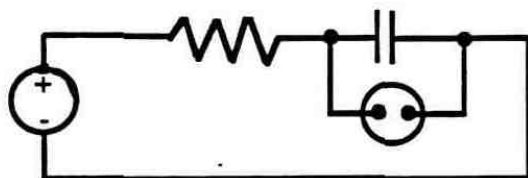


## G. KOVACS' QUALS QUESTION JAN 1995

*circuits*

This question involved oscillators built using gas discharge lamps. The objective of the examination was only partly to see if the student could correctly answer the questions posed... equally important was the student's approach.

The basic circuit employed was as follows:



The voltage applied to the circuit was provided by a DC-to-DC converter running off a low-voltage, adjustable DC laboratory supply. The student was told of this and it was pointed out that the DC-to-DC converter had nothing to do with the phenomena to be discussed. The voltage applied to the circuit was displayed using a digital multimeter so that the student realized that it was  $> 80$  V.

Several of the circuits as shown above were assembled in a stack. The neon lamps were flashing (each at a steady rate) and the student was asked to explain the operation of the circuit. This explanation was facilitated by the available information, including the measured applied voltage, clues provided during the exam, and the student's observations (looking at the physical circuit was helpful!). Knowing the exact component values was not necessary.

The mechanism is that the capacitor charges up to the discharge voltage of the neon lamp, at which point it stays lit as the capacitor discharges down to a substantially lower voltage (where it can no longer maintain a discharge). The capacitor then charges up to the discharge voltage and the cycle repeats.

The student was then instructed to look at another similar circuit with an LED in series with the neon lamp and explain why the LED was flashing (simply because the current was gated by the neon lamp).

Finally, the student was asked to look at a circuit wherein an LED (the fact that it was some kind of LED was either already clear to the student or was pointed out) was flashing in a similar circuit. The question was whether or not one could construct such an oscillator from an ordinary pn junction diode (such as an LED), a capacitor and a resistor. The point here was to see if the student understood how such oscillators might work and whether he or she believed what they were seeing or what they knew to be correct.

Again, the student's approach to the problem was most important.