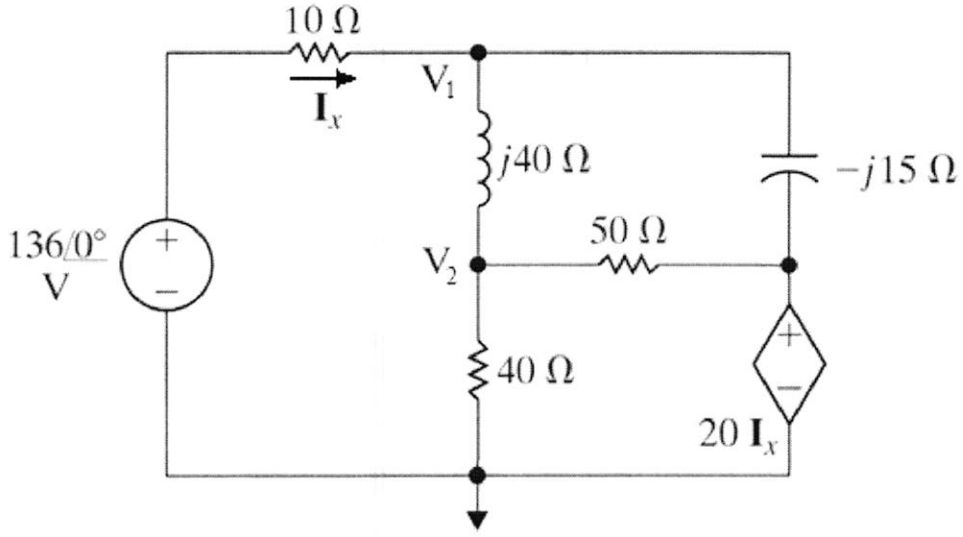
Student Name:_____

***EE201 Midterm Exam #2*** Jan. 9, 2018

**(30 pts) 1)** Write the necessary equations for solving the node voltages $V_1$ and $V_2$; and, the current $I_x$ in the following AC circuit. **Do not** solve the equations; just write them correctly and completely.




**Equation 1:**

$$\frac{V_1 - 136}{10} + \frac{V_1 - V_2}{j40} + \frac{V_1 - 20I_x}{-j15} = 0$$

**Equation 2:**

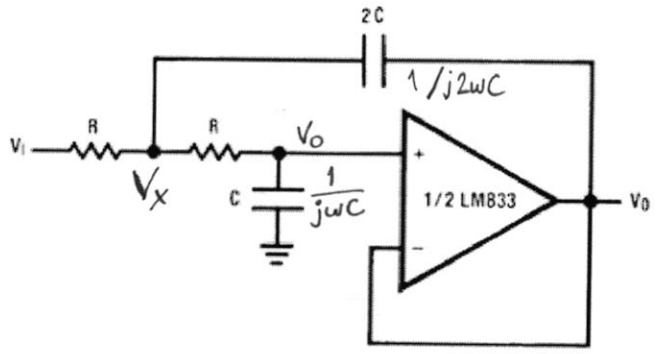
$$\frac{V_2 - V_1}{j40} + \frac{V_2 - 20I_x}{50} + \frac{V_2}{40} = 0$$

**Equation 3:**

$$I_x = \frac{136 - V_1}{10}$$

*Note:* Total time allowed is 100 min. Please show all your work and write legibly.

**(30 pts) 2)** For the second order Butterworth circuit below, find the transfer function $H(j\omega) = \dfrac{V_o(j\omega)}{V_I(j\omega)}$




**Answer 2:**

$$\frac{V_x - V_I}{R} + \frac{V_x - V_o}{R} + (V_x - V_o)\cdot j2wC = 0$$

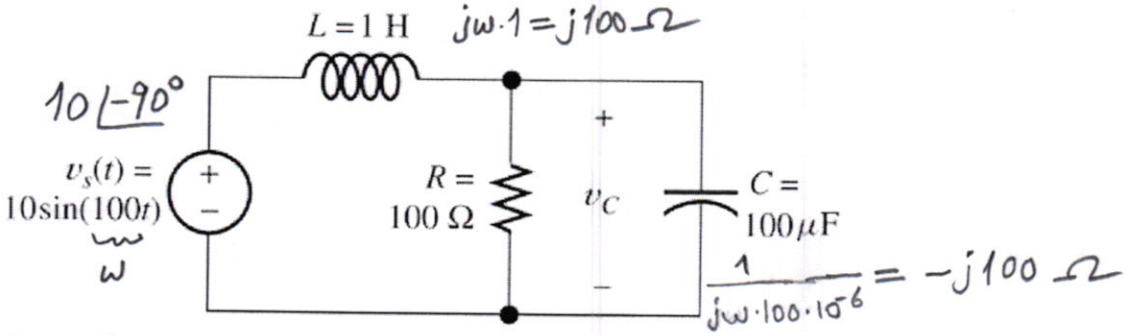
$$\frac{V_o - V_x}{R} + V_o \cdot jwC = 0$$

$$\Rightarrow V_x = V_o \cdot (1 + jwRC)$$

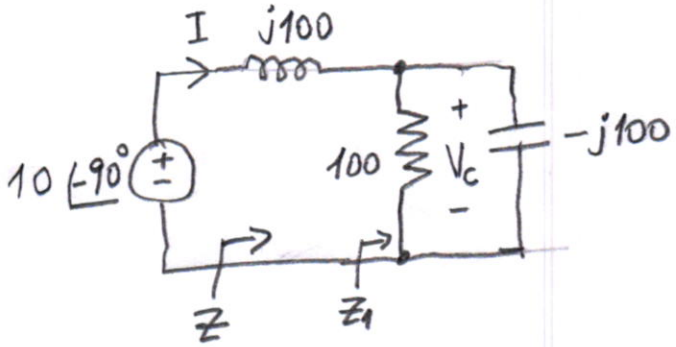
$$\Rightarrow V_o(1+jwRC) - V_I + V_o jwRC + V_o jwRC \cdot j2wRC = 0$$

$$\Rightarrow H = \frac{V_o}{V_I} = \frac{1}{(jw)^2 \cdot 2R^2C^2 + jw2RC + 1}$$

**(40 pts) 3)** For the following AC circuit, find the voltage $v_C(t)$, and, the average, reactive and apparent power delivered by the voltage source.




**Answer 3:**




$$Z = j100 + \frac{1}{\frac{1}{100} + \frac{1}{100j}} = j100 + \underbrace{50 - j50}_{Z_1} = 50 + j50\ \Omega$$

$$\Rightarrow I = \frac{-10j}{50 + j50} = -0.1 - 0.1j\ \text{A}$$

$$\Rightarrow V_c = I \cdot Z_1 = (-0.1 - 0.1j)(50 - j50) = -10\ \text{V}$$

$$\Rightarrow v_c(t) = 10 \cdot \cos(100t - 180°)$$

S = 1/2 Vs I* = 0.5x(-10j)x(-0.1+0.1j) = 0.5 +0.5j VA

Average Power = 0.5 W
Reactive Power = 0.5 VAR
Apparent Power = 0.707 VA