



# **UNIVERSITATEA TEHNICĂ DIN CLUJ-NAPOCA**

**UNIVERSITATEA TEHNICĂ DIN CLUJ- NAPOCA  
FACULTATEA DE ELECTRONICĂ,  
TELECOMUNICAȚII ȘI TEHNOLOGIA INFORMAȚIEI**

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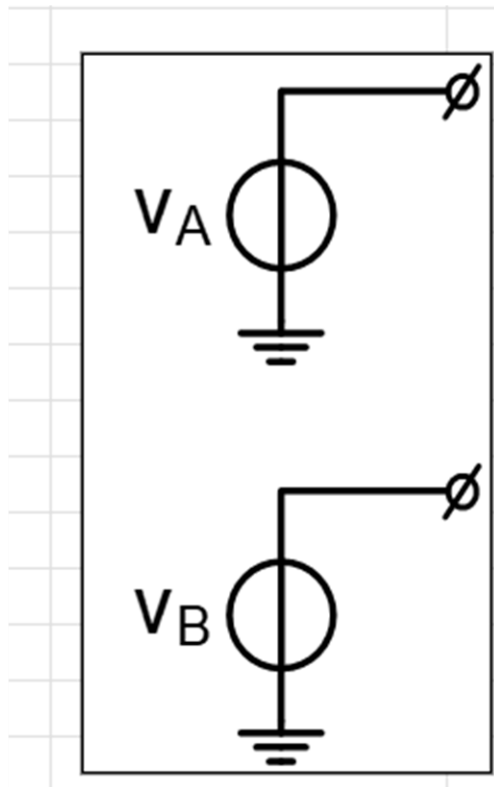
drd. Mădălina Farcaș

conf.dr.ing Marius Neag

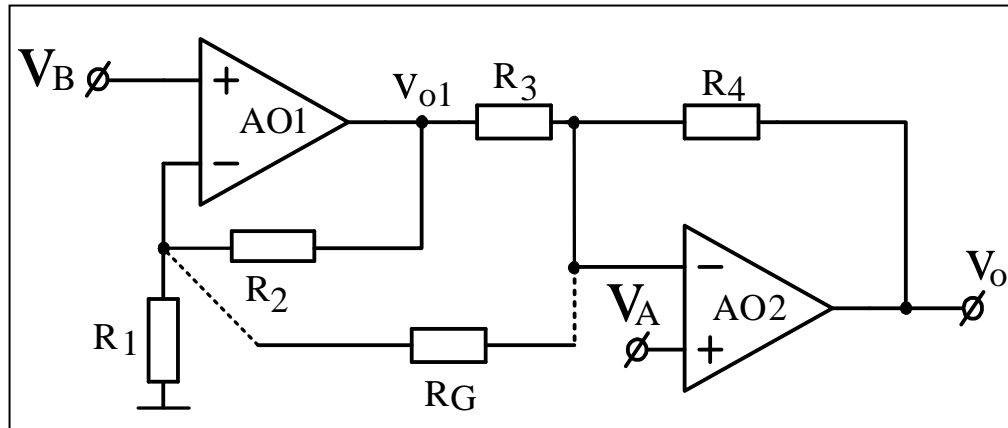
## 1. Tematica proiectului :

Să se realizeze circuitul format din următoarele etaje :

### 1.1 Sursă de tensiune diferențială :

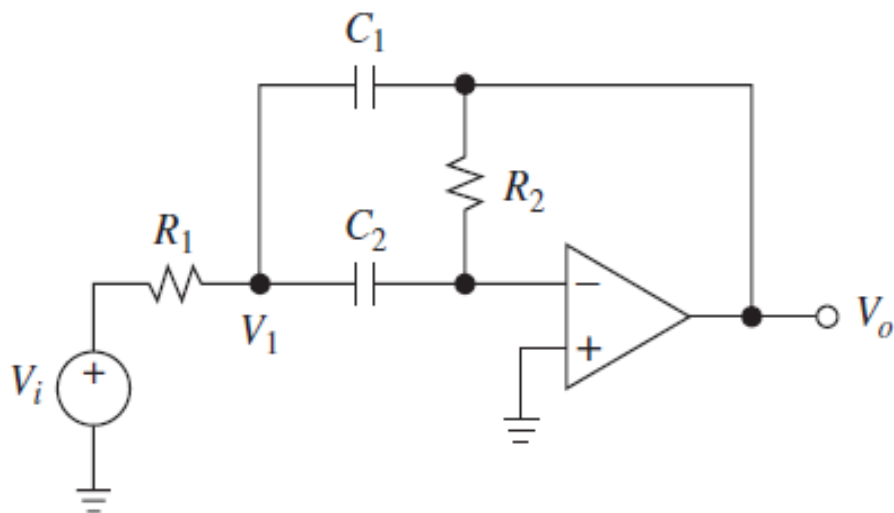


## 1.2 Etajul 1 : AI cu 2 Amplificatoare operaționale, neinversor, intrare V



- Amplificare maximă :  $7.81 \times 10^{-2}$
- Amplificare minimă :  $2.77 \times 10^{-2}$
- Câștig liniar : 9

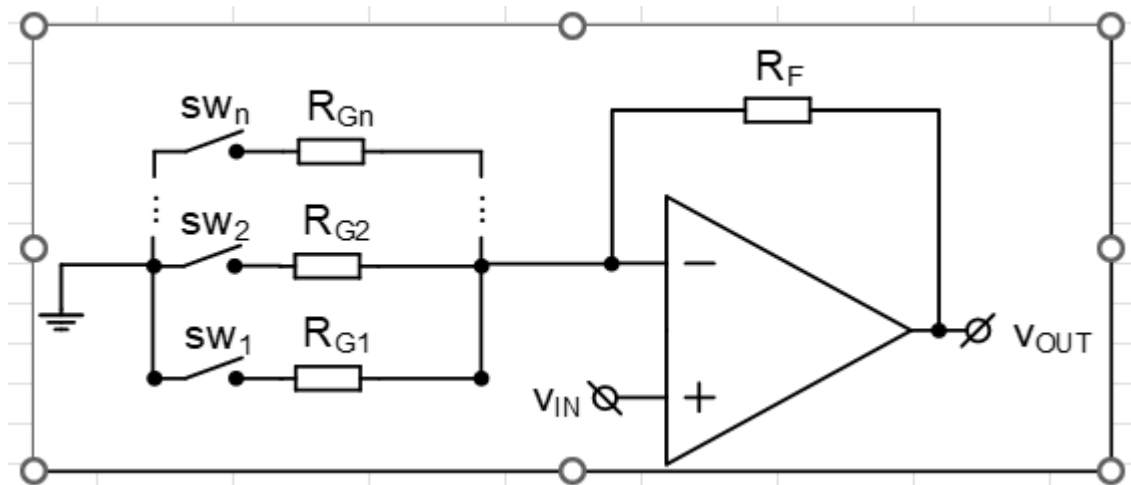
## 1.3 Etajul 2 : Trece bandă cu 1 Amplificator Operațional V-V Rauch



- Câștig liniar în banda de trecere : 1
- $R_{\text{intrare}}$  :  $1\text{k}\Omega$

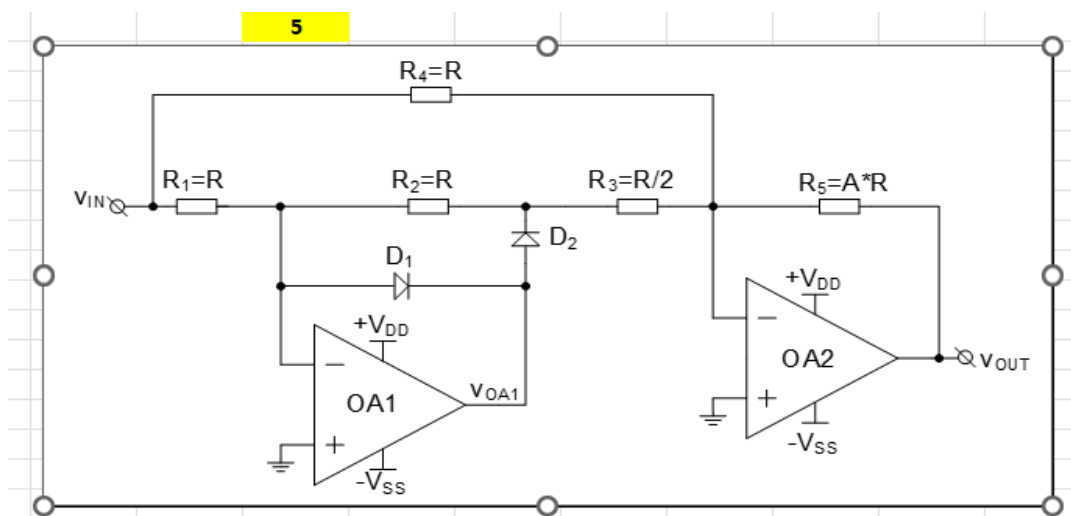
- Banda : 3kHz
- Factorul de calitate : 0.707

#### 1.4 Etaj 3 : PGA cu RG în paralel



- Câștig minim : 5 dB
- Câștig maxim : 14 dB
- Rezoluție : 3 dB
- Număr de pași : 4

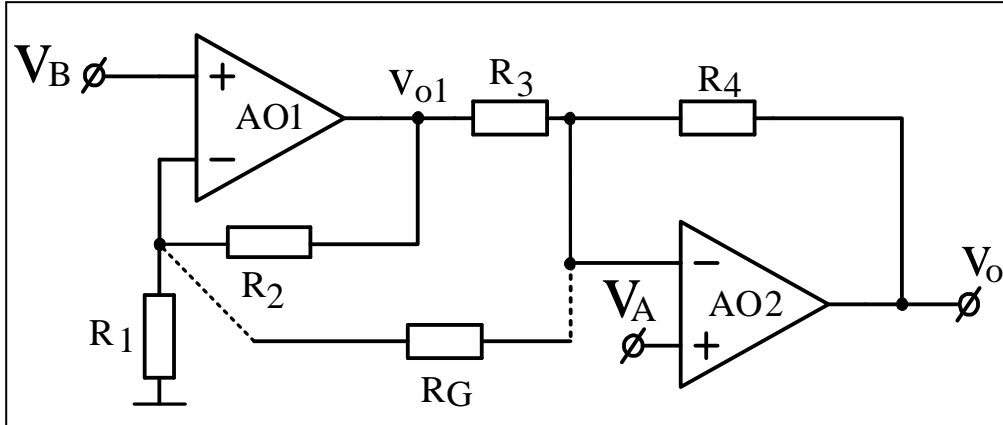
#### 1.5 Etaj 4 : Redresor



- Câștig linear : 2 cu OP27

## 2. Dimensionarea etajelor :

Etaj 1 :



Pentru a dimensiona primul etaj ne folosim de expresia câștigului care este :

$$A_d = \frac{v_o}{v_a - v_B} = 1 + \frac{R_4}{R_3} \left( 1 + \frac{R_2 + R_3}{R_G} \right)$$

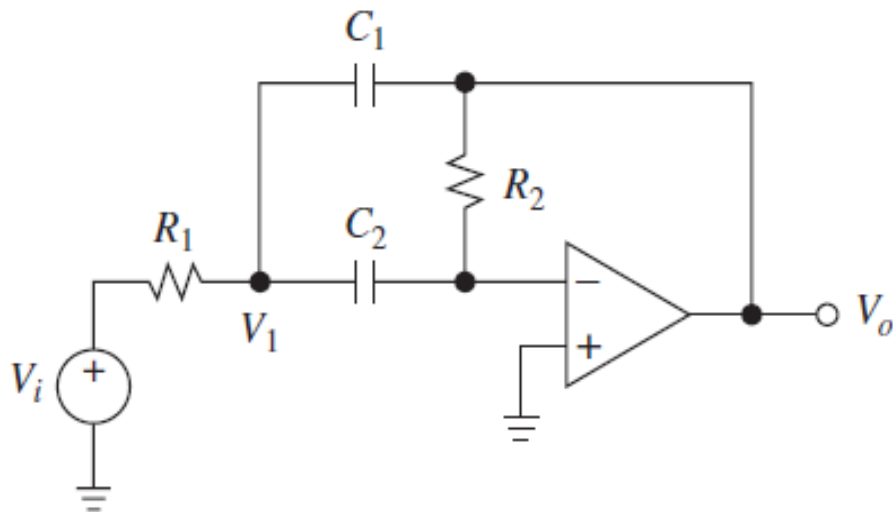
În baza formulei precezate anterior, dimensionăm elementele circuitului astfel :

Pentru  $A_d=9$  alegem  $R_3=5k$  și  $R_g=5k$ .

Din calcul reiese ca  $R_4=10k$  și  $R_2=5K$

În urma unei analize parametrice, reiese faptul că  $R_1=20k$ .

**Etaj 2:**



Pentru dimensionare aflăm  $W_0$  care poate fi determinat din formula  $F_0 = Bw \cdot Q = 2121 \text{ Hz}$ .

Valorile aferente pentru  $C_1$  și  $C_2$  sunt alese după convenție ca fiind  $1 \text{ nF}$  și după din ecuațiile :

$$R_1 = \frac{1}{2W_0QC}$$

$$R_2 = \frac{2Q}{W_0C}$$

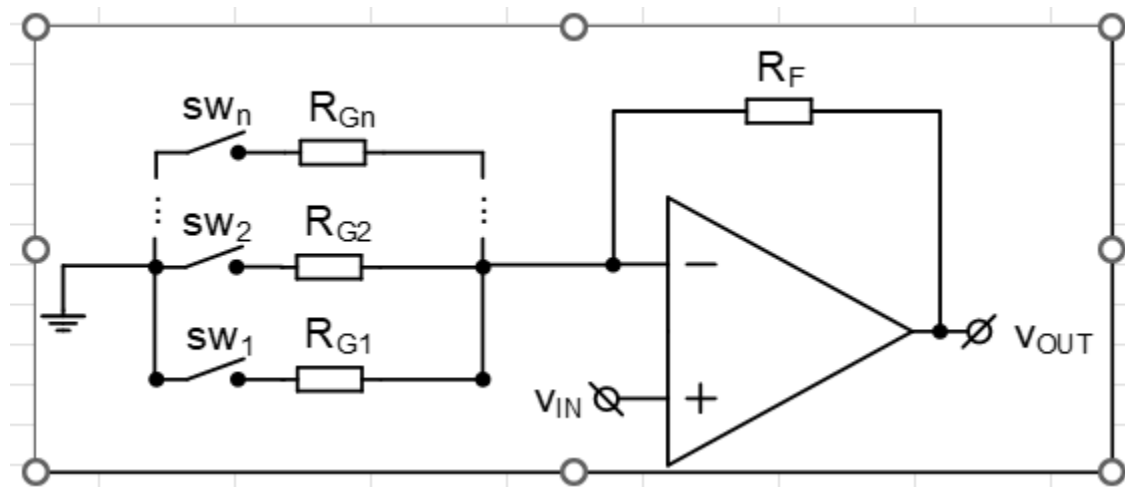
Aflăm  $R_1$ ,  $R_2$ . Astfel :

$$C_1 = C_2 = 1 \text{ nF}$$

$$R_1 = R_{in} = 53.1 \text{ k}$$

$$R_2 = 106 \text{ k}$$

**Etaj 3:**



Cum treptele de castig sunt 5 8 11 14 in db, convertite in liniar vor fi:

1.78

2.51

3.55

5.01

Astfel, pentru fiecare treapta formula castigului va fi  $1 + \frac{R_f}{R_{g_n}}$ . Alegand  $R_f=10k$  vom avea valorile:

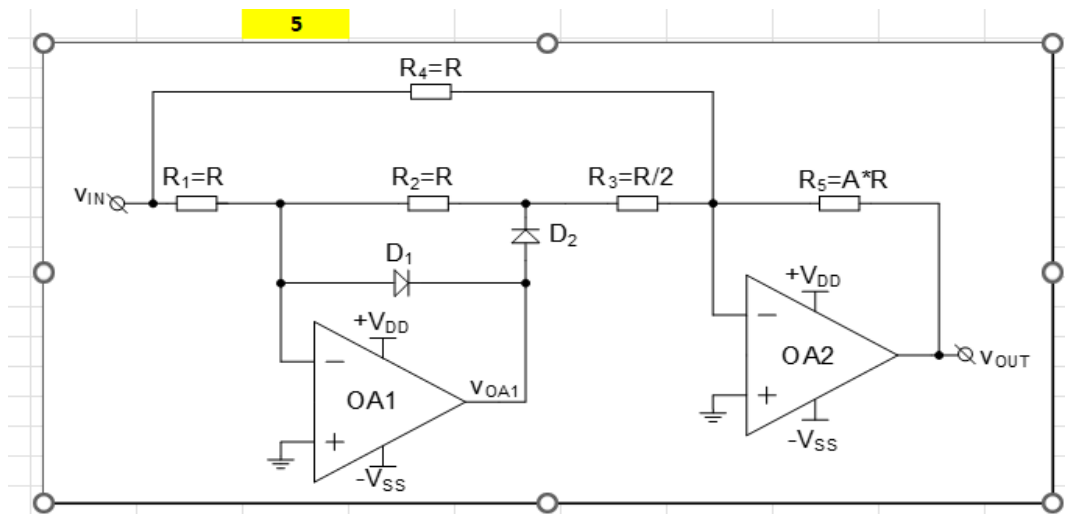
$R_{g1}=12.82K$

$R_{g2}=6.62k$

$R_{g3}=3.92k$

$R_{g4}=2.493k$

Etaj 4:



Cum castigul este egal cu 2 si conditia de redresor este data de relatia

$$\frac{R_2}{R_1 R_3} = \frac{2}{R_4}$$

Alegem  $R = 5k$  iar din figura de mai sus reiese ca

$R_1 = 5K$

$R_2 = 5k$

$R_3 = 2.5k$

$R_4 = 5k$

$R_5 = 10k$



### **3. Caracterizarea etajelor**

#### **Etaj 1:**

**Castig: 9**

**BW: 919.33834KHz**

**Total Harmonic Distortion: 0.063862%**

**SR: 0.104466V/Us**

#### **Etaj 2:**

**THD: Total Harmonic Distortion: 0.064331%**

**BW: 3khz**

**F0:2121hz**

**Castig in banda de trecere:1**

#### **Etaj 3:**

**Bw castig max=Bw castig min=1Mhz**

**castig max: Total Harmonic Distortion: 0.064457%**

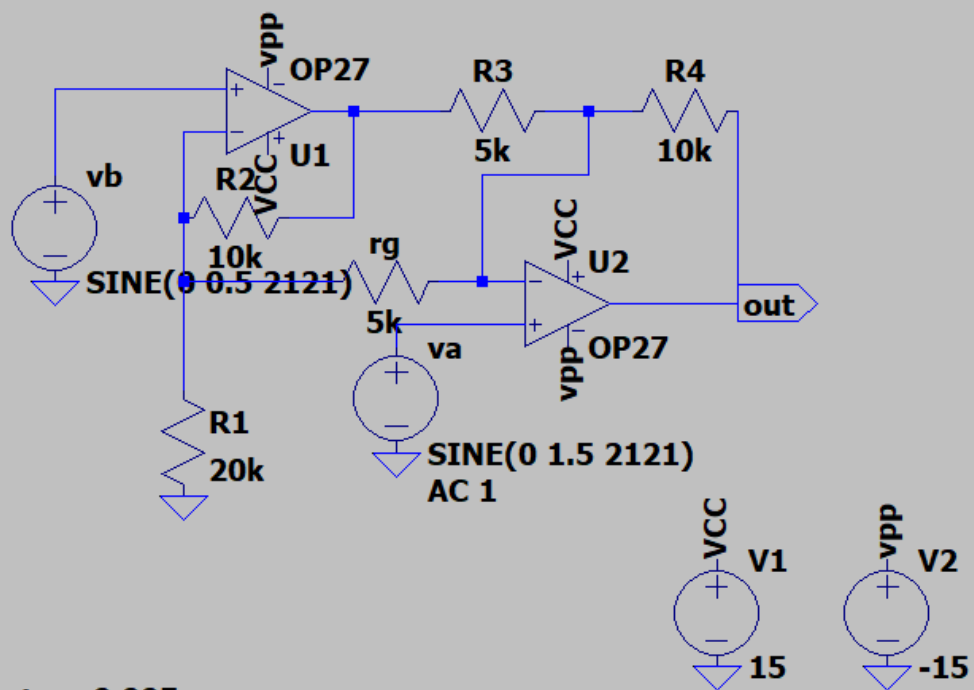
**castig min: Total Harmonic Distortion: 0.065409%**

#### **Etaj 4**

**Castig=2**

### **4. Verificarea si caracterizarea interfetei analogice**

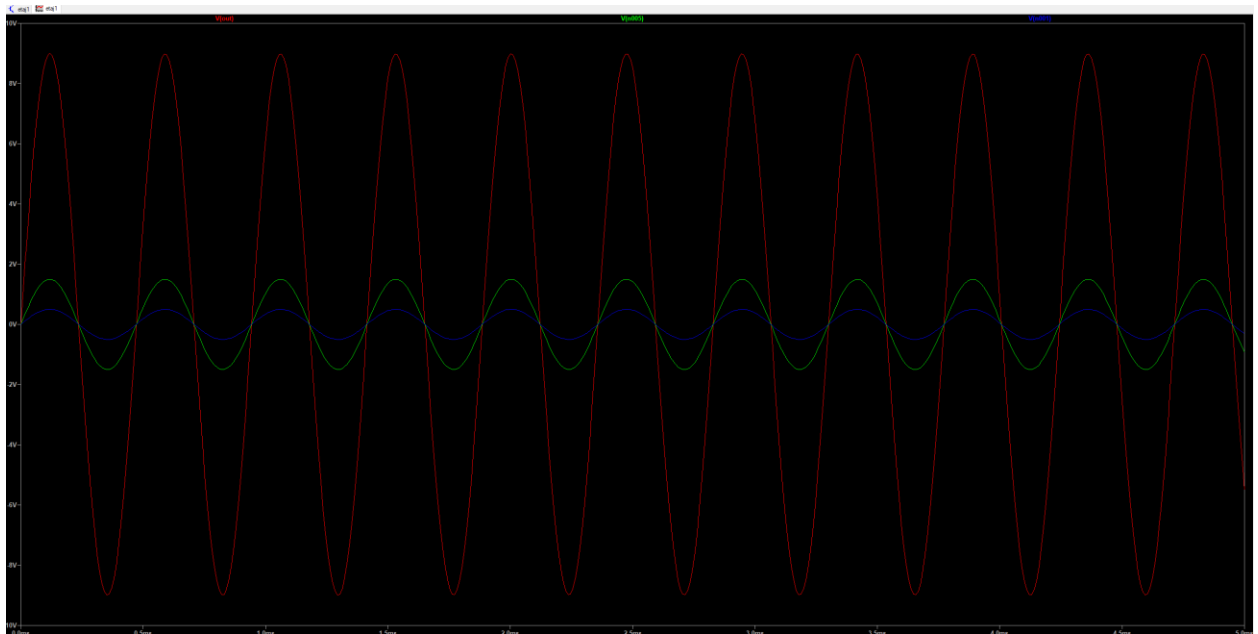
#### **Etaj 1:**



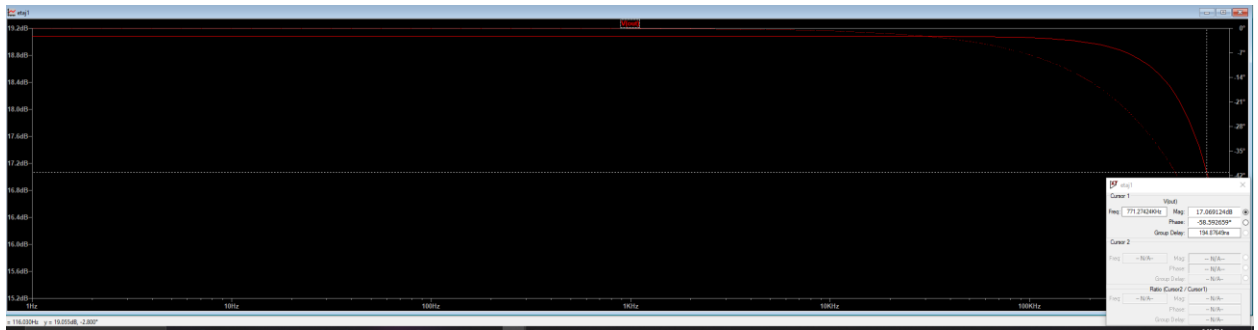
```
.tran 0.005
.op

;ac dec 20 1 1meg
.FOUR 10khz 10 V(out)
```

Tranisent:



**AC:**



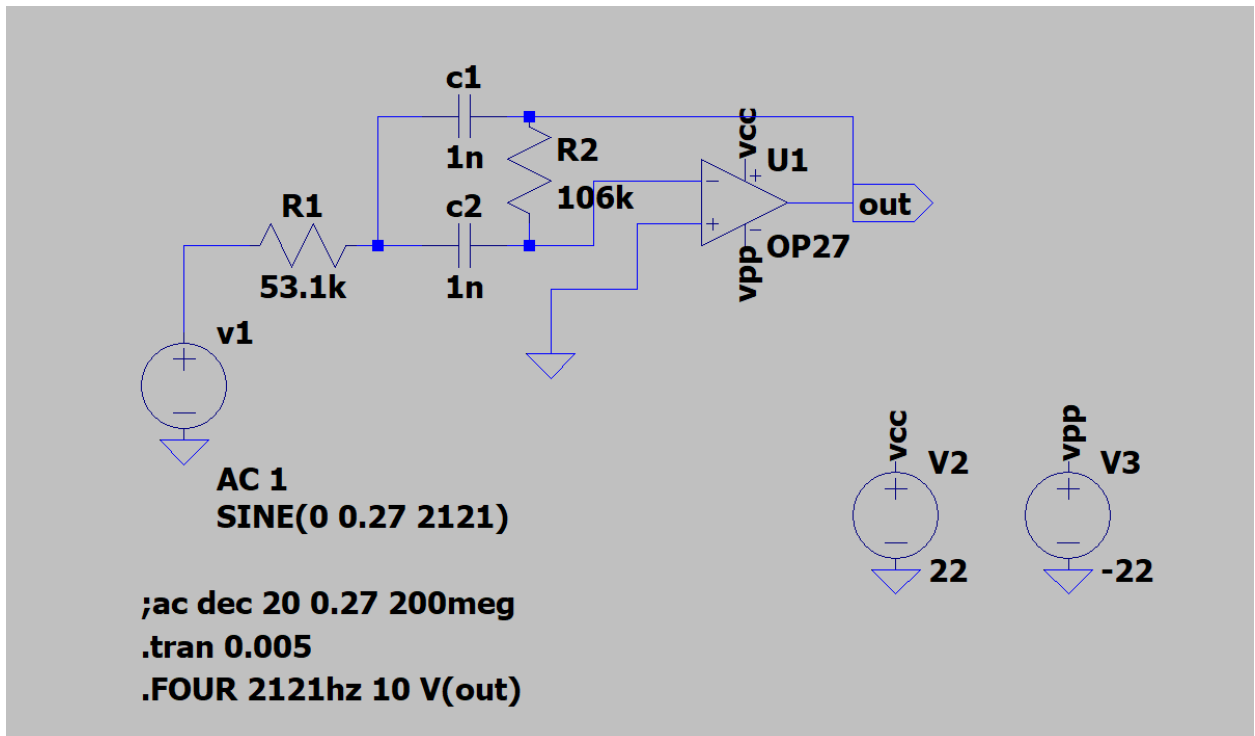
**OP:**

\* D:\florica\proiect 2025\rares\etaj1.asc

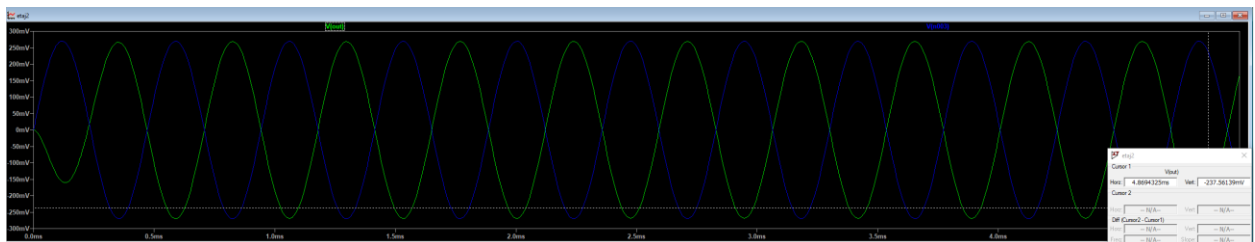
--- Operating Point ---

V(n001) :	0	voltage
V(n004) :	0	voltage
V(vcc) :	15	voltage
V(n002) :	0	voltage
V(vpp) :	-15	voltage
V(n003) :	0	voltage
V(n005) :	0	voltage
V(out) :	0	voltage
I(R2) :	0	device_current
I(R3) :	0	device_current
I(R4) :	0	device_current
I(Rg) :	0	device_current
I(R1) :	0	device_current
I(Vb) :	0	device_current
I(Va) :	0	device_current
I(V1) :	-0.00593506	device_current
I(V2) :	0.00593506	device_current
Ix(u1:1) :	0	subckt_current
Ix(u1:2) :	0	subckt_current
Ix(u1:3) :	0.00296753	subckt_current
Ix(u1:4) :	-0.00296753	subckt_current
Ix(u1:5) :	0	subckt_current
Ix(u2:1) :	0	subckt_current
Ix(u2:2) :	0	subckt_current
Ix(u2:3) :	0.00296753	subckt_current
Ix(u2:4) :	-0.00296753	subckt_current
Ix(u2:5) :	0	subckt_current

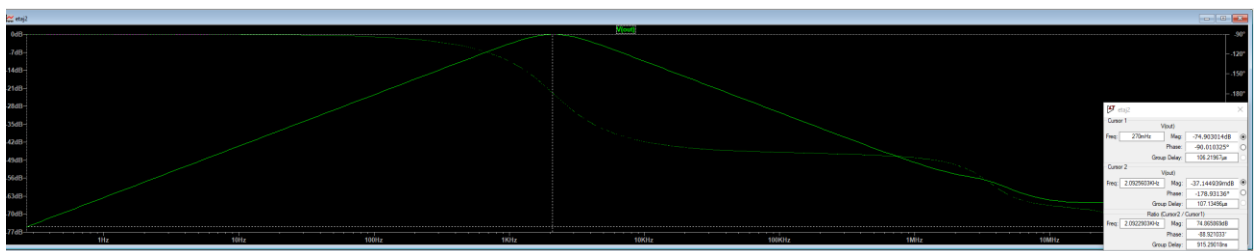
**Etaj 2:**



Transient:



AC:

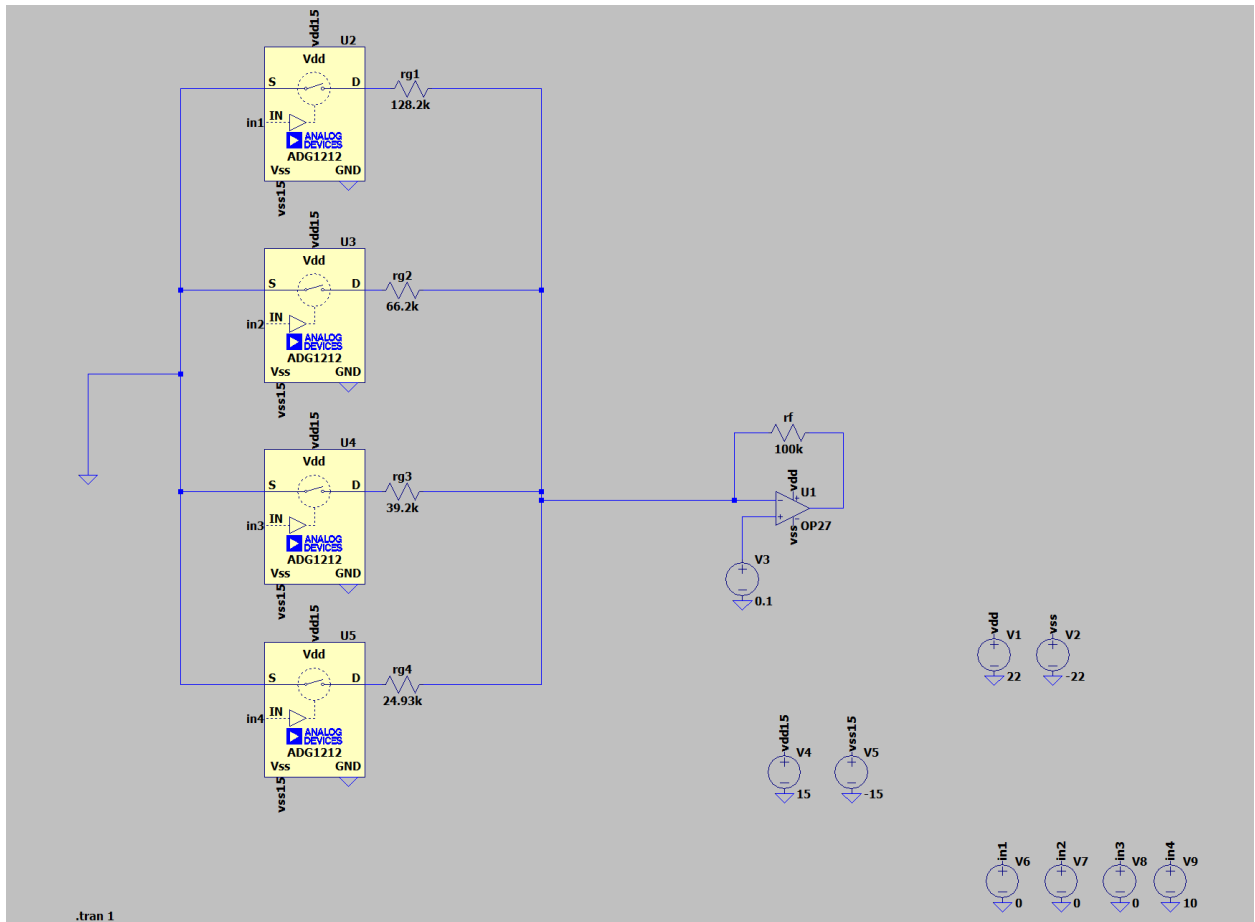


DCOP:

--- Operating Point ---

V(n002) :	0	voltage
V(n001) :	0	voltage
V(out) :	0	voltage
V(n003) :	0	voltage
V(vcc) :	22	voltage
V(vpp) :	-22	voltage
I(C2) :	0	device_current
I(C1) :	0	device_current
I(R1) :	0	device_current
I(R2) :	0	device_current
I(V1) :	0	device_current
I(V2) :	-0.00331753	device_current
I(V3) :	0.00331753	device_current
Ix(u1:1) :	0	subckt_current
Ix(u1:2) :	0	subckt_current
Ix(u1:3) :	0.00331753	subckt_current
Ix(u1:4) :	-0.00331753	subckt_current
Ix(u1:5) :	0	subckt_current

**Etaj 3:**

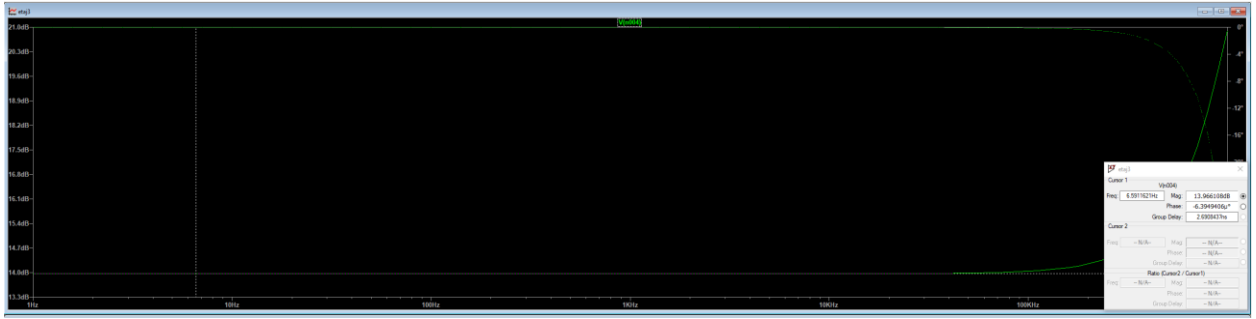


AC:

Gain min:



Gain max:



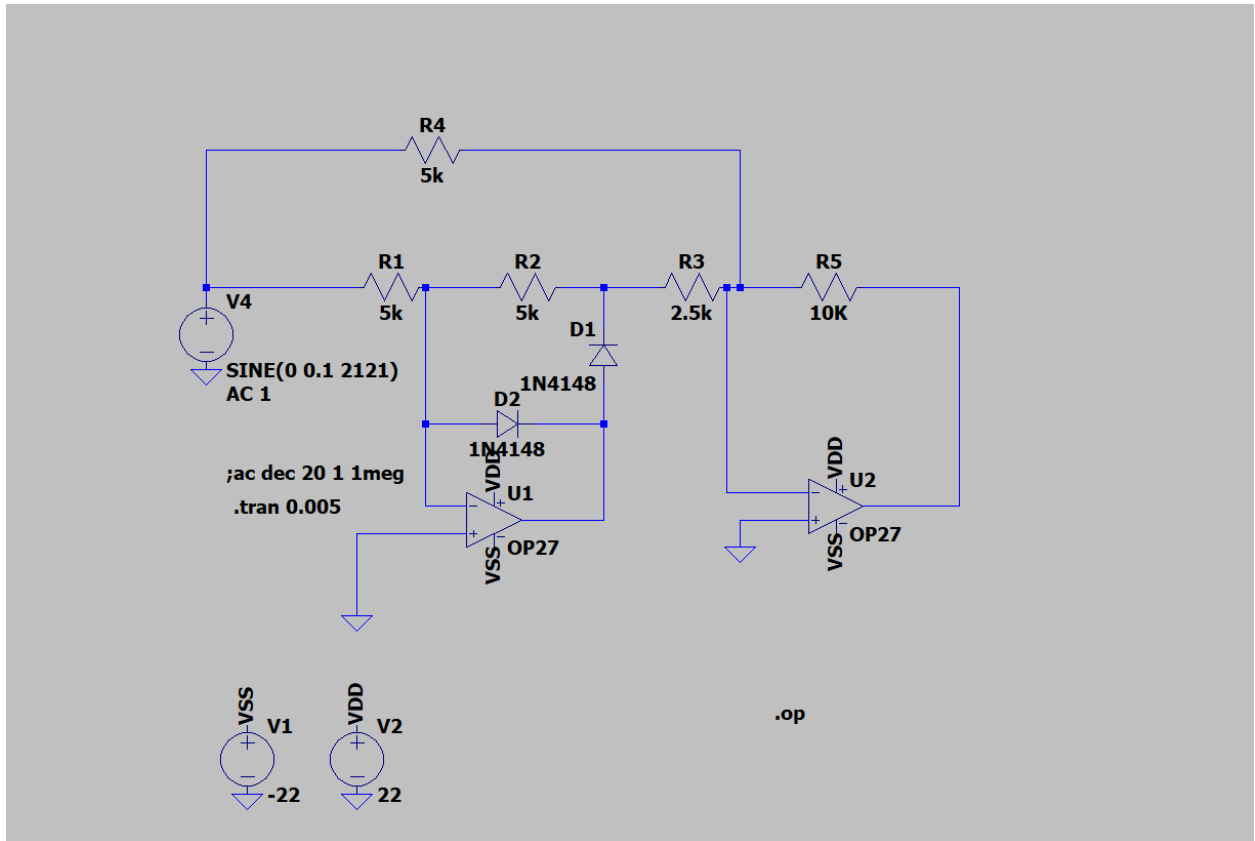
DC:



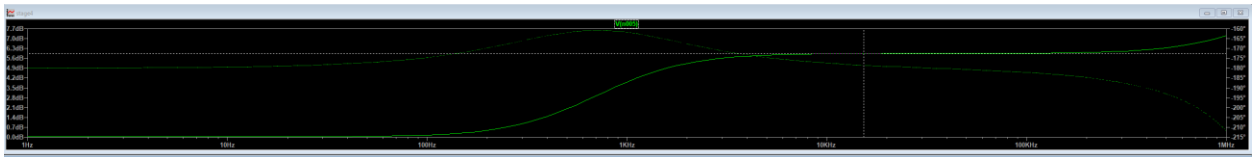
--- Operating Point ---

V(n002) :	0.0999998	voltage
V(n006) :	0.1	voltage
V(vdd) :	22	voltage
V(n004) :	0.499235	voltage
V(vss) :	-22	voltage
V(vdd15) :	15	voltage
V(n001) :	0.0999741	voltage
V(vss15) :	-15	voltage
V(in1) :	0	voltage
V(n003) :	0.0999865	voltage
V(in2) :	0	voltage
V(n005) :	0.0999919	voltage
V(in3) :	0	voltage
V(n007) :	0.000485736	voltage
V(in4) :	10	voltage
I(Rf) :	3.99236e-06	device_current
I(Rg1) :	2.00348e-10	device_current
I(Rg2) :	2.00373e-10	device_current
I(Rg3) :	2.00384e-10	device_current
I(Rg4) :	3.99174e-06	device_current
I(V1) :	-0.00331969	device_current
I(V2) :	0.0033157	device_current
I(V3) :	-1.67022e-11	device_current
I(V4) :	-3.5994e-07	device_current
I(V5) :	3.60541e-07	device_current
I(V6) :	0	device_current
I(V7) :	0	device_current
I(V8) :	0	device_current
I(V9) :	-2.5e-23	device_current
Ix(u1:1) :	1.67022e-11	subckt_current
Ix(u1:2) :	1.66311e-11	subckt_current
Ix(u1:3) :	0.00331969	subckt_current
Ix(u1:4) :	-0.0033157	subckt_current
Ix(u1:5) :	-3.99236e-06	subckt_current
Ix(u2:1) :	0	subckt_current
Ix(u2:2) :	2.00148e-10	subckt_current
Ix(u2:3) :	-1.99948e-13	subckt_current
Ix(u2:4) :	-9.016e-08	subckt_current
Ix(u2:5) :	-9.99741e-30	subckt_current
Ix(u2:6) :	8.99601e-08	subckt_current
Ix(u3:1) :	0	subckt_current
Ix(u3:2) :	2.00173e-10	subckt_current
Ix(u3:3) :	-1.99973e-13	subckt_current
Ix(u3:4) :	-9.016e-08	subckt_current
Ix(u3:5) :	-9.99865e-30	subckt_current
Ix(u3:6) :	8.99601e-08	subckt_current
Ix(u4:1) :	0	subckt_current
Ix(u4:2) :	2.00184e-10	subckt_current
Ix(u4:3) :	-1.99984e-13	subckt_current
Ix(u4:4) :	-9.016e-08	subckt_current
Ix(u4:5) :	-9.99919e-30	subckt_current
Ix(u4:6) :	8.99601e-08	subckt_current
Ix(u5:1) :	2.5e-23	subckt_current
Ix(u5:2) :	3.99174e-06	subckt_current
Ix(u5:3) :	-3.99174e-06	subckt_current
Ix(u5:4) :	-9.00605e-08	subckt_current
Ix(u5:5) :	-2.5e-23	subckt_current
Ix(u5:6) :	9.00596e-08	subckt_current

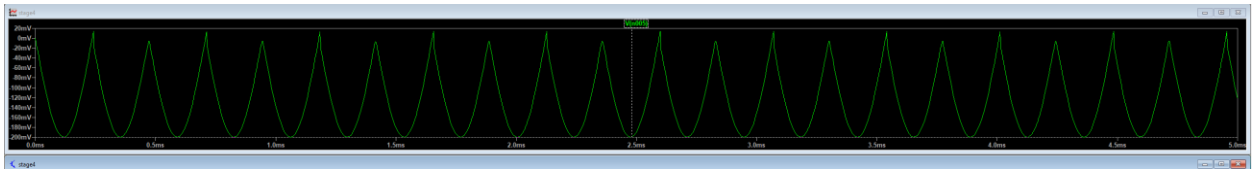
## Etaj 4:



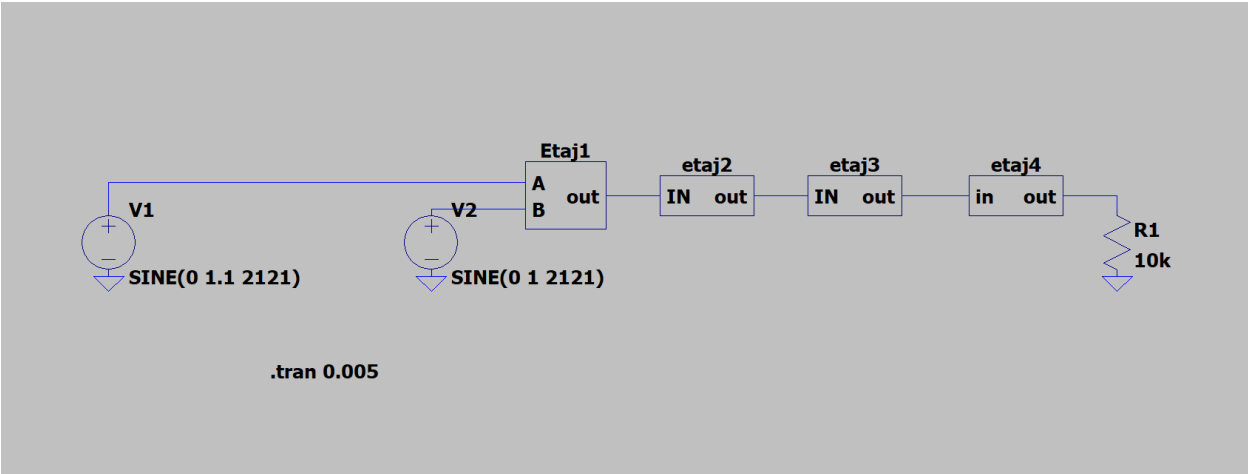
## Ac:



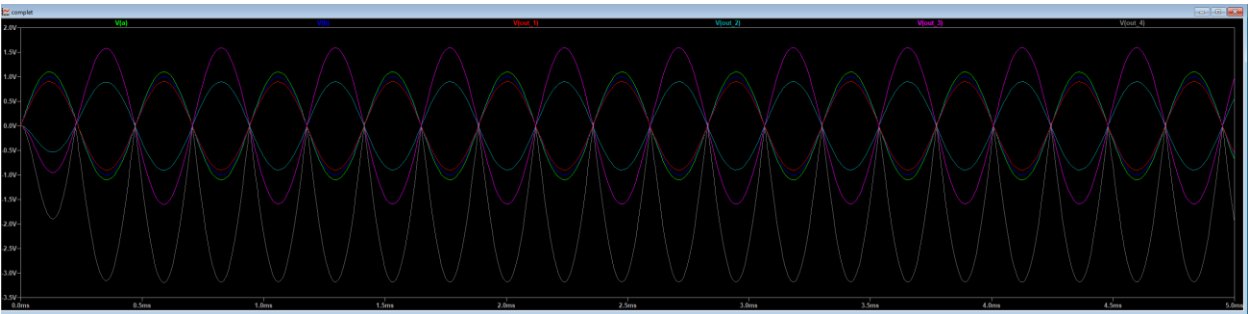
## Trans:



Proiect Complet:



TRANSIENT:



AC:

