CSE 7350 – Test 2
November 3, 2021

Name: _____

ID_____

- This exam is **closed book** and **closed notes**.
- No cell phones, or other electronics.
- Pencil and/or pen and TI - 30Xa calculator only are permitted. No sharing of calculators.
- It is **3 hours** in duration.
- You should have 12 problems. Pay attention to the point value of each problem and dedicate time as appropriate.

If you are a distance student and would like your graded test emailed back to you, provide your email address

E-MAIL:_____

On my honor, I have neither given nor received unauthorized aid on this exam.

SIGNED:_____

DATE:_____

CSE 5/7350 – Exam #2
November 3, 2021

Name: _____
[+5 pts for 5350 students]

ID: _____

1. [9 pts] Define the following terms as succinctly as possible:

(i) NP-Hard _____

_____

_____

(ii) GCD _____

_____

_____

(iii) Dynamic Programming _____

_____

_____

(iv) Longest Common Subsequence _____

_____

_____

(v) Heap _____

_____

_____

(vi) LZW _____

_____

_____

2. [2 pts] Compute $\Phi(55) =$ 40

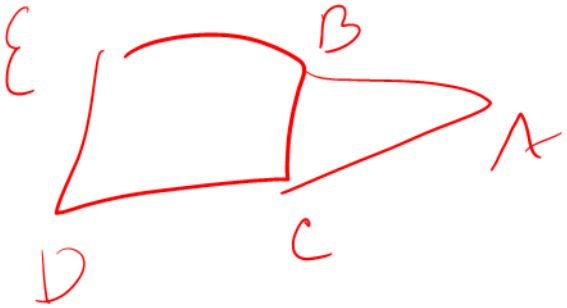
3. [6 pts] If a smallest last ordering has the largest degree when deleted of 9 and a terminal clique size of 8

   (i) What is the maximum number of colors that might be required by the ordering? 10

   (ii) What is the minimum number of colors that must be required by the graph? 8

4. [9 pts] Consider the Smallest Last Vertex Ordering:

   (i) Draw a graph and give a smallest last vertex ordering of that graph where the terminal clique is not the largest complete subgraph in the graph. (Note the terminal clique is the complete subgraph at the end of deleting vertices with the SLVO algorithm)



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E B C D A

   (ii) Give another smallest last vertex ordering for the graph above where the terminal clique is the largest complete subgraph in the graph.

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A B C D E

5. [12 pts] Consider the following NP completeness questions. Answer them with "some" "all" "none" or "unknown"

   (i) Which Problems in P are also in NP? ("some" "all" "none" or "unknown")

   (ii) Which Problems in NP-Hard are also in NP? ("some" "all" "none" or "unknown")

   (iii) Which Problems in NP-Complete are in NP-Hard ("some" "all" "none" or "unknown")

   (iv) If someone can solve an NP-Hard problem in Polynomial Time, then all NP and all NP complete problems can be solved in polynomial time. (true or false)

   (v) At least 1 NP problem can be solved in polynomial time? (True or False)

   (vi) NP-Complete problems are in P ("true" "false" or "unknown")

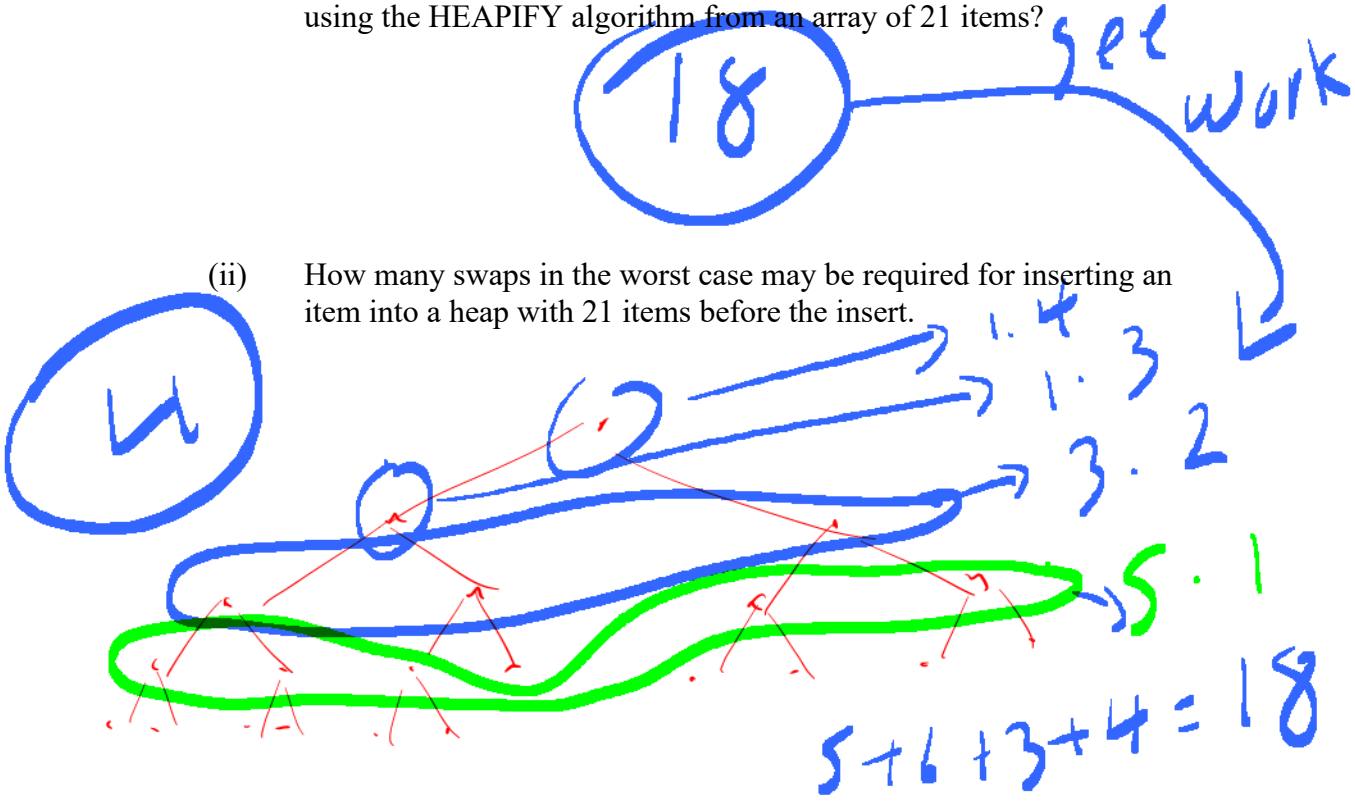
   (vii) At least 1 NP problem can be solved in polynomial time? (True or False)

   (viii) Which NP-Hard Problems are also NP-Complete? ("some" "all" "none" or "unknown")

6. [8 pts] Consider a Heap:

   (i) How many swaps in the worst case may be required to form a heap using the HEAPIFY algorithm from an array of 21 items?

   (ii) How many swaps in the worst case may be required for inserting an item into a heap with 21 items before the insert.



7. [9 pts] Consider an RSA encryption system that has a public key of 8591 for the value e and 95129 for the value of the modulus N. You also saw a message that had been encrypted by the public key. The value of this encrypted message is 18407.

(i) You are able to factor N=95129 into the product of two prime numbers 379 * 251. What is the value of the private key? Show your work including the table for computing the Extended Euclidean Algorithm.

k	A	B	Q	R	alpha	beta
-1					1	0
0	94500	8591	10	8590	0	1
1	8591	8590	1	1	1	-10
2	8590	1	8590	0	-1	11

private key = 11, 95129

(ii) What was the message before it was encrypted (you may give a formula)

$18407^{11} \% 95129 = 17$

8. [7 pts] A sequence of 21 values was used with the Longest Increasing Subsequence algorithm to create the following table. (the 99's are equivalent to infinity) The actual values in the original sequence have been omitted from the table:

Index	Value	-1	99	99	99	99	99	99	99	99
1		-1	6	99	99	99	99	99	99	99
2		-1	6	8	99	99	99	99	99	99
3		-1	6	8	13	99	99	99	99	99
4		-1	6	8	13	15	99	99	99	99
5		-1	6	8	9	15	99	99	99	99
6		-1	5	8	9	15	99	99	99	99
7		-1	5	8	9	11	99	99	99	99
8		-1	5	8	9	11	17	99	99	99
9		-1	5	7	9	11	17	99	99	99
10		-1	5	7	9	11	16	99	99	99
11		-1	5	7	9	10	16	99	99	99
12		-1	5	7	8	10	16	99	99	99
13		-1	5	7	8	10	16	99	99	99
14		-1	5	7	8	10	16	18	99	99
15		-1	5	7	8	10	12	18	99	99
16		-1	5	7	8	9	12	18	99	99
17		-1	4	7	8	9	12	18	99	99
18		-1	4	7	8	9	12	18	20	99
19		-1	4	7	8	9	12	17	20	99
20		-1	4	7	8	9	11	17	20	99
21		-1	4	6	8	9	11	17	20	99

(i) What is the longest increasing subsequence of the original sequence?

8 9 11 16 18 20

(ii) What does the value 11 represent on the last row?

11 is the smallest ending value of a subsequence of length 5.

9. [9 pts] Consider the Levensthein Edit Distance for two strings A and B.

(i) Write the equation describing what you would put in the table for location i,j?

$$T[i,j] = \min \begin{cases} T[i-1,j]+1 \\ T[i,j-1]+1 \\ T[i-1,j-1] + \begin{cases} 0 & \text{when } A[i] = B[j] \\ 1 & \text{when } A[i] \neq B[j] \end{cases} \end{cases}$$

(ii) How would you modify this equation for a different version of the Levensthein Edit Distance where substitution is not allowed?

$$T[i,j] = \min \begin{cases} T[i-1,j]+1 \\ T[i,j-1]+1 \\ [redacted] \end{cases}$$

(iii) Fill in the following table for finding the regular, unmodified "Levensthein Edit Distance" for two strings, M and N

M = A X B Y C N = A Z B C Y

	–	A	X	B	Y	C		
–	0	1	2	3	4	5		
A	1	0	1	2	3	4		
Z	2	1	1	2	3	4		
B	3	2	2	1	2	3		
C	4	3	3	2	2	2		
Y	5	4	4	3	2	3		

10. [8 pts] You know that problem B is NP-Complete and you want to use that to prove that problem A is NP-Complete. What two things must you show about problem A?

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11. [12 pts] You have 4 dice. Each one is different. Die #1 has sides { -1, 0, 1 }. Die #2 has sides { -1, -1, 0, 0 } Die #3 has sides {1, 1, 1, 1} and Die #4 has sides {0,0,0, 1,1,1}

(i) Fill in the table below

(ii) How many ways can you roll a 0 with these 4 dice?

72

(iii) What is the probability of rolling a 0 with these 4 dice?

72/288 = 1/4

(iv) How many ways can you roll a 2 with these 4 dice?

72

(v) What is the probability of rolling a 2 with these 4 dice?

1/4

	D1	+D2	+D3	+D4
-2	0	2	0	0
-1	1	4	8	24
0	1	4	16	72
1	1	2	16	96
2	0	0	8	72
3	0	0	0	24
4	0	0	0	0

12. [9 pts] You have received a message that was compressed with LZW. Remember that A=65, B=66, C=67, D=68 and E=69. The dictionary starts with entry 256. The message you received was

67 65 67 68 257 256 69 258 260

(i) What was the original message and what is your dictionary after decompression?

Start W	Read k	entry	output	Dictionary	next W
Nil	67	C	C		C
C	65	A	A	256 - CA	A
A	67	C	C	257 - AC	C
C	68	D	D	258 - CD	D
D	257	AC	AC	259 - DA	AC
AC	256	CA	CA	260 - ACC	CA
CA	69	E	E	261 - CAE	E
E	258	CD	CD	262 - EC	CD
CD	260	ACC	ACC	263 - CDA	ACC

Original Message: C A C D AC CA E CD ACC

(ii) Assuming 8 bits per character, how many bits were in the uncompressed message?

112

(iii) Assuming the last entry of your dictionary was 2047, how many bits were in the compressed message

99

Scratch Paper