

※ 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。

(25 marks, 5 marks for each sub-question)

1. Answer the following questions:

- (a) There are three major 3G mobile cellular standards in the world. Please write down their names (i.e., their abbreviations).
- (b) Many Taiwanese mobile service providers have claimed that they have started to offer 4G services. Please write down its name (i.e., its abbreviation).
- (c) In a communication system, white Gaussian noise is a common performance-limiting factor. Why do we use the two words, "white" and "Gaussian", to describe the noise?
- (d) In three most common analogue modulations, AM, FM, and PM, which one is most sensitive to the additive interferences?
- (e) If we have known the transmitted power  $P_t$ , please write down the relationship between the received power  $P_r$  and the distance between the transmitter and receiver  $d$  (assume that the signal is sent into a free space propagation channel).

(25 marks)

2. A periodic signal  $x(t)$  is expressed by the following Fourier series:

$$x(t) = 3\cos(4\pi t) + \cos(8\pi t - 2\pi/3) + 2\cos(16\pi t + 2\pi/3).$$

- a) Sketch the amplitude and the phase spectrum for this signal. (13 mark)
- b) By inspection of spectra in Part (a), write down the exponential Fourier series for this signal, where the exponential Fourier series is defined as  $x(t) = \sum_n x_n \exp(j2\pi n f_0 t)$ . (12 mark)

(25 marks)

3. The message signal  $m(t)$  is given by  $m(t) = \text{sinc}(100t)$ , where  $\text{sinc}(x) = \sin(x)/x$ . The message signal is modulated by the carrier  $\cos(2\pi f_c t)$ , where  $f_c = 250$  Hz to produce a DSB signal  $y(t)$ .
- a) Plot the spectrum for the message signal  $m(t)$ . (8 mark)
  - b) Plot the spectrum for the DSB signal  $y(t)$ . (9 mark)
  - c) What is the bandwidth of the DSB modulated signal? (8 mark)

(25 marks)

4. Let  $X_1$  and  $X_2$  be two independent Gaussian random variables, with mean 2 and standard deviation 4. Also, define  $Y = 2X_1 + X_2$
- a) Evaluate  $E[X_1 X_2]$ . (6 mark)
  - b) What is the mean of  $Y$ ? (6 mark)
  - c) What is the variance of  $Y$ ? (6 mark)
  - d) Write down the probability density function of  $Y$ ,  $f_Y(y)$ . (7 mark)