COS 454/554 Fall 2021 *Midterm Exam 1*   60 pts.; 60 minutes; 5 questions; 10 pages.   2021-10-07 09:30 a.m.

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Name: _____

1. (1 pt.)
   - **Read all material carefully.**
   - *If in doubt whether something is allowed, ask, don't assume.*
   - You may refer to your books, papers, and notes during this test.
   - E-books may be used *subject to the restrictions* noted in class.
   - Computers are not permitted, except when used strictly as ebooks.
   - Network access of any kind (cell, voice, text, data, ...) is not permitted.
   - Write, and draw, carefully. Ambiguous or cryptic answers receive zero credit.
   - Use class and textbook conventions for notation, algorithmic options, etc.

   Write your name in the space provided above.

$\boxed{\text{WAIT UNTIL INSTRUCTED TO CONTINUE TO REMAINING QUESTIONS.}}$

Do not write on this page below this point.

Q	Full	Score
1	1	
2	20	
3	14	
4	10	
5	15	
total	60	

2. (20 pts.) Trace the execution of the BOTTOM-UP-CUT-ROD(p, n) algorithm for $n = 10$ and the following pricing array:

length:	1	2	3	4	5	6	7	8	9	10
price:	4	7	9	14	18	22	30	30	28	38

Depict the state of the array r at least at the following three points during the execution:

(a) At the bottom of the outer loop in the iteration with $j = 3$.
(b) As above, but with $j = 6$.
(c) At the very end of the algorithm.

It is a good idea to show more of the intermediate steps and work, but those are not strictly required. (Depicting only the states of the array is sufficient.)

[additional space for answering the earlier question]

3. (14 pts.) Depict the *first three levels* of the recursion tree that outlines the recursive calls made by the FIND-MAXIMUM-SUBARRAY algorithm when invoked on the following array, with `low` and `high` equal to 1 and 10, respectively.

The *nodes* of the tree should be labeled with the function invoked: FIND-MAXIMUM-SUBARRAY (M) or FIND-MAX-CROSSING-SUBARRAY (X).

The *edges* should connect each function's node (child) to the node of its invoker (parent).

i:	1	2	3	4	5	6	7	8	9	10
A[i]:	88	-1	-11	-23	43	-6	8	-19	-58	50

[additional space for answering the earlier question]

4. (10 pts.) Solve the following recurrences. *Clearly state the methods you use for your solutions and outline their important steps.* (Show your work.) [Hint: No calculator is needed, although it is permitted.]

(a) $T(n) = 3T(n/3) + 4n + 2$

(b) $S(n) = 7S(n/2) + 8n^{1.85}$

[additional space for answering the earlier question]

5. (15 pts.) Depict tables similar to those in Figure 15.5 of the textbook for MATRIX-CHAIN-ORDER on the following input:

$$
\begin{array}{cccccc}
\text{matrix:} & A_1 & A_2 & A_3 & A_4 \\
\text{dimension:} & 10 \times 30 & 30 \times 50 & 50 \times 100 & 100 \times 40
\end{array}
$$

[additional space for answering the earlier question]

[additional space for answering the earlier question]