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Analog Electronics Lab #3 - Design of VCVS, VCCS, CCVS and CCCS using LM741

### **Objectives**

To design the following four topologies using LM741 OPAMP

- 1. Voltage Controlled Voltage Source (VCVS)
- 2. Current Controlled Voltage Source (CCVS)
- 3. Voltage Controlled Current Source (VCCS)
- 4. Current Controlled Current Source (CCCS)

and find

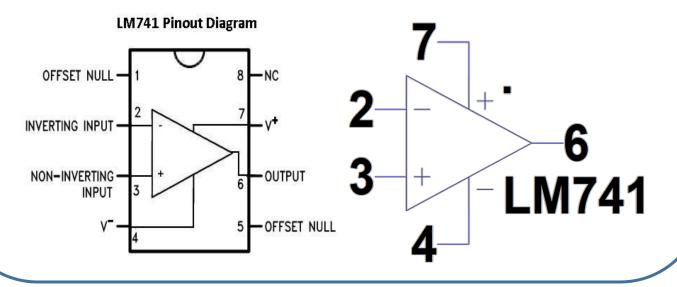
Simulated values of voltage gain (A<sub>v</sub>) by

- a) Varying R<sub>L</sub> with constant source
- b) Varying source with constant R<sub>L</sub>

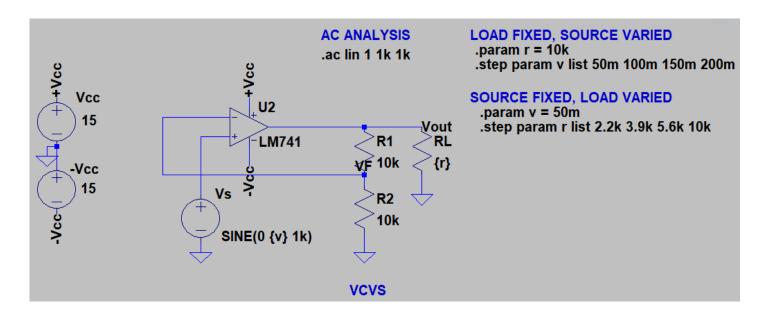
Compare the results from simulation with the theoretical values of A<sub>v</sub>.

### IC LM-741

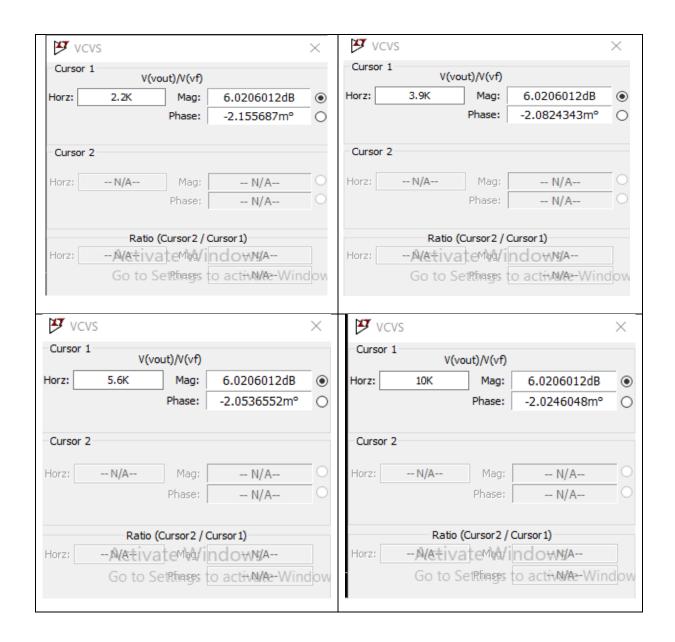
- LM741 operational amplifier is a DC-coupled high gain electronic voltage amplifier.
- It has only one op-amp inside.
- An operational amplifier IC is used as a comparator, which compares the two signal, the inverting and non-inverting signal.
- The main function of this IC is to do mathematical operation in various circuits.
- Op-amps have large gain and usually used as Voltage Amplifier.
- The LM741 can operate with a single or dual power supply voltage.

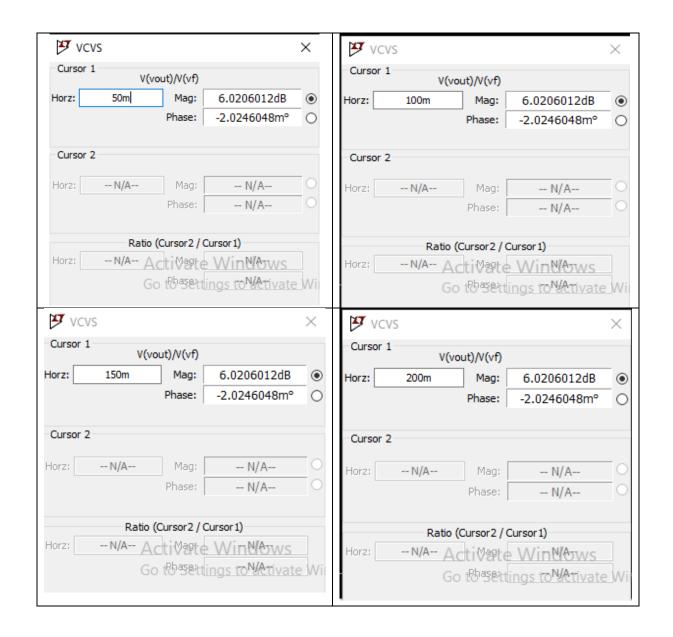


# Voltage Controlled Voltage Source (VCVS)



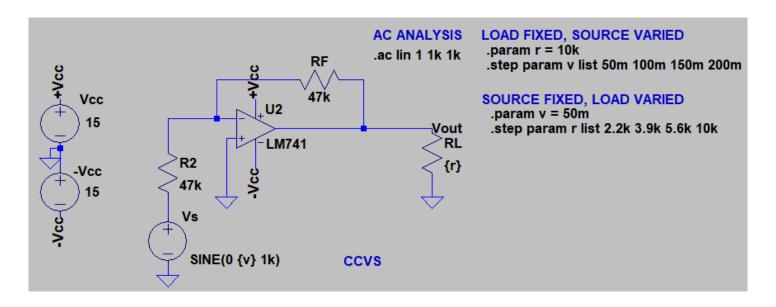
Source  $V_s = 50 \text{mV}$  and load varied



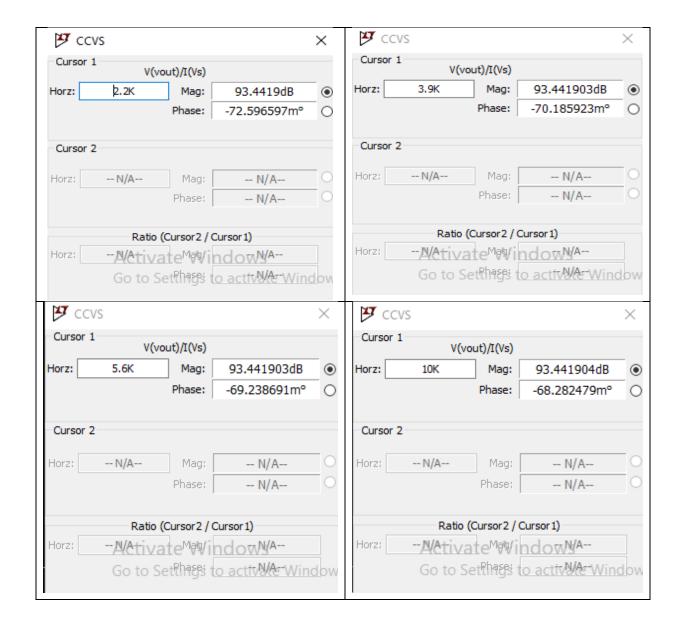


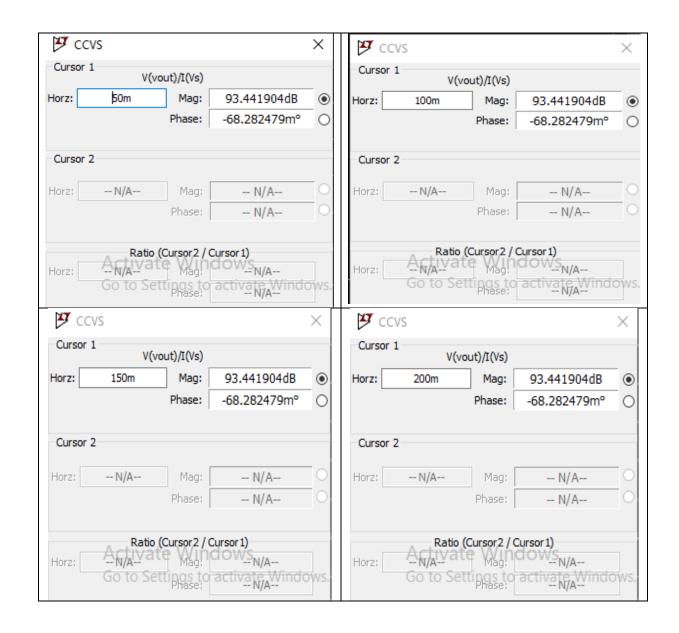
V <sub>s</sub> (mV)	$R_{l}$ (k $\Omega$ )	Simulated A <sub>v</sub>	Theoretical $A_v = 1 + (R_1/R_2)$
50	2.2	6.0206012  dB = 2  V/V	$1 + (10k\Omega/10k\Omega) = 2 \text{ V/V}$
50	3.9	6.0206012  dB = 2  V/V	$1 + (10k\Omega/10k\Omega) = 2 V/V$
50	5.6	6.0206012  dB = 2  V/V	$1 + (10k\Omega/10k\Omega) = 2 \text{ V/V}$
50	10	6.0206012  dB = 2  V/V	$1 + (10k\Omega/10k\Omega) = 2 \text{ V/V}$
50	10	6.0206012  dB = 2  V/V	$1 + (10k\Omega/10k\Omega) = 2 \text{ V/V}$
100	10	6.0206012  dB = 2  V/V	$1 + (10k\Omega/10k\Omega) = 2 \text{ V/V}$
150	10	6.0206012  dB = 2  V/V	$1 + (10k\Omega/10k\Omega) = 2 \text{ V/V}$
200	10	6.0206012  dB = 2  V/V	$1 + (10k\Omega/10k\Omega) = 2 \text{ V/V}$

# Current Controlled Voltage Source (CCVS)



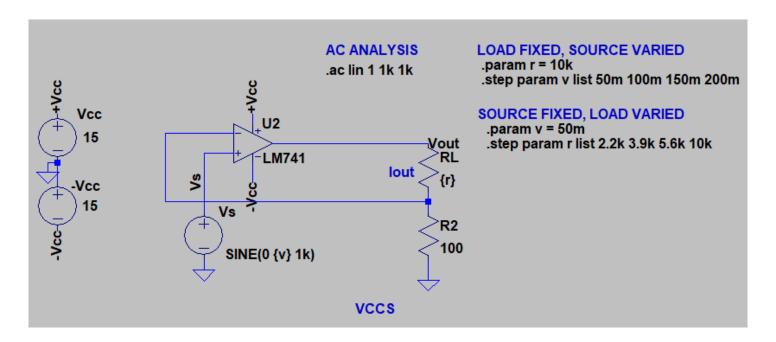
Source  $V_s = 50 \text{mV}$  and load varied



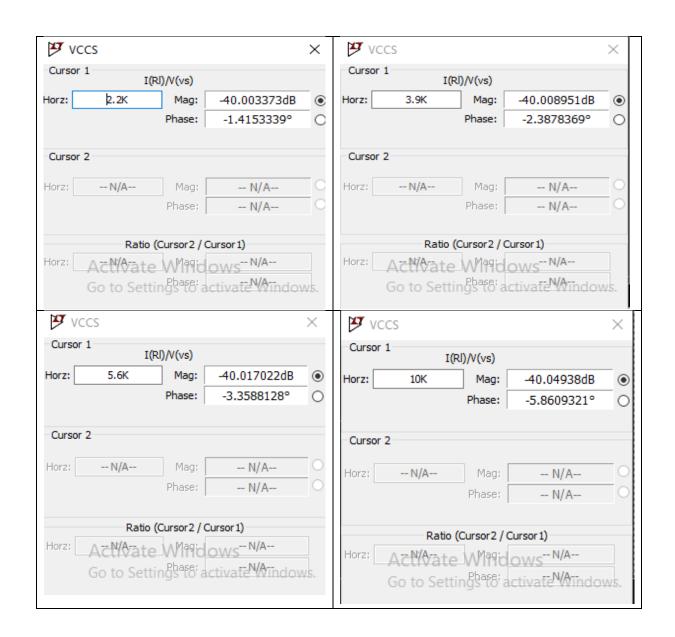


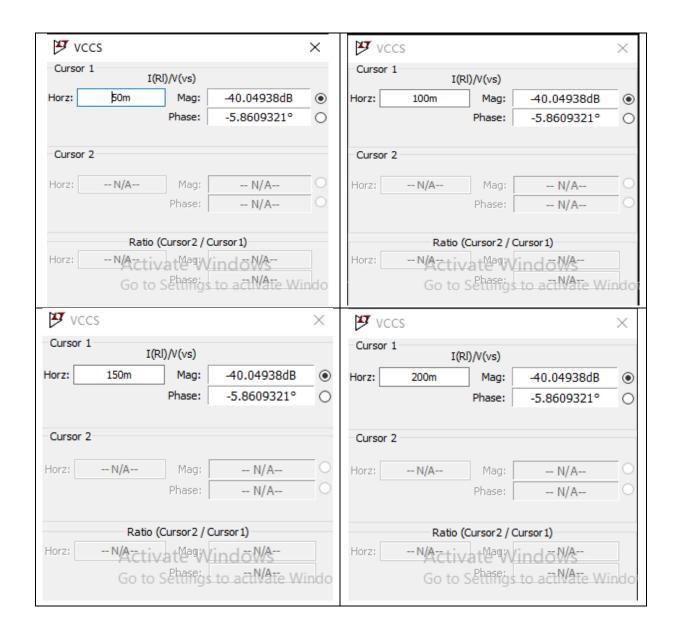
V <sub>s</sub> (mV)	$R_{l}(k\Omega)$	Simulated A	Theoretical $A = R_F$	
50	2.2	$93.4419 \text{ dB} = 46.99969 \text{ k}\Omega$	47 kΩ	
50	3.9	93.441903  dB = 46.99971  kΩ	47 kΩ	
50	5.6	93.441903  dB = 46.999707  kΩ	47 kΩ	
50	10	$93.441904 \text{ dB} = 46.999712 \text{ k}\Omega$	47 kΩ	
50	10	$93.441904 \text{ dB} = 46.999712 \text{ k}\Omega$	47 kΩ	
100	10	$93.441904 \text{ dB} = 46.999712 \text{ k}\Omega$	47 kΩ	
150	10	$93.441904 \text{ dB} = 46.999712 \text{ k}\Omega$	47 kΩ	
200	10	$93.441904 \text{ dB} = 46.999712 \text{ k}\Omega$	47 kΩ	

# Voltage Controlled Current Source (VCCS)



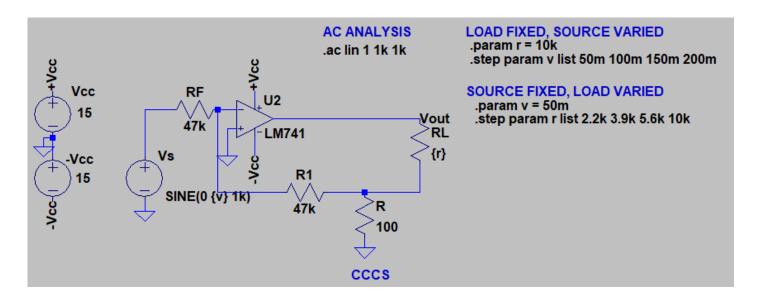
Source  $V_s = 50 \text{mV}$  and load varied





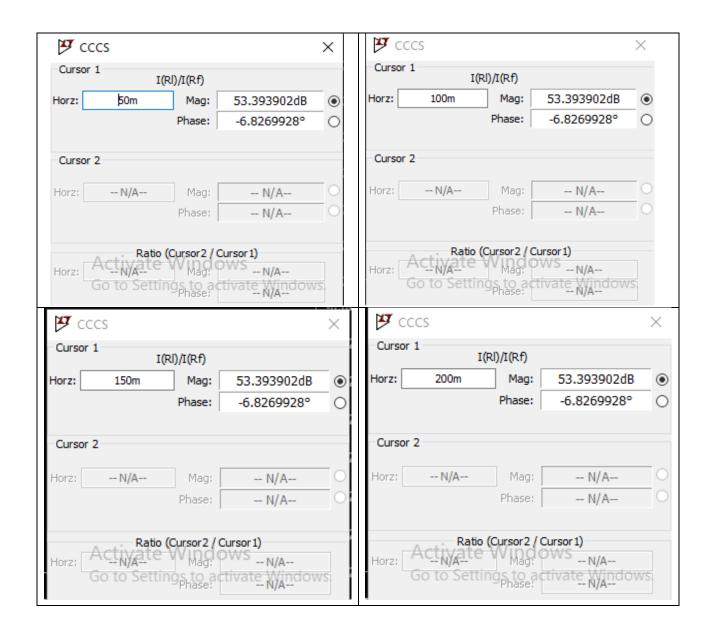
V <sub>s</sub> (mV)	$R_{l}(k\Omega)$	Simulated A	Theoretical $A = 1/R_2$
50	2.2	$-40.003373 \text{ dB} = 0.009996 \ \Omega^{-1}$	$1/100\Omega = 0.01 \ \Omega^{-1}$
50	3.9	$-40.008951 \text{ dB} = 0.009989 \ \Omega^{-1}$	$1/100\Omega = 0.01 \ \Omega^{-1}$
50	5.6	$-40.017022 \text{ dB} = 0.009980 \ \Omega^{-1}$	$1/100\Omega = 0.01 \ \Omega^{-1}$
50	10	$-40.04938 \text{ dB} = 0.009943 \Omega^{-1}$	$1/100\Omega = 0.01 \ \Omega^{-1}$
50	10	$-40.04938 \text{ dB} = 0.009943 \Omega^{-1}$	$1/100\Omega = 0.01 \ \Omega^{-1}$
100	10	$-40.04938 \text{ dB} = 0.009943 \Omega^{-1}$	$1/100\Omega = 0.01 \ \Omega^{-1}$
150	10	$-40.04938 \text{ dB} = 0.009943 \Omega^{-1}$	$1/100\Omega = 0.01 \ \Omega^{-1}$
200	10	$-40.04938 \text{ dB} = 0.009943 \Omega^{-1}$	$1/100\Omega = 0.01 \ \Omega^{-1}$

# Current Controlled Current Source (CCCS)



Source  $V_s = 50 \text{mV}$  and load varied

💆 cccs			×	CCCS CCCS			×
Cursor 1	I(RI)/I(Rf)			Cursor 1	I(RI)/I(Rf)		
Horz: 2.2K	Mag:	53.455683dB	•	Horz: 3.9K	Mag:	53.448248dB	•
	Phase:	-1.6500055°	0		Phase:	-2.7839348°	0
Cursor 2				Cursor 2			
Horz: N/A	Mag; Phase;	N/A N/A	0	Horz: N/A	Mag; Phase;	N/A N/A	0
Horz: Activate Go to Sett	io (Cursor2 / C Mag: mgs to act Phase:	Cursor 1) VVS N/A ivate Windows N/A		Horz: Activate NA- Go to Sett	tio (Cursor 2 / C V In Go Mag; ings to act Phase;	Cursor 1) WS N/A ivate Windows: N/A	
y cccs			×	CCCS CCCS			$\times$
Cursor 1	I(RI)/I(Rf)			Cursor 1	I(RI)/I(Rf)		
Horz: 5.6K	Mag:	53.437428dB	•	Horz: 10K	Mag:	53.393902dB	•
	Phase:	-3.915483°	0		Phase:	-6.8269928°	0
Cursor 2				Cursor 2			
Horz; N/A	Mag;	N/A		Horz: N/A	- Mag;	N/A	
	Phase:	N/A	0		Phase;	N/A	0
Activate		Cursor 1) W/S N/A ivate Windows N/A		Horat N/A	atio (Cursor2 / Mag;	Cursor 1)  VVS N/A tivate Window:	



V <sub>s</sub> (mV)	$R_1$ (k $\Omega$ )	Simulated A <sub>i</sub>	Theoretical $A_i = 1 + (R_1/R)$	
50	2.2	53.455683 dB = 470.7433 A/A	$1 + (47k\Omega/100\Omega) = 471 \text{ A/A}$	
50	3.9	53.448248  dB = 470.3405  A/A	$1 + (47k\Omega/100\Omega) = 471 \text{ A/A}$	
50	5.6	54.437428 dB = 469.755 A/A	$1 + (47k\Omega/100\Omega) = 471 \text{ A/A}$	
50	10	54.393902 dB = 467.4069 A/A	$1 + (47k\Omega/100\Omega) = 471 \text{ A/A}$	
50	10	54.393902 dB = 467.4069 A/A	$1 + (47k\Omega/100\Omega) = 471 \text{ A/A}$	
100	10	54.393902 dB = 467.4069 A/A	$1 + (47k\Omega/100\Omega) = 471 \text{ A/A}$	
150	10	54.393902 dB = 467.4069 A/A	$1 + (47k\Omega/100\Omega) = 471 \text{ A/A}$	
200	10	54.393902 dB = 467.4069 A/A	$1 + (47k\Omega/100\Omega) = 471 \text{ A/A}$	