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Reg. No. : ....

Name : ....

First Semester M.Tech. Degree Examination, February 2015
(2013 Scheme)
Electronics and Communication
Stream : Signal Processing
TSM 1001 : LINEAR ALGEBRA FOR SIGNAL PROCESSING

Time : 3 Hours Max. Marks : 60

Instruction : *Answer **any two** questions from **each** module. **10** marks for **each** question.*

Module – 1

1. a) What are the axioms defining a ring ? Give an example.

   b) If R is a ring and has a unit element 1 show that $(-1)(-1) = 1$.

2. Define basis and dimension for a vector space. If V be a vector space of 2×2 matrices over R, determine whether A, B,C $\in$ V are linearly dependant or not.
   $A = \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}, B = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}, C = \begin{bmatrix} 1 & 1 \\ 0 & 0 \end{bmatrix}$.

3. a) Define inner product space. If V be a vector space and u, v, $\in$ V then prove the triangular inequality $\|u + v\| \le \|u\| + \|v\|$.

   b) If W be a vector space of 2×2 symmetric matrices over R, what is the dimension of W. Also find a basis for W. **(10×2=20 Marks)**

Module – 2

4. a) If CD = – DC and λ is an Eigen value of C show that $C(Dx) = -\lambda(Dx)$.

   b) A linear operator T is defined by T (x, y, z) = (2y + z, x – 4y, 3x). Find the matrix T in the basis $\left\{ \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}, \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix}, \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} \right\}$.

P.T.O.

5. a) If the non-zero vectors $v_1, v_2, ...v_k$ are mutually orthogonal show that they are linearly independent.

   b) What is Cayley-Hamilton theorem ? Prove Cayley-Hamilton theorem for the square matrix $A = \begin{bmatrix} 1 & 2 \\ 3 & 2 \end{bmatrix}$.

6. a) What is minimum polynomial of a linear operator ? Find the minimum polynomial of the transformation matrix $A = \begin{bmatrix} 5 & -6 & -6 \\ -1 & 4 & 2 \\ 3 & -6 & -4 \end{bmatrix}$. **(10×2=20 Marks)**

Module – 3

7. Define unitary transformation. Give an example for a unitary matrix. State and prove any two properties of a unitary matrix.

8. a) If λ is an Eigen value of the invertible operator T show that λ^{-1} is an Eigen value of T^{-1}.

   b) What is Eigen vector of a linear operator, T. Express the following transformation matrix in Eigen vector basis $A = \begin{bmatrix} 1 & -3 & 3 \\ 3 & -5 & 3 \\ 6 & -6 & 4 \end{bmatrix}$.

9. a) Write short notes on Jordan canonical form.

   b) Translation invariant linear transformation. **(10×2=20 Marks)**

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