ElecEng 2CF4
Assignment 1 Report 1

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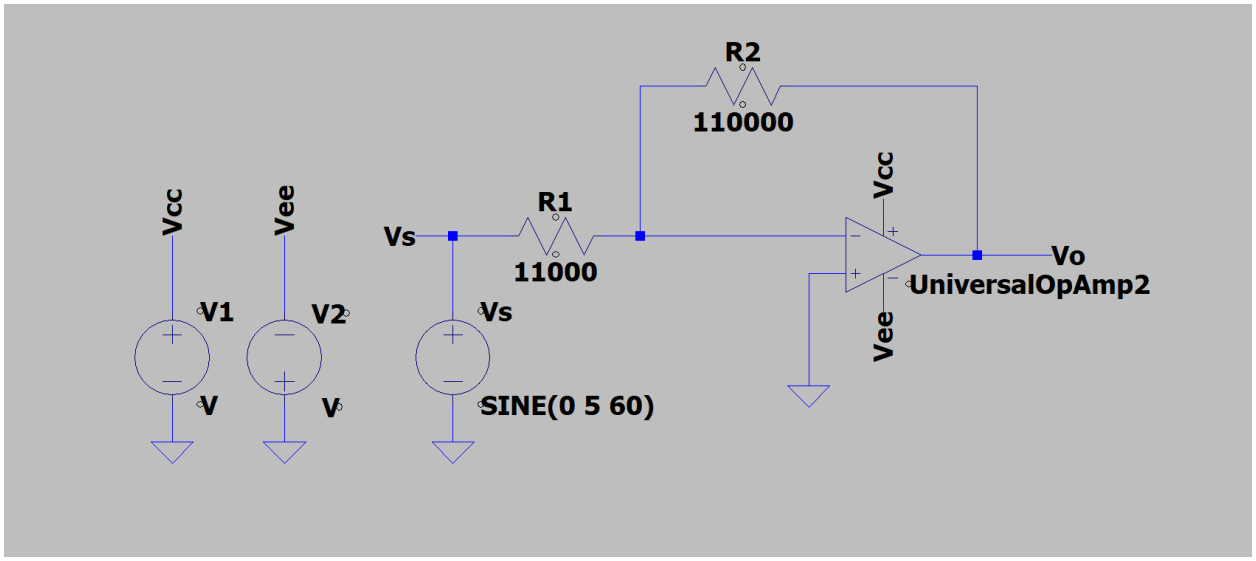
1.A.

1. **Image of schematic**

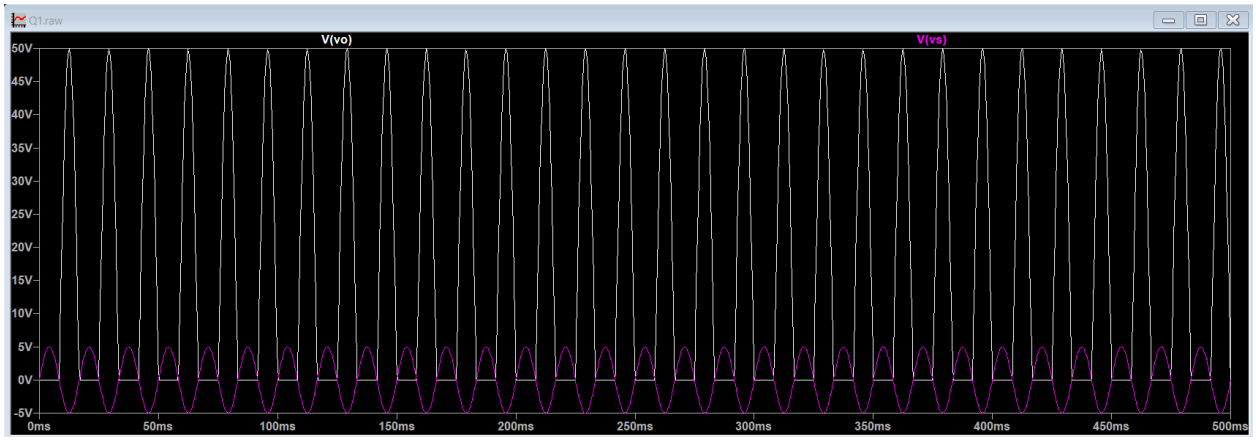


2. **Spice Netlist**

```
* C:\Users\Josh\Documents\COMPENG\Y2S2\2CF3\Asignment1\Q1.asc
V1 Vcc 0 V
V2 0 Vee V
R1 N001 Vs 11000
Vs Vs 0 SINE(0 5 60)
R2 Vo N001 110000
X§UniversalOpAmp2 0 N001 Vcc Vee Vo level2 Avol=1Meg GBW=10Meg Slew=10Meg
Ilimit=25m Rail=0 Vos=0 En=0 Enk=0 In=0 Ink=0 Rin=500Meg
.lib UniversalOpAmp2.lib
.backanno
.end
```

1.B.

1. **Plot of Vo and Vs as a function of time**



2. **Spice Netlist**

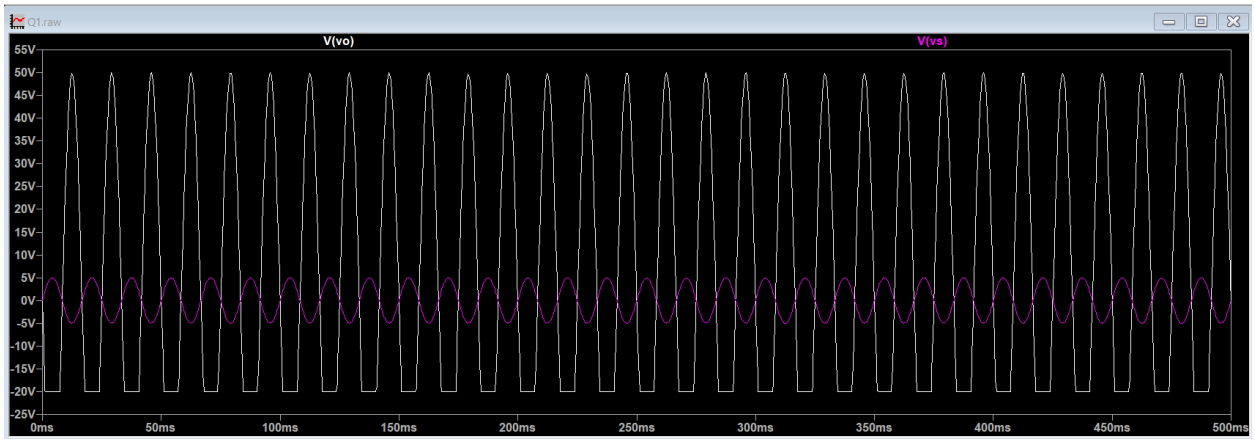
```
* C:\Users\Josh\Documents\COMPENG\Y2S2\2CF3\Asignment1\Q1.asc
V1 Vcc 0 100
V2 0 Vee 0
R1 N001 Vs 11000
Vs Vs 0 SINE(0 5 60)
R2 Vo N001 110000
X§UniversalOpAmp2 0 N001 Vcc Vee Vo level2 Avol=1Meg GBW=10Meg Slew=10Meg
Ilimit=25m Rail=0 Vos=0 En=0 Enk=0 In=0 Ink=0 Rin=500Meg
.tran 0 0.5 0
.lib UniversalOpAmp2.lib
.backanno
.end
```

3. **Explain the behavior of Vo. State which half-periods of Vs (positive or negative) are amplified and transferred to the output and which are clipped, and why this happens.**

The positive half-periods of Vs are clipped at 0 because the op-amp cannot exceed its supply rail limits. During the positive cycle, the op-amp saturates, resulting in an output of 0 V. The negative half-periods are amplified with a gain of -10, determined by R1 and R2 that we derived previously, producing a maximum Vo of 50 V. This behavior reflects the op-amp's inverting configuration and supply constraints.

1.C.

1. **Plot of Vo and Vs as a function of time**



2. **Spice Netlist**

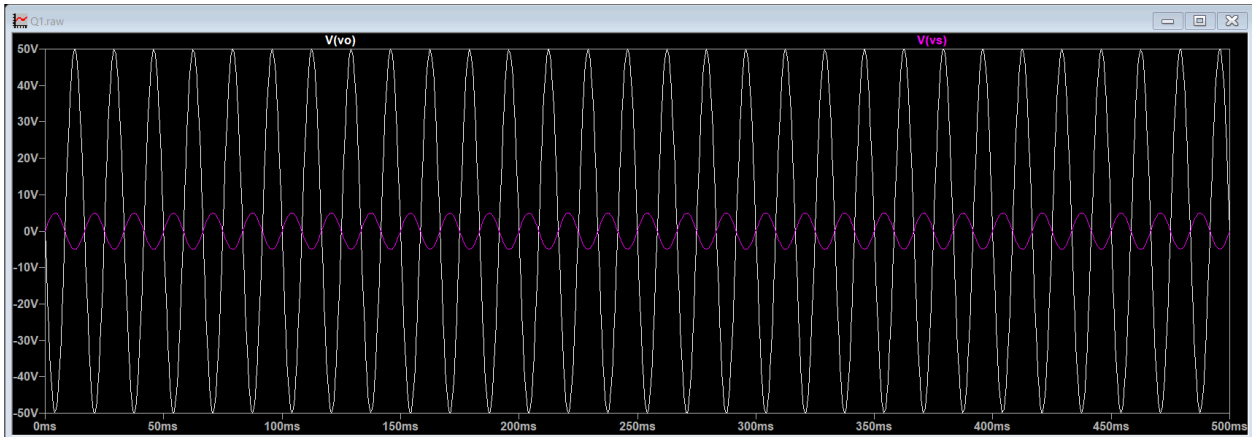
```
* C:\Users\Josh\Documents\COMPENG\Y2S2\2CF3\Asignment1\Q1.asc
V1 Vcc 0 100
V2 0 Vee 20
R1 N001 Vs 11000
Vs Vs 0 SINE(0 5 60)
R2 Vo N001 110000
X§UniversalOpAmp2 0 N001 Vcc Vee Vo level2 Avol=1Meg GBW=10Meg Slew=10Meg
Ilimit=25m Rail=0 Vos=0 En=0 Enk=0 In=0 Ink=0 Rin=500Meg
.tran 0 0.5 0
.lib UniversalOpAmp2.lib
.backanno
.end
```

3. **Explain the behavior of Vo . State which values within the Vs waveform are amplified and transferred to the output and which are clipped, and why this happens.**

With the negative terminal of the op-amp set to -20 V, the positive half-periods of Vs are clipped at −20V / −10 = 2V. This occurs because the op-amp output cannot exceed the limits imposed by its supply rails, resulting in saturation during the positive cycle. The negative half-periods behave the same as in part b with a gain of -10 resulting in a maximum V0 of 50V.

1.D.

1. **Plot of Vo and Vs as a function of time**

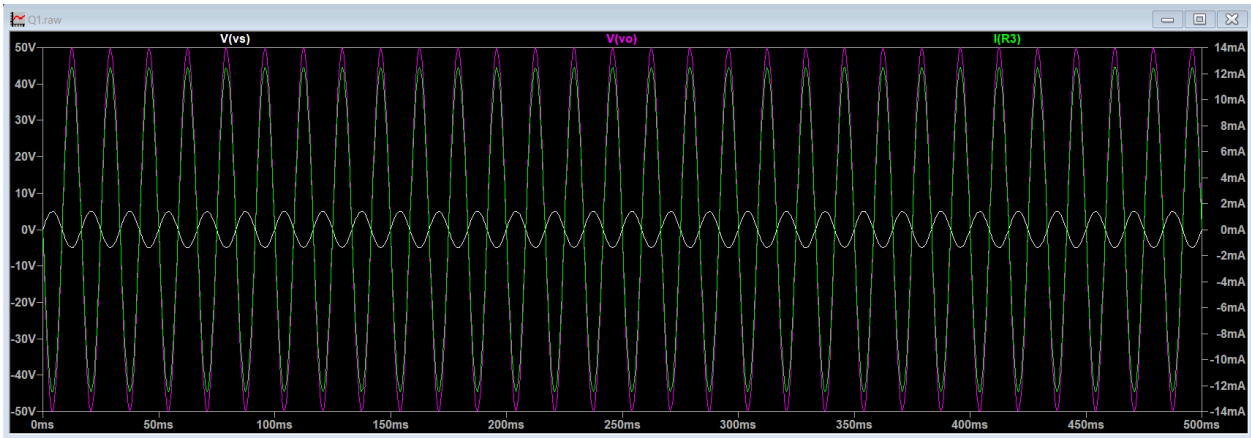


2. **Spice Netlist**

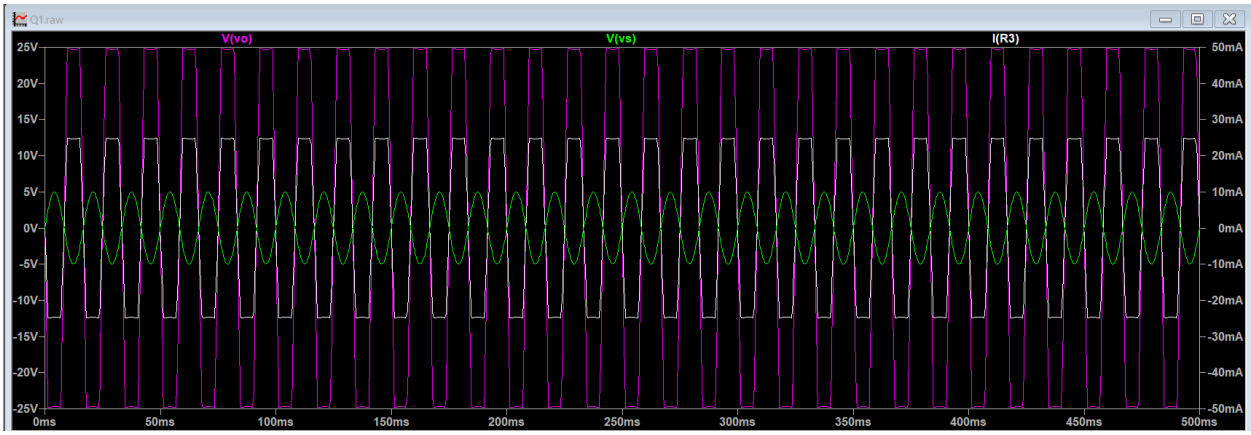
```
* C:\Users\Josh\Documents\COMPENG\Y2S2\2CF3\Asignment1\Q1.asc
V1 Vcc 0 100
V2 0 Vee 100
R1 N001 Vs 11000
Vs Vs 0 SINE(0 5 60)
R2 Vo N001 110000
X§UniversalOpAmp2 0 N001 Vcc Vee Vo level2 Avol=1Meg GBW=10Meg Slew=10Meg
Ilimit=25m Rail=0 Vos=0 En=0 Enk=0 In=0 Ink=0 Rin=500Meg
.tran 0 0.5 0
.lib UniversalOpAmp2.lib
.backanno
.end
```

1.E.

1. **Plot of Vs, Vo, and Io as a function of time where $R_L = 2\ R_{L,min}$**



2. **Plot of Vs, Vo, and Io as a function of time where $R_L = 0.5\ R_{L,min}$**



3. **Spice Netlist**

```
* C:\Users\Josh\Documents\COMPENG\Y2S2\2CF3\Asignment1\Q1.asc
V1 Vcc 0 100
V2 0 Vee 100
R1 N001 Vs 11000
Vs Vs 0 SINE(0 5 60)
R2 Vo N001 110000
X§UniversalOpAmp2 0 N001 Vcc Vee Vo level2 Avol=1Meg GBW=10Meg Slew=10Meg
Ilimit=25m Rail=0 Vos=0 En=0 Enk=0 In=0 Ink=0 Rin=500Meg
R3 Vo 0 1000
.tran 0 0.5 0
.lib UniversalOpAmp2.lib
.backanno
.end
```

4. **Derivation of $R_{L,min}$**

$V_{0,max} = | g | V_{S,max}$
$V_{0,max} = | -10 | 5$
$V_{0,max} = 50V$

$I_{0,max} = 25mA$
$R_{L,min} = V_{0,max} / I_{0,max}$
$R_{L,min} = 50V/25mA = 2k\Omega$

5. **$V_{0,max}$ in the case of $R_L = 2R_{L,min}$**

$V_{0,max} = 50V$

6. **$V_{0,max}$ in the case of $R_L = 0.5R_{L,min}$**

$V_{0,max} = 25V$

7. **Comment on whether there is a difference between the observed maximum values of Vo in parts 5 and 6? Explain the reasons for the presence or absence of difference, bearing in mind the observed maximum values of Io in both cases.**

The observed maximum values of Vo in parts 5 and 6 differ because of the op-amp's current limit. When RL = $2R_{L,min}$, the load current is 12.5 mA, which remains below the maximum output current $I_{o,max}$. This allows the op-amp to maintain the expected maximum Vo in the linear regime. However, when RL=$0.5R_{L,min}$, the load current should exceed $I_{o,max}$ causing the op-amp to limit its output current. This results in a lower Vo since the op-amp cannot supply the necessary current to maintain the expected output voltage.