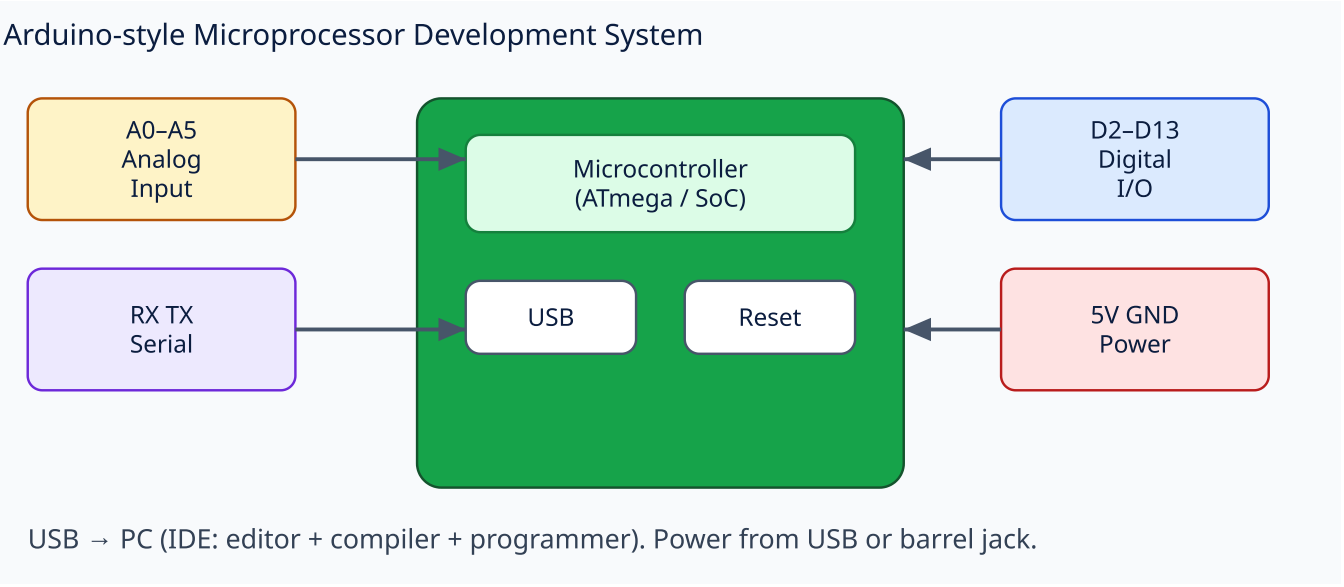
Grade 13 A/L ICT · Lesson 11

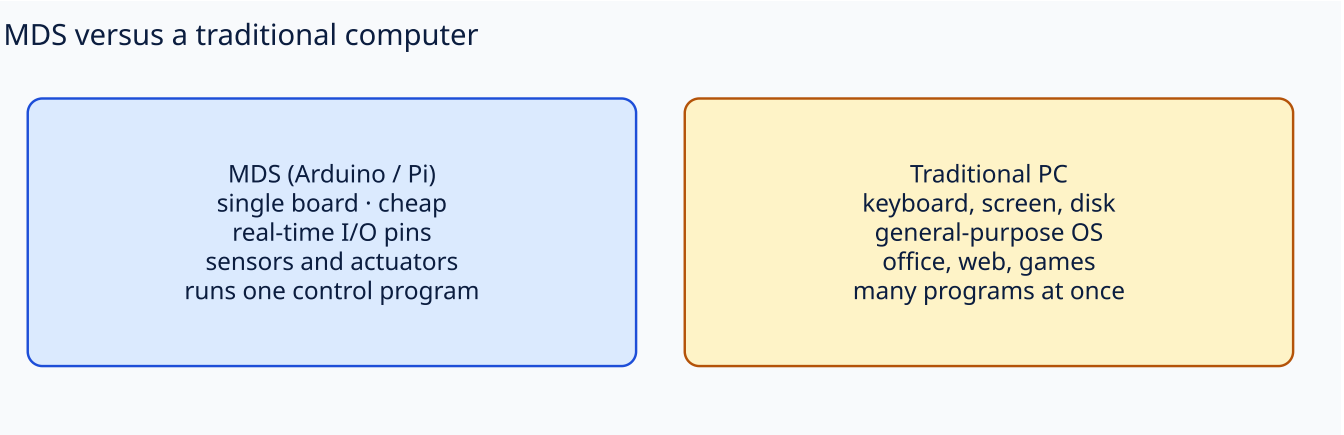
11.1 Microprocessor Development Systems

Syllabus 11.1. A **Microprocessor Development System (MDS)** is a single board (Arduino, Raspberry Pi and similar boards) with a **microcontroller**, **I/O pins** and ports you can program. Unlike a traditional PC, an MDS is cheap, talks directly to **sensors** and **actuators**, and runs one control program in real time. You write a sketch in an **IDE** (editor, compiler, programmer), upload it over **USB**, and build simple applications: LEDs, LDR lighting, temperature fans and magnetic door switches.

1. What is an MDS?



Arduino-style board and its main parts



MDS compared with a traditional computer

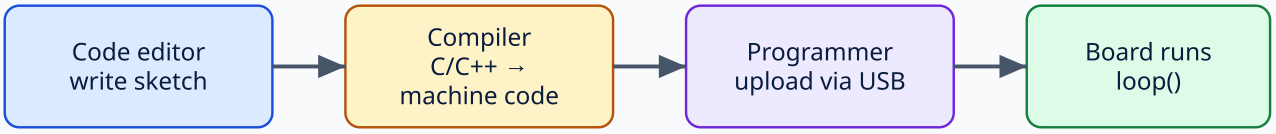
- **Microcontroller** – the “brain” that runs your program.
- **Analog input** (A0–A5) – reads voltages from sensors (0–5 V → 0–1023).
- **Digital input / output** (D2–D13) – HIGH or LOW for buttons, LEDs, relays.

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

- **RX / TX** – serial communication; **USB** – power and programming; **Reset** – restart; **Power** – 5 V / 3.3 V / GND.

2. Connecting and the IDE

Arduino IDE toolchain



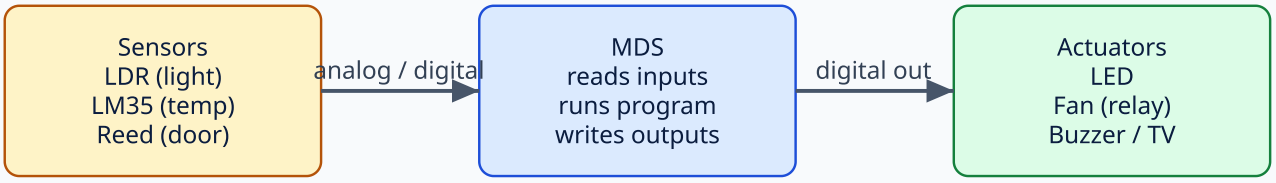
Download the IDE free from the Internet; select the board and the COM/serial port.

Editor, compiler and programmer

- Download the free **Arduino IDE** (or similar) from the Internet.
- Connect the board to the PC with a **USB** cable; select the board and the COM/serial port.
- Write the sketch → **Verify/Compile** → **Upload**. setup() runs once; loop() runs forever.

3. Sensors, actuators and numbers

Sensors → MDS → actuators

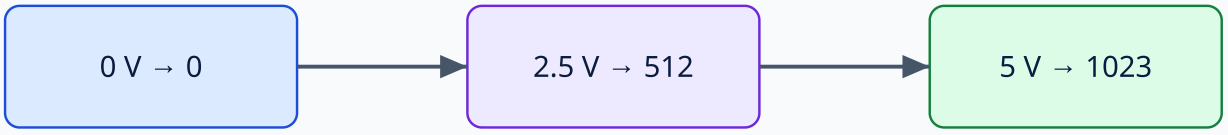


Analog input (A0): 0–5 V → ADC → 0–1023. Digital I/O: HIGH ≈ 5 V, LOW ≈ 0 V.

LED resistor R = (Vcc − Vf) / I. Example: (5 − 2) / 0.02 = 150 Ω.

From sensors through the MDS to actuators

10-bit ADC: voltage to a number



Step = Vref / 1024 ≈ 4.88 mV. V = raw × 5 / 1024.

LM35: 10 mV/°C → T (°C) = V × 100.

How the 10-bit ADC turns voltage into a number

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

Quantity	Value
ADC levels (10-bit)	1024
Voltage step (5 V / 1024)	≈ 0.005 V
raw 820 → voltage	4.004 V
LDR divider in light (2 kΩ + 10 kΩ)	4.167 V
LDR divider in dark (50 kΩ + 10 kΩ)	0.833 V
LED series resistor (5 V, Vf 2 V, 20 mA)	150 Ω
PWM duty 64/255	25.1% → 1.25 V avg

🧱 **Worked example: Why does raw 820 mean about 4.004 V, and which LED resistor do you need?**
V = raw × Vref / 1024 = 820 × 5 / 1024 ≈ **4.004 V**. For a red LED, R = (Vcc − Vf) / I = (5 − 2) / 0.02 = **150 Ω**.

4. Application 1 – Blink an LED

🔌 Blink an LED on pin 13

```
// Blink LED on pin 13 (built-in LED on many Arduino boards)
const int LED = 13;

void setup() {
  pinMode(LED, OUTPUT);   // digital output
}

void loop() {
  digitalWrite(LED, HIGH);  // LED on
  delay(1000);              // wait 1 second
  digitalWrite(LED, LOW);   // LED off
  delay(1000);
}
```

▶ Simulated run

```
LED 13 = HIGH
delay 1000 ms
LED 13 = LOW
delay 1000 ms
(loop repeats)
```

5. Application 2 – Ambient light (LDR) controls an LED

🔌 Switch LED on when it is dark (LDR)

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

```
// LDR on A0 (voltage divider with 10 kΩ); LED on pin 8
const int LDR = A0;
const int LED = 8;
const int THRESHOLD = 400;   // below this = dark

void setup() {
  pinMode(LED, OUTPUT);
  Serial.begin(9600);
}

void loop() {
  int light = analogRead(LDR);   // 0–1023
  Serial.print("Light: ");
  Serial.println(light);
  if (light < THRESHOLD) {
    digitalWrite(LED, HIGH);     // dark → LED on
  } else {
    digitalWrite(LED, LOW);      // bright → LED off
  }
  delay(500);
}
```

▶ Simulated run

```
Light: 820
LED 8 = LOW
delay 500 ms
Light: 180
LED 8 = HIGH
delay 500 ms
```

> 🧱 **Worked example: At raw 820 the LED is off; at raw 180 it turns on. Why?**
> 820 is above the threshold 400 (bright → LED LOW). 180 is below 400 (dark → LED HIGH).

6. Application 3 – Temperature sensor runs a fan

🔌 Run a fan when temperature is high

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

```
// LM35 on A1 (10 mV/°C); fan relay on pin 7
const int TEMP = A1;
const int FAN = 7;
const float ON_C = 28.0;
const float OFF_C = 26.0;
int fanOn = 0;

void setup() {
  pinMode(FAN, OUTPUT);
  Serial.begin(9600);
}

void loop() {
  int raw = analogRead(TEMP);
  float volts = raw * (5.0 / 1024.0);
  float celsius = volts * 100.0;   // LM35: 10 mV per °C
  Serial.print("Temp: ");
  Serial.print(celsius);
  Serial.println(" C");
  if (celsius >= ON_C) {
    digitalWrite(FAN, HIGH);
    fanOn = 1;
  } else if (celsius <= OFF_C) {
    digitalWrite(FAN, LOW);
    fanOn = 0;
  }
  // between OFF_C and ON_C keep previous state (hysteresis)
  delay(1000);
}
```

▶ Simulated run

```
Temp: 24.9 C
FAN 7 = LOW
delay 1000 ms
Temp: 29.8 C
FAN 7 = HIGH
delay 1000 ms
Temp: 26.9 C
FAN 7 stays HIGH (hysteresis)
delay 1000 ms
Temp: 25.4 C
FAN 7 = LOW
delay 1000 ms
```

🧱 **Worked example: Trace the four readings [24.9, 29.8, 26.9, 25.4] °C. When does the fan change?**

24.9 ≤ 26 → fan **LOW**. 29.8 ≥ 28 → fan **HIGH**. 26.9 is between 26 and 28 so hysteresis keeps it **HIGH**. 25.4 ≤ 26 → fan **LOW** again. LM35: T = V × 100 with V = raw × 5 / 1024.

7. Application 4 – Magnetic door switch

🔌 Door open/close with a magnetic switch

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

```
// Reed (magnetic) switch on pin 2 with INPUT_PULLUP; alarm LED on pin 9
// Magnet near switch → pin reads HIGH (closed); magnet away → LOW (open)
const int DOOR = 2;
const int ALARM = 9;

void setup() {
  pinMode(DOOR, INPUT_PULLUP);
  pinMode(ALARM, OUTPUT);
  Serial.begin(9600);
}

void loop() {
  int state = digitalRead(DOOR);
  if (state == LOW) {
    Serial.println("Door OPEN");
    digitalWrite(ALARM, HIGH);
  } else {
    Serial.println("Door CLOSED");
    digitalWrite(ALARM, LOW);
  }
  delay(200);
}
```

▶ Simulated run

```
Door CLOSED
ALARM 9 = LOW
delay 200 ms
Door OPEN
ALARM 9 = HIGH
delay 200 ms
```

💡 Use INPUT_PULLUP for a reed switch so the pin is HIGH when the door is closed (magnet present) and falls LOW when it opens.

🚀 **Beyond the syllabus (2026 update)** *Not required for the exam – read for interest.* In 2026 school MDS boards often ship with Wi-Fi (ESP32) already on the board, so the same LED and sensor sketches can talk to a phone app with a few extra lines.

Key Words

MDS – Microprocessor Development System – a programmable single board.

Microcontroller – Chip that runs the control program on the board.

Analog input – Pin that measures a voltage as a number.

Digital I/O – Pin that is either HIGH or LOW.

ADC – Analog-to-digital converter (e.g. 10-bit, 0–1023).

Sensor – Device that measures a physical quantity.

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

Actuator – Device the MDS drives – LED, motor, relay, buzzer.	**LDR** – Light-dependent resistor used to sense light.
LM35 – Temperature sensor that outputs 10 mV per °C.	**Reed switch** – Magnetic switch used to detect a door open/close.
IDE – Software with editor, compiler and programmer.	**USB** – Cable/port used to power and program the board.

Sample Q&A

1. MDS vs traditional PC – one difference?

> **Answer:** MDS talks directly to sensors/actuators; a PC is general-purpose.

2. What does the 10-bit ADC return for 5 V?

> **Answer:** 1023 (0–1023).

3. Voltage for raw 820?

> **Answer:** About 4.004 V.

4. LED resistor for 5 V, Vf 2 V, 20 mA?

> **Answer:** 150 Ω.

5. When does the LDR sketch turn the LED on?

> **Answer:** When analogRead is below 400 (dark).

6. Why use hysteresis on the fan?

> **Answer:** Stops the fan switching on/off rapidly near the threshold.

MCQ

1. An Arduino board is an example of a

A. web server
B. hard disk
C. Microprocessor Development System
D. desktop PC
E. router only

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

2. Pins A0–A5 are mainly used for

A. USB power
B. reset
C. crystal clocks
D. Wi-Fi only
E. analog input

3. A 10-bit ADC maps 0–5 V to

A. 0–1023
B. 0–100
C. 0–5
D. 0–255
E. 0–65535

4. raw 820 equals about

A. 1.000 V
B. 2.500 V
C. 5.000 V
D. 4.004 V
E. 0.500 V

5. LED series resistor (5 V, Vf 2 V, 20 mA) is

A. 220 Ω
B. 50 Ω
C. 150 Ω
D. 100 Ω
E. 1 kΩ

6. In the LDR sketch, raw 180 makes the LED

A. LOW (off)
B. HIGH (on)
C. reset
D. blink
E. TX

7. LM35: 10 mV/°C. Near 29.8 °C the fan turns

A. HIGH (on)
B. reset
C. TX only
D. LOW forever
E. compile error

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

8. A magnetic reed switch on a door is a

A. actuator
B. router
C. sensor
D. compiler
E. power supply

9. Which term means: “Microprocessor Development System – a programmable single board”?

A. IDE
B. LDR
C. Sensor
D. Analog input
E. MDS

10. Which term means: “Chip that runs the control program on the board”?

A. USB
B. Microcontroller
C. Actuator
D. Digital I/O
E. LM35

11. Which term means: “Pin that measures a voltage as a number”?

A. ADC
B. LDR
C. MDS
D. Reed switch
E. Analog input

12. Which term means: “Pin that is either HIGH or LOW”?

A. LM35
B. IDE
C. Sensor
D. Digital I/O
E. Microcontroller

13. Which term means: “Analog-to-digital converter (e.g. 10-bit, 0–1023)”?

A. Actuator
B. Analog input
C. USB
D. ADC
E. Reed switch

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

14. Which term means: “Device that measures a physical quantity”?

A. Sensor
B. Digital I/O
C. IDE
D. LDR
E. MDS

15. Which term means: “Device the MDS drives – LED, motor, relay, buzzer”?

A. Actuator
B. LM35
C. USB
D. Microcontroller
E. ADC

16. Which term means: “Light-dependent resistor used to sense light”?

A. Analog input
B. MDS
C. Reed switch
D. Sensor
E. LDR

17. Which term means: “Temperature sensor that outputs 10 mV per °C”?

A. Digital I/O
B. LM35
C. IDE
D. Actuator
E. Microcontroller

18. Which term means: “Magnetic switch used to detect a door open/close”?

A. ADC
B. Analog input
C. Reed switch
D. LDR
E. USB

19. Which term means: “Software with editor, compiler and programmer”?

A. LM35
B. IDE
C. Sensor
D. MDS
E. Digital I/O

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

20. Which term means: “Cable/port used to power and program the board”?

A. ADC
B. Reed switch
C. Actuator
D. USB
E. Microcontroller

Structured Questions

1. Compare an MDS with a traditional computer (three points). *(4 marks)*

> Board vs PC; I/O pins; real-time control; cost/size.

2. List the main features of an Arduino-style board. *(6 marks)*

> Analog in; digital I/O; MCU; RX/TX; USB; power; reset.

3. Explain how the IDE gets a sketch onto the board. *(4 marks)*

> Editor; compile; USB upload/programmer; board and port.

4. Calculate V for raw 820 and the LED resistor for 20 mA, Vf 2 V. *(2 marks)*

> 4.004 V; 150 Ω.

5. Describe the LDR, temperature-fan and door-switch applications. *(3 marks)*

> Threshold LED; LM35 with hysteresis fan; reed + alarm LED.

Summary

- An MDS is a programmable board for sensing and control.
- Features: analog/digital I/O, USB, RX/TX, power, reset.
- The IDE edits, compiles and uploads over USB.
- ADC: V = raw × 5 / 1024.
- Apps: LED, LDR, temperature fan, magnetic door.

MCQ answer key – 11.1

1. **C** – MDS.
2. **E** – Analog.
3. **A** – 2^10 − 1.
4. **D** – 820×5/1024.
5. **C** – (5−2)/0.02.
6. **B** – Below 400.
7. **A** – ≥ 28 °C.

© 2026 schoolict.net (Ruwan Mangala Suraweera) · All rights reserved

8. **C** – Senses open/close.
9. **E** – MDS – Microprocessor Development System – a programmable single board.
10. **B** – Microcontroller – Chip that runs the control program on the board.
11. **E** – Analog input – Pin that measures a voltage as a number.
12. **D** – Digital I/O – Pin that is either HIGH or LOW.
13. **D** – ADC – Analog-to-digital converter (e.g. 10-bit, 0–1023).
14. **A** – Sensor – Device that measures a physical quantity.
15. **A** – Actuator – Device the MDS drives – LED, motor, relay, buzzer.
16. **E** – LDR – Light-dependent resistor used to sense light.
17. **B** – LM35 – Temperature sensor that outputs 10 mV per °C.
18. **C** – Reed switch – Magnetic switch used to detect a door open/close.
19. **B** – IDE – Software with editor, compiler and programmer.
20. **D** – USB – Cable/port used to power and program the board.

© 2026 schoolict.net (Ruwan Mangala Suraweera). All rights reserved.