國立成功大學

112學年度碩士班招生考試試題

編　號：110

系　所：工程科學系

科　目：通信系統

日　期：0207

節　次：第 1 節

備　註：不可使用計算機

※ 考生請注意：本試題不可使用計算機。 請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1) (20 marks, 4 marks each) Answer the following questions:

    a) Additive white Gaussian noise (AWGN) is a performance impairing factor in a communication system. Please specify what does it mean in each letter: "A", "W", and "G"? (You must give your explanations for each letter, rather than just spell out the word for each letter.)

    b) Mobility in a cellular system makes the channel a time-variant channel. Explain what is a time-variant channel.

    c) Multi-path propagation in a wireless communication system normally is a cause of frequency-selectivity of the channel. Explain what is a frequency-selective channel.

    d) What is the name of the satellite communication system developed by Ellon Mask?

    e) Which are the major technical features in 5G wireless communications (you can list them as many as possible)?

2) (30 marks, 5 marks each) One way to implement conventional AM modulation is to use a square-law device whose input-output voltage curve can be written as $v_{out} = a_1 v_{in} + a_2 v_{in}^2$. Assume that the input signal is $v_{in} = m(t) + \cos(2\pi f_c t)$, where $m(t)$ is the normalized message signal, f_c is the carrier frequency, and the bandwidth of $m(t)$ is W.

    a) Write down the expressions step-by-step to generate the conventional AM modulated signal at a transmitter.

    b) Draw a block diagram for a conventional AM signal transmitter.

    c) Draw a block diagram for a conventional AM signal receiver.

    d) If a bandpass filter should be used in the transmitter, what is the bandwidth of the bandpass filter?

    e) If a bandpass filter and a lowpass filter should be used in the receiver, what are the bandwidths of the two filters? (You must give your reasons for the bandwidths selected for the two filters.)

    f) Please write down an expression for the values of a_1 and a_2 in order to avoid over-modulation.

3) (20 marks, 4 marks each) Assume that $m(t)$ is a message signal, $\hat{m}(t)$ is the Hilbert transform of $m(t)$, and $c(t) = A_c \cos(2\pi f_c t)$ is the carrier signal. Please write down the signal expressions for the AM modulations as follows:

    a) Double-sided band suppressed carrier (DSB-SC) modulation.

    b) Conventional AM modulation.

    c) Single-sided band (SSB) modulation.

    d) If we want to use an envelope detector (ED) to detect the above AM signals, which

AM modulated signals can be detected by ED, and which can not? (You must explain why)

e) Assume that a local reference carrier $\cos(2\pi f_c t + \theta)$ is used to detect the received AM signal, and θ is not equal to zero. Is it possible to detect the aforementioned three AM modulated signals at a receiver successfully? (You must explain why)

4) (30 marks, 5 marks each) Assume that $m(t)$ is a message signal with its bandwidth W, $A_c \cos(2\pi f_c t)$ is the carrier signal, β_f and β_p are modulation indexes for frequency and phase modulators, and k_f and k_p are frequency and phase deviation constants.

a) Write down the expressions to explain how to generate a frequency modulated (FM) signal with a phase modulator.

b) Draw a block diagram to show the receiver structure to generate the FM signal with a phase modulator.

c) Write down the expressions to explain how to generate a phase modulated (PM) signal with a frequency modulator.

d) Draw a block diagram to show the receiver structure to generate the PM signal with a frequency modulator.

e) Normally two filters are needed in a FM signal receiver. One is a bandpass filter and the other is a lowpass filter. Please give the bandwidths for the two filters, and explain why.

f) FM and PM signals are also called angle modulated signals. Explain why FM is used much more widely than PM. (Hint: you need to answer this question based on the differences in the output signal to noise ratios at FM and PM receivers.)