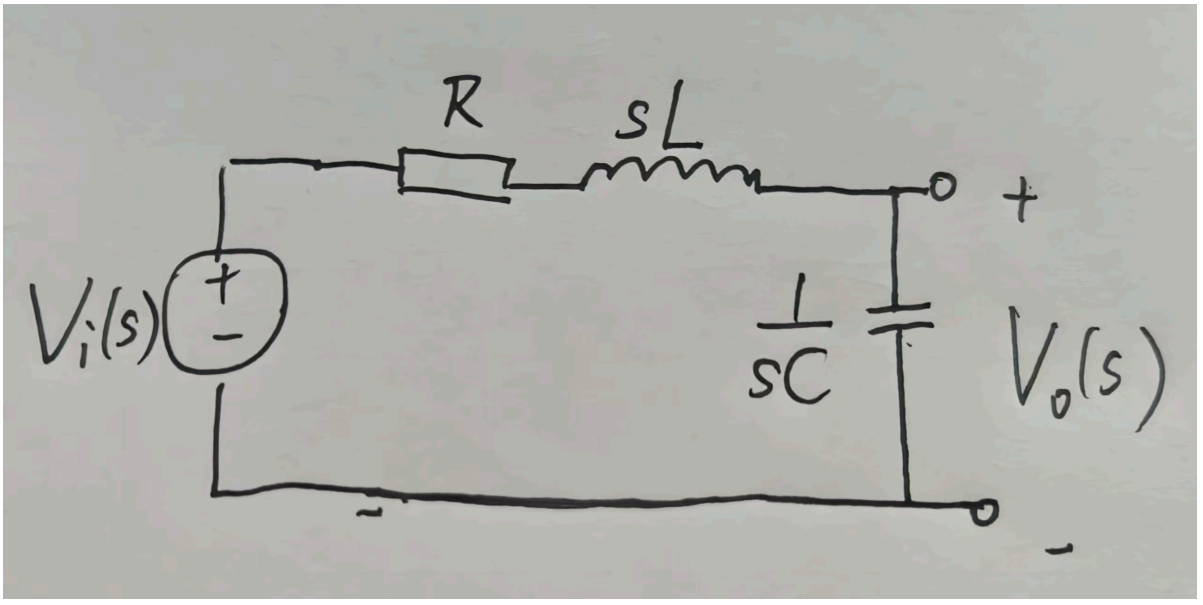
第二题

(1)



(2)

$V_i(s) - V_o(s) = I(s)(R+sL)$

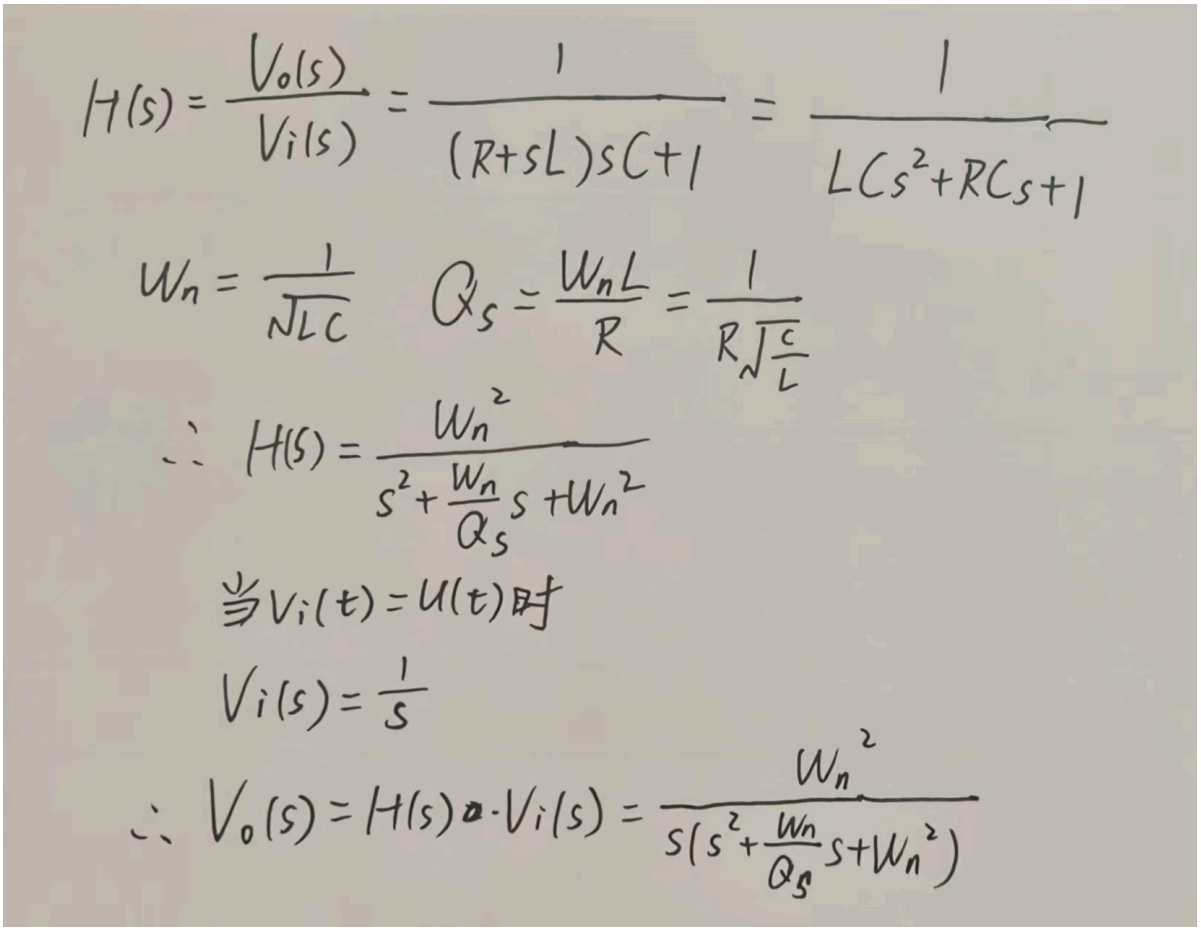
电容电流：$I_c(s) = sCV_o(s)$

$I(s) = sCV_o(s)$

$\therefore V_i(s) - V_o(s) = sCV_o(s)$

$\therefore$ 电路方程为 $V_i(s) = V_o(s)(1+sC(R+sL))$

(3)



(4)

情形 A（R=1 Ω, L=0.01 H, C=553 μF）：

$$\omega_n = \frac{1}{\sqrt{LC}} \approx 425.24 \text{ rad/s}$$

$$Q_s = \frac{\sqrt{L/C}}{R} \approx 4.25$$

情形 B（R=0.1 Ω, L=0.01 H, C=100 μF）：

$$\omega_n = 1000 rad/s$$

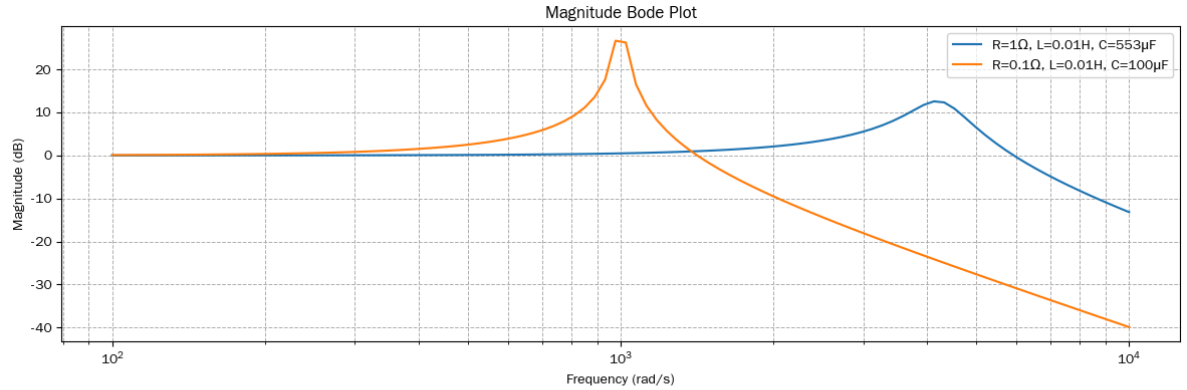
$$Q_s = 100$$

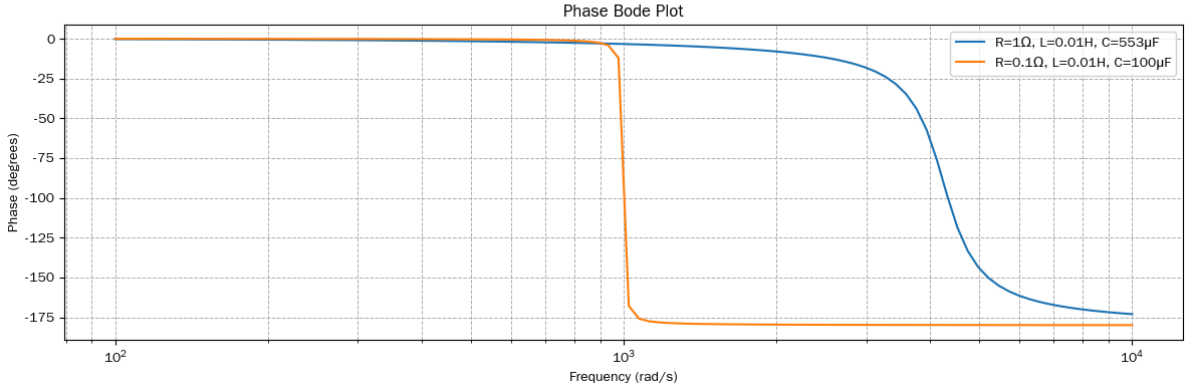
python代码及其解释

```
import numpy as np
import matplotlib.pyplot as plt
from scipy import signal

# 情况一参数
R1 = 1
L1 = 0.01
C1 = 553e-6
omega_n1 = 1 / np.sqrt(L1 * C1)
```

```
Q_s1 = 1 / (R1 * np.sqrt(C1 / L1))
num1 = [omega_n1**2]
den1 = [1, omega_n1 / Q_s1, omega_n1**2]
sys1 = signal.TransferFunction(num1, den1)

# 情况二参数
R2 = 0.1
L2 = 0.01
C2 = 100e-6
omega_n2 = 1 / np.sqrt(L2 * C2)
Q_s2 = 1 / (R2 * np.sqrt(C2 / L2))
num2 = [omega_n2**2]
den2 = [1, omega_n2 / Q_s2, omega_n2**2]
sys2 = signal.TransferFunction(num2, den2)

# 绘制波特图
w, mag1, phase1 = signal.bode(sys1)
w, mag2, phase2 = signal.bode(sys2)

plt.figure(figsize=(12, 8))

# 幅频特性
plt.subplot(2, 1, 1)
plt.semilogx(w, mag1, label='R=1Ω, L=0.01H, C=553μF')
plt.semilogx(w, mag2, label='R=0.1Ω, L=0.01H, C=100μF')
plt.title('Magnitude Bode Plot')
plt.xlabel('Frequency (rad/s)')
plt.ylabel('Magnitude (dB)')
plt.legend()
plt.grid(which='both', linestyle='--', linewidth=0.7)  # 更清晰的网格

# 相频特性
plt.subplot(2, 1, 2)
plt.semilogx(w, phase1, label='R=1Ω, L=0.01H, C=553μF')
plt.semilogx(w, phase2, label='R=0.1Ω, L=0.01H, C=100μF')
plt.title('Phase Bode Plot')
plt.xlabel('Frequency (rad/s)')
plt.ylabel('Phase (degrees)')
plt.legend()
plt.grid(which='both', linestyle='--', linewidth=0.7)  # 更清晰的网格

plt.tight_layout()
plt.show()

# 输出ωn和Qs值
print("情况一：ωn =", omega_n1, "rad/s, Qs =", Q_s1)
print("情况二：ωn =", omega_n2, "rad/s, Qs =", Q_s2)
```

波特图


Magnitude Bode Plot
R=1Ω, L=0.01H, C=553μF
R=0.1Ω, L=0.01H, C=100μF
Magnitude (dB)
20
10
0
-10
-20
-30
-40
10^2
10^3
10^4
Frequency (rad/s)


Phase Bode Plot
R=1Ω, L=0.01H, C=553μF
R=0.1Ω, L=0.01H, C=100μF
Phase (degrees)
0
-25
-50
-75
-100
-125
-150
-175
10^2
10^3
10^4
Frequency (rad/s)