

※ 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。

Problem 1 (20 marks)

Q1. Answer the following questions.

- Describe the major differences between Fourier Series and Fourier Transform.
- What is the difference between a power-type signal and an energy-type signal?
- Give the main properties of Hilbert Transform?
- What are the major functions of low-pass and band-pass filters in a transmitter and a receiver of a communication system?
- Why AM signal is always vulnerable to external interferences?
- What are the main features of a super-heterodyne AM radio receiver?
- What is the frequency range and the bandwidth of each channel in an FM radio broadcasting system?
- How to use an FM module to implement PM for a give carrier signal: $A_c \cos(\omega t)$? Draw its block diagram.
- Why do we always use device's non-linearity to implement modulation and demodulation units?
- Pre-emphasis is widely used in FM broadcasting systems. How does it work?

Problem 2 (10 marks)

Q2. Prove that we have the following Fourier transform pair:

$$\mathcal{F}[\cos(\pi t)] = \frac{1}{2}\delta\left(f + \frac{1}{2}\right) + \frac{1}{2}\delta\left(f - \frac{1}{2}\right)$$

Problem 3 (10 marks)

Q3. Answer the following questions.

- What is the name of the fourth generation (4G) mobile communication systems currently used in Taiwan?
- Explain the differences between an analogue communication system and a digital communication system. Give an example for each of the two.
- Explain the shadowing effect in a wireless communication environment.
- What is the main cause of Doppler effect in a mobile communication system?
- Tell us what is frequency selective fading channel.

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Problem 4 (20 marks)

Q4. A signal $x(t)$ has the double-sided amplitude and phase spectra as shown in Fig. 1. Write a time-domain expression for the signal $x(t)$.

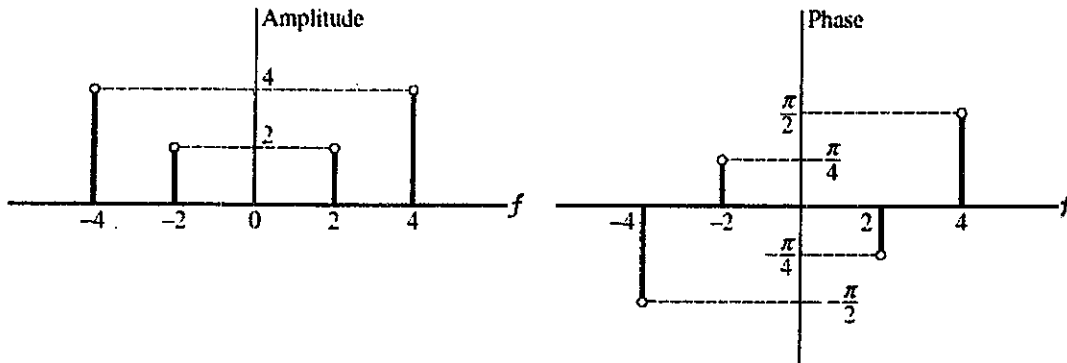


Fig. 1. The double-sided amplitude and phase spectra of signal $x(t)$.

Problem 5 (20 marks)

Q5. Assume that a DSB-SC signal:

$$x_c(t) = A_c m(t) \cos(2\pi f_c t + \phi_0)$$

is demodulated using the demodulation carrier:

$$2 \cos[2\pi f_c t + \theta(t)]$$

- Determine, in general, the demodulated output signal $y(t)$.
- Let $A_c=1$ and $\theta(t) = \theta_0$, where θ_0 is a constant. Determine the error between message signal $m(t)$ and the demodulated output $y(t)$ as a function of ϕ_0 and θ_0 .

Problem 6 (20 marks)

Q6. The block diagram of an FMFB demodulator is shown in Fig. 2.

- Describe the purpose of using VCO in such an FMFB demodulation system?
- Why the use of the feedback loop with a VCO helps to reduce the noise power at the output signal?
- Describe the purposes of using band-pass and low-pass filters in Fig. 2, respectively.
- Draw the desirable amplitude frequency response of the discriminator, and explain why such a desirable amplitude frequency response is required?

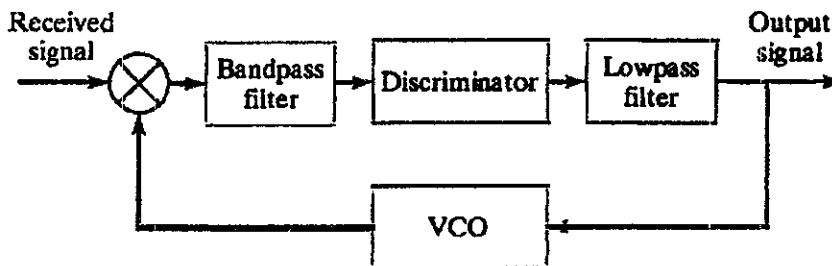


Fig. 2. Illustrative block diagram of an FMFB demodulator.