Lab Assignment No: 03

AIM: Interface generic Biomedical (various types of sensors) used in Smart Healthcare. Measure parameters: Normal Heart Rate, Measure the heart abnormality conditions and Real-time streaming data in healthcare applications through sensor signals.

OBJECTIVES:

- To study and interface various biomedical sensors (e.g., ECG, PPG, Heart Rate, Blood Pressure) used in smart healthcare systems.
- To measure normal heart rate parameters using appropriate sensors like PPG and ECG and establish reference ranges.
- To design a system for continuous remote health monitoring using a cloud platform or mobile interface for visualization and alerting.

COMPONENTS REQUIRED:

- ESP32 development board
- MAX30102 sensor module
- Breadboard and jumper wires

THEORY:

Biomedical sensors integrated into smart healthcare systems are designed to monitor physiological parameters continuously, providing early diagnosis, remote patient monitoring, and real-time alerts. These sensors interface with microcontrollers, mobile apps, or cloud platforms via standard communication protocols**.**

Sensor Type	Measured Parameter	Interface Options
ECG Sensors	Electrical activity of the heart	UART, I2C, SPI, Bluetooth
PPG Sensors	Heart rate, SpO2	I2C, SPI, BLE
Heart Rate Sensor	Pulse rate	Analog/Digital GPIO, I2C

Blood Pressure Sensors	Systolic & Diastolic pressure	I2C, SPI
Accelerometers/Gyros	Motion-related activity	I2C, SPI
Temperature Sensors	Body temperature	I2C, Analog

Measuring Normal Heart Rate

- **PPG Sensors** (e.g., MAX30100/30102) and **ECG modules** (e.g., AD8232):
  - Detect blood volume changes or electrical heart signals.
  - Output signals processed by a microcontroller (e.g., Arduino, ESP32).
  - Filtered and peak-detected to calculate beats per minute (BPM).
  - Normal range: **60–100 BPM** (for adults at rest).

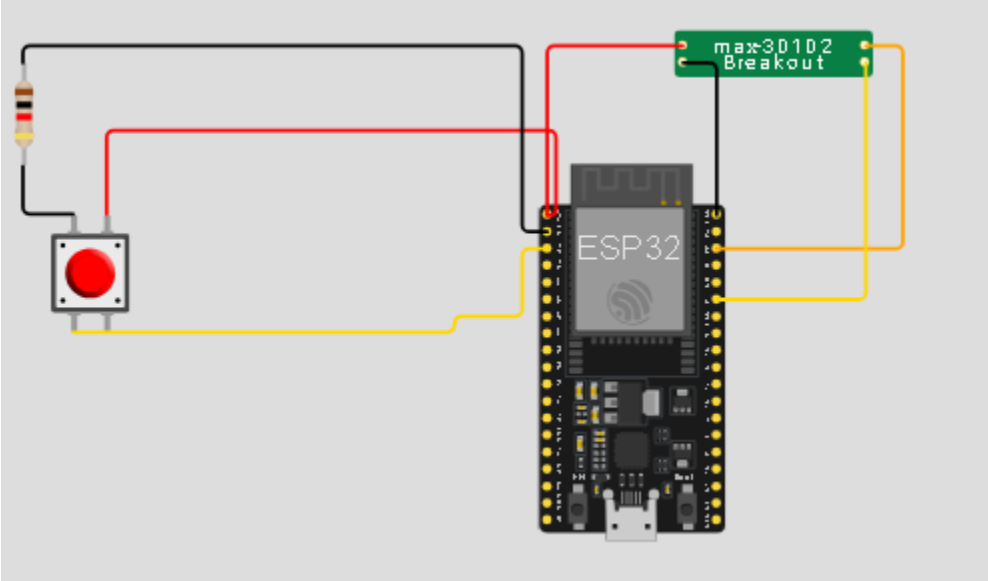
4. Detecting Heart Abnormalities

- **ECG Analysis**:
  - Abnormalities such as **arrhythmia**, **tachycardia**, or **bradycardia** can be detected.
  - Signal patterns analyzed using:
    - DSP (Digital Signal Processing)
    - ML models (e.g., CNN for ECG pattern recognition)
- **AI Integration**:
  - Data fed into models (TensorFlow Lite on edge devices) for prediction.
  - Alerts triggered on anomalies.

5. Real-Time Streaming of Sensor Data

- **Data Acquisition**:
  - Sensors connected to microcontrollers (e.g., Arduino, ESP32, Raspberry Pi).
- **Communication Interfaces**:
  - **Bluetooth/BLE**: For wearable devices to smartphones.
  - **Wi-Fi**: For direct cloud upload.

  - **LoRa/NB-IoT**: For long-range rural monitoring.
- **Cloud Platforms**:
  - ThingsBoard, AWS IoT, or Firebase for visualization and storage.
- **Mobile Apps**:
  - Real-time dashboards using Flutter/React Native.



Output:

CONCLUSION: