F.2.3 Sample Exam Answers and Videos Questions 3-4

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Question 3

0 points possible (ungraded)

3. Compute the inverses of the following matrices

(a) (4 points) $A = \begin{pmatrix} 5 & 2 \\ 2 & 1 \end{pmatrix}$. $A^{-1} =$

(b) (3 points) $B = \begin{pmatrix} 1 & 0 \\ -1 & 1 \end{pmatrix}$. $B^{-1} =$

(c) (3 points) $C = BA$ where A and B are as in parts (a) and (b) of this problem.
$C^{-1} =$

3. Compute the inverses of the following matrices

(a) (4 points) $A = \begin{pmatrix} 5 & 2 \\ 2 & 1 \end{pmatrix}$. $A^{-1} = \frac{1}{(5)(1)-(2)(2)} \begin{pmatrix} 1 & -2 \\ -2 & 5 \end{pmatrix} = \begin{pmatrix} 1 & -2 \\ -2 & 5 \end{pmatrix}$

(b) (3 points) $B = \begin{pmatrix} 1 & 0 \\ -1 & 1 \end{pmatrix}$. $B^{-1} = \begin{pmatrix} 1 & 0 \\ 1 & 1 \end{pmatrix}$.

(c) (3 points) $C = BA$ where A and B are as in parts (a) and (b) of this problem.
$C^{-1} = (BA)^{-1} = A^{-1}B^{-1} = \begin{pmatrix} 1 & -2 \\ -2 & 5 \end{pmatrix} \begin{pmatrix} 1 & 0 \\ 1 & 1 \end{pmatrix}$

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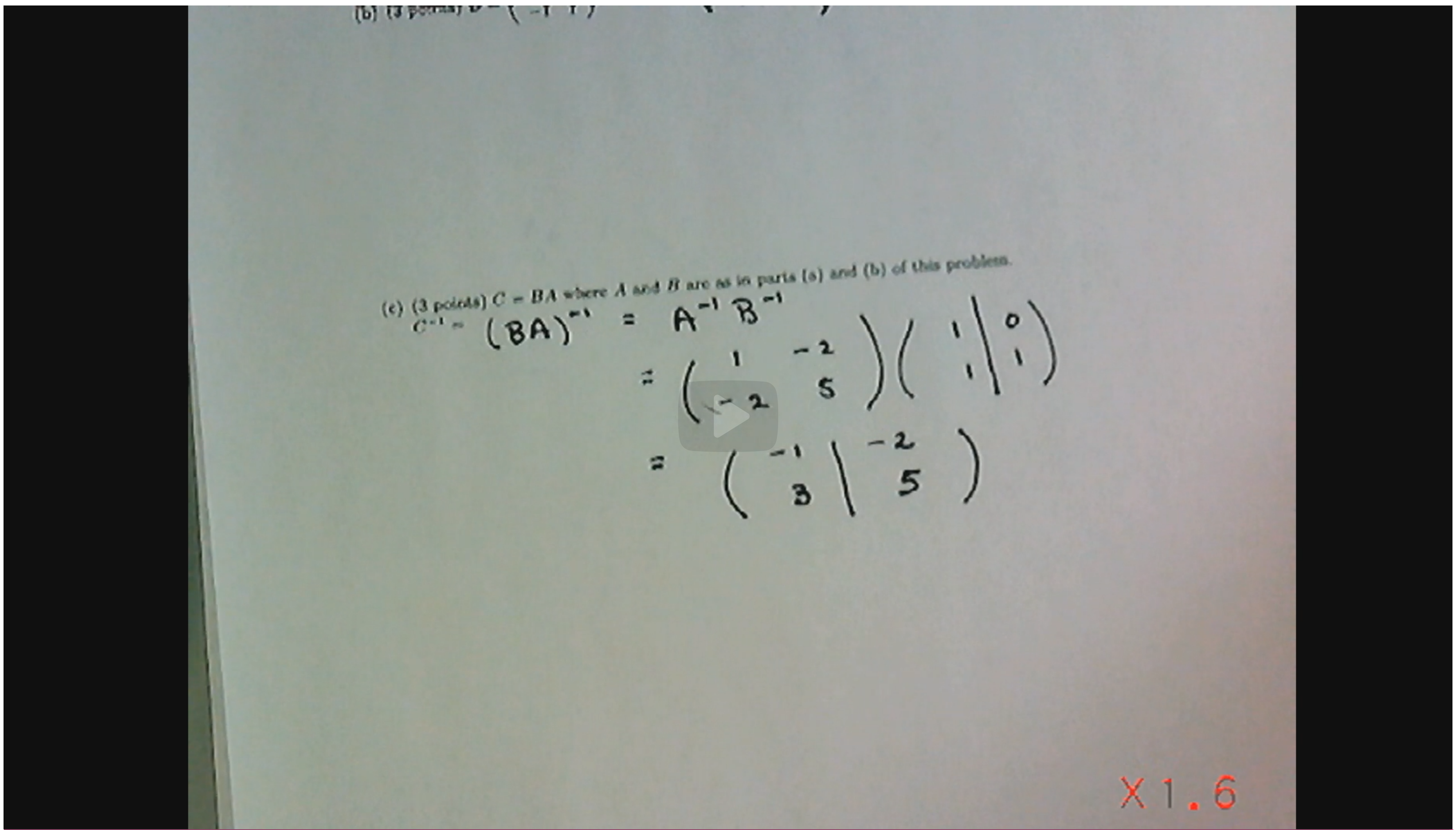
Question 3



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Question 4

0 points possible (ungraded)

4. Consider the vectors $a_0 = \begin{pmatrix} 1 \\ 1 \\ 0 \end{pmatrix}$ and $a_1 = \begin{pmatrix} 1 \\ 0 \\ 2 \end{pmatrix}$.

   (a) (6 points) Compute the projection of $b = \begin{pmatrix} 0 \\ 1 \\ 1 \end{pmatrix}$ onto the space spanned by the vectors a_0 and a_1. (The numbers may not work out very nicely. Set the problem up first, plug in the numbers, then move on and solve other problems. Then come back and solve this one. There may be fractions.)

   (b) (4 points) Compute the linear least-squares solution to find an approximate solution to $Ax = b$. (The numbers may not work out very nicely. Set the problem up first, plug in the numbers, then move on and solve other problems. Then come back and solve this one. There may be fractions.)

4. Consider the vectors $a_0 = \begin{pmatrix} 1 \\ 1 \\ 0 \end{pmatrix}$ and $a_1 = \begin{pmatrix} 1 \\ 0 \\ 2 \end{pmatrix}$.

   (a) (6 points) Compute the projection of $b = \begin{pmatrix} 0 \\ 1 \\ 1 \end{pmatrix}$ onto the space spanned by the vectors a_0 and a_1. (The numbers may not work out very nicely. Set the problem up first, plug in the numbers, then move on and solve other problems. Then come back and solve this one. There may be fractions.)

   The formula is $A \underbrace{(A^TA)^{-1}A^Tb}_{x}$ where a_0 and a_1 are the columns of A.

   Now,

   - $A = \begin{pmatrix} 1 & 1 \\ 1 & 0 \\ 0 & 2 \end{pmatrix}$
   - $A^TA = \begin{pmatrix} 1 & 1 \\ 1 & 0 \\ 0 & 2 \end{pmatrix}^T \begin{pmatrix} 1 & 1 \\ 1 & 0 \\ 0 & 2 \end{pmatrix} = \begin{pmatrix} 2 & 1 \\ 1 & 5 \end{pmatrix}$
   - $(A^TA)^{-1} = \begin{pmatrix} 2 & 1 \\ 1 & 5 \end{pmatrix}^{-1} = \frac{1}{(2)(5)-(1)(1)} \begin{pmatrix} 5 & -1 \\ -1 & 2 \end{pmatrix} = \frac{1}{9} \begin{pmatrix} 5 & -1 \\ -1 & 2 \end{pmatrix}$.
   - $A^Tb = \begin{pmatrix} 1 & 1 \\ 1 & 0 \\ 0 & 2 \end{pmatrix}^T \begin{pmatrix} 0 \\ 1 \\ 1 \end{pmatrix} = \begin{pmatrix} 1 \\ 2 \end{pmatrix}$.
   - $x = (A^TA)^{-1}A^Tb = \frac{1}{9} \begin{pmatrix} 5 & -1 \\ -1 & 2 \end{pmatrix} \begin{pmatrix} 1 \\ 2 \end{pmatrix} = \frac{1}{9} \begin{pmatrix} 3 \\ 3 \end{pmatrix} = \frac{1}{3} \begin{pmatrix} 1 \\ 1 \end{pmatrix}$
   - $A(A^TA)^{-1}A^Tb = Ax = \begin{pmatrix} 1 & 1 \\ 1 & 0 \\ 0 & 2 \end{pmatrix} \frac{1}{3} \begin{pmatrix} 1 \\ 1 \end{pmatrix} = \frac{1}{3} \begin{pmatrix} 2 \\ 1 \\ 2 \end{pmatrix}$.

   (b) (4 points) Compute the linear least-squares solution to find an approximate solution to $Ax = b$. (The numbers may not work out very nicely. Set the problem up first, plug in the numbers, then move on and solve other problems. Then come back and solve this one. There may be fractions.)

   This is just the x computed above.

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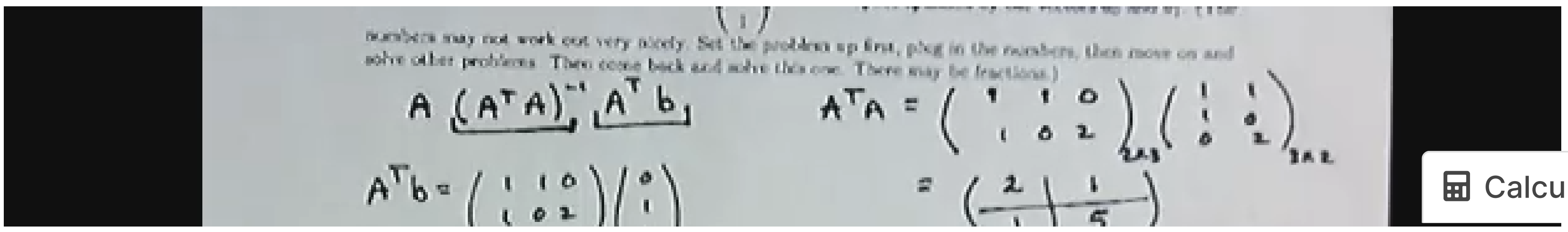
Question 4



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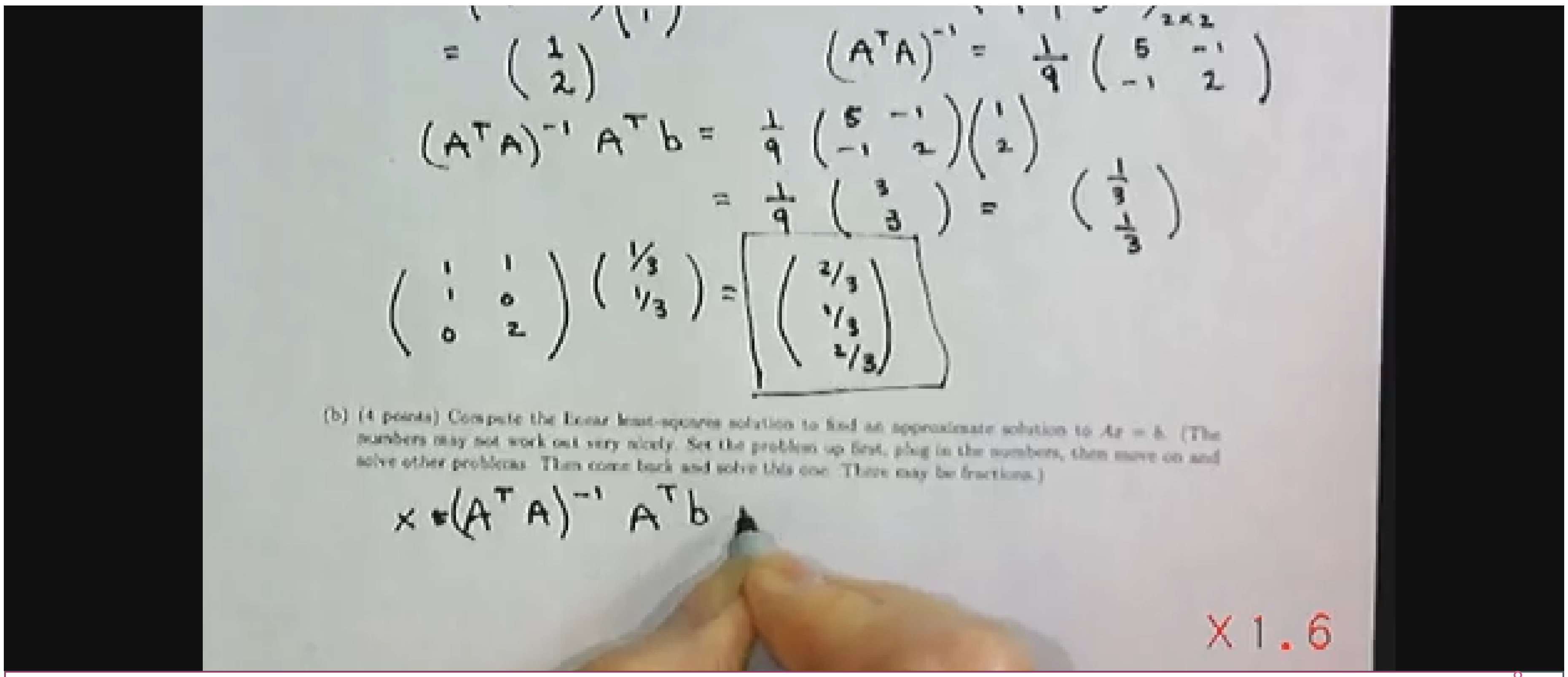

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