

**EECS 145L, Fall 1999  
Midterm #2 Solutions  
Professor S. Derenzo**

**Problem #1a**

A sensor converts a physical quantity into an electrical signal  
An actuator converts electrical energy into physical energy

**Problem #1b**

A thermocouple: (i) consists of two dissimilar wires, (ii) produces a voltage (Seebeck emf) proportional to a difference in temperature, and (iii) requires voltage amplification to produce a useful voltage

A thermistor: (i) is a semiconducting element, (ii) its resistance changes with temperature, and (iii) it requires a bridge and differential amplification to convert the electrical signal into a useful voltage.

**Problem #2a**

Technical requirements of a ground fault interrupter circuit:

(i) open both current carrying power conductors (hot and neutral) when the difference in their currents exceeds 5 mA

(ii) provide a reset button

(iii) provide a test button

[2 points off for missing the reset and test button - everyone missed these]

**Problem #2b**

How the ground fault interrupter circuit functions:

(i) the difference in currents is converted into a 60 Hz voltage using a differential transformer

(ii) this voltage is amplified and rectified

(iii) the resulting dc voltage trips two relays which hold both conductors open until reset

[1 point off for no amplification, 2 points off for no relays]

**Problem #3a**

Technical requirements of the electronic ice point circuit:

Provide a correction voltage to the thermocouple output that compensates for variations in the temperature of the reference junction.

Alternatively: Provide a correction voltage that (i) is proportional to the temperature of the reference junction and (ii) has the same sensitivity as the thermocouple

**Problem #3b**

How the electronic ice point circuit functions:

(i) The temperature of the reference junction is sensed using a secondary temperature sensor such as a thermistor or solid-state temperature sensor.

(ii) The secondary sensor output is converted into a voltage that has the same sensitivity (volts per degree of temperature) as the thermocouple

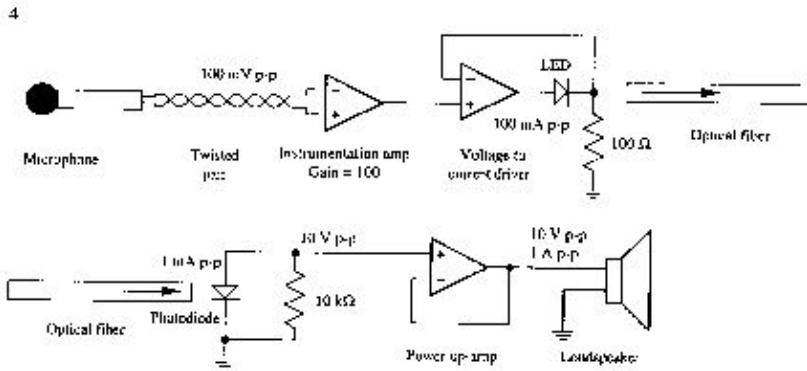
(iii) the result is added to the thermocouple output to compensate for changes in the temperature of the reference junction

[this circuit was in the reading assignment in INTERFACING section 4.3.7, was on last year's midterm, and

was discussed in the review lecture last Wednesday]

**Problem #4**

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