2.086 Numerical Computation for Mechanical Engineers

MINI-QUIZ 4 Fall 2014

You may refer to the textbook, lecture notes, Matlab® tutorials, and other class materials as well as your own notes and scripts.

You may use a calculator (for simple arithmetic operations and function evaluations). However, laptops, tablets, and smartphones are not permitted.

You have 30 minutes of recitation to complete the mini quiz. When you are finished, you can hand in your quiz and start working on your assignment.

NAME ____

There are a total of 100 points: four questions, each worth 25 points.

All questions are multiple choice; ***circle one and only one answer***. Make sure to fully erase or indicate "Retracted" on any other circles not associated with your single final answer.

We provide two blank pages at the end of the quiz which you may use for any derivations, but note that we will *only grade your multiple choice selections*.

This (same) quiz will be administered in all recitation sections. *You may not discuss this quiz with other people until the graded quizzes are returned to the class.*

Question 1 (25 points). You are given a matrix A of size 2×3,

$$A = \begin{pmatrix} a & -b & c \\ d & e & f \end{pmatrix},$$

and a second matrix B of size 3×2,

$$B = \begin{pmatrix} g & h \\ i & -j \\ k & \ell \end{pmatrix}.$$

where $a, b, ..., \ell$ are real numbers. The product $C = (AB)^{\mathrm{T}}$ is given by

$$(a)\ C = \begin{pmatrix} ag + dh & -bg + eh & cg + fh \\ ai - dj & -bi - ej & ci - fj \\ ak + d\ell & -bk + e\ell & ck + f\ell \end{pmatrix}$$

$$(b)\ C = \begin{pmatrix} ag + dh & ai - dj & ak + d\ell \\ -bg + eh & -bi - ej & -bk + e\ell \\ cg + fh & ci - fj & ck + f\ell \end{pmatrix}$$

$$(c)\ C = \begin{pmatrix} ag & -bh \\ di & -cj \end{pmatrix}$$

$$(d)\ C = \begin{pmatrix} ag & di \\ -bh & -cj \end{pmatrix}$$

$$(e)\ C = \begin{pmatrix} ag - bi + ck & ah + bj + c\ell \\ dg + ei + fk & dh - ej + f\ell \end{pmatrix}$$

$$(f)\ C = \begin{pmatrix} ag - bi + ck & dg + ei + fk \\ ah + bj + c\ell & dh - ej + f\ell \end{pmatrix}$$

(g) can not be performed

where "can not be performed" means that the operation is not allowed by the rules of matrix algebra.

Question 2 (25 points). Consider the three 3-vectors $(1, 1, 1)$, $(1, 1, -2)$ and $(-3, 3, 0)$. Which of the following statements is <u>incorrect</u>?

(a) The three vectors are linearly independent.

(b) The three vectors are pairwise orthonormal.

(c) The three vectors do not have the same norm.

(d) The three vectors are pairwise orthogonal.

(e) The three vectors can be uniquely linearly combined to form any other 3-vector.

Note that a set of vectors satisfy a given property (e.g., orthogonality, or othonormality) *pairwise* if each pair of vectors in the set satisfies the property.

Question 3 (25 points). A certain radar system tracks airplanes in the sky as point particles. Let v and u denote vectors (in three dimensional space) corresponding to the locations of airplane 1 and 2, respectively. The distance between the two airplanes is

(a) $\sqrt{(u-v)^{\mathrm{T}}(u-v)}$

(b) $\sqrt{u^{\mathrm{T}}v}$

(c) $\dfrac{v+u}{2}$

(d) $\sqrt{u^{\mathrm{T}}u}-\sqrt{v^{\mathrm{T}}v}$

(e) $u-v$

Question 4 (25 points). Let A be an $n \times n$ (square) matrix and v be an $n \times 1$ (column) vector. If all entries of v are equal to one ($v_i = 1$, $1 \le i \le n$), then the product $v^{\mathrm{T}} A v$ is equal to

(a) the matrix A

(b) the scalar 1

(c) a scalar equal to the sum of the diagonal entries of A; i.e., $\sum_{i=1}^{n} A_{i\,i}$

(d) a scalar equal to the sum of all the elements of A; i.e., $\sum_{i=1}^{n} \sum_{j=1}^{n} A_{i\,j}$

(e) a matrix B whose diagonal elements are equal to the diagonal elements of A and non-diagonal elements are zero ($B_{i\,i} = A_{i\,i}$, $1 \le i \le n$; $B_{i\,j} = 0$, $1 \le i \le n$, $1 \le j \le n$, $i \ne j$)

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