ECE3204 Lecture 7

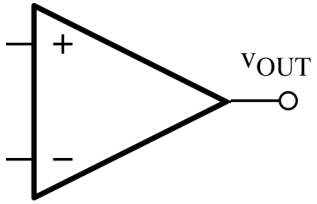
Gain-bandwidth product relationship

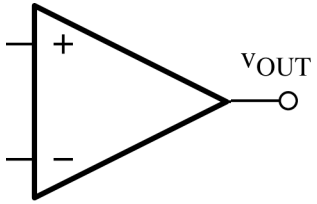
Op-Amp as a classical feedback system

Op-Amp Design Example

Handouts:
Design Example
Op-Amp Error Matrix

What's the difference between
OPEN LOOP GAIN CLOSED LOOP GAIN
?





Op-Amp Design Example

a) Design an inverting amplifier with an input resistance of 1kΩ and a gain of -100

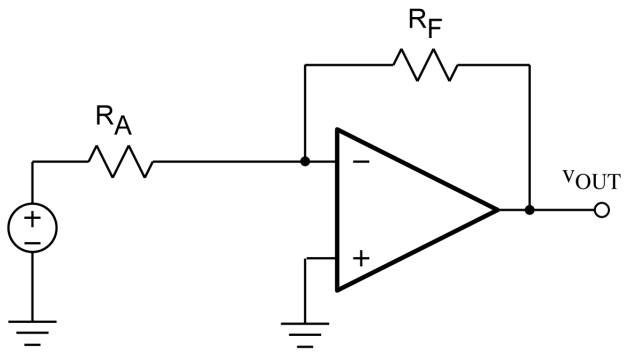
b) If an LM741 (f_T = 1MHz) is used, determine the closed loop transfer function, and express in the form showing the DC gain and closed loop 3-dB frequency (bandwidth) f_{3dB}

c) Determine $v_{OUT}(t)$ for an input step of 0 to 100mV. At what time will the output $v_{OUT}(t)$ reach within 100mV of its final value?

d) Determine $v_{OUT}(t)$ for an input sine wave of $(100mV)\sin(2\pi[100Hz]t)$

e) Determine $v_{OUT}(t)$ for an input sine wave at the upper edge of the audio frequency range $(100mV)\sin(2\pi[20kHz]t)$

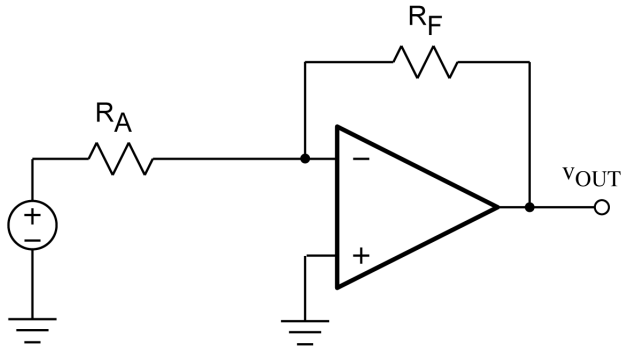
f) If we want a closed loop 3-dB frequency (bandwidth) f_{3dB} = 20kHz for an audio application, determine the op-amp unity gain frequency f_T required

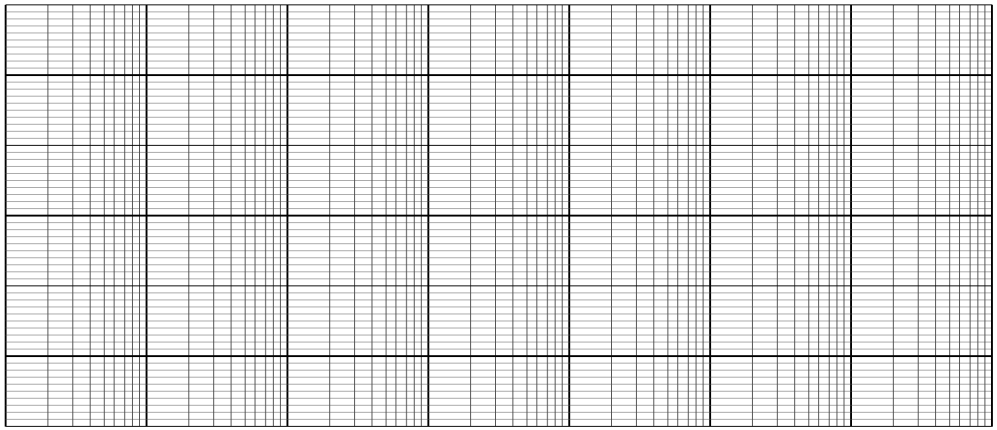


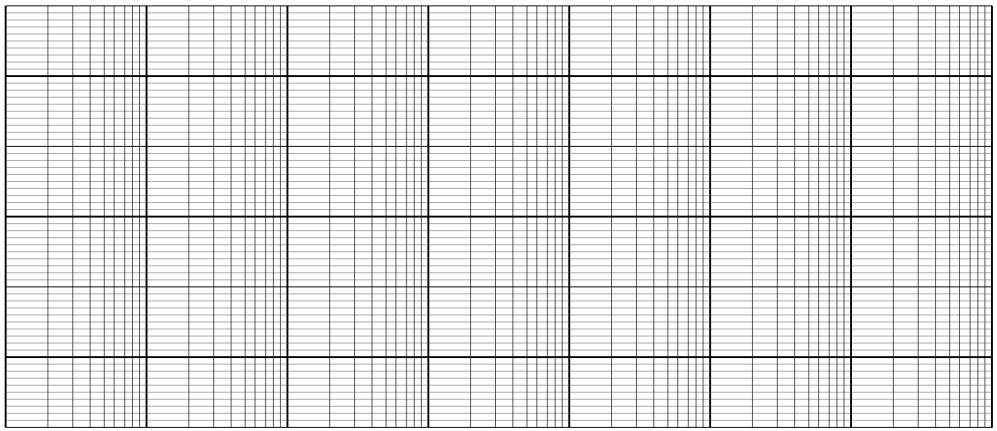
b) If an LM741 (f_T = 1MHz) is used, determine the closed loop transfer function, and express in the form showing the DC gain and closed loop 3-dB frequency (bandwidth) f_{3dB}

Gain-bandwidth product procedure:

1. Redraw circuit with all inputs suppressed (set = 0)
2. Find feedback factor β (fraction of output fed back to inverting input)
3. Closed loop bandwidth $f_{3\text{-}dB}$ will be unity gain frequency f_t multiplied by β



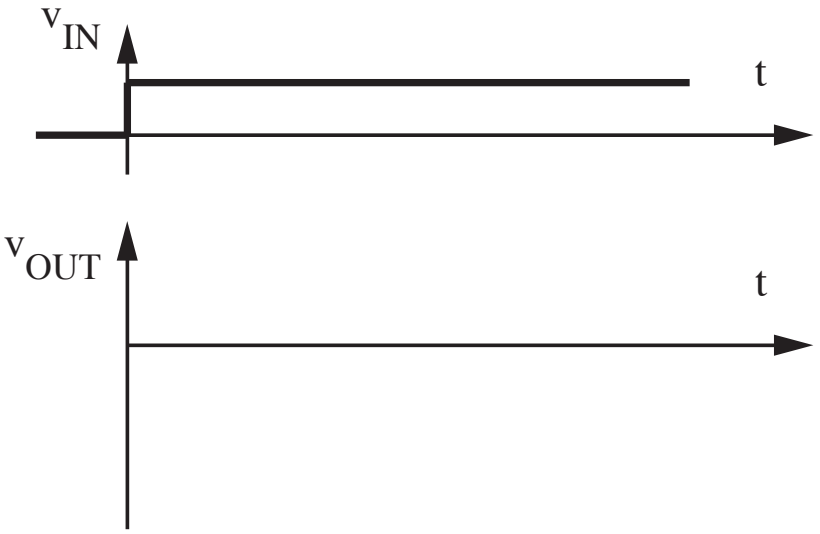




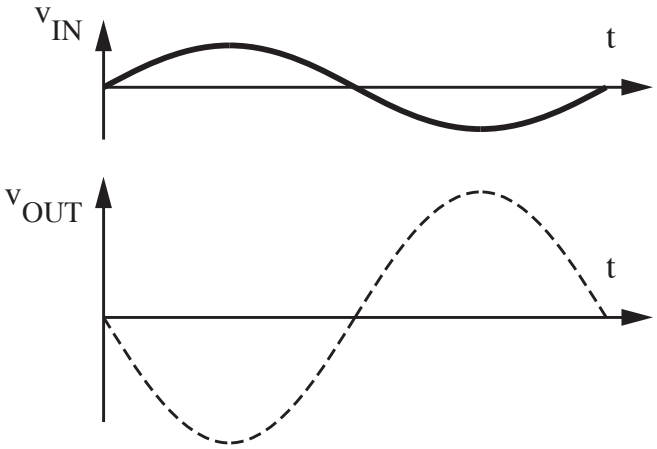
c) Determine $v_{OUT}(t)$ for an input step of 0 to 100mV.

What is the 10%-to-90% rise time?

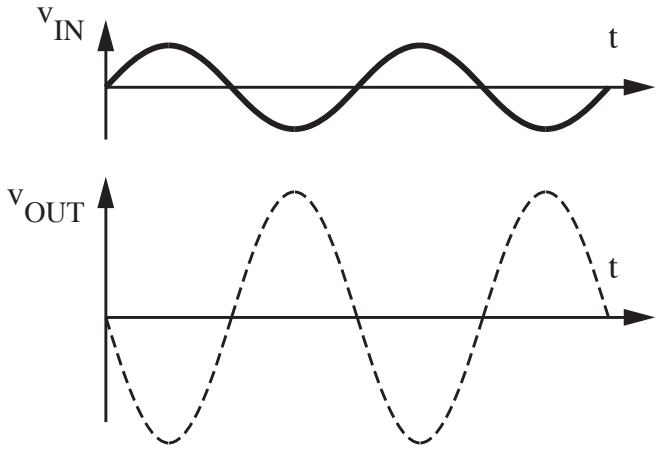
At what time will the output $v_{OUT}(t)$ reach within 100mV of its final value?



d) Determine $v_{OUT}(t)$ for an input sine wave of (100mV)sin(2π[100Hz]t)



e) Determine $v_{OUT}(t)$ for an input sine wave at the upper edge of the audio frequency range (100mV)sin(2π[20kHz]t)



f) If we want a closed loop 3-dB frequency (bandwidth) f_{3dB} = 20kHz for an audio application, determine the op-amp unity gain frequency f_T required

What about f_T (unity gain bandwidth) variability?

Electrical Characteristics (Note 5) (Continued)

Parameter	Conditions	LM741A			LM741			LM741C			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Bandwidth (Note 6)	$T_A = 25^\circ C$	0.437	1.5								MHz

LM741

If you need to depend on closed loop f_{3dB}, get it from (better controlled) passive element values