PROCESS INSTRUMENTATION

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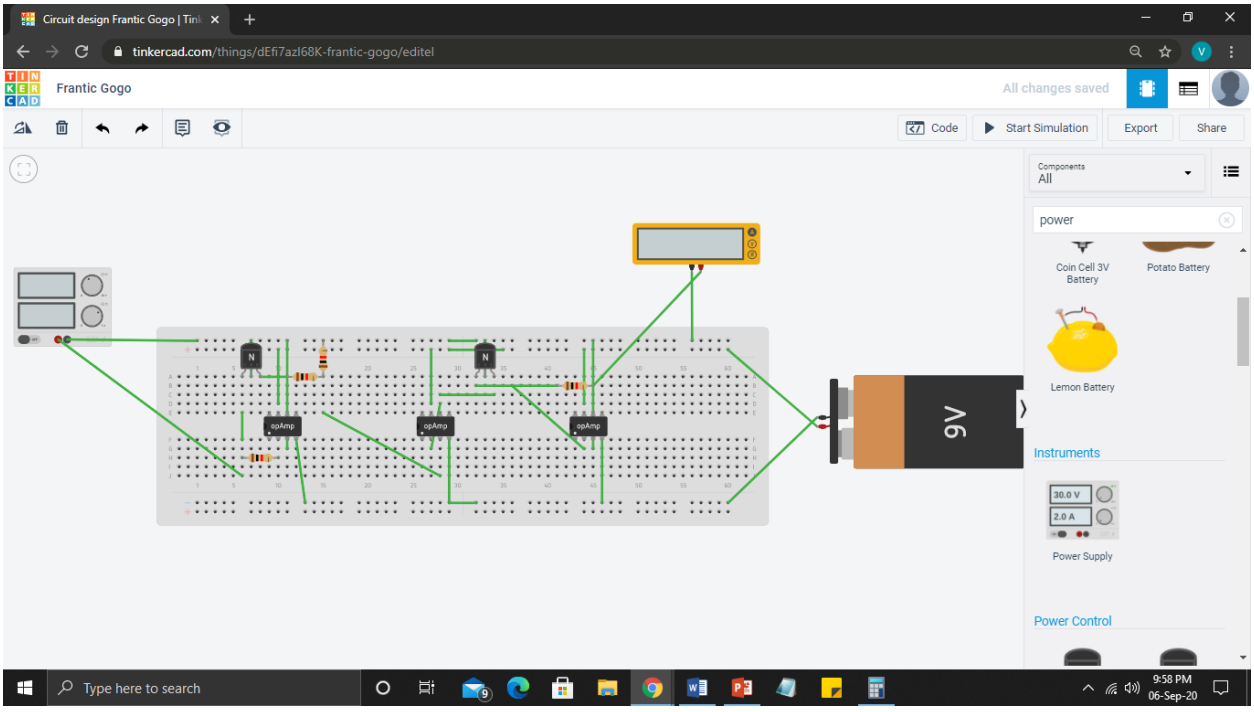
LAB 3:

Aim – Study and design the square root extractor

Op-amp based implementation of square root extractor in Tinkercad-



Python Code –

```
import math
```

x = float(input('Input current to SRE ='))

x1 = 4*(math.sqrt(x-4))

y = x1+4

print('The output current is =',y)

```
In [2]: import math
        x = float(input('Input current to SRE ='))
        x1 = 4*(math.sqrt(x-4))
        y = x1+4
        print('The output current is =',y)

        Input current to SRE =10
        The output current is = 13.797958971132712
```

Pneumatic Square Root Extractor

The square root extractor is a device that takes the square root of the signal from the flow transmitter and outputs a corresponding linear flow signal. Following image shows a Moore Products model 65 (1) pneumatic square root extractor.

We know that the volumetric flow rate (y) is proportional to the square root of the differential pressure (x). So the input-output relationship in terms of pneumatic pressure is given as follows –

Relationship between input & output in terms of pressure -

Range = 3 to 15 PSI , Span = 12

$$y \propto \sqrt{x}$$

$$y \propto \sqrt{12\,x}$$

$$(y-3) = 2\sqrt{3(x-3)}$$

$$\therefore \boxed{y = 2\sqrt{3(x-3)} + 3}$$

The following table shows the ideal response of a **pneumatic square root relay**:

Input signal	Input %	Output %	Output signal
3 PSI	0%	0%	3 PSI
4 PSI	8.33%	28.87%	6.464 PSI
5 PSI	16.67%	40.82%	7.899 PSI
6 PSI	25%	50%	9 PSI
7 PSI	33.33%	57.74%	9.928 PSI
8 PSI	41.67%	64.55%	10.75 PSI
9 PSI	50%	70.71%	11.49 PSI
10 PSI	58.33%	76.38%	12.17 PSI
11 PSI	66.67%	81.65%	12.80 PSI
12 PSI	75%	86.60%	13.39 PSI
13 PSI	83.33%	91.29%	13.95 PSI
14 PSI	91.67%	95.74%	14.49 PSI
15 PSI	100%	100%	15 PSI

As you can see from the table, the square-root relationship is most evident in comparing the input and output percentage values. For example, at an input signal pressure of 6 PSI (25%), the output signal percentage will be the square root of 25%, which is 50% (0.5 = √0.25) or 9 PSI as a pneumatic signal.

At an input signal pressure of 10 PSI (58.33%), the output signal percentage will be 76.38%, because of 0.7638 = √0.5833, yielding an output signal pressure of 12.17 PSI.

Conclusion: Designed a op-amp based square root extractor circuit in simulation software. A square root extractor eliminates the square root relationship between input and output and helps to get a linear ouput.