Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
Manipal University

SIXTH SEMESTER B.TECH (E & C) DEGREE END SEMESTER EXAMINATION - APRIL / MAY 2017

SUBJECT: LINEAR ALGEBRA FOR SIGNAL PROCESSING (ECE - 336)

TIME: 3 HOURS **MAX. MARKS: 50**

Instructions to candidates

- Answer **ANY FIVE** full questions.
- Missing data may be suitably assumed.

1A. Solve the following set of linear equations using Gauss-Jordan method.

$$\begin{aligned} x_1 - 3x_3 &= -2 \\ 3x_1 + x_2 - 2x_3 &= 5 \\ 2x_1 + 2x_2 + x_3 &= 4 \end{aligned}$$

1B. Consider a LTI system with impulse response h(n) = u[n] – u[n-3]. If the applied input is x(n) = cos(nπ/2), compute the response of the LTI system for N=4 using matrix multiplication method.

1C. Compute L2-norm distance between X and Y.

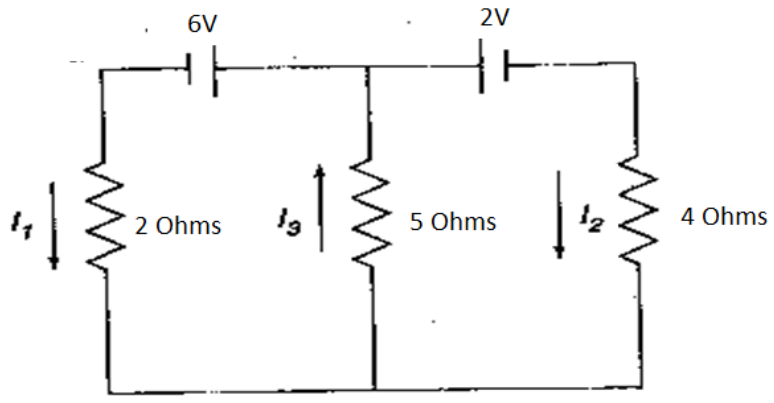
X = [1+j3 1-j 3+j2]

Y = [j 2-j 1+j]

(5+3+2)

2A. Define a linear vector space along with all its properties. Determine if $x=\begin{bmatrix} 6 \\ 7 \\ 1 \\ -4 \end{bmatrix}$ is in the subspace spanned by the columns of A, where $A=\begin{bmatrix} 5 & -5 & -9 \\ 8 & 8 & -6 \\ -5 & -9 & 3 \\ 3 & -2 & -7 \end{bmatrix}$

2B. Find the currents in the following circuit using linear algebra.



2C. Define the following (i) Jacobian of a matrix (ii) Positive semidefinite matrix

(5+3+2)

3A. Discuss the method of estimating narrow band signal frequency buried in white noise using signal subspace decomposition. If observed signal is $x(n) = Ae^{j\omega n} + v(n)$ {where A = amplitude, ω = angular frequency, v(n) is noise} and the autocorrelation matrix is estimated to be $\begin{bmatrix} 8 & 2-j3 \\ 2+j3 & 8 \end{bmatrix}$. Estimate the signal frequency and noise variance.

3B. Find the values of K for which following system of linear equations have (i) unique solution (ii) no solution (iii) infinite solutions.

$$Kx + y + z = 1$$
$$x + Ky + z = 1$$
$$x + y + Kz = 1$$

3C. Define the following (i) Hessian of a matrix (ii) Toeplitz matrix

(5+3+2)

4A. Solve the following system of linear equations using QR factorization.

$$x - 3y + z = 4$$
$$2x - 8y + 8z = -2$$
$$-6x + 3y - 15z = 9$$

4B. Using the expression for generalized Fourier Series, derive the expression for continuous Fourier series.

4C. Define Hankel matrix and mention its applications in signal processing.

(5+3+2)

5A. Find an orthonormal basis for the following subspace of R^4

$$\begin{bmatrix} 1 & -1 & 4 \\ 1 & 4 & -2 \\ 1 & 4 & 2 \\ 1 & 1 & 0 \end{bmatrix}$$

5B. Find the standard matrix for the stated composition of linear operators on R^3. A rotation of 30° about the x-axis, followed by a rotation of 30° about the z-axis, followed by a contraction with factor 0.25.

5C. Eigen values of a Hermitian matrix are _____and Eigen vectors are _____.

(5+3+2)

6A. Discuss the use of singular value decomposition in edge detection of RGB images.

6B. Find SVD of $\begin{bmatrix} 1 & 2 \\ 1 & 2 \end{bmatrix}$

6C. Define vector space isomorphism.

(5+3+2)