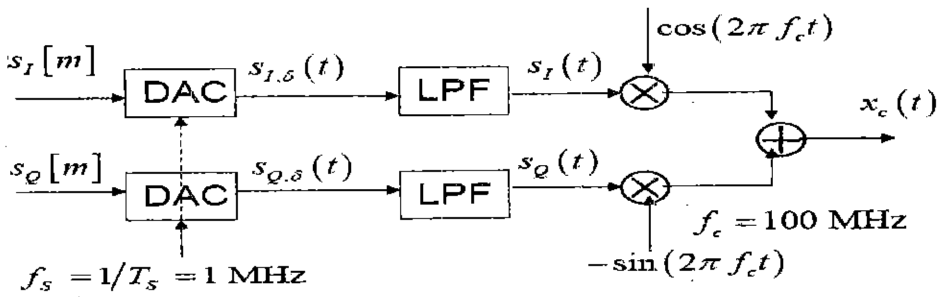
國立中央大學104學年度碩士班考試入學試題

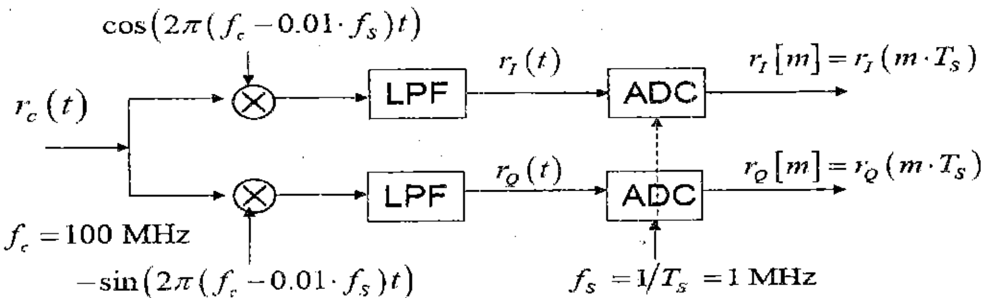
所別：通訊工程學系碩士班 不分組(一般生)　科目：通訊系統　共 2 頁 第 1 頁

本科考試禁用計算器　　　　*請在答案卷（卡）內作答

1. In an analog transceiver system as shown below with **the analog message signal** $m(t)$ and $M(f)=\Im\{m(t)\}=\begin{cases}1, & |f|\le 100\text{ KHz}\\ 0, & \text{otherwise}\end{cases}$, 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/frequency response $h_{LP}(t)/H_{LP}(f)=\Im\{h_{LP}(t)\}=\begin{cases}1, & |f|<0.5\cdot f_S\\ 0, & \text{otherwise}\end{cases}$ (all LPFs have the same specification), (a) plot the Fourier spectrum of $s_{I,\delta}(t)$ in the range $-2.5\text{MHz}\le f\le 2.5\text{MHz}$ when $s_I[m]=m(m\cdot T_S)$ (6%); (b) find **the formula of** $x_c(t)$, $s_I[m]$ **and** $s_Q[m]$ **in terms of** $m(t)$ such that the system is an Upper-SideBand SSB modulator (6%) ; (c) find **the formula of** $x_c(t)$, $s_I(t)$ **and** $s_Q(t)$ **in terms of** $m(t)$ such that the system is an FM modulator with a frequency deviation constant f_d (Hz/V) (6%) ; (d) find **the formula** of $r_I(t)$ and $r_Q(t)$ in terms of $m(t)$ when $r_c(t)=2m(t)\cdot\cos(2\pi\cdot f_c\cdot t+\theta_c)$ (6%); (e) find **the values of** ω_0 **and** θ_0 such that $(r_I[m]+j\cdot r_Q[m])\cdot\exp(-j(\omega_0\cdot m+\theta_0))=m(m\cdot T_S)$ when $r_c(t)$ is given in (d) (6%).



DAC: digital-to-analog converter
LPF : Lowpass Filter



ADC: analog-to-digital converter
LPF : Lowpass Filter

2. Consider a complex baseband communication system having the received signal given by $r_B(t)=\sum_{k=-\infty}^{\infty}a[k]\cdot p_T(t-k\cdot T_{sym}-\tau_0)+n_B(t)$ where $p_T(t)=\begin{cases}1, & 0\le t<0.5T_{sym}\\ 2, & 0.5T_{sym}\le t<T_{sym}\\ 0, & \text{otherwise}\end{cases}$ 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) **plot the waveform of** $r_B(t)$ **in the range** $0\le t<4T_{sym}$ when $n_B(t)=0$, $a[k=-1\sim 4]=[1,\underset{\uparrow}{1},-1,1,1,-1]$ and $\tau_0=0.5T_{sym}$ (5%); (b) find **the power** ($E\{|r_B(t)|^2\}$) of the received signal when $n_B(t)=0$ and $a[k]\in\{-4,-2,2,4\}$ with equiprobability (5%); (c) find **the**

注意：背面有試題

sampling time t_k of the matched filter output, **the values of** A and $E\{|n_M[k]|^2\}$ when $r_M(t)=r_B(t)*p_T(T_{sym}-t)$, $r_M(t_k)=A\cdot a[k]+n_M[k]$ and $\tau_0=1.5T_{sym}$ (15%); (d) find **the decision rule based on** $r_M(t_k)$ **given in (c)** and **the decision error probability in terms of** Q **function** such that the decision error probability is minimized when $a[k]\in\{-2,4\}$ with equiprobability (10%); (e) find **the formula of** $r_M(t_k+0.5T_{sym})$ **in terms of** $a[k]$ when $n_B(t)=0$ and **the sampling time** t_k is given in (c) (5%). (Hint: Q function: $Q(u)=\int_u^{\infty}\frac{1}{\sqrt{2\pi}}\exp\left(\frac{-x^2}{2}\right)\cdot dx$)

3. Consider the observations given by $Z_1=4\cdot A+N_1$ and $Z_2=A+N_2$ where N_1 and N_2 are independent Gaussian noise with zero mean and variance σ_n^2, find $E\left[\left(\hat{A}-A\right)^2\right]$ when (a) $\hat{A}=(Z_1+Z_2)/5$ (5%); (b) $\hat{A}=\arg\max_A f_{Z_1,Z_2|A}(Z_1,Z_2|A)$ (the maximum-likelihood estimate of A based on Z_1 & Z_2 (4%).

4. Consider a binary symmetrical channel (input: x_k, output: y_k) 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 entropy of y_k (i.e., $H(y_k)$) when $\Pr(x_k=1)=1-\Pr(x_k=0)=\frac{1}{3}$ (5%); (b) find the joint entropy of x_k and y_k (i.e., $H(x_k,y_k)$) when $\Pr(x_k=1)=\Pr(x_k=0)=\frac{1}{2}$ (4%).

5. Explain the following terms: (a) Nyquist's Pulse-Shaping Criterion; (b) spread-spectrum; (c) power efficiency in digital communication; (d) Cellular Radio Communication System. (12%)