

**KFUPM - COMPUTER ENGINEERING DEPARTMENT****COE-543 – Mobile Computing and Wireless Networks****Student Name:****Student Number:**

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**1) (10 points)** on short distance baseband transmission.

Explain how Pulse Position Modulation (PPM) is used in IEEE802.11 to provide 1 Mb/s and 2 Mb/s rates over the air.

Solution:

Refer to Example 3.3 of the textbook and Figure 3.5.

**2) (40 points)** on the carrier modulation techniques

- a) Explain how basic FSK works? What is the difference between FSK and MSK?
- b) Define the time-bandwidth product for a filter? How to measure the time-bandwidth product for a Gaussian filter?
- c) What happens to the filter output as the time-bandwidth for the filter decreases? What is the impact on the transmitted MSK signal?
- d) For QPSK modulation, the Txer/Rxer can be thought of using 4 baseband symbols for communication. List these symbols.

Solution:

a) Basic FSK: the baseband binary data is used to select the frequency of transmitted symbol.

The frequency spacing used for FSK symbols determines whether the transmissions are orthogonal and if the detection can be optimal at the receiver. An FSK scheme with minimum frequency spacing of  $1/(2T)$  is referred to as minimum shift keying.

b) The time-bandwidth product is the symbol duration times the bandwidth of the low pass filter used to smoothen the signal. For the Gaussian filter, the 3-dB bandwidth is used as a practical estimate of the filter bandwidth.

c) As the time-bandwidth product decreases, the signal is excessively low-pass filtered  $\rightarrow$  smooth PSD with no side lobes, however, the transmitted signal becomes more vulnerable for errors.

{for parts a, b, and c refer to the textbook pages 97-99 for the perfect answer}

d) The symbols are  $s_i(t) = A \cos(2\pi f_c t + \theta_i)$  where  $\theta_i$  belongs to  $\{\pi/4, 3\pi/4, -3\pi/4, -\pi/4\}$ .