

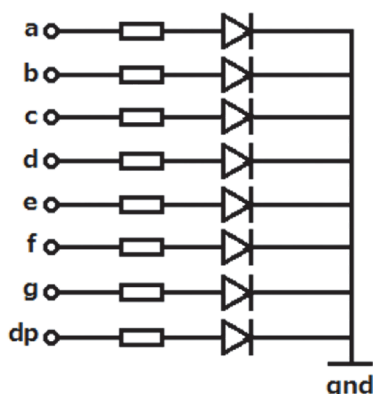
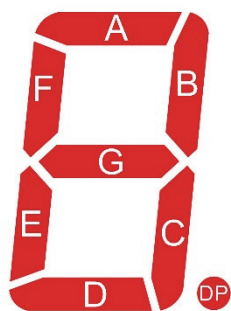
Nastavni predmet:	Ugradbeni računalni sustavi
Vježba: 01	Arduino – Sedam segmentni LED indikator
Cilj vježbe:	Naučiti ispisivati brojeve i slova na 7 segmentni LED display

Upute

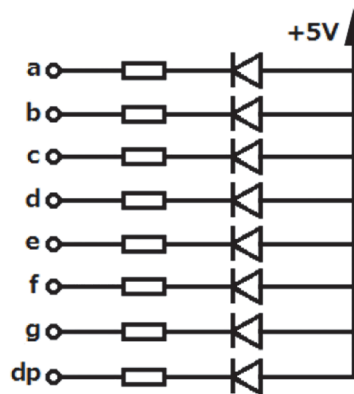
Sve zadatke spremi na USB, a u bilježnici za sve zadatke napiši:

- postupak izrade programa
- objašnjenje korištenih naredbi
- dobivene rezultate po točkama
- odgovoriti u bilježnicu na postavljena pitanja vezana uz ovu vježbu
- Ukoliko u kòdu postoji greška, korigiraj i objasni!

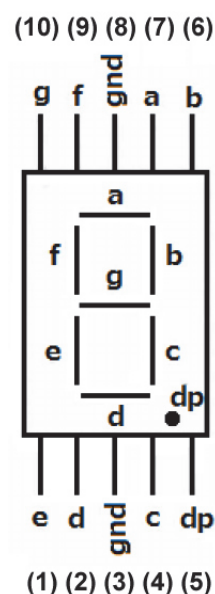
Sedam segmentni LED indikator (SSD – od engl. Seven Segment Display) sastoji se od 8 LED dioda koje predstavljaju 7 segmenata i jednu decimalnu točku. Služe za prikaz brojeva i nekih slova. Uobičajeni način obilježavanja segmenata dan je na slici.



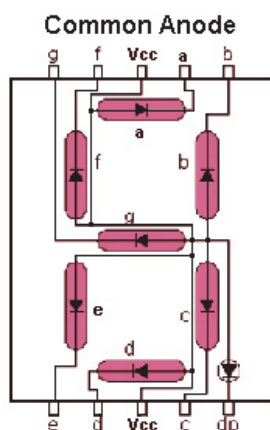
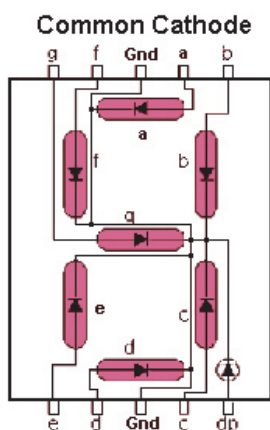
Zajednička KATODA



Zajednička ANODA



Radi smanjenja broja nožica, na 7 segmentnom LED indikatoru jedna nožica je zajednička. Ovisno o izvedbi može biti izvedba sa zajedničkom **katodom** ili izvedba sa zajedničkom **anodom**.



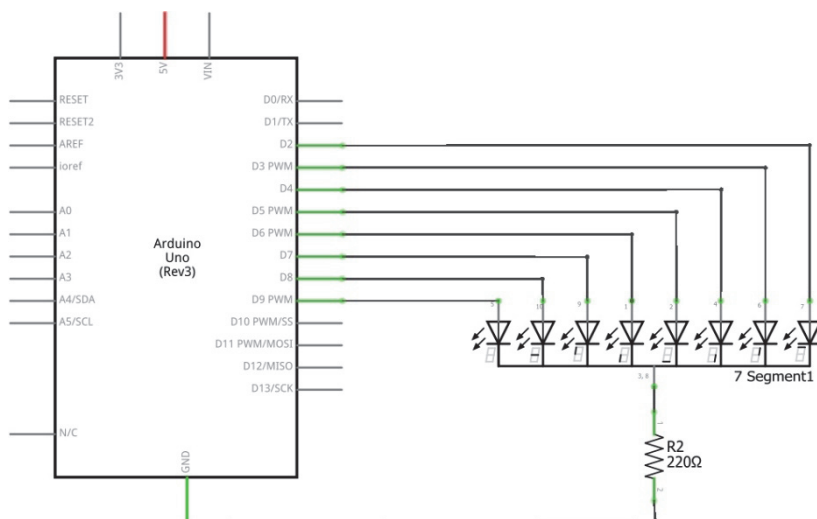
Raspored segmenata za zajedničku katodu

Segments (✓ = ON)							Display	Segments (✓ = ON)							Display
a	b	c	d	e	f	g		a	b	c	d	e	f	g	
✓	✓	✓	✓	✓	✓		0	✓	✓	✓	✓	✓	✓	✓	8
	✓	✓					1	✓	✓	✓			✓	✓	9
✓	✓		✓	✓		✓	2	✓	✓	✓		✓	✓	✓	A
✓	✓	✓				✓	3			✓	✓	✓	✓	✓	b
	✓	✓		✓	✓		4	✓			✓	✓	✓		c
✓		✓	✓		✓	✓	5		✓	✓	✓	✓		✓	d
✓		✓	✓	✓	✓	✓	6	✓			✓	✓	✓	✓	E
✓	✓	✓					7	✓				✓	✓	✓	F

Za zajedničku anodu, segmente treba invertirati

Zadatak 1. Spoji 7-segmentni LED display i napiši program kojim će display odbrojavati od 0-9.

Električna shema:



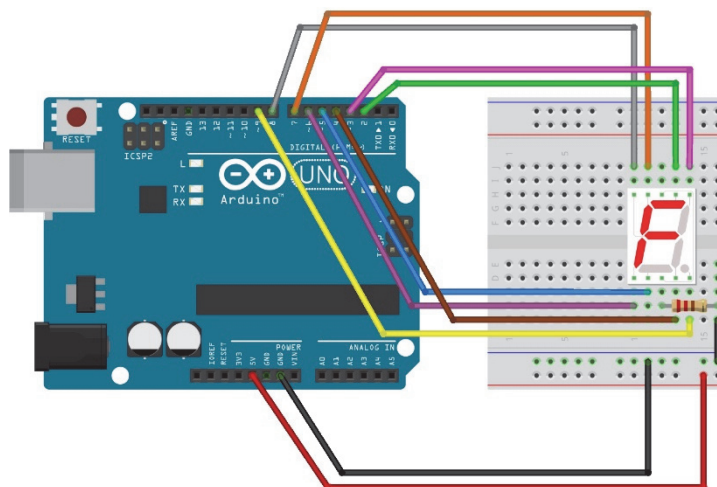
Raspored pinova:

Arduino Pin	7 segmentni LED display Pin
2	7 (A)
3	6 (B)
4	4 (C)
5	2 (D)
6	1 (E)
7	9 (F)
8	10 (G)
9	5 (DP)
GND	3 i/ili 8

NAPOMENA: Između GND pina Arduino i Pina 3 7 segmentnog LED treba biti otpornik od oko 220Ω.

1. Zašto je potreban otpornik između GND Arduino i pina 3 i GND?
2. Koji 7 segmentni LED display koristiš na LV, sa zajedničkom anodom ili katodom?

Grafička shema:



Kòd zadatka

```
int intDelay = 200; // vrijeme čekanja između ispisa dviju znamenki u ms
int intPause = 1000; // vrijeme čekanja između ispisa nove serije
// znamenki u ms

void setup() {
  pinMode(2, OUTPUT);
  pinMode(3, OUTPUT);
  pinMode(4, OUTPUT);
  pinMode(5, OUTPUT);
  pinMode(6, OUTPUT);
  pinMode(7, OUTPUT);
  pinMode(8, OUTPUT);
  pinMode(9, OUTPUT);
  digitalWrite(9, 0); // isključujemo točku decimalnu
}
```

```

void loop() {
    // piši '0'
    digitalWrite(2, 1);    // segment A
    digitalWrite(3, 1);    // segment B
    digitalWrite(4, 1);    // segment C
    digitalWrite(5, 1);    // segment D
    digitalWrite(6, 1);    // segment E
    digitalWrite(7, 1);    // segment F
    digitalWrite(8, 0);    // segment G
    delay(intDelay);

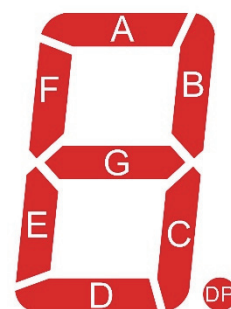
    // piši '1'
    digitalWrite(2, 0);    // segment A
    digitalWrite(3, 1);    // segment B
    digitalWrite(4, 1);    // segment C
    digitalWrite(5, 0);    // segment D
    digitalWrite(6, 0);    // segment E
    digitalWrite(7, 0);    // segment F
    digitalWrite(8, 0);    // segment G
    delay(intDelay);

    // piši '2'
    digitalWrite(2, 1);    // segment A
    digitalWrite(3, 1);    // segment B
    digitalWrite(4, 0);    // segment C
    digitalWrite(5, 1);    // segment D
    digitalWrite(6, 1);    // segment E
    digitalWrite(7, 0);    // segment F
    digitalWrite(8, 1);    // segment G
    delay(intDelay);

    // piši '3'
    digitalWrite(2, 1);    // segment A
    digitalWrite(3, 1);    // segment B
    digitalWrite(4, 1);    // segment C
    digitalWrite(5, 1);    // segment D
    digitalWrite(6, 0);    // segment E
    digitalWrite(7, 0);    // segment F
    digitalWrite(8, 1);    // segment G
    delay(intDelay);

    // piši '4'
    digitalWrite(2, 0);    // segment A
    digitalWrite(3, 1);    // segment B
    digitalWrite(4, 1);    // segment C
    digitalWrite(5, 0);    // segment D
    digitalWrite(6, 0);    // segment E
    digitalWrite(7, 1);    // segment F
    digitalWrite(8, 1);    // segment G
    delay(intDelay);
}

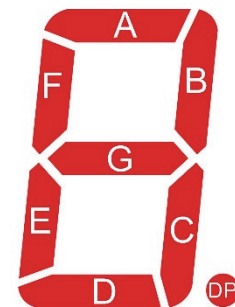
```



```
// piši '5'
digitalWrite(2, 1);    // segment A
digitalWrite(3, 0);    // segment B
digitalWrite(4, 1);    // segment C
digitalWrite(5, 1);    // segment D
digitalWrite(6, 0);    // segment E
digitalWrite(7, 1);    // segment F
digitalWrite(8, 1);    // segment G
delay(intDelay);
```

```
// piši '6'
digitalWrite(2, 1);    // segment A
digitalWrite(3, 0);    // segment B
digitalWrite(4, 1);    // segment C
digitalWrite(5, 1);    // segment D
digitalWrite(6, 1);    // segment E
digitalWrite(7, 1);    // segment F
digitalWrite(8, 1);    // segment G
delay(intDelay);
```

```
// piši '7'
digitalWrite(2, 1);    // segment A
digitalWrite(3, 1);    // segment B
digitalWrite(4, 1);    // segment C
digitalWrite(5, 0);    // segment D
digitalWrite(6, 0);    // segment E
digitalWrite(7, 0);    // segment F
digitalWrite(8, 0);    // segment G
delay(intDelay);
```



```
// piši '8'
digitalWrite(2, 1);    // segment A
digitalWrite(3, 1);    // segment B
digitalWrite(4, 1);    // segment C
digitalWrite(5, 1);    // segment D
digitalWrite(6, 1);    // segment E
digitalWrite(7, 1);    // segment F
digitalWrite(8, 1);    // segment G
delay(intDelay);
```

```
// piši '9'
digitalWrite(2, 1);    // segment A
digitalWrite(3, 1);    // segment B
digitalWrite(4, 1);    // segment C
digitalWrite(5, 1);    // segment D
digitalWrite(6, 0);    // segment E
digitalWrite(7, 1);    // segment F
digitalWrite(8, 1);    // segment G
delay(intPause);
```

```
}
```

Zadatak 2. Doradi program iz prethodnog zadatka tako da slijedno prikazuje slova od A do F.

Zadatak 3. Napisati program kojim će na displej ispisati „PULA“.

Zadatak 4. Prouči skraćenu verziju programa kojim će displej odbrojavati od 0-F. Ovaj zadatak ne treba realizirati praktično!

Kòd zadatka

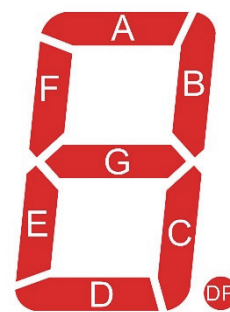
```
int intDelay = 500;    // vrijeme čekanja između ispisa dviju znamenki u ms
int intPause = 4000;   // vrijeme čekanja između ispisa nove serije

// Deklaracija pinova Arduina za spoj na 7 segmentni LCD display
byte s7segment[] = { 2, 3, 4, 5, 6, 7, 8, 9 };

byte digits[][17] = { // Definicija bitova za paljenje određenog segmenta
  displaya pritiskom na neku tipku
  // { A, B, C, D, E, F, G, dp}, // segmenti
  { 1, 1, 1, 1, 1, 1, 0, 0 }, // broj 0
  { 0, 1, 1, 0, 0, 0, 0, 0 }, // broj 1
  { 1, 1, 0, 1, 1, 0, 1, 0 }, // broj 2
  { 1, 1, 1, 1, 0, 0, 1, 0 }, // broj 3
  { 0, 1, 1, 0, 0, 1, 1, 0 }, // broj 4
  { 1, 0, 1, 1, 0, 1, 1, 0 }, // broj 5
  { 1, 0, 1, 1, 1, 1, 1, 0 }, // broj 6
  { 1, 1, 1, 0, 0, 0, 0, 0 }, // broj 7
  { 1, 1, 1, 1, 1, 1, 1, 0 }, // broj 8
  { 1, 1, 1, 1, 0, 1, 1, 0 }, // broj 9
  { 1, 1, 1, 0, 1, 1, 1, 0 }, // slovo A
  { 0, 0, 1, 1, 1, 1, 1, 0 }, // slovo B
  { 1, 0, 0, 1, 1, 1, 0, 0 }, // slovo C
  { 0, 1, 1, 1, 1, 0, 1, 0 }, // slovo D
  { 1, 0, 0, 1, 1, 1, 1, 0 }, // slovo E
  { 1, 0, 0, 0, 1, 1, 1, 0 }, // slovo F
  { 0, 0, 0, 0, 0, 0, 0, 0 }, // Ugasi
};

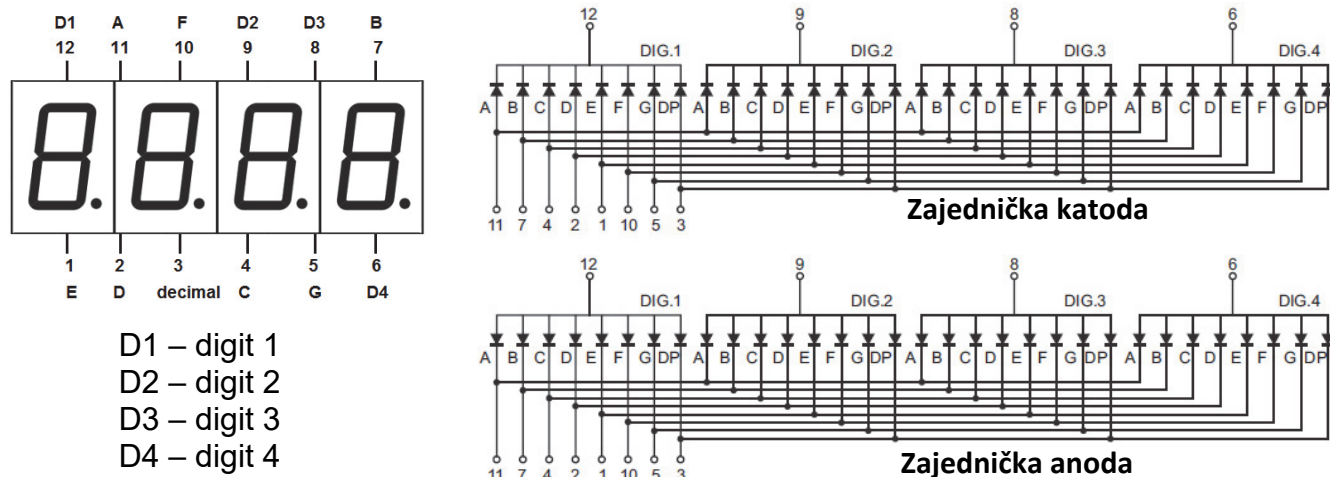
void setup() {
  for (int i = 0; i<7; i++) { // Definiraj sve pinove za
    pinMode(s7segment[i], OUTPUT); // kao display izlazne
  }
}

void loop() {
  for (int i = 0; i<17; i++) { // Petlja za ispis svih znamenki
    for (int j = 0; j <= 7; j++) { // Petlja za ispis svih segmenata
      digitalWrite(s7segment[j], digits[i][j]);
    }
    delay(intDelay);
  }
  delay(intPause);
}
```



4 X 7 segmentni LED displej

U praksi je vrlo često potrebno prikazati više od jedne znamenke, pa se koristi 4 X 7 segmentni LED zaslon. Uobičajeni raspored izvoda i unutarnja električna shema dani su u nastavku.



Kako bi se smanjio broj izvoda, 4 X 7 segmentni LED je multipleksiran, tj. za pojedinu znamenku treba uključiti zajedničku nožicu (katodu ili anodu) za tu znamenku.

Displej ima 8 nožica za 8 standardnih segmenata + 4 nožice za odabir pojedine znamenke. Znamenke se naizmjenice uključuju i ispisuju se odgovarajući segmenti za tu znamenku.

Ako se znamenka za znamenkom ispisuju dovoljno velikom brzinom, ljudsko oko će prepoznati kao da sve 4 znamenke svijetle istovremeno.

Osim decimalne točke, ovi indikatori mogu imati i dvotočku pomoću kojih se može realizirati sat.

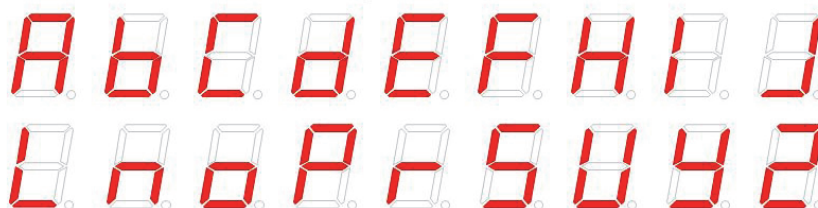
Znakovi koji se mogu prikazati pomoću 7 segmentnog LED displeja:

SSD Display Possibilities

Decimal Digits 0-9



Select Alpha Characters



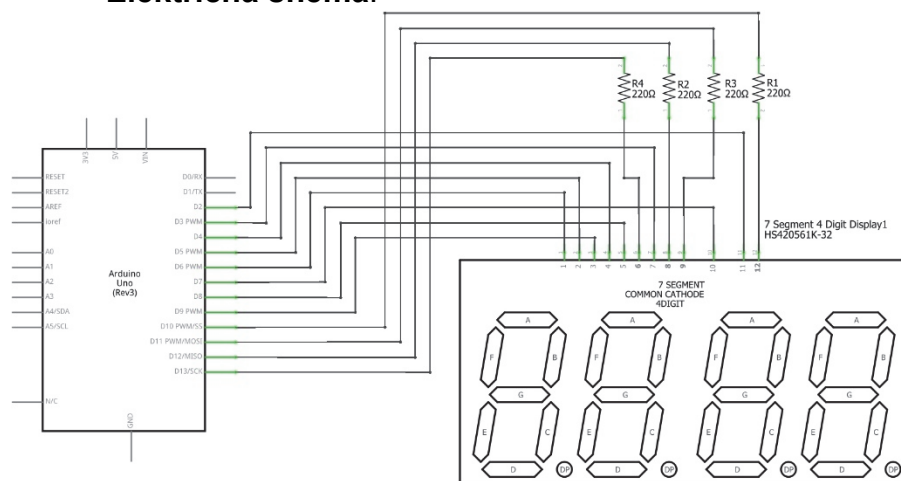
Simple Messages



Zadatak 5. Modificiraj spoj tako da umjesto 7 segmentnog LED displeja koristiš 7 segmentni LED displej s 4 znamenke. Modificiraj program tako da na njemu piše „PULA“.

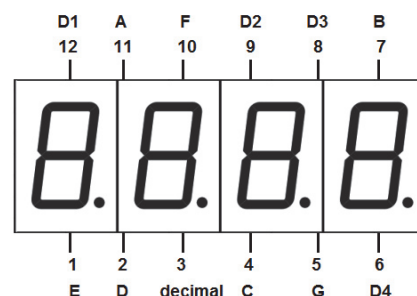
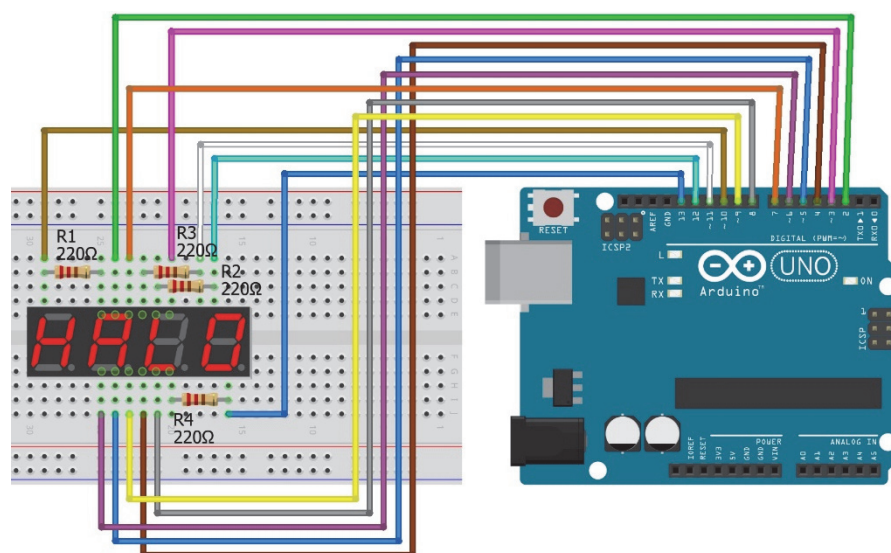
NAPOMENA: Između pinova D1 (12), D2 (8), D3 (9) i D4(6) LED displeja i odgovarajućih pinova Arduina treba spojiti otpornik oko 220 ohma.

Električna shema:



Arduino Pin	4x7 segment. LED display Pin
2	11 (A)
3	7 (B)
4	4 (C)
5	2 (D)
6	1 (E)
7	10 (F)
8	5 (G)
9	3 (DP)
10	12 (D1)
11	8 (D2)
12	9 (D3)
13	6 (D4)

Grafička shema:



Kòd zadatka

```
int intDelay = 500; // vrijeme čekanja između ispisa dviju znamenki

void setup() {
  // put your setup code here, to run once:
  pinMode(2, OUTPUT); // segment A
  pinMode(3, OUTPUT); // segment B
  pinMode(4, OUTPUT); // segment C
  pinMode(5, OUTPUT); // segment D
  pinMode(6, OUTPUT); // segment E
  pinMode(7, OUTPUT); // segment F
  pinMode(8, OUTPUT); // segment G
  pinMode(9, OUTPUT); // decimalna točka
}
```

```

    digitalWrite(9, 0);      // isključujemo decimalnu točku

    pinMode(10, OUTPUT);    // Pin za katodu prve znamenke D1
    pinMode(11, OUTPUT);    // Pin za katodu druge znamenke D2
    pinMode(12, OUTPUT);    // Pin za katodu treće znamenke D3
    pinMode(13, OUTPUT);    // Pin za katodu četvrte znamenke D4
}

void loop() {
    // piši 'P'
    digitalWrite(2, 1);
    digitalWrite(3, 1);
    digitalWrite(4, 0);
    digitalWrite(5, 0);
    digitalWrite(6, 1);
    digitalWrite(7, 1);
    digitalWrite(8, 1);

    digitalWrite(10, 0);    // Aktivna samo prva znamenka D1
    digitalWrite(11, 1);
    digitalWrite(12, 1);
    digitalWrite(13, 1);
    delay(intDelay);

    // piši 'U'
    digitalWrite(2, 0);
    digitalWrite(3, 1);
    digitalWrite(4, 1);
    digitalWrite(5, 1);
    digitalWrite(6, 1);
    digitalWrite(7, 1);
    digitalWrite(8, 0);

    digitalWrite(10, 1);
    digitalWrite(11, 0);    // Aktivna samo druga znamenka D2
    digitalWrite(12, 1);
    digitalWrite(13, 1);
    delay(intDelay);

    // piši 'L'
    digitalWrite(2, 0);
    digitalWrite(3, 0);
    digitalWrite(4, 0);
    digitalWrite(5, 1);
    digitalWrite(6, 1);
    digitalWrite(7, 1);
    digitalWrite(8, 0);

    digitalWrite(10, 1);
    digitalWrite(11, 1);
    digitalWrite(12, 0);    // Aktivna samo treća znamenka D3
    digitalWrite(13, 1);
    delay(intDelay);
}

```



```

    // piši 'A'
    digitalWrite(2, 1);
    digitalWrite(3, 1);
    digitalWrite(4, 1);
    digitalWrite(5, 0);
    digitalWrite(6, 1);
    digitalWrite(7, 1);
    digitalWrite(8, 1);

    digitalWrite(10, 1);
    digitalWrite(11, 1);
    digitalWrite(12, 1);
    digitalWrite(13, 0);    // Aktivna samo četvrta znamenka D4
    delay(intDelay);
}

```

Zadatak 6. Prethodni zadatak modificiraj tako da dodaš potencijometar na ulaz A0 Arduina pomoću kojeg ćeš regulirati brzinu ispisa slova. Brzinu ispisa treba regulirati u granicama 1 ms do 250 ms.

1. Koje modifikacije u kodu treba napraviti da se dobije čist i stabilan prikaz znamenki?

Zadatak 7. Modificiraj program iz prethodnog zadatka tako da na 4 X 7 segmentnom zaslonu ispisuješ očitanu A/D vrijednost potencijometra priključenog na A0 ulaz.

Kòd zadatka

```

int a = 2;
int b = 3;
int c = 4;
int d = 5;
int e = 6;
int f = 7;
int g = 8;
int p = 9;

int d1 = 10;
int d2 = 11;
int d3 = 12;
int d4 = 13;

int nDelayMicroseconds = 200;

int data;
void setup()
{
    pinMode(A0, INPUT);

    pinMode(d1, OUTPUT);
    pinMode(d2, OUTPUT);
    pinMode(d3, OUTPUT);
}

```

```

pinMode(d4, OUTPUT);

pinMode(a, OUTPUT); //DDR.D.2
pinMode(b, OUTPUT); //DDR.D.3
pinMode(c, OUTPUT); //DDR.D.4
pinMode(d, OUTPUT); //DDR.D.5
pinMode(e, OUTPUT); //DDR.D.6
pinMode(f, OUTPUT); //DDR.D.7

pinMode(g, OUTPUT);
pinMode(p, OUTPUT);

//DDR.D = B11111110;
//DDR.B = B00111111;

Serial.begin(9600);
}

void loop()
{
    int d1, d2, d3, d4;

    data = analogRead(A0);

    d1 = data / 1000 % 10;    // Znamenska tisucice
    d2 = data / 100 % 10;    // Znamenska stotice
    d3 = data / 10 % 10;     // Znamenska desetice
    d4 = data % 10;          // Znamenska jedinice

    Serial.print(data);
    Serial.print("\t");
    Serial.print(d1);
    Serial.print("\t");
    Serial.print(d2);
    Serial.print("\t");
    Serial.print(d3);
    Serial.print("\t");
    Serial.print(d4);
    Serial.print("\n");

    for (int m = 0; m<80; m++) {
        clearLEDs();          //Turn off all LED lights
        pickDigit(1);         //Selection of a digital display
        pickNumber(d1);       //Display digital d1
        delayMicroseconds(nDelayMicroseconds);

        clearLEDs();          //Turn off all LED lights
        pickDigit(2);         //Select the first two digital display
        pickNumber(d2);       //Display digital d2
        delayMicroseconds(nDelayMicroseconds);

        clearLEDs();          //Turn off all LED lights
        pickDigit(3);         //Select the first three digital display
    }
}

```

```

        pickNumber(d3);          //Display digital d3
        delayMicroseconds(nDelayMicroseconds);

        clearLEDs();             //Turn off all LED lights
        pickDigit(4);             //Select the first four digital display
        pickNumber(d4);          //Display digital d4
        delayMicroseconds(nDelayMicroseconds);
    }
}

void pickDigit(int x) //Defined pickDigit (x), whose role is to open the
port dx
{
    digitalWrite(d1, HIGH);
    digitalWrite(d2, HIGH);
    digitalWrite(d3, HIGH);
    digitalWrite(d4, HIGH);
    switch (x)
    {
        case 1:
            digitalWrite(d1, LOW);
            break;
        case 2:
            digitalWrite(d2, LOW);
            break;
        case 3:
            digitalWrite(d3, LOW);
            break;
        default:
            digitalWrite(d4, LOW);
            break;
    }
}

void pickNumber(int x) //Defined pickNumber (x), whose role is to display
digital x
{
    switch (x)
    {
        case 1:
            one();
            break;
        case 2:
            two();
            break;
        case 3:
            three();
            break;
        case 4:
            four();
            break;
        case 5:
            five();
    }
}

```

```

        break;
    case 6:
        six();
        break;
    case 7:
        seven();
        break;
    case 8:
        eight();
        break;
    case 9:
        nine();
        break;
    default:
        zero();
        break;
    }
}

void dispDec(int x)  //Decimal point setting Open
{
    digitalWrite(p, HIGH);
}

void clearLEDs()  //Clear screen
{
    digitalWrite(a, LOW);
    digitalWrite(b, LOW);
    digitalWrite(c, LOW);
    digitalWrite(d, LOW);
    digitalWrite(e, LOW);
    digitalWrite(f, LOW);
    digitalWrite(g, LOW);
    digitalWrite(p, LOW);
}

void zero()  //Define those figures 0 cathode pin switch
{
    digitalWrite(a, HIGH);
    digitalWrite(b, HIGH);
    digitalWrite(c, HIGH);
    digitalWrite(d, HIGH);
    digitalWrite(e, HIGH);
    digitalWrite(f, HIGH);
    digitalWrite(g, LOW);
}

void one()  //Define those figures 1 cathode pin switch
{
    digitalWrite(a, LOW);
    digitalWrite(b, HIGH);
    digitalWrite(c, HIGH);

```

```

    digitalWrite(d, LOW);
    digitalWrite(e, LOW);
    digitalWrite(f, LOW);
    digitalWrite(g, LOW);
}

void two() //Define those figures 2 cathode pin switch
{
    digitalWrite(a, HIGH);
    digitalWrite(b, HIGH);
    digitalWrite(c, LOW);
    digitalWrite(d, HIGH);
    digitalWrite(e, HIGH);
    digitalWrite(f, LOW);
    digitalWrite(g, HIGH);
}

void three() //Define those figures 3 cathode pin switch
{
    digitalWrite(a, HIGH);
    digitalWrite(b, HIGH);
    digitalWrite(c, HIGH);
    digitalWrite(d, HIGH);
    digitalWrite(e, LOW);
    digitalWrite(f, LOW);
    digitalWrite(g, HIGH);
}

void four() //Define those figures 4 cathode pin switch
{
    digitalWrite(a, LOW);
    digitalWrite(b, HIGH);
    digitalWrite(c, HIGH);
    digitalWrite(d, LOW);
    digitalWrite(e, LOW);
    digitalWrite(f, HIGH);
    digitalWrite(g, HIGH);
}

void five() //Define those figures 5 cathode pin switch
{
    digitalWrite(a, HIGH);
    digitalWrite(b, LOW);
    digitalWrite(c, HIGH);
    digitalWrite(d, HIGH);
    digitalWrite(e, LOW);
    digitalWrite(f, HIGH);
    digitalWrite(g, HIGH);
}

void six() //Define those figures 6 cathode pin switch
{
    digitalWrite(a, HIGH);

```

```

    digitalWrite(b, LOW);
    digitalWrite(c, HIGH);
    digitalWrite(d, HIGH);
    digitalWrite(e, HIGH);
    digitalWrite(f, HIGH);
    digitalWrite(g, HIGH);
}

void seven() //Define those figures 7 cathode pin switch
{
    digitalWrite(a, HIGH);
    digitalWrite(b, HIGH);
    digitalWrite(c, HIGH);
    digitalWrite(d, LOW);
    digitalWrite(e, LOW);
    digitalWrite(f, LOW);
    digitalWrite(g, LOW);
}

void eight() //Define those figures 8 cathode pin switch
{
    digitalWrite(a, HIGH);
    digitalWrite(b, HIGH);
    digitalWrite(c, HIGH);
    digitalWrite(d, HIGH);
    digitalWrite(e, HIGH);
    digitalWrite(f, HIGH);
    digitalWrite(g, HIGH);
}

void nine() //Define those figures 9 cathode pin switch
{
    digitalWrite(a, HIGH);
    digitalWrite(b, HIGH);
    digitalWrite(c, HIGH);
    digitalWrite(d, HIGH);
    digitalWrite(e, LOW);
    digitalWrite(f, HIGH);
    digitalWrite(g, HIGH);
}

```