

# The Properties of Vibrating Systems, Eigenvalues and Eigenvectors

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## 1. Introduction

We have seen that the equations of motion for lumped parameter systems can be derived by use of free body diagrams (FBD) and Newton's second law of motion. We now look at alternative methods, for derivation of the equations of motion, which may be more convenient when dealing with systems with many degrees of freedom (MDOF).

The dynamic behavior of a structure or system may be modelled in terms of either its stiffness or its flexibility. Thus, the equations of motion may be formulated on the basis of either the stiffness matrix  $[k]$  or the flexibility matrix  $[d]$ . In the stiffness formulation, forces are expressed in terms of displacements, as follows:

$$\{f\} = [k]\{x\} \quad (1)$$

Thus, for an undamped, unforced vibrating system, the differential equations of motion may be expressed as follows:

$$[m]\{\ddot{x}\} + [k]\{x\} = 0 \quad (2)$$

In particular, for an undamped, unforced two DOF vibrating system, the differential equations of motion may be expressed in full, in matrix notation, as follows:

$$\begin{bmatrix} m_{11} & m_{12} \\ m_{21} & m_{22} \end{bmatrix} \begin{Bmatrix} \ddot{x}_1 \\ \ddot{x}_2 \end{Bmatrix} + \begin{bmatrix} k_{11} & k_{12} \\ k_{21} & k_{22} \end{bmatrix} \begin{Bmatrix} x_1 \\ x_2 \end{Bmatrix} = \begin{Bmatrix} 0 \\ 0 \end{Bmatrix} \quad (3)$$

On the other hand, in the flexibility formulation, displacements are expressed in terms of forces as follows:

$$\{x\} = [d]\{f\} \quad (4)$$

Thus, for an undamped, unforced vibrating system, the differential equations of motion may be expressed as follows:

$$[d][m]\{\ddot{x}\} + [I]\{x\} = 0 \quad (5)$$

With  $[I]$  being the identity matrix, it should be evident from equations (2) and (5) that

# Vibrating Systems Library Of Mathematics

**David Baud**



## **Vibrating Systems Library Of Mathematics:**

## **Vibrating Systems Library Of Mathematics** Book Review: Unveiling the Power of Words

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web grivation is calculated by adding variation and convergence algebraically in this case variation is west and convergence is east opposite directions so the algebraic sum becomes 29 w 69 e 40 e grivation the grivation is then applied to the magnetic heading grivation east magnetic least 345 40 025 g

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web around uk coasts variation is around 4 west to 7 west in other parts of the world it can reach more than 50 east or west because the magnetic north pole moves the variation changes from year to year the compass rose on the chart gives the annual change around 7 east per year around the uk

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