

# A Study on the Eigen-Property of the Cylindrical Coaxial Cavity by FEM

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*Received: 10 December 2015 Accepted: 3 January 2016 Published: 15 January 2016*

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## Abstract

The eigen-properties of the cylindrical coaxial cavity have been investigated by FEM. The eigen-equation has been constructed basing on tangential edge vectors of the tetrahedral element. It was retreated with the shift-invert strategy to maintain the calculation stability. Krylov-Schur iteration method has been applied to it in order to obtain the eigen-pairs of TM and TE modes. Eigen-modes were calculated from the unitary similar transforming matrices of this iteration loop. Eigen-values have been determined from diagonal components of the Schur matrix. The eigen-pairs have been revealed as a result in the schematic representations for each modes. The eigen-modes were so complex that the surface features also have been shown in accompanying with them to identify their characteristics.

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*Index terms*— eigen-pair, FEM, Krylov-Schur iteration method, TM, TE, Galerkin method, Helmholtz equation.

## 1 I. Introduction

It has been well known that the knowledge about eigen-mode is one of the most important thing designing the resonant cavity. Acquiring an information about the eigen-property is indispensable in the process of developing more valuable product. There are several factors influencing the eigen-property in the cavity. Among others, the geometrical structure has been considered as the most dominant factor influencing on the eigen-property. Its structure determines the eigen-mode which characterizes the resonant electromagnetic field. The cavity would be taken a variety of form in accordance with its applying purpose. Previously, we have studied the eigenproperties of cylindrical and rectangular resonant cavities using FEM (Finite Element method) [1] [2]. These studies have revealed the several prominent eigen-modes and corresponding eigen-values for each TM and TE modes. The spectra have been shown visually with the 3-Dim (Dimensional) schematic representation. These results have suggested that the similar method may be carried out on varied 3dimensional cavities and give valuable information understanding the physical property of more complicating system. In this study, FEM has been performed on the cylindrical coaxial cavity as like the previous study. The mesh element was a simple tetrahedron and the shape functions were constructed with constant tangential edge vectors. The matrix eigen-equation was established basing on the vector Helmholtz equation. For a three-dimensional problem, the number of variables increases drastically comparing to a two-dimensional problem. It may be very difficult problem to calculate the huge dimensional matrix equation by common eigen-solving method. Krylov-Schur iteration method has been known as one of the most important and actively developing algorithms for calculating the large dimensional eigen-equation [4]. This method compresses and transforms similarly the eigen-matrix into the Schur form. Even using personal computer, this method was easily carried out on the calculation obtaining the several prominent eigen-pairs. Accompanying with it, the shift-invert strategy add more helpful benefit to obtain the specific eigen-mode. So, Krylov-Schur iteration method has applied to the matrix eigen-equation in this study. As the results, the spectra for each eigen-pairs have been visualized with the schematic representations as like the



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## 104 4 IV. Conclusion

105 The 3-Dim eigen-equation of the cylindrical coaxial cavity has been constructed by FEM. Eigenpairs have been  
106 calculated by applying the Krylov-Schur iteration method to the shift inverted matrix. As a result, the spectra  
107 have been represented schematically in the figure ?? To identify the mode type, the surface component were  
108 separated from the 3-Dim spectra. The mode type and wave numbers have been written under each spectra.  
109 From these results, it could be identified that the spectra reflect the characteristics of the coaxial cylindrical  
cavity. <sup>1 2</sup>



Figure 1: [

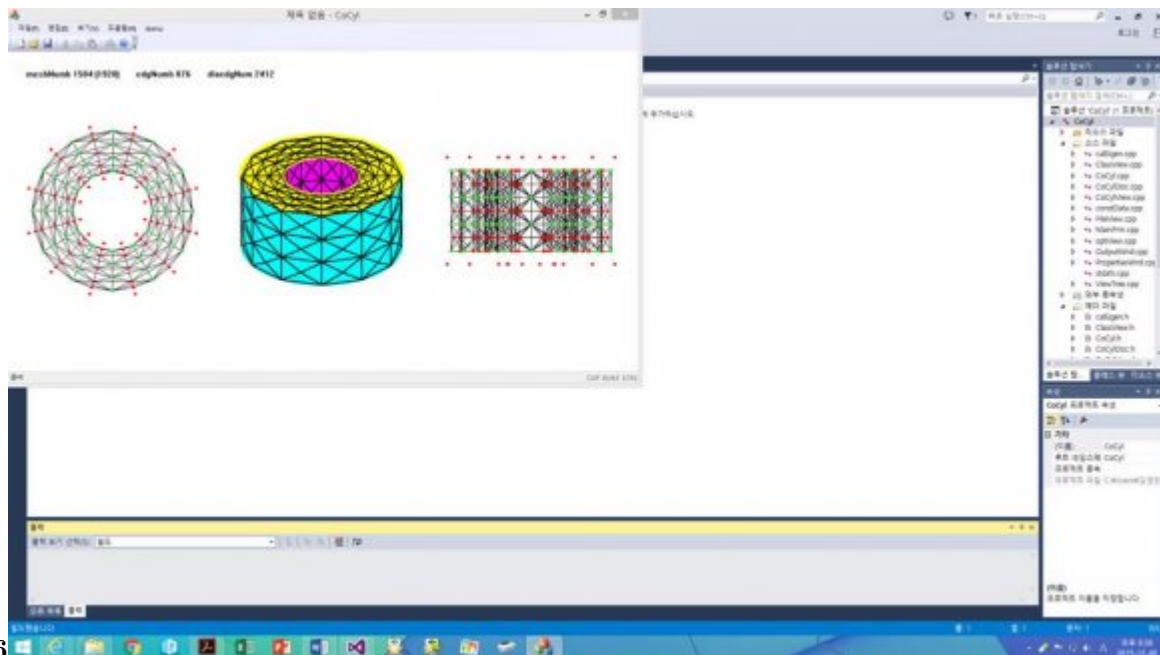
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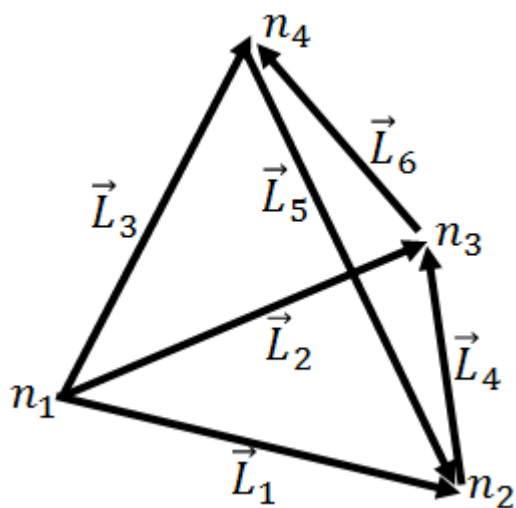
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#### 4 IV. CONCLUSION



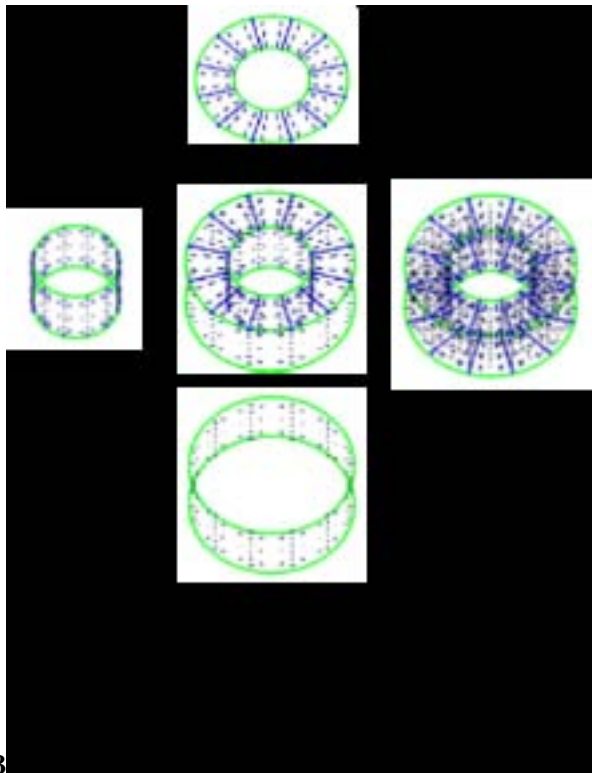
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Figure 2: 2016 F©



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Figure 3: 1 ?? 2



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Figure 4: Fig. 3 :



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