

Final Exam

June 21, 2017

Rules and Regulations: It is permitted to bring three pieces of paper of A4 size with handwritten formulas. There is a time limit of two hours and fifty minutes.

Problems for Solution:

1. A band-pass filter has the transfer function

$$\mathbf{H}(\omega) = -\frac{j\omega\omega_2}{(\omega_1 + j\omega)(\omega_2 + j\omega)}$$

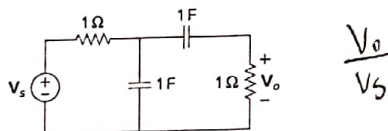
- (a) (5%) Find the center frequency ω_0 such that $|\mathbf{H}(\omega_0)|$ is maximized.
 (b) (5%) Determine the exact half-power frequencies $\hat{\omega}_1$ and $\hat{\omega}_2$ such that $|\mathbf{H}(\hat{\omega}_1)|^2 = |\mathbf{H}(\hat{\omega}_2)|^2 = |\mathbf{H}(\omega_0)|^2/2$.

2. (10%) For a band-pass filter with the transfer function

$$\mathbf{H}(\omega) = \frac{j\omega B}{(j\omega)^2 + j\omega B + \omega_0^2}$$

show that the bandwidth is B and the center frequency is ω_0 .

3. An RC circuit is given as follows.

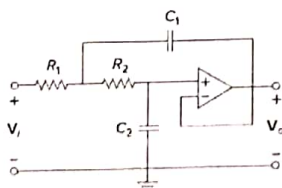


- (a) (5%) Identify the type of the filter.
 (b) (5%) Determine the center frequency and the bandwidth of the filter.
4. (10%) A band-pass filter has the transfer function

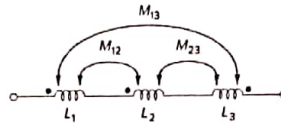
$$\mathbf{H}(\omega) = 1 - \frac{1 + j2\omega/\omega_2 + (j\omega)^2/(\omega_1\omega_2)}{(1 + j\omega/\omega_1)(1 + j\omega/\omega_2)}$$

Find the center frequency ω_0 such that $|\mathbf{H}(\omega_0)|$ is maximized.

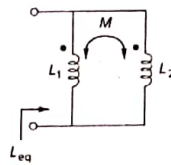
5. An active filter circuit is given as follows.



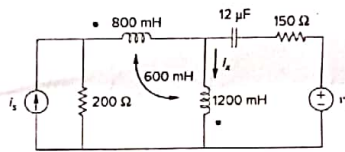
- (a) (5%) Find the transfer function $H(\omega) = V_o(\omega)/V_i(\omega)$.
 (b) (5%) Identify the type of this filter.
6. Express the total inductance in terms of L_1 , L_2 , L_3 , M_{12} , M_{23} , and M_{13} for the following circuit.



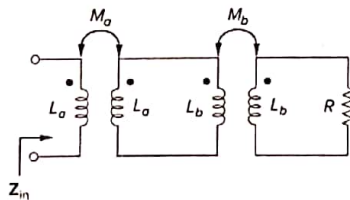
7. (10%) For the coupled coils as given below, determine the equivalent inductance L_{eq} .



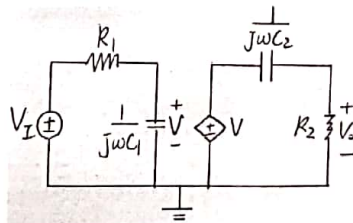
8. (10%) Let $i_s = 4 \cos(600t)$ A and $v_s = 110 \cos(600t + 30^\circ)$ V. Find i_x in the following circuit.



9. (10%) Two linear transformers are cascaded as shown below. Express the input impedance Z_{in} in terms of L_a , L_b , M_a , M_b , and R .



10. 感謝提供題目的陳芃文、謝茹媛、張竣佑、李昱、張壹登、廖克允、賴建勳、鄧有敦同學。 A circuit is given as follows.



- (a) (5%) Find the transfer function $H(\omega) = V_o(\omega)/V_i(\omega)$.
 (b) (5%) Identify the type of this filter.