系所別：通訊工程學系　甲組　科目：通訊系統

(10%) **1.** X and Y are two independent random variables. X and Y have means and variances given as: $E(X)=1$, $E(Y)=2$, $\mathrm{Var}[X]=3$, $\mathrm{Var}[Y]=4$.

(a) Compute $\mathrm{Var}[2X-3Y-1]$.
(b) Compute $\mathrm{Var}[XY]$.
(c) Compute correlation coefficient $\rho(Y-X, Y+X)$.

(15%) **2.** The sgn(f) function is defined as: $\mathrm{sgn}(f)=\begin{cases}1, & f>0\\ 0, & f=0\\ -1 & f<0\end{cases}$, and has the Fourier transform pair $\frac{j}{\pi t} \Leftrightarrow \mathrm{sgn}(f)$. Let $x(t)$ be the input signal to the filter $h(t)=\frac{1}{\pi t}$, and the output signal is represented as $\hat{x}(t)=x(t)*h(t)$, where $*$ denotes the convolution operation. If $y(t)=x(t)\cos(\omega_0 t)+\hat{x}(t)\sin(\omega_0 t)$:

(a) Please express the spectrum Y(f) of $y(t)$ in terms of f_0, X(f) and sgn(f), where X(f) is the spectrum of $x(t)$, which is lowpass with the bandwidth $B<f_0=\frac{\omega_0}{2\pi}$.

(b) Sketch Y(f) if X(f) is shown as in Figure 1.

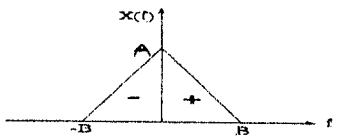

Figure 1

(15%) **3.** An FM modulator has output : $x_c(t)=50\cos[\omega_c t+2\pi f_d\int^t m(\alpha)\partial\alpha]$, where $f_d=25$Hz/V. Assume that $m(t)$ is the signal equal to $2\prod[\frac{1}{4}(t-2)]+4\prod[\frac{1}{2}(t-6)]$, where $\prod(t)=\begin{cases}1 & |t|<\frac{1}{2}\\ 0 & otherwise\end{cases}$

(a) Determine the peak frequency deviation in hertz.
(b) Determine the peak phase deviation in radians.
(c) Determine the power at the modulator output.

(10%) **4.** Consider the system: $x(t)\rightarrow\oplus\rightarrow\boxed{\frac{\partial}{\partial t}}\rightarrow\boxed{\begin{matrix}Lowpass\\ filter\end{matrix}}\rightarrow y(t)$. The signal $x(t)$ is defined by

$n(t)$

$x(t)=A\cos(2\pi f_c t)$ The lowpass filter has unit gain in the passband and bandwidth W, where $f_c<W$. The noise $n(t)$ is white with two-sided power spectral density $N_0/2$. The signal component of $y(t)$ is defined to be the component at frequency f_c. Determine the signal-to-noise ratio of $y(t)$.

注意：背面有試題

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(30%) **5.** 有 3 個銅板，假設第 1、2、3 個銅板是正面的機率分別是 1/3、1/3、1/2。今告知您下列資訊，請問第 3 個銅板是正面的機率爲多少?

請在下列答案中選出適當項目號碼，每小題答錯不倒扣，答案若爲其它請寫出應該多少。

項目號碼	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
答案	1/2	1/3	1/4	1/5	1/6	1/7	1/8	1/9	其它

a). 全部銅板都是一樣花色(即正面或反面)。

b). 有偶數個正面(包含零個)。

c). 有 1 個正面、2 個反面。

參考用

(10%) **6.** We have two hypotheses for the observed data Z

Hypotheses H_0 $Z = N$ (noise alone) Pr(H_0 true)=1/4,

Hypotheses H_1 $Z = k + N$ (signal plus noise) Pr(H_1 true)=3/4.

Assume that the noise N is an added white Gaussian noise with zero mean and variance σ^2. And k is a constant. Use the Bayes' criterion to find the threshold of Z for deciding whether Z belongs H_1 or H_0.

請在下列答案中選出適當項目號碼，答錯不倒扣，答案若爲其它請寫出應該多少。

項目號碼	(1)	(2)	(3)	(4)	(5)	(6)	(7)
答案	$\frac{k}{2}$	$\frac{k}{2}-\frac{\sigma^2}{k}\ln 3$	$\frac{k}{3}-\frac{\sigma^2}{k}\ln$	$\frac{k}{3}$	$\frac{k}{2}-\frac{\sigma^2}{k}\ln 2$	$\frac{k}{3}-\frac{\sigma^2}{k}\ln 3$	其它

(10%) **7.** 有一接收機，其工作方式爲：連續收 4 個位元(bits)才決定訊號是 1 或 0；其判斷方法是：若 4 個位元中至少有 2 個 1，則決定訊號是 1，否則爲 0。若假設每個位元是 1 的機率爲 0.6，問此接收機決定訊號是 0 的機率爲多少?

請在下列答案中選出適當項目號碼，答錯不倒扣，答案若爲其它請寫出應該多少。

項目號碼	(1)	(2)	(3)	(4)	(5)	(6)	(7)
答案	0.2388	0.1928	0.1842	0.1768	0.1792	0.1898	其它