STUDENT STUDY PROJECT

TITLE: APPLICATIONS OF EIGEN VALUES AND EIGEN VECTORS

Submitted to

THE DEPARTMENT OF MATHEMATICS

GOVERNMENT DEGREE COLLEGE,

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ACKNOWLEDGEMENT

We sincerely thank Sri G.Narender Reddy and T.Srinivasulu, Asst.Professors of Mathematics, who have given the task and guided us where ever we feel it difficult. While doing project work, we could learn how to apply Mathematical knowledge in daily, which will be useful in my future career.

We, further thank Dr. J. Rajaram, Principal of the college for his support and encouragement.

Contents

APPLICATIONS OF EIGEN VALUES AND EIGEN VECTORS

1. Abstract

We find one application on “Eigen values and Eigen vectors” which is useful in real world.

2. Key words

Eigen values and Eigen vectors, Matrix.

3. Introduction (Literary review)

“Eigen values and Eigen vectors” is an important concept in Mathematics because many real world problems can be solved by using this concept. Eigen values and Eigen vectors have so many applications in real life. Some applications of Eigen values and vectors;

1. System of first order differential equations are solved by using eigen values and eigen vectors.

2. Communication systems: Eigenvalues were used by Claude Shannon to determine the theoretical limit to how much information can be transmitted through a communication medium like your telephone line or through the air. This is done by calculating the eigenvectors and eigenvalues of the communication channel (expressed a matrix).

3. Designing bridges: The natural frequency of the bridge is the eigenvalue of smallest magnitude of a system that models the bridge. The engineers exploit this knowledge to ensure the stability of their constructions

4. Designing car stereo system: Eigenvalue analysis is also used in the design of the car stereo systems, where it helps to reproduce the vibration of the car due to the music.

5. Electrical Engineering: The application of eigenvalues and eigenvectors is useful for decoupling three-phase systems through symmetrical component transformation.

6. Mechanical Engineering: Eigenvalues and eigenvectors allow us to "reduce" a linear operation to separate, simpler, problems.

Eigenvalues are not only used to explain natural occurrences, but also to discover new and better designs for the future. Finally they can be useful in further areas of Mathematics.

Definition of Eigen value and Eigen vector: An eigen vector of an $n \times n$ matrix A is a nonzero vector x such that $Ax = \lambda x$ for some scalarλ . A scalar λ is called an eigenvalue of A if there is a nontrivial solution x of $Ax = \lambda x$; such an x is called Eigen vector corresponding to λ.

Consider a system of differential equations:

$$x_1' = a_{11}x_1 + --- \mp a_{1n}x_n$$

$$x_2' = a_{21}x_1 + --- \mp a_{2n}x_n$$

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$$x_n' = a_{n1}x_1 + ---\mp a_{nn}x_n$$

Here x_1,x_2………x_n are differential functions of t with derivatives x_1',…..x_n', and a_{ij} are constants. The crucial feature of this system is that it is linear. To see this , write the system as a matrix differential equation $x'(t) = Ax(t)$ -------(1)

Where $x(t) = \begin{bmatrix} x_1(t) \\ \vdots \\ x_n(t) \end{bmatrix}$, $x'(t) = \begin{bmatrix} x_1'(t) \\ \vdots \\ x_n'(t) \end{bmatrix}$ and $A = \begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & . & \vdots \\ a_{n1} & \cdots & a_{nn} \end{bmatrix}$

A solution of equation (1) is a vector –valued function that satisfies (1) for all t in some interval of real numbers, such as ≥ 0 .

Equation (1) is linear because both differentiation of functions and multiplications of vectors by matrix are linear transformations. Thus ,if u and v are solutions of $x' = Ax$ then $cu + dv$ is also a solution, because

$$(cu + dv)' = cu' + dv' = cAu + dAv = A(cu + dv)$$

If a vector x_0 $is\ specified$, then the initial value problem is construct the function x such that $x' = Ax\ and\ x(0) = x_0$. By using this concept and solved the following problem.

Find the solution of coupled differential equations

$\dot{x}$=$4x + 2y$ and $\dot{y}$ = -x +y with initial condition $x(0) = 1$, $y(0) = 0$.

Here $\dot{x} = \frac{dx}{dt}$, $\dot{y} = \frac{dy}{dt}$.

Solution:

$$A = = \begin{bmatrix} 4 & 2 \\ -1 & 1 \end{bmatrix},$$

A has eigen values $\lambda_1 = 3\ and\ \lambda_2 = 2$ and corresponding eigen vectors are

$X_1 = \begin{bmatrix} -2 \\ 1 \end{bmatrix}$ and $X_2 = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$, $P = \begin{bmatrix} -2 & 1 \\ 1 & -1 \end{bmatrix}$

$\therefore x(t) = 2e^{3t} - e^{2t}$ and $y(t) = -\,e^{3t} + e^{2t}$

4.METHODOLOGY: Problem solving method.

5.References :

1) Google Searching .

2) David C Lay Linear Algebra and its applications 4e.

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