Name: _____

1. (1 pt.)
   - **Read all material carefully.**
   - This test is **closed book, closed notes**.
   - However, you may refer to **one** standard Letter-sized sheet of paper (both sides) that has **notes hand-written by you**. If used, this sheet of notes must **include your name** near the top and must be **submitted** along with the test.
   - Computing or communication devices of any kind (laptop computers, tablets, phones, calculators, etc.) are not permitted.
   - Network access of any kind (cell, voice, text, data, etc.) is not permitted.
   - Write, and draw, carefully. Ambiguous or cryptic answers receive zero credit.
   - Use class and textbook conventions for notation, algorithmic options, etc.

Print your name clearly in the space provided above.
Do not write anything else on this page.

WAIT UNTIL INSTRUCTED TO CONTINUE TO REMAINING QUESTIONS.

(Do not view any other pages.)

Do not write on this page.
(It is for use in grading only.)

Q	Full	Score
1	1	
2	9	
3	5	
4	10	
5	5	
6	10	
total	40	

2. (9 pts.) Trace the action of the *furthest-in-future* cache-replacement strategy on the following sequence of block requests, for a cache size of 4 blocks. Break ties by evicting the lower-numbered block.

   Depict the state of the cache after each request using lines of the form

   ```
   request :  resulting-cache-contents :  hit/miss
   ```

   where `hit/miss` indicates whether the access is a cache hit or miss.

   State the **number of cache misses**.

   ```
   1 2 3 4 5 6 7 8 9 3 6 1 2 7 1 9 8
   ```

3. (5 pts.) Recall the textbook and classroom discussion of encoding schemes that map characters to binary strings. Prove or disprove: If an encoding scheme is prefix-free then the lengths of the codes (binary strings) of all characters are equal.

4. (10 pts.) Following textbook and classroom conventions, trace the execution of the textbook's HUFFMAN algorithm on the following set of characters and associated frequencies. Ensure that the final tree is fully labeled following the conventions used by the figures in the textbook example. Depict at least some intermediate trees to better qualify for partial credit.

character:	a	b	c	d	e	f	g	h	i	j
frequency:	20	10	4	2	25	3	3	5	10	1

[additional space for earlier material]

5. (5 pts.) Recall the textbook's RECURSIVE-ACTIVITY-SELECTOR algorithm, reproduced here for convenience:

```
RECURSIVE-ACTIVITY-SELECTOR(s, f, k, n)
1  m = k + 1
2  while m ≤ n and s[m] < f[k]
3        m = m + 1
4  if m ≤ n
5        return {a_m} ∪ RECURSIVE-ACTIVITY-SELECTOR(s, f, m, n)
6  else return ∅
```

Provide a tail-recursive version of this algorithm, changing it as little as possible while making it tail-recursive. Explain briefly why your answer is correct.

6. (10 pts.) List the *sequence of recursive calls* made by the *unmodified* algorithm (non-tail-recursive) of Question 5 on the following input. Clearly indicate which call invokes which other call. Also clearly indicate the *actual arguments of each call*. You may abbreviate provided the result is completely unambiguous and clear. State the *final result* (returned by the top-level call).

i:	1	2	3	4	5	6	7	8	9	10
s_i:	1	1	2	4	4	2	3	11	18	16
f_i:	3	5	5	5	7	19	15	18	20	20