

Student: Ty Davis

Course: ECE 5420

Subject: Programming Assignment 5 - Channel Coding

Date: December 7, 2025

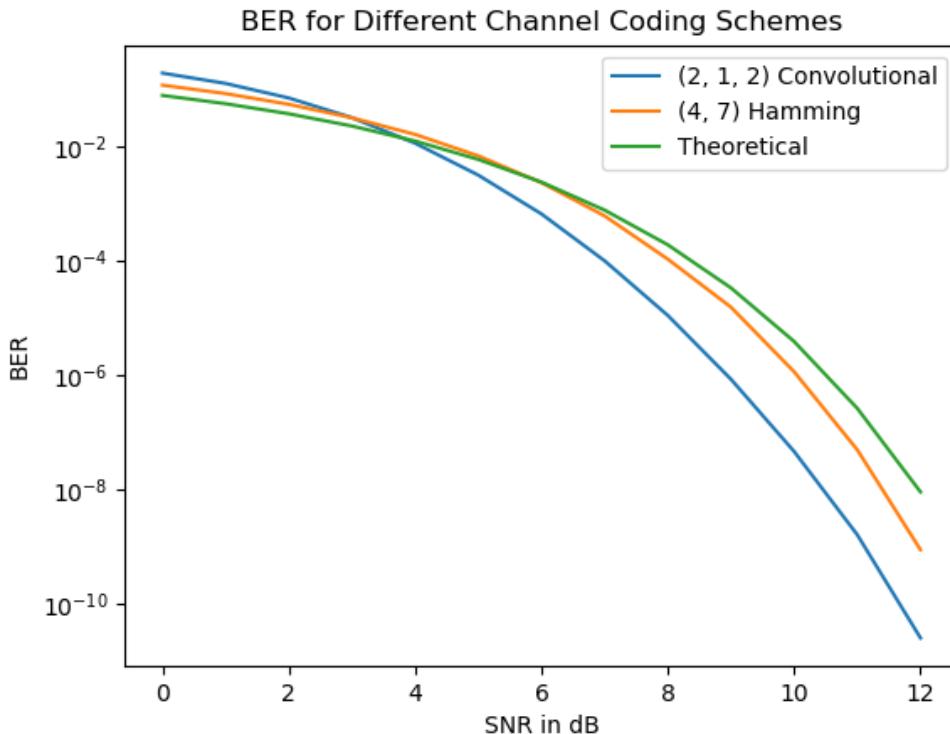


WEBER STATE UNIVERSITY
Engineering, Applied Science & Technology

DEPARTMENT OF
ELECTRICAL & COMPUTER
ENGINEERING

Simulations were run for BPSK with and without channel coding. The channel coding was done with a (7, 4) hamming code and with and (2, 1, 2) convolutional filter. For the convolutional filter, I chose to zero-pad and use 128 bits in each pass of the filter, and as such I decided to use $R = 1/2$ for my coded-bit energy calculations.

E_b	1	1	1	1
E_c for (7, 4) Hamming Code	1	1	1	1
E_c for Convolutional Code	1	1	1	1
N_0	0.251	0.158	0.1	0.0631
N_0 for (7, 4) Hamming Code	0.251	0.158	0.1	0.0631
N_0 for Convolutional Code	0.251	0.158	0.1	0.0631
$\frac{E_b}{N_0}$ in dB	6	8	10	12
P_b in Q function	2.82	3.55	4.47	5.63
P_b theoretical value	0.00239	0.000191	3.87e-06	9.01e-09
P_b Simulated without Encoding	0.00239	0.000193	3.9e-06	1.5e-08
P_b Simulated with (7, 4) Hamming Code	0.00233	0.000107	1.14e-06	8.75e-10
P_b Simulated with Convolutional Code	0.000663	1.11e-05	4.6e-08	2.5e-11



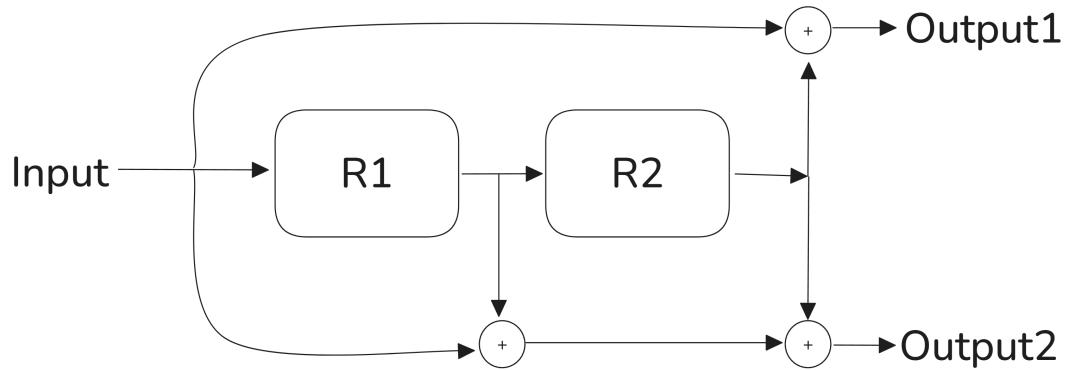


Figure 1: The $(2, 1, 2)$ block diagram used in the convolutional encoder/decoder

Output from the Python script:

SNR_dB	conv_sim	hamming_sim	uncoded_theory
0	1.93390e-01	1.18919e-01	7.86496e-02
1	1.27401e-01	8.46048e-02	5.62820e-02
2	7.09712e-02	5.49236e-02	3.75061e-02
3	3.20615e-02	3.18923e-02	2.28784e-02
4	1.14453e-02	1.63133e-02	1.25008e-02
5	3.16460e-03	6.87367e-03	5.95387e-03
6	6.62710e-04	2.33411e-03	2.38829e-03
7	1.00120e-04	6.11660e-04	7.72675e-04
8	1.10700e-05	1.07110e-04	1.90908e-04
9	8.46000e-07	1.54340e-05	3.36272e-05
10	4.60000e-08	1.14400e-06	3.87211e-06
11	1.60000e-09	4.91000e-08	2.61307e-07
12	2.50000e-11	8.75000e-10	9.00601e-09