HEART RATE SENSOR

Introduction:

A heart rate sensor is a biomedical device used to measure the rate at which the heart beats per minute (BPM). It is one of the most important physiological parameters that indicates the health condition of a person. The human heart continuously pumps blood throughout the body, and by measuring the pulse rate, we can detect abnormalities such as stress, fatigue, or heart diseases. Heart rate sensors are widely used in medical instruments, fitness bands, smartwatches, and hospital monitoring systems. With the advancement of technology, modern sensors are small, accurate, and can continuously track heart activity in real time.

Working Principle:

The working of a heart rate sensor is based on the Photoplethysmography (PPG) principle. PPG is an optical measurement technique that uses light to detect the blood volume changes in the microvascular tissue beneath the skin. When the heart beats, the blood volume in the arteries increases, and during relaxation, it decreases. These changes affect the amount of light absorbed or reflected by the blood. The LED (Infrared or Green) emits light onto the skin surface, and the Photodiode or LDR receives the reflected or transmitted light. When blood flow increases, more light is absorbed and less is reflected. The difference in light intensity is converted into an electrical signal, which is amplified by an operational amplifier (LM358). Finally, a microcontroller processes the signal and calculates the beats per minute (BPM).

Hardware Components Used:

1. Infrared / Green LED – Emits light through the skin to detect blood flow changes.
2. Photodiode / LDR – Detects the reflected light from the skin.
3. LM358 Operational Amplifier – Amplifies the weak pulse signal from the photodiode.
4. Resistors & Capacitors – Used for filtering and biasing in the circuit.
5. Microcontroller (Arduino / PIC / 8051) – Processes the signal and displays the heart rate value.
6. Display (LCD or OLED) – Shows the heart rate in BPM.

Software Implementation:

The software part involves reading the sensor output, filtering noise, detecting peaks, and calculating BPM. The analog signal from the sensor is read by the microcontroller, which counts the number of pulse peaks in a given time and converts it into beats per minute (BPM). The calculated BPM value is displayed on an LCD or transmitted wirelessly to a smartphone or computer.

Applications:

• Medical Monitoring – Used in hospitals to continuously monitor patient heart rate.
• Fitness Devices – Smartwatches and fitness trackers use heart rate sensors to monitor activity levels.
• Sports Training – Helps athletes track their performance.
• Stress Detection – Monitors heart rate variability to estimate stress levels.
• Telemedicine – Enables remote health monitoring for elderly or critical patients.

Advantages:

• Non-invasive and painless measurement.
• Compact, lightweight, and easy to use.
• Provides real-time and continuous monitoring.
• Low power consumption.
• Can be integrated with wireless devices.

Limitations:

• Accuracy can be affected by movement or poor placement.
• Skin color and ambient light may interfere with readings.
• Requires calibration for different individuals.

Conclusion:

The heart rate sensor is an essential biomedical device in healthcare and fitness industries. It provides an accurate, simple, and continuous way to monitor the heart’s performance. The integration of heart rate sensors with wearable and IoT-based systems has made health monitoring easier and more efficient. With future advancements, these sensors will become even more precise and vital in preventive healthcare.