1. **RFID Reader (MFRC522)**

**Explanation:**  
The RFID reader is used to scan RFID-enabled student ID cards. It captures the unique ID embedded in the cards when students pass through checkpoints. The MFRC522 module supports contactless communication and integrates seamlessly with microcontrollers like Arduino.

**Associated Software Requirements:**

* **RFID Library (MFRC522):** Required to interface the RFID reader with the Arduino.
* **Arduino IDE:** For programming the Arduino to process RFID data.

2. **RFID Cards**

**Explanation:**  
Each student is issued an RFID card containing a unique identifier. These cards are scanned at checkpoints to track attendance and location.

**Associated Software Requirements:**

* **Database Management System (e.g., MySQL, MongoDB):** Stores student IDs and profiles linked to RFID tags.

3. **GPS Module (NEO-6M)**

**Explanation:**  
The GPS module captures real-time location data (latitude and longitude) of students when they are outside the campus. It works with the Arduino to tag locations with student IDs.

**Associated Software Requirements:**

* **GPS Library (TinyGPS++):** Enables communication between the GPS module and Arduino.

4. **Arduino Mega 2560**

**Explanation:**  
Acts as the central processing unit. It processes data from the RFID reader and GPS module, validates student IDs, and transmits data to the NodeMCU.

**Associated Software Requirements:**

* **Arduino IDE:** For coding and uploading firmware to the Arduino.
* **SoftwareSerial Library:** Facilitates serial communication between Arduino and other modules.

5. **NodeMCU (ESP8266)**

**Explanation:**  
An IoT gateway that transmits processed data from the Arduino to the cloud via Wi-Fi. It ensures real-time data uploads to the web dashboard.

**Associated Software Requirements:**

* **NodeMCU Firmware:** Enables Wi-Fi connectivity and HTTP requests.
* **ThingSpeak API:** For cloud data storage and retrieval.

6. **LCD Display**

**Explanation:**  
Displays real-time information such as student names, IDs, and location data at checkpoints for on-site verification.

**Associated Software Requirements:**

* **LiquidCrystal Library:** Controls the LCD screen via Arduino.

7. **Power Supply (5V/12V)**

**Explanation:**  
Provides stable power to all components. Includes a 5V adapter for low-power modules and a 12V battery backup for uninterrupted operation during outages.

8. **Cloud-Based Dashboard**

**Explanation:**  
A web interface where administrators, faculty, and parents can monitor student locations, attendance records, and alerts in real-time.

* **ThingSpeak:** Cloud platform for data visualization and storage.

**Software Requirements**

1. **Arduino IDE**
   * Used for programming the Arduino Mega and NodeMCU.
   * Required Libraries:
     + MFRC522 (RFID)
     + TinyGPS++ (GPS)
     + LiquidCrystal (LCD)
     + SoftwareSerial (serial communication).
2. **ThingSpeak**
   * Cloud platform for storing and visualizing real-time data (RFID, GPS).
3. **NodeMCU Firmware**
   * Enables Wi-Fi connectivity and HTTP communication for IoT integration.