Benha University | **June 2014**
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): [21 Marks]

a) There are four general categories of pacemaker: *asynchronous*, *demand*, *R-wave inhibited*, and *AV synchronized*. Explain briefly each type and mention the difference between them.

See item 9-33-1 "Pacemaker classification" in your book

b) Mention three faults for the **ECG** machine and how to cure them.

See examples 8-1 & 8-2 & 8-3 for faults and troubleshooting.

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

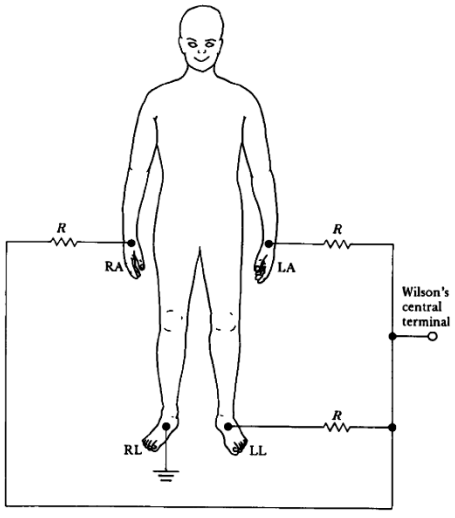
Wilson Central Terminal:

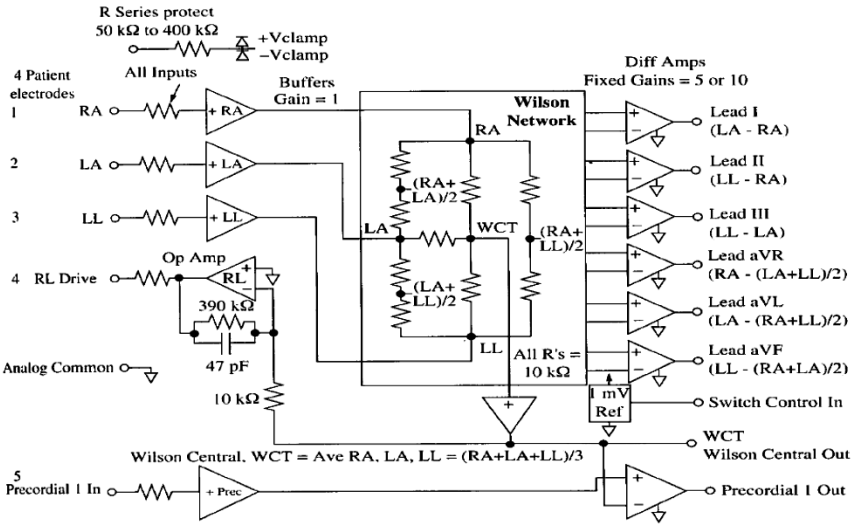
Configuration used with Unipolar Chest Leads where RA LA and LL are summed in resistor network and this is sent to the inverting input of an amplifier.

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.





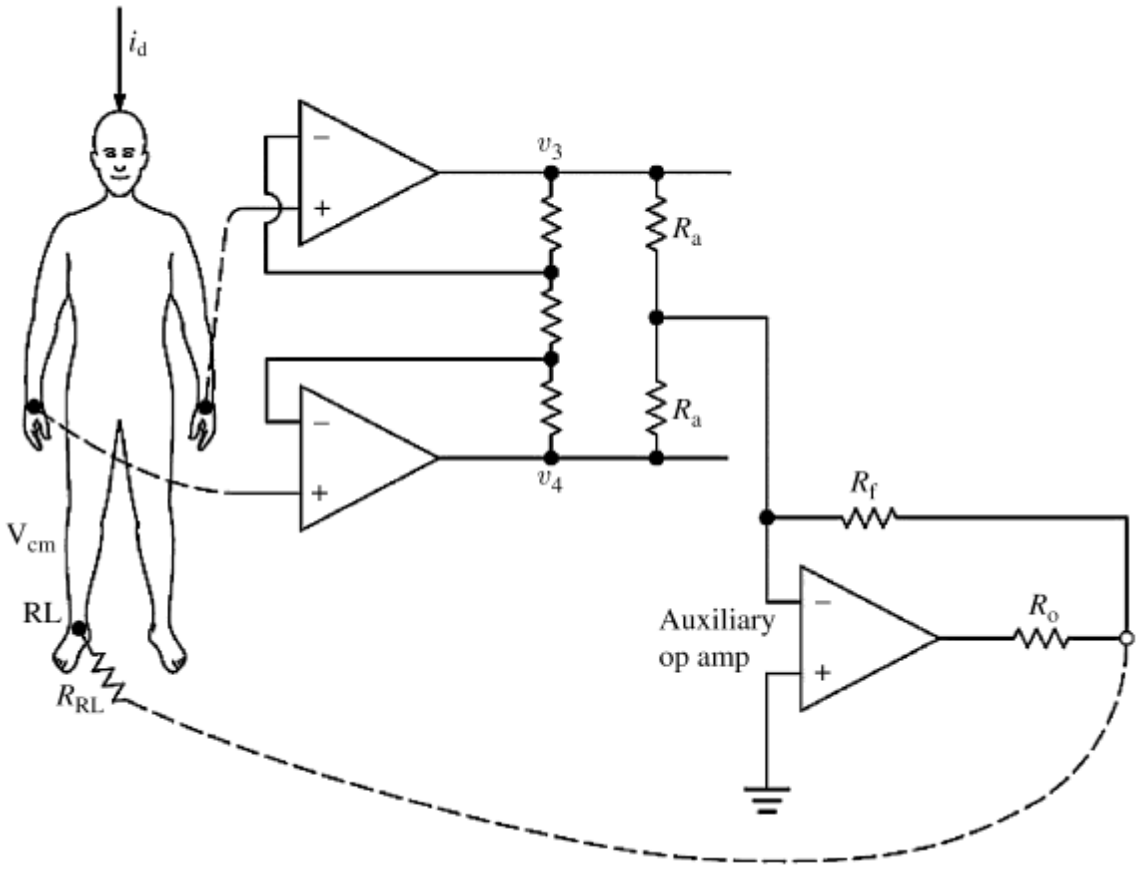
d) Differentiate between the unipolar and bipolar limb leads.

See the book

e) Describe the meaning of right leg drive and why it is used

In most modern electrocardiographic systems, the patient is not grounded at all. Instead, the right-leg electrode is connected (as shown in Figure below) to the output of an auxiliary op amp. The common-mode voltage on the body is sensed by the two averaging resistors R_a, inverted, amplified, and fed back to the right leg. This negative feedback drives the common-mode voltage to a low value. The body's displacement current flows not

to ground but rather to the op-amp output circuit. This reduces the interference as far as the ECG amplifier is concerned and effectively grounds the patient.
The circuit can also provide some electric safety. If an abnormally high voltage should appear between the patient and ground as a result of electric leakage or other cause, the auxiliary op amp in Figure below saturates. This effectively ungrounds the patient, because the amplifier can no longer drive the right leg. Now the parallel resistances R_f and R_o are between the patient and ground. They can be several megohms in value—large enough to limit the current. These resistances do not protect the patient, however, because 120 V on the patient would break down the op-amp transistors of the ECG amplifier, and large currents would flow to ground.

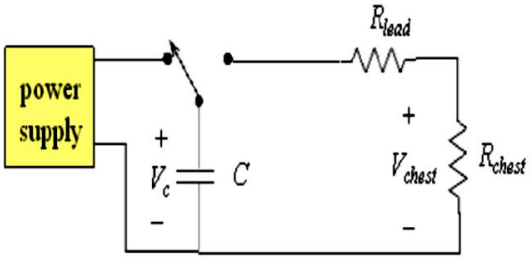


f) Mention the purpose of the Electosurgery unit (ESU) interference filter. And how it is connected with both the defibrillator protection circuit and the ECG Amp.

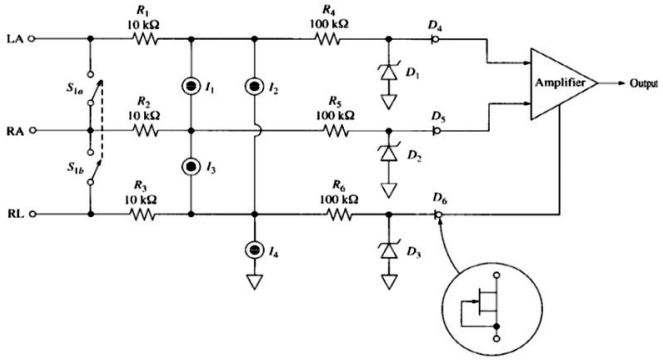
Solved exactly in Lecture.

Question (2): [12 Marks] ***Draw only***

a) Defibrillator circuit and defibrillator protection circuit.



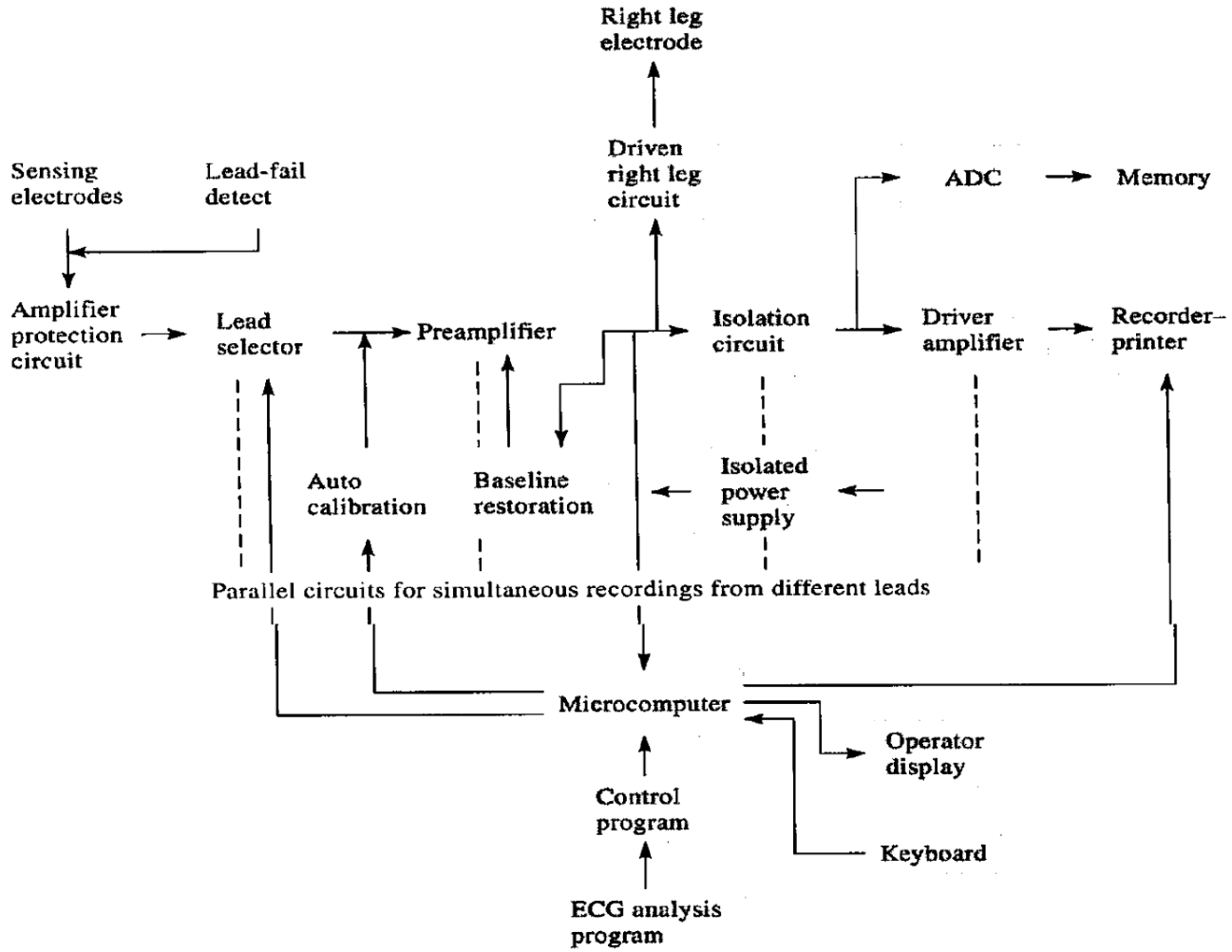
Defibrillator Circuit



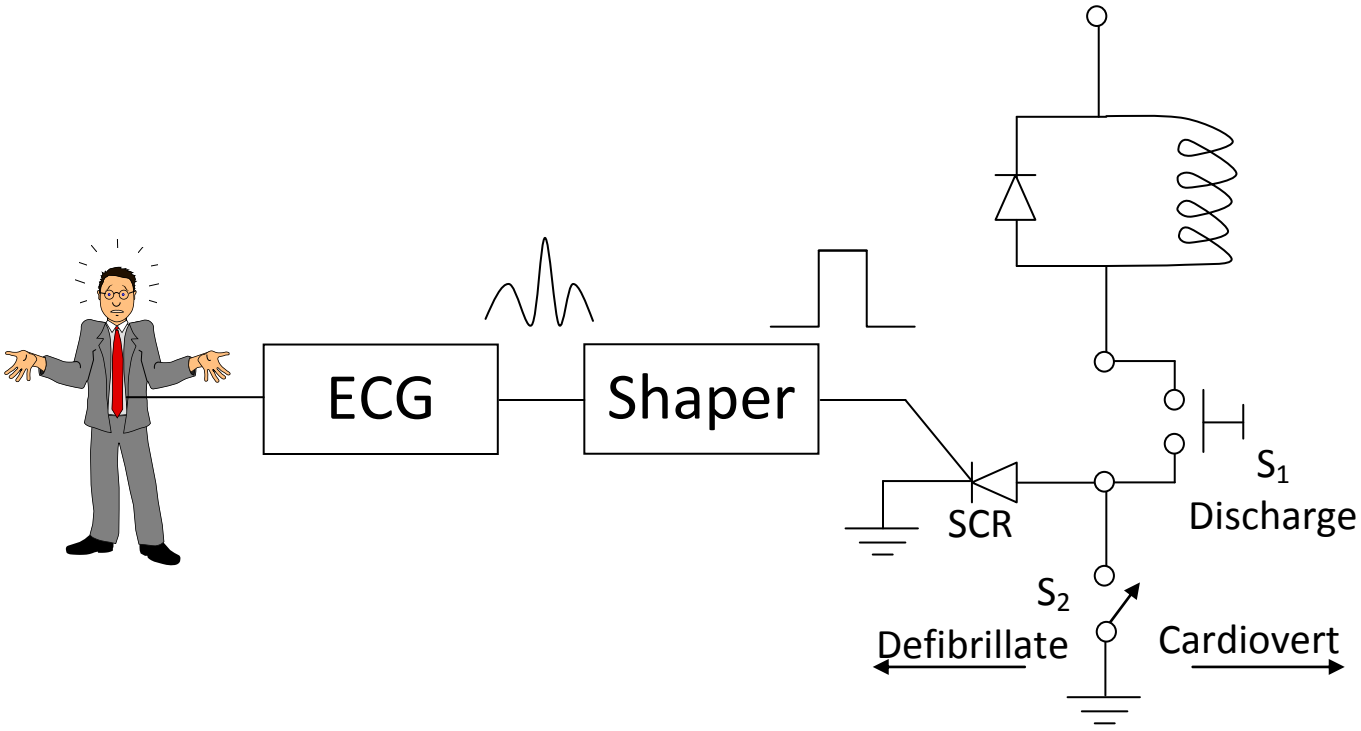
Defibrillator protection circuit

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

b) The general block diagram of a basic ECG machine.



c) Defibrillate/Cardiovert circuit diagram.



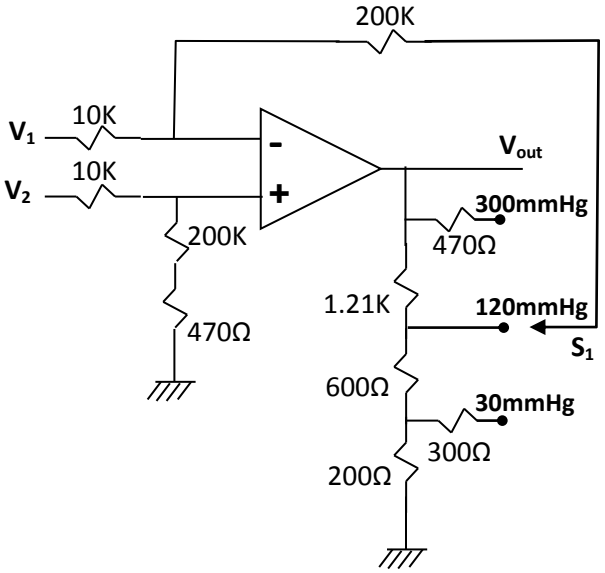
Question (3): **[16 Marks]**

1) A defibrillator produces a square pulse of 3000 V with a duration of 5 ms, the instrument resistance R_D= 10 Ω and the skin electrode resistance 30 Ω and the thorax resistance is 30 Ω, compute;
   a. The energy delivered to the patient thorax when the defibrillator is applied.
   b. The energy absorbed by the two electrodes.

Solved Exactly in sheet

2) 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.



Question (4): **[11 marks]**

A- Complete the following:

1) ECG measurement module is designed to detect ECG signal from six different leads using four electrodes connected to RA, LA, LL and RL.
2) In ECG signal P wave represents atrial depolarization, QRS wave represents ventricular depolarization while T wave represents ventricular repolarization.
3) Loss of blood fluidity occurs in two cases Hemorrhage and Blood clotting.
4) In systemic circulation left ventricle pumps blood to the whole body through the aorta.
5) In pulmonary circulation left atrium receives blood from the lungs through four pulmonary veins.
6) Right ventricle pumps blood to the lungs through the pulmonary artery so as to make gas exchange.
7) Systolic blood pressure is the highest pressure exerted by blood on the arterial wall during systole.
8) Diastolic blood pressure is the lowest pressure exerted by blood on the arterial wall during diastole.

B- Answer the following:

1) Draw 2nd order low pass filter and 2nd order high pass filter? How to test both of them?
2) What is band reject filter "with drawing"? How to test? Why we use it?

Solved exactly in the laboratory.

With best wishes