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Lesson plan 1

Aine:	Füüsika/Elektrotehnika		
Teema:	Vahelduvvoolu ahelad		
Tunni pealkiri:	Takisti, pooli ja kondensaatori jadaühendus		
Tase:	4. taseme kutseharidus (sh kutsekeskharidus)	Kestvus:	1 tund/45 minutit
Tunni eesmärgid:			
Õpilane: <ul style="list-style-type: none"> • omandab algteadmised elektriskeemide projekteerimisest ja virtuaalsimulaatorite tööpõhimõttest; • arendab sügavat arusaamist vahelduvvooluahelate kontseptsioonist; • arendab kvalitatiivset ja kvantitatiivset mõtlemisoskust; • arendab andmeanalüüsi oskusi; • omandab simulatsioonivaatlusoskused; • arendab aruande koostamise oskusi. 			
Ülesannete kokkuvõte:			
Ülesande täitmisel õpib: <ol style="list-style-type: none"> 1. tutvub tööjuhendiga, 2. seadistab vooluringi vastavalt skeemile 3. teeb rea virtuaalseid mõõtmisi, mis võimaldavad tal vahelduvvooluahelate teemat tundma õppida ja mõista. 			
Varustus:			
Falstad on tasuta JavaScriptil põhinev rakendus, mis töötab lubatud veebibrauseris ja võimaldab kasutajal lihtsalt ja lihtsalt simuleerida erinevaid elektriskeeme. Ülesannete täitmiseks on vaja Interneti-toega seadet, näiteks arvutit, MAC-i, tahvelarvutit või nutitelefoni.			



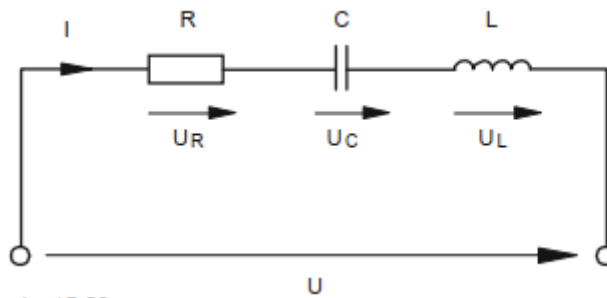
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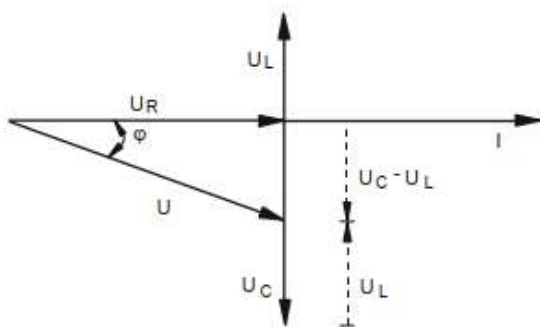
Takisti, kondensaatori ja mähise seeriaühendus

Põhitõed

Kui vahelduvpinge rakendatakse takisti, kondensaatori ja mähise jadaühendusele, kannab iga komponent sama voolu. Pinge U_R on faasis vooluga I . Pinged U_R , U_C , U_L ja U on faasinihked. Takistid käituvad vastavalt pingetele, vaata pilti. 2 ja 3.

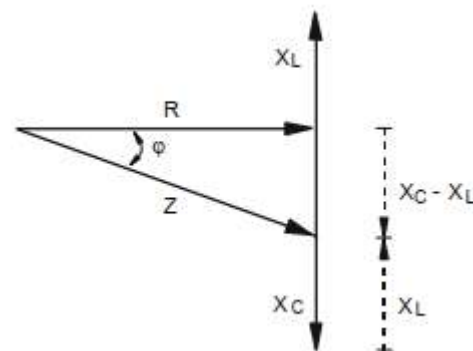


pic. 1



pic. 2

Pingete osuti diagramm ($U_C > U_L$)



pic. 3

Takistite ($X_C > X_L$) osuti diagramm

U_R = efektiivne pinge V
 U_L = reaktiivpinge (induktiivne),
 pooli pinge V
 U_C = reaktiivpinge (mahtuvuslik),
 kondensaatori pinge
 U = näivpinge,
 kogupinge V
 I = vool A-s
 φ = faasinihke nurk ° (kraadides)

X_L = reaktants (induktiivne),
 pooli takistus Ω -des
 X_C = reaktants (mahtuvuslik),
 kondensaatori takistus Ω -des
 R = efektiivne takistus Ω -des
 Z = näivtakistus Ω -des

Osutidiagrammid näitavad juhtumit, kui pinge U_C vastav takisti X_C on kõrgem kui pinge U_L , vastav takisti X_L , tähendab, et domineerib mahtuvuslik osa.

Pinge U on efektiivsest pingest U_R tagapool. Kui domineerib induktiivne osa ($U_L > U_C$), on olukord vastavalt vastupidine. Kui induktiivne osa on võrdne mahtuvusliku osaga,

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neutraliseerivad nad üksteist 180° faasinihke tõttu. Sel juhul on pinge U võrdne efektiivse pingega U_R ja näivtakistus Z on võrdne efektiivse takistusega R .

Allpool on valemid mõnede parameetrite arvutamiseks takisti, mähise ja kondensaatori jadaühenduses:

näivpinge U

$$U = \sqrt{U_R^2 + (U_L - U_C)^2} = Z \times I,$$

näivtakistus

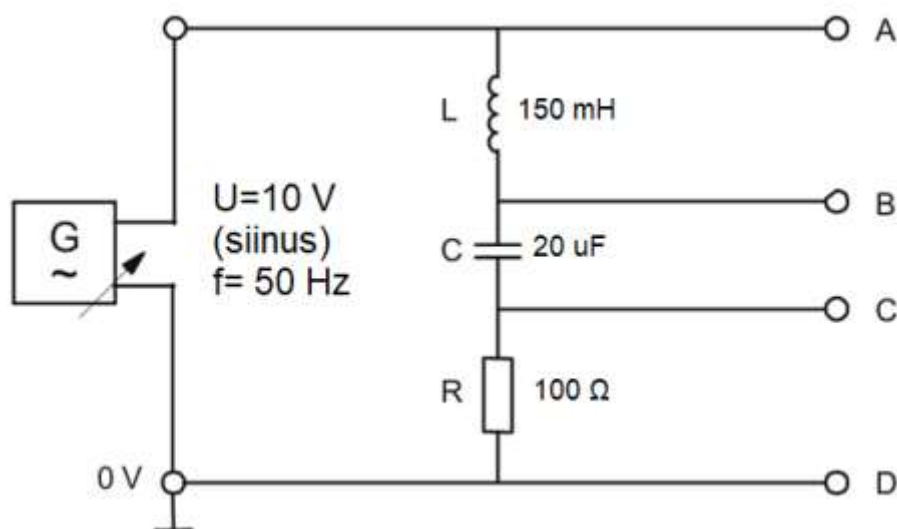
$$Z = \sqrt{R^2 + (X_L - X_C)^2} = \frac{U}{I}$$

faasinurga φ tangens

$$\tan\varphi = \frac{U_L - U_C}{U_R} = \frac{X_L - X_C}{R}$$

Mõõtmine

Ava <https://www.falstad.com/circuit/> ning koosta joonisel toodud skeem.



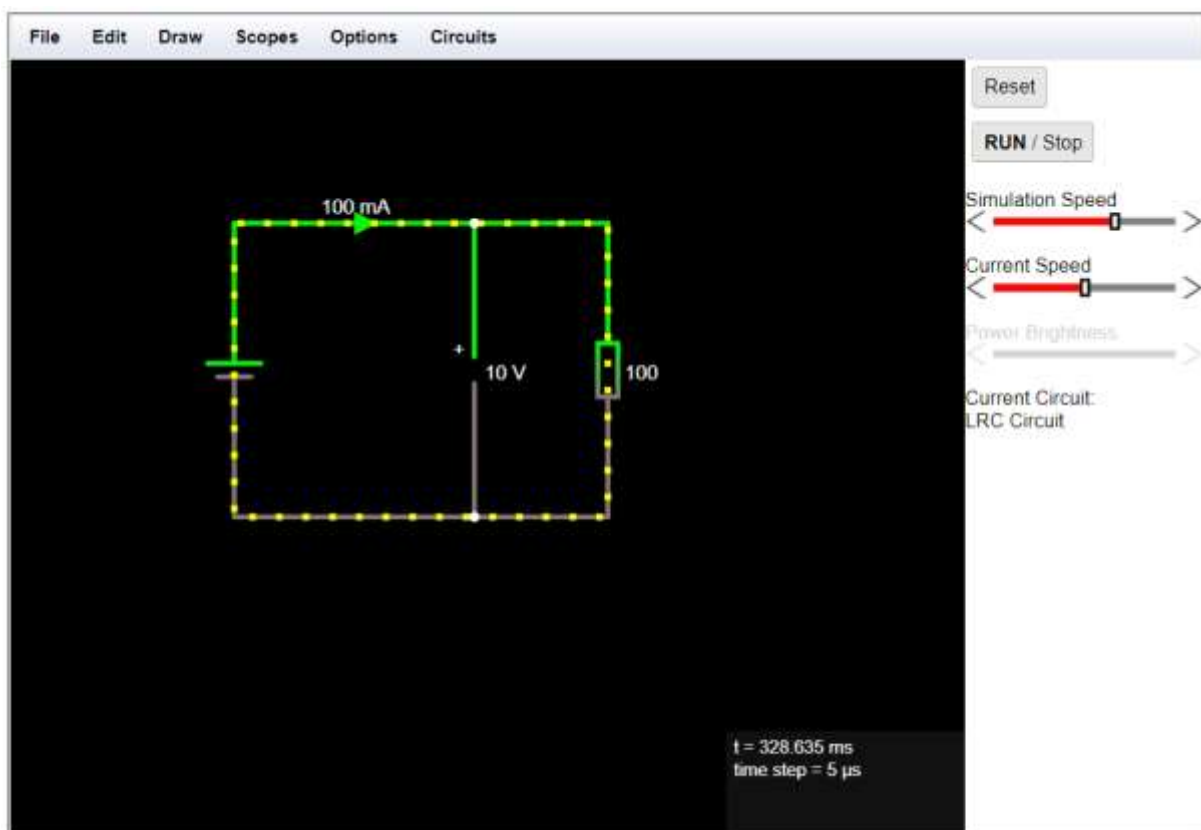


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Vajalikud komponendid leiad menüüst Draw.

- Ühendusjuhe
 - Draw > Add Wire (kiirklahv w)
- Alalisvoolu toiteallikas:
 - Draw > Inputs and Sources > Add Voltage Source (2-terminal)
- Takisti:
 - Draw > Add Resistor (kiirklahv r)
- Ampermeeter:
 - Draw > Outputs and Lables > Add Ammeter
- Voltmeeter:
 - Draw > Outputs and Lables > Add Voltmeter/Scope Probe



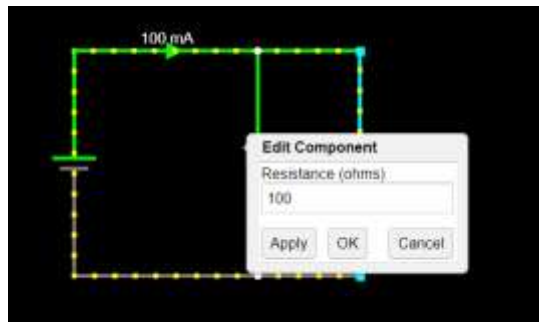


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Vooluringi pingestamiseks vajuta nuppu „RUN/Stop“.

Komponendi parameetrite muutmiseks tee komponendil toplektklikk.



Käivita simulatsioon ning määrä järgmised suurused:

1. Pinge induktiivpoolil U_L ehk punktide A ja B vaheline pinge

$$U_L = \boxed{}$$

2. Pinge kondensaatoril U_C ehk punktide B ja C vaheline pinge

$$U_C = \boxed{}$$

3. Pinge aktiivtakistil U_R ehk punktide C ja D vaheline pinge

$$U_R = \boxed{}$$

Saadud andmete põhjal arvuta kogupinge U :

$$U = \sqrt{U_R^2 + (U_L - U_C)^2} =$$

Kas arvutatud väärtus on võrdne ahelale rakendatud pingega?

--

Arvuta:

1. Period T

$$T = \frac{1}{f} = \underline{\hspace{2cm}} \text{ s}$$

- ## 2. Faasinihkenurk φ



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$$\cos\varphi = \frac{U_R}{U} = \underline{\hspace{2cm}}$$

$$\varphi = \underline{\hspace{2cm}}^\circ$$

Lesson plan 1

Subject:	Physics/Electrical Engineering		
Topic:	AC circuits		
Lesson Title:	Series Connection of Resistor, Capacitor and Coil		
Level:	4. level vocational education (incl. vocational secondary education)	Duration:	1 lesson/45 min
Lesson Objectives:			
The student: <ul style="list-style-type: none"> • acquires basic knowledge of electrical circuit design and the principle of operation of virtual simulators; • develops a deeper understanding of the concept of AC power circuits; • develops qualitative and quantitative thinking skills; • develops data analysis skills; • acquires simulation observation skills; • develops report preparation skills. 			
Summary of Tasks:			
During performing of the task, the student will: <ol style="list-style-type: none"> 1. familiarize himself with the task manual, 2. sets up the circuit according to the circuit diagram 3. makes a series of virtual measurements, which will allow him to get to know and understand the topic of alternating current circuits. 			
Equipment:			
Falstad is a free JavaScript-based application that works in an enabled Web browser and allows the user to simply and easily simulate various electrical circuits. For completing the tasks the Internet-enabled device such as a PC, MAC, tablet PC, or Smartphone is needed.			

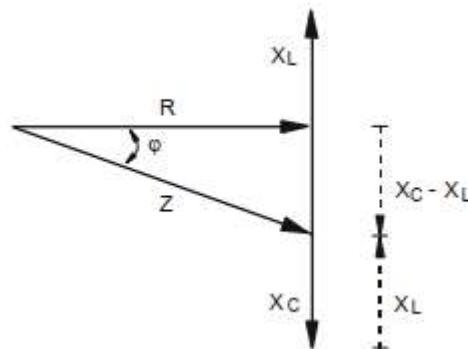
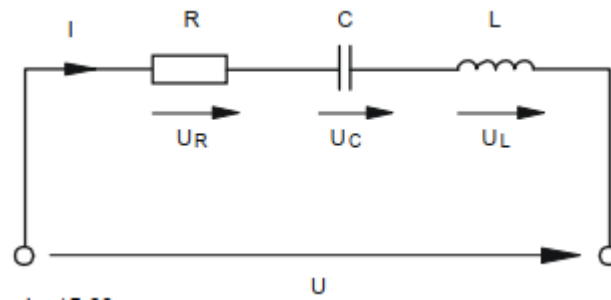
Series Connection of Resistor, Capacitor and Coil

Basics

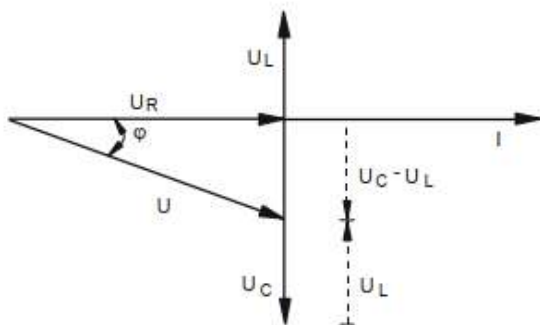
If AC voltage is applied to a series connection of resistor, capacitor and coil, each component carries the same current. Voltage U_R is in phase with current I . Voltages U_R , U_C , U_L and U are phase shifted. The resistors behave according to the voltages, see pic. 2 and 3.



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pic. 1



The pointer diagrams show the case in which voltage U_C respective resistor X_C is higher than voltage U_L respective resistor X_L , means capacitive portion predominates.

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Voltage U is behind the effective voltage U_R . If inductive portion ($U_L > U_C$) predominates the situation is respectively opposed. If the inductive portion is equal to the capacitive portion, they neutralize each other due to the phase shifting of 180° . In this case, voltage U is equal to the effective voltage U_R and apparent resistance Z is equal to effective resistance R .

Below are formulas for the calculation of some parameters within a series connection of resistor, coil and capacitor:

apparent voltage U

$$U = \sqrt{U_R^2 + U_L^2 - U_C^2} = Z \times I,$$

apparent resistance

$$Z = \sqrt{R^2 + X_L^2 - X_C^2} = U/I$$

tangent of phase shift angle φ

$$\tan \varphi = \frac{U_L - U_C}{U_R} = \frac{X_L - X_C}{R}$$

Tests

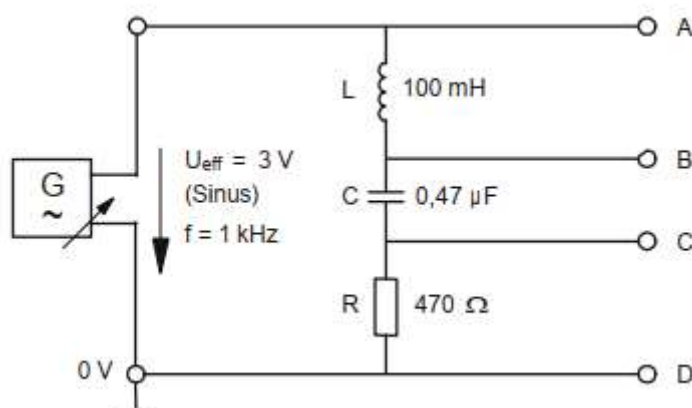
Measure the voltages U_L , U_C and U_R within a series connection of resistor, capacitor and coil. Determine if total voltage U is in front or behind U_R . Measure with your oscilloscope the phase shift angle φ .

Test proceeding

Open <https://www.falstad.com/circuit/> and Set up the circuit according to pic 4 and connect the function generator with following voltage:

$$U_{\text{eff}} = 3 \text{ V (sinus)}, f = 1 \text{ kHz}.$$

The right components are found in the menu Draw.



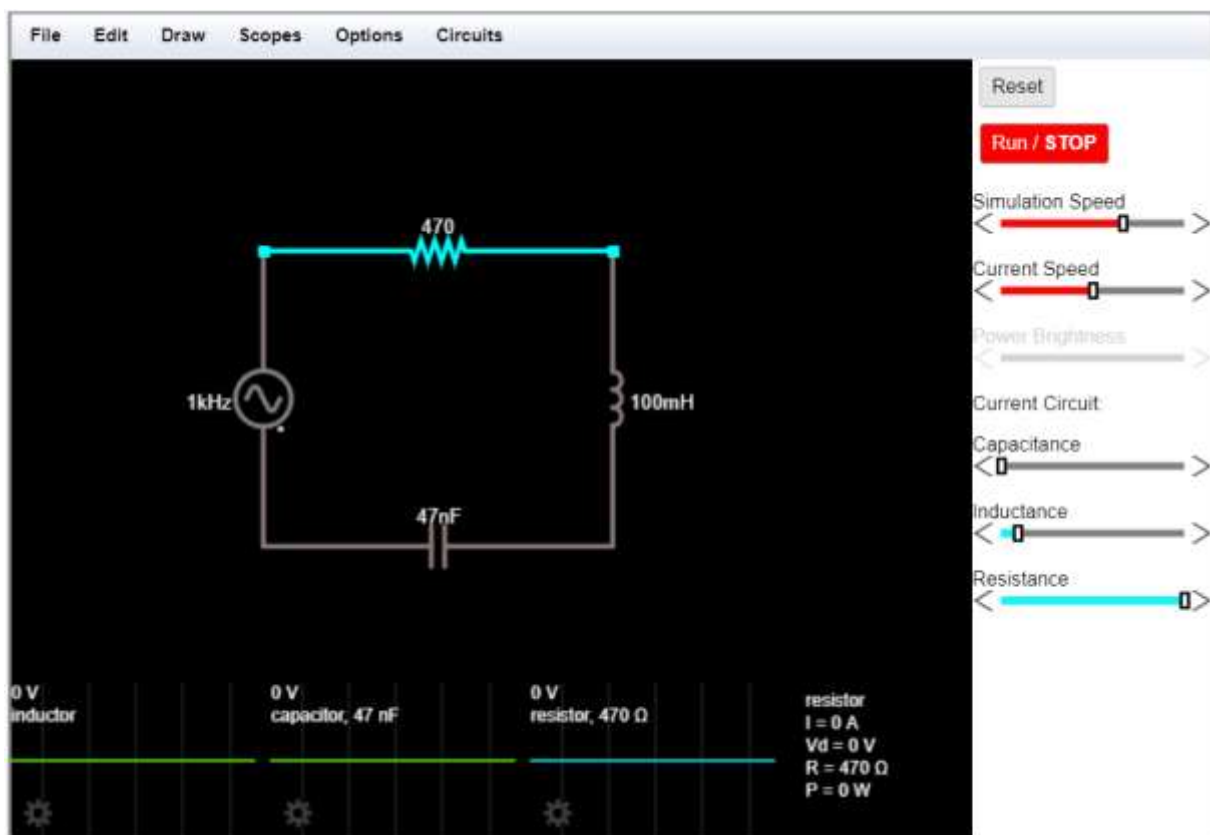
- Connection wire



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- Draw > Add Wire (shortcut w)
- AC source:
 - Draw > Inputs and Sources > Add A/C Voltage Source (2-terminal)
- Resistor:
 - Draw > Add Resistor (shortcut r)
- Coil:
 - Draw > Passive Components > Add Inductor (shortcut L)
- Capacitor:
 - Draw > Passive Components > Add Capacitor (shortcut c)



When the applet starts up you will see an animated schematic of a simple LRC circuit.

- The green color indicates positive voltage.
- The gray color indicates ground.
- A red color indicates negative voltage.
- The moving yellow dots indicate current.

If you move the mouse over any component of the circuit, you will see a short description of that component and its current state in the lower right corner of the window.

To modify a component, move the mouse over it, click the right mouse button and select "Edit".

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Start the simulator and measure:

1. Coil voltage U_L (Measuring points A ja B)

$$U_L = \boxed{}$$

2. **Capacitor voltage** U_C (measuring points B - C)

$$U_C = \boxed{}$$

3. **Effective Voltage** U_R (measuring points C - D)

$$U_R = \boxed{}$$

Calculate the apparent voltage from the data obtained U :

$$U = \sqrt{U_R^2 + U_L^2 + U_C^2} = \boxed{}$$

Is the calculated value equal to the voltage applied to the circuit?

Calculate:

1. **Cycle time** T

$$T = 1/f = \underline{\hspace{2cm}} \text{ s}$$

2. **Phase shift angle**

$$\cos \varphi = \frac{U_R}{U} = \underline{\hspace{2cm}}$$

$$\varphi = \underline{\hspace{2cm}}^\circ$$

Take a screenshot of your circuit and insert in the box below.



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Lesson plan 2

Aine:	Füüsika/Elektrotehnika		
Teema:	Vahelduvvoolu ahelad		
Tunni pealkiri:	Takisti, pooli ja kondensaatori rööpühendus		
Tase:	4. taseme kutseharidus (sh kutsekeskharidus)	Kestvus:	1 tund/45 minutit
Tunni eesmärgid:			
Õpilane: <ul style="list-style-type: none"> • omandab algteadmised elektriskeemide projekteerimisest ja virtuaalsimulaatorite tööpõhimõttest; • arendab sügavamat arusaamist vahelduvvooluahelate kontseptsioonist; • arendab kvalitatiivset ja kvantitatiivset mõtlemisoskust; • arendab andmeanalüüsi oskusi; • omandab simulatsioonivaatlusoskused; • arendab aruande koostamise oskusi. 			
Ülesannete kokkuvõte:			
Ülesande täitmisel õpib: <ol style="list-style-type: none"> 1. tutvub tööjuhendiga, 2. seadistab vooluringi vastavalt skeemile 3. teeb rea virtuaalseid mõõtmisi, mis võimaldavad tal vahelduvvooluahelate teemat tundma õppida ja mõista. 			
Varustus:			
Falstad on tasuta JavaScriptil põhinev rakendus, mis töötab lubatud veebibrauseris ja võimaldab kasutajal lihtsalt ja lihtsalt simuleerida erinevaid elektriskeeme. Ülesannete täitmiseks on vaja Interneti-toega seadet, näiteks arvutit, MAC-i, tahvelarvutit või nutitelefoni.			

Takisti, kondensaatori ja mähise rööpühendus

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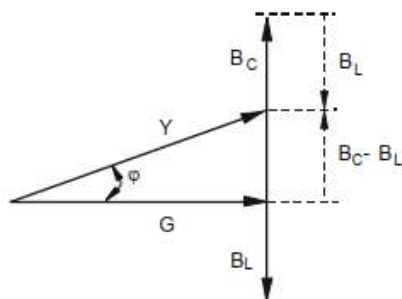
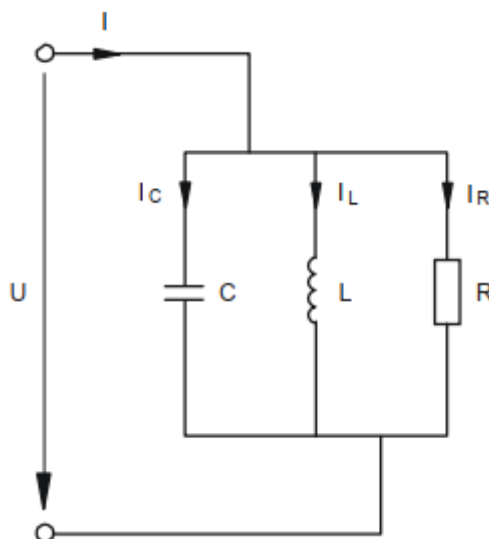


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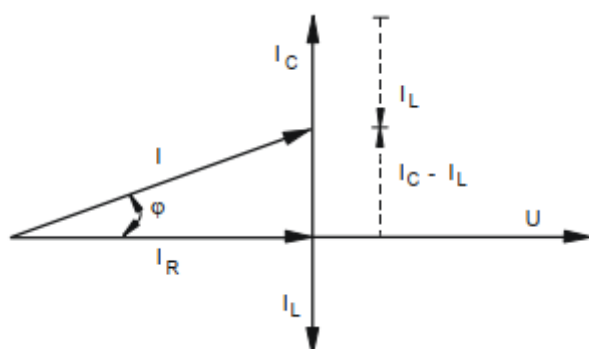


Põhitõed

Kui siinuslaine vahelduvpinge rakendatakse takisti, kondensaatori ja mähise paralleelühendusele, on igal komponendil sama pinge. Koguvool I jaguneb efektiivseks vooluks I_R , kondensaatori vooluks I_C ja mähisvooluks I_L . Mähise reaktantsi X_L ja kondensaatori X_C reaktantsi tõttu toimub voolude I_L , I_C , I_R ja I vahel faasinihe. (vt osuti pilti 1)



pic. 1





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Praegune IC on pidevalt 90° IR-st ees, praegune IL aga pidevalt 90° efektiivsest praegusest IR-st tagapool. See tähendab, et voolud IC ja IL on parafaasitud (180°) ja neutraliseerivad üksteist osaliselt või täielikult.

Kui $IC = IL$, neutraliseerivad mõlemad voolud üksteist, koguvool I on faasis ja väärtus on võrdne efektiivse vooluga IR (resonants).

Kui domineerib mahtuvuslik vool $IC > IL$, on koguvool I efektiivsest IR-st ees.

Kui domineerib $IC < IL$ induktiivne vool, jääb koguvool I alla efektiivse voolu IR.

Osuti diagrammid on tingimusel, et $IC > IL$ ja $BC > BL$.

Valemid parameetrite arvutamiseks, kui R, L ja C on järjestikku ühendatud:

vool I

$$I = \sqrt{I_R^2 + I_L - I_C^2} = Z \times I,$$

näivjuhtivus Y

$$Y = G^2 + BL - BC^2$$

faasinihe φ

$$\tan \varphi = I_L - I_C / I_R = BL - BCG$$

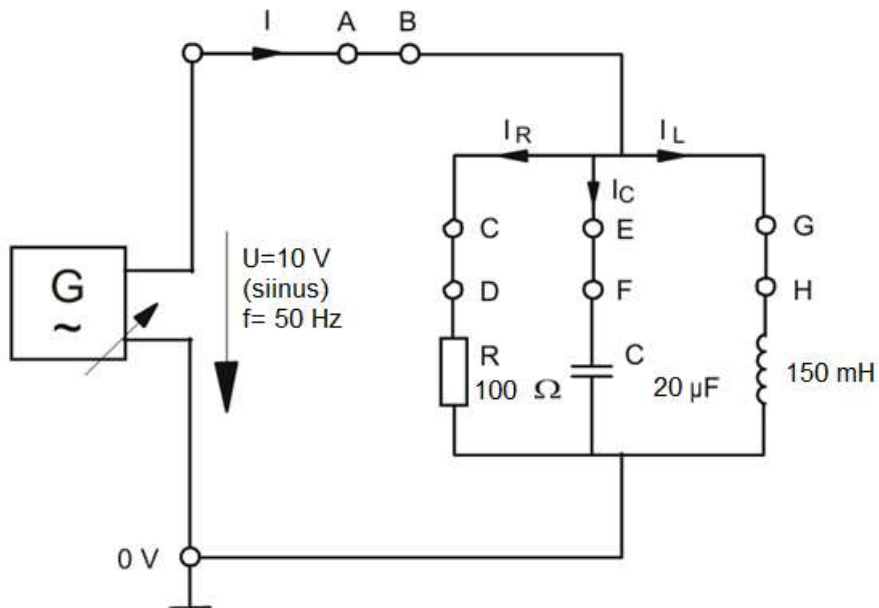
Mõõtmine

Ava <https://www.falstad.com/circuit/> ning koosta joonisel toodud skeem.

Ühenda punktide A ja B vahele 1Ω takisti.



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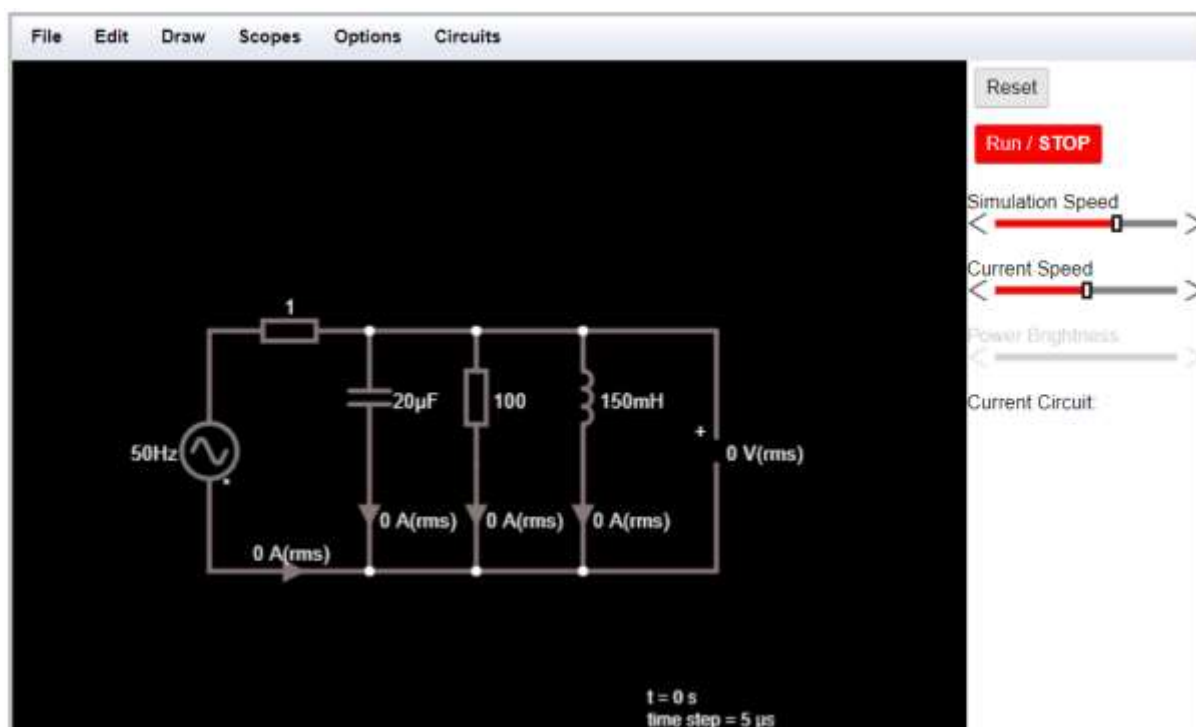


Vajalikud komponendid leiad menüüst Draw.

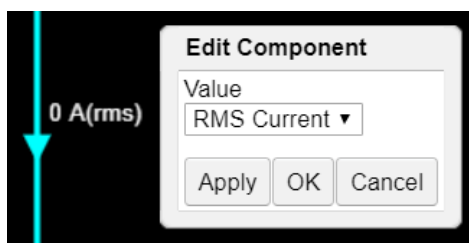
- Ühendusjuhe
 - Draw > Add Wire (kiirklahv w)
- Vahelduvvoolu toiteallikas:
 - Draw > Inputs and Sources > Add A/C Voltage Source (2-terminal)
- Takisti:
 - Draw > Add Resistor (kiirklahv r)
- Induktiivpool:
 - Draw > Passive Components > Add Inductor (kiirklahv L)
- Kondensaator:
 - Draw > Passive Components > Add Capacitor (kiirklahv c)
- Ampermeeter
 - Draw > Outputs and Lables > Add Ammeter
- Voltmeeter:
 - Draw > Outputs and Lables > Add Voltmeter/Scobe Probe



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Voolu ja pine efektiivväärtuse mõõtmiseks kliki kaks korda ampermeetri tingmärgil ning vali RMS Current.



Käivita simulatsioon ning määra järgmised suurused:

1. Ahela vool I

$$I = \boxed{} \text{ A}$$

2. Takistit läbiv vool I_R

$$I_R = \boxed{} \text{ A}$$

3. Kondensaatorit läbiv vool I_C

$$I_C = \boxed{} \text{ A}$$

4. Induktiivpooli läbiv vool I_L

$$I_L = \boxed{} \text{ A}$$

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Saadud andmete põhjal arvuta ahela vool I:

$$I = I_{R2} + I_L - I_{C2} = \boxed{}$$

Kas arvutatud väärtus on võrdne simulatsioonis mõõdetud väärtusega?

Arvuta:

1. Periood T

$$T = 1/f = \text{_____ s}$$

2. Faasinihkenurk

$$\cos\varphi = I_{RI} = \text{_____}$$

$$\varphi = \text{_____}^\circ$$

Koostatud skeemi kuvatõmmis

Lesson plan 2

Subject:	Physics/Electrical Engineering		
Topic:	AC circuits		
Lesson Title:	Pararell Connection of Resistor, Capacitor and Coil		
Level:	4. level vocational education (incl. vocational secondary education)	Duration:	1 lesson/45 min
Lesson Objectives:			

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The student:

- acquires basic knowledge of electrical circuit design and the principle of operation of virtual simulators;
- develops a deeper understanding of the concept of AC power circuits;
- develops qualitative and quantitative thinking skills;
- develops data analysis skills;
- acquires simulation observation skills;
- develops report preparation skills.

Summary of Tasks:

During performing of the task, the student will:

1. familiarize himself with the task manual,
2. sets up the circuit according to the circuit diagram
3. makes a series of virtual measurements, which will allow him to get to know and understand the topic of alternating current circuits.

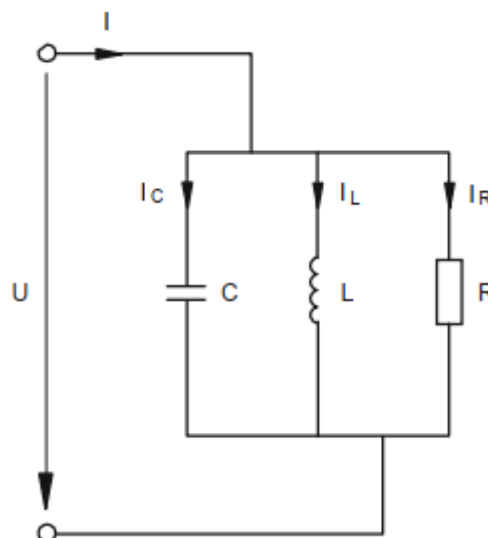
Equipment:

Falstad is a free JavaScript-based application that works in an enabled Web browser and allows the user to simply and easily simulate various electrical circuits. For completing the tasks the Internet-enabled device such as a PC, MAC, tablet PC, or Smartphone is needed.

Series Connection of Resistor, Capacitor and Coil

Basics

If sine-wave AC voltage is applied to a parallel connection of resistor, capacitor and coil, each component carries the same voltage. Total current I is divided in effective current I_R , capacitor current I_C and coil current I_L . Due to reactance X_L of the coil and X_C of the capacitor, there is phase shifting between the currents I_L , I_C , I_R and I . (see pointer pic. 1)

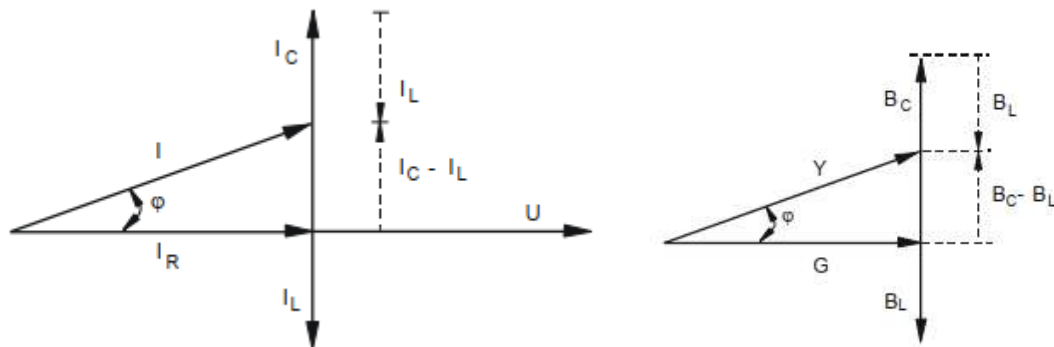




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pic. 1



Current I_C is constantly 90° ahead of I_R , current I_L , however, is constantly 90° behind effective current I_R . That means the currents I_C and I_L are paraphased (180°) and neutralize each other partial or total.

When $I_C = I_L$ the both currents neutralize each other, total current I is in phase and value equal to the effective current I_R (resonance).

When $I_C > I_L$ capacitive current predominates, the total current I is ahead of effective current I_R .

When $I_C < I_L$ inductive current predominates, the total current I is behind the effective current I_R .

The pointer diagrams are under condition that $I_C > I_L$ and $B_C > B_L$.

Formulas for the calculation of the parameters when R, L and C are connected in series:

apparent current I

$$I = \sqrt{I_R^2 + I_L^2 - I_C^2} = Z \times I_R$$

apparent conductance Y

$$Y = \sqrt{G^2 + B_L^2 - B_C^2}$$

tangent of phase shift angle φ

$$\tan \varphi = \frac{I_L - I_C}{I_R} = \frac{B_L - B_C}{G}$$

Tests

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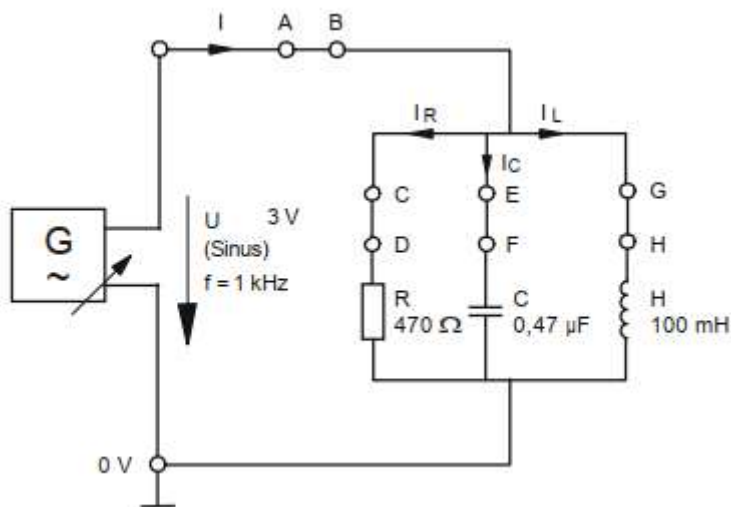
Measure currents I_L , I_C and I_R in a parallel connection of resistor, capacitor and coil. Then determine the phase shift angle φ and draw the pointer diagrams for currents and conductances.

Test proceeding

Open <https://www.falstad.com/circuit/> and Set up the circuit according to pic 4 and connect the function generator with following voltage:

$U_{\text{eff}} = 3 \text{ V}$ (sinus), $f = 1 \text{ kHz}$.

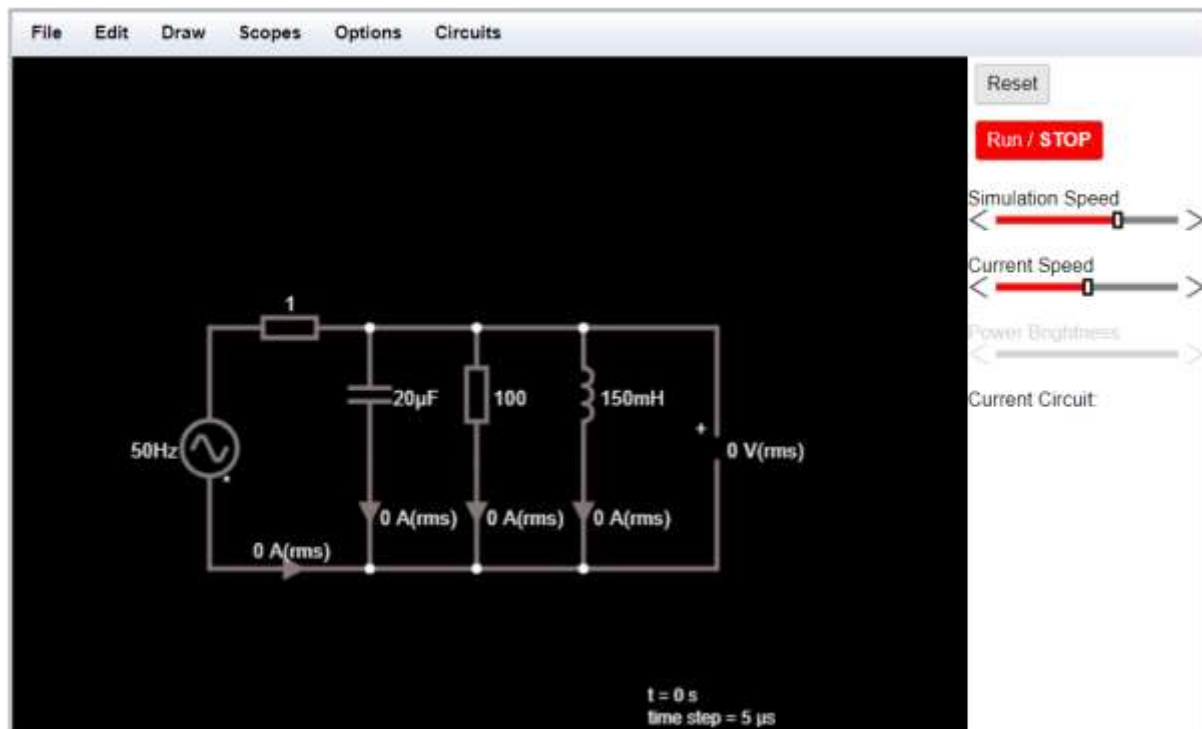
The right components are found in the menu Draw.



- Connection wire
Draw > Add Wire (shortcut w)
- AC source:
Draw > Inputs and Sources > Add A/C Voltage Source (2-terminal)
- Resistor:
Draw > Add Resistor (shortcut r)
- Coil:
Draw > Passive Components > Add Inductor (shortcut L)
- Capacitor:
 - Draw > Passive Components > Add Capacitor (shortcut c)



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When the applet starts up you will see an animated schematic of a simple LRC circuit.

- The green color indicates positive voltage.
- The gray color indicates ground.
- A red color indicates negative voltage.
- The moving yellow dots indicate current.

If you move the mouse over any component of the circuit, you will see a short description of that component and its current state in the lower right corner of the window.

To modify a component, move the mouse over it, click the right mouse button and select “Edit”.

Start the simulator and measure:

1. **Total current I** (measuring points A - B))

$$I = \boxed{}$$

2. **Effective current I_R** (measuring points C - D)

$$I_R = \boxed{}$$

3. **Capacitor current I_C** (measuring points E - F)

$$I_C = \boxed{}$$

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4. Coil current I_L (measuring points G - H)

$$I_L = \boxed{}$$

5. phase shift angle φ

$$\tan \varphi = I_L - I_C / R = ___ - ______$$

Calculate the apparent current from the data obtained I:

$$I = \sqrt{I_R^2 + I_C^2} = \boxed{}$$

Is the calculated value equal to the voltage applied to the circuit?

Calculate:

1. reactive conductance (capacitive) B_C

$$B_C = \omega C = ______$$

2. reactive conductance (inductive) B_L

$$B_L = 1/\omega \times L = ______$$

3. effective conductance G

$$G = 1/R = ______$$

4. apparent conductance Y

$$Y = \sqrt{G^2 + B_L^2 - B_C^2} = ______$$

Take a screenshot of your circuit and insert in the box below.



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Lesson plan

Aine:	Microprocessor technology		
Teema:	Basics of Arduino		
Alateema:	Flashing LED		
Tase:	4. level vocational education (incl. vocational secondary education)	Duration:	1 lesson/45 min
Tunni eesmärk:			
Õpilane: <ul style="list-style-type: none"> • omandab algteadmised elektriskeemide projekteerimisest ja programmeeritava mikrokontrolleri tööpõhimõttest; • arendab sügavamalt arusaamist mikroprotsessorite mõistest; • arendab kvalitatiivset ja kvantitatiivset mõtlemisoskust; • arendab andmeanalüüsi oskusi; • omandab simulatsioonivaatlusoskused; • arendab aruande koostamise oskusi. 			
Kokkuvõte:			
Ülesande täitmisel õpib: <ol style="list-style-type: none"> 1. tutvuma tööjuhendiga, 2. seadistab vooluringi vastavalt skeemile 3. kirjutab ülesande kirjelduse järgi koodi. 			
Varustus:			
<ul style="list-style-type: none"> • Windowsi põhinev arvuti • Arduino UNO stardikomplekt • Arduino IDE 			

Arduino programmeerimine

Põhitõed

Arduino Uno on mikrokontrolleri plaat, mis põhineb ATmega328P-l. Sellel on 14 digitaalset sisend/väljundviiku (6), 6 analoogsisendit (5), 16 MHz keraamiline resonaator, USB-ühendus (2), toitepesa (1), ICSP päis ja lähtestusnupp (3).

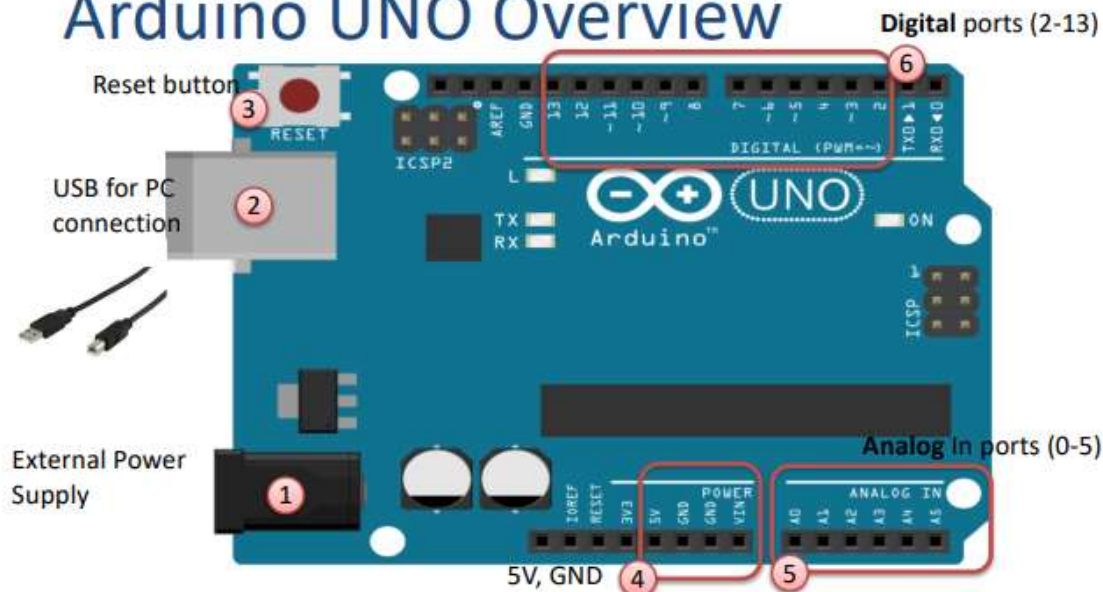
Arduino plaat on ühendatud arvutiga USB kaudu, kus see ühendub Arduino arenduskeskkonnaga (IDE). Kasutaja kirjutab IDE-sse Arduino koodi, seejärel laadib selle üles mikrokontrollerisse, mis käivitab koodi, toimides sisendite ja väljunditega, nagu andurid, mootorid ja tuled.



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Arduino UNO Overview



pic. 1 Overview Arduino UNO

Ülesande kirjeldus

Selle ülesande eesmärk on luua ahel, mis rakendab ja katkestab pidevalt ühe valgusdiodi võimsust.

Varustus

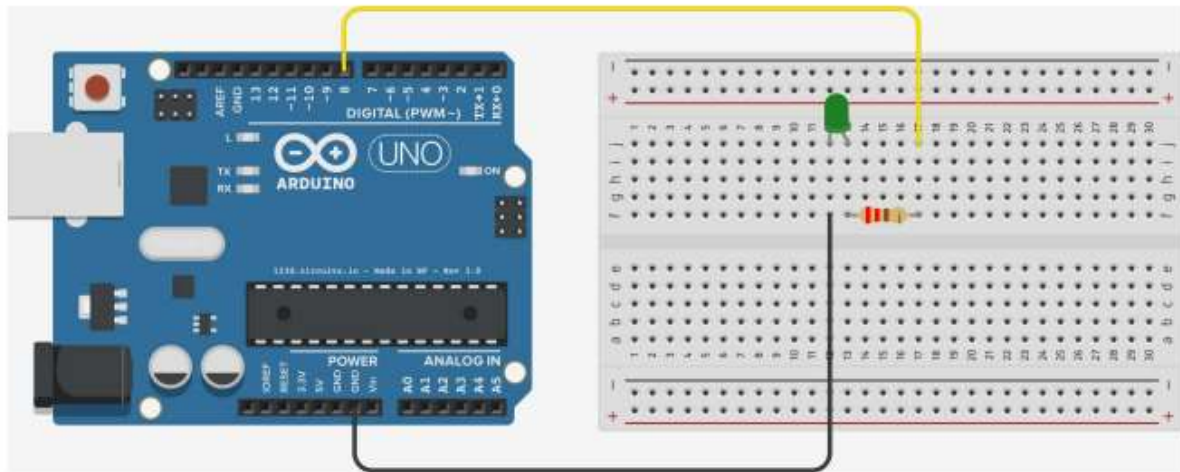
- Arduino UNO
- Breadboard
- LED
- 270 Ω takisti
- Jumperjuhtmed

Ühendamine

Koosta näite järgi skeem:



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pic. 2 Wiring diagram

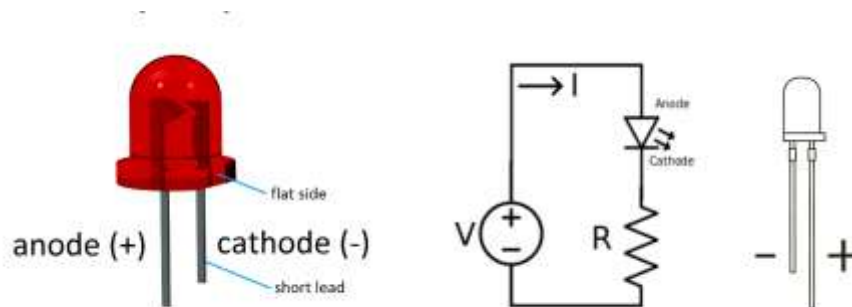
Skeemi ja komponentide kirjeldus

Valgusdiood (LED)

Valgusdiood (LED) on pooljuhtvalgusallikas, mis kiirgab valgust, kui seda läbib vool. Sellel on kaks tihvti. Toiteallika positiivne klemm on ühendatud anoodiga ja negatiivne klemm on ühendatud katoodiga.



pic. 3 LED symbol



pic. 4 LED and example of a circuit.

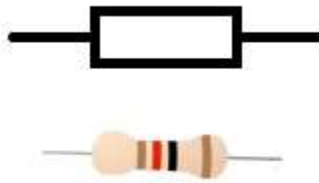
Takisti

Takisti on passiivne elektrikomponent, mis tekitab takistuse elektrivoolu voolus. Peaaegu kõigis elektrivõrkudes ja elektroonikaahelates võib neid leida. Takistust mõõdetakse oomides (Ω).

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pic. 5 IEC resistor symbol and a resistor

Programmeerimine

Programmi struktuur:

```
//Globale variable
...

void setup()
{
    //Initialization
}

void loop()
{
    //Main Program
}
```

Kasuta:

pinMode(pin, mode);

Kus:

- pin kirjeldab, millist tihvti kasutatakse (ülal näites digitaalne viik 8),
- režiim kirjeldab digitaalse viigu funktsiooni. See võib olla kas SISEND või VÄLJUND. Kuna seda kasutatakse LED-i sisselülitamiseks, tuleks see seada asendisse OUTPUT.

digitalWrite(pin, value);

Kus:

- Digitaalviigul võib olla 2 väärtust, kas HIGH (LED sees) või LOW (LED väljas).

delay(ms);

- Funktsioon delay() teeb väikese pausi millisekundites (ms), nt. delay(1000) peatab programmi 1 sekundiks

NÄIDE

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```
void setup()
{
  pinMode(8, OUTPUT);
}

void loop()
{

  digitalWrite(8, HIGH);    // Turn on the LED
  delay(1000);              // Wait for one second
  digitalWrite(8, LOW);     // Turn off the LED
  delay(1000);              // Wait for one second
}
```



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Lesson plan 3

Subject:	Microprocessor technology		
Topic:	Basics of Arduino		
Lesson Title:	Flashing LED		
Level:	4. level vocational education (incl. vocational secondary education)	Duration:	1 lesson/45 min
Lesson Objectives:			
The student: <ul style="list-style-type: none"> • acquires basic knowledge of electrical circuit design and the principle of operation programmable microcontroller; • develops a deeper understanding of the concept microprocessors; • develops qualitative and quantitative thinking skills; • develops data analysis skills; • acquires simulation observation skills; • develops report preparation skills. 			
Summary of Tasks:			
During performing of the task, the student will: <ol style="list-style-type: none"> 1. familiarize himself with the task manual, 2. sets up the circuit according to the circuit diagram 3. writes a code according to the task description. 			
Equipment:			
<ul style="list-style-type: none"> • Windows based PC • Arduino UNO Starter Kit • Arduino IDE 			

Programming of Arduino

Basics

Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (6), 6 analog inputs (5), a 16 MHz ceramic resonator, a USB connection (2), a power jack (1), an ICSP header and a reset button (3).

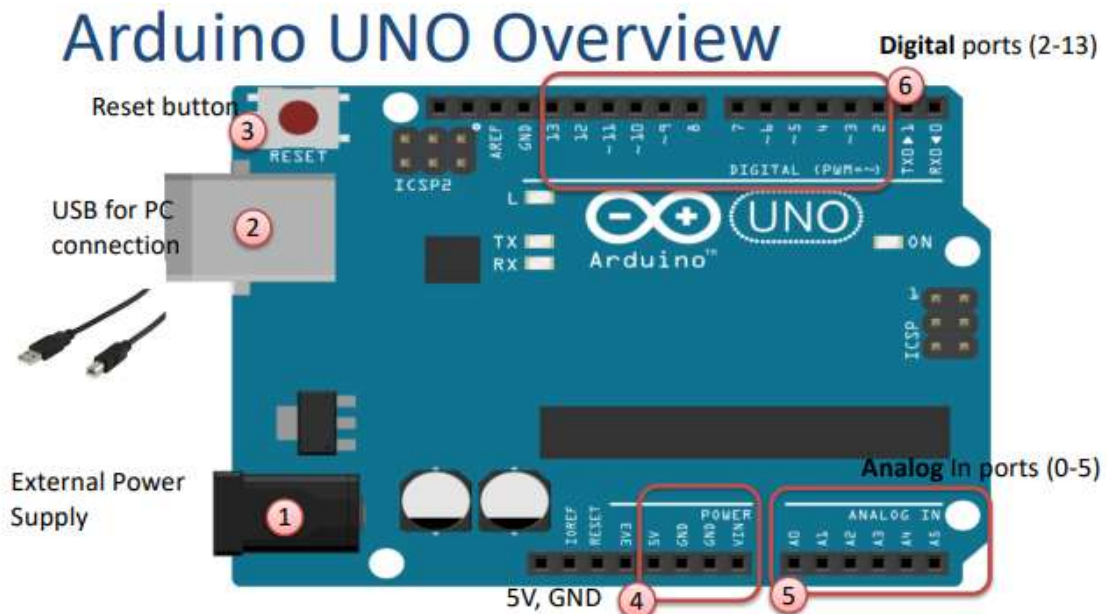
The Arduino board is connected to a computer via USB, where it connects with the Arduino development environment (IDE). The user writes the Arduino code in the IDE, then uploads it to



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the microcontroller which executes the code, interacting with inputs and outputs such as sensors, motors, and lights.



pic. 1 Overview Arduino UNO

Task description

The objective of this task is to make a circuit that continuously applies and interrupts power of one light-emitting diode.

Equipment

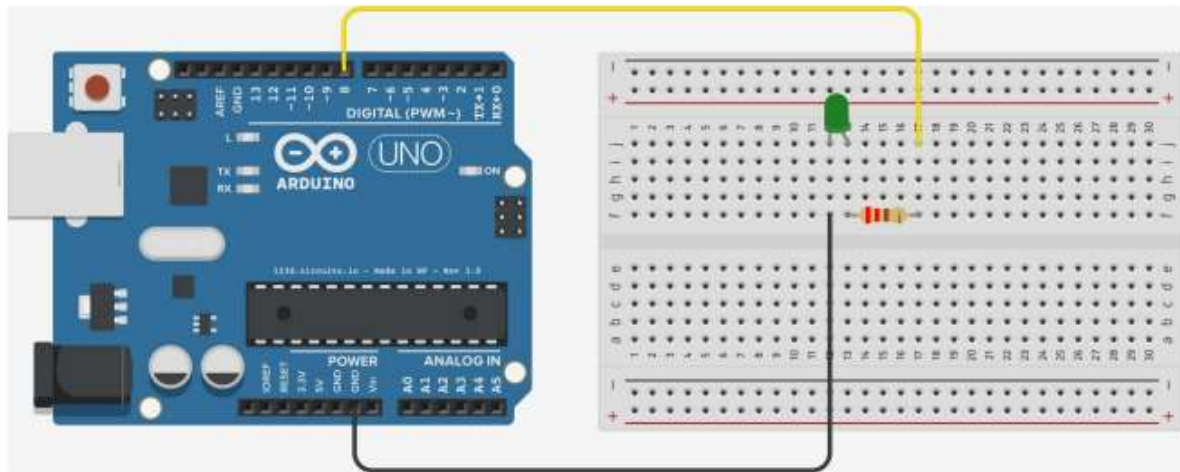
- Arduino UNO
- Breadboard
- LED
- 270 Ω resistor
- Jumper wires

Wiring

Assemble the circuit according to the diagram below:



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pic. 2 Wiring diagram

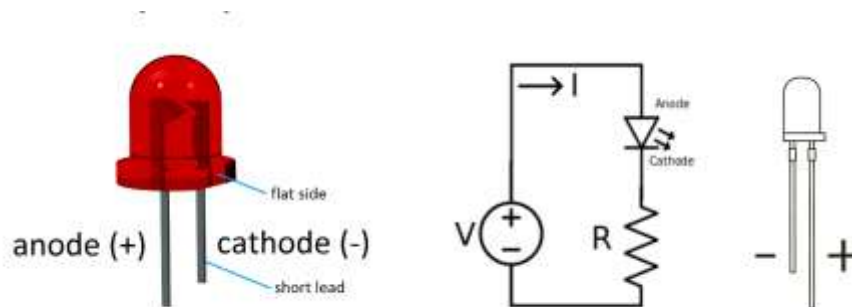
Wiring diagram and components description

LED

A light-emitting diode (LED) is a semiconductor light source that emits light when current flows through it. It has two pins. The positive terminal of a power source is connected to the anode and the negative terminal is connected to the cathode.



pic. 3 LED symbol



pic. 4 LED and example of a circuit.

Resistor

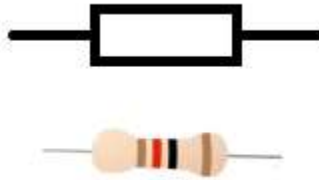
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A resistor is a passive electrical component that creates resistance in the flow of electric current. In almost all electrical networks and electronic circuits, they can be found. The resistance is measured in ohms (Ω).



pic. 5 IEC resistor symbol and a resistor

Programming

Program structure:

```
//Globale variable
...

void setup()
{
    //Initialization
}

void loop()
{
    //Main Program
}
```

Use following:

pinMode(pin, mode);

Where:

- pin describes which pin is used (digital pin 8 in example above),
- mode describes the function of the digital pin. It can be either an INPUT or an OUTPUT. Since it shall be used to turn-on a LED, it should be set to OUTPUT.

digitalWrite(pin, value);

Where:

- Digital pin can have 2 values, either HIGH (LED on) or LOW (LED off).

delay(ms);

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- The `delay()` function make a small pause in milliseconds (ms), e.g., `delay(1000)` pause the program for 1 second

EXAMPLE

```
void setup()
{
    pinMode(8, OUTPUT);
}

void loop()
{
    digitalWrite(8, HIGH);    // Turn on the LED
    delay(1000);              // Wait for one second
    digitalWrite(8, LOW);     // Turn off the LED
    delay(1000);              // Wait for one second
}
```



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Lesson plan 4

Subject:	Microprocessor technology		
Topic:	Basics of Arduino		
Lesson Title:	Using LDR as a light switch		
Level:	4. level vocational education (incl. vocational secondary education)	Duration:	1 lesson/45 min
Lesson Objectives:			
The student: <ul style="list-style-type: none"> • acquires basic knowledge of electrical circuit design and the principle of operation programmable microcontroller; • develops a deeper understanding of the concept microprocessors; • develops qualitative and quantitative thinking skills; • develops data analysis skills; • acquires simulation observation skills; • develops report preparation skills. 			
Summary of Tasks:			
During performing of the task, the student will: <ol style="list-style-type: none"> 1. familiarize himself with the task manual, 2. sets up the circuit according to the circuit diagram 3. writes a code according to the task description. 			
Equipment:			
<ul style="list-style-type: none"> • Windows based PC • Arduino UNO Starter Kit • Arduino IDE 			

Programming of Arduino

Basics

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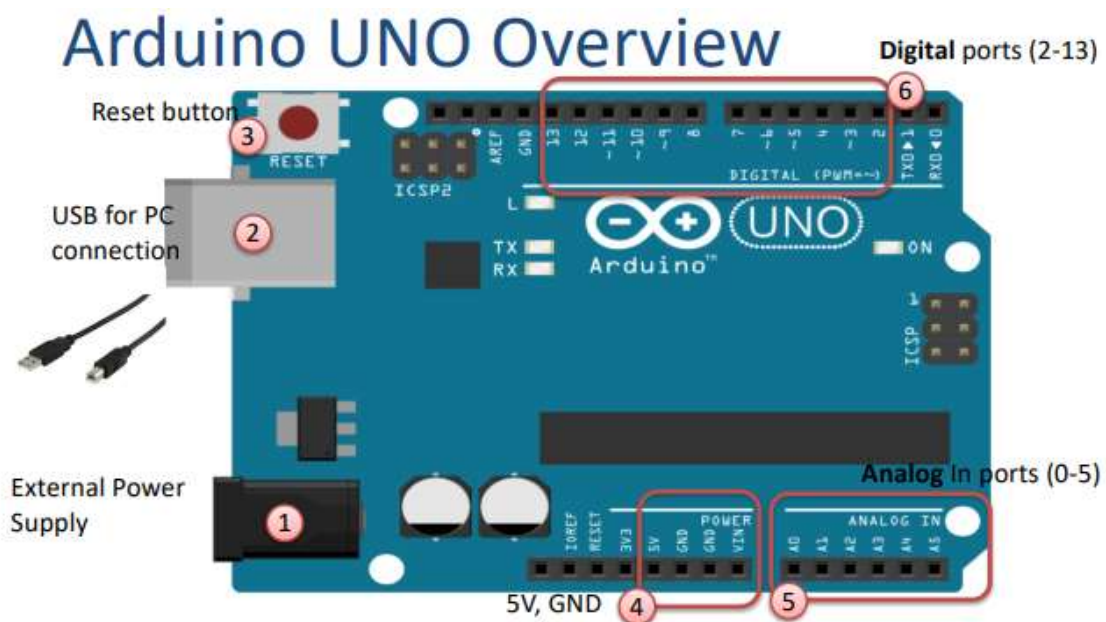


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Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (6), 6 analog inputs (5), a 16 MHz ceramic resonator, a USB connection (2), a power jack (1), an ICSP header and a reset button (3).

The Arduino board is connected to a computer via USB, where it connects with the Arduino development environment (IDE). The user writes the Arduino code in the IDE, then uploads it to the microcontroller which executes the code, interacting with inputs and outputs such as sensors, motors, and lights.



pic. 1 Overview Arduino UNO

Task description

The objective of this task is to make a program that senses light density in a room. If the light density is low, the application applies power to a light source (LED). If the light density is above threshold, the program disconnects the light source from power supply.

Equipment

- Arduino UNO
- Breadboard
- Light sensor
- LED
- 220 Ω and 10 k Ω resistor
- Jumper wires

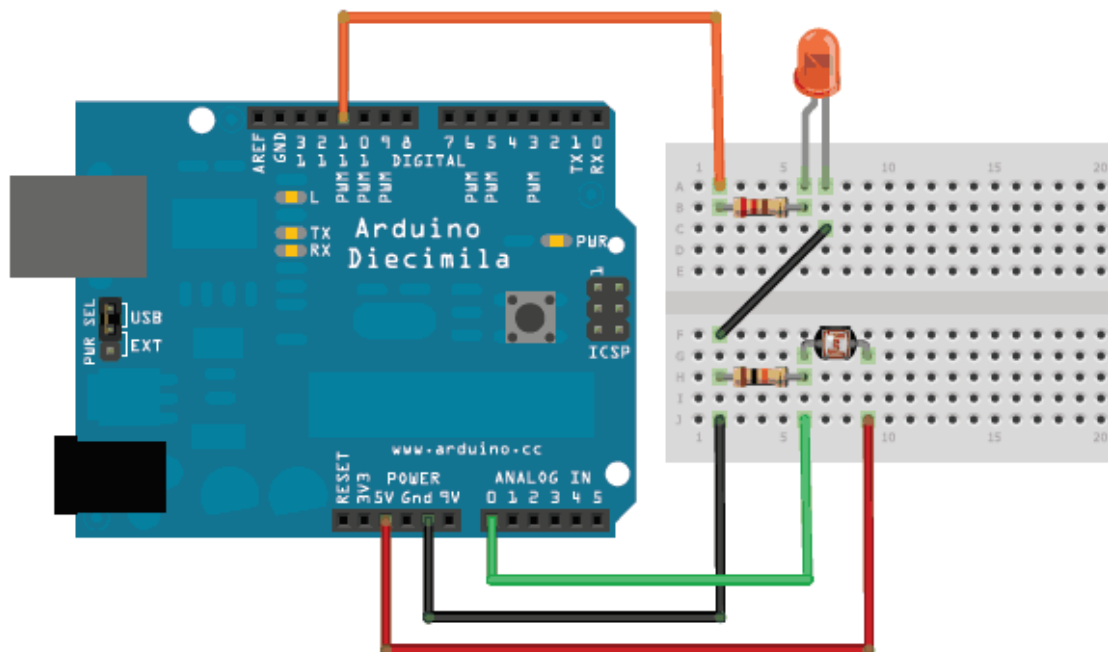
Wiring

Assemble the circuit according to the diagram below:

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pic. 2 Wiring diagram

Connect one end of the photocell to 5V, the other end to Analog 0. Then connect one end of a 10K resistor from Analog 0 to ground. Connect LED from pin 11 through a resistor to ground.

Wiring diagram and components description

LED

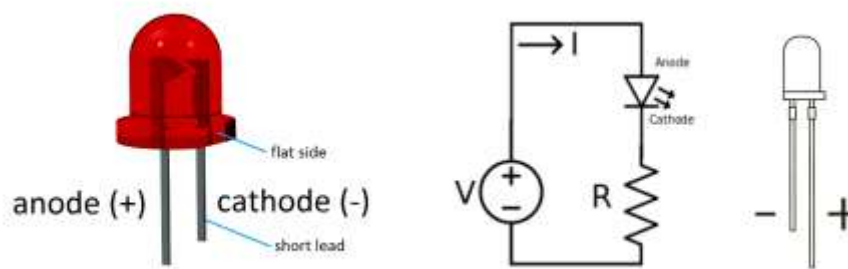
A light-emitting diode (LED) is a semiconductor light source that emits light when current flows through it. It has two pins. The positive terminal of a power source is connected to the anode and the negative terminal is connected to the cathode.



pic. 3 LED symbol



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pic. 4 LED and example of a circuit.

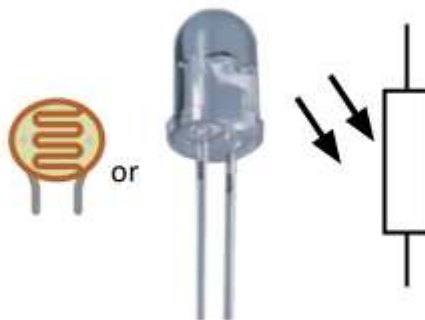
Light sensor

Light dependent resistors, LDRs or photoresistors are electronic components that are often used in electronic circuit designs where it is necessary to detect the presence or the level of light.

LDRs are very different to other forms of resistor like the carbon film resistor, metal oxide film resistor, metal film resistor and the like that are widely used in other electronic designs. They are specifically designed for their light sensitivity and the change in resistance this causes.

These electronic components can be described by a variety of names from light dependent resistor, LDR, photoresistor, or even photo cell, photocell or photoconductor.

The LDR resistance decreases with increasing light intensity (stronger light).



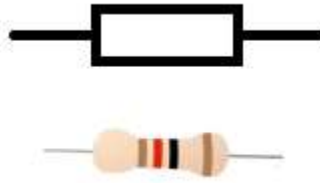
pic. 5 LDR types and its IEC symbol

Resistor

A resistor is a passive electrical component that creates resistance in the flow of electric current. In almost all electrical networks and electronic circuits, they can be found. The resistance is measured in ohms (Ω).



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pic. 6 IEC resistor symbol and a resistor

Programming

Program example:

```
int photocellPin = 0;    // the cell and 10K pulldown are connected to a0
int photocellReading;    // the analog reading from the sensor divider
int LEDpin = 11;         // connect Red LED to pin 11 (PWM pin)
int LEDbrightness;       //
void setup(void) {
    // We'll send debugging information via the Serial monitor
    Serial.begin(9600);
}

void loop(void) {
    photocellReading = analogRead(photocellPin);

    Serial.print("Analog reading = ");
    Serial.println(photocellReading);    // the raw analog reading

    // LED gets brighter the darker it is at the sensor
    // that means we have to -invert- the reading from 0-1023 back to 1023-0
    photocellReading = 1023 - photocellReading;
    //now we have to map 0-1023 to 0-255 since thats the range analogWrite
    uses
    LEDbrightness = map(photocellReading, 0, 1023, 0, 255);
    analogWrite(LEDpin, LEDbrightness);

    delay(100);
}
```

Use following:

Serial.begin(baud);

Sets the data rate in bits per second (baud) for serial data transmission. For communicating with the computer, use one of these rates: 300, 600, 1200, 2400, 4800, 9600, 14400, 19200, 28800, 38400, 57600, or 115200. You can, however, specify other rates - for example, to communicate over pins 0 and 1 with a component that requires a particular baud rate.

Example:

```
Serial.begin(9600); // opens serial port, sets data rate to 9600 bps
```

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Serial.println()

Prints data to the serial port as human-readable ASCII text followed by a carriage return character (ASCII 13, or '\r') and a newline character (ASCII 10, or '\n'). This command takes the same forms as Serial.print().

Example:

```
Serial.println(analogValue); // print as an ASCII-encoded decimal
```

pinMode(pin, mode);

Where:

- pin describes which pin is used (digital pin 8 in example above),
- mode describes the function of the digital pin. It can be either an INPUT or an OUTPUT. Since it shall be used to turn-on a LED, it should be set to OUTPUT.

digitalWrite(pin, value);

Where:

- Digital pin can have 2 values, either HIGH (LED on) or LOW (LED off).

delay(ms);

- The delay() function make a small pause in milliseconds (ms), e.g., delay(1000) pause the program for 1 second



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Lesson plan 5

Subject:	Mathematics		
Topic:	Geometry		
Lesson Title:	Ruumiliste kujundite pindala ja ruumala leidmine		
Level:	4. level vocational education (incl. vocational secondary education)	Duration:	2 lessons / 45 + 45 min
Lesson Objectives:			
<p>The student:</p> <ul style="list-style-type: none"> • seostab matemaatikat igapäevaeluga – tunneb esemetes ära matemaatilisi kujundeid (püstprisma, silinder, kera); • mõõdab esemete pindala ja ruumala arvutamiseks vajalikud suurused, sh leiab võimaluse kera diameetri mõõtmiseks; • rakendab õpitud valemeid eseme pindala ja ruumala arvutamiseks; • hindab arvutustulemuste tõepärasust; • develops qualitative and quantitative thinking skills; • develops data analysis skills; • develops probleemilahendus-, meeskonnatöö- ja selgitamisoskust. 			
Summary of Tasks:			
<p>During performing of the task, the students will (paarides töötades):</p> <ol style="list-style-type: none"> 1. määrab kujundi, mõõdab vajalikud suurused, arvutab kujundi pindala ja ruumala (1. tund); 2. kontrollib mõne teise paari mõõtmisi ja arvutusi ning hindab nende tööd, põhjendades oma arvamust (2. tund). 			
Equipment:			
<ul style="list-style-type: none"> • joonlaud, kalkulaator, valemitega töölehed; • mänguklotsid ja muud esemed, näiteks 			



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