Instructions:

- Put your Legi-Card on the Table.
- Write your Name and your Legi-Number on top of this page.
- Accurately read each question before solving it.
- There is at least one correct solution.
- You will get points only for correct and complete answers.
- Supporting Materials: Printouts, handwritten notes, and calculators are allowed. Devices that can be used for communication (laptops, phones, tablets, mp3 players, etc.) are NOT allowed.
- After test duration, leave your filled test and Legi-Card on the table in front of you. Do Not collect/aggregate tests in your row.
- Test duration: 10 minutes. Good luck!

Task 1: Low power

Consider a processor that has two states, an Active state with a power dissipation of 100 mW and an Idle state with a power dissipation of 20 mW. Switching between the states happens instantaneously but consumes an additional energy of $10^{-4}$ J for each switching action (both ways).

(a) (2 Points) What is the breakeven time for switching to the Idle state:

- □ 1.5 ms
- □ 2 ms
- ☒ 2.5 ms
- □ 10 ms

(b) (2 Points) For the same processor, consider a third Sleep state in which the power dissipation is 0 W. The break-even time for the Idle state is less than that of the Sleep state. If there is a time-interval of inactivity that is exactly equal to the break-even time of the Sleep state, which of the following statements are true?

- ☒ Switching to the Idle state saves more energy compared to switching to Sleep state.
- □ Switching to the Sleep state saves more energy compared to switching to Idle state.
- □ Switching to any of the states saves the same amount of non-zero energy.
- □ Switching to any of the states saves zero energy.
Task 2: Communication

In Figure 1 there is a piconet with three nodes communicating using Bluetooth. In the Bluetooth standard, the duration of a single time slot is 625 µs. After each transmission, a frequency hop occurs. Assume that nodes A and C use 1-slot DH1 packets, and node B uses 3-slot DH3 packets. Multislot packets have been introduced to improve channel efficiency, as the transmitter stays fixed on a hop frequency during the length of packet transmission and skips over the missed hops after the transmission is complete. The communication between the three nodes is periodic with a period of six slots. A diagram of communication is given in Figure 1.

Table 1: Packet details for DH1 and DH3

<table>
<thead>
<tr>
<th>Packet Type</th>
<th>MAC Header</th>
<th>Header</th>
<th>Payload</th>
<th>CRC</th>
</tr>
</thead>
<tbody>
<tr>
<td>DH1</td>
<td>126 bits</td>
<td>8 bits</td>
<td>216 bits</td>
<td>16 bits</td>
</tr>
<tr>
<td>DH3</td>
<td>126 bits</td>
<td>16 bits</td>
<td>1464 bits</td>
<td>16 bits</td>
</tr>
</tbody>
</table>

Figure 1: A piconet with three nodes, and the associated communication diagram

(a) (2 point) Which node is the Master node in this piconet?  ☒ A  ☐ B  ☐ C

(b) (2 points) Mark all true statements:

☐ Slots #0 and #1 certainly use the same frequency.
☐ Slots #0 and #2 certainly use the same frequency.
☒ Slots #1 and #7 certainly use the same frequency.
☐ Slots #3 and #4 certainly use the same frequency.

(c) (2 points) An application is using this network to communicate from node B to node A. What throughput does it observe?

☐ \[
\frac{216 \text{ bits}}{625 \mu s} \quad \frac{216 \text{ bits}}{625 \mu s \cdot 3} \quad \frac{216 \text{ bits}}{625 \mu s \cdot 4} \quad \frac{216 \text{ bits}}{625 \mu s \cdot 6}
\]

☐ \[
\frac{1464 \text{ bits}}{625 \mu s} \quad \frac{1464 \text{ bits}}{625 \mu s \cdot 3} \quad \frac{1464 \text{ bits}}{625 \mu s \cdot 4} \quad \frac{1464 \text{ bits}}{625 \mu s \cdot 6}
\]