國立成功大學
111學年度碩士班招生考試試題

編　號：109

系　所：工程科學系

科　目：通信系統

日　期：0220

節　次：第 1 節

備　註：不可使用計算機

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※ 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) Please spell out the full names of OFDM and OFDMA.
   b) Please tell me if the satellite communications will be introduced in 6G.
   c) Please spell out the abbreviation of AWGN.
   d) Please explain what are M2M communications and D2D communications.
   e) Which one is a major performance impairing factor in mobile communications? a) noise; b) time-selective fading.

2) (20 marks, 4 marks each) Anwser the following questions:
   a) If $m(t)$ is the message signal and $c(t) = A_c\cos(2\pi f_c t)$ is the carrier signal, write down the expression of a DSB-SC signal $u(t)$.
   b) What are the differences between the single-side band (SSB) signal and the vestigial single-side band (VSB) signal.
   c) If $m(t)$ is the message signal and $c(t) = A_c\cos(2\pi f_c t)$ is the carrier signal, write down the expression of the phase modulated signal with its phase deviation constant of k_p.
   d) If $m(t)$ is the message signal and $c(t) = A_c\cos(2\pi f_c t)$ is the carrier signal, write down the expression of the frequency modulated signal with its frequency deviation constant of k_f.
   e) If $m(t)$ of bandwidth W is the message signal and $c(t) = A_c\cos(2\pi f_c t)$ is the carrier signal, please compare the bandwidths of DSB-SC signal and FM signal (if the frequency modulation index is β_f, where $\beta_f = \frac{k_f \max[|m(t)|]}{W}$).

3) (20 marks, 4 marks each) Consider the conventional AM signal of

$$u(t) = A_c[1 + k_a\cos(2\pi f_m t)]\cos(2\pi f_c t), \tag{1}$$

where $m(t)$ is a sinusoidal modulating signal with frequency f_m, k_a is the modulation factor, A_c is the amplitude of the carrier signal, and f_c is the carrier frequency ($f_c \gg f_m$). Assume that the modulation index is $k_a = 2$, and the modulated conventional AM signal $u(t)$ is applied to an ideal envelop detector to produce the output signal $v(t)$.
   a) Write down the expression of the output signal $v(t)$.
   b) Is $v(t)$ is a periodic signal or a non-periodic signal?
   c) Is $v(t)$ an even or odd function?
   d) If needed, determine the Fourier series representation of $v(t)$.
   e) What is the ratio of the second-harmonic term amplitude to the fundamental frequency term amplitude in $v(t)$?

4) (20 marks, 5 marks each) Assume that a square-law detector uses a nonlinear device whose transfer characteristic is defined as $v_2(t) = a_1 v_1(t) + a_2 v_1^2(t)$, where a_1 and a_2 are constants, $v_1(t)$ is the input signal, and $v_2(t)$ is the output signal. The input signal is an AM modulated signal $v_1(t) = A_c[1+k_a m(t)]\cos(2\pi f_c t)$, where A_c is the amplitude of AM modulated signal, k_a is the modulation factor, $m(t)$ is the message signal of bandwidth of W, and f_c is the carrier frequency ($f_c \gg W$).
   a) What is the output signal $v_2(t)$.
   b) Please identify which terms in $v_2(t)$ are interferences and which are useful signals.
   c) If the signal $v_2(t)$ passes through a low-pass filter of bandwidth W, please write down the output signal $v_3(t)$ from the filter.
   d) Find the conditions for which the message signal $m(t)$ can be successfully recovered from $v_3(t)$ (Hint: all baseband signals in $v_3(t)$ should be taken into account to recover the message signal $m(t)$).

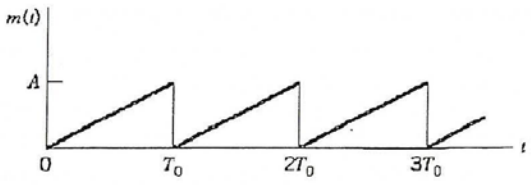

Fig. 1. The message signal $m(t)$ in an angle modulation system.

5) (20 marks, 4 marks each) Assume that the message signal $m(t)$ fed into an angle modulation system is shown in Fig. 1, which is a sawtooth wave defined in the positive time axis with its peak amplitude of A and its period of T_0.
   a) If the message signal $m(t)$ is fed into a phase modulation (PM) device, write down the expression of the output PM signal $u_{PM}(t)$.
   b) What is the instantaneous frequency of the PM signal?
   c) Sketch the time-domain PM signal waveform $u_{PM}(t)$.
   d) If the message signal $m(t)$ is fed into a frequency modulation (FM) device, write down the expression of the output FM signal $u_{FM}(t)$.
   e) Sketch the time-domain FM signal waveform $u_{FM}(t)$.