# Assignment

**Q1.**

R1 = 50kΩ with a tolerance of ±5%

R2 = 25kΩ with a tolerance of ±1%

The input voltage Vin = 10V

### a) Calculate the nominal output voltage Vout\_nominal.

**Vout\_nominal** = Vin \* R2/*R1+R2 = 10 \* (25*K/50K+25K) = **3.33V .**

**Simulation result = 3.33V**

### **b) Calculate the worst case output voltage Vout\_min/max.**

R1 has a tolerance of ±5%:

R1\_max = 50k + (50 \*5/100)K = 52.5K

R1\_min = 50k - (50 \*5/100)K = 47.5K

R2 has a tolerance of ±1%:

R2\_max = 25k + (25 \* 1/100)K = 25.25K

R2\_min = 25k - (25 \* 1/100)K = 24.75k

**Vout\_max** = Vin **( R2\_max/R1\_min+R2\_max)**

**=10**\*(25.25K/47.5K+25.25K)= **3.47V.**

**Simulation Result = 3.47 V**

**Vout\_min** = Vin **( R2\_min/R1\_max+R2\_min)**

**= 10\*(24.75K/(52.5K+24.75K) = 3.2V**

**Simulation Result = 3.21V**

**Q2:**

**a) Calculate the time constant τ of the circuit.**

R1 = 50 Ohm

C1 = 500 uf

As we know that **τ = R\*C**

therefore **τ =** 50Ohm \* 500uf = 0.025s = **25ms.**

b) If the circuit is powered by a 200V supply, how long will it take for the voltage across the capacitor C1 to reach approximately 98% of Vin?

Time **τ** required for the voltage across the capacitor to reach 98% of Vin.

**τ = 4\*RC**

therefore time required for capacitor to reach 98% is approximately

**4\*25ms = 100ms.**

**For Precision,**

**VC(t)=Vin \*(1−e^-t/RC)**

As we know that VC(t)=0.98×Vin

0.98×Vin = **Vin \*(1−e^-t/RC)**

0.98 = (1-e^-t/RC)

**e^-t/RC = 1 - 0.98 = 0.02**

Take the natural logarithm of both sides ,

-t/**τ**  = ln(0.02)

subsitute **τ** = 0.025s

hence , t = ln(0.02)\*0.025

ln(0.02) is approximately −3.912

t = -3.912 \* 0.025 = 0.0978s which is approx . **97.8ms.**

**Simulation Result = 95.51ms**

**hence Simulation Value approx to Calculation Value.**

**Q3.**

a) Value of the shunt resistor.

b. Power rating for the shut resistor.

c) ADC output in 12-bit binary for Ipeak = 200A.

Ans:

**Value of the shunt resistor:**

As we are having 12 bit ADC & Amplifier having gain of 100 having output 3.3V in design .

Output of Amplifier = 100 \* Rshunt Voltage drop.

Hence we can understand that the voltage drop across Rshunt should be

Rshunt Voltage drop = 3.3 /100 = 0.033V = **33mV**

According to Ohms Law,

V = I \* R

As we know ,

I = 200A

**Rshunt = 0.033 V/ 200 A = 0.000165 Ohm = 165 micro ohm**

**ADC output in 12-bit binary for Ipeak = 200A:**

With a 12-bit ADC over a 3.3 Vref & ADC Resolution 4096, the smallest voltage change it can detect measure is = Vref/2^12 = 3.3/4095 = 0.000805V = **805uV.**

For maximum current there will be maximum output of Amplifie having 3.3V.

Then theADC Output = 4095

which is in term equal to Vin = 3.3V, Vref = 3.3V.

**ADC Out =4095 \* Vin/Vref *= 4095 \*(3.3/*3.3) = 4095**

**Power rating for the shut resistor:**

The power dissipated in the shunt resistor Pshunt is given by:

Pshunt = I^2 \* Rshunt

therefore ,

**Pshunt = 200\*200\*165micro-ohm = 6.6W**

However it is better to have some margin for selection of Power rating hence we would preffer around **7W.**

**Simulation Vs Calculation Observation:**

Current = 200A , Sumlation Observation = 200.33A

**Voltage Drop Across Rshunt:**

Calulation = 33mV , Simulation = 33.06mV

**Amplifier Output:**

Calculation: 3.3V , Simulation = 3.34V

**Conclusion:**

After simulation it has been observed that the Manual Calulation result are similar to the Simulation result.