Program: BS (CS, SE, DS) Semester: Fall Duration: 3 hours Paper Date: 20-1-22 Weight 50-54% Section: All Page(s): 03 Exam: Final term Programmable calculators are not allowed. Show complete working in all questions. 54% wtg. is applicable to only those sections who had no quiz-3 due University Application in Computer Graphics Question#1[05+05][CLO-1]: Use Elementary Matrices to find the Inverse of $A = \begin{bmatrix} 0 & -1 \\ -1 & 0 \end{bmatrix}$. Also weight working in all questions. 54% wtg. is applicable to only those sections who had no quiz-3 due University Application in Computer Graphics Question#1[05+05][CLO-1]: Use Elementary Matrices to find the Inverse of $A = \begin{bmatrix} 0 & -1 \\ -1 & 0 \end{bmatrix}$. Also weify that $A = E_1^{-1} E_2^{-1} E_3^{-1} \dots E_{k-1}^{-1} E_k^{-1}$ for some k . Any other method used to evaluate the inverse will not be considered for marking. Application in Computer Graphics Question#2[2+5+5+5+3][CLO-1,5]: Discuss the Geometric Effect on the Unit Square of multiplication by the matrix $A = \begin{bmatrix} 0 & -1 \\ -1 & 0 \end{bmatrix}$ using the following steps: 1. Decompose $A = E_1^{-1} E_2^{-1} E_3^{-1} \dots E_{k-1}^{-1} E_k^{-1}$ for some k . 2. Show the effect of $E_1^{-1} E_2^{-1} E_3^{-1} \dots E_{k-1}^{-1} E_k^{-1}$ for some k . 3. Show mathematically action of each elementary matrix on the end points of the edges. 4. Illustrate the geometric effects at each step. 2. Show the effect of the effect of each elementary matrix on the end points of the edges. 4. Illustrate the geometric effects at each step. 2. Show the effect of the effect of each elementary matrix on the end points of the edges. 3. Show mathematically action of each elementary matrix on the end points of the edges. 4. Illustrate the geometric effects at each step. 3. Show and the effect of effects at each step. 4. Illustrate the geometric effects at each step. 4. Illustrate the geometric effects at each step. 5. Exam: Final term 6. Exam: Final term 7. Exam: Final term 8. For intermediate to only those sections who had no quiz-3 due University 9.	AND THE PERSON NAMED IN COLUMN TO PERSON NAM	Course:	Linear Algebra	Course Code:	
Duration: 3 hours Total Marks: 100 Paper Date: 20-1-22 Weight 50-54% Section: All Page(s): 03 Exam: Final term Roll No: 201-105 Instruction/Notes: 54% wtg. is applicable to only those sections who had no quiz-3 due University Closure. 0 : 0 99 is BONUS question. Application in Computer Graphics Question#1[05+05][CLO-1]: Use Elementary Matrices to find the Inverse of $A = \begin{bmatrix} 0 & -1 \\ -1 & 0 \end{bmatrix}$. Also yother method used to evaluate the inverse will not be considered for marking. Application in Computer Graphics Question#2[2+5+5+5+3][CLO-1,5]: Discuss the Geometric Effect on the Unit Square of multiplication by the matrix $A = \begin{bmatrix} 0 & -1 \\ -1 & 0 \end{bmatrix}$ using the following steps: 1. Decompose $A = E_1^{-1} E_2^{-1} E_3^{-1} \dots E_{k-1}^{-1} E_k^{-1}$ for some k . 2. Show the effect of $E_1^{-1} E_2^{-1} E_3^{-1} \dots E_{k-1}^{-1} E_k^{-1}$ on the unit square. Also show the action of elementar matrix (each) via diagram separately. 3. Show mathematically action of each elementary matrix on the end points of the edges. 4. Illustrate the geometric effects at each step. 2. Show the effect of $E_1^{-1} E_2^{-1} E_3^{-1} \dots E_{k-1}^{-1} E_k^{-1}$ on the unit square. Also show the action of elementar matrix (each) via diagram separately. 3. Show mathematically action of each elementary matrix on the end points of the edges. 4. Illustrate the geometric effects at each step. 2. Show the effect of $E_1^{-1} E_2^{-1} E_3^{-1} \dots E_{k-1}^{-1} E_k^{-1} = 0$ or the unit square. Also show the action of elementary matrix on the end points of the edges. 3. Show mathematically action of each elementary matrix on the end points of the edges. 4. Illustrate the geometric effects at each step. 2. Show the effect of $E_1^{-1} E_2^{-1} E_3^{-1} \dots E_{k-1}^{-1} E_k^{-1} = 0$ or the unit square of multiplication of each elementary matrix on the end points of the edges. 3. Show mathematically action of each elementary matrix on the end points of the edges. 4. Illustrate the geometric effects at each step. 3. Each Park Park Park Park Pa	THIONAL UNIVERSITY	Program:			
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4(a)[10]: Use the Gram – Schmidt process to find the orthogonal set of vectors $\{v_1, v_2, v_3\}$ and orthonormal set of vectors $\{q_1, q_2, q_3\}$ by considering standard inner product between the vector

(b) [10]. Also find a matrix R and verify A = QR where, $Q = [q_1 \mid q_2 \mid q_3]$ and R is given by

$$R = \begin{bmatrix} \langle u_1, q_1 \rangle & \langle u_2, q_1 \rangle & \langle u_3, q_1 \rangle \\ 0 & \langle u_2, q_2 \rangle & \langle u_3, q_2 \rangle \\ 0 & 0 & \langle u_3, q_3 \rangle \end{bmatrix}.$$

General Linear Transformations

 $\sqrt{\text{Question}#5} [2+2+2+2][\text{CLO-5}]$: Let $T: \mathbb{R}^2 \to \mathbb{R}^3$ be the linear transformation defined by the formula

$$T(x_1, x_2) = (x_1 + 3x_2, x_1 - x_2, x_1)$$

- a. Find the Standard Basis Matrix (A) for the above transformation.
- b. Find the rank of A i.e. rank(A).
- c. Find the nullity of A i.e. null(A).
- d. Find the rank of the At i.e. rank(At).
- e. Find the nullity of the At i.e. null(At).

Question#6 [10][CLO-5]: Let
$$T: R^2 \to R^3$$
 be defined as $\binom{x_1}{x_2} = \begin{bmatrix} x_1 + 2x_2 \\ -x_1 \\ 0 \end{bmatrix}$. Find the matrix $[T]_{B',B} = \begin{bmatrix} [T(u_1)]_{B'} + [T(u_2)]_{B'} \end{bmatrix}$ relative to the basis $B = \{u_1, u_2\}$ and $B' = \{v_1, v_2, v_3\}$, where

$$u_1 = \begin{bmatrix} 1 \\ 3 \end{bmatrix}$$
, $u_2 = \begin{bmatrix} -2 \\ 4 \end{bmatrix}$, $v_1 = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$, $v_2 = \begin{bmatrix} 2 \\ 2 \\ 0 \end{bmatrix}$, $v_3 = \begin{bmatrix} 3 \\ 0 \\ 0 \end{bmatrix}$

Question #7[2+2+2+2][CLO-5]: Let $T: \mathbb{R}^3 \to \mathbb{R}^3$ be a linear operator defined as

$$T(x_1, x_2, x_3) = (0x_1 + x_2 - x_3, x_1 + 0x_2 + 2x_3, -1x_1 + x_2 + 0x_3) \text{ defined by } T(X) = AX \text{ as, where}$$

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

- a) Check whether T is One to One.
- b) Check whether T is Onto.
- c) Find Kernel of T and Basis for Kernel of T.
- d) Find Range of T and Basis for Range of T.
- e) Find Null space of T and Row space of T.

$$\begin{bmatrix} 1/J_2 & 0 & 56/6 \\ -1/J_3 & 1/J_3 & 56/3 \\ 56/6 & 56/3 & -56/6 \end{bmatrix} \begin{bmatrix} 52 & 52 & 52 \\ 0 & 53 & -53/3 \\ 0 & 0 & 256/3 \end{bmatrix} = 1$$

Question#8[10]: STATE ONLY the Equivalent Statements (as much as you remember) for the n x n Matrix, if it's given that:

- a) A is invertible.
- b)

Note: For each equivalent statement one point will be given. Maximum points are 10.

Similarity of Operators (Bonus)

Question#9[05+05][CLO-3,5]: If
$$C = \begin{bmatrix} 1 & 1 \\ -2 & 4 \end{bmatrix}$$
 and $= \begin{bmatrix} 2 & 0 \\ 0 & 3 \end{bmatrix}$, then

- a. Find a matrix P (consisting of the Eigen vectors of the matrix C) using Eigenvalues of C & show that $P^{-1}CP = D$. Also, find the dimension of Eigen Spaces associated with each Eigen value.
- b. Show that C and D represents the same linear operator $T: \mathbb{R}^2 \to \mathbb{R}^2$ by showing $P^{-1}CP = D$, $P^{-1} = P_{B \to B'}$, $B' = \{u'_1, u'_2\}$, $B = \{e_1, e_2\}$, $u'_1 = \begin{bmatrix} 1 \\ 1 \end{bmatrix} \& u'_2 = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$. Here $P \& P^{-1}$ represents the where $P = P_{B' \to B} = [[u'_1]_B \ [u'_2]_B]$ and transition matrices.

Good Luck

$$2+2$$
 $2-4$ $-1-2$ $-1+4$

$$\begin{bmatrix}
4 & -2 \\
-3 & 3
\end{bmatrix}
\begin{bmatrix}
1 & 1 \\
1 & 2
\end{bmatrix}$$

$$4+-2 & 4-4 \\
-3+3 & -3+6$$