There are 120 possible points. Work all problems. Be **specific** and **concise** in all answers. You have 60 minutes. Your answers are either right or wrong... be careful in your computations! Use only the space provided for your answers. Please turn in your answers promptly when asked. State any assumptions you might make in answering a question.

(1) 46 Points

Assume: Job Scheduling Discipline: FIFO within Highest priority
Process Scheduling Discipline: Processor Sharing within Highest priority
System Resources: 100K Memory, 5 Tape Drives (exclusive access)

Consider: Job Arrival Time Priority Runtime Memory Tape Drives

<table>
<thead>
<tr>
<th>Job</th>
<th>Arrival Time</th>
<th>Priority</th>
<th>Runtime</th>
<th>Memory</th>
<th>Tape Drives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.0</td>
<td>High</td>
<td>1.5</td>
<td>50K</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>3.0</td>
<td>Low</td>
<td>2.0</td>
<td>30K</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>3.0</td>
<td>High</td>
<td>1.0</td>
<td>10K</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>4.0</td>
<td>High</td>
<td>1.0</td>
<td>40K</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>4.0</td>
<td>Low</td>
<td>1.0</td>
<td>50K</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>5.5</td>
<td>High</td>
<td>0.5</td>
<td>10K</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>6.0</td>
<td>High</td>
<td>1.0</td>
<td>10K</td>
<td>0</td>
</tr>
</tbody>
</table>

For each process compute the start time, the finish time, the turnaround time, and the wait time.

<table>
<thead>
<tr>
<th>Job</th>
<th>Start time</th>
<th>Finish time</th>
<th>Turnaround Time</th>
<th>Wait Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For the complete set of jobs compute the average turnaround time and the average wait time.
Suppose we are given independent processes A and B. Process A reads from the shared variable X, Process B writes to that variable. We want to ensure that every value written by B is read by A. Assuming that the following code is syntactically correct and executes, does it meet the requirement? Justify your answer.

```
shared semaphore: sem <- 0;
char X;

Proc A:
For (i=1; i<5; i++) {
    P(sem);
    read(X);
}

Proc B:
For (i=1; i<5; i++) {
    write(X);
    V(sem);
}
```
(4) 10 points

Threads instantiated using the Conway fork() share the same runtime stack. Confirm or refute this statement. Justify your answer.

(5) 20 points

Consider the following code segment:

```c
Program X;
{
    Int a;
    a = 3;
    Fork();
    a++;
    If (a == 4)
        Print ("Yes");
    Else
        Print ("No");
}
```

(a) Assuming the semantics associated with the UNIX fork(), is each executing process/thread deterministic? Justify your answer – be specific.

(b) Assuming the semantics associated with the Conway fork(), is each executing process/thread deterministic? Justify your answer – be specific.
Suppose we are tuning a time-sharing system and are asked to determine the time quantum to use. In selecting the time quantum we want to meet two objectives:

1. provide an acceptable response time to the user, and
2. minimize the time spent context switching between processes, or alternatively, maximize the CPU utilization by the processes.

Let $RT$ be the maximum (longest) response time acceptable to the user,
$NU$ be the maximum number of users that can be on the system at any given time,
$TQ$ be the time quantum given to each process, and
$CTX$ be the cost of context switch.

Assuming that a user can only have one process associated with it at any given time

For the worst case, i.e. when the number of users is at its maximum, define $TQ$ in terms of $RT$, $NU$ and $CTX$ such that it meets the two above stated objectives.

Hint: Write an equation that “makes sense” and then solve for $TQ$. 