Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
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SIXTH SEMESTER B. Tech. (E & C) DEGREE END SEMESTER EXAMINATION
MAY/JUNE 2016
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. Discuss the design of matched filter for digital communication systems to detect discrete signal buried in noise. If the communication channel is modelled as AWGN channel, compute the maximum SNR and the threshold chosen to minimize the probability of error.

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

1C. What is a Toeplitz matrix? Mention its applications.

(5+3+2)

2A. Explain an algorithm to detect the edges in a RGB colour image using singular value decomposition.

2B. Solve the following system of linear equations using LU factorization

$$\begin{aligned} x - 3y + z &= 4 \\ 2x - 8y + 8z &= -2 \\ -6x + 3y - 15z &= 9 \end{aligned}$$

2C. Find null space (A) or kernel(A)

$$A = \begin{bmatrix} 2 & 2 & -1 & 0 & 1 \\ -1 & -1 & 2 & -3 & 1 \\ 1 & 1 & -2 & 0 & -1 \\ 0 & 0 & 1 & 1 & 1 \end{bmatrix}$$

(5+3+2)

3A. Determine the currents I_1, I_2, I_3, I_4, I_5 and I_6 for the electrical network shown in Fig. 3A.

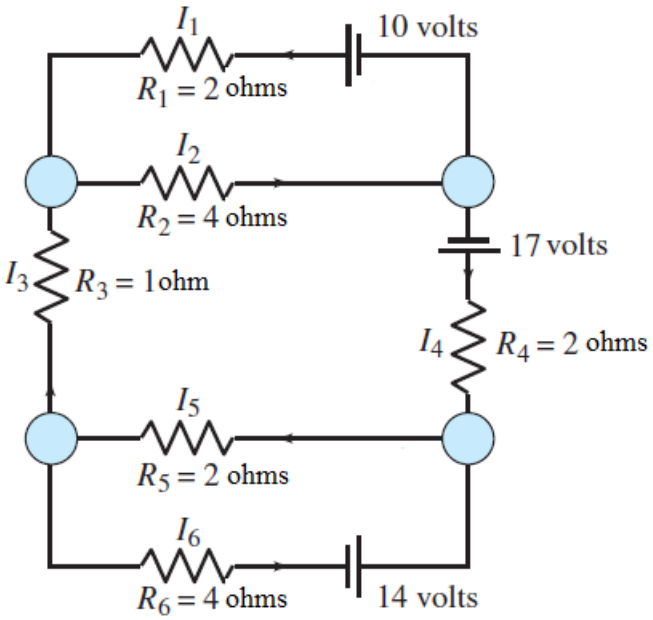

Fig. 3A

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

3C. Find out this matrix so that it has rank 1.

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

(5+3+2)

4A. Water is flowing through a network of pipes (in thousands of cubic meters per hour), as shown in Fig. 4A.

i. Solve this system for the water flow represented by x_i , i=1,2,3,4,5,6,7

ii. Find the water flow when $x_6 = x_7 = 0$

iii. Find the water flow when $x_5 = 1000$ and $x_6 = 0$

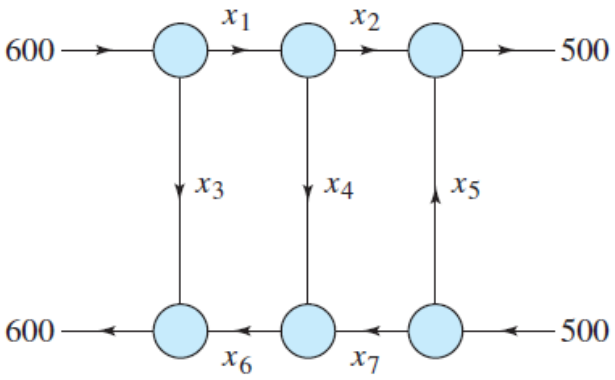

Fig. 4A

4B. Find an equation involving g, h and k that makes this augmented matrix correspond to a consistent system.

$$\begin{bmatrix} 1 & -4 & 7 & g \\ 0 & 3 & -5 & h \\ -2 & 5 & -9 & k \end{bmatrix}$$

4C. (i)_____is an Eigen noise in the case of LTI systems.
(ii) Eigen values and Eigen vectors of a Hermitian matrix are _____

(5+3+2)

5A. Diagonalize the matrix A.

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

5B. Find the linear transformation T: $R^3 \rightarrow R^4$ whose image is spanned by $(1, 2, 0, -4)^T$ and $(2, 0, -1, -3)^T$.

5C. Can each vector in R^4 can be written as a linear combination of columns of matrix A? Do the columns of matrix A span R^4?

$$A = \begin{bmatrix} 1 & 3 & 0 & 3 \\ -1 & -1 & -1 & 1 \\ 0 & -4 & 2 & -8 \\ 2 & 0 & 3 & -1 \end{bmatrix}$$

(5+3+2)

6A. Sketch the line that appears to be the best fit for the points shown in Fig. 6A. Use the method of least squares to find the least squares regression line. Also calculate the sum of the squared error.

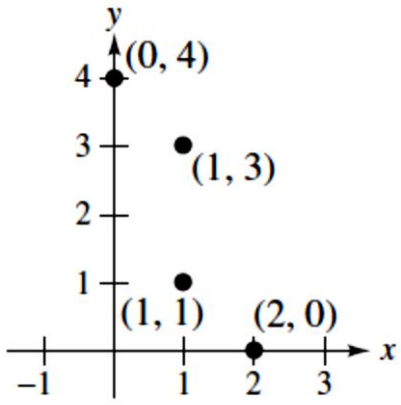

Fig. 6A

6B. Given B = {u_1; u_2; u_3}, where u_1 = (1, 2, 1), u_2 = (1, 1, 3) and u_3 = (2, 1, 1), use the Gram-Schmidt procedure to find a corresponding orthonormal basis.

6C. Compute L_∞ norm of (2+j3, j3, 3-j4, j4)

(5+3+2)