



# 19MCE305-Medical Mechatronics

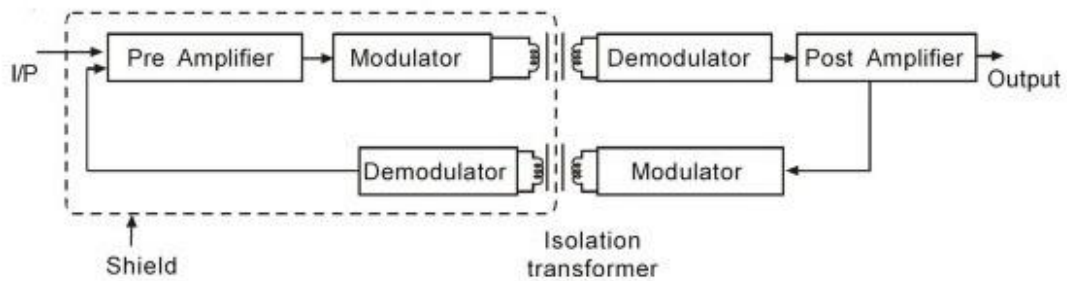


## UNIT-3

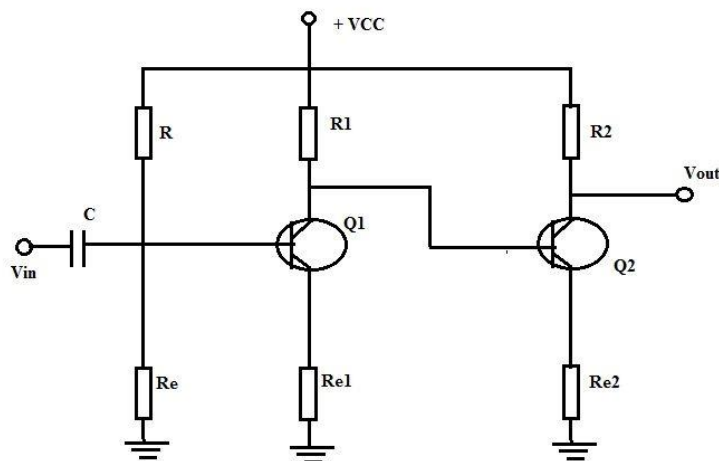
### RECORDING AND MONITORING SYSTEMS

#### Isolation amplifiers

Isolation amplifiers are used to provide protection against leakage currents. They break the ohmic continuity of electric signals between the input and output of the amplifier.



#### DC amplifiers



DC amplifiers are commonly used in medical mechatronics for various purposes, such as amplifying signals from sensors, measuring biological signals, and controlling medical devices.

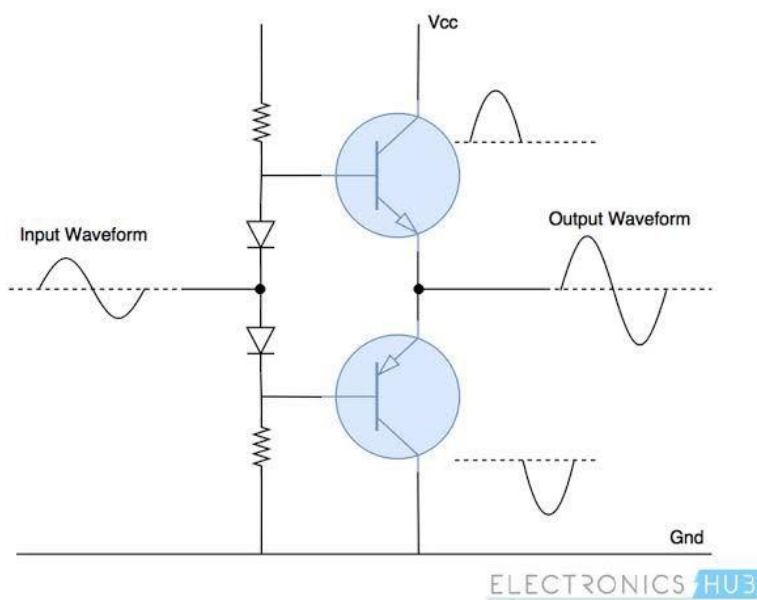
One common application of DC amplifiers in medical mechatronics is in electrocardiography (ECG) machines. ECG machines use DC amplifiers to amplify the electrical signals generated by the heart and detect abnormalities in the heart's rhythm. The DC amplifier helps to amplify and filter the signal to ensure accurate diagnosis of any potential heart conditions.

DC amplifiers are also used in medical devices that monitor brain activity, such as electroencephalography (EEG) machines. EEG machines use DC amplifiers to amplify and filter the electrical signals generated by the brain, which are then used to diagnose neurological disorders and monitor brain activity during surgeries.

In addition to medical diagnosis, DC amplifiers are also used in mechatronic prosthetic devices. For example, prosthetic limbs can be fitted with DC amplifiers to amplify signals from the user's muscles and control the movement of the prosthetic limb accordingly.

Overall, DC amplifiers are a critical component of many medical mechatronic devices and are essential for accurately measuring and controlling biological signals.

## Power Amplifier



A power amplifier is an electronic circuit that amplifies a low-power electrical signal to a higher power level suitable for driving loudspeakers, motors, or other loads. Power amplifiers are

commonly used in audio systems, such as stereo systems, guitar amplifiers, and PA systems, as well as in industrial control applications and in RF systems.

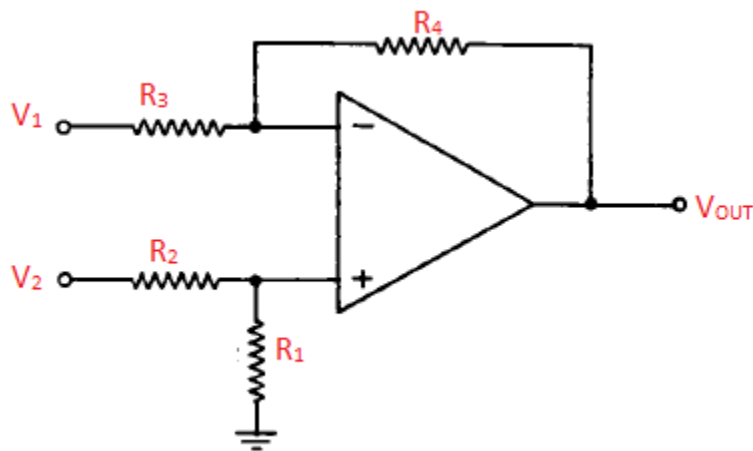
Power amplifiers can be classified into different types based on their input and output signals. For example, Class A amplifiers use a single transistor that conducts continuously, while Class B amplifiers use a pair of transistors that each conduct for only half of the input cycle. Other amplifier classes include Class AB, Class C, Class D, and Class E.

The main parameters of a power amplifier are its power output, efficiency, distortion, and frequency response. The power output is the maximum amount of power that the amplifier can deliver to the load. The efficiency is the ratio of the output power to the input power, and it determines the amount of power that is wasted as heat. The distortion is the amount of unwanted signal that is added to the output, and it can be caused by nonlinearities in the amplifier circuit. The frequency response is the range of frequencies over which the amplifier can accurately reproduce the input signal.

Power amplifiers can be designed using discrete components, such as transistors and resistors, or using integrated circuits (ICs). IC power amplifiers are often used in consumer electronics because they are small, lightweight, and low cost. However, discrete power amplifiers are preferred in high-power applications, such as professional audio systems and industrial control systems, where high power, high efficiency, and high reliability are required.

Overall, power amplifiers are essential components of many electronic systems, and their performance characteristics are critical to the quality and reliability of the overall system.

## Differential Amplifier



A differential amplifier is an electronic amplifier that amplifies the difference between two input signals while rejecting any signals that are common to both inputs. Differential amplifiers are commonly used in electronic circuits where high accuracy and low noise are required, such as in instrumentation, communication systems, and audio systems.

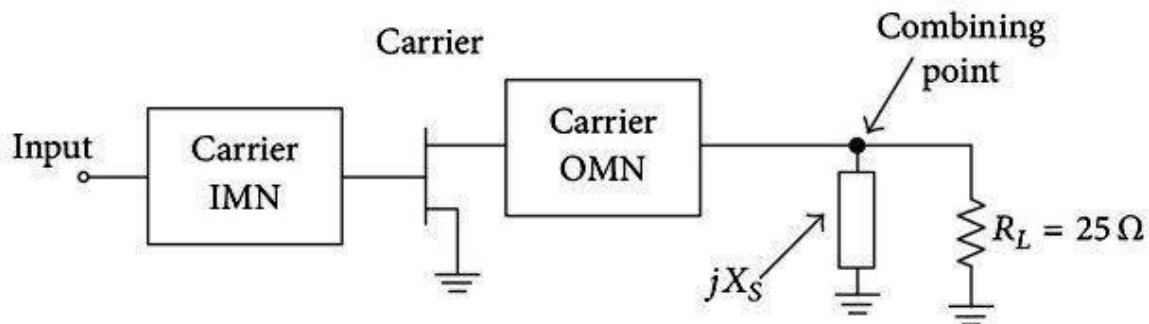
The basic structure of a differential amplifier consists of two input terminals, two output terminals, and an amplifier circuit that amplifies the difference between the two input signals. The output voltage of the differential amplifier is proportional to the voltage difference between the two input signals.

The advantages of using a differential amplifier include:

- **Common-mode rejection:** Differential amplifiers can reject signals that are common to both inputs, such as noise or interference from the power supply. This makes them useful in applications where low noise and high accuracy are required.
- **High gain:** Differential amplifiers can provide high gain, which is useful in applications where weak signals need to be amplified.

- **Balanced input impedance:** The input impedance of the differential amplifier is balanced, which means that it is the same for both input signals. This makes it easier to match the impedance of the input signals. Differential amplifiers can be implemented using various amplifier circuits, such as operational amplifiers (op-amps), transistor-based circuits, and integrated circuits. Op-amp based differential amplifiers are commonly used in electronic circuits because they are easy to use, have high gain, and are available in a variety of package types. Overall, differential amplifiers are useful components in electronic circuits that require high accuracy, low noise, and high gain.

### Carrier Amplifier



A carrier amplifier is an electronic circuit that amplifies a high-frequency carrier signal, such as a radio frequency (RF) or intermediate frequency (IF) signal. Carrier amplifiers are used in radio and communication systems, where they are used to amplify and modulate a carrier signal with the desired information, such as voice or data.

The basic structure of a carrier amplifier consists of a signal source, a frequency-selective circuit, an amplifier circuit, and a modulator circuit. The signal source generates a high-frequency carrier signal, which is then filtered by the frequency-selective circuit to remove any unwanted signals. The carrier signal is then amplified by the amplifier circuit, which increases its power level.

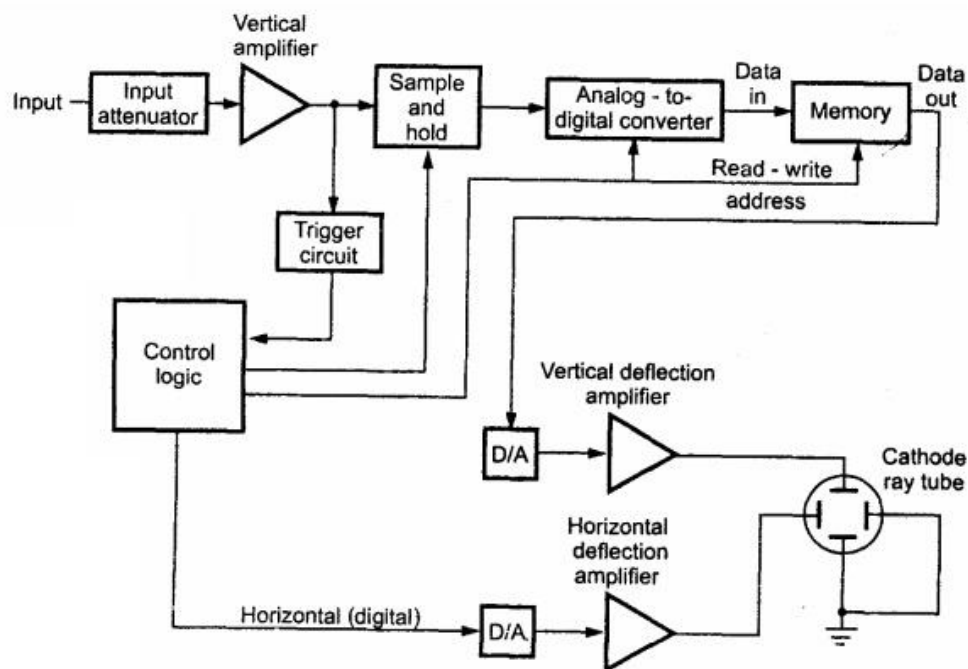
Finally, the modulator circuit modulates the carrier signal with the desired information, such as voice or data.

The performance of a carrier amplifier is determined by various parameters, such as its frequency response, gain, noise figure, and linearity. The frequency response is the range of frequencies over which the amplifier can accurately amplify the carrier signal. The gain is the ratio of the output power to the input power, and it determines the amount of amplification provided by the amplifier circuit. The noise figure is a measure of the amplifier's noise performance, and it indicates the amount of noise added to the carrier signal. The linearity is a measure of how well the amplifier can maintain the shape of the modulated signal.

Carrier amplifiers can be implemented using various amplifier circuits, such as class A, class B, class AB, and class C amplifiers. The choice of amplifier circuit depends on the desired performance parameters and the specific application.

Overall, carrier amplifiers are essential components of radio and communication systems, and their performance characteristics are critical to the quality and reliability of the overall system.

## Oscillography



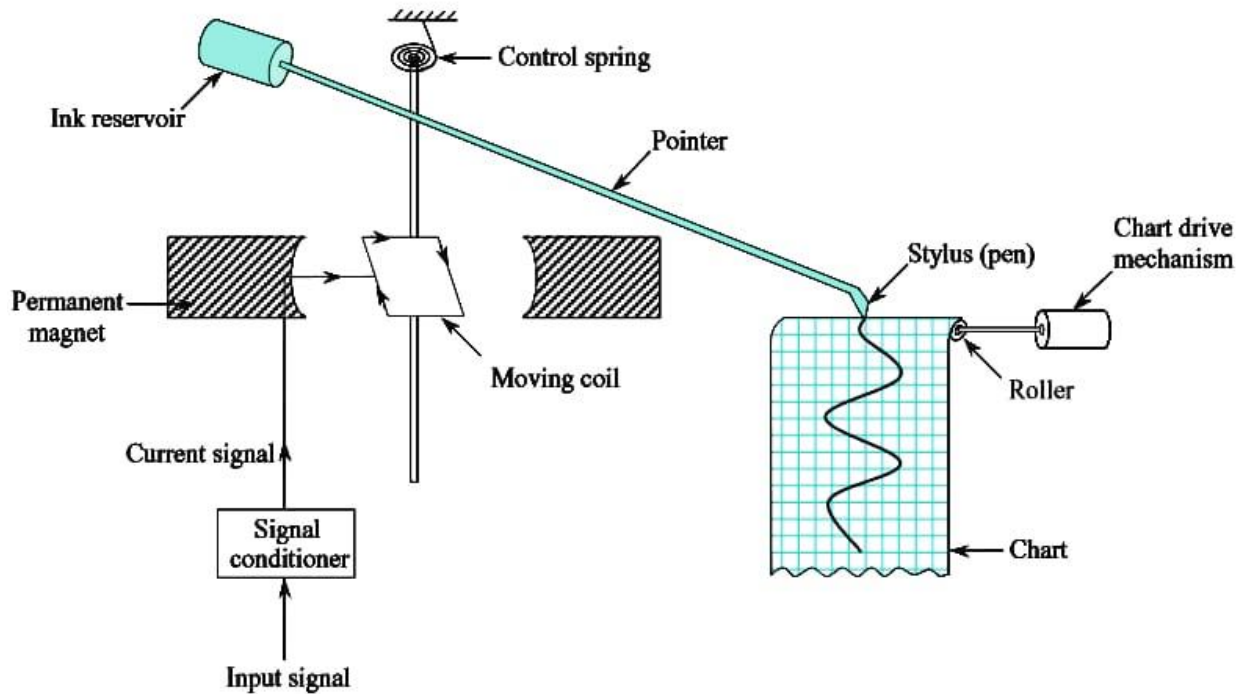
Oscillography is the study of the behavior of an electric signal over time using an oscilloscope, which is an electronic instrument used to display and measure waveforms of electrical signals. Oscillography is an important tool in the field of electronics and is used to measure and analyze various electrical signals, such as voltage, current, and frequency.

An oscilloscope displays the electrical signal on a screen in the form of a waveform, which is a graphical representation of the signal over time. The vertical axis of the waveform represents the amplitude or voltage of the signal, while the horizontal axis represents time. The waveform can be analyzed to determine various characteristics of the signal, such as its frequency, amplitude, and shape.

Oscillography is used in various applications, such as in electronic design and testing, telecommunications, medicine, and research. In electronic design and testing, oscillography is used to measure the performance of electronic circuits and to diagnose problems in electronic systems. In telecommunications, oscillography is used to analyze signals in communication systems and to troubleshoot network problems. In medicine, oscillography is used to measure and analyze biological signals, such as electrocardiograms (ECGs) and electroencephalograms (EEGs). In research, oscillography is used to study and analyze various phenomena in physics, chemistry, and other fields.

Overall, oscillography is an important tool in the field of electronics and is used to measure, analyze, and troubleshoot various electrical signals. The use of oscilloscopes has evolved over the years, and modern oscilloscopes are equipped with advanced features, such as digital signal processing, automated measurements, and remote control, which make them more versatile and powerful.

## Galvanometric X-Y plotter



A galvanometric X-Y plotter, also known as a galvanometer scanner, is an instrument used to measure and display two-dimensional patterns or images. It is commonly used in laser scanning systems, optical microscopy, and other applications that require precise and rapid scanning of a laser beam or other light source.

The basic principle behind a galvanometric X-Y plotter is the use of two galvanometers, one for each axis of the plotter. A galvanometer is a type of electromechanical transducer that converts an electrical signal into mechanical motion. The galvanometers used in X-Y plotters are designed to rotate a mirror or prism in two dimensions, allowing the laser beam to be directed to different locations on a surface.

The laser beam is usually directed onto a sample or surface, and the position of the beam is controlled by the galvanometric X-Y plotter. As the galvanometers rotate the mirrors or prisms, the laser beam is scanned across the surface, creating a two-dimensional pattern or image.

The advantages of using a galvanometric X-Y plotter include high precision, fast scanning speeds, and the ability to create complex patterns or images. The use of galvanometers allows for

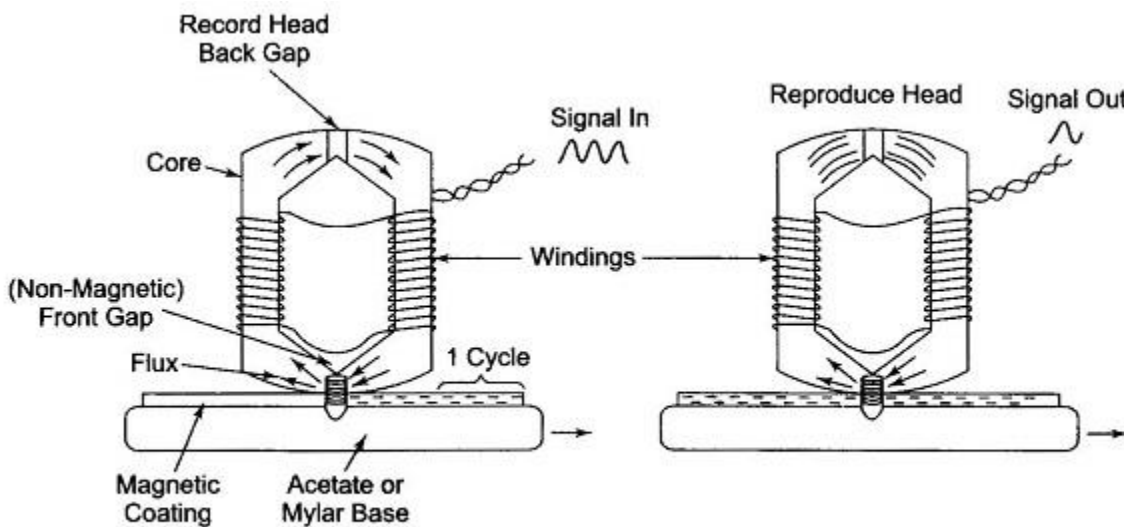


very precise and accurate control of the laser beam position, which is important in many applications, such as microfabrication, material processing, and biophotonics.

However, the use of galvanometric X-Y plotters has some limitations, such as a limited field of view and a dependence on the properties of the sample or surface being scanned. In addition, galvanometric X-Y plotters can be sensitive to environmental factors, such as temperature and vibration.

Overall, galvanometric X-Y plotters are an important tool in many fields, particularly in laser scanning systems and microscopy, and their use continues to grow with the development of new applications and technologies.

## Magnetic recorder



**Fig. 12.10(b)** Magnetisation of Tape

A magnetic recorder is a device that records and plays back audio or data signals using magnetic tape. Magnetic recorders were widely used in the past for audio recording and playback, and are still used today for specialized applications such as data storage in computer systems.

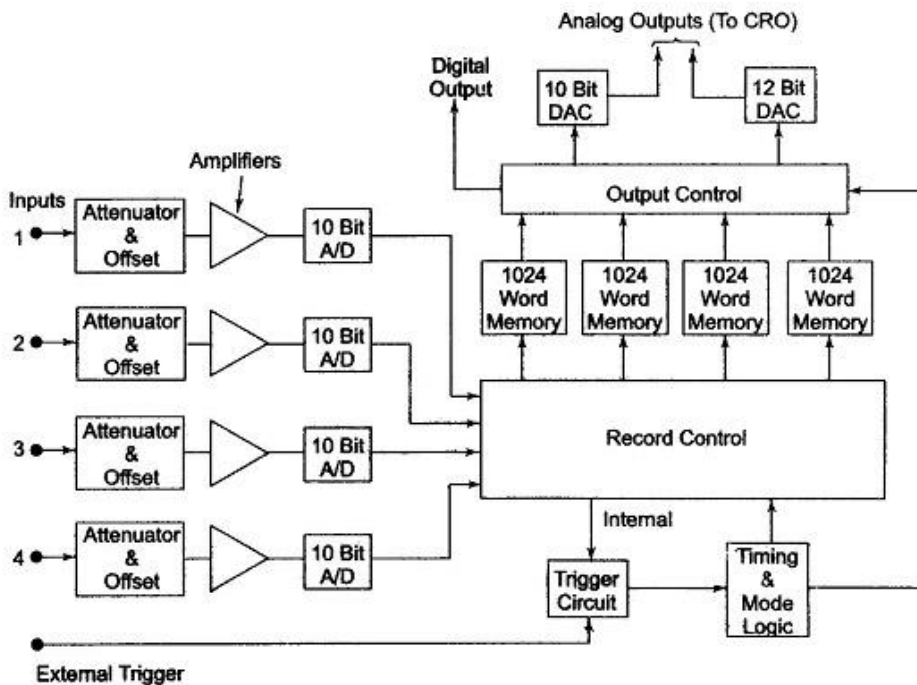
The basic principle behind magnetic recording is the use of a magnetic field to record the signal onto the magnetic tape. The tape is coated with a thin layer of magnetic material, and as the tape moves past a recording head, the magnetic field from the head magnetizes the material in a pattern that corresponds to the signal being recorded. During playback, the tape moves past a playback head that detects the magnetic pattern and converts it back into an electrical signal.

Magnetic recorders have several advantages over other recording technologies, such as vinyl records or digital storage media. They can store large amounts of data or audio signals, and can be easily erased and re-recorded. Magnetic tapes are also durable and can last for many years if stored properly. In addition, magnetic tapes have a high signal-to-noise ratio, which means that they can record low-level signals with relatively little background noise.

However, magnetic recorders also have some limitations. The magnetic tape can degrade over time, which can cause signal loss or distortion. Magnetic tapes are also sensitive to magnetic fields and can be erased or corrupted by exposure to strong magnetic fields. In addition, magnetic tapes can be bulky and require specialized equipment for recording and playback.

Overall, magnetic recorders have played an important role in the history of audio recording and data storage, and while their use has declined in recent years due to advances in digital storage technologies, they continue to be used in certain specialized applications.

## Storage oscilloscope



**Fig. 7.51** Digital Storage CRO

A storage oscilloscope, also known as a digital storage oscilloscope (DSO), is an electronic instrument used to display and analyze electrical waveforms. Unlike traditional analog

oscilloscopes that display the waveform in real-time and only allow for a brief view of the signal, a storage oscilloscope can store and display the waveform for a longer period of time, allowing for more detailed analysis of the signal.

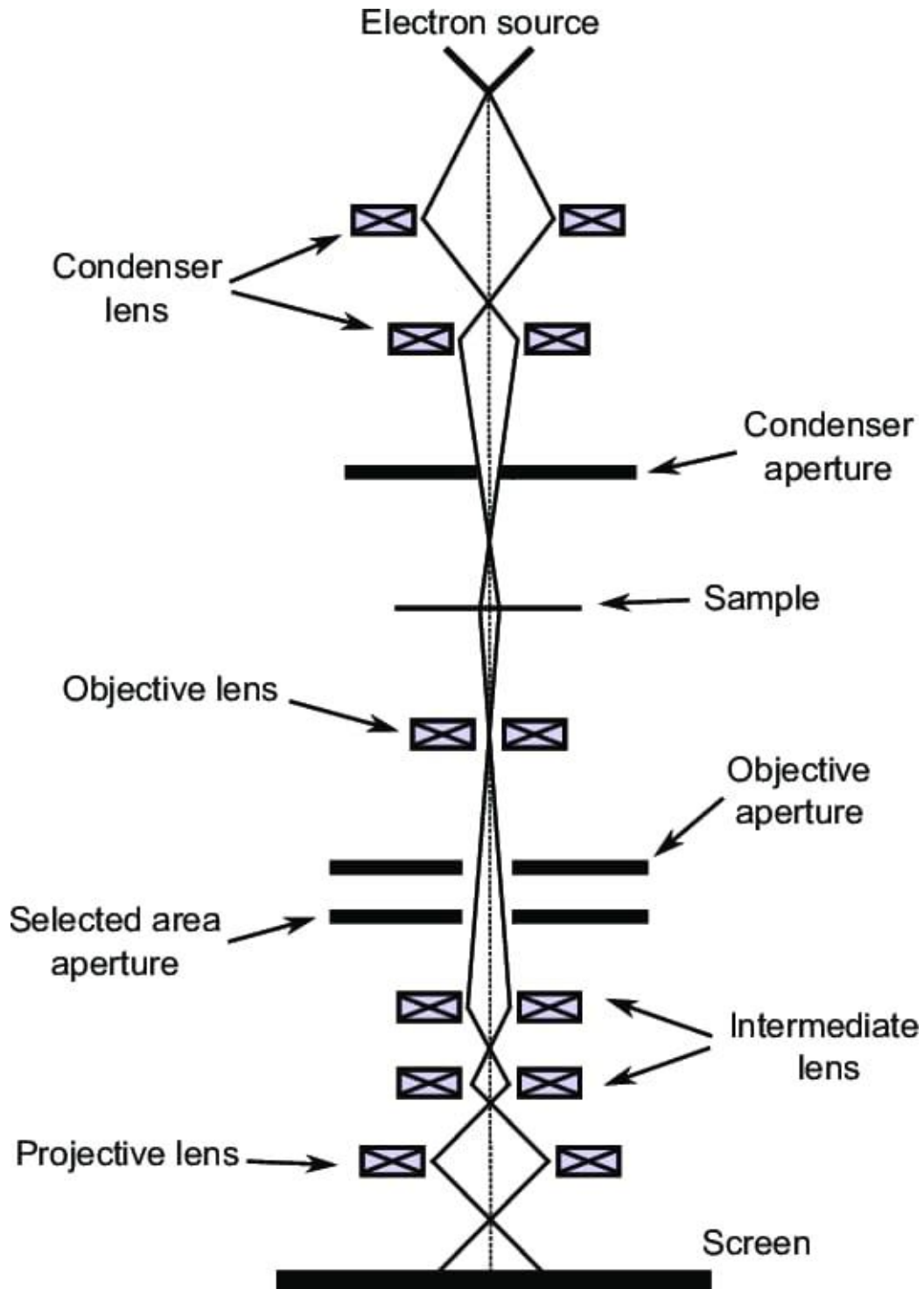
A storage oscilloscope works by sampling the input signal at regular intervals and converting the analog signal into a digital signal that can be stored in memory. The stored waveform can then be displayed on the oscilloscope screen and analyzed using various tools, such as cursors, measurements, and mathematical functions.

One of the main advantages of a storage oscilloscope is its ability to capture and store waveforms that are too fast or too complex for traditional analog oscilloscopes. A storage oscilloscope can capture and display waveforms with high frequency, low amplitude, or multiple channels, making it a versatile tool for a wide range of applications in electronics, telecommunications, and research.

Another advantage of a storage oscilloscope is its ability to trigger and capture intermittent or transient signals, such as glitches or spikes, that may be missed by traditional oscilloscopes. The storage capability allows the user to capture and analyze the signal after the event has occurred, making it easier to identify and troubleshoot problems in electronic systems.

Storage oscilloscopes are available in various types and sizes, from portable handheld units to large benchtop models. They are widely used in electronic design and testing, telecommunications, and research, and have become an essential tool for engineers and scientists in these fields.

## Electron microscope



An electron microscope is a type of microscope that uses a beam of electrons to produce images of very small objects, such as cells, viruses, and nanomaterials. Unlike optical microscopes that use visible light to produce images, electron

microscopes use electrons, which have a much shorter wavelength and can provide higher resolution images.

There are two main types of electron microscopes: transmission electron microscopes (TEM) and scanning electron microscopes (SEM). TEMs use a beam of electrons that is transmitted through a thin sample to produce an image, while SEMs use a beam of electrons that is scanned across the surface of a sample to produce an image.

In both types of electron microscopes, the electrons are generated by an electron gun and then focused onto the sample using a series of electromagnetic lenses. The electrons interact with the atoms in the sample, producing signals that are detected and used to produce an image.

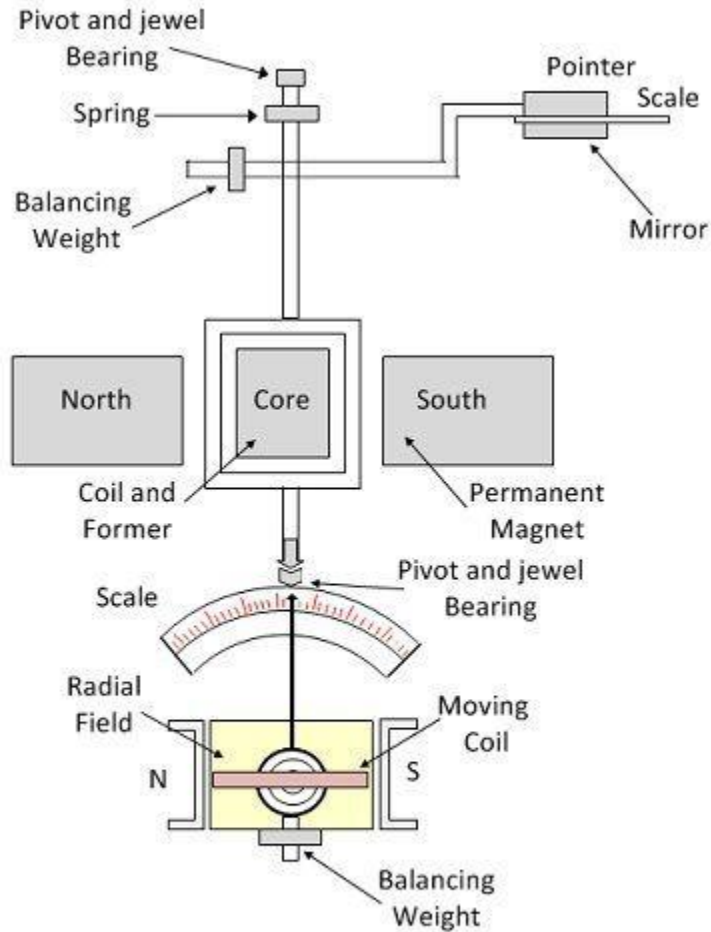
One of the main advantages of electron microscopes is their ability to provide high-resolution images of very small objects. The resolution of an electron microscope can be up to 100 times better than that of an optical microscope, allowing researchers to study the details of cellular structures and nanomaterials in great detail.

Another advantage of electron microscopes is their ability to provide information about the composition and structure of the sample being studied. By analyzing the way that the electrons interact with the sample, researchers can obtain information about the chemical composition and crystal structure of the material.

However, electron microscopes also have some limitations. They require a vacuum environment to operate, which can limit the types of samples that can be studied. They are also expensive and require specialized training to operate and maintain.

Overall, electron microscopes are powerful tools for research in fields such as biology, materials science, and nanotechnology, and have contributed significantly to our understanding of the microscopic world.

## PMMC writing system



### Permanent Magnet Moving Coil Instrument

Circuit Globe

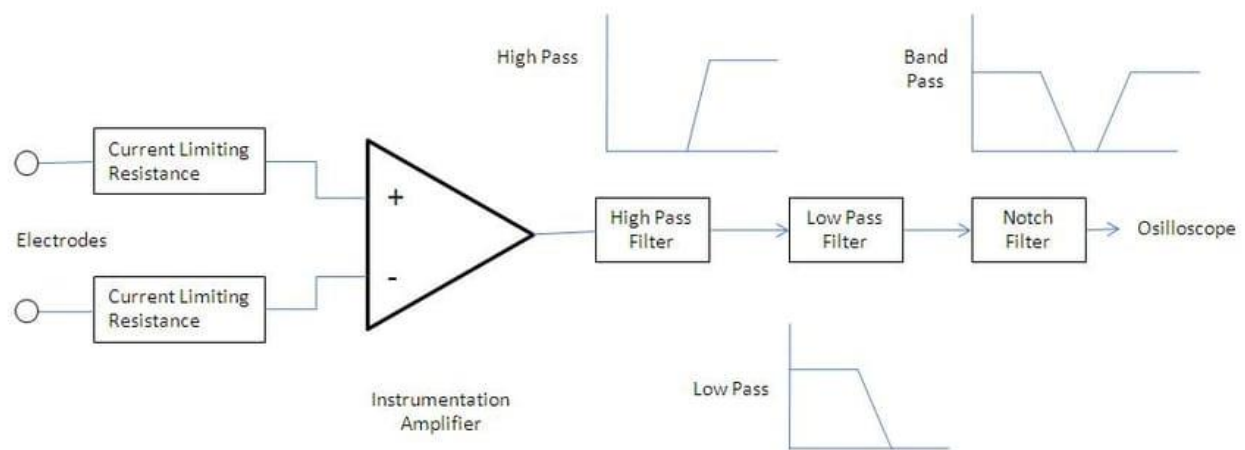
PMMC (Permanent Magnet Moving Coil) writing systems are a type of electromechanical system used for recording and reproducing analog signals, such as audio or video signals. The PMMC writing system consists of a permanent magnet, a moving coil, and a stylus, which is used to write or read the signal on the recording medium.

In a PMMC writing system, the stylus is attached to the moving coil, which is suspended in a magnetic field produced by the permanent magnet. When an electrical signal is applied to the coil, it produces a magnetic field that interacts with the field produced by the permanent magnet, causing the coil and stylus to move back and forth in response to the signal. This motion of the stylus creates a groove in the recording medium, which represents the recorded signal.

During playback, the stylus is placed in the groove and the motion of the groove causes the coil to move back and forth, generating an electrical signal that corresponds to the recorded signal. The electrical signal can then be amplified and played back through a speaker or other output device.

PMMC writing systems were commonly used in the early days of audio recording, and are still used today in some specialized applications, such as in the production of vinyl records. However, PMMC systems have some limitations, such as limited frequency response and susceptibility to noise and distortion. They have largely been replaced by other recording technologies, such as magnetic tape and digital storage media, which offer higher fidelity and greater storage capacity.

## Electrocardiograph



An electrocardiograph, also known as an ECG or EKG, is a medical device used to record the electrical activity of the heart. The ECG machine measures the electrical impulses generated by the heart as it beats, and produces a graph that shows the pattern of electrical activity over time.

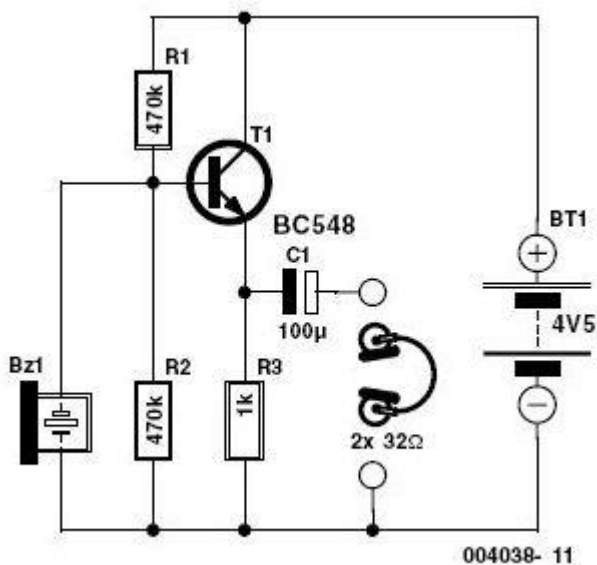
To perform an ECG, small metal electrodes are attached to the skin on the patient's chest, arms, and legs. These electrodes are connected to the ECG machine, which records the electrical activity of the heart and produces a graphical representation of the electrical signals.

The ECG waveform consists of several different components, including the P wave, QRS complex, and T wave. These components represent the electrical activity of different parts of the heart during the cardiac cycle.

ECGs are commonly used in the diagnosis and management of various cardiac conditions, including arrhythmias, heart attacks, and heart disease. They can also be used to monitor the effects of medications and other interventions on the heart's electrical activity.

ECGs are a safe and non-invasive procedure that can be performed in a variety of settings, including hospitals, clinics, and physician's offices. They are an essential tool in the diagnosis and management of cardiac conditions, and have been used for decades to provide important information about the health and function of the heart.

### Digital stethoscope



A digital stethoscope is a modern medical device that captures and amplifies sound waves from the heart, lungs, and other body organs, and then converts them into digital signals that can be analyzed and stored on a computer or other digital device.

Digital stethoscopes are equipped with sensors that capture the sounds from the body and convert them into electronic signals, which are then amplified and processed by software. This technology allows the sounds to be heard more clearly and with greater accuracy than traditional acoustic stethoscopes.

Digital stethoscopes offer several advantages over traditional stethoscopes. They can amplify the sound of the heart and lungs, making it easier for healthcare providers to detect subtle abnormalities that might be missed with traditional stethoscopes. They can also filter out background noise and interference, which



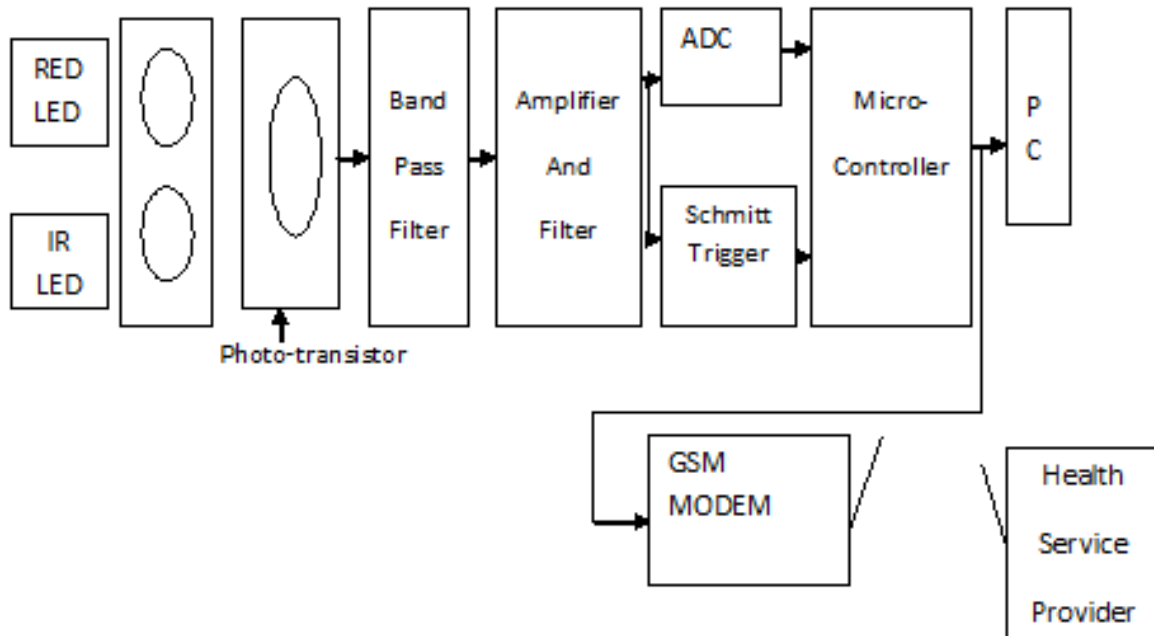
can be particularly useful in noisy environments or when working with critically ill patients.

Another advantage of digital stethoscopes is that they can be used to record and store the sound data for later analysis. This allows healthcare providers to track changes in the patient's condition over time, and to share the data with other healthcare professionals for consultation or second opinions.

Digital stethoscopes are widely used in clinical settings, including hospitals, clinics, and doctor's offices. They are particularly useful for diagnosing conditions such as heart murmurs, arrhythmias, and lung disorders, and can help healthcare providers make more accurate and timely diagnoses.

Overall, digital stethoscopes are an important advancement in medical technology that offer improved accuracy and diagnostic capabilities compared to traditional stethoscopes.

## Oximeter



An oximeter is a medical device used to measure the oxygen saturation level in a person's blood. It is a non-invasive and painless method of measuring oxygen levels, and it is commonly used in hospitals, clinics, and doctor's offices.

Oximeters work by shining a light through the patient's skin, usually on the fingertip, and measuring the amount of light that is absorbed by the blood.

Oxygenated blood absorbs more light than deoxygenated blood, so by measuring the amount of light absorbed, the oximeter can determine the oxygen saturation level in the blood.

Oximeters are particularly useful for patients with respiratory or cardiovascular conditions, such as asthma, chronic obstructive pulmonary disease (COPD), and heart failure. They are also used during surgical procedures to monitor the patient's oxygen levels and ensure that they are receiving enough oxygen.

There are two types of oximeters: pulse oximeters and continuous oximeters. Pulse oximeters measure oxygen levels in the blood at specific points in time, and are often used during rest or activity. Continuous oximeters, on the other hand, provide a continuous measurement of oxygen levels over a longer period of time, and are often used in critical care settings.

Overall, oximeters are an important tool in modern medicine, providing healthcare providers with an accurate and non-invasive method of measuring a patient's oxygen levels. By monitoring oxygen saturation, healthcare providers can quickly identify changes in a patient's condition and make appropriate treatment decisions.