EE230 Test 2 – Frequency Response and Fourier Series Topics

Frequency Response

- Transfer function H(ω)
  - — Given circuit, find H(ω) ..... HW: Problem 11:1, 17:3
  - — Given SSS input x(t) and H(ω), find y(t)..... 11:2
- Bode Plots
  - — Convert between linear gain and dB 12:1,2
  - — Convert between H(ω) and magnitude Bode plot..... 12: 3,4,5
- Filter Design
  - — Given real-world problem, choose filter type (Bessel, Butterworth, etc.) ....Lab
  - — Given real-world problem, choose filter order.....Lab
  - — Given real-world problem and AFD, design filter .....Lab

Fourier Series

- Given equation or sketch of periodic $f(t)$, identify T, f, ω..... 15:1
- Given sketch or equation of periodic $f(t)$, find Fourier Series coefficients
  - — a_0, a_n, b_n..... 15:2, 16:2, 17:1
  - — A_0, A_n, ϕ_n..... 15:3
  - — c_n 19:2
- Given Fourier Series coefficients, find $f(t)$ 15:5, 16:4
- Convert among different Fourier Series coefficients 15:3, 16:3, 17:1,2, 19:1

* Given a circuit and periodic input x(t), find y(t) using Fourier Series 17:5,6

- Signal power, given both $v(t)$ and $i(t)$ or single periodic signal $f(t)$
  - — Find the power at a specific frequency, including DC 18:4
  - — Find the total average power..... 18:2

Notes

- There will be four questions, evenly balanced from the above main two topics. Hint: one will be the subtopic with a starred instead of a circular bullet.
- The attached Useful Equations for Fourier Series will be on the last page of the test.
- You may bring a
  - hand calculator
  - a 3x5 card, both sides, of your notes. No restrictions on content as long as it is not copied from another student
  - clean FE handbook that you personally own

Useful Equations for Fourier Series Problems

Integrals

$$\int \cos(\omega t)\,dt = \frac{1}{\omega}\sin(\omega t)$$

$$\int \sin(\omega t)\,dt = -\frac{1}{\omega}\cos(\omega t)$$

$$\int t\cos(\omega t)\,dt = \frac{1}{\omega^2}\cos(\omega t) + \frac{t}{\omega}\sin(\omega t)$$

$$\int t\sin(\omega t)\,dt = \frac{1}{\omega^2}\sin(\omega t) - \frac{t}{\omega}\cos(\omega t)$$

Your Own

Trig Products

$$\sin(a)\cos(b) = \tfrac{1}{2}[\sin(a+b)+\sin(a-b)]$$

$$\cos(a)\cos(b) = \tfrac{1}{2}[\cos(a+b)+\cos(a-b)]$$

$$\sin(a)\sin(b) = \tfrac{1}{2}[\cos(a-b)-\cos(a+b)]$$

Euler's Identities

$$\cos(\omega) = \tfrac{1}{2}[e^{j\omega}+e^{-j\omega}]$$

$$\sin(\omega) = \tfrac{1}{j2}[e^{j\omega}-e^{-j\omega}]$$

$$e^{j\omega} = \cos(\omega) + j\sin(\omega)$$

Fourier Series

given $f(t)$ periodic in T so $\omega_o = 2\pi/T$

$$f(t) = a_o + \sum_{n=1}^{\infty} a_n\cos(n\omega_o t) + b_n\sin(n\omega_o t) = A_o + \sum_{n=1}^{\infty} A_n\cos(n\omega_o t + \phi_n) = \sum_{n=-\infty}^{\infty} c_n e^{jn\omega_o t}$$

coefficient formulae

$$a_o = \frac{1}{T}\int_{<T>} f(t)\,dt, \quad a_n = \frac{2}{T}\int_{<T>} f(t)\cos(n\omega_o t)\,dt, \quad b_n = \frac{2}{T}\int_{<T>} f(t)\sin(n\omega_o t)\,dt$$

coefficient relationships

$$A_o = a_o = c_o, \qquad A_n\angle\phi_n = a_n - jb_n = 2c_n$$

Your Own