1) A system function is \( H(s) = \frac{4(s+1)}{s^2 + 8s + 15} \).

(a) Plot the pole/zero diagram.

(b) By the help of the pole/zero diagram, sketch the (approximate) magnitude and phase characteristics.

2) A transfer admittance is \( Y_T(s) = \frac{s+4}{s^2+7s+9} \).

(a) Plot the pole/zero diagram.

(b) Sketch the magnitude and phase characteristics.

(c) Given the input \( v_1(t) = 9 + 3 \cos(2t+15°) - 7 \sin(3t-60°) \), find the steady-state output \( i_2(t) \).

3)

(a) Obtain the input impedance \( Z(s) \).

(b) Plot the pole/zero diagram.

(c) By the help of the pole/zero diagram, sketch the (approximate) magnitude and phase characteristics.

4) (a) Obtain the system function.

(b) Plot the pole/zero diagram.

(c) Sketch the magnitude and phase characteristics.

\[ C = 5 \text{ nF}, \quad R = 4 \text{ k\Omega} \]

\( L_1 = 60 \text{ mH}, \quad L_2 = 20 \text{ mH}, \quad M = 20 \text{ mH} \)

(a) - \( I - \)
4) Synthesize $N$.

5) (a) Find the natural frequencies of the circuit.
(b) Obtain the transfer function $H(s) = \frac{V_{R}(s)}{V_{C}(s)}$.
   Plot the pole/zero diagram.
   Sketch the magnitude and phase characteristics.
(c) Repeat Part (b) for the input admittance $Y_i(s) = \frac{I_{C}(s)}{V_{C}(s)}$.
(d) What are the natural frequencies of $V_{R}(s)$ and $V_{C}(s)$?

6) (a) Obtain the input admittance.
   Plot the pole/zero diagram.
   Sketch the magnitude and phase characteristics.
(b) Obtain the input admittance.
   Plot the pole/zero diagram.
   Find the resonant frequency $\omega_0$.
   Sketch the approximate magnitude and phase characteristics.
(c) Let $E$ be the total average stored energy in the one-port and $P$ be the average power input to the one-port at $\omega_0$.
   Compute $\omega_0 E/P$. Discuss.
7) \( R = 5 \Omega, \ C = \frac{1}{10} F, \ L = \frac{1}{8} H, \ r = \frac{1}{20} \Omega \). Obtain the input impedance. Plot the pole/zero diagram. Find the resonant frequency \( \omega_0 \).

Sketch the approximate magnitude and phase characteristics.

Scale the circuit so that the new value of \( R \) is 10 k\( \Omega \) and the new value of \( C \) is 1 \( \mu F \).

8) \( \omega_0 = \frac{1}{\sqrt{LC}} \), \( 2\alpha = r/L \), \( \Omega = \omega_0/2\alpha \), \( \text{Req} = \frac{\Omega}{\Omega^2 r} \).

Find the resonant frequency \( \omega_0 \). Express it in terms of \( \omega_0 \) and \( \Omega \).

Obtain the input impedance \( Z(s) \). Express it in terms of \( s/\omega_0 \), \( \Omega \), and \( \text{Req} \).

Plot the pole/zero diagram.

Sketch the approximate magnitude and phase characteristics.

Let \( E \) be the total average stored energy in the one-port and \( P \) be the average power input to the one port at \( \omega_0 \). Show that \( \frac{\omega_0 E}{P} = \Omega \).

\[
L = \frac{5}{2} H, \ r = \frac{7}{5} \Omega, \ C = \frac{1}{10} F
\]
\( \hat{\Omega} = \frac{\omega_0 L}{r} \)

\[
L = \frac{5}{2} H, \ r = \frac{7}{5} \Omega, \ C = \frac{1}{10} F
\]
\( \hat{\Omega} = \frac{1}{\omega_0 CR} \)
9) The op-amp is ideal and operates in the linear region.

(a) Obtain the transfer function. Plot the pole/zero diagram.
(b) Scale the circuit so that the new value of R is 10 kΩ and the magnitude response peaks at 4 kHz/sec.

10) K = 0, R = 10 kΩ, C = 1 F.

(a) Obtain the transfer function.
(b) Scale the circuit so that R = 10 kΩ and C = 100 nF.
(c) Sketch the magnitude and phase characteristics of the scaled circuit.

11) The op-amp is ideal and operates in the linear region.

(a) Obtain the transfer function.
(b) Design the circuit (find C and R) so that the circuit is a second order bandpass filter whose center frequency is 10 kHz/sec and half-power bandwidth is 1 kHz/sec.

12) Plot the pole/zero diagram. Sketch the magnitude and phase Bode plots.

(a) \( H(s) = \frac{100(5s+1)}{(s+1)(s+1000)} \), (b) \( H(s) = \frac{60s^2}{(s+20)(s^2+14s+4)} \), (c) \( H(s) = \frac{s^2+100s+1000}{(s+10)^2} \), (d) \( H(s) = \frac{100s}{(s+20)(s+1000)} \)

13) Obtain the transfer function.

Plot the pole/zero diagram.
Sketch the magnitude and phase Bode plots.
Sketch the approximate magnitude and phase characteristics.