EE 113D Digital Signal Processing Lab

Feb. 2011

Midterm exam

Closed Book

Name: _____

email: _____

Student ID No.:_____

1) _____ / 5

2) _____ /5

3) _____ / 5

4) _____ / 10

5) _____ / 10

TOTAL _____ / 35

TABLE A.1 Fourier Transforms

$x(t)$	$X(f)$
1. $\delta(t)$	1
2. 1	$\delta(f)$
3. $\cos 2\pi f_0 t$	$\frac{1}{2}[\delta(f - f_0) + \delta(f + f_0)]$
4. $\sin 2\pi f_0 t$	$\frac{1}{2j}[\delta(f - f_0) - \delta(f + f_0)]$
5. $\delta(t - t_0)$	$\exp(-j2\pi f t_0)$
6. $\exp(j2\pi f_0 t)$	$\delta(f - f_0)$
7. $\exp(-a\lvert t\rvert), \quad a > 0$	$\frac{2a}{a^2 + (2\pi f)^2}$
8. $\exp\left[-\pi\left(\frac{t}{T}\right)^2\right]$	$T\exp[-\pi(fT)^2]$
9. $u(t) = \begin{cases} 1 & \text{for } t > 0 \\ 0 & \text{for } t < 0 \end{cases}$	$\frac{1}{2}\delta(f) + \frac{1}{j2\pi f}$
10. $\exp(-at)\,u(t), \quad a > 0$	$\frac{1}{a + j2\pi f}$
11. $t\exp(-at)\,u(t), \quad a > 0$	$\frac{1}{(a + j2\pi f)^2}$
12. $\text{rect}\left(\frac{t}{T}\right)$	$T\,\text{sinc}\,fT$
13. $\cos 2\pi f_0 t\left[\text{rect}\left(\frac{t}{T}\right)\right]$	$\frac{T}{2}[\text{sinc}(f - f_0)T + \text{sinc}(f + f_0)T]$
14. $W\,\text{sinc}\,Wt$	$\text{rect}\left(\frac{f}{W}\right)$
15. $\begin{cases} 1 - \frac{\lvert t\rvert}{T} & \text{for } \lvert t\rvert \le T \\ 0 & \text{for } \lvert t\rvert > T \end{cases}$	$T\,\text{sinc}^2 fT$
16. $\sum_{m=-\infty}^{\infty} \delta(t - mT_0)$	$\frac{1}{T_0}\sum_{n=-\infty}^{\infty} \delta\left(f - \frac{n}{T_0}\right)$

Note: rect $(f/2W) = 1$ for $-W < f < W$, 0 for $|f| > W$, and sinc $x = (\sin \pi x)/\pi x$.

Fourier Transform

$$X(f) = \int_{-\infty}^{\infty} x(t)\, e^{-j2\pi f t}\, dt$$

$$x(t) = \int_{-\infty}^{\infty} X(f)\, e^{j2\pi f t}\, dt$$

Discrete Fourier Transform

$$X(w) = \sum_{n=-\infty}^{\infty} x(n)\, e^{-jwn}$$

$$x(n) = \frac{1}{2\pi} \int_{-\pi}^{\pi} X(w)\, e^{jwn}$$

2's Compl.

$A_{10} = a_m a_{m-1} \cdots a_0$ (2's compl.)

$$A_{10} = a_m(-1)\, 2^m + \sum_{j=0}^{m-1} a_j\, 2^j$$

Bilinear Transformation

$$s = \frac{2}{T}\,\frac{1 - z^{-1}}{1 + z^{-1}} \qquad z = \frac{2/T + s}{2/T - s}$$

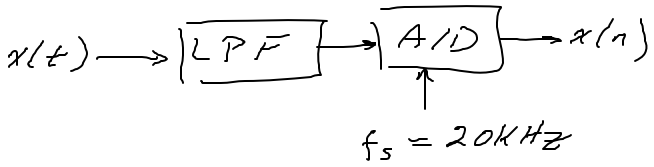
$$\Omega = \frac{2}{T} \tan\left(\frac{w}{2}\right) \qquad w = 2 \tan^{-1}\left(\frac{\Omega T}{2}\right)$$

5 pts

Problem 1:

Write down the expression for x(n) for the following system. Note the low pass filter (LPF) is a first order single zero LPF with the cut-off frequency equal to 5000 Hz.

$x(t) = \sin(2\pi 5000t) + \cos(2\pi 1500t) + \text{sqr}(100t)$



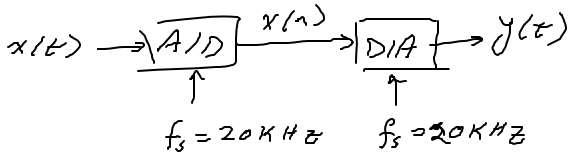
5 pts

Problem 2:

Given the system shown below write down the expression for x(n) and y(t). What is the frequency of y(t)? Is y(t) a sinusoide?

Note that this system does not have any filtering before the A/D or after the D/A.

$x(t) = \sin(2\pi \cdot 25\text{KHz}\, t)$



5 pts

Problem 3:

Assuming 5 bit 2's complement representation, express the results of the following operation in both 2's complement and based 10 representations. Please show your work.

a. 10+12
b. 7+3

Problem 4:

Sketch the Fourier transform of the following analog signals.

2 pts
3 pts
5 pts

a. $x(t) = \sin(2\pi 10^6 t)$
b. Infinite square wave with period = 2 micro-seconds
c. z(t) given below

$$z(t) = \sin(2\pi 10^5 t)\left[\sum_{n=0}^{\infty} \delta(t - n\,10^{-6})\right]$$

Problem 5:

For the C code given below, answer the following questions

2 pts
2 pts
4 pts
2 pts

a. Why do we need to call DSK6416_AIC23_write() twice in a row?
b. What will the code produce at the output?
c. If we change F1 to 12, what will you see when you connect the output to the oscilloscope? Why?
d. What do you need to change in the code to be able to plot the output in CCS?

```
#include "tonecfg.h"
#include "dsk6416.h"
#include "dsk6416_aic23.h"
#define F1   1
#define F2  48

DSK6416_AIC23_Config config = {
        0x0017, 0x0017, 0x00d8, 0x00d8, 0x0011, 0x0000,
        0x0000, 0x0043, 0x0001, 0x0001
};

void main()
{
        DSK6416_AIC23_CodecHandle hCodec;
        Int16 sample,value,HF, FF;
        DSK6416_init();
        hCodec = DSK6416_AIC23_openCodec(0, &config);
        DSK6416_AIC23_setFreq(hCodec, DSK6416_FREQ_48KHZ);
        FF = F2 / F1;
        HF = F2 / 2 / F1;

        while (1)
        {
                for (sample = 0; sample < FF; sample++)
                {
                        if (sample < HF)
                                value = 32765;
                        else
                                value = -32765;

                                while (!DSK6416_AIC23_write(hCodec, value));
                                while (!DSK6416_AIC23_write(hCodec, value));
                }
        }
   DSK6416_AIC23_closeCodec(hCodec);
}
```