

**Problem 7.20**

Extraction of the bit-timing may proceed as follows:

(i) Given the MSK signal  $s(t)$ , a band-pass analyzer is used to extract the in-phase component  $s_I(t)$  and quadrature component  $s_Q(t)$ .

(ii) From the first line of Eq. (7.31), and Eqs. (7.33) and (7.34), we have

$$r(t) = \frac{s_Q(t)}{s_I(t)} = -\tan\left(\frac{\pi t}{2T_b}\right) = -\tan(\theta(t))$$

which depends on the bit duration  $T_b$  alone.

(iii) From Eq. (7.32), we recall that whenever two successive binary symbols in the original data stream are the same, then  $\theta(t)$  is negative and therefore the ratio  $r(t)$  is positive. On the other hand, from Eq. (7.33), we recall that whenever two successive binary symbols are different, then  $\theta(t)$  is positive and therefore the ratio  $r(t)$  is negative.

Hence, by observing the zero-crossings of the waveform obtained from  $r(t) = [s_Q(t)/s_I(t)]$ , it should be possible to extract the timing waveform.