# Exercises

Consider a controller for an electric water heater (as shown below) as an embedded computer system.



1. What are the inputs devices?

User control (e.g rotary knob) specifying desired (setpoint) temperature for water

Two thermometers.

1. What are the outputs?

Power control for each heating element.

Optional: user display of setpoint and actual temperatures.

1. Name at least two safety features to include, and specify what hardware and/or software is needed for each.

Over-temperature – software needs to monitor the temperature sensor and detect if it is over-range.

Over-pressure – software needs to monitor an additional pressure sensor.

Detect empty tank – could have a pressure switch, or could use software to detect that water temperature isn’t changing when heater switches on or off.

1. Describe a useful feature which could you add in software without requiring additional hardware.

Freeze prevention – when in standby mode, prevent water from cooling enough to freeze

1. Describe two useful energy-saving features which could you add in software if the controller could keep track the time of day.

Use a timer to adjust setpoint based on time (e.g. let water cool down at midnight, start to heat it at 6 AM, or learn from past use of water)

Use a timer to heat water when electricity is less expensive (e.g. at 3 AM)

1. Describe a useful feature which could you add in software if the water heater included an internet connection.

Remote control and monitoring of water heating.

Demand-side management – allows power company to temporarily shut down water heater to reduce peak power requirements.