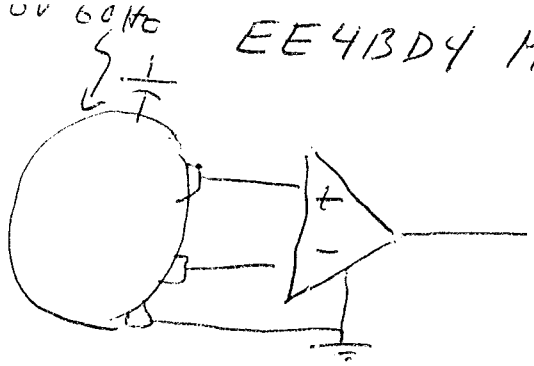
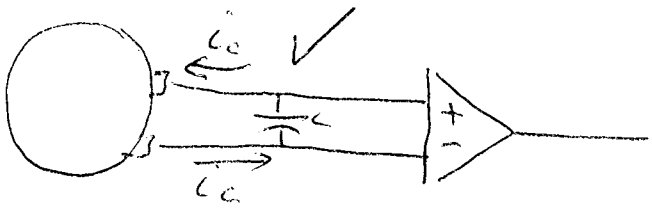
EE4BD4 Midterm Solutions 2017

1.

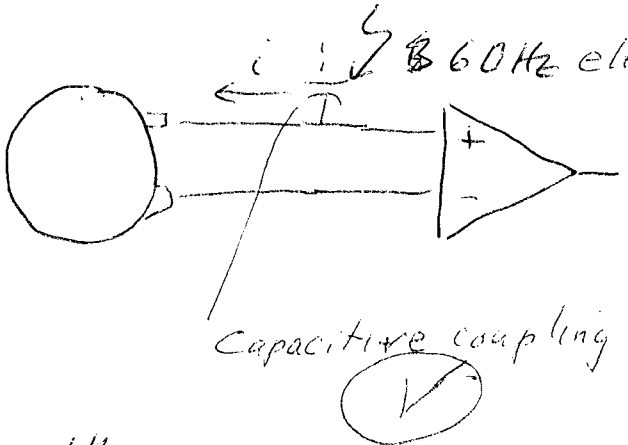
a) 

60 Hz signal on the skin surface (✓)
Use a differential amplifier (✓)
CMRR ≥ 90 db (✓)
Use a gnd electrode for best CMRR (✓)
Make sure two electrode impedances ~~are~~ similar and << Z amplifier (✓)
(or any reasonable answer)

b) 

Cable motion artifact (✓)
caused by cable capacitance (2)
changing as distance between wires changes resulting in current i_c flowing through electrodes causing voltage $V = i_c Z_e$

Sol^n Remove by high pass filter $f_c \approx 10$-20 Hz (2)
Make sure electrode impedance as low as possible (✓)

c) 

(✓)

60 Hz ~~signal~~ induced current in electrode wires from (2)
power lines, equipment, etc
causes current i to flow through electrode impedance Z_e
resulting in $V = i Z_e$ at electrode

Sol^n
1) Shield cables and keep transducer wires short (✓)
2) Keep electrode impedances as low as possible (✓)
3) Use 60 Hz notch filter as last resort
(or any reasonable solution)

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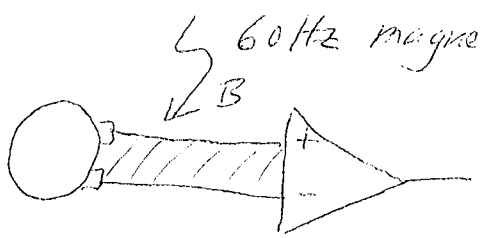
1 d)



(2)

Solns

1) Reduce area enclosed by electrode cables (✓)
2) Keep leads short (✓)
3) Twist signal wires (leads) to reduce area (✓)
4) Keep subject away from magnetic sources (transformers, flourescent lights, etc). (✓)

In all the above a solution can be to do recording in a shielded room (Faraday cage) (2)

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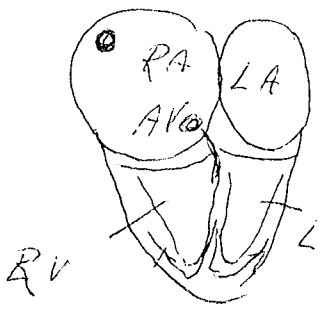
2. SA



(ii) Signal (trigger) is initiated at the sino-atrial (SA) node (1)

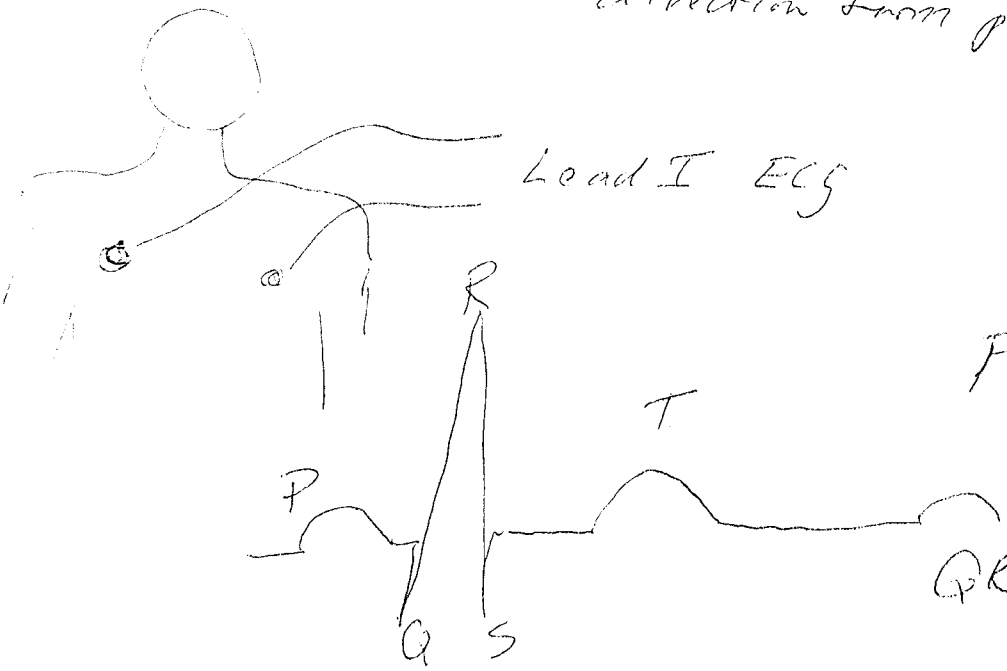
(iii) transmitted quickly to the atria causing atria to contract (1)

(iii) Signal transmitted through AV node (atrio-ventricular) and bundle of His (1) acts as delay line 120-200 ms (1)

(iv) Signal sent to right and left ventricle via Purkinje fibres (1)

(v) spreads quickly through all ventricular muscle via gap junctions (cell-to-cell connections) causing contraction (1)

(vi) muscle cells repolarize in opposite direction from polarization (1)



Lead I ECG (1)

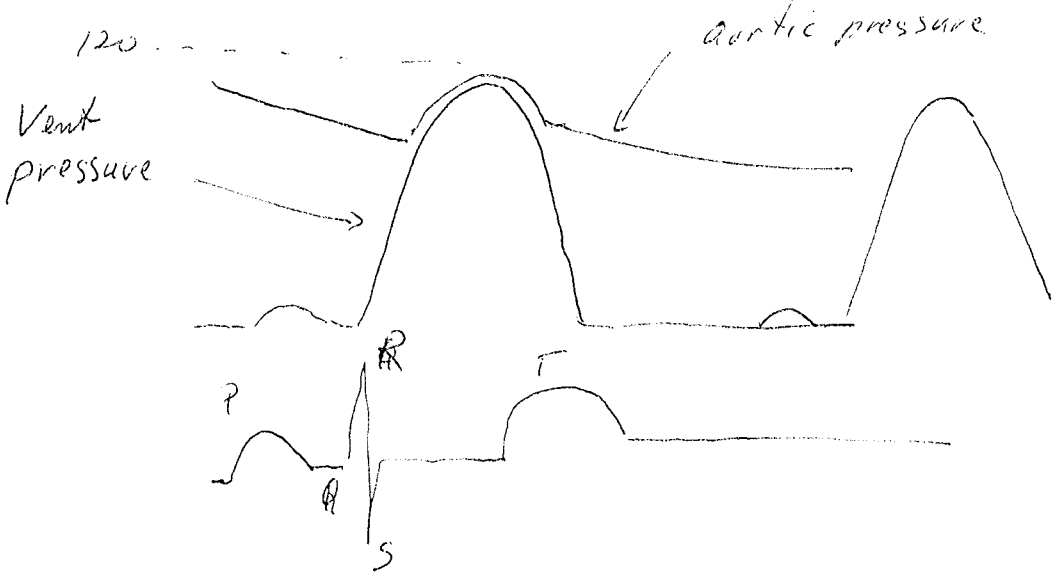
P: wave atrial depolarization and contraction of atria (1)

QRS: ventricular depolarization and contraction (1)

T: ventricular repolarization

2. cont'd

Could also show



up to 4 marks depending on detail.

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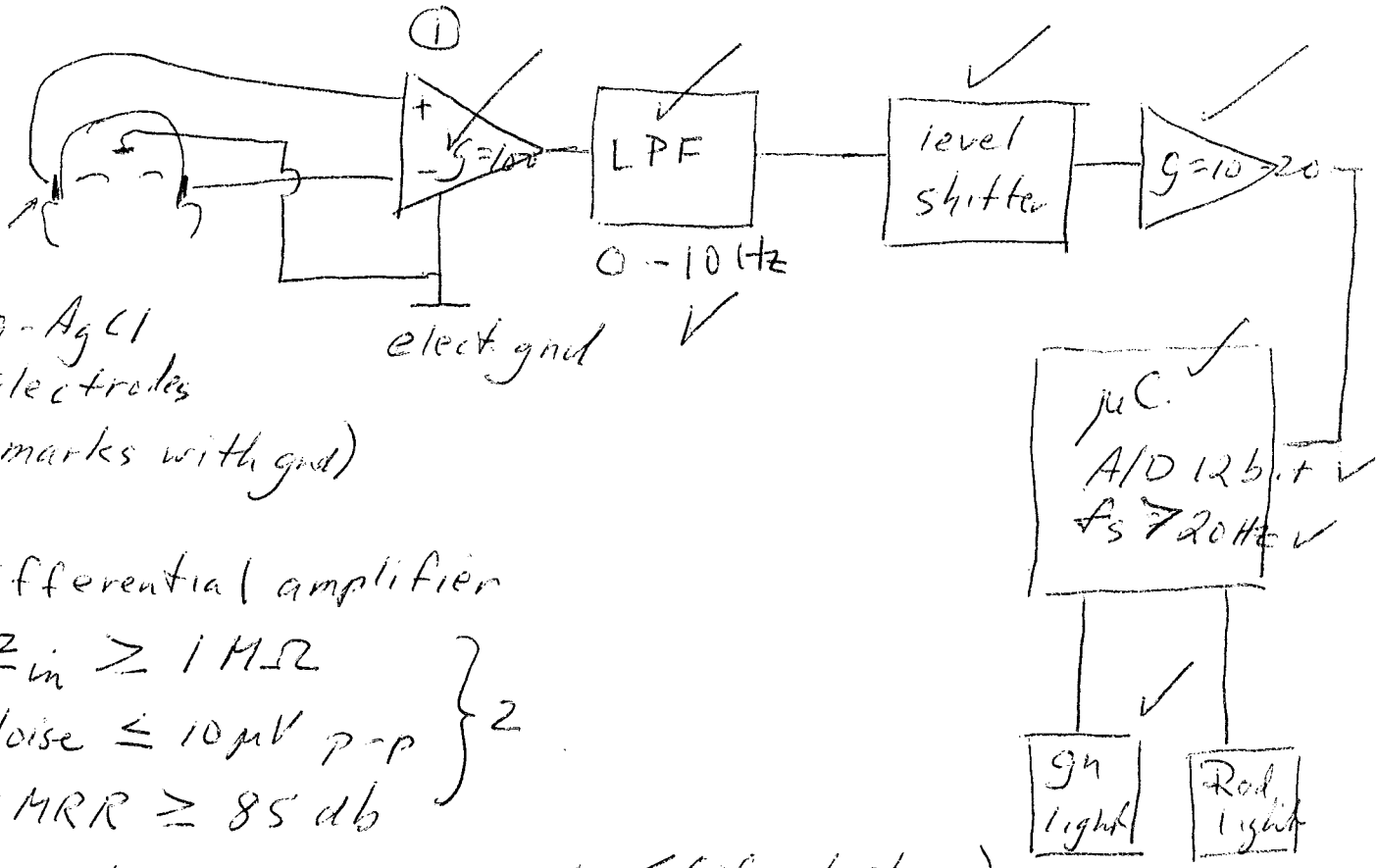
3.



(2 marks with gnd)

① Differential amplifier

$Z_{in} \geq 1 M\Omega$
Noise $\leq 10 \mu V$ p-p
CMRR ≥ 85 db
} 2

$G = 1000 - 2000$ overall ✓ (if not shown)

Power src – battery powered ✓ — or
– if line need isolation ckt ✓

For µC sample signal at 20Hz or greater
– when signal $\geq .5$ mV turn on gn ✓
when signal $\leq -.5$mV turn on red. ✓

For clean turn on/off use hysteresis (i.e. when signal increasing for right, reduce threshold, when decreasing for left increase threshold – ~~return~~ to do reverse when signal is decreasing. 2

Can use hysteresis comparators instead