Benha University | **Jan. 2015 من الخارج**
Benha Faculty of Engineering | **Electrical Department**
Hospital Instrumentations (E472) | **4Th year (control)**
Dr.Wael Abdel-Rahman Mohamed | **Time: 3 Hrs**

Exam with model answer

Answer the following questions with the aid of drawing and equations as possible.

Question (1): [28 Marks]

a) Mention three faults for the **ECG** machine and how to cure them.
See examples 8-1 & 8-2 & 8-3 for faults and troubleshooting.

b) What is meant by **Wilson central terminal** and **Wilson network**. Explain why Nelson network is used and what leads could be obtained from it.

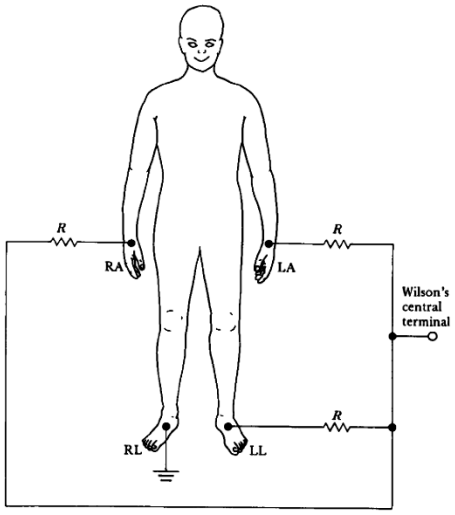
Wilson Central Terminal:

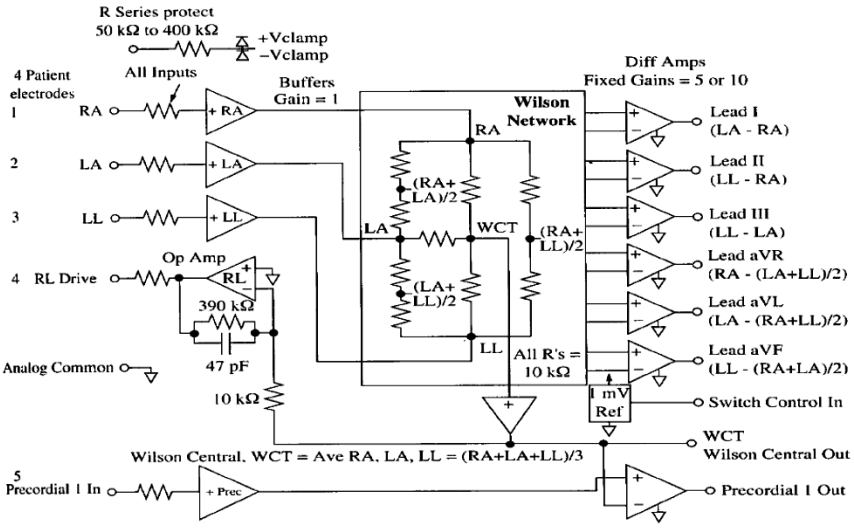
Configuration used with Unipolar Chest Leads where RA LA and LL are summed in resistor network and this is sent to the inverting input of an amplifier.

Wilson Network:

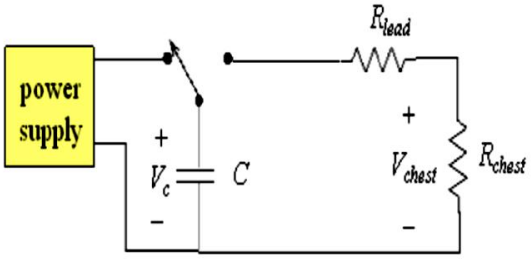
A ***precision*** resistor network (Wilson network) sums the various electrode voltages to achieve the standard voltages for the different ECG selections.

From Wilson network we get the limb leads (unipolar and bipolar) and the precordial lead with the Wilson central terminal which used to get the unipolar chest leads.

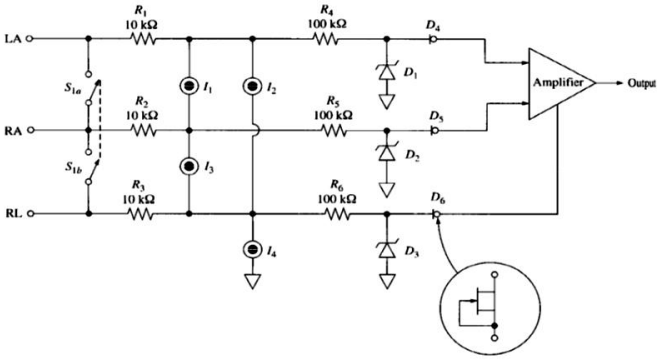




c) Draw only the defibrillator circuit and defibrillator protection circuit.



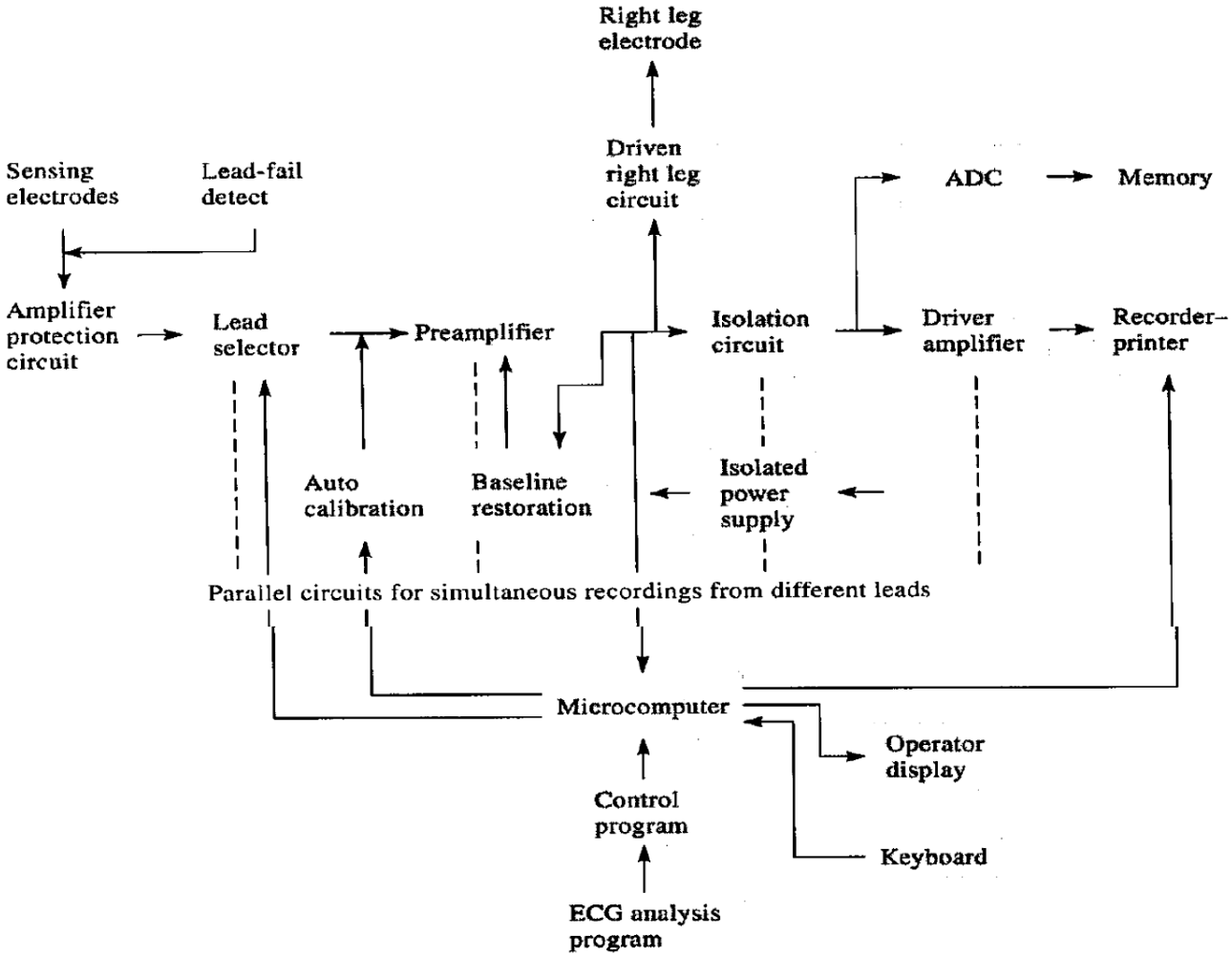
Defibrillator Circuit



Defibrillator protection circuit

The protection circuit may be only the series resistors or the zener diodes or the neon glow lamps or the FET diodes.

d) Draw only the general block diagram of a basic ECG machine.



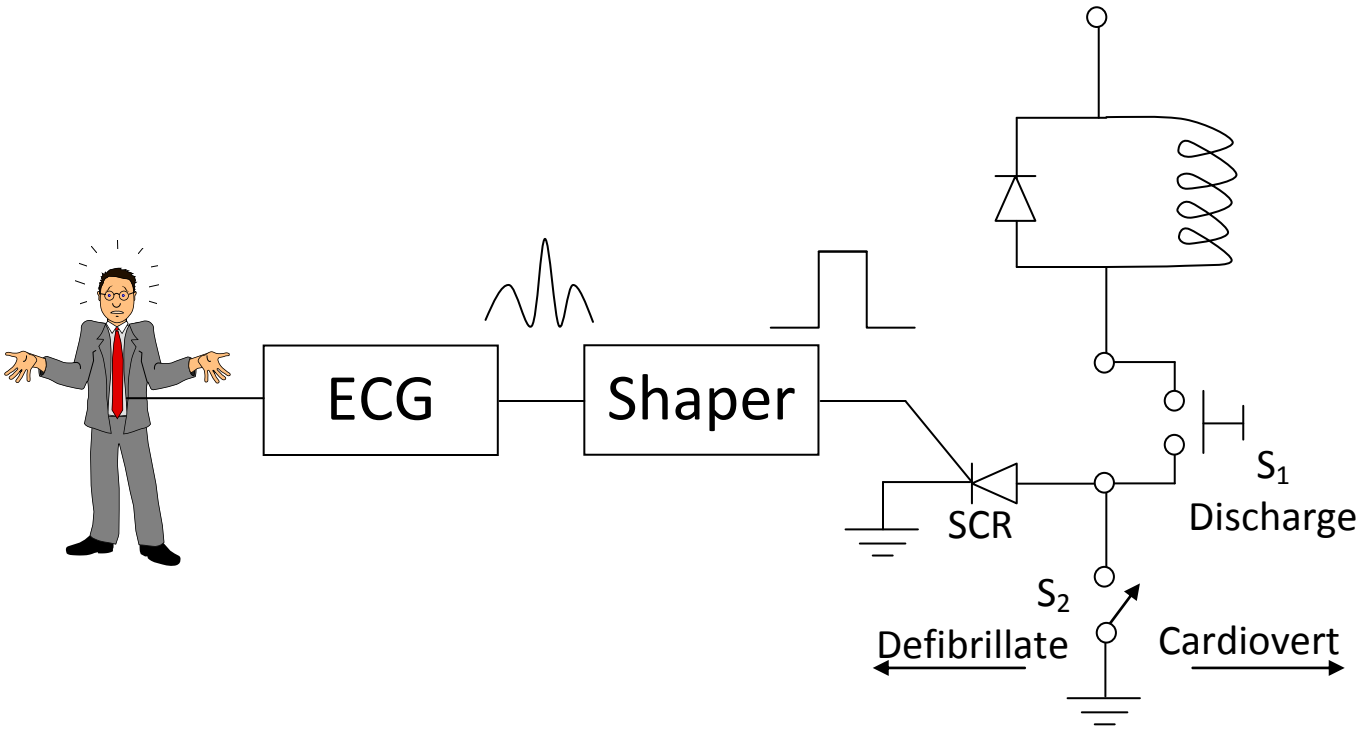
e) Draw only the ESU protection circuit.

The ESU protection circuit may be an RC or LC filter banks (Fig.8.8) in your text book.

f) Differentiate between the atrial and ventricular fibrillation. Which one of them is more dangerous? List three possible causes for ventricular fibrillation.

- If a person has atrial fibrillation, the atrium beats 400-600bpm. However, only 100-150 beats will pass through the AV node to the ventricles. At a rate of 100-150 beats, the person's body still receives enough blood to keep the person going. However, if the ventricle beats 400-600 bpm, there won't be enough blood to be bumped out of the heart to the rest of the body (including the coronary blood vessel). At the end, the person with ventricular fibrillation will die to myocardial infarction or heart attack (due to lack of blood to the coronary blood vessels).
- Ventricular fibrillation (irregular heart beat) is more dangerous since ventricle is the ultimate pump that pumps blood to the rest of your body.
- Three possible causes for ventricular fibrillation are:
  - Using AC defibrillators.
  - Delivering the shock during the ventricles' refractory period (the T-wave feature of the ECG waveform).
  - Using a pacemaker with energy greater than 400µj.

g) Draw the circuit used to select between defibrillator and cardioverter and explain how it works.



Defibrillator action:

When there is no ECG signal the switch S_2 is closed to select defibrillator and to make a path to the ground and when pressing the switch S_1 the shock is delivered to the patient.

Cardioverter action:

With the presence of the ECG signal, the shaper will detect the R-wave and use it to trigger the SCR that enables a second path to the ground when S_2 is opened and when the switch S1 is pressed the shock will be delivered only when the SCR is triggered to prevent delivering the shock during the T-wave which may convert the atrial fibrillation (if exist) into ventricular fibrillation.

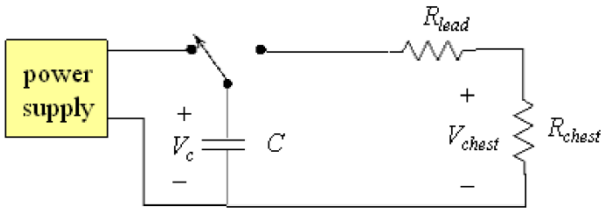
Question (2): **[16 Marks]**

Consider the defibrillator circuit given in the following Figure. $R_{chest} = 95\ \Omega$, $R_{lead} = 5\ \Omega$, total energy stored in C is $W = 300\ J$. We want to deliver 90% of energy to heart in $8\ ms$.

a) What value of C should be used?

b) What is the initial capacitor voltage $V_c(0)$?

(Help: $V_c(t) = V_c(0)e^{-t/RC}$, $W = 0.5\ CV^2$, $W = \int P(t)dt$)



1) a) $V_{chest} = \frac{V_c}{95+5} \cdot 95 = 0{,}95\ V_c = c$

$$W = \int_0^{8ms} \frac{V_{chest}^2}{95}\,dt = \int_0^{8ms} \frac{(0{,}95\ V_c(0)}{95}$$

$$= 0{,}0095\ V_c(0)^2 \int_0^{8ms} e^{-2t/100C}\,dt$$

$$= 0{,}0095\ V_c(0)^2 \left[-\frac{100C}{2} e^{-2t/100C}\right]$$

$$= -0{,}475\ C V_c(0)^2 \left(e^{-16\times10^{-5}/C} - \right.$$

$$e^{-16\times10^{-5}/C} = 0{,}052$$

$$-\frac{16\times10^{-5}}{C} = \ln(0{,}0$$

$$C = 54{,}4\times10^{-6}\ F =$$

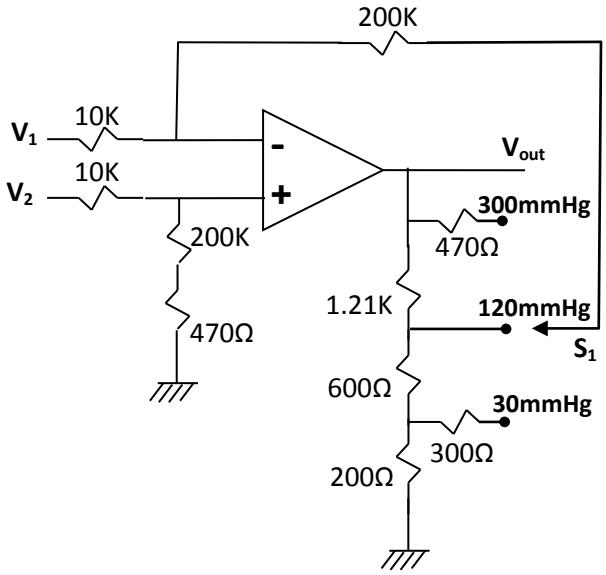
b)

$$300 = \frac{1}{2}\ 54.4\times10^{-6}\ V_c^2(0)$$

Question (3): **[16 Marks]**

In the circuit of the DC pressure amplifier, the pressure transducer is a resistive Wheatstone bridge strain gauge. Find the amplifier output voltage if the output from the bridge was $V_1 = 1.5\ V$ and $V_2 = 1.7\ V$ when the input pressure was 100 mmHg.

Take care that the applied pressure is 100 mmHg, then you must select the 120 mmHg range to validate the condition of making the reading midrange or higher of the meter. Solve to get the output voltage in this case.



With best wishes