Handin3 EITN45, Anthony Smith

# 1 Hand-in 3

## 1.1 a)

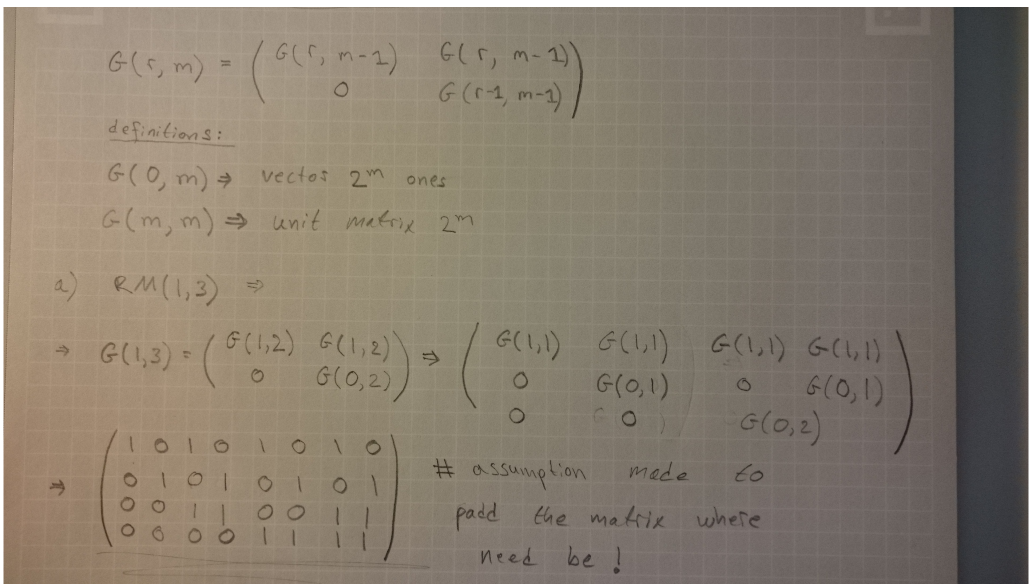
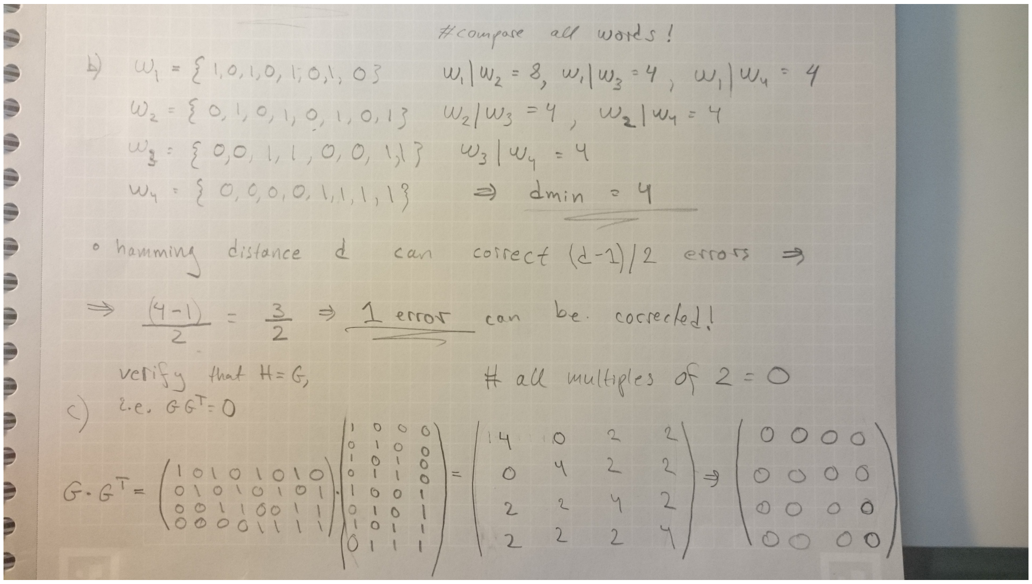



Figure 1: Generator matrix

## 1.2 b) c)


#compare all words!

b) $w_1 = \{1,0,1,0,1,0,1,0\}$  $w_1|w_2 = 8$, $w_1|w_3 = 4$, $w_1|w_4 = 4$

$w_2 = \{0,1,0,1,0,1,0,1\}$  $w_2|w_3 = 4$, $w_2|w_4 = 4$

$w_3 = \{0,0,1,1,0,0,1,1\}$  $w_3|w_4 = 4$

$w_4 = \{0,0,0,0,1,1,1,1\}$  $\Rightarrow$ dmin $= 4$

∘ hamming distance d can correct $(d-1)/2$ errors $\Rightarrow$

$\Rightarrow \frac{(4-1)}{2} = \frac{3}{2} \Rightarrow$ 1 error can be corrected!

c) verify that H=G, i.e. $GG^T = 0$   # all multiples of 2 = 0

$$G \cdot G^T = \begin{pmatrix} 1&0&1&0&1&0&1&0 \\ 0&1&0&1&0&1&0&1 \\ 0&0&1&1&0&0&1&1 \\ 0&0&0&0&1&1&1&1 \end{pmatrix} \cdot \begin{pmatrix} 1&0&0&0 \\ 0&1&0&0 \\ 1&0&1&0 \\ 0&1&1&0 \\ 1&0&0&1 \\ 0&1&0&1 \\ 1&0&1&1 \\ 0&1&1&1 \end{pmatrix} = \begin{pmatrix} 4&0&2&2 \\ 0&4&2&2 \\ 2&2&4&2 \\ 2&2&2&4 \end{pmatrix} \Rightarrow \begin{pmatrix} 0&0&0&0 \\ 0&0&0&0 \\ 0&0&0&0 \\ 0&0&0&0 \end{pmatrix}$$

Figure 2: Code words

Table 1: Code words for matrix G, generated by multiplying matrix G with information

| Information | Code word |
|---|---|
| 0000 | 0000 0000 |
| 0001 | 0000 1111 |
| 0010 | 0011 0011 |
| 0011 | 0011 1100 |
| 0100 | 0101 0101 |
| 0101 | 0101 1010 |
| 0110 | 0110 0110 |
| 0111 | 0110 1001 |
| 1000 | 1010 1010 |
| 1001 | 1010 0101 |
| 1010 | 1001 1001 |
| 1011 | 1001 0111 |
| 1100 | 1111 1111 |
| 1101 | 1111 0111 |
| 1110 | 1100 1100 |
| 1111 | 1100 0011 |

## 1.3 d)

See the attached file handin3.m for calculations of the syndrome table. The derived single-errors are:

| syndrome | error |
|---|---|
| 0111 | 0000 0001 |
| 1011 | 0000 0010 |
| 0101 | 0000 0100 |
| 1001 | 0000 1000 |
| 0110 | 0001 0000 |
| 1010 | 0010 0000 |
| 0100 | 0100 0000 |
| 1000 | 1000 0000 |

## 1.4 e)

Chosen information 1100 is encoded as 1111 1111. Introducing an error at bit number five, gives 1111 0111, which corresponds to 1101 according to table 1. Calculate $codeword * G^T$, where code word is 1111 0111, results in 1001. According to table 2, 1001 corresponds with 0000 1000, showing that is in fact bit number five causing the error. By calculating 1111 0111 XOR 0000 1000 the original message can be recovered.

## 1.5 f)

The result from the attached file handin3.m, states that zero rows are remaining after finding all single-error and 2-error patterns. Thus indicating all double errors are detected. The code words consist of eight bits, and the syndrome table consists eight patterns, all single-errors can be corrected.

The syndromes will differ for zero-errors/single-errors and double-errors.