Solutions # 6
EE 6391 - Prof. Terlak
Coding and Interleaving

6.1
a) \[ G = \begin{bmatrix}
1 & 0 & 0 & 0 & 1 & 1 & 1 & 1 & 0 \\
0 & 1 & 0 & 1 & 0 & 1 & 1 & 1 & 1 \\
0 & 0 & 1 & 0 & 1 & 1 & 0 & 1 & 1 \\
\end{bmatrix} \]

b) \[ H = \begin{bmatrix}
I_{n-k} \\
\begin{bmatrix}
1 & 0 & 0 & 0 & 1 & 0 & 1 \\
0 & 1 & 0 & 0 & 1 & 1 & 1 \\
0 & 0 & 1 & 0 & 1 & 1 & 0 \\
0 & 0 & 0 & 1 & 0 & 1 & 1 \\
\end{bmatrix}
\end{bmatrix} \]
\[ H^T G = 0 \]

c) \[ s = e H^T \]

<table>
<thead>
<tr>
<th>Syndrome</th>
<th>Error Pattern (e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0</td>
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<tr>
<td>1 1 0 1</td>
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<tr>
<td>0 1 1 1</td>
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<tr>
<td>1 1 1 0</td>
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<td>0 0 0 1</td>
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<td>1 0 0 0</td>
<td>1 0 0 0 0 0 0 0</td>
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</tbody>
</table>


d) The minimum distance can be found by applying
2 bits inputs of all combinations to generate corresponding
codewords

\[ d_{\text{min}} = 4 \]

e) \[ 1 \ 0 \ 1 \rightarrow [1 \ 0 \ 1 \ 0 \ 0 \ 1 \ 1] = c \]

\[ H \cdot c^T = 0 \]

6.2. \[ f_d = 80 \text{ Hz} \]

\[ y = 15 \text{ dB} \]

\[ T_c = \frac{0.423}{f_m} = \frac{0.423}{80} \approx 0.0053 \]

Interleaver matrix

\[ (d-1) T_b > T_c \]

\[ T_b = \frac{1}{30.15^2} = 0.33 \times 10^{-4} \]

Interleaver depth \[ n \times d = 8 \times 10 \text{ bits} \]

Delay \[ 8 \times 10 + T_b = 0.0267 \text{ sec} \]
BPSK In Rayleigh fading

\[ p = \frac{1}{2} \left[ 1 - \sqrt{\frac{5}{1+5}} \right] \approx 0.0077 \]

Major error leading

\[ P_e = p^5 + 5p^4(1-p) + 10p^3(1-p)^2 \]

\[ = 4.55 \times 10^{-6} \]

It will work fine for voice since delay is less than 80 msec (which is considered the limit).