Name: _____

Student ID: _____

Signature: _____

CITY UNIVERSITY OF HONG KONG

Semester A 2015/2016

EE3210: Signals and Systems

Quiz 9

1. Time allowed: 15 minutes
2. Total number of problems: 2
3. Total marks available: 11
4. This paper may not be retained by candidates

Special Instructions

5. This is a closed book exam
6. Attempt all questions from each problem
7. A list of possibly relevant equations is attached at the end of this paper

Problem 1: (6 marks)

Given that the continuous-time signal $x(t)$ has the Fourier transform $X(\omega)$, express the Fourier transform $Y(\omega)$ of the signal

$$y(t) = x(1-t) * x(1-2t)$$

in terms of $X(\omega)$.

Problem 2: (5 marks)

Given that the discrete-time signal $x[n]$ has the Fourier transform $X[\Omega]$, express the Fourier transform $Y[\Omega]$ of the signal

$$y[n] = \sum_{k=0}^{+\infty} x[n-k]$$

in terms of $X[\Omega]$.

Appendix – A list of possibly relevant equations

- Continuous-time Fourier transform:
  - Formulas:
    - Analysis: $X(\omega) = \int_{-\infty}^{+\infty} x(t) e^{-j\omega t} dt$
    - Synthesis: $x(t) = \frac{1}{2\pi} \int_{-\infty}^{+\infty} X(\omega) e^{j\omega t} d\omega$
  - Properties: Consider $x(t) \leftrightarrow X(\omega)$, $y(t) \leftrightarrow Y(\omega)$.
    - Linearity: $ax(t) + by(t) \leftrightarrow aX(\omega) + bY(\omega)$
    - Time shift: $x(t - t_0) \leftrightarrow e^{-j\omega t_0} X(\omega)$
    - Time reversal: $x(-t) \leftrightarrow X(-\omega)$
    - Time scaling: $x(at) \leftrightarrow \frac{1}{|a|} X\left(\frac{\omega}{a}\right)$
    - Multiplication: $x(t)y(t) \leftrightarrow \frac{1}{2\pi} \int_{-\infty}^{\infty} X(\theta) Y(\omega - \theta) d\theta$
    - Convolution: $x(t) * y(t) \leftrightarrow X(\omega) Y(\omega)$
    - Parseval's relation: $\int_{-\infty}^{+\infty} |x(t)|^2 dt = \frac{1}{2\pi} \int_{-\infty}^{+\infty} |X(\omega)|^2 d\omega$

- Discrete-time Fourier transform:
  - Formulas:
    - Analysis: $X[\Omega] = \sum_{n=-\infty}^{+\infty} x[n] e^{-j\Omega n}$
    - Synthesis: $x[n] = \frac{1}{2\pi} \int_{2\pi} X[\Omega] e^{j\Omega n} d\Omega$
  - Properties: Consider $x[n] \leftrightarrow X[\Omega]$, $y[n] \leftrightarrow Y[\Omega]$.
    - Linearity: $ax[n] + by[n] \leftrightarrow aX[\Omega] + bY[\Omega]$
    - Time shift: $x[n - n_0] \leftrightarrow e^{-j\Omega n_0} X[\Omega]$
    - Time reversal: $x[-n] \leftrightarrow X[-\Omega]$
    - Multiplication: $x[n]y[n] \leftrightarrow \frac{1}{2\pi} \int_{-\pi}^{\pi} X[\theta] Y[\Omega - \theta] d\theta$
    - Convolution: $x[n] * y[n] \leftrightarrow X[\Omega] Y[\Omega]$
    - Parseval's relation: $\sum_{n=-\infty}^{+\infty} |x[n]|^2 = \frac{1}{2\pi} \int_{2\pi} |X[\Omega]|^2 d\Omega$

— End of Paper —