



ODSJEK AERONAUTIKA

ZAVOD ZA AERONAUTIKU

Laboratorij za aerodinamiku



Voditeljica

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DIVISION OF AERONAUTICS

DEPARTMENT OF AERONAUTICS



Aerodynamics Laboratory



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Naziv opreme / Equipment name

Podzvučni aerotunel
Subsonic windtunnel

Proizvođač / Manufacturer

Ručni rad
Handmade



Namjena i opis / Purpose and description

Podzvučni aerotunel namijenjen je za istraživanje temeljnih zakona strujanja podzvučnog (nestlačivog) fluida. Aerodinamički tunel Laboratorija za aerodinamiku je zatvoreni tip tunela izrađen od iverice s dvostrukim stjenkama između kojih su postavljena rebra.

Glavni dijelovi tunela su: test-sekcija, konvergentna mlaznica, umirivačka sekcija, difuzor, ventilator, motor, usmjerivači zraka te povratni vod.

Tunel je kružnog poprečnog presjeka, osim radne sekcije, izlaznog dijela mlaznice i ulaza u prvi difuzor koji su eliptični. Radna sekcija otvorena je sa bočnih strana.

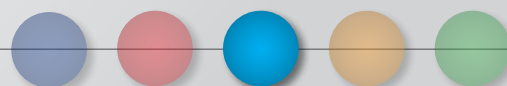
Dimenzije radne sekcije su 0,352 x 0,310 m, duljine 0,450 m.

Ukupna snaga potrebna za pogon tunela, odnosno prirast tlaka izražava se kroz mjeru djelotvornosti tunela, ER i zavisi od brzine strujanja zraka. Pogonska sekcija (asinkroni motor i ventilator) nalazi se u metalnom kućištu postavljenom na zasebnom nosaču. Motor ima upravljanje frekvencijom tako da je frekvencija nezavisni parametar za koji se određuju ostale veličine. Maksimalna frekvencija motora je 50 Hz, snaga motora je 4 kW, a brzina vrtnje 2900 okr/min.

Subsonic wind tunnel is used for study of the fundamental laws of subsonic, incompressible fluid flow. Wind tunnel at the Aerodynamics Laboratory is a closed type tunnel made of plywood with a double-wall and ribs between them.

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The main parts of the tunnel are: test-section, contraction section, flow straighteners, diffuser, fan, drive motor, and turning vanes.

The tunnel has a circular cross-section, except for the test-section, nozzle output and entrance to the first diffuser that are elliptical. Test-section is open on the sides. Dimensions of the test-section are 0,352 x 0,310 m, 0,450 m length.

The total power required for the operation of the tunnel, or increase pressure expressed through measure the effectiveness of the tunnel, ER and depends on airspeed. Drive section (asynchronous motor and fan) is located in a metal casing mounted on a separate carrier. The engine is controlled by frequency so that the frequency is independent variable that determines all other variables. Maximum motor frequency is 50 Hz, power is 4 kW, a speed 2900 RPM .





Naziv opreme / Equipment name

Piezometarska harfa
Multilevel piezometer

Proizvođač / Manufacturer

Ručni rad
Handmade



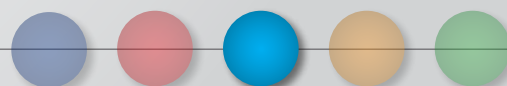
Namjena i opis / Purpose and description

Oprema je namijenjena za mjerenje relativnog tlaka. Harfa ima spremnik za tekućinu i 30 prozirnih cjevčica koje se pneumatskim cijevima spajaju na mjerna mjesta. Jedna cjevčica služi za mjerenje referentnog tlaka, a ostalih 29 za mjerenje lokalnih tlakova. Pored svake cjevčice nalazi se mjerilo na kojem se očitava visina nivoa tekućine. Razlika lokalnog i referentnog tlaka (izražena razlikom nivoa tekućine) predstavlja relativni (diferencijalni) tlak. Harfa ima mogućnost naginjanja čime se može povećati razlučivost očitavanja. Mjerni opseg: cca ± 5000 Pa.

Multilevel piezometer is used for relative pressure measurements. It has a fluid reservoir and 30 transparent tubes connecting pressure measurement points. One tube is used to measure the reference pressure, and the remaining 29 for the measurement of local pressures. In each tube there is a scale on which the height of the liquid level is read. Difference between local and reference pressure (expressed in different fluid levels) is a relative (differential) pressure. Multilevel piezometer can be tilted to increase the reading resolution. Measuring range: approximately ± 5000 Pa.

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Naziv opreme / Equipment name

Model aeroprofila NACA 2421 s otvorima za mjerenje tlaka
NACA 2421 airfoil model with pressure taps

Proizvođač / Manufacturer

Ručni rad
Handmade



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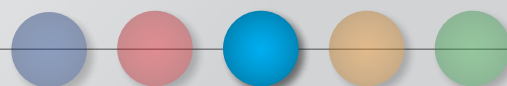
Namjena i opis / Purpose and description

Model aeroprofila NACA 2421 duljine tetive: $c = 0,15$ m, metal. Aeroprofil ima otvor na prednjem bridu te po 14 otvora na gornjaci i donjaci koji služe za osjećanje tlaka. Otvori se pneumatskim cijevima povezuju s piezometarskom harfom.

- određivanje raspodjele tlaka oko aeroprofila pri različitim napadnim kutovima i brzinama slobodne struje zraka;
- prikaz raspodjele tlaka oko aeroprofila iznad kritičnog napadnog kuta (uvjeti sloma uzgona, *stall*)

NACA 2421 airfoil model chord length: $c = 0.15$ m, metallic. Airfoil has an opening at the front edge and 14 pressure taps at upper surface and lower surface. Pressure taps are connected with pneumatic tubes to the multilevel piezometer.

- determination of pressure distribution around the airfoil at various angles of attack and available air-flow speeds;
- display of pressure distribution around the airfoil above the critical angle of attack (stall conditions).





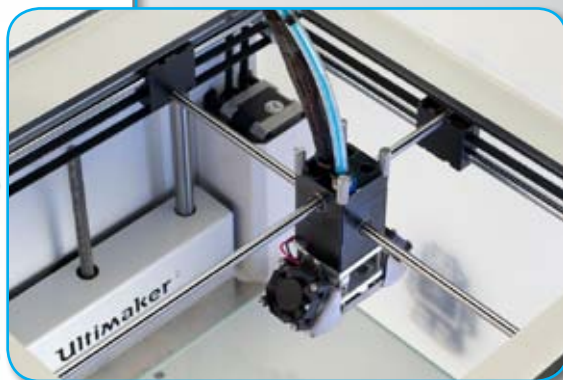
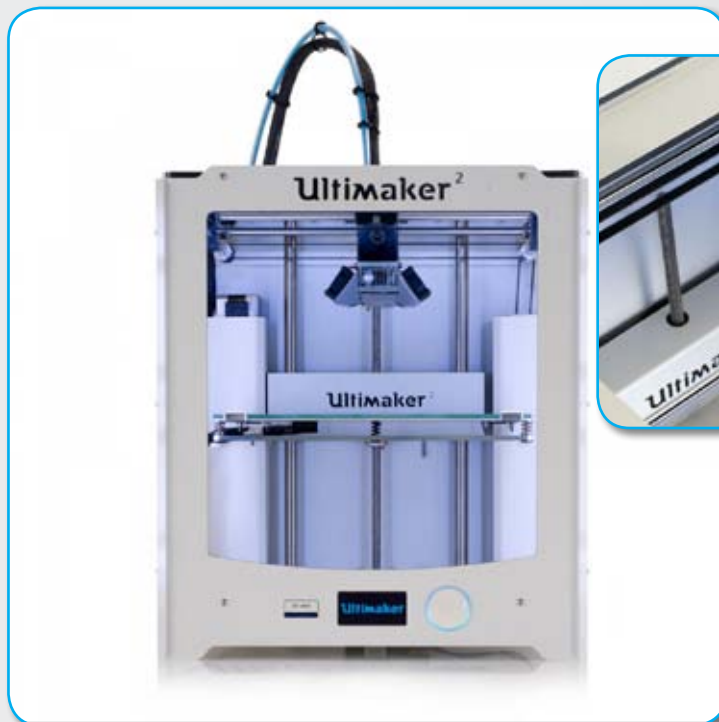


Naziv opreme / Equipment name

3D printer Ultimaker 2
3D printer Ultimaker 2

Proizvođač / Manufacturer

Ultimaker, Geldermalsen, Nizozemska



Namjena i opis / Purpose and description

Uređaj za printanje 3D modela za potrebe laboratorija. Koristi se za printanje 3D modela zrakoplova, aeroprofila, propelera za ispitivanje u aerotunelu.

Specifikacije

- Glasnoća u radu: 49 dB
- Materijal: PLA ili ABS
- Kvaliteta: do 20 μm
- Brzina: 30 do 300 mm/s
- Volumen za printanje: 230 x 225 x 205 mm
- Preporučeni promjer punjenja: 2.85 mm
- Cijena printanja: $\sim \text{€}0.05 / \text{cm}^3$ (materijal i snaga)
- Software: Cura (besplatan, otvoreni kod)

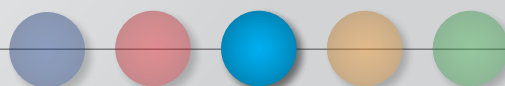
3D printing device for Laboratory purposes. The purpose of Ultimaker 2 is aircraft, airfoil and propeller 3D models printing for wind tunnel testing.

Features

- Loudness while working: 49 dB
- Material: PLA ili ABS

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- Layer resolution: do 20 μm
- Travel speed: 30 do 300 mm/s
- Build volume: 230 x 225 x 205 mm
- Recommended filament diameter: 2.85 mm
- Usage cost: \sim €0.05 / cm^3 (material and power)
- Software: Cura (free, open access)



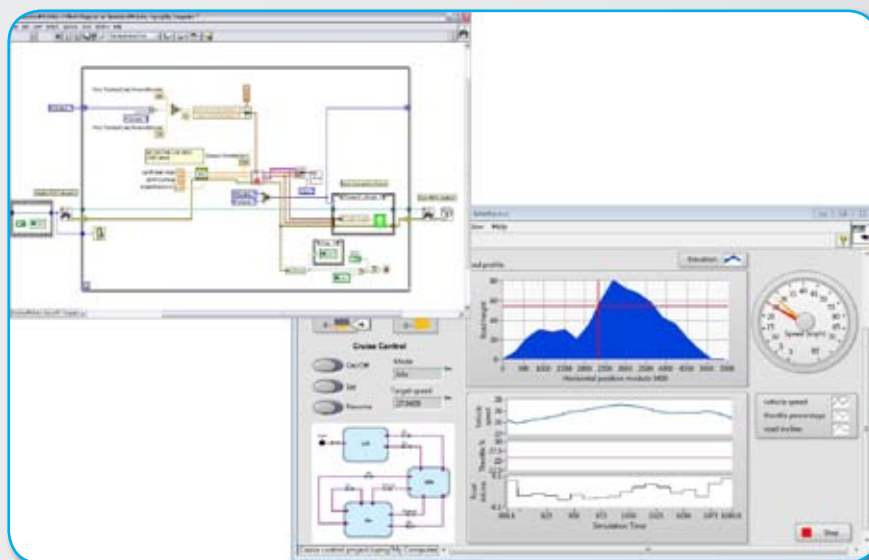


Naziv opreme / Equipment name

Grafičko razvojno okruženje za vizualno programiranje LabVIEW 2014
System-design platform and development environment for a visual programming LabVIEW 2014

Proizvođač / Manufacturer

National Instruments, Austin, Texas, SAD



Namjena i opis / Purpose and description

LabVIEW (Laboratory Virtual Instrumentation Engineering Workbench) je grafički programski jezik za mjerenje, automatizaciju i vizualizaciju sustava i procesa. Koristi se kao razvojni alat za aplikacije u mjeriteljstvu i testiranju, za dohvat podataka, analizu i upravljanje instrumentacijom i procesima.

LabVIEW (short for Laboratory Virtual Instrument Engineering Workbench) is a system-design platform and development environment for a visual programming language. It is used to develop sophisticated measurement, test, and control systems, data acquisition, instrumentation and process control.

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