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 – 4008)

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

Instructions to candidates

- Answer **ALL** questions.
- Missing data may be suitably assumed.

1A. Consider a road network shown in Figure 1A. The streets are one way and the flow of traffic is measured in vehicles per hour (vph).

(i) Write the following traffic as system of linear equations in Ax=b form.
(ii) Find the LU decomposition of matrix A.
(iii) What is the minimum value of x_3 that would not lead to traffic congestion?

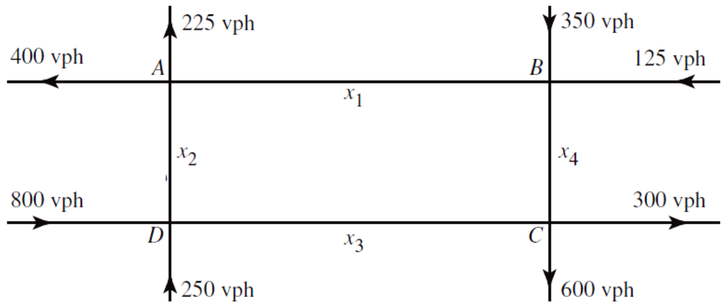

Figure 1A

1B. Consider the following basis for R^2 :

$E = \{\begin{bmatrix} 1 \\ 2 \end{bmatrix}, \begin{bmatrix} 3 \\ 5 \end{bmatrix}\}$

(i) Find the coordinates for the vector $\begin{bmatrix} -2 \\ 4 \end{bmatrix}$ in terms of the basis E.

(ii) Let T : $R^2 \rightarrow R^2$ be the following linear transformation: T(x, y) = (2x - y, 3x - 2y)
Find the matrix representing T with respect to the basis E.

1C. For what value of 'x' will the matrix given becomes singular? $\begin{bmatrix} 8 & x & 0 \\ 4 & 0 & 2 \\ 12 & 6 & 0 \end{bmatrix}$

(5+3+2)

2A. In a certain experiment, the first five measurements of the two quantities x and y are given by (1, 0), (2, 3), (3, 7), (4, 14), (5, 22). Due to random errors in the measurements the ordered pairs (x_i, y_i) do not lie on a straight line. Find the equation of the straight line that best fits these data points. Also find the sixth data point.

2B. Find the coordinates of a vector (2, 1) after rotating 90 degrees in counter clockwise direction, scaling by a factor of 2 in the x-direction and translate 3 units in the y-direction.

2C. Define the following and mention any one application: (i) Vandermonde matrix (ii) Permutation matrix.

(5+3+2)

3A. Find the Jordan canonical form of matrix A. Mention any two applications. A = $\begin{bmatrix} 1 & -3 & -2 \\ -1 & 1 & 1 \\ 2 & 4 & 5 \end{bmatrix}$

3B. How SVD is useful in detecting the edges in a colour image? Explain .

3C. Consider the matrix A = $\begin{bmatrix} 5 & 0 & 0 & 0 \\ 0 & 5 & 0 & 0 \\ 0 & 0 & 2 & 1 \\ 0 & 0 & 3 & 1 \end{bmatrix}$. Which one of the following is an Eigen vector of matrix A? (i) $\begin{bmatrix} 1 \\ -2 \\ 1 \\ 0 \end{bmatrix}$ (ii) $\begin{bmatrix} 1 \\ -2 \\ 0 \\ 1 \end{bmatrix}$ (iii) $\begin{bmatrix} 1 \\ 0 \\ -2 \\ 1 \end{bmatrix}$ (iv) $\begin{bmatrix} 1 \\ -2 \\ 0 \\ 0 \end{bmatrix}$

(5+3+2)

4A. Solve the currents in the following electrical circuit using QR factorization.

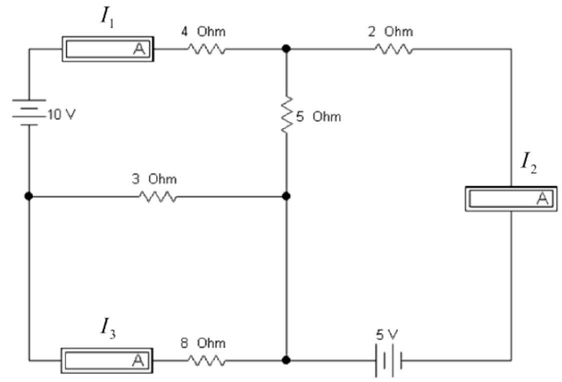

Figure 4A

4B. If the observed signal is x(n) = $Ae^{j\omega n}$ + noise, and the autocorrelation matrix is estimated to be $\begin{bmatrix} 6 & 3-j4 \\ 3+j4 & 6 \end{bmatrix}$. Estimate the frequency of the signal and also find the noise variance.

4C. What are the benefits of Hermitian matrices?

(5+3+2)

5A. State Schwarz's inequality. Using this design a matched filter to detect a continuous signal in a digital communication system having a white noise channel with power spectral density $N_0/2$. Calculate the maximum SNR and the noise variance.

5B. What is pseudo inverse? Discuss the method of obtaining pseudoinverse of a system of linear equations.

5C. Find an equation involving g, h and k that makes this augmented matrix correspond to a consistent system.

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

(5+3+2)