編號： 197

國立成功大學103學年度碩士班招生考試試題

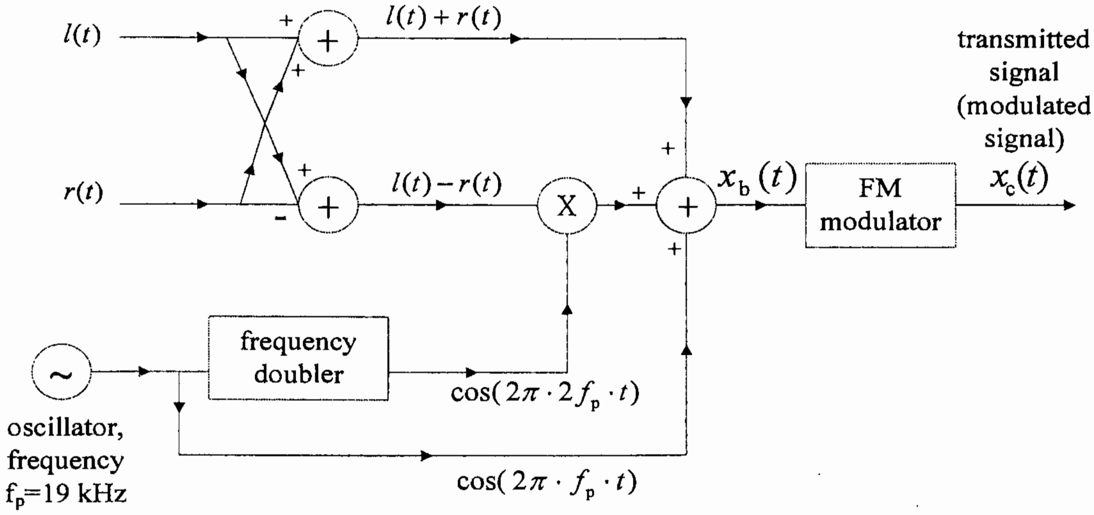
系所組別：電腦與通信工程研究所乙組

考試科目：通信系統

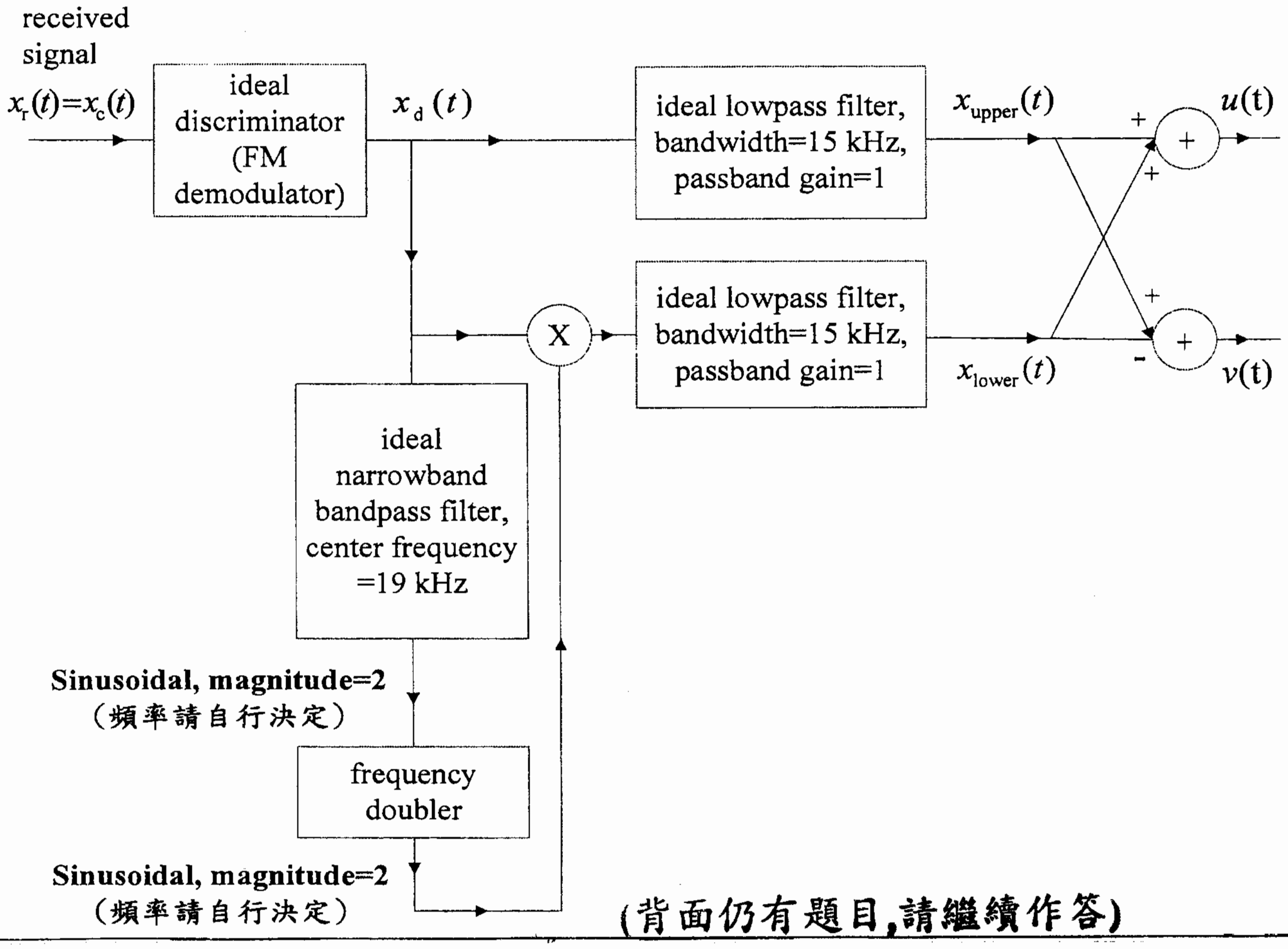
考試日期：0222，節次：2

※ 考生請注意：本試題可使用計算機。 請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. Consider the modulator structure shown below. (本大題 20%)



The two message signals to be transmitted, $l(t)$ and $r(t)$, are both bandlimited with bandwidth=15 kHz. The transmitted signal is given by $x_c(t) = A_c\cos(\omega_c t + \emptyset(t))$ where A_c is a constant, ω_c is the carrier frequency (rad/sec), $\emptyset(t) = K_f \int_{-\infty}^{t} x_b(\alpha)d\alpha$ is the phase deviation, and K_f is the frequency deviation constant. Let us assume that the received signal $x_r(t)$ is exactly the same as the transmitted signal $x_c(t)$. The received signal is processed by the demodulator structure shown below, where $u(t) = x_{\text{upper}}(t) + x_{\text{lower}}(t)$ and $v(t) = x_{\text{upper}}(t) - x_{\text{lower}}(t)$.



(背面仍有題目,請繼續作答)

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(a) Determine $u(t)$. Use the following model for the ideal discriminator shown in the demodulator structure:

$x_d(t) = \frac{K_d}{2\pi}\frac{d\emptyset(t)}{dt}$ where K_d is the discriminator constant. (10%)

(b) Is this demodulator structure a coherent demodulator? Justify your answer. If your answer is a yes, explain what the modulator does to facilitate coherent demodulation and what the demodulator does to obtain a coherent reference. If your answer is a no, briefly explain how the noncoherent demodulator works. (5%)

(c) 本題之 modulator structure 讓你聯想到與哪些類比調變方法有何相似之處? (5%)
[Note:你的答案應包含: "XX 部份和 XXX modulation scheme 相似，因為...(簡要說明相似點)"。必須寫出二個相似點。]

2. Consider the DSB-SC (double-sideband suppressed carrier) system in which the transmitted signal is given by $x_c(t) = m(t)\cos(\omega_c t + \theta_0)$ where $m(t)$ represents the message signal, ω_c is the carrier frequency (rad/sec), and θ_0 represents the initial phase of the oscillator at the transmitter. Let us assume that the received signal $x_r(t)$ is given by $x_r(t) = x_c(t - \tau_0)$ where τ_0 denotes the propagation delay. Demonstrate how you can recover $m(t - \tau_0)$ from $x_r(t)$ in a coherent manner.
[Note] (a) You can assume that the receiver can achieve perfect carrier synchronization by using, for example, the phase-locked loop techniques. (b) You need to draw the block diagram of the coherent demodulator that you design, in addition to mathematically showing that your design actually works. (本大題 10%)

3. Consider the following LTI system

$$y(n) = \alpha x(n) + (1-\alpha)y(n-1)$$

where

$\alpha > 0$: a real-valued constant,
$x(n)$: input of the system,
$y(n)$: output of the system with $y(n)$=0 for n<0. (本大題 20%)

(a) Draw the block diagram of this system. (5%)
(b) Determine the unit impulse response of this system. Is this system a finite impulse response (FIR) or infinite impulse response (IIR) system? Justify your answer. (5%)
(c) Determine the range of α such that this system is stable. (5%)
(d) Determine the unit impulse response of the inverse of the system. (5%)

4. Compare the bandwidth efficiencies R_b/B, where R_b and B are respectively bit rate and null-to-null bandwidth, of various M-ary digital modulation schemes, including the PSK, QAM, coherent FSK and non-coherent FSK. Note that the minimum frequency separation is assumed for FSK. (本大題 20%)

5. Consider the non-coherent FSK with the transmitted signals as

$$s_1(t) = A\cos(w_c t + \theta), 0 \le t \le T$$

and

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$$s_2(t) = A\cos((w_c + \Delta w)t + \theta), 0 \le t \le T$$

where Δw is sufficiently large that $s_1(t)$ and $s_2(t)$ occupy different spectral regions. The AWGN channel environment with noise power N is assumed. Calculate the error probability.

Note that the Ricean probability density function can be expressed as

$$f_R(r) = \frac{r}{\sigma^2}\exp\left(-\frac{r^2+A^2}{2\sigma^2}\right) I_0\left(\frac{rA}{\sigma^2}\right), r \ge 0$$

where A is the amplitude of the specular component; σ^2 is the variance of each quadrature diffuse component; $I_0(u)$ is the modified Bessel function of the first kind and order zero. (本大題 15%)

6. Consider a two-hypothesis decision problem where

$$f_Z\left(\frac{z}{H_1}\right) = \frac{\exp\left(-\frac{1}{2}z^2\right)}{\sqrt{2\pi}}$$

and

$$f_Z\left(\frac{z}{H_2}\right) = \frac{1}{2}\exp(-|z|)$$

(a) Find the likelihood ratio $\Lambda(Z)$. (5%)

(b) Letting the threshold η be arbitrary, find the decision region R_1 and R_2. Note that both R_1 and R_2 cannot be connected regions for this problem; that is, they will involve a multiplicity of line segments. (10%) (本大題 15%)