

Tutorial 3: Carrier and Symbol Synchronization

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ELEC 4190 - Digital Communications

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Note: You should try the problems before and during the tutorial session. Your solutions will not be collected or graded.

1. Consider a three-stage self-synchronizing scrambler where the input S and output T are related as follows:

$$T(k) = S(k) \oplus T(k-1) \oplus T(k-3)$$

- (a) Design the corresponding descrambler.
(b) If the sequence $S = 1111100000$ is applied to the input of the scrambler, find the output sequence T . Assume the initial state is 011.
(c) Verify that if this T is applied to the input of the descrambler, the output is sequence S .
2. Suppose that the loop filter for a PLL in Slide 12 has the transfer function

$$G(s) = \frac{1}{s + \sqrt{2}}$$

- (a) Determine the closed-loop transfer function $H(s)$ and indicate if the loop is stable when $K = 2$.
(b) Determine the damping factor and natural frequency of the loop.
3. Consider the PLL in Slide 12 for estimating the carrier phase of a signal in which the loop filter has the transfer function

$$G(s) = \frac{K_1}{1 + \tau_1 s}$$

- (a) Determine the closed-loop transfer function $H(s)$ and its gain at $f = 0$ when $K = 2$.
- (b) For what range of values of K_1 and τ_1 is the loop stable and the damping factor is less than 1?
4. The loop filter in a PLL is implemented by the circuit shown below. Determine the system function $G(s)$ and express the time constants τ_1 and τ_2 such that $G(s) = \frac{1+\tau_2 s}{1+\tau_1 s}$.

