HUMAN FACTORS ENGINEERING
IE 442
LABORATORY MANUAL

LAB - 5

ECG Measurement

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Objective:

The objective of this Experiment is to give you practical experience on how to measure the Electrocardiogram (ECG).

Experiment description

Every stimulation of the cardiac muscle is accompanied by electric voltage changes, which propagate from one cardiac muscle cell to the other. Due to the large number of cells, the generated voltages can be tapped with electrodes attached to the body and, after amplification, made visible in the form of diagrams. For the electrocardiogram the Einthoven limb leads are used (I, II, III).

The electrodes measure potential changes (voltage changes) when the different heart chambers contract. At rest the cardiac muscle cells are polarized, i. e. there is a slight potential difference between the inside of the cell membrane and the outside. The cardiac muscle cells can depolarize without any influence from outside, i. e. spontaneously. The group of cells which are the first to depolarize constitute the so-called "pacemaker" (sinoatrial node). This node is located in the right atrium of the heart. The two atria contract almost at the same time due to the high-speed conduction of stimulus between the cells.

The ventricles of the heart are electrically insulated from the atria. Only at one place there is a group of cells (atrioventricular node) which transmit the electric signal of the atrium contraction to the ventricles. A slight delay of the transmission of excitation ensures that the ventricles do not contract simultaneously with the atria so that the blood has enough time to flow from the atria into the ventricles.

The atrioventricular node transmits the depolarization over special fibres (His bundles) to the ventricles. In the muscular wall of the ventricles there are other fibres (Purkinje fibres) that provide quick conduction of stimulus. So simultaneous and complete contraction of the ventricles is ensured.

The depolarization, contraction and subsequent repolarization is a continuously repeated process which make small currents flow due to the close neighbourhood of polarized a unpolarized cells. The changes of the currents can be measured from outside, amplified and plotted as a function of time. The ECG is the graphic representation of the measured electric currents.

Safety notes

The values and diagrams obtained in this experiment have no medical significance and are not suitable for monitoring human health.

Use the ECG/EMG box only as described in the Instruction Sheet.

Equipment list

1	Sensor-CASSY	524 010
1	CASSY Lab	524 200
1	ECG/EMG box	524 049
1	Electrode gel	662 112
1	Disinfectant spray	662 113
1	PC with Windows 98/2000/XP/Vista	

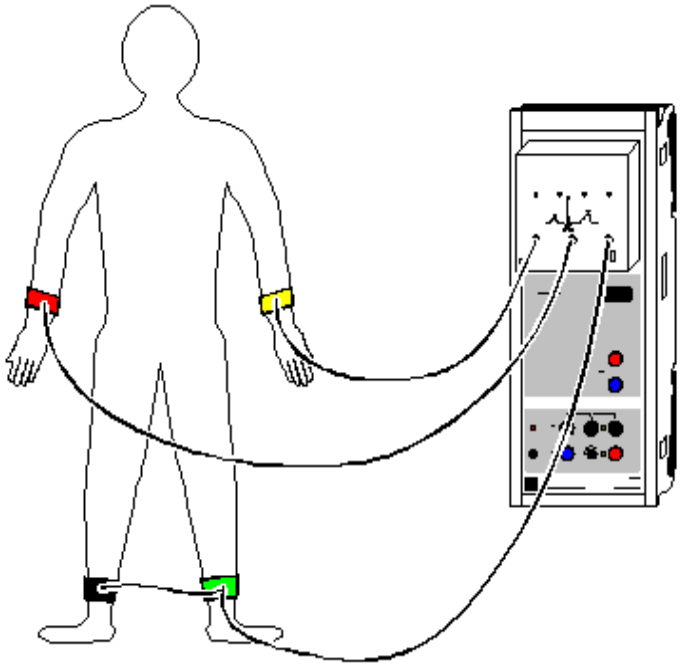

Figure 4.1 Experimental Setup for measuring ECG

Experiment setup (see figure 4.1)

The test subject should be relaxed and in a resting posture, as otherwise the ECG signal can be overlaid by the electrical potentials of the skeletal musculature, falsifying the measurement. To reduce the skin resistance, spread electrode gel (662 112) on the electrodes and attach them to the appropriate points in the body using the rubber straps. Then attach the leads to the electrodes as follows:

red	right arm
yellow	left arm
green	left calf
black	right calf

Important

Clean the electrodes after each use with a paper towel or similar to prevent a salt layer from forming when the gel dries. Then spray the electrodes and the corresponding skin sites with disinfectant (662 113) to ensure maximum hygiene.

Carrying out the experiment

- Start Cassy Lab software and Load settings for ECG measurement.
- Start the measurement with **F9**.
- The three leads according to Einthoven are recorded simultaneously.
- Stop the measurement with **F9**.

Evaluation

For the sake of clarity, part of the display should be enlarged with the Zoom function before evaluation

A typical part of an ECG is given by a flat line, the iso-electric line. Deviations from this line are due to the electric activity of the cardiac muscle.

In a typical ECG, the first deviation from this line is a small upward deflection. The P-wave last approx. 0.05 seconds. For the evaluation a vertical line can be set at the beginning and the end of the P-wave. The duration can be determined by a differential measurement between the two lines. The P-wave is based on the depolarization and contraction of the atria.

Next the ECG returns to the isoelectric line. During this time, the atrioventricular node transmits the excitation via the His bundle and the Purkinje fibres to the ventricles. The depolarization of the AV node leads to a slight downward pulse, the Q-wave. Immediately afterwards a quick rise (R-wave) and a subsequent drop below the isoelectric line (S-wave) occur. Then the ECG returns to the initial value. These three waves are called the QRS complex, which is brought about by the depolarization and contraction of the ventricles.

After a further break the cell repolarize. The corresponding current causes an upward wave, the T-wave.

The sequence from P over QRS to T is one cycle of the heart. The number of cycles per minute corresponds to the pulse beat.