Exam II - Thursday, March 26, 8:45-10pm

- Show all your work and simplify your answers. Answers should include units if appropriate.

- **Important:** Throughout the exam, you will use a parameter α, whose numerical value is equal to the last non zero digit of your UIN. Use that numerical value whenever α is referenced, so the symbol α should not appear in any answers. You will automatically get zero points for any problem where the parameter is not correctly recorded and used.

- The last page includes Fourier series tables that might be useful.

1. (25 pts) Parts (b) and (c) of this problem are unrelated.

   (a) [00 pts] Write down the numerical value of α. $\alpha =?$

   (b) [10 pts] Convert each of the following two time signals into phasors in exponential form:
      i. [05 pts] $f_1(t) = -10\sin\left(2t - \frac{\pi}{\alpha}\right)$. $F_1 =?$
   ii. [05 pts] $f_2(t) = -\alpha\cos(3t) + \alpha\sin(3t)$. $F_2 =?$
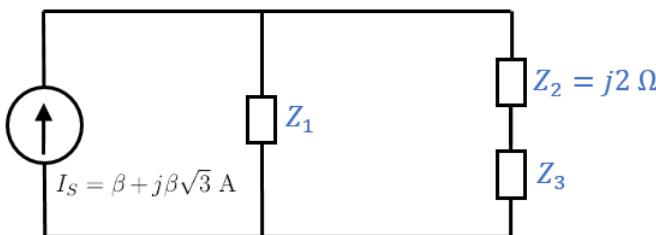
   (c) [15 pts] An LTI system is given by the following differential equation.
   $\frac{d^2}{dt^2}y + \frac{d}{dt}y + \alpha y = f(t)$.
   Determine the steady-state solution if $f(t) = \sin(\alpha t)$. $y_{ss}(t) =?$

2. (25 pts) Consider the following phasor network. The individual parts of the problem are independent from each other, except for part (a). A parameter $\beta = 10\alpha + 7$ will be used throughout this problem.



   (a) [00 pts] Write down the numerical value of β. $\beta=?$
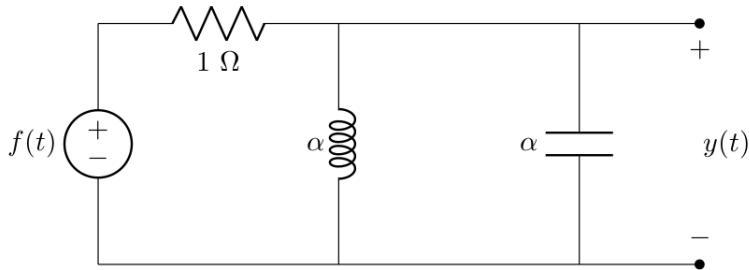
   (b) [05 pts] Let $Z_1 = 2.72 + j2\beta$ Ω, $Z_3 = 3\beta + j4\beta$ Ω. Determine the average absorbed power of Z_2. $P_{Z_2}=?$

   (c) [06 pts] Let $\omega = 2$ rad/s, and Z_1 be composed of a resistor (resistance $= \beta$ Ω) and a capacitor (capacitance $= \frac{0.5}{\beta}$ F) in parallel. Determine the value of Z_1. $Z_1=?$
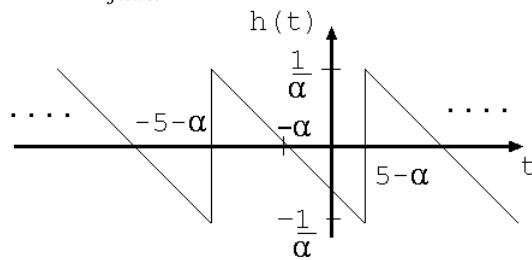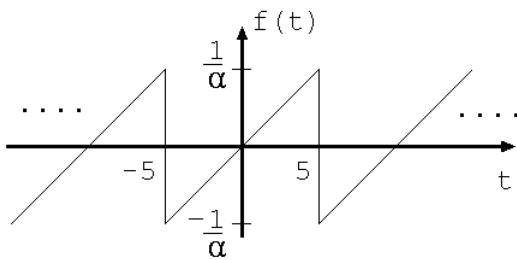
   (d) [06 pts] Let $Z_1 = 2\beta + j\beta$, and $Z_3 = Z_1 - Z_2$. Determine the average absorbed power of Z_1. $P_{Z_1}=?$

   (e) [08 pts] Let $Z_1 = \beta + j3.14$ Ω, and P_{Z_2} and P_{Z_3} represent the average absorbed power of Z_2 and Z_3, respectively. Determine the value of Z_3 that maximizes $P_{Z_2} + P_{Z_3}$. $Z_3=?$

3. (25 pts) Consider the circuit below.

(a) [00 pts] Write down the numerical value of α. $\qquad$ $\alpha =?$

(b) [03 pts] What is the natural (resonant) frequency of the circuit? $\qquad$ $\omega_0=?$

(c) [12 pts] What is the frequency response of the circuit? $\qquad$ $H(\omega)=?$

(d) [10 pts] What is the output $y(t)$ if the input is $f(t) = 2 + 2\cos(2t)$? $\qquad$ $y(t)=?$

4. (25 pts) Consider the periodic signal $f(t)$ shown below, which can be expressed as a Fourier series with exponential coefficients $F_0 = 0$ and $F_n = \frac{(-1)^{n+1}}{jn\pi\alpha}$ for $n \neq 0$.

(a) [00 pts] Write down the numerical value of α. $\qquad$ $\alpha =?$

(b) [10 pts] Determine the exponential Fourier series coefficients of $h(t)$. $\qquad$ $H_n=?$

(c) [15 pts] $f(t)$ is the input to an LTI system with frequency response

$$H(\omega) = \begin{cases} \alpha^2 \sin\left(\frac{5\omega}{2} - \frac{\pi}{2}\right) & |\omega| < \pi \\ 0 & \text{else.} \end{cases}$$

Determine the output, $y(t)$, and its fundamental frequency, $\omega_{0,y}$. $\qquad$ $y(t)=?$
. $\qquad$ $\omega_{0,y}=?$