PROBLEM 1. Consider the three probability distributions $R = \{0.25, 0.25, 0.25, 0.25\}$, $P = \{0.4, 0.35, 0.15, 0.1\}$ and $Q = \{0.25, 0.35, 0.15, 0.25\}$.

1. Compute the three entropies $H(R)$, $H(P)$ and $H(Q)$. Which one is larger?

2. Can you answer the above question without computing explicitly $H(R)$, $H(P)$ and $H(Q)$?

PROBLEM 2. Consider a random variable $s$ which takes an infinite number of values with corresponding probabilities $p_i = \frac{\alpha}{2^i + 1}$, $i \in \mathbb{N} = \{1, 2, 3, \ldots \}$.

1. For what value of $\alpha$ is this a probability distribution?

2. What is the entropy of $s$?

Hint: If $|r| < 1$, $\sum_{i=0}^{\infty} (a + id)r^i = \frac{a}{1-r} + \frac{rd}{(1-r)^2}$.

PROBLEM 3. For each of the following three codes, say if it is uniquely decodable. If so, is it instantaneous?

<table>
<thead>
<tr>
<th></th>
<th>Code 1</th>
<th>Code 2</th>
<th>Code 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>$s_1$</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$s_2$</td>
<td>1</td>
<td>10</td>
<td>01</td>
</tr>
<tr>
<td>$s_3$</td>
<td>00</td>
<td>110</td>
<td>011</td>
</tr>
<tr>
<td>$s_4$</td>
<td>11</td>
<td>111</td>
<td>111</td>
</tr>
</tbody>
</table>