國立成功大學 108 學年度碩士班招生考試試題

系　　所：工程科學系

考試科目：通信系統

考試日期：0224，節次：1

※ 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) Are the following claims true or false? You do not need to explain your answer. Just fill in the bracket with either "T" or "F" (For each of the claims below, a correct answer gives you 2 points, while an incorrect answer or no answer gives you 0 point). (請於答案卷上作答)

   a) The power spectrum density of AWGN is flat across the entire frequency axis ( ).
   b) The shorter the wavelength of a RF signal is, more likely it will bounce back when it hits smooth surface of an object ( ).
   c) Convolutional codes are examples of source coding schemes ( ).
   d) The frequency of the signal carries the information in ASK modulation ( ).
   e) 16-QAM is a two-dimensional signal constellation ( ).
   f) Multipath propagation is the main cause of frequency selective fading in wireless channels ( ).
   g) Mobility in a mobile cellular system causes time-variation in the channels ( ).
   h) Fourier transform can be used to analyze both periodic and non-periodic signals ( ).
   i) A lowpass filter should be used right after an antenna of a receiver to reduce noise power ( ).
   j) All major third generation (3G) cellular standards use CDMA as their multiple access scheme ( ).

2) (20 marks) In electronic circuits, there is a type of nonlinear circuits that perform the operation as shown in Fig. 1 (note that the constant a is positive). We call such a device a square-law device. Describe how we can use the square-law device to build a frequency multiplier with n=2. Also, briefly discuss how we can build a frequency multiplier with n=4, 8, 16, 64, ... (you need to draw a block diagram for each n value). Note that you are allowed to use more than one square-law device, as well as other devices such as filters here.

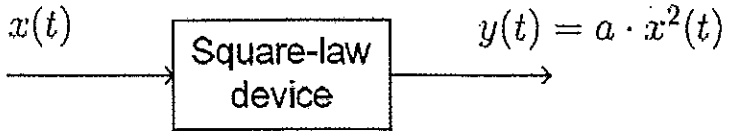

Fig. 1. The use of square-law devices to build a frequency multiplier.

3) (20 marks) Determine the bit rate, symbol rate, and transmission bandwidth of baseband PCM (pulse coded modulation) signals for the following settings.
   a) (6 marks) Message bandwidth W=22.05 kHz, Nyquist sampling (or the minimum sampling rate without information loss), 65536-level quantization, 2-ary PAM (pulse amplitude modulation), and full-width rectangular pulse.
   b) (7 marks) The same as (a), except that half-width rectangular pulse is used.
   c) (7 marks) The same as (a), except that 4-ary PAM is used.

4) (20 marks) Let X_1 and X_2 be two independent Gaussian random variables, with their means 2 and their standard deviations 4. We form a new random variable Y such that $Y = 2X_1 + X_2$.
   a) (5 marks) Evaluate $E[X_1X_2]$, where $E[z]$ is to calculate the expectation of z.
   b) (5 marks) What is the mean of Y?
   c) (5 marks) What is the variance of Y?
   d) (5 marks) Write down the probability density function of Y, $f_Y(y)$.

5) (20 marks) Consider a real baseband signal $x(t)$ with its Fourier transform as

$$X(f) = \begin{cases} e^{j\pi f}, & 0 \le f < 1, \\ 0, & f \ge 1, \end{cases} \tag{1}$$

for positive frequencies. Also define $y(t) = x(t)\cos(6\pi t)$ with its Fourier transform $Y(f)$.
   a) (10 marks) Sketch $\mathrm{Re}\{X(f)\}$ and $\mathrm{Im}\{X(f)\}$ for both positive and negative frequencies.
   b) (10 marks) Sketch $\mathrm{Re}\{Y(f)\}$ and $\mathrm{Im}\{Y(f)\}$ for both positive and negative frequencies.