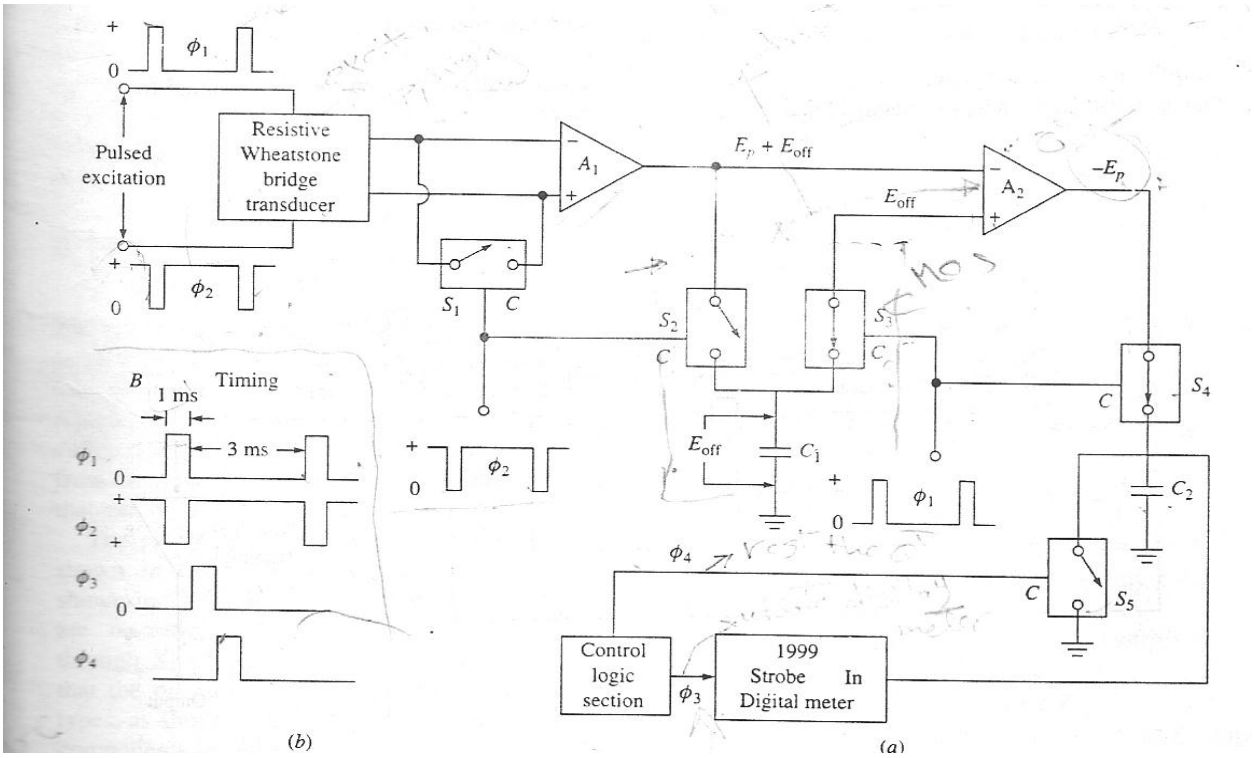
Benha University | **June 2014 تخلفات**
Benha Faculty of Engineering | **Electrical Department**
Hospital Instrumentations (E472) | **4Th year (control)**
Dr.Wael Abdel-Rahman Mohamed | **Time: 3 Hrs**

Exam with Model Answer

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

Question (1): [15 Marks]

a) Draw the blood pressure pulse excitation amplifier circuit and explain its operation.



1- the excitation signal is a biphasic short duration pulse (duration on 1ms)
2- A1 is a dc pressure amplifier & A2 is a unity gain summation stage
3- Switches S1 to S5 are CMOS electronic switches which close when control line is high
4- All circuit action is controlled by 4 phases
   -phase Φ1 & Φ2 excite the transducer & operate the drift cancellation (offset volt due to thermal changes)
   - Φ3 update the display meter
   - Φ1 reset the circuit
5- the transducer is excited only when Φ1 is high and Φ2 is low at all other times the transducer is not excited

b) 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

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

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

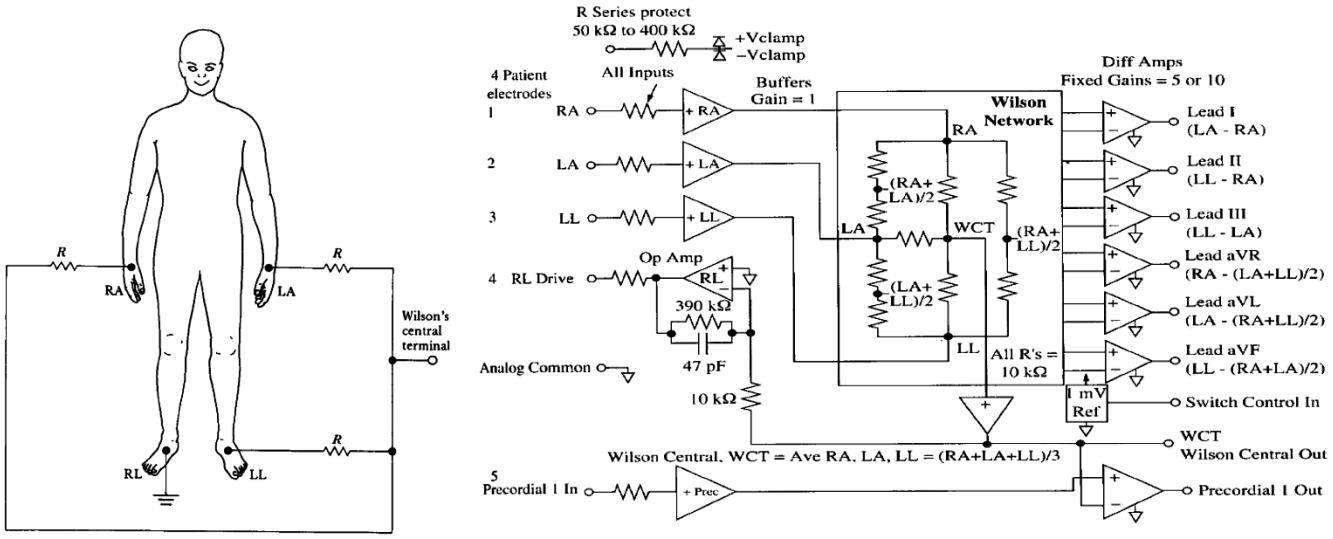
Wilson Central Terminal:

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.



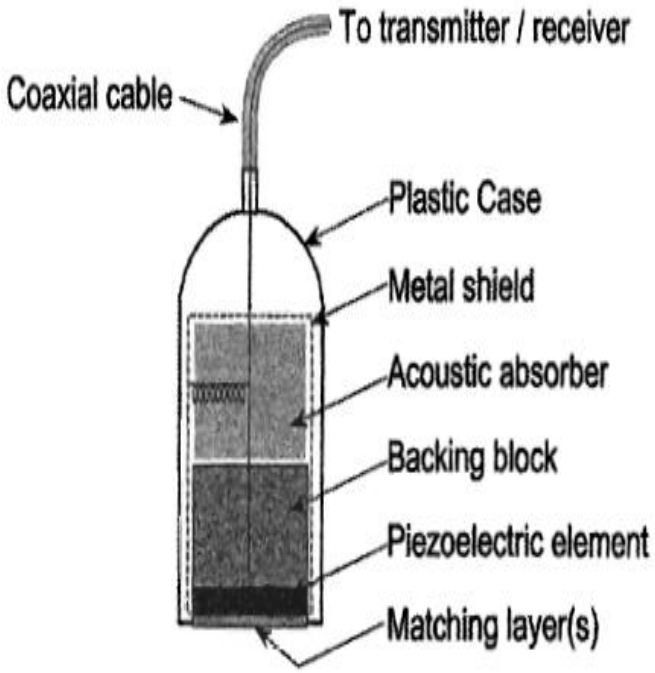
e) Explain the function for each part of ultrasound transducer construction.

1- **Piezoelectric Element** change in shape of the crystal increases and decreases the pressure in front of the transducer, thus producing ultrasound waves When the crystal is subjected to pressure changes by the returning ultrasound echoes, the pressure changes are converted back into electrical energy signals

2- **Damping Block** composed of epoxy resin impregnated with tungsten bonded to the back of the elements to reduce the # of cycles in the pulse

-The damping block absorbs the backward directed ultrasound energy and attenuates stray ultrasound signals from the housing

-It also dampens (ring-down) the transducer vibration to create an ultrasound pulse with a short spatial pulse



length, which is necessary to preserve detail along the beam axis (axial resolution)

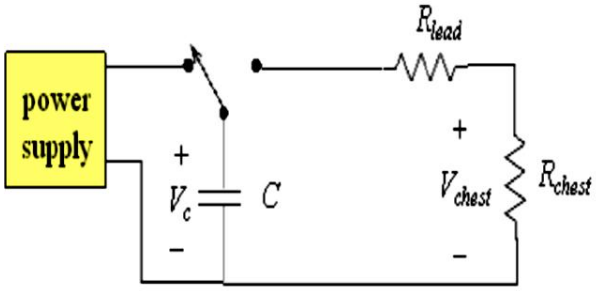
3- **Matching Layer** A matching layer of material is placed on the front surface of the transducer to improve the efficiency of energy transmission into the patient

4- **Insulating Case** Plastic or metal casing around transducer
Protects: Keeps outside interference/electrical noise from entering Protects the transducer's components

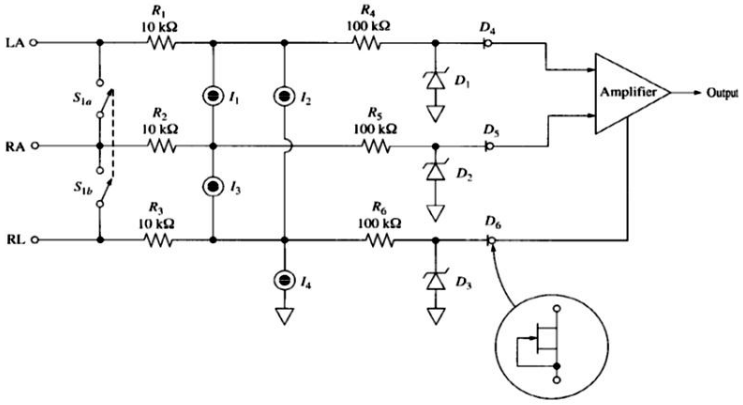
5- **Wiring** Carries electrical pulse to the crystal
Transmits voltage from the receiving crystal back to the US unit

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

a) Defibrillator circuit and defibrillator protection circuit.



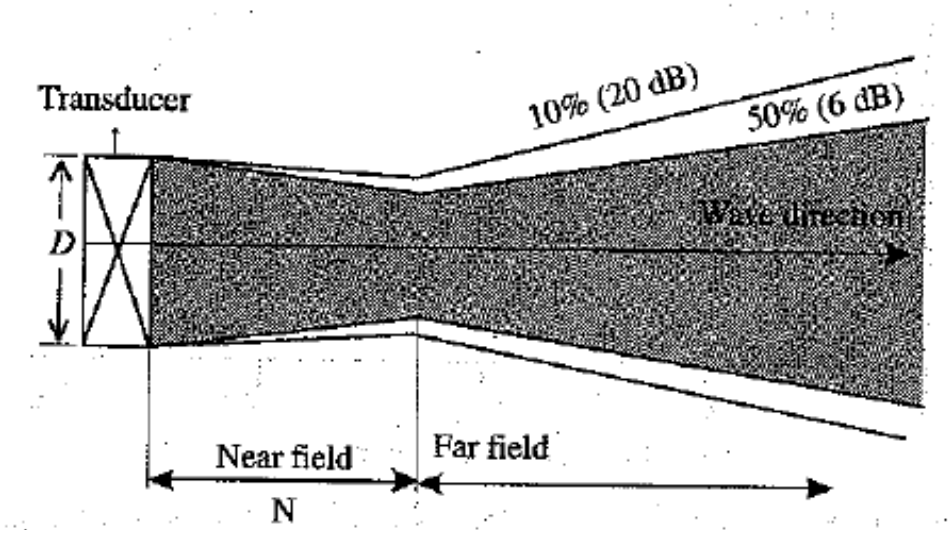
Defibrillator Circuit



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 beam profile of ultrasound transducer & write the equations for each field and angle.

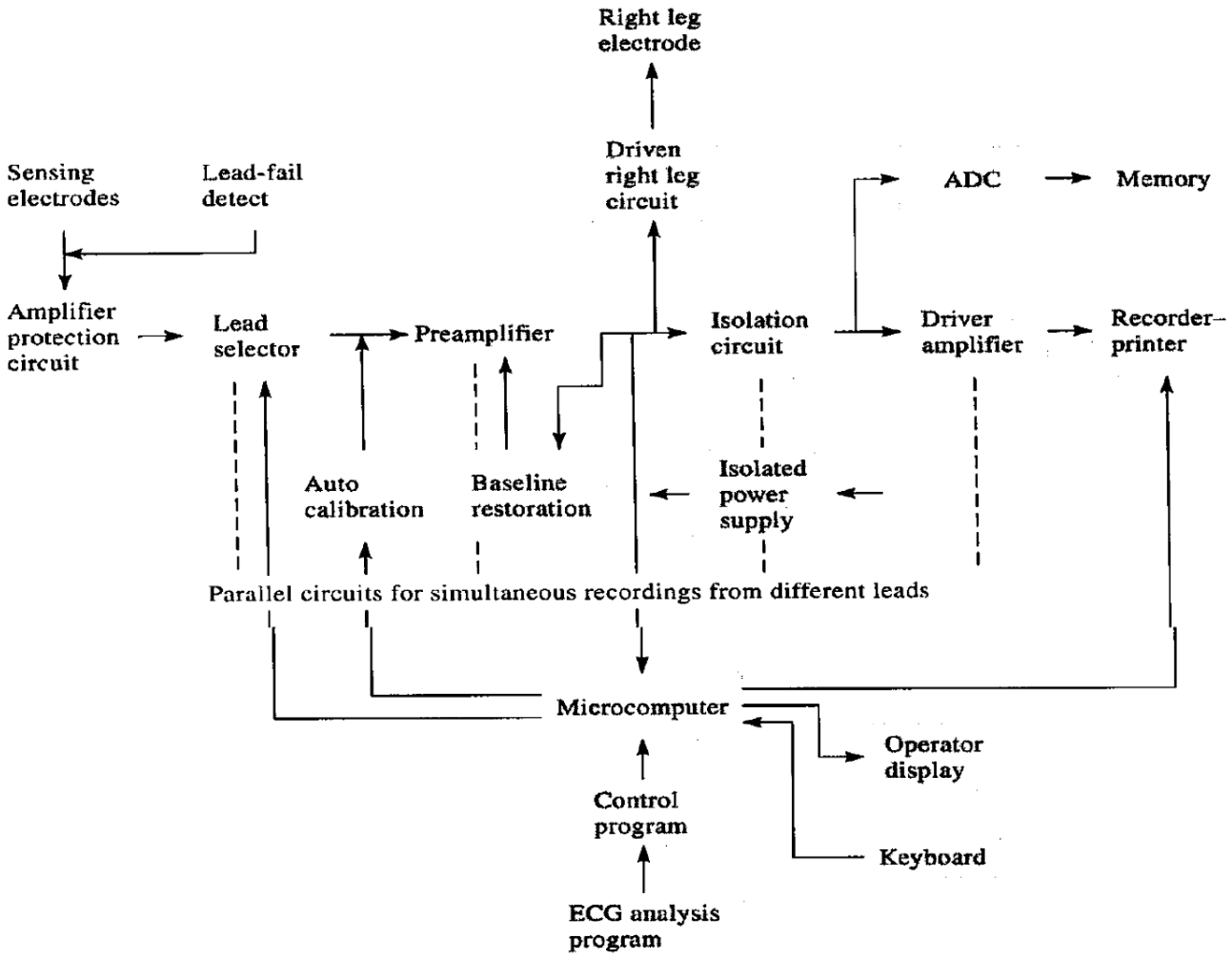


- Near Field: $d \leq \frac{D^2}{4\lambda}$
- Far Field: $d > \frac{D^2}{4\lambda}$

- Beam spreading angle: $\theta = \frac{1.2\lambda}{D}$

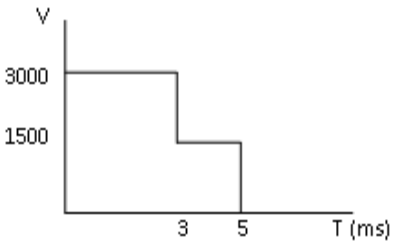
c) The internal circuit design of automatic blood pressure measurement device with **operational amplifier**.
Solved in the lecture

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

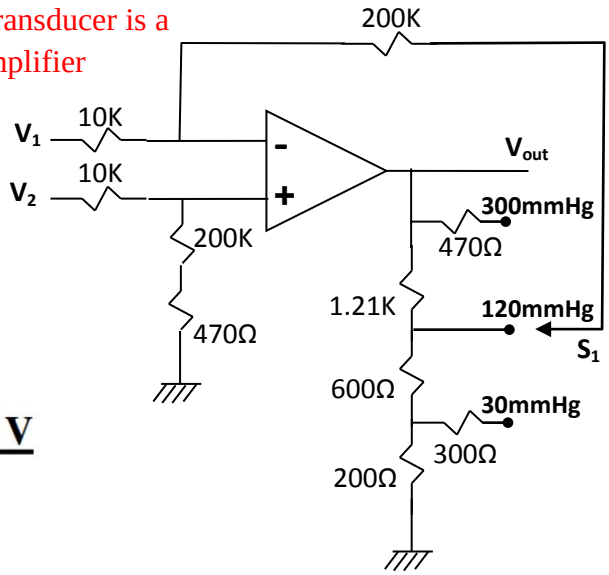


Question (3): [14 Marks]

1) The voltage pulse delivered to defibrillator paddles attached to a patient is given in the shown figure. The thorax resistance RT= 50 Ω, what must be the skin-electrode resistance in order that 110 J of energy will be delivered to the thorax of the patient? Assume that R_D= 10 Ω.
Solved exactly in the 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 140mmHg.



Take care that the applied pressure is 140 mmHg
Then you **must** select the 300 mmHg range
V_o=[(200K+470)/10K](V_2-V_1)=20.047x0.2=**4.0094 V**

Question (4): [15 marks]

Complete the following:

1) Systolic blood pressure is 120 mmHg and Diastolic blood pressure is 80 mmHg.
2) The EEG peak to peak signal amplitude is 1 to 100 µV & frequency range is 0.5 to 100 Hz.
3) The five electrodes used to make 12 lead ECG recording are connected to the patient's right arm, left arm, right leg, left leg, and Chest.
4) The frequency response of diagnostic ECG machine is from .05 to100 Hz.
5) Defibrillator protection in the input of bioelectric amplifiers uses Glow lamps, followed by series resistors and Zener diodes.

With best wishes