

EE 4BD4 Midterm
2015

1. Surface skin temperature $10 < t_s < 35$ in cold climate this could be even colder.

All four sensors thermocouple, RTD, thermistor or ~~semiconductor~~
cover this range.

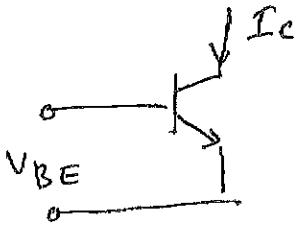
Choose thermistor: because it has the closest range (2)
(1) sensitivity is very good

Choose semiconductor: because it has a reasonable range.
Linearity and accuracy are 1°C
which is good enough for skin measurements.

Operating principles

thermistor: change in resistance (-ve for increasing T)
can use variety of shapes & sizes for fast or slow response
Resistance typically 10's of k Ω .

(2) Semiconductor:



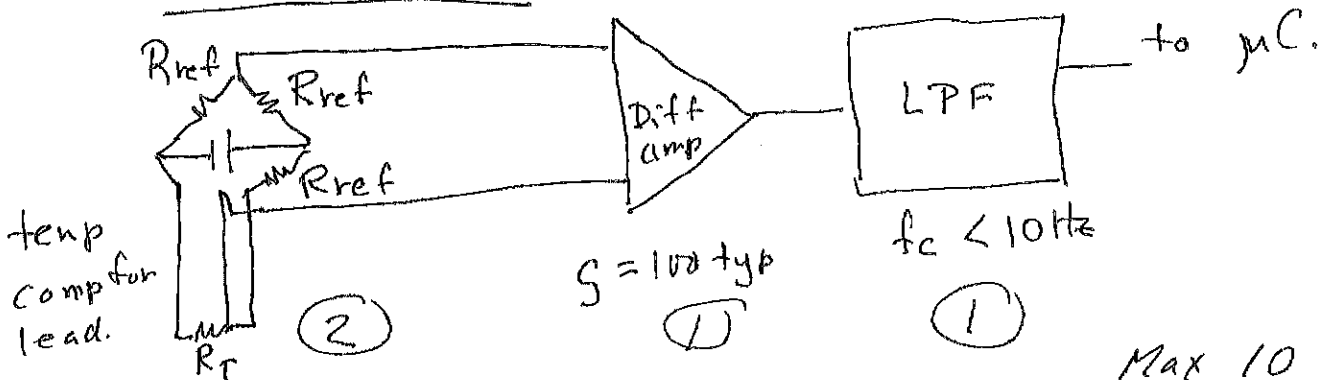
$$V_{BE} = \frac{kT}{q} \ln\left(\frac{I_C}{I_B}\right)$$

base-emitter voltage increases with T

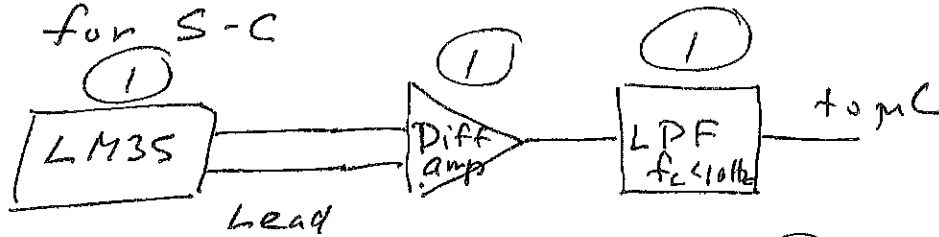
LH35 is all it is a typical S-C sensor
calibrated as 10mV/ $^\circ\text{C}$

Noise: 60 Hz coupling in leads and on transducer itself.

(2) Perhaps motion artifact.
for any two Lead change in resistance with temperature as well
Instumentation for thermistor



1 cont'd

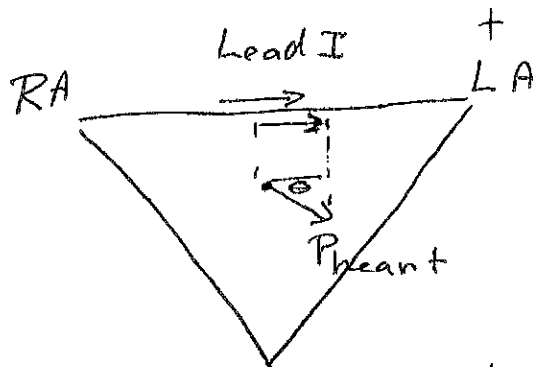


power from µC for both Max 10

2. Assumptions

- Thorax (chest) is a volume conductor — (valid)
- Heart is at centre of an equilateral triangle with apices at shoulders and pubis (partially valid)
- Entire electrical activity of heart can be represented by a dipole (changing amplitude & direction) (partially valid)
- arms & legs are linear conductors (partially valid)
- Chest tissue is homogeneous (invalid)

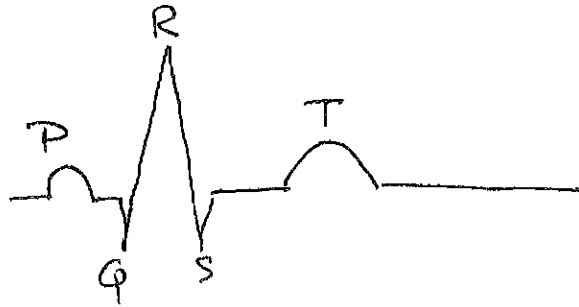
② for validity assessment



Lead I is unit measurement vector from RA to LA (shown in diag)
Lead I signal is a scalar, is projection of P_{heart} onto Lead I vector

also $Lead\ I = P_{heart} \cdot P_{Lead\ I}$
 $= P \cos \theta$ where P is amplitude of heart dipole

2 cont'd



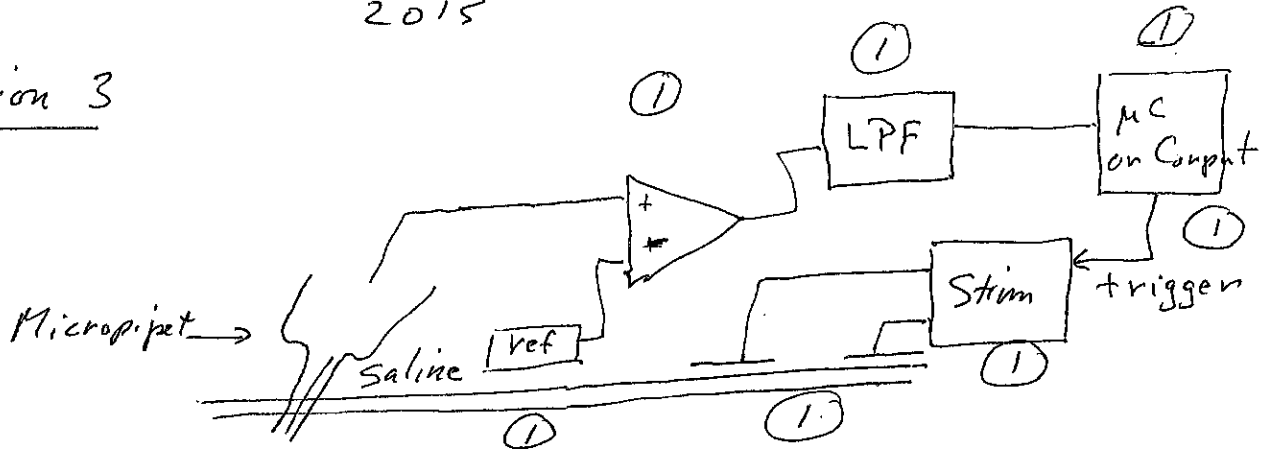
P = atrial depolarization and atrial contraction

QRS = ventricular depolarization and ventricular contraction
(atrial repolarization & relaxation hidden)

③ T = Start of ventricular repolarization and relaxation

Max 10

Question 3



↑ fiber
Electrodes - ref + stimulator
① Ag-AgCl or plain metal

Stimulator
Can be two surface, current or voltage, stimulus pulse 50ms → 200µs
monopolar. Ideal is constant current. Can also have internal voltage or

Amplifier Overall Gain = 10-20
Differential
Z_{in} very high > 10¹⁰ ②

LPF
Cutoff 10 → 20 kHz ①

Display / Recording

- Simplest, oscilloscope at single shot, triggered by stimulator time base set to 10-20 ms.
- Alternative µC A/D 12-bit max, f_s 20 kHz ②

Technique

Need adjustable amplitude input for stimulator ①

Set amplitude low and stimulate and record. If ~~not~~ action pot. recorded, increase amplitude of stimulus. repeat until AP recorded. max V_m just before AP is threshold.

③

