# S-72.3410 Coding Methods

1. (6p.) Let **C** be a 4-ary cyclic code of length 15 generated by the polynomial $g(x) = x^6 + x^4 + x^2 + \beta x + \beta^2$, where $\beta = \beta^2 + 1$ is a primitive element in GF(4).

   (a) (3p.) Compute the parity polynomial $h(x)$ for **C** and show that $g(x)$ is a valid generator polynomial.

   (b) (2p.) Determine the dimension of **C** and compute the number of codewords in **C**.

   (c) (1p.) What is the generator polynomial of the dual code $\mathbf{C}^\perp$?

2. (a) (2p.) What is an interleaver?

   (b) (4p.) Describe the principles of turbo coding.

3. (6p.) Consider the convolutional encoder shown below. What is the rate of this code? Find the impulse responses and the transfer function matrix for the encoder. Use the transfer function matrix to determine the codeword associated with the input sequence $\mathbf{x} = (1011)$. Is the code catastrophic?
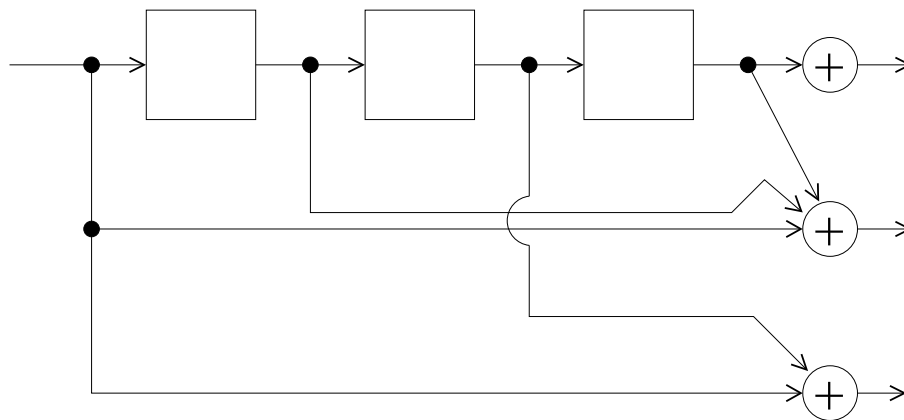


4. (a) (2p.) Describe briefly the two types of type-I hybrid ARQ protocols.

   (b) (2p.) What are the two distinct types of packet combining systems, and how do they differ from each other?

   (c) (2p.) Describe briefly the type-II hybrid ARQ protocols.