Name: ....
Student Number ....

COMPSCI 3SH3 - Online Version

DAY CLASS — Dr. Bojan Nokovic
DURATION OF EXAMINATION: 50 min
McMaster University Midterm Examination — March 24, 2021

1. **TF** (0.5 marks each)

   I) A binary semaphore is is semantically equivalent to a lock.
   Answer: True

   II) Threads may be terminated only by deferred cancellation.
   Answer: False

   III) Transposing a matrix in parallel can be solved by data parallelism.
   Answer: True

   IV) When a thread is performing an I/O operation, such as read() the thread is busy waiting until the operation completes.
   Answer: False

   V) It is possible to have a deadlock involving only one single-threaded process.
   Answer: False

   VI) A system of four resources of the same type that are shared by three threads, each of which needs at most two resources, is in a deadlock state.
   Answer: True

2. **Q 7** (2 Marks)
   For actual length of CPU bursts t0 = 6, t1 = 4 predict length of next burst T2 by exponential averaging formula if α=1/2 and
   a) T0 = 10
   b) T0 = 4
   Answer:
   Tn+1 = α*tn + (1-α)*Tn
   a)
   T1= α*t0 + (1-α)*T0 = 0.5*6 + 0.5*10=3+5=8
   T2= α*t1 + (1-α)*T1 = 0.5*4 + 0.5*8=2+4=6
   b)
   T1= α*t0 + (1-α)*T0 = 0.5*6 + 0.5*4=3+2=5
   T2= α*t1 + (1-α)*T1 = 0.5*4 + 0.5*5=2+2.5=4.5

3. **Q 8** (6 Marks)
   Three processes synchronize by semaphores S0 and S1.

```
semaphore S0=3, S1=0; /* initialization */
```

/* Process 1 */	/* Process 2 */	/* Process 3 */

L1:
    P(S0);
    putc('Z');
    V(S1);
 	
    goto L1;
	L2:
	    P(S1);
	    putc('X');
	    putc('Y');
	    V(S1);
	    goto L2;
		L3:
		    P(S1);
		
		    putc('W');
		
		    goto L3;

Figure 1: Three processes

(a) (2 marks) How many W's are printed when this set of processes runs?
Answer: 3

(b) (2 marks) What is the smallest number of X's that might be printed when this set of processes runs?
Answer: 0

(c) (1 mark) Is ZXYXZWYXYZWW a possible output sequence when this set of processes runs?
Answer: Yes
We have
Process1 "Z"
S0 =2 S1=1
Process2 "XY"
S0 =2 S1=1
Process2 "X" (interrupted)
S0 =2 S1=0
Process 1 "Z"
S0 =1 S1=1
Process 3 "W"
S0 =1 S1=0
Process2 "Y" (continue)
S0 =1 S1=1
Process2 "XY"
S0 =1 S1=1
Process1 "Z"
S0 =0 S1=2
Process 3 "W"
S0 =0 S1=1
Process 3 "W"
S0 =0 S1=0

Critical sections are not implemented by disabling interrupts and do not prevent preemption. If a user-mode thread could block interrupts and/or preemption, it would be trivial for a user-mode process to crash the entire system.

(d) (1 mark) Is ZXYXYWWZXYZXYW a possible output sequence when this set of pro-

cesses runs?
Answer: NO,
"WW" is not possible

4. **CPU Scheduling Q9** (6 Marks) Consider the following set of processes to be scheduled for execution on a single CPU system.

	Arrival Time	*Size*	*Priority*
J_1	0	10	2
J_2	2	8	1
J_3	3	3	3
J_4	10	4	2
J_5	12	1	3
J_6	15	4	1

a) (2 marks) Draw a Gantt chart showing FCFS scheduling.
Answer: x0=10, x1=18, x2=21, x3=25, x4=26
Average waiting time= (0+(10-2)+(18-3)+(21-10)+(25-12)+(26-15)/6 = (8+15+11+13+11)/6 = 58/6 = 9.66 time units

b) (2 marks) Draw a Gantt chart showing (non-preemptive) SJF scheduling.
Answer: y0=10, y1=13, y2=14, y3=18, y4=22
Average waiting time= (0+(10-3)+(13-12)+(14-10)+(18-15)+(22-2)= 7 + 1 + 4 + 3 + 12 = 15+20=35/6 = 5.83 time units

c) (1 marks) Draw a Gantt chart showing non-preemptive PRIORITY scheduling.
Answer: z0=10, z1=18, z2=22, z3=26, z4=29
Average waiting time= (0+(10-2)+(18-15)+(22-10)+(26-3)+(29-12)= 8+3+12+23+17=63/6 = 10.5

d) (1 marks) Draw a Gantt chart showing preemptive PRIORITY scheduling.
Answer: w0=2, w1=10, w2=15, w3=19, w4=22, w5=26, w6=29
Average waiting time= (0+(10-2)+(19-15)+(22-10)+(26-3)+(29-12)= 8+4+12+23+17=64/6 = 10.66 time units

(a) Draw a Gantt chart showing FCFS scheduling for these jobs.

J_1	J_2	J_3	J_4	J_5	J_6

0 10 18 21 25 26 30

(b) Draw a Gantt chart showing (non-preemptive) SJF scheduling.

J_1	J_3	J_5	J_4	J_6	J_2

0 10 13 14 18 22 30

(c) Draw a Gantt chart showing non-preemptive PRIORITY scheduling.

J_1	J_2	J_6	J_4	J_3	J_5

0 10 18 22 26 29 30

(d) Draw a Gantt chart showing preemptive PRIORITY scheduling.

J_1	J_2	J_1	J_6	J_1	J_4	J_3	J_5

0 2 10 15 19 22 26 29 30

(e) Which of the foregoing scheduling policies provides the lowest waiting time for this set of jobs? What is the waiting time with this policy?

```
SJF.
J1:  0    J2:  20    J3:  7    J4:  4    J5:  1    J6:  3
Average is 35/6 time units.
```

Figure 2: CPU Scheduling Solution

5. **Deadlocks Q10** (3 Marks)

Consider the following snapshot of a system:

	Allocation	Max
	A B C D	*A B C D*
T_0	3 0 1 4	5 1 1 7
T_1	2 2 1 0	3 2 1 1
T_2	3 1 2 1	3 3 2 1
T_3	0 5 1 0	4 6 1 2
T_4	4 2 1 2	6 3 2 5

Figure 3: Safe or Not

Using the banker's algorithm, determine whether or not each of the following states is unsafe. If the state is safe, illustrate the order in which the threads may complete. Otherwise, illustrate why the state is unsafe.

a) (2 marks)

Available = (1,0,0,2)

Solution:
Safe. Threads T1, T2,and T3 are able to finish. Following this, T0 and T4 are also able to finish.

b) (1 mark) Available = (0,3,0,1)

Solution:
Not safe. Threads T2, T1,and T3 are able to finish, but no remain-ing processes can finish.

The End