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sandipan_dey ~

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★ Course / Week 6: Gaussian Elimination / 6.3 Solving Ax = b via LU Factorization

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6.3.5 Cost

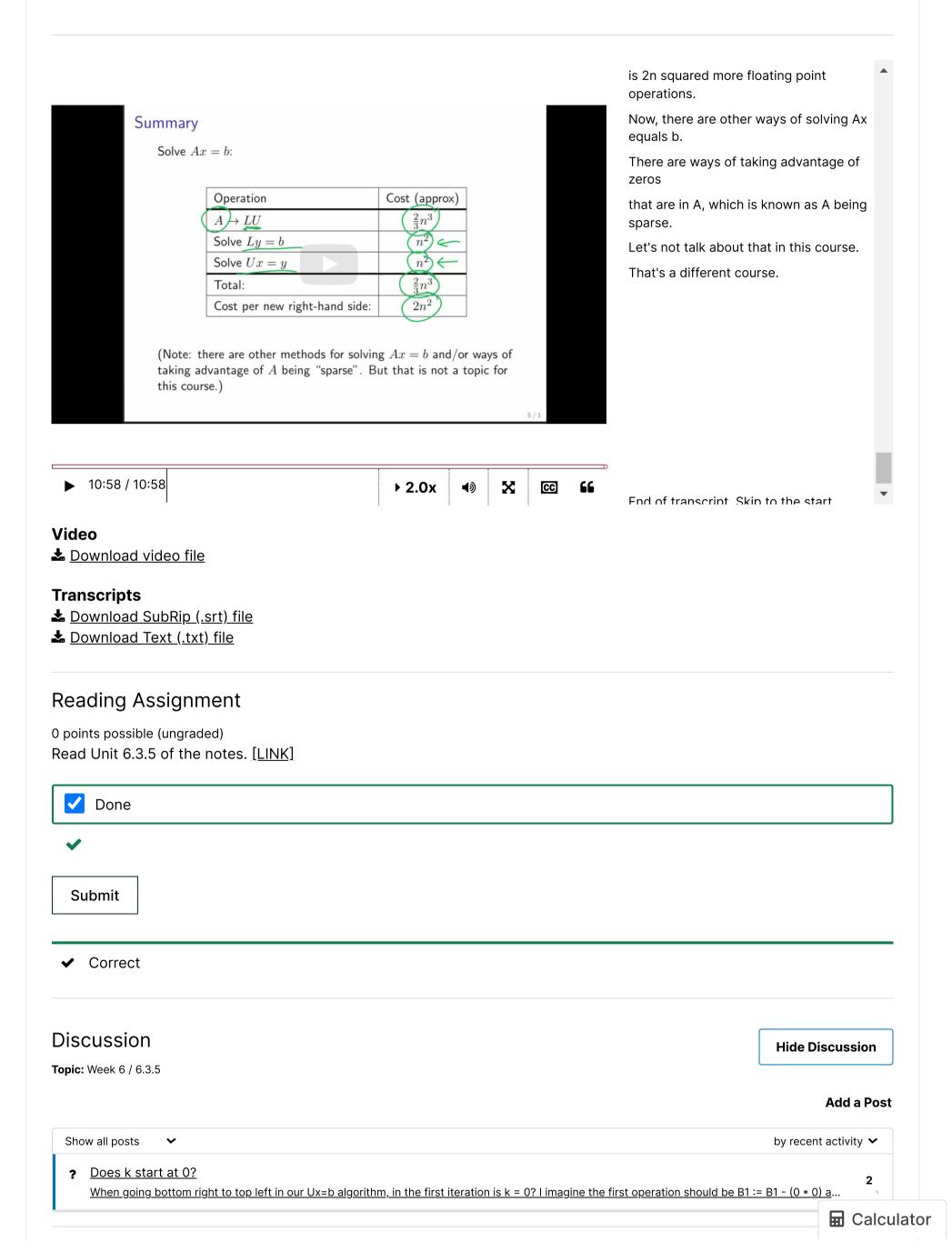
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■ Calculator

Week 6 due Nov 13, 2023 12:12 IST

6.3.5 Cost



Homework 6.3.5.1

5/5 points (graded)

Consider the following algorithm for solving Ux=b where U is an n imes n upper triangular matrix and b is overwritten with the solution x.

$$\begin{array}{c|c} \textbf{Algorithm:} & [b] := \text{UTRSV_UNB_VAR1}(U,b) \\ \hline \textbf{Partition} & U \rightarrow \left(\begin{array}{c|c} U_{TL} & U_{TR} \\ U_{BL} & U_{BR} \end{array} \right), \ b \rightarrow \left(\begin{array}{c|c} b_{T} \\ b_{B} \end{array} \right) \\ \textbf{where} & U_{BR} \text{ is } 0 \times 0, \ b_{B} \text{ has } 0 \text{ rows} \\ \hline \textbf{while} & m(U_{BR}) < m(U) \text{ do} \\ \hline \textbf{Repartition} \\ \hline \begin{pmatrix} U_{TL} & U_{TR} \\ 0 & U_{BR} \end{pmatrix} \rightarrow \left(\begin{array}{c|c} U_{00} & u_{01} & U_{02} \\ \hline 0 & v_{11} & u_{12}^{T} \\ \hline 0 & 0 & U_{22} \end{array} \right), \ \begin{pmatrix} b_{T} \\ b_{B} \end{pmatrix} \rightarrow \left(\begin{array}{c|c} b_{0} \\ \hline \beta_{1} \\ \hline b_{2} \end{array} \right) \\ \hline \beta_{1} := \beta_{1} - u_{12}^{T}b_{2} \\ \beta_{1} := \beta_{1}/v_{11} \\ \hline \\ \textbf{Continue with} \\ \hline \begin{pmatrix} U_{TL} & U_{TR} \\ \hline 0 & U_{BR} \end{pmatrix} \leftarrow \left(\begin{array}{c|c} U_{00} & u_{01} & U_{02} \\ \hline 0 & v_{11} & u_{12}^{T} \\ \hline 0 & 0 & U_{22} \end{array} \right), \ \begin{pmatrix} b_{T} \\ b_{B} \end{pmatrix} \leftarrow \left(\begin{array}{c|c} b_{0} \\ \hline \beta_{1} \\ \hline b_{2} \end{array} \right) \\ \textbf{endwhile} \end{array}$$

Assume that during the kth iteration U_{BR} is $k \times k$. (Notice we are purposely saying that U_{BR} is $k \times k$ because this algorithm moves in the opposite direction!)

Answer the following questions:

•	What	is	the	size	of	submatrix	U_{i}	22	?
---	------	----	-----	------	----	-----------	---------	----	---

 \bigcirc 1×1

 $\bigcirc k \times 1$

 $\bigcirc 1 \times k$

 \bigcirc $k \times k$

V

ullet What is the size of row vector u_{12}^T ?

() 1

 \bigcirc 1 × k

 \bigcirc 1 × n

■ Calculator

ig igcup 1 imes (n-k)	6.3 Solving Ax = b via LU Factorization Week 6: Gaussian Elimination Linear Algebra - Foundations to Frontiers edX $1 imes (n-k)$								
✓									
• What is the size of									
<u> </u>									
_ n									
$\bigcap n-k$									
✓									
Approximately how	many flops does the	dot operation $eta_1:eta_1-u_{12}^Tb_2$ requires?							
○ 2k									
○ 2n									
✓									
We need to sum th	is over all iterations $m{k}$	$=0,\ldots,(n-1)$ (You may ignore the divisions)							
Compute how man	y floating point operat	tions this equals. What is the approximite result?							
<u> </u>									
_ n									
○ n ²									
\bigcirc n^3									
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