جامعة الأمير مقرن بن عبد العزيز
University of Prince Mugrin

Electronics 1 Project

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Course Title

EE222-Electronics 1

Instructor

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Date

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Content

Introduction

- Appling the gained knowledge

- Achieving the objectives:
1. Designing a circuit based on requirements.
2. Incorporating only (Electronics 1) materials.
3. Simulation and data acquisition.

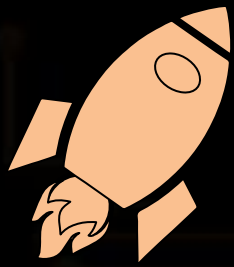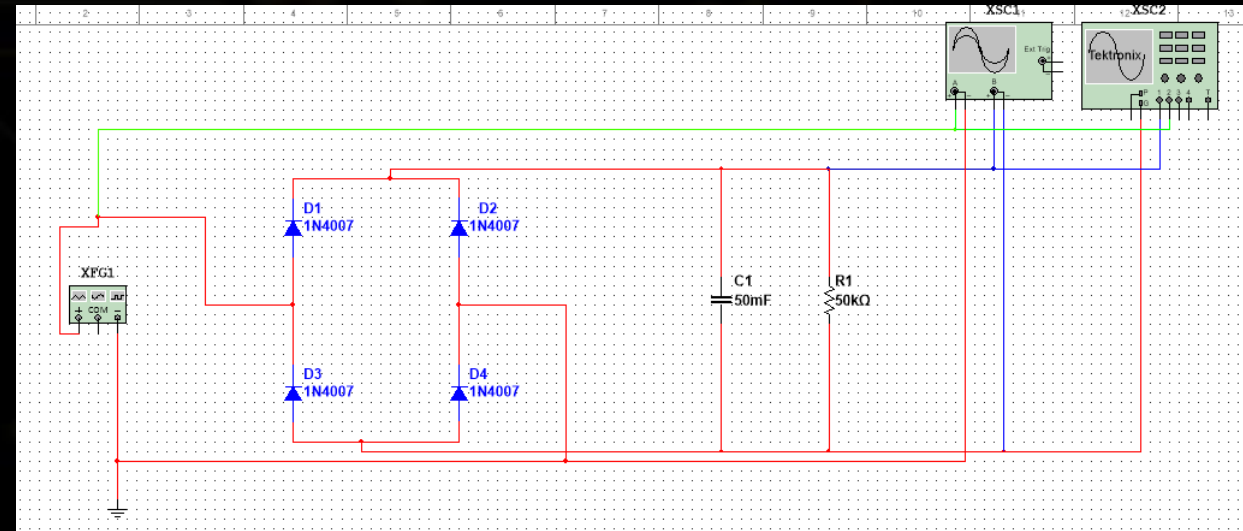| Tasks	Topic
Task 1	Diodes.
Task 2	Online research and electrical circuit background.
Task 3	BJTs.
Task 4	
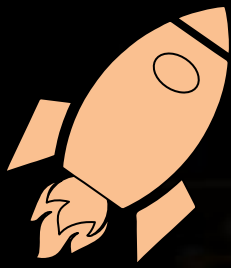
🚀 Task 1 / Full Bridge Rectifier

- Converting AC to DC.

- The positive half-wave & the negative half-wave Cycle.

- Diode characteristics.
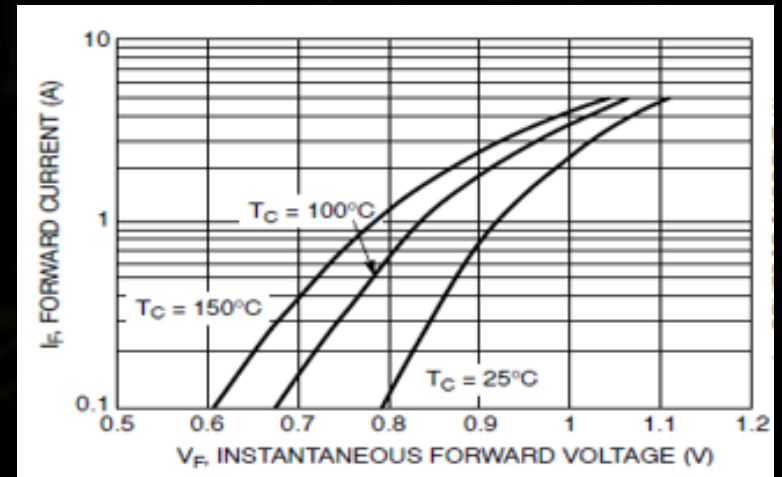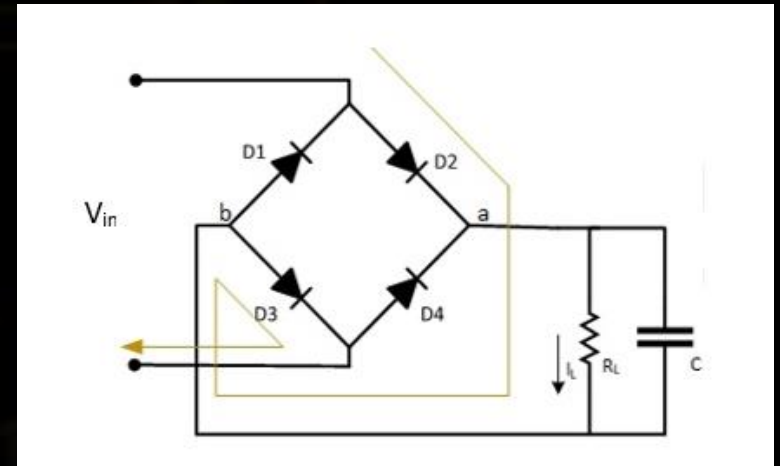
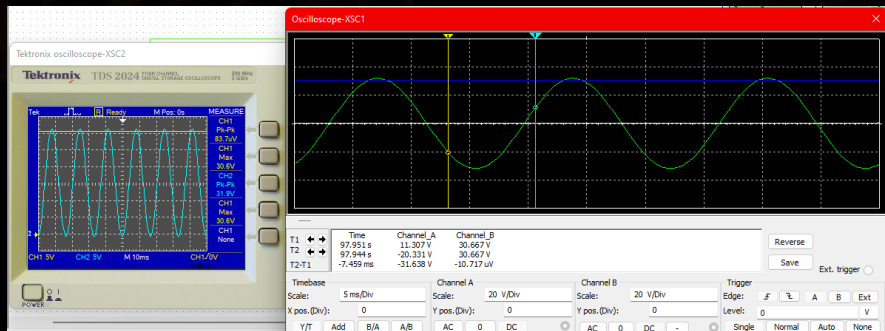# Task 1/ SIMULATION

$$V_{r(pp)} = \left(\frac{1}{fR_LC}\right)V_{p(rect)}$$

The simulation of the bridge rectifier circuit

The peak-peak ripple voltage was found 83.7uV

The minimal output Ripple Voltage (DC Voltage)
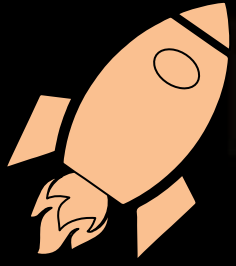
🚀 Task 2 / Touch Sensor Circuit

- **Difficulties:**

1- Amperes = Less than 1 mA, Less than 10 mA

2- 1k Ohm < Human resistor < 10k Ohm.

- **Mechanism:**

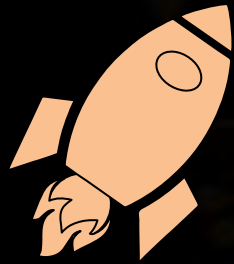   Switch + Resistor + Effects of the Comparator Circuit

Task 2 / Simulation

I: 765 nA
I(p-p): 862 uA
I(rms): 428 uA
I(dc): 269 uA
I(freq): 60.0 Hz

S1

PR1

R4

1kΩ

Key = Space
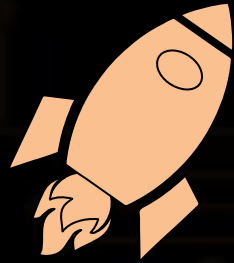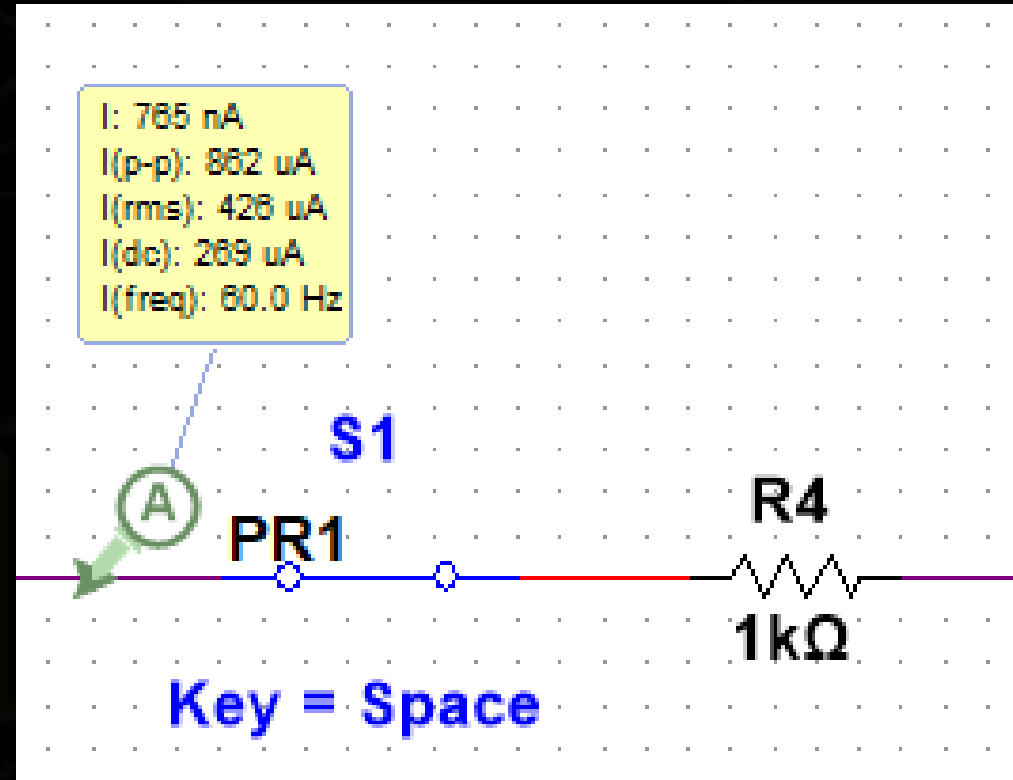
Simulation + Representation of the Touch Sensor

Task 3 / Comparator Circuit

- **NPN BJT used.**

Symbol	Parameter	Value		Unit
		BD235	**BD237**	
V_{CBO}	Collector-base voltage ($I_E = 0$)	60	100	V
V_{CER}	Collector-emitter voltage ($R_{BE} = 1\ k\Omega$)	60	100	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	60	80	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	5		V
I_C	Collector current	2		A
I_{CM}	Collector peak current ($t_p <$ ms)	6		A
P_{TOT}	Total dissipation at $T_{case} = 25°C$	25		W
T_{stg}	Storage temperature	-65 to 150		°C
T_J	Max. operating junction temperature	150		°C

Absolute maximum ratings

IB ▶ IC ▶ VCE
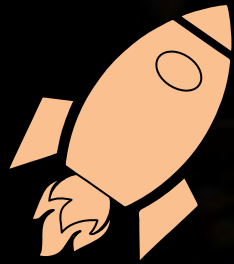
Task 3 / Comparator Circuit

| Symbol	Parameter	Test conditions		Min.	Typ.	Max.	Unit
I_{CBO}	Collector cut-off current ($I_E = 0$)	V_{CB} = rated V_{CBO} V_{CB} = rated V_{CBO} T_C= 150°C			-	0.1 2	mA mA
I_{EBO}	Emitter cut-off current ($I_C = 0$)	V_{EB} = 5V			-	1	mA
$V_{CEO(sus)}$[1]	Collector-emitter sustaining voltage ($I_B = 0$)	I_C = 100mA for BD235 for BD237		60 80	-		V V
$V_{CE(sat)}$[1]	Collector-emitter saturation voltage	I_C = 1A	I_B = 0.1A		-	0.6	V
$V_{BE(on)}$[1]	Base-emitter on voltage	I_C = 1A	V_{CE} = 2V		-	1.3	V
h_{FE}[1]	DC current gain	I_C = 150mA I_C = 1A	V_{CE} = 2V V_{CE} = 2V	40 25	-		

Electrical characteristics
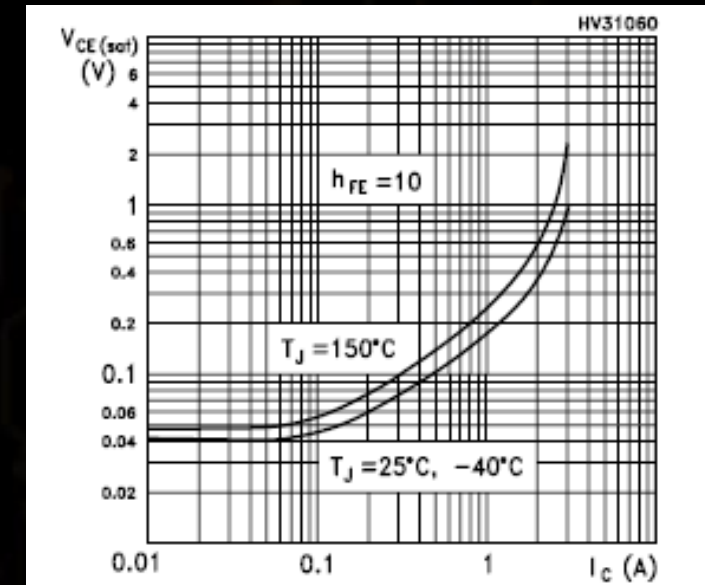
BJT characteristic curve
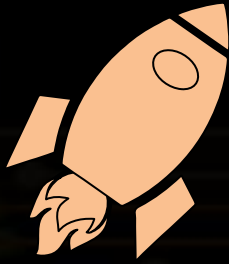
Task 3 / Simulation
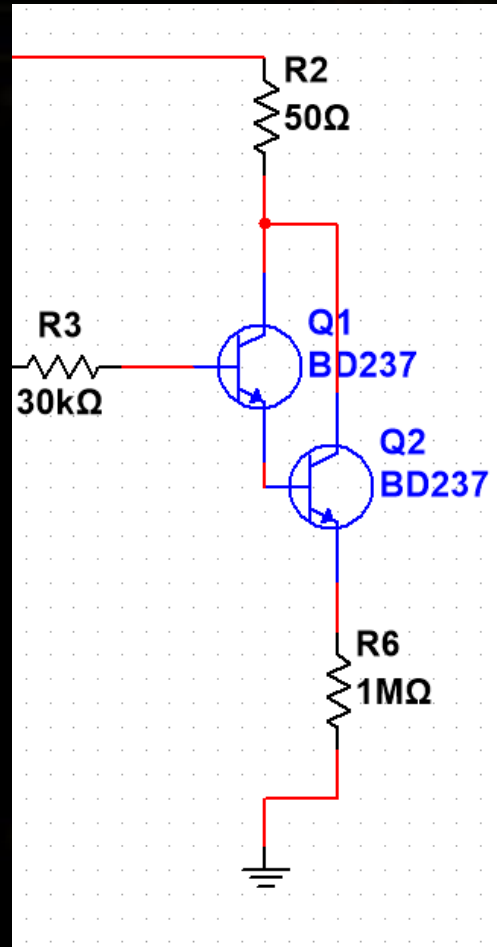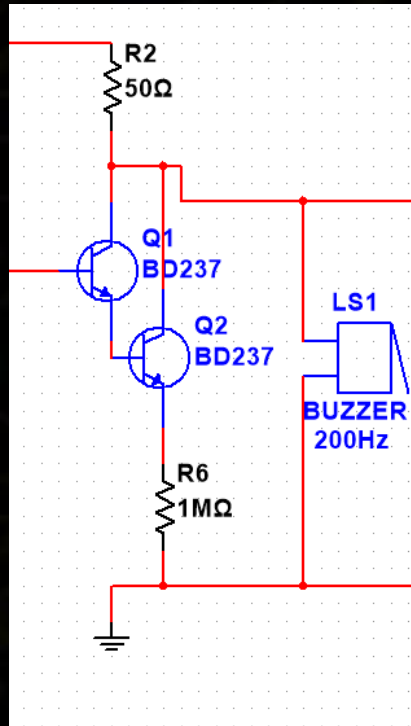

Comparator Circuit Simulation
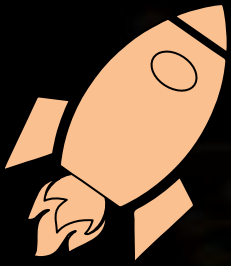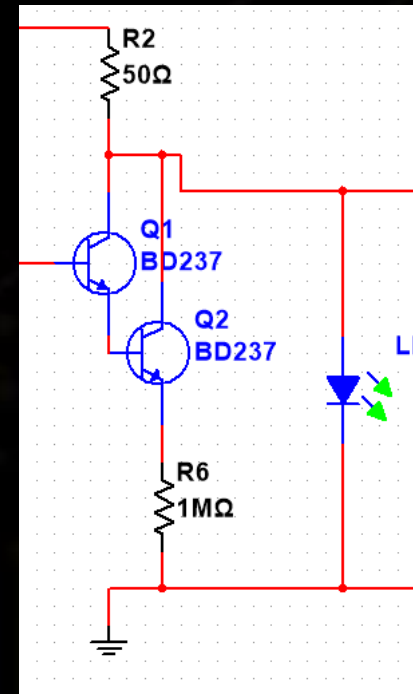
🚀 Task 4 / Testing different loads

- We needed to make sure that the circuit works with different loads. Such as:
  - Different colored LEDs.
  - Lasers.
  - Buzzers.
- The circuit must operate these loads while keeping the current through the touch sensor low.

The Buzzer Connected to the Circuit

LED Connected to the Circuit

Parameters Calculations
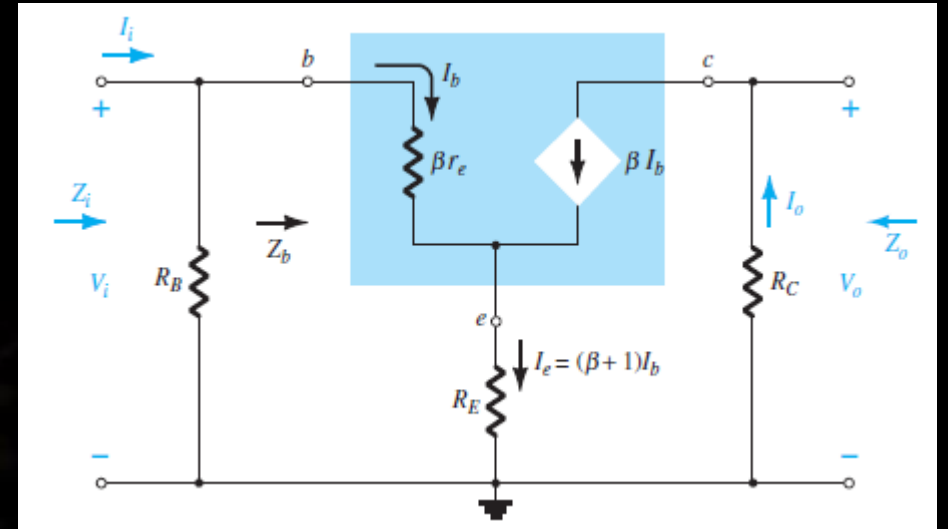
- the most important parameters are:

1. Zi: input impedance.

2. Zo: output impedance.

3. Ii: current entering the Base.

4. Io: current entering the Collector.

- We can find some variables first:

- r_{e1} & r_{e2} (reverse emitter resistors): $r_{e1} = r_{e2} = 25mV / Ie = 25m / 111u = 225$ Ohm.

- Beta: $I_C / I_B = 153$

- Zb (I_B path impedance) = Beta*R_E = 153M Ohm

Parameters Calculations

- So, our parameters will be:

1- Zi = Zb // RB = 29994 Ohm

2- Zo = RC = 50 Ohm

3- Ii = 458 nA

4- Io = 70.1 uA
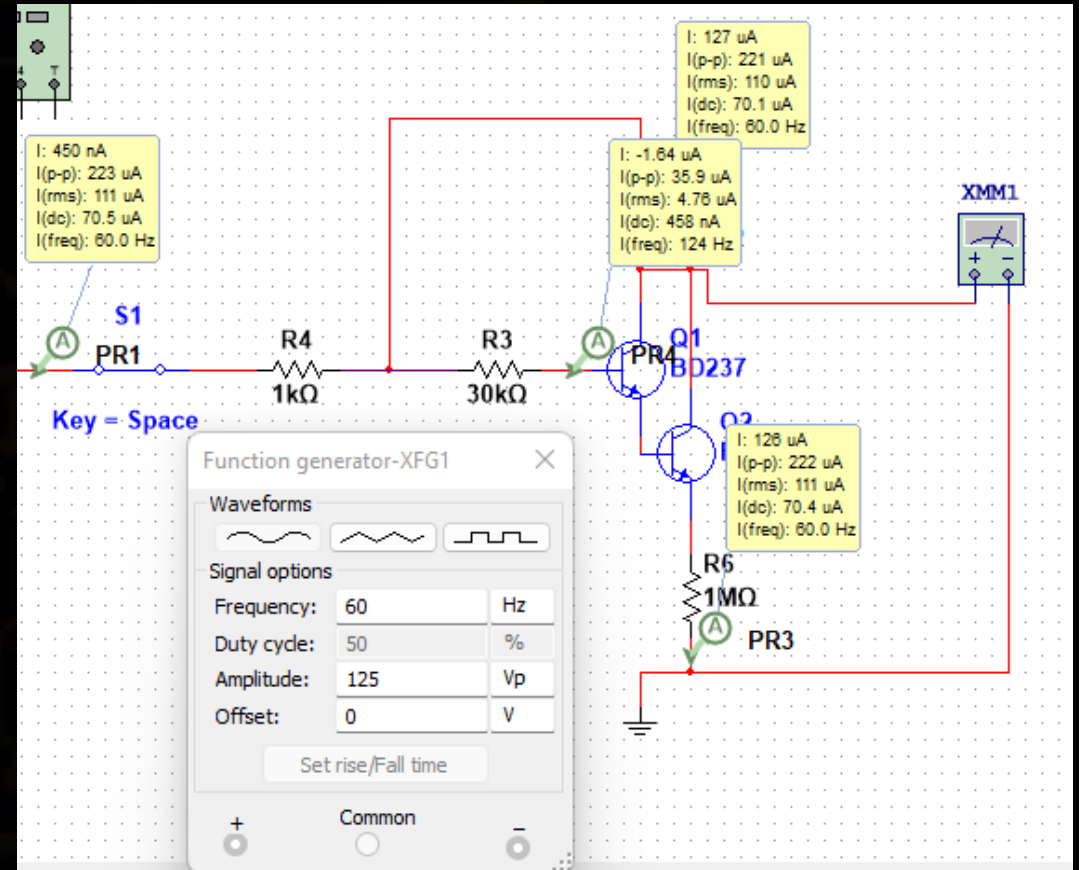
- And the final important parameter is the gain AV = -RC/RE = - 50 ʊ

Limitation

- Our circuit was limited between 125 and 311 Vpeak - AC.

  – Below 125Vp, the buzzer will stop working.

  – Above 311Vp, the current through the touch sensor will cause a shock to the person touching it.

Challenges

- **Challenges:**

1) Multiple error in Multisim

2) Miscalculations

3) Finding proper current through the human hand

4) Having suitable voltage for output

Work distribution

- **Work distribution:**

1. Mustafa = Task 1 + Simulation 1 + written content + ppt design

2. Marwan = Task 2 + Task 3 + Simulation 2 + written content + ppt content

3. Abdulsalam = Task 4 + Simulation 3 + written content + ppt content

NOTE: there was an overlap between the members in the work.

Conclusion

3 Working Circuits → ← **4 Tasks Done**

- Seeking improvements in the future

References

- BD237 Data-sheet, STMicroelectronics.

- Electrical Engineering Department, University of Prince Mugrin (UPM). Laboratory Manual for Electronic Circuits 1.

- Nashelsky, L., & Boylestad, R. L. (2021). Electronic Devices and Circuit Theory Eleventh Edition.

- *Resistance of Humans*. (2021). Fundamentals of Electricity. https://c03.apogee.net/mvc/home/hes/land/el?utilityname=citizenselectric&spc=foe&id=4657#:%7E:text=Human%20resistance%20is%20about%2010%2C000,or%20impedance%20to%20current%20flow

- 1N4007 Data-sheet, Onsemi.

Thank You