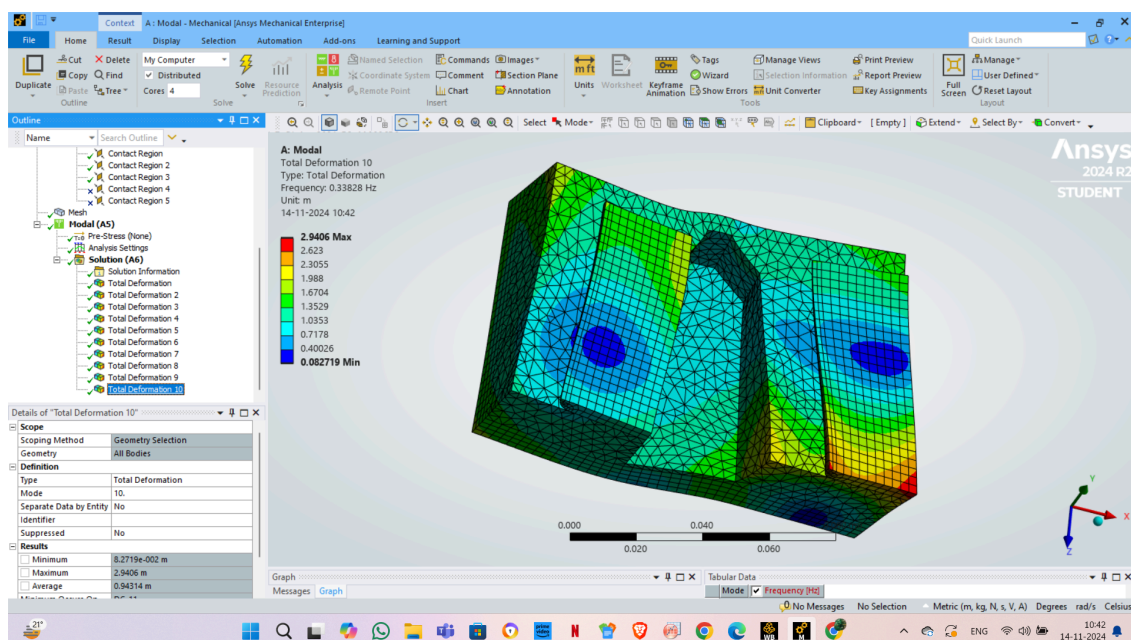The resonant frequencies from ANSYS Modal Analysis for the first 10 modes are presented below:

Mode	Frequency (Hz)
1	0.0000
2	0.0000
3	0.0000
4	1.723×10^{-7}
5	2.649×10^{-7}
6	3.968×10^{-7}
7	0.13022
8	0.16789
9	0.37553

Mode-1 of Deformation:

Mode-10 of Deformation:

4. Comparison

- The theoretical resonant frequency was calculated as **111.77 Hz**, significantly higher than the frequencies obtained from ANSYS.
- ANSYS results show much lower frequencies for the first 10 modes, possibly due to higher-order modes or structural constraints.

Possible Causes of Discrepancy:

1. Differences in boundary conditions between theory and simulation.
2. Inclusion of damping effects or nonlinear material behaviour in ANSYS.

5. Conclusion

The theoretical calculation and ANSYS Modal Analysis provide differing results for the resonant frequency of the graphene-based structure.