

## 2018 EBU5302 Week Three Problems

1. A multilevel digital communication system is to operate at a data rate of 1500kb/s. If a 4-bit words are encoded into each level for transmission over the channel. What is the minimum required bandwidth for each channel?
2. A multilevel digital communication system sends of 16 possible levels over the channel every 0.8ms?
  - 1) what is the number of bits corresponding to each level?
  - 2) What is the baud rate?
  - 3) What is the bit rare?
3. A binary waveform of 9600 bits/s is converted into an 8-level waveform that is passing through a channel with a raised cosine roll-off Nyquist filter. The channel has a conditional (equalised) phase response out to 2.4KHz:
  - 1) What is the baud rate?
  - 2) What is the roll-off factor?
4. An analog signal is to be converted into a PCM signal that is a binary polar NRZ line code. The signal is transmitted over a channel that is absolutely band limited to 4kHz. Assume that the PCM quantizer has 16 steps, and the overall equivalent system transfer function is of the raised cosine roll-off type with  $r=0.5$ . (Note: the binary signalling is used)
  - 1) Find the maximum PCM bit rate that can be supported by this system without introducing ISI.
  - 2) Find the bandwidth that can be permitted for the analog signal.
5. Consider a random data pattern consisting of binary 1's and 0's where the probability of obtaining either a binary 1 or binary 0 is 50%. Calculate the PSD for the unipolar NRZ signalling as a function of  $T_b$  (the time needed to send 1 bit of data).