

## HWK #1

## Transistor Relay Driver

(Due 2/3/16)

### Background:

You need a sample prep oven to do your research. You find an old oven in the shop but it doesn't work. You're told that you can have it if you can fix it. You determine the temperature controller is bad and everything else (heating element, insulation, etc) is OK. You decide to buy a generic temperature controller for \$209 (<http://www.alliedelec.com/red-lion-controls-t4820000/70031276>). You mount a thermocouple in the oven and connected it to the controller. The pulse output on controller goes high (7V) when below the temperature set point and low (0.3V) when above the temperature set point. Note: The pulse output on the controller can source or sink 20mA.

### Requirements:

You need the oven to reach 200C and estimate it will take 450W of power to overcome the oven's heat loss at 200C.

You measure the ovens heating element with the ohm meter and it measures  $20\Omega$ . If you run the heater off the wall outlet it could put out  $(120V)^2 / 20\Omega = 720W$ . This is well above the 450W you think will be needed (a good safety margin). You decide to use the pulse output of the temperature controller to control a mechanical relay that will connect 120VAC to the furnace heating element.

### Summary:

Load: A resistive  $20\Omega$  heater

Power: 120VAC

Controller: Pulse output for heater (on =  $7V@20mA$ , off =  $0.3V@20mA$ ).

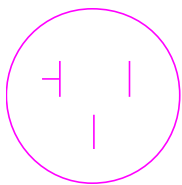
Let's also assume the controller provides 12VDC @ 200mA to power your circuit.

### Design Problem:

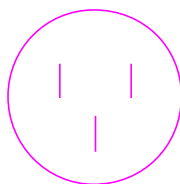
Select a relay and transistor from [www.digikey.com](http://www.digikey.com) that meets the voltage & current requirements. Design a circuit that will use the pulse output from the controller to turn on the transistor which will turn on the relay. Show your calculations for determining resistor values and list the transistor  $B_{DC}$  or  $h_{fe}$ . Draw the circuit schematic and **label the parts** (resistor values, transistor part number, and the relay part #) (I need to look up the relay and transistor specs to check your circuit).

**Note:** The link to the temperature controller is just so you can see what a temperature controller looks like. You don't need to use the link to do the homework.

### Note on Power Availability:



20A



15A

The 120VAC outlet near the furnace is rated at 20A. When the heating element is on the oven will draw  $120V/20\Omega = 6A$  (so this outlet is OK to use). Note: Most of the time multiple outlets share a single breaker (Ex: in the labs there are multiple outlets on each wall but only one breaker per wall). You should check to see what else is plugged into the same breaker and that the total current is less than 20A. Most outlets in the home are rated at 15A.