2012-2013 EE Ph.D. Qualifying Exam
Question area: *Engineering Physics*
Examiner: *Jelena Vuckovic*

Clearly state any assumptions you make while solving the problems. Good luck!

1. Electron source

Suppose you need to generate an electron beam for your experiment.

You have access to the following equipment:

- a source of ultraviolet radiation (e.g., a UV lamp with radiation spectrum covering 200nm-400nm wavelength range);
- a high voltage source (DC);
- a strong magnet (generating DC magnetic fields of up to 4T);
- a metal evaporator, that you can use to coat substrates with gold, platinum, or aluminium;
- a variety of substrates (e.g., quartz and glass microscope slides and silicon wafers);
- a sensitive screen detecting electrons, which you can use to characterize the profile of the electron beam

(a) Explain how you would generate an electron beam using the available equipment.

(b) What would you do to focus the electron beam, so that the spot on the detector screen is as small as possible?

Hint: The following parameters can be useful for your analysis:

- the workfunctions of gold, platinum, and aluminium are 5.1eV, 6.35eV, and 4.08eV, respectively;
- electron mass $m=9.1\cdot10^{-31}$kg; electron charge $e=-1.6\cdot10^{-19}$ C;
- Planck's constant $h=6.626\cdot10^{-34}$Js

2. Coffee cooling

Explain the process by which a hot cup of coffee cools.