Quiz 3 (Sep 24, 2025)

Name: ANSWERS NetID (e.g., ap191):

Please write your answers clearly and keep them brief.

Problem	Score
Question 1	/ 8
Question 2	/ 2
Total	/ 10

1. The program below contains concurrency bugs (including violations of the class's concurrency coding standard). Identify and fix them by modifying the listing as appropriate. Note, the function `main` and `t` has no bugs. [8 points]

```
1  struct Node {
2          int id, iter;
3          mutex_t m;
4          cond_var c;
5  };
6
7  void node_signal(Node *node, Node *succ) {
8
9          mutex_lock(&node->m);
10         mutex_lock(&succ->m);
11         succ->iter++;
12
13         cond_signal(&succ->c, &node->m&succ->m);
14
15         mutex_unlock(&node->m);
16         mutex_unlock(&succ->m);
17
18 }
19
20 void node_wait(Node *node, int until) {
21
22         mutex_lock(&node->m);
23
24         ifwhile (node->iter < until) {
25
26                 cond_wait(&node->c, &node->m);
27
28         }
29
30         mutex_unlock(&node->m);
31
32 }
33
34 void node_display(Node *node) {
35         mutex_lock(&node->m);
36         printf("Node %d Iteration %d\n", node->id, node->iter);
37         mutex_unlock(&node->m);
38 }
39
40 struct ThreadArg {
41         Node *node, *succ;
42 };
43
44 void t(void *a) {
45
46         ThreadArg *arg = (ThreadArg*)a;
47
48         int current = 1;
49
50         while (1) {
51
52                 node_wait(a->node, current);
53
54                 node_display(a->node);
55
```

```
56                  node_signal(a->node, a->succ);
57
58                  current++;
59
60          }
61
62  }
63
64  /* There are no bugs in this function. */
65  int main(int argc, char* argv[]) {
66          tid_t tids[3];
67          Node nodes[3];
68          ThreadArg args[3];
69          for (int i = 0; i < 3; i++) {
70                  memset(&nodes[i], 0, sizeof(Node));
71                  mutex_init(&nodes[i].m);
72                  cond_var_init(&nodes[i].c);
73                  nodes[i].id = i;
74                  nodes[i].iter = 0;
75          }
76
77          for (int i = 0; i < 3; i++) {
78                  args[i].node = &nodes[i];
79                  args[i].succ = &nodes[(i+1)%3];
80                  tids[i] = thread_create(t, (void*)&args[i]);
81          }
82
83          node_signal(&nodes[0], &nodes[0]);
84
85          for (int i = 0; i < 3; i++) {
86                  thread_join(tids[i]);
87          }
88  }
```

2. What are the first five lines printed when the program above is run? If the precise sequence of lines is non-deterministic, i.e., it might change from one execution to another, state that this is the case as a part of your answer.[2 points]

```
Node 0 iteration 1
Node 1 iteration 1
Node 2 iteration 1
Node 0 iteration 2
Node 1 iteration 2
```