[1.] The following table gives the arrival times, execution times, and deadlines for some processes in a real-time system. Answer the following questions. \[15 \text{ pts} + 15 \text{ pts} = 30 \text{ pts}\].

<table>
<thead>
<tr>
<th>Process</th>
<th>Arrival</th>
<th>Execution</th>
<th>Deadline</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>0</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>P2</td>
<td>5</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>P3</td>
<td>10</td>
<td>5</td>
<td>30</td>
</tr>
<tr>
<td>P4</td>
<td>15</td>
<td>5</td>
<td>25</td>
</tr>
</tbody>
</table>

- Identify when each process is going to end if a Round-Robin scheduling without preemption is used with a time quantum of two. You are encouraged to draw the time line to illustrate your answer.

- Does the RR scheduling above meet the deadline of the processes? If not, assign the processes priorities which will result in all deadlines being met, assuming a strict priority-based preemptive scheduling algorithm. Identify when each process is going to end.

[2.] Assume you have a computer system with four page frames, using an LRU page replacement strategy. Initially, the page frames are all empty. Simulate this page replacement strategy on the following page reference string: 6 7 3 7 2 6 5 9 2 4. \[10 \text{ pts}\]

[3.] The string 1010110101010 includes a message and CRC bits, computed using a generating polynomial of \(1 + X^2 + X^3\). Does the message contain any errors? Show the steps you followed to come to your conclusion. The message is given with its highest-order bit on the left. \[15 \text{ pts}\]

[4.] Answer the following general questions:

- Here is a question that appeared recently on Usenet, in the context of Unix-like operating systems:

  Subject: Knowing execed
  Newsgroups: comp.os.linux.development.apps
  Date: Sun, 19 Jul 2009 22:37:10 +0000 (UTC)

  How can I determine that my application has been execed from another program? (Specifically execv() if it makes any difference.)
How would you respond to his question? [5 pts]

- In a uniprocessor system, comment on the efficiency of using a spin lock to achieve mutual exclusion between two processes. Can you improve the efficiency? Explain. [10 pts]

- Why is the page table size chosen to be a power of 2? Can you the size be a power of 3? [10 pts]

- Explain what is thrashing in the context of memory. Propose a technique to reduce thrashing. [5 pts]

[5.] Some computer system uses a virtual memory scheme with the following characteristics:
Type: Hierarchical Forward Mapped
Virtual Memory Address Width: 45 bits
Page Size: 16K
Page Table Entry Size: 8 Bytes
Bits of Physical Frame Number in Page Table Entry: 40

- How large is the virtual memory? [5 pts]

- How wide is a physical address? [10 pts]