***IOT Lab Assignment-4***

* *How do UART, I²C, SPI, CAN, and USB communication protocols differ in terms of data transmission speed, complexity, pin usage, and device-to-device communication?*

**UART (Universal Asynchronous Receiver-Transmitter)**

Data Transmission Speed: Moderate

Complexity: Low

Pin Usage: 2 pins (TX, RX)

Device-to-Device Communication: Point-to-point or multi-point

**I²C (Inter-Integrated Circuit)**

Data Transmission Speed: Low to moderate

Complexity: Moderate

Pin Usage: 2 pins (SDA, SCL)

Device-to-Device Communication: Multi-master, multi-slave

**SPI (Serial Peripheral Interface)**

Data Transmission Speed: High

Complexity: Moderate

Pin Usage: 3-4 pins (MOSI, MISO, SCK, SS)

Device-to-Device Communication: Master-slave

**CAN (Controller Area Network)**

Data Transmission Speed: Moderate to high

Complexity: High

Pin Usage: 2 pins (CANH, CANL)

Device-to-Device Communication: Multi-master, multi-slave

**USB (Universal Serial Bus)**

Data Transmission Speed: High

Complexity: High

Pin Usage: Varies (USB-A, USB-B, USB-C)

Device-to-Device Communication: Host-device

* *What are the key features that make each protocol suitable for specific applications, and in what types of embedded systems would each be most commonly used ?*

**UART** is a simple, two-wire protocol (TX, RX) that doesn’t require a clock signal, making it ideal for direct, low-speed communication between two devices, such as GPS and Bluetooth modules, and microcontroller interfaces.

**I²C** supports multiple devices using just two wires (SDA, SCL) with device addressing, making it perfect for connecting low-speed peripherals like sensors and EEPROMs in embedded systems.

**SPI** provides fast, full-duplex communication over 4-5 wires (MOSI, MISO, SCK, CS), making it ideal for high-speed data transfer in applications like SD cards, displays, and sensors.

**CAN** is highly reliable, handles noise effectively, and supports multiple devices with priority-based messaging, making it ideal for use in automotive and industrial systems where robustness is critical.

**USB** offers high-speed data transfer, power delivery, and support for multiple devices, making it the standard for computers, smartphones, and consumer electronics like storage devices and printers.