YTU FACULTY OF ELECTRICAL & ELECTRONICS ENGINEERING
DEPARTMENT OF CONTROL & AUTOMATION ENGINEERING
KOM3751 CONTROL SYSTEMS, QUIZ-1

Name, Surname: **Student number:** **Signature:** **Solutions**	**Grading:** Each question has the same value. **Time:** 4th January, 2021, **12 noon** **Due Time:** 4th January, 2021, **12:40 pm** *Send your files to* odevyl.ytu@gmail.com *not later than* 12:45 pm.

Problem-1 Consider the Low Pass RC circuit given below and answer the questions ***i*** to ***vi***.

i. Obtain the $G_1(s) = V_o(s)/V_i(s)$ transfer function of the circuit.

ii. Determine the time constant of this circuit in seconds for $R = 500\text{k}\Omega$ and $C = 0.1\mu\text{F}$.

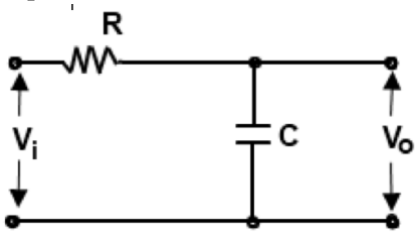
Suppose that you found the transfer function as $G_1(s) = 40/(s+10)$ now,

iii. Draw the Bode magnitude plot of the circuit (the asymptotic then actual plots on the same plane).

iv. Draw the Bode phase plot of the circuit (first the asymptotic then the actual plots on the same plane).

v. Write the slopes of the magnitude plot at LF (low freq.) and HF in dB per octave and dB per decade.

vi. Indicate all slopes of the phase plot.



Problem-2 Consider a negative feedback system, which has the following open-loop transfer function,

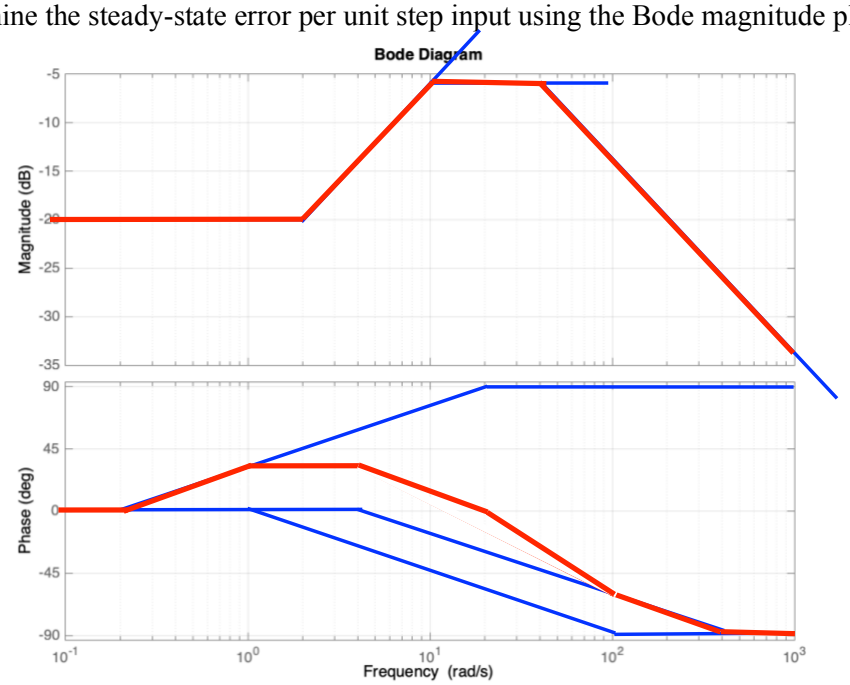
$$G_2(s) = \frac{20(s+2)}{(s+10)(s+40)}$$

vii. Draw the Bode magnitude plot of the transfer function. Indicate all slopes on the plot.

viii. Draw the Bode phase plot of the transfer function. Show all slopes on the plot.

ix. What is the magnitude at LF and HF (at 1k rad/s) in dB?

x. Determine the steady-state error per unit step input using the Bode magnitude plot.



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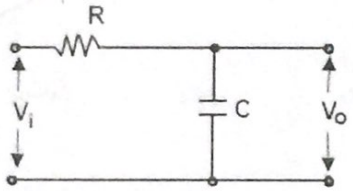

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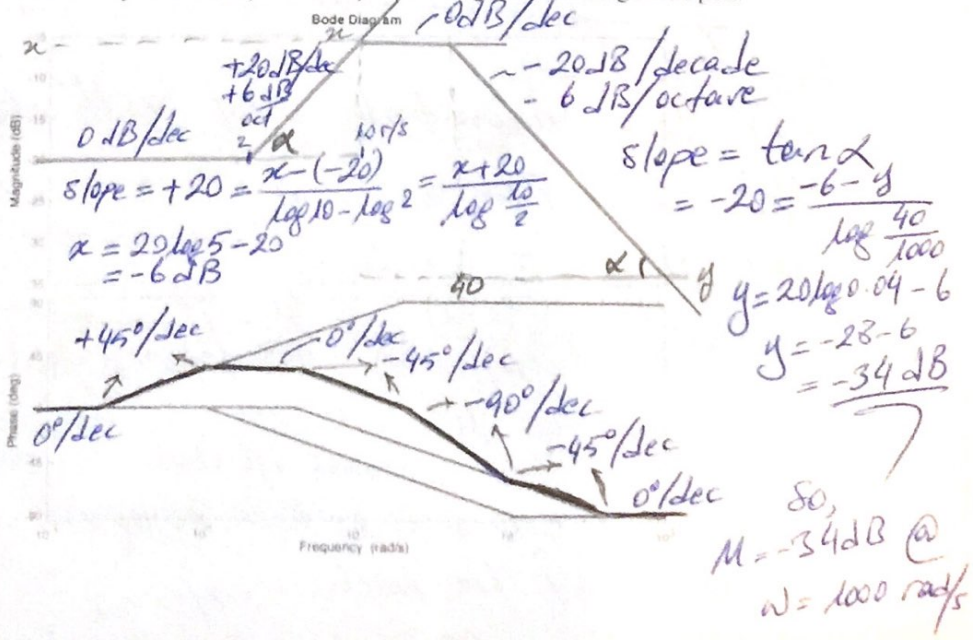
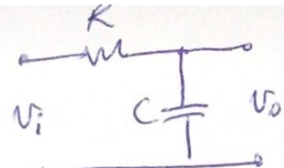


Solutions

Problem-1

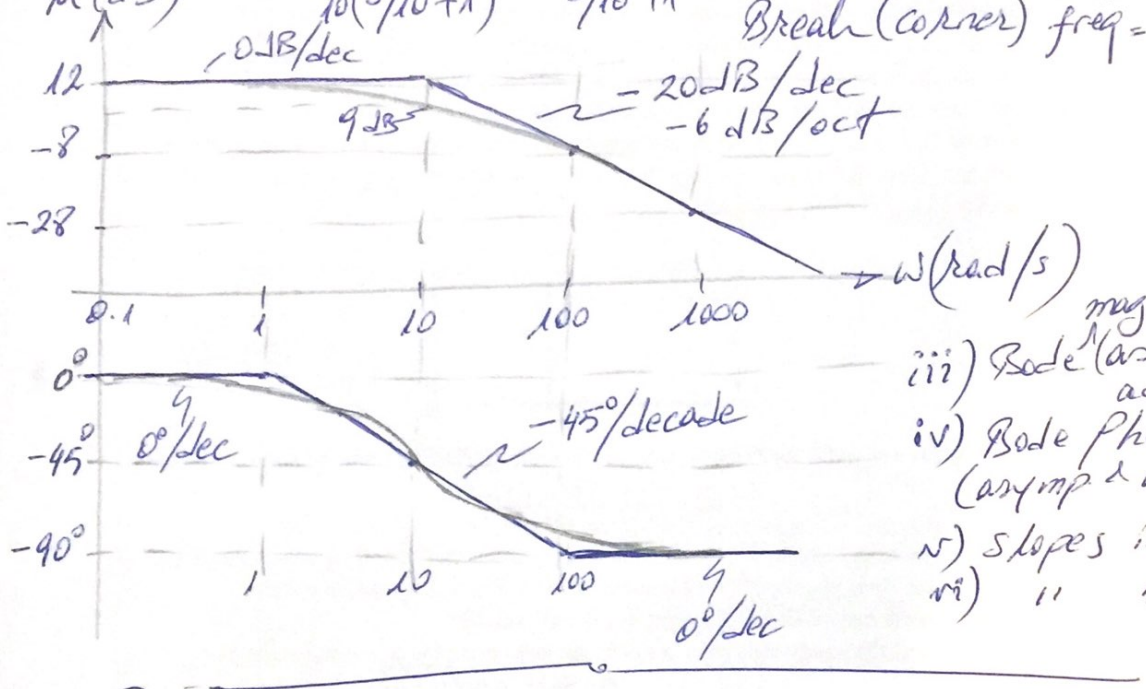


i) $\frac{V_o(s)}{V_i(s)} = \frac{\frac{1}{Cs}}{R+\frac{1}{Cs}} = \frac{1}{RCs+1} = \frac{\frac{1}{RC}}{s+\frac{1}{RC}}$

ii) $T_c = \tau = RC = 500\,k\Omega * 0.1\,\mu F$
$= 0.5\,M\Omega * 0.1\,\mu F = 0.05$ sec.
$= 50$ ms

iii) $G_1(s) = \frac{40}{s+10} = \frac{40}{10(s/10+1)} = \frac{4}{s/10+1}$ ⇒ @ LF: $20\log M = 20\log 4$
$= 12$ dB

Break (corner) freq = 10 rad/s



iii) Bode magnitude (asymp & actual)
iv) Bode Phase (asymp & actual)
v) slopes in M
vi) " " ∠

Problem-2

vii) Bode magnitude plot with slopes → at the back
viii) " phase " " " → " "
ix) M @ LF = -20 dB

$G_2(s) = \frac{20(s+2)}{(s+10)(s+40)} = \frac{40}{400}\frac{s/2+1}{(s/10+1)(s/40+1)}$, @LF $20\log\frac{40}{400} = -20$ dB

@ 1000 rad/sec $M = \frac{20\sqrt{2^2+1000^2}}{\sqrt{10^2+1000^2}\sqrt{40^2+1000^2}} = \frac{20}{1000}$ → $20\log 0.02 = -34$ dB

$20\log M = 20\log 2 + 20\log 10 - 20\log 10^3 = 6 + 20 - 60$
$= -34$ dB

Or (soln-2): at the back

x) $20\log K_p = -20 \Rightarrow K_p = 10^{-20/20} = 10^{-1} = 0.1 \Rightarrow e_{ss} = \frac{1}{1+0.1} = 0.91$