United International University
Spring 2025, Operating System Concepts
Class Test - 4 (Set A), Time: 30 minutes, Marks: 20

1. Look at the code snippet below and answer the questions.

```
1.  #include <bits/stdc++.h>
2.  using namespace std;
3.  #define NUM_OF_STUDENTS 4
4.  #define THINK 3
5.
6.  bool printers[2] = {1, 1};  // Two printers
7.  bool scanners[2] = {1, 1};  // Two scanners
8.
9.  void acquire(bool *device) {
10.    while (*device == false);
11.    *device = false;
12. }
13.
14. void release(bool *device) {
15.    *device = true;
16. }
17.
18. void student_labwork(int id) {
19.    if (id % 2 == 0) {
20.       acquire(&printers[id % 2]);
21.       sleep(THINK);
22.       acquire(&scanners[id % 2]);
23.
24.       release(&printers[id % 2]);
25.       release(&scanners[id % 2]);
26.
27.       printf("Student %d finished printing and scanning.\n", id);
28.    } else {
29.       acquire(&scanners[id % 2]);
30.       sleep(THINK);
31.       acquire(&printers[id % 2]);
32.
33.       release(&scanners[id % 2]);
34.       release(&printers[id % 2]);
35.
36.       printf("Student %d finished scanning and printing.\n", id);
37.    }
38. }
39.
40. int main() {
41.    thread students[NUM_OF_STUDENTS];
42.    for (int i = 0; i < NUM_OF_STUDENTS; i++) {
43.       students[i] = thread(student_labwork, i);
44.    }
45.    for (int i = 0; i < NUM_OF_STUDENTS; i++) {
46.       students[i].join();
47.    }
48.    return 0;
49. }
```

a) Draw the resource allocation graph for the above code. [4 marks]

b) Is there a deadlock? If so, identify the students' IDs responsible for the deadlock. Otherwise, determine the output. [2 marks]

c) What will happen if we replace the statement of lines 30 and 33? [4 marks]

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2. Consider the Table-1 snapshot of a system:

Process	Allocation				Max			
	A	B	C	D	A	B	C	D
T0	3	0	1	4	5	1	1	7
T1	2	2	1	0	3	2	1	1
T2	3	1	2	1	3	3	2	1
T3	0	5	1	0	4	6	1	2
T4	4	2	1	2	6	3	2	5

Table 1: Process along with resources

a) Determine whether the system is in a safe state or not if the available resources are {0,3,0,1}? If the state is safe, illustrate the order in which the threads may be completed. Otherwise,Calculate the minimum number of additional available resources required to ensure the execution of all threads. [5+2 marks]

b) "If a request from thread T3 arrives for (0,0,0,1), the request will be granted immediately."- Justify the statement. [Assume, available resources={1,0,0,2}] [3 marks]

OS CT-4 Solution
Spring 2025

United International University

Name (Optional)

ID No. Section

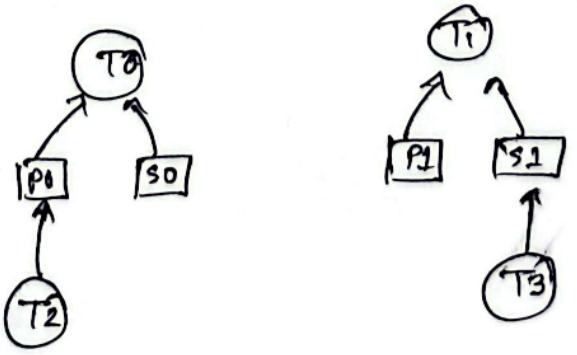
Invigilator's Signature with date

Course Code Trimester / Semester: Spring / Summer / Fall, 20..... Date: .....

Name of Exam: Class Test / Mid-term / Mid-term (Makeup/Improvement) / Final / Final (Makeup/Improvement)

1(a)

Threads	Hold	wait
0	P0, S0	
1	S1, P1	P0
2		S1
3		



1(b)

There is no deadlock.

Output:

Student 0 finished printing and scanning
Student 1 finished scanning and printing.
Student 2 finished printing and scanning
Student 3 finished scanning and printing

1(c)

If we replace the lines 30 and 33, then the threads T1 and T3 will not hold the resources while going to sleeping state. Thus Hold & wait characteristics of deadlock is prevented.

2(a)

Process	Allocation				Max				Need				Safe State
	A	B	C	D	A	B	C	D	A	B	C	D	T2
T0	3	0	1	4	5	1	1	7	2	1	0	3	T1
T1	2	2	1	0	3	2	1	1	1	0	0	1	T3
T2	3	1	2	1	3	3	2	1	0	2	0	0	
T3	0	5	1	0	4	6	1	2	4	1	0	2	
T4	4	2	1	2	6	3	2	5	2	1	1	3	

Available			
A	B	C	D
0	3	0	1
3	4	2	2
5	6	3	2
5	11	4	2

∴ T0 and T4 are not in safe state.

Minimum number of additional available resources required = {0, 0, 0, 1}

2(b)

Available ≥ Request