1. (14 pts) A frequency response curve is shown below (dashed line).

(a) Draw the Bode plot of $H(s)$ (the straight-line approximation) right on the curve above.
(b) List any and all corner frequencies that you can find from the graph above.
(c) If there are any corners in the Bode plot associated with poles in the transfer function, list that/those corner frequency(ies) below ($f_p$).
(d) If there are any corners in the Bode plot associated with zeroes in the transfer function, list that/those corner frequency(ies) below ($f_z$).
(e) This Bode plot is for what type of filter? Circle the best answer.
   i) low pass  ii) high pass  iii) band pass  iv) band reject  v) sludge  vi) coffee  vii) can't tell

2. (18 pts) Analysis of a circuit (not pictured) yields the characteristic equation below.
   \[ 0 = s^2 + 20s + 6500 \]
   Further analysis yields the following initial and final conditions:
   \[
   i_L(0) = 220\text{mA}\quad v_L(0) = -6\text{V} \quad v_C(0) = 8\text{V} \quad i_C(0) = 100\text{mA}
   \]
   \[
   i_L(\infty) = 80\text{mA}\quad v_L(\infty) = 0\text{V} \quad v_C(\infty) = 2\text{V} \quad i_C(\infty) = 0\text{mA}
   \]
   Write the full expression for $i_L(t)$, including all the constants that you find.
   \[ i_L(t) = ? \]

3. (20 pts) Consider the circuit at right. The current source has been 50 mA for a long time and changes from 50 mA to 20 mA at time $t = 0$.
   (a) What are the final conditions of $i_L$ and the $v_C$?
      \[ i_L(\infty) = ? \quad v_C(\infty) = ? \]
   (b) Find the initial condition and initial slope of $i_L$ that you would need to have in order to find all the constants in $i_L(t)$. Don't find $i_L(0)$ or it's constants, just the initial conditions.
   (c) Find the initial condition and initial slope of $v_C$ that you would need to have in order to find all the constants in $v_C(t)$. Don't find $v_C(t)$ or it's constants, just the initial conditions.
4. (20 pts) a) A feedback system is shown in the figure. What is the transfer function of the whole system, with feedback.

\[ H(s) = \frac{X_{\text{out}}(s)}{X_{\text{in}}(s)} = ? \]

Simplify your expression for \( H(s) \) so that the denominator is a simple polynomial.

b) Find the value of \( K \) to make the transfer function critically damped.

c) If \( K \) is less than this value the system will be: underdamped or overdamped Circle one

d) Does the transfer function have a zero? Answer no or find the \( s \) value(s) of the zero(s).

5. (8 pts) Find:

a) The average, DC \( (V_{\text{DC}}) \) voltage.

b) The RMS (effective) voltage

6. (20 pts) For the 60 Hz load shown in the figure, the RMS voltmeter measures 220 V, the wattmeter measures 560 W, and the power factor is 82%.

Find the following:

a) The reading on the RMS ammeter.

b) The apparent power. \( |I| = ? \)

c) The reactive power. \( Q = ? \)

d) The complex power. \( S = ? \)

e) The power factor is: i) leading ii) lagging (circle one)

f) The load box cannot be opened. Add (draw it) another component to the circuit above which can correct the power factor (make \( \text{pf} = 1 \)). Show the correct component in the correct place and find its value. This component should not affect the real power consumption of the load.

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**Answers**

1. a) \( |H(f)| \) (dB)

2. \( i_L(t) = 80 \text{ mA} + e^{10t} \cdot (140 \text{ mA} \cdot \cos(80t) - 920 \text{ mA} \cdot \sin(80t)) \)

3. a) \( 2 \text{ V} \) b) \( 20 \text{ mA} \) c) \( \frac{600}{\text{sec}} \) d) \( 5 \text{ V} \) e) \( -75000 \text{ V/sec} \)

4. a) \( \frac{-600 \cdot K \cdot (s + 40)}{s^2 + 65s + 500K + 1000} \) b) 0.113 c) overdamped d) -40

5. a) \( -3 \text{ V} \) b) 4.64 V

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**Draw the component on drawing!**

b) 40-Hz 2-kHz c) 40-Hz d) 2-kHz
e) i) low pass