HOMEWORK 1 **EE -295 Image Processing** **January 21, 2008**

Due Date: Tuesday Jan. 29, 2008

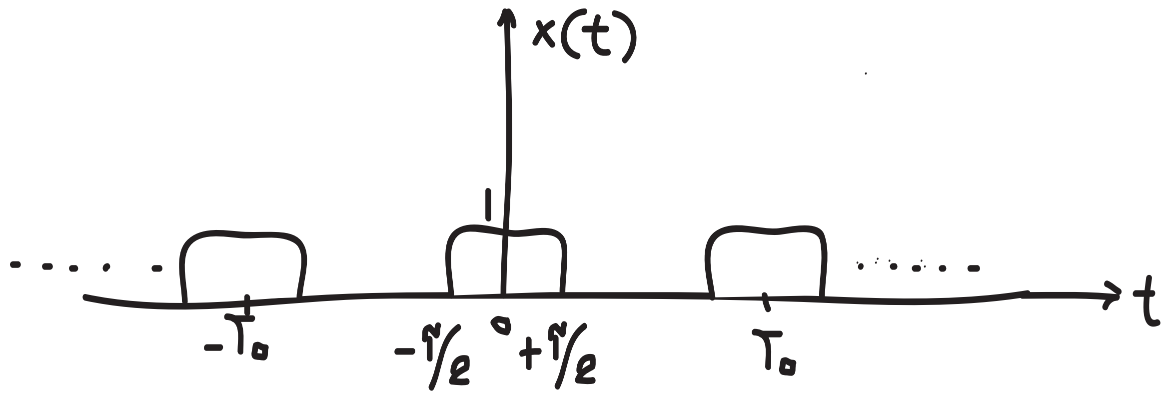

Figure 1: Periodic signal

For this Homework, please refer to the Signals & Systems (An Introduction) notes posted on the course web site. Solutions to all problems starting from problem 3 are given in the notes.

1. Find the Fourier series of the periodic signal $x(t)$ with period T_o.

2. Find the Fourier transform of the rectangular pulse between $-\tau/2 \leq t \leq +\tau/2$.

3. Find the DTFT $X(e^{j\omega})$ of $x[n] = \delta[n]$.

4. Find the DTFT $X(e^{j\omega})$ of $x[n] = \delta[n - n_o]$.

5. Find the DTFT $X(e^{j\omega})$ of $x[n] = a^n u[n]$.

6. Prove the formula for the DTFT of the rectangular pulse, p. 16, notes.

7. On p. 18, you see $X(e^{j\omega})$ which could be $H(e^{j\omega})$, the frequency response of an ideal low-pass digital filter. Verify its impulse response $x[n] = h[n]$. Note that it is not causal.

8. On p.19, verify the FT of $x(t) = e^{j\Omega_o t}$. Then verify the DTFT of $x[n] = e^{j\omega_o n}$.

9. On p.22, verify the periodic property of the DTFT.

10. On p.23, verify the time shifting property of the DTFT.

11. On. p. 23, verify the modulation property of the DTFT.

12. On p. 24, verify the conjugate symmetry property of the DTFT.

13. State Parseval's Relation, as given on p.27, notes.

14. State the input/output property of a discrete-time LTI system in terms of the DTFT as per p.27, notes.

15. State the output of a discrete-time LTI system to the input $e^{j\omega_o n}$, as per p.28, notes. Note that you can prove this very easily in the time domain by finding the output $y[n]$, using convolution, for input $x[n] = e^{j\omega_o n}$, $-\infty < n < +\infty$, n integer.

16. Find the Transfer function $H(e^{j\omega})$ of the first order recursive system, p.34 notes.

17. State the DTFT multiplicative property as given on p. 35 notes.

18. Observe the CTFT duality, p.39 notes.

19. State the impulse response of an ideal continuous-time LP filter, p.55 notes.

20. Note that, as per p.65 notes, a number of continuous signals can have the same samples. What property assures a unique reconstruction?

21. As per p.73, how is the continuous-time signal reconstructed from the discrete-time signal?

22. As per p. 133, find the z-Transform $X(z)$ of $x[n] = a^n u[n]$ and its Region of Convergence.

22. As per p. 152, state the convolution property of the system function $H(z)$.

22. As per p. 155, what is the stability property in terms of $H(z)$?