Electronics for Pedestrians

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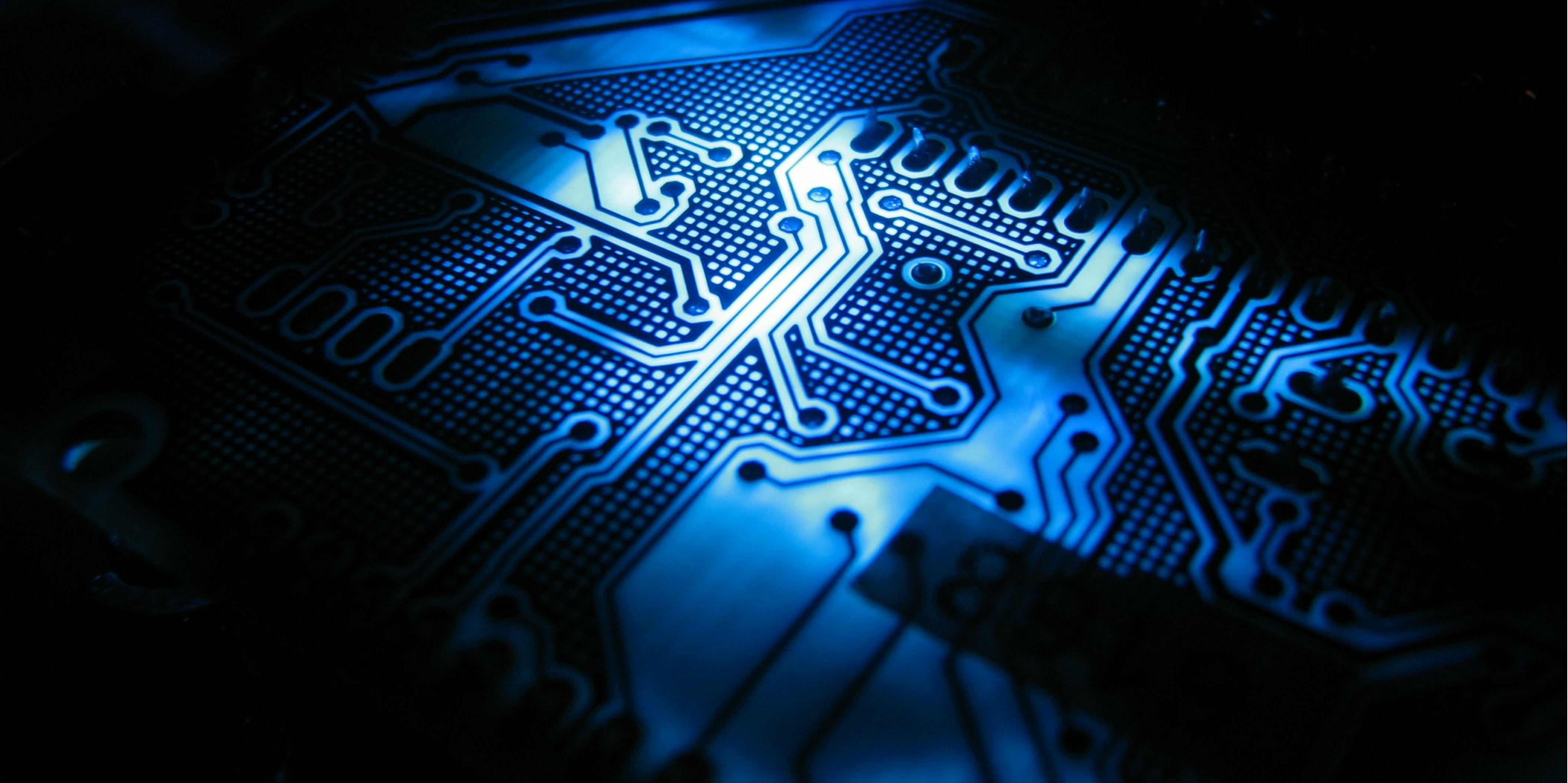
– Tutorial II/II –



“In theory, 'theory' and 'praxis' are the same, in praxis they aren't”

Exercises – your turn

"I was lying on the floor watching TV and my mom accidentally sucked the test answers out of my head while she was vacuuming."

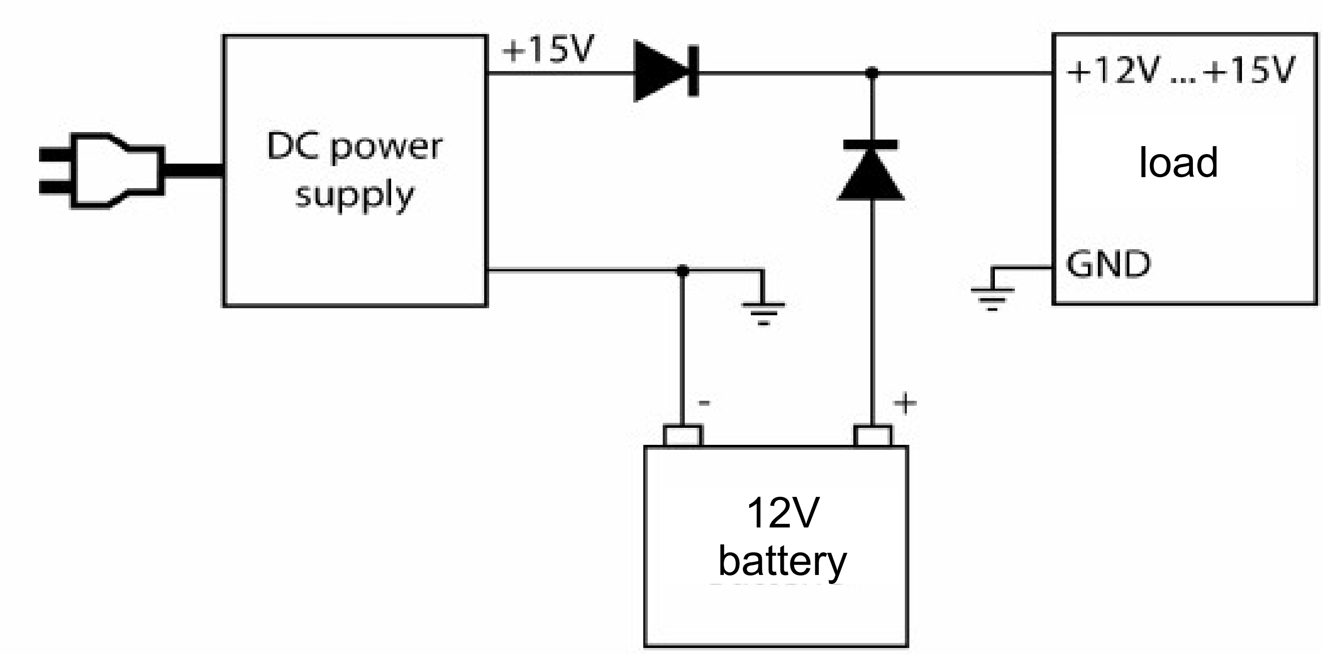
Exercise I

- Diodes are probably the single most important non-linear devices in RF application.
  a) Simulate and plot the V-I response curve for the following diodes (N.B. 'DC simulation', use 'DC voltage source' and 'Current Probes'):
    - 1N4002, 1N4148, 1N746, BAS40, BAS70, LED (IR, red, …)
      – Specific diodes are found at: *'Tools → Component Library'*
    - Compare and discuss the differences

  b) Simulate and plot the AC voltage-response of the above diodes connected to a 50 Ohm load (exciting frequency: 10 kHz, 1 MHz & 1GHz)
    - Which one would you use for RF applications and why?

Exercise II

- For the given schematic (N.B. this doesn't need to be simulated):
  - Explain its function.
  - Suggest a modification that loads the battery with a constant current of 10 mA.



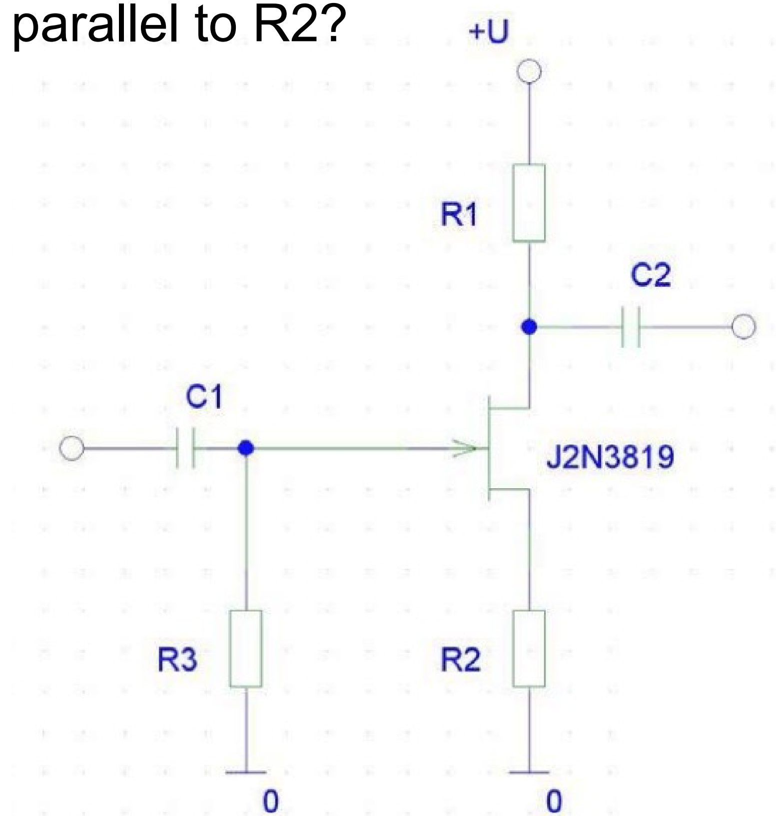
Exercise III

- Design a circuit schematics for a voltage doubler. Assume a series resistance of R_s=10 Ohm prior to the diode, a load resistance R_L=1 kOhm and parallel capacity C=1 uF. Simulate and plot
  a) Transient response for a 1kHz AC voltage source (i.e. first 15 ms)
  b) Re-simulate at 2 MHz.

- Optional: design a full-size high-voltage source (i.e. Cockcroft-Walton, Greiner)
  – What do you reckon are the limitations of such circuits?

Exercise IV – Optional

- In the given amplifier circuit, the gate bias-voltage is U_{GS}=- 2 V and the drain-source voltage U_{DS}=15 V. The operating voltage +U is 25 V.
  a) Compute R1 and R2 so that the drain current is 5 mA.
  b) "Build" the given schematic and verify the amplification gain for an input voltage of V_{pp}= 10, 100 and 1000 mV.
  c) What would be the impact of a capacitor in parallel to R2?

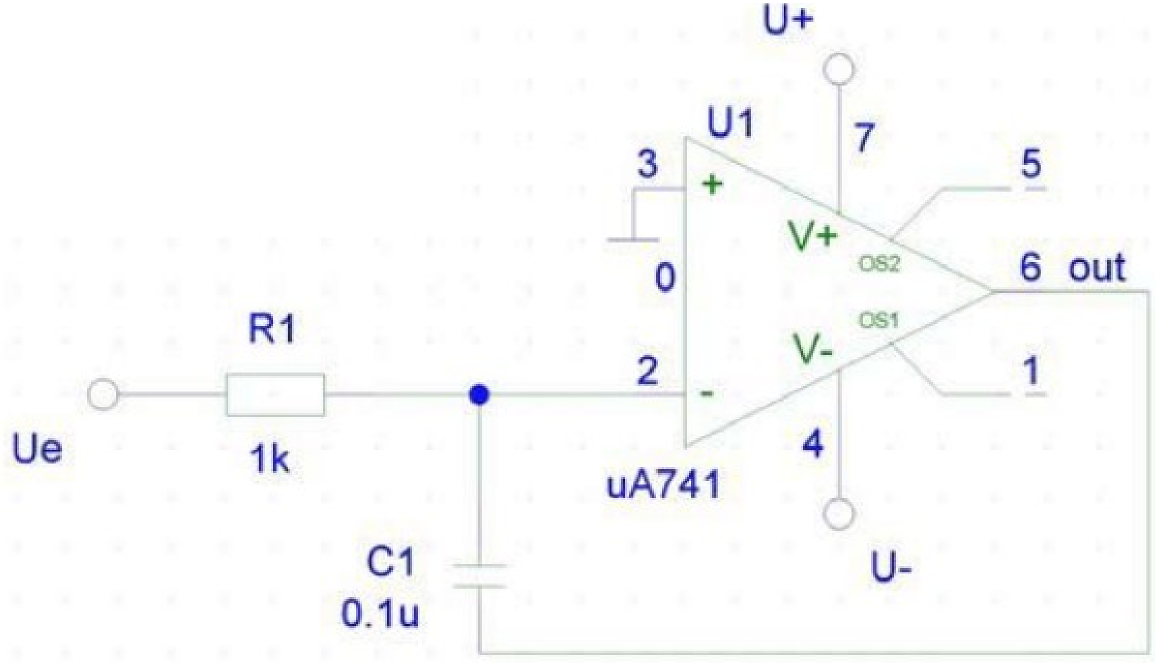


Exercise V

- Using the 741 opamp, design an inverted amplifier with a symmetric ±10 V supply voltage, R1=100 Ohm input resistor and for an AC input voltage V_{pp} < 500 mV@1 kHz.
  a) Simulate and plot the AC- and transient response for input frequencies ranging from 1 Hz to 10 MHz
  b) Check the amplifier gain for the feedback resistor values R2=0.1, 1, 10, 1k, and 100 kΩ.
  c) Confirm the relationship between gain and bandwidth
  d) Are there significant offset-voltage effects?

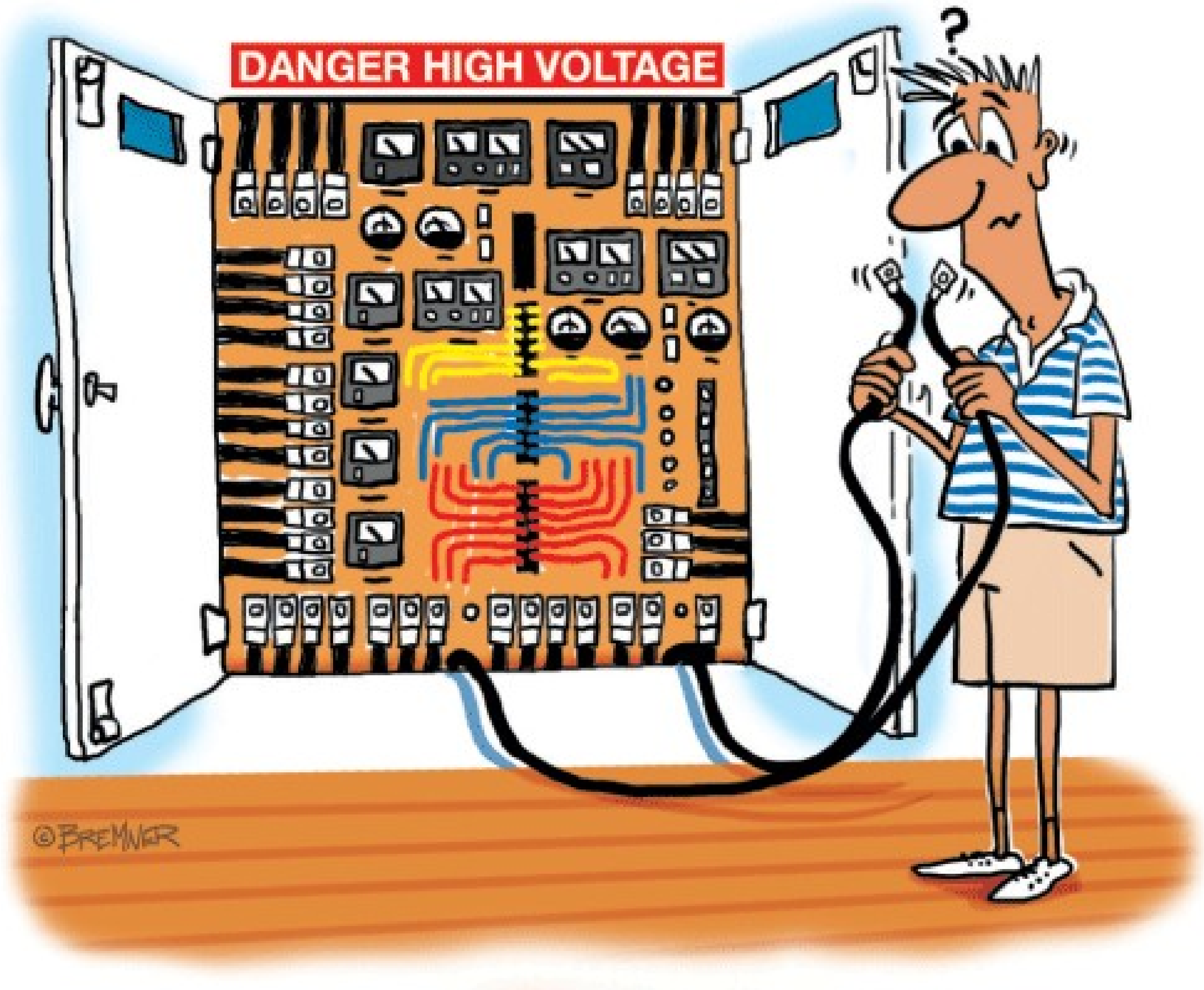
Exercise VI

- Somebody drew up the schematic below:
  - What does the circuit do?
  - Assume an input signal $U_e(\omega,t)=U_0\cdot\sin(\omega\cdot t)$. Compute (analytically) the output signal $U_a(\omega,t)$. Then...
  - Simulate and confirm your hypothesis using Qucs.
  - How does the circuit behave for square or single/periodic pulses



Exercise VII – Optional

- Build a voltage stabiliser using an opamp and JFET
- Simulate and plot the performance.


DANGER HIGH VOLTAGE
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