

Name:
Student Number

COMPSCI 3SH3 - Online Version

DAY CLASS
DURATION OF EXAMINATION: 50 min
McMaster University Midterm Examination

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

I) A binary semaphore 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 $t_0 = 6$, $t_1 = 4$ predict length of next burst T_2 by exponential averaging formula if $\alpha = 1/2$ and

a) $T_0 = 10$

b) $T_0 = 4$

Answer:

$$T_{n+1} = \alpha * t_n + (1-\alpha) * T_n$$

a)

$$T_1 = \alpha * t_0 + (1-\alpha) * T_0 = 0.5 * 6 + 0.5 * 10 = 3 + 5 = 8$$

$$T_2 = \alpha * t_1 + (1-\alpha) * T_1 = 0.5 * 4 + 0.5 * 8 = 2 + 4 = 6$$

b)

$$T_1 = \alpha * t_0 + (1-\alpha) * T_0 = 0.5 * 6 + 0.5 * 4 = 3 + 2 = 5$$

$$T_2 = \alpha * t_1 + (1-\alpha) * T_1 = 0.5 * 4 + 0.5 * 5 = 2 + 2.5 = 4.5$$

3. **Q 8** (6 Marks)

Three processes synchronize by semaphores S_0 and S_1 .

```
semaphore S0=3, S1=0; /* initialization */
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<pre>/* Process 1 */ L1: P(S0); putc('Z'); V(S1); goto L1;</pre>	<pre>/* Process 2 */ L2: P(S1); putc('X'); putc('Y'); V(S1); goto L2;</pre>	<pre>/* Process 3 */ L3: P(S1); putc('W'); goto L3;</pre>
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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.

	<u>Arrival Time</u>	<u>Size</u>	<u>Priority</u>
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: $x_0=10, x_1=18, x_2=21, x_3=25, x_4=26$

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: $y_0=10, y_1=13, y_2=14, y_3=18, y_4=22$

Average waiting time = $(0+(10-3)+(13-12)+(14-10)+(18-15)+(22-2)) = 7 + 1 + 4 + 3 + 12 = 27/6 = 4.5$ time units

- c) (1 marks) Draw a Gantt chart showing non-preemptive PRIORITY scheduling.

Answer: $z_0=10, z_1=18, z_2=22, z_3=26, z_4=29$

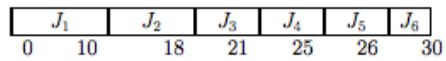
Average waiting time = $(0+(10-2)+(18-15)+(22-10)+(26-3)+(29-12)) = 8+3+12+23+17=63/6 = 10.5$

- d) (1 marks) Draw a Gantt chart showing preemptive PRIORITY scheduling.

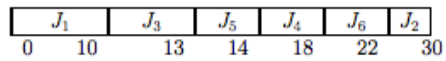
Answer: $w_0=2, w_1=10, w_2=15, w_3=19, w_4=22, w_5=26, w_6=29$

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

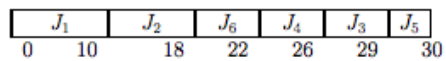
- (a) Draw a Gantt chart showing FCFS scheduling for these jobs.



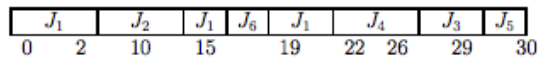
- (b) Draw a Gantt chart showing (non-preemptive) SJF scheduling.



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



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



- (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:

	<u>Allocation</u>	<u>Max</u>
	<i>A B C D</i>	<i>A B C D</i>
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 T_1 , T_2 , and T_3 are able to finish. Following this, T_0 and T_4 are also able to finish.

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

Solution:

Not safe. Threads T_2 , T_1 , and T_3 are able to finish, but no remaining processes can finish.

The End