

※ 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)