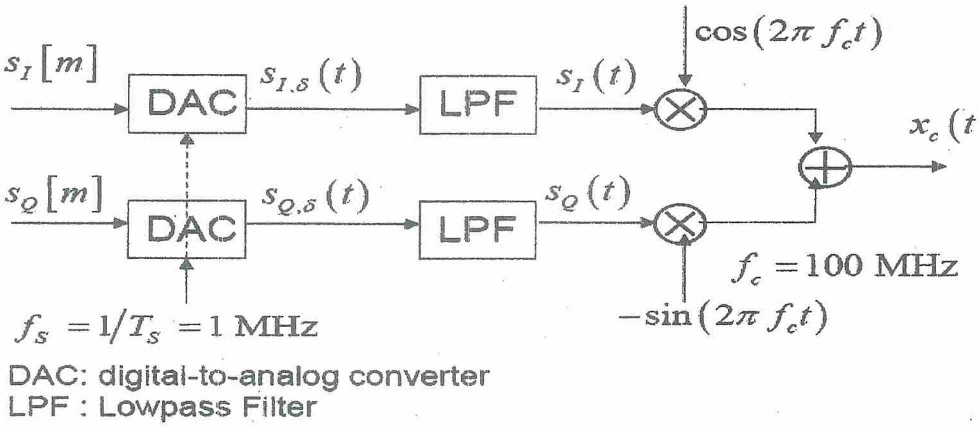
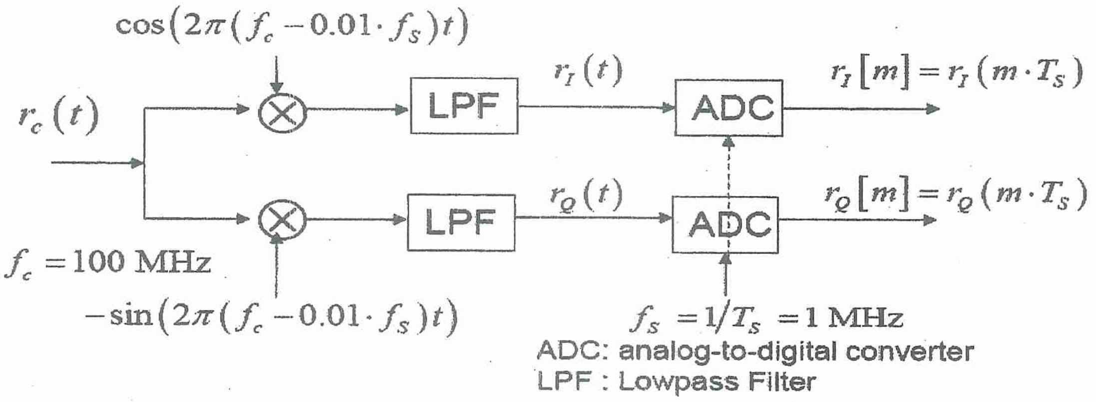
國立中央大學103學年度碩士班考試入學試題卷

所別：通訊工程學系碩士班 甲(通訊系統及訊號處理)組(一般生)　科目：通訊系統　共 2 頁 第 1 頁
本科考試禁用計算器
＊請在試卷答案卷（卡）內作答

1. In a quadrature modulator system as shown below with the DAC outputs $s_{I,\delta}(t)=\sum_{m=-\infty}^{\infty} s_I[m]\cdot\delta(t-m\cdot T_S)$, $s_{Q,\delta}(t)=\sum_{m=-\infty}^{\infty} s_Q[m]\cdot\delta(t-m\cdot T_S)$ and the LPF impulse response $h_{LP}(t)$, (a) find **the condition** of $h_{LP}(m\cdot T_S)$, $m\in$ integer such that $s_I(m\cdot T_S)=\{s_{I,\delta}(t)*h_{LP}(t)\}|_{t=m\cdot T_S}=s_I[m-10]$ (4%); (b) find **the Fourier transform** of $s_{I,\delta}(t)=\sum_{m=-\infty}^{\infty} s_I[m]\cdot\delta(t-m\cdot T_S)$ when $s_I[m]=2\cdot\cos(0.1\cdot\pi\cdot m)$ (5%); (c) find **the formula** of $s_I[m]$ and $s_Q[m]$ such that $x_c(t)=2\cdot\cos(2\pi\cdot(f_c+0.1\cdot f_S)\cdot t+\theta_c)$ when $H_{LP}(f)=\Im\{h_{LP}(t)\}=\begin{cases}1, & |f|<0.5\cdot f_S\\ 0, & \text{otherwise}\end{cases}$ (5%). ("*" denotes the convolution)



2. In a quadrature demodulator system as shown below with the LPF having a frequency response $H_{LP}(f)=\Im\{h_{LP}(t)\}=\begin{cases}2, & |f|<0.5\cdot f_S\\ 0, & \text{otherwise}\end{cases}$, (a) find $E\{|r_I(t)|^2\}$ when $E\{r_c(t)\cdot r_c(t+\tau)\}=\frac{N_0}{2}\cdot\delta(\tau)$ (4%); (b) find $E\{r_I[m]\cdot r_I[m+n]\}$ and $E\{r_I[m]\cdot r_Q[m+n]\}$ when $E\{r_c(t)\cdot r_c(t+\tau)\}=\frac{N_0}{2}\cdot\delta(\tau)$ (6%); (c) find **the formula** of $r_I[m]$ and $r_Q[m]$ when $r_c(t)=2\cdot\cos(2\pi\cdot(f_c+0.1\cdot f_S)\cdot t+\theta_c)$ (6%).



3. Consider a complex baseband communication system having the received signal given by $r_B(t)=\sum_{k=-\infty}^{\infty} a[k]\cdot p_{srrc}(t-k\cdot T_{sym}-\tau_0)+n_B(t)$ where $p_{rc}(t)=p_{srrc}(t)*p_{srrc}(-t)$ **being a**

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raised-cosine pulse with a roll-off factor 0.5 and $p_{rc}(m\cdot T_{sym})=\begin{cases}2, & m=0\\ 0, & m\neq 0\end{cases}$, and $n_B(t)=n_I(t)+j\cdot n_Q(t)$ being the complex Gaussian noise with $E\{n_I(t)\cdot n_Q(t+\tau)\}=0$ and $E\{n_I(t)\cdot n_I(t+\tau)\}=E\{n_Q(t)\cdot n_Q(t+\tau)\}=\frac{N_0}{2}\cdot\delta(\tau)$, (a) find **the bandwidth** and **the power** ($E\{|r_B(t)|^2\}$) of the received signal excluding noise when $a[k]\in\{-3,-1,1,3\}$ with equiprobability (10%); (b) find **the sampling time** t_k of the matched filter output, **the value of** A and $E\{|n_M[k]|^2\}$ such that $r_M(t)=r_B(t)*p_{srrc}(T-t)$ with $r_M(t_k)=A\cdot a[k]+n_M[k]$ (12%); (c) find **the decision rule** based on $r_M(t_k)$ given in (b) and **the decision error probability** in terms of Q function such that the decision error probability is minimized when $a[k]\in\{-3,-1,1,3\}$(10%); (d) repeat (c) when $a[k]\in\{1,j,-1,j\}$ (8%). (Q function: $Q(u)=\int_u^\infty\frac{1}{\sqrt{2\pi}}\exp\left(\frac{-x^2}{2}\right)\cdot dx$)

4. Consider the observations given by $Z_1=2\cdot A+N_1$ and $Z_2=4\cdot A+N_2$ where N_1 and N_2 are independent Gaussian noise with zero mean and variance σ_n^2, (a) find the maximum-likelihood estimate of A based on Z_1, i.e., $\hat{A}_{ML}=\arg\max_a f_{Z_1|A}(Z_1\,|\,a)$, **and** $E\left[\left(\hat{A}_{ML}-A\right)^2\right]$ (4%); (b) find the maximum-likelihood estimate of A based on Z_1 & Z_2, i.e., $\hat{A}_{ML}=\arg\max_a f_{Z_1,Z_2|A}(Z_1,Z_2\,|\,a)$ **and** $E\left[\left(\hat{A}_{ML}-A\right)^2\right]$ (6%).

5. Consider a binary symmetrical channel with the transition probabilities $\Pr(y_k=(1-x_k)\,|\,x_k)=1-\Pr(y_k=x_k\,|\,x_k)=p_0$ and $x_k\in\{0,1\}$, (a) find the code rate and decoding error probability when a (***n=7,k=4***) Hamming code is used prior to transmission through this channel (5%); (b) repeat (a) when the channel coding rule is given by $d_m=0\Rightarrow\{x_{3m},x_{3m+1},x_{3m+2}\}=\{1,0,1\}$ and $d_m=1\Rightarrow\{x_{3m},x_{3m+1},x_{3m+2}\}=\{0,1,0\}$ (d_m : the mth source data) (5%).

6. Explain the following terms: (a) source coding; (b) channel equalization; (c) bandwidth efficiency; (d) OFDM. (10%)

參考用

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