Yuntech EE - *Signals and Systems* Final Exam

Name: ____________________ Student ID: ____________________ 95/01/17

1. (Chapter 3, 10%) In Fourier series representation of a periodic continuous-time signal, the truncated Fourier series approximation of a discontinuous signal will in general exhibit high-frequency ripples and overshoot near the discontinuities. This is called the ***Gibbs phenomenon***. Please explain why this phenomenon does not exist in the Fourier series representation of a periodic discrete-time signal.

2. (Chapter 3, 10%) Let $x[n]$ be a ***real and odd*** periodic signal with period $N = 7$ and Fourier coefficients a_k. Given that $a_8 = j$, $a_9 = 2j$, $a_{10} = 3j$, determine the values of a_0,a_{-1}, a_{-2}, and a_{-3}.

3. (Chapter 3, 10%) Let a_k be the Fourier coefficient of the discrete-time ***real*** signal $x[n]$ with period N. What is the Fourier coefficient of the signal $x[-n] - x[n-3]$?

4. (Chapter 4, 10%) The definition of a **sinc** function is $\text{sinc}(\theta) = \frac{\sin \pi\theta}{\pi\theta}$. Please rewrite the following signal $\frac{\sin(3Wt)}{2\pi t}$ in terms of the sinc functions.

5. (Chapter 4, 10%) Determine the Fourier transform of the periodic signal $1 + \cos(6\pi t)$.

6. (Chapter 4, 20%) Consider the Fourier transform pair $e^{-|t|} \leftrightarrow \frac{2}{1+\omega^2}$.
(a) Use the appropriate Fourier transform properties to find the Fourier transform of $te^{-|t|}$.
(b) Use the result from part (a), along with the ***duality property***, to determine the Fourier transform of $\frac{4t}{(1+t^2)^2}$.

7. (Chapter 5, 10%) Determine the signal $x[n]$ whose Fourier transform is $X(e^{jw}) = e^{-jw/2}$ for $-\pi \leq w \leq \pi$.

8. (Chapter 5, 10%) Please determine the Fourier transform of the signal $x[n] = \delta[n-1]+\delta[n+1]$ and depict $X(e^{jw})$.

9. (Chapter 5, 10%) Use Tables 5.1 and 5.2 to determine (a) the Fourier transform of the signal $x[n] = n(\frac{1}{2})^n u[n]$ and (b) the value of $X(e^{j0})$.

10. (Chapter 7, 10%) Determine the ***Nyquist rate*** corresponding the signal$x(t) = 1+\cos(2000\pi t)$ $+ \sin(3000\pi t)$.

11. (Chapter 7, 10%) The signal $y(t)$ is generated by convolving a band-limited signal $x_1(t)$ with another band-limit signal $x_2(t)$, that is, $y(t) = x_1(t) * x_2(t)$, where $X_1(jw) = 0$ for $|w| > 1000\pi$ and $X_2(jw) = 0$ for $|w| > 2000\pi$. Impulse-train sampling is performed on $y(t)$ to obtain
$$y_p(t) = \sum_{n=-\infty}^{\infty} y(nT)\delta(t - nT).$$
Specify the range of values for the sampling period T which ensures that $y(t)$ is recoverable from $y_p(t)$.

Good luck and happy winter vacation!