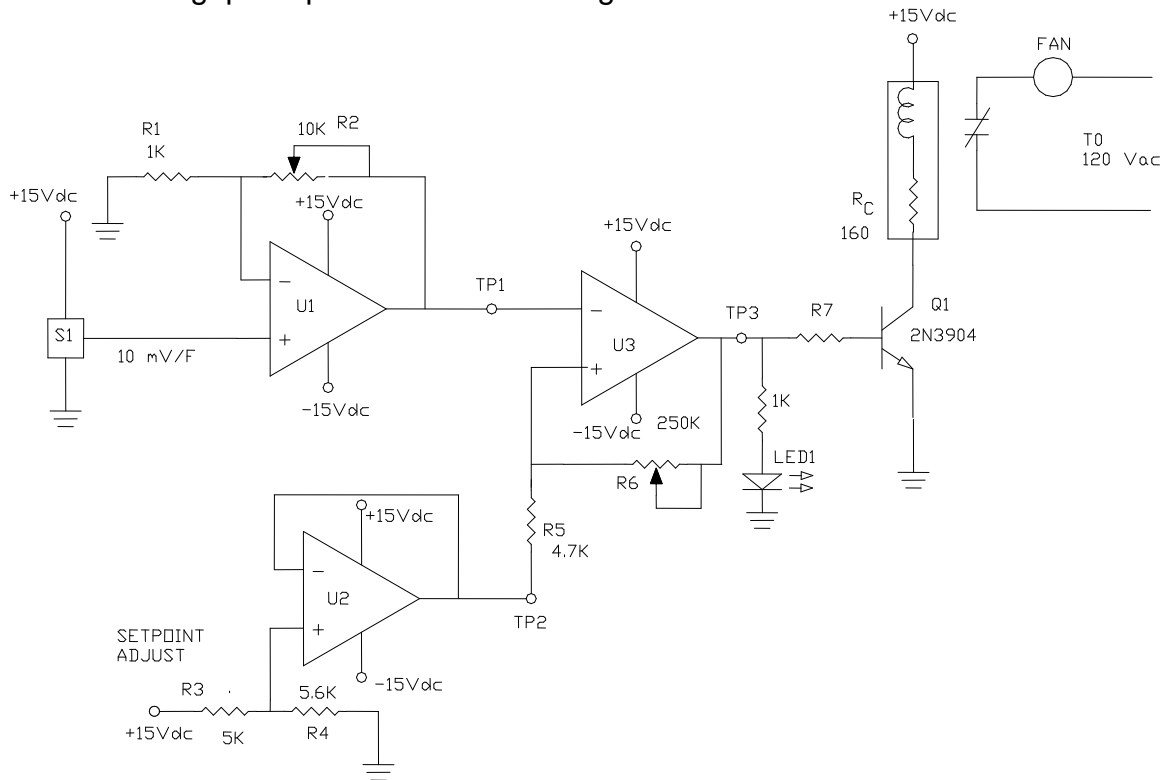


ET 438b  
Continuous and Digital Control  
Differential Gap Controller

Refer to the schematic diagram below for the following questions. This circuit implements a differential gap temperature control using OP AMP.



- 1.) Calculate the setting of R2 so that a sensor, S1, input of 50 F will give a voltage of 5.0 V at TP1.
- 2.) Determine the setting of R7 so that U3 has a 10 F deadband voltage scaled to be compatible with the input at TP1. Assume that  $V_{sat} = 0.8V_{cc}$ .
- 3.) Determine the voltage at TP2 so that the LTP of the comparator U3 will be 90 F.
- 4.) Calculate the value of R3 so that the voltage at TP2 is equal to the LTP value.
- 5.) Make a sketch of the input/output response of U3 and mark the input voltage values where 65 F, 95 F and 120 F are located. Also identify the voltages of the upper and lower trip points.
- 6.) Calculate the value of R7 so that the cooling fan relay will be activated when the control circuit detects an over temperature. ( $h_{FE} = 200$  for 2N3904) Use the 10 times rule to assure that Q1 goes into saturation.
- 7.) For what range of temperatures will LED1 be on?