EE160 Midterm1 – Topics

- Harmonics in nonlinear amplifiers
  - Input-output power characteristic
  - 1-dB compression point
  - Third-order intercept point
  - Two-tone test
- Fourier series (FS)
  - Properties
  - Discrete amplitude spectrum
- Fourier transform (FT)
  - Properties
  - Periodic signals
  - Amplitude spectrum
  - Computing the FS using the FT
- Spectrum Analyzer

Bring and submit one double-sided letter-size cheat sheet to the exam

Exam Mechanics

- The exam is closed book and notes. <u>Only an electronic calculator is allowed</u>
- Do not forget to <u>attach a one-page DOUBLE-SIDED cheat sheet</u>
- <u>Estimated duration</u>: 50 minutes

- Three questions of two/three parts each
- One question involves the spectrum analyzer (to cover a lab question)

- The exam is similar to (but not the same as) the sample midterm exam.

TABLE 2.1 TABLE OF FOURIER-TRANSFORM PAIRS

Time Domain	Frequency Domain
$\delta(t)$	1
1	$\delta(f)$
$\delta(t - t_0)$	$e^{-j2\pi f t_0}$
$e^{j2\pi f_0 t}$	$\delta(f - f_0)$
$\cos(2\pi f_0 t)$	$\frac{1}{2}\delta(f - f_0) + \frac{1}{2}\delta(f + f_0)$
$\sin(2\pi f_0 t)$	$-\frac{1}{2j}\delta(f + f_0) + \frac{1}{2j}\delta(f - f_0)$
$\Pi(t)$	$\text{sinc}(f)$
$\text{sinc}(t)$	$\Pi(f)$
$\Lambda(t)$	$\text{sinc}^2(f)$
$\text{sinc}^2(t)$	$\Lambda(f)$
$e^{-\alpha t}u_{-1}(t), \alpha > 0$	$\frac{1}{\alpha + j2\pi f}$
$te^{-\alpha t}u_{-1}(t), \alpha > 0$	$\frac{1}{(\alpha + j2\pi f)^2}$
$e^{-\alpha\|t\|}$	$\frac{2\alpha}{\alpha^2 + (2\pi f)^2}$
$e^{-\pi t^2}$	$e^{-\pi f^2}$
$\text{sgn}(t)$	$\frac{1}{j\pi f}$
$u_{-1}(t)$	$\frac{1}{2}\delta(f) + \frac{1}{j2\pi f}$
$\delta'(t)$	$j2\pi f$
$\delta^{(n)}(t)$	$(j2\pi f)^n$
$\frac{1}{t}$	$-j\pi\text{sgn}(f)$
$\sum_{n=-\infty}^{n=+\infty}\delta(t - nT_0)$	$\frac{1}{T_0}\sum_{n=-\infty}^{n=+\infty}\delta\left(f - \frac{n}{T_0}\right)$

TABLE 2.2 TABLE OF FOURIER-TRANSFORM PROPERTIES

Signal	Fourier Transform
$\alpha x_1(t) + \beta x_2(t)$	$\alpha X_1(f) + \beta X_2(f)$
$X(t)$	$x(-f)$
$x(at)$	$\frac{1}{\lvert a \rvert} X\left(\frac{f}{a}\right)$
$x(t - t_0)$	$e^{-j2\pi f t_0} X(f)$
$e^{j2\pi f_0 t} x(t)$	$X(f - f_0)$
$x(t) \star y(t)$	$X(f)Y(f)$
$x(t)y(t)$	$X(f) \star Y(f)$
$\frac{d}{dt} x(t)$	$j2\pi f X(f)$
$\frac{d^n}{dt^n} x(t)$	$(j2\pi f)^n X(f)$
$t x(t)$	$\left(\frac{j}{2\pi}\right) \frac{d}{df} X(f)$
$t^n x(t)$	$\left(\frac{j}{2\pi}\right)^n \frac{d^n}{df^n} X(f)$
$\int_{-\infty}^{t} x(\tau)\, d\tau$	$\frac{X(f)}{j2\pi f} + \frac{1}{2} X(0)\delta(f)$

$$X(f) = \sum_{n=-\infty}^{\infty} x_n \delta\left(f - \frac{n}{T_0}\right), \tag{2.3.63}$$

we conclude that

$$x_n = \frac{1}{T_0} X_{T_0}\left(\frac{n}{T_0}\right). \tag{2.3.64}$$

This equation gives an alternative way to find the Fourier-series coefficients.

Given the periodic signal $x(t)$, we can find x_n by using the following steps:

1. First, we determine the truncated signal $x_{T_0}(t)$ using Equation (2.3.58).
2. Then, we determine the Fourier transform of the truncated signal using Table 2.1 and the Fourier-transform theorems and properties.
3. Finally, we evaluate the Fourier transform of the truncated signal at $f = \frac{n}{T_0}$ and scale it by $\frac{1}{T_0}$, as shown in Equation (2.3.64).