

INSTRUMENTATIE VIRTUALA

CURS 1



Structura curs

2

Prezentare structură curs; bibliografie; Instrumentație. Concepte de bază.
Instrumentație virtuală, Proiectare grafică de sistem

Mediu de programare grafică LabVIEW

- Noțiuni de bază
- Ferestre de lucru, uneltele paletelor de controale și funcții
- Elemente de programare - Programarea modulară

Elemente de programare 1

- Tipuri și structuri de date
- Structuri de programare

Elemente de programare 2

- reprezentări grafice și lucru cu fișiere

Elemente de programare 3

- Variabile locale, globale și distribuite.
- Noduri de proprietăți

Arhitecturi de programare în LabVIEW

Achiziția de date in LabVIEW utilizând hardware dedicat (intrări/ieșiri analogice și digitale, numărătoare,...)

Programarea sistemelor RT (NI myRIO, NI ELVIS III și NI cRIO) in LabVIEW

Procesarea de imagini în LabVIEW

Drivere de instrumente bazate pe arhitecturile de tip VISA, IVI, ...

1

3

4

2

2

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4

2

2

2

Evaluare

3

Tip de activitate	10.1 Criterii de evaluare	10.2 Metode de evaluare	10.3 Pondere din nota finală
10.4 Curs	Explicarea corectă a unui proces, structuri, funcții, etc. specifice instrumentației virtuale folosind noțiunile teoretice predate	Evaluare scrisă cu itemi subiectivi sau obiectivi Verificare pe parcurs, teste rapide.	40%
	Analiza comparativă a unor procese, structuri, funcții		
	Alegerea variantei corecte dintr-o serie de situații propuse și argumentarea alegerii folosind noțiunile teoretice predate		
	Utilizarea corectă a limbajului de specialitate		
	Claritatea, coerenta și concizia expunerii		
	Gradul de acoperire a problematicii cerute de subiecte		
10.5 Seminar/ laborator/ proiect	Abilitatea de implementare a unei aplicații de măsurare/control/ analiză utilizând LabVIEW pentru hardware-ul utilizat in laborator.	Test pe calculator si verificarea efectuarii lucrarilor pe parcursul laboratorului.	50%

Cuprins

4

- Conceptul de instrumentatie
- Proiectarea grafica de sistem - Graphical System Design
 - Instrumentatia Virtuala
- Software
 - NI Multisim si NI Ultiboard
 - NI LabVIEW
- Hardware
 - NI ELVIS II
 - myDAQ
 - myRIO
- Demonstratii

Instrumentatie

Instrumentatie

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□ Definitii

- 1 : aranjamente sau compozitii muzicale pentru instrumente in special pentru formatii sau orchestra.
- 2 : utilizarea instrumentelor (pentru observatii, masurari sau control)
- 3 : instrumente pentru un anumit scop: o selecție sau aranjament de instrumente

<https://www.merriam-webster.com/dictionary/instrumentation>

Instrumentatie

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□ Definitii

- In the context of **computer programming**, instrumentation refers to an **ability to monitor or measure the level of a product's performance, to diagnose errors, and to write trace information**. Programmers implement instrumentation in the form of code instructions that monitor specific components in a system (for example, instructions may output logging information to appear on the screen). When an application contains instrumentation code, it can be managed by using a management tool. Instrumentation is necessary to review the performance of the application.

[https://en.wikipedia.org/wiki/Instrumentation_\(computer_programming\)](https://en.wikipedia.org/wiki/Instrumentation_(computer_programming))

Provocarile in realizarea masuratorilor sunt date de:

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- Software si Hardware dedicat
- Abordari de programare diferite
- Performanta hardware-ului inadecvata
- Drivere diferite
- Diferiti senzori si conectivitatea lor
- Conditionare de semnal proprietara
- Vizualizarea avansata a rezultatelor
- Cerinte ale aplicatiilor petru modificare
- Algoritmi de analiza complexi
- Trendul de evolutie a tehnologiei
- Stocarea datelor confusa
- Rate de esantionare diferite



Aplicatii diverse cu masuratori diverse

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Vibratii



Cuplu



Deplasari



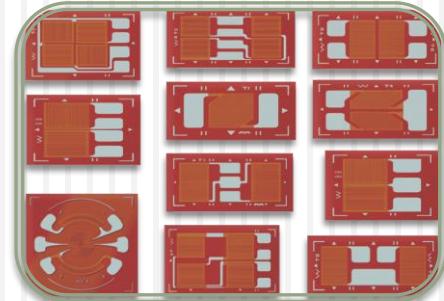
Presiune



Temperatura



Forță



Deformari

Exemplu de aplicatie: Masuratori de calitate a aerului

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Senzori necesari

Context

de GPS

Timp

Pozitie

de altitudine

de distanta

Mediu

de temperatura

de oxigen

de CO₂

de Ozon

de Azot



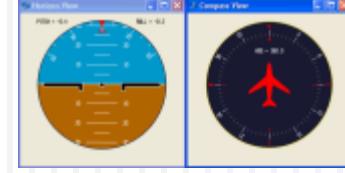
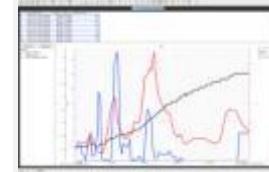
Senzori, interfete si conditionarea de semnal

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Senzor	Interfata	Conditionare?
GPS	 RS232	Nu
Altitudine	 RS232	Nu
LiDAR	 Ethernet	Nu
Temperatura	 Semnal analogic	Necesara
O ₂ , CO ₂ , O ₃ , NH ₃	 Semnal analogic	Necesara

Software furnizat cu senzorii

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Senzor	Software
GPS	
Altitudine	
LiDAR	
Temperatura	
O ₂ , CO ₂ , O ₃ , NH ₃	<fara software>

Cu un sistem de acest gen, cum se poate realiza:

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- ...schimbari in cerinte?
- ...masurari mixte intr-un singur sistem?
- ...conectivitate variata?
- ...conditionarea de semnal pentru senzori?
- ...adaugarea sau inlocuirea senzorilor?
- ...incorporarea de temporizari, triggerari sau sincronizari?
- ...mentinerea cu trendul tehnologic?



Strategie:

Proiectarea grafica de sistem - Graphical System Design

o abordare modernă de proiectare a sistemelor de control și măsurare care combina software-ul de proiectare de sistem cu hardware-ul *commercial off-the-shelf* (COTS) pentru simplificarea puternică a procesului de dezvoltare.

Proiectarea grafica de sistem

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- National Instruments (NI) defineste GSD ca o abordare bazata pe o *platforma unificata pentru proiectarea, prototiparea si implementarea de aplicatii*

Proiectare

Prototipare

Implementare

algoritmi sau modele matematice implementarea proiectului pe adaptarea si dimensionarea ale sistemului => simulare hardware de tip COTS (nivele aplicatiei la dispozitivele hardware ajutorul aplicatiilor software de testare) => verificare si validare finale (productia si constrangeri)

Proiectarea grafica de sistem

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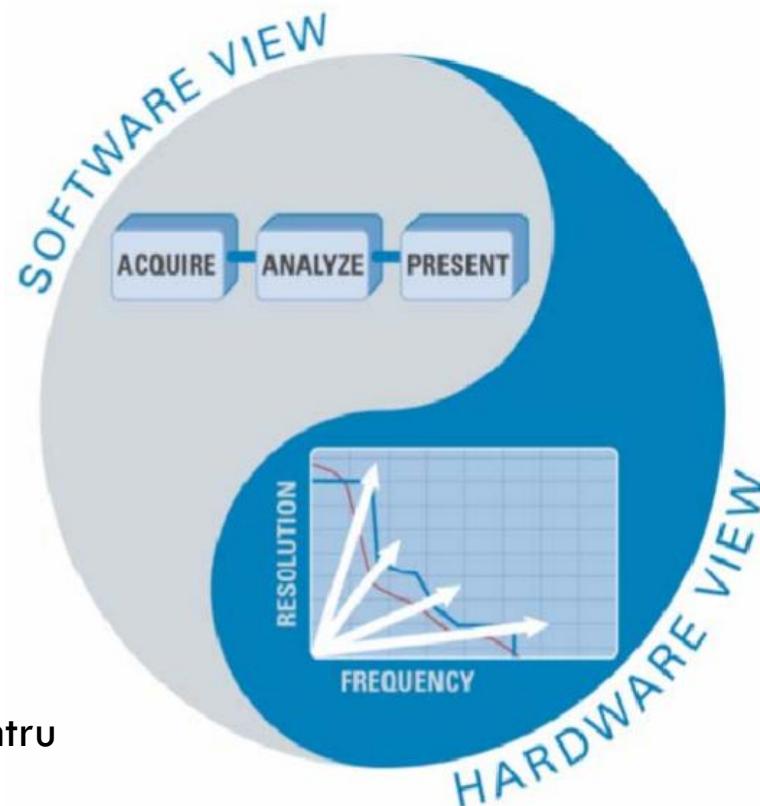
abordare bazata pe o platforma unificata pentru masurari scalate peste...



La baza sta:

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□ Instrumentatia virtuala



VI este definita ca o combinatie de hardware modular si software personalizabil folosita pentru realizarea de sisteme de masura si control definite de utilizator.

Instrument Virtual (VI-Virtual Instrument)

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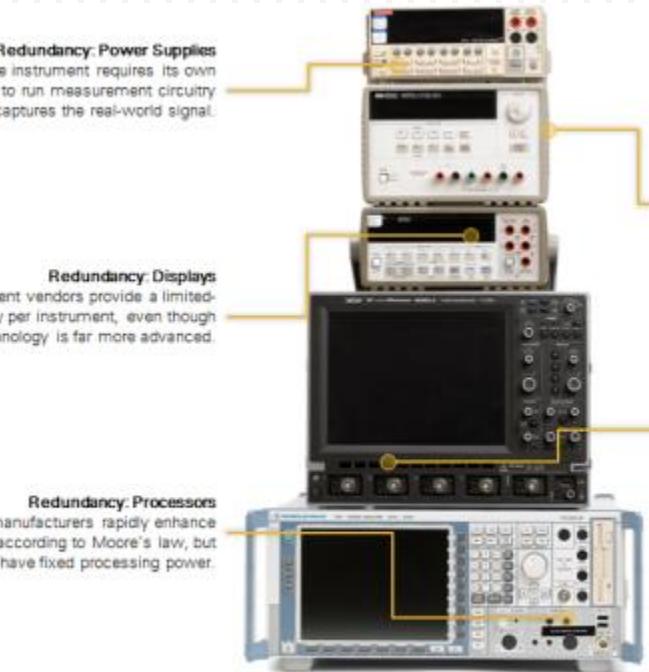
Beneficiind de componente PC, software-ul devine instrumental



Redundancy: Power Supplies
Each separate instrument requires its own power supply to run measurement circuitry that captures the real-world signal.

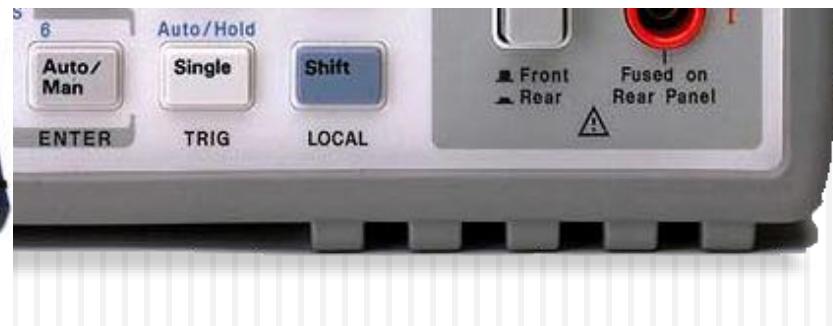
Redundancy: Displays
Instrument vendors provide a limited-quality display per instrument, even though monitor technology is far more advanced.

Redundancy: Processors
Chip manufacturers rapidly enhance processors according to Moore's law, but instruments have fixed processing power.



Redundancy: Memory
PCs can quickly capitalize on a performance boost from a memory upgrade from readily available RAM.

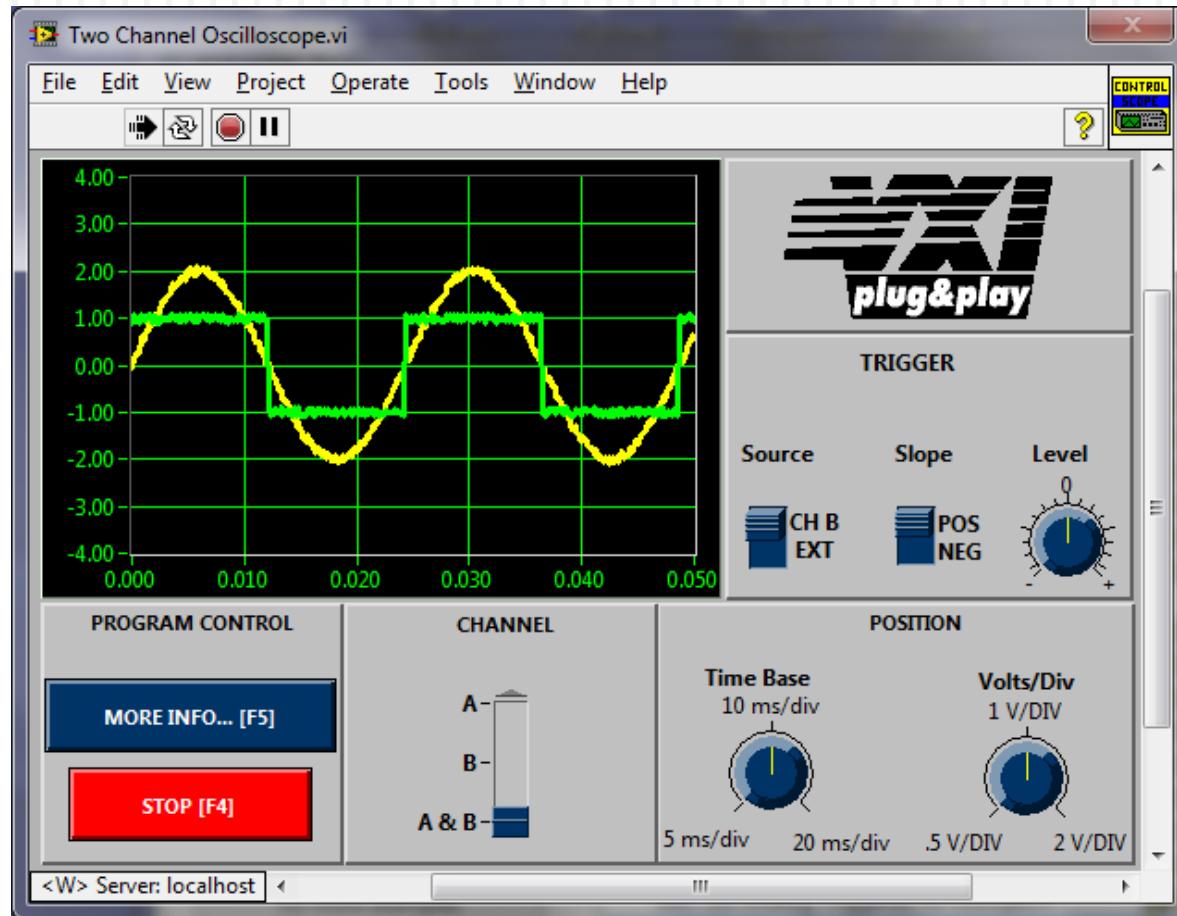
Redundancy: Storage
Each instrument duplicates onboard storage even though PC hard drives are plentiful and cost-effective.



Instrumentatia Virtuala-Exemple

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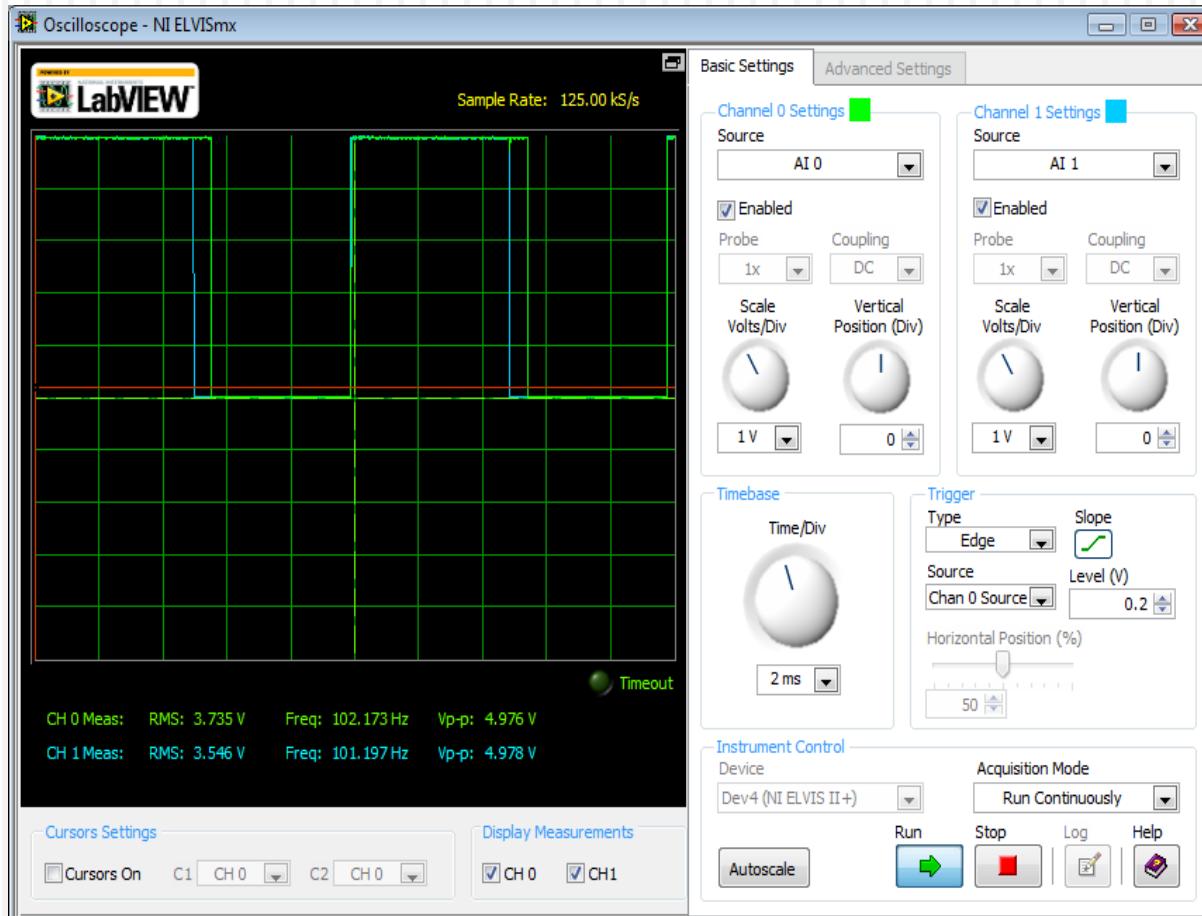
□ Osciloscop



Instrumentatia Virtuala-Exemple

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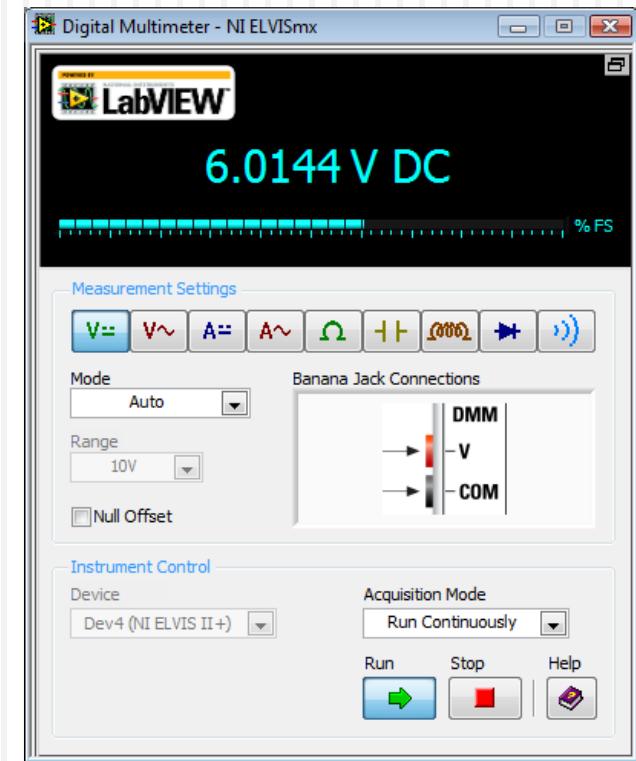
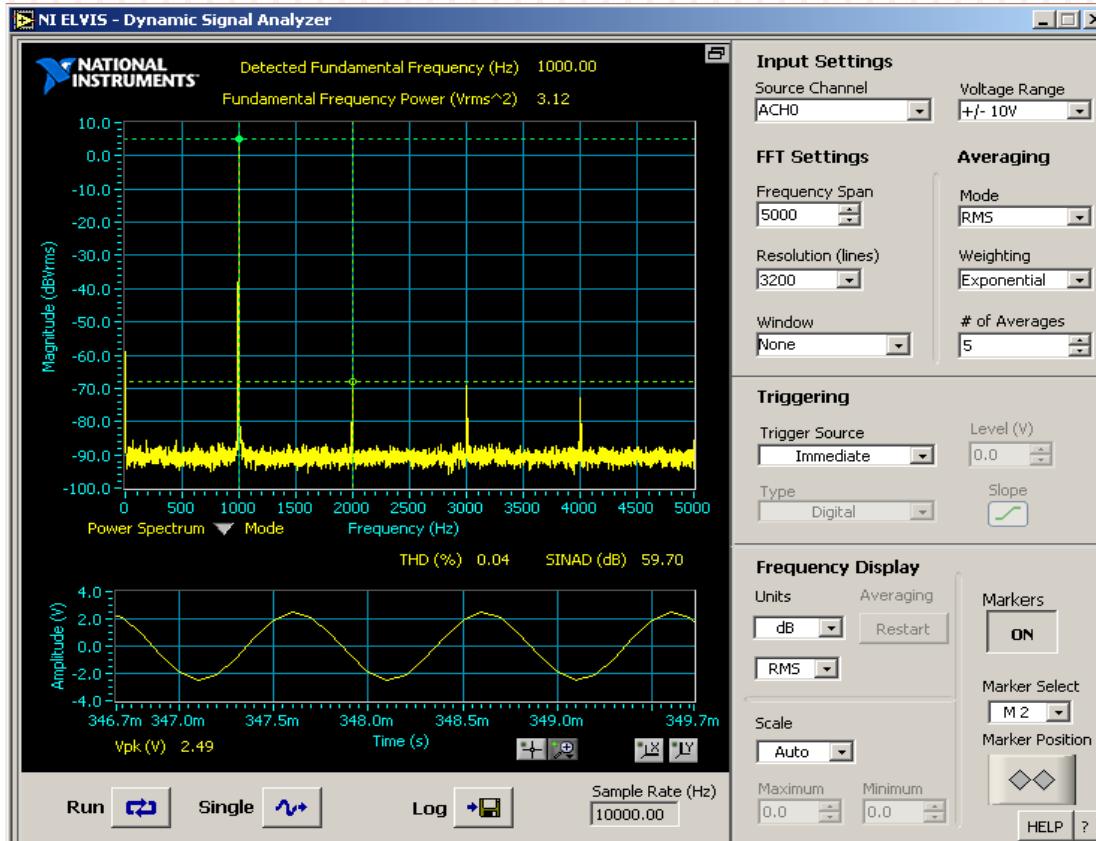
□ Osciloscop imbunatatit



Instrumentatia Virtuala-Exemple

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□ Acelasi hardware alte instrumente



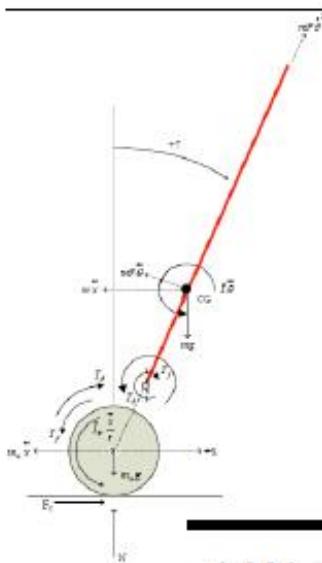
Proiectarea grafica de sistem – Ex.

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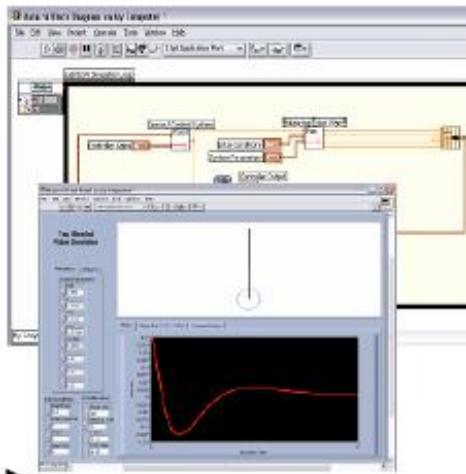
□ NI Week

RPI Human Transporter (Senior Design Project: 3 Students, 13 Weeks)

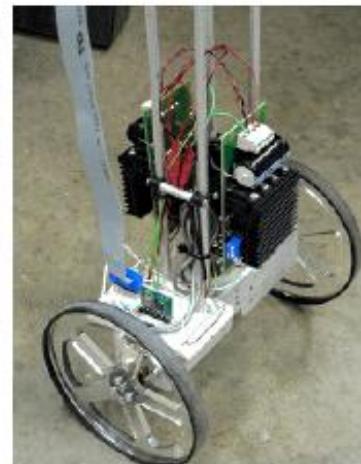
Theory



Design



Benchtop Prototype



8 Weeks

Full-Scale Prototype



1 Week

4 Weeks

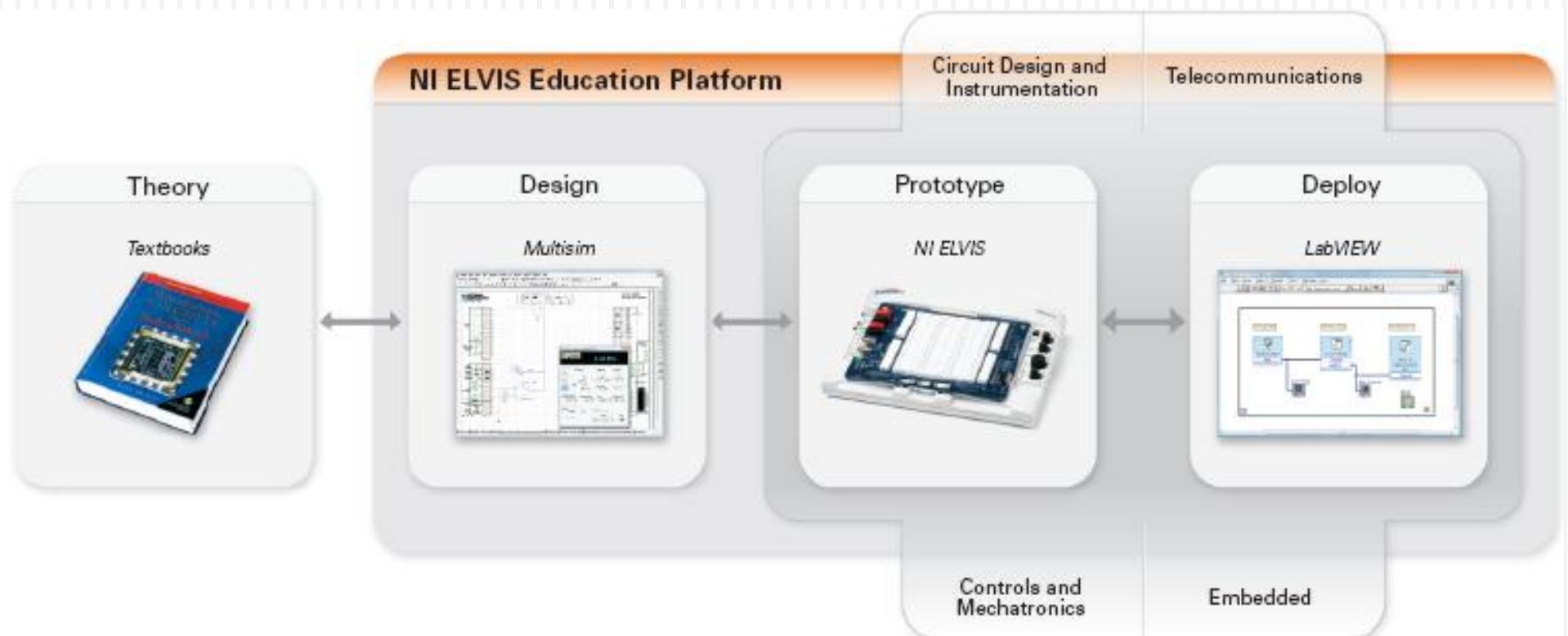
Proiectarea grafica de sistem – Ex.

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- Dynamic Anthropomorphic Robot with Intelligence (DARwIn) - studenți de la Robotics & Mechanisms Laboratory (RoMeLa) de la Virginia Tech.
- dedicat imitării miscărilor umane - usor de adaptat pentru a participa la competiția de fotbal RoboCup.



□ Proiectarea grafica de sistem



Software

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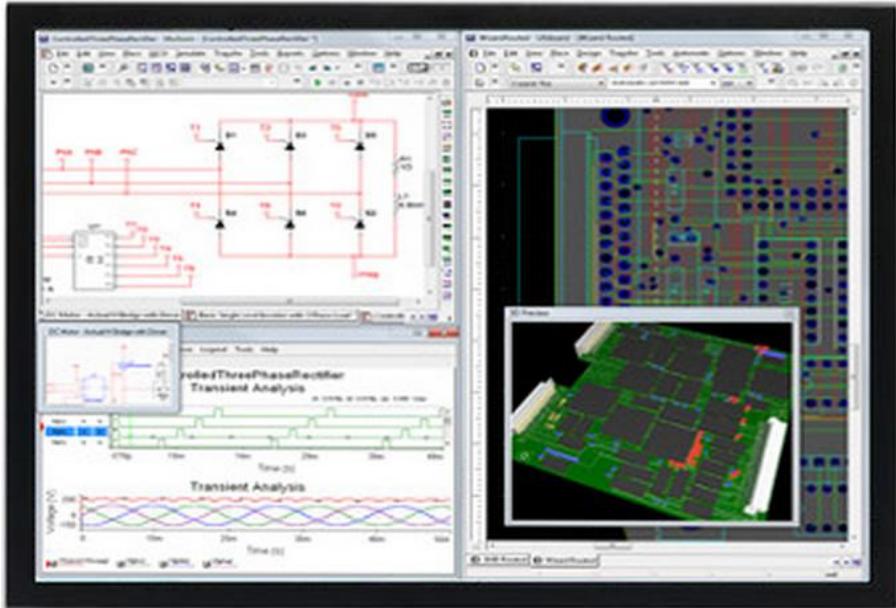
□ NI Circuit Design – Multisim si Ultiboard

□ Multisim

- este un soft ce permite combinarea intre simularea de circuite cu realizarea de scheme electronice intr-un laborator de electronica integrat in totalitate pe PC
- Este unul dintre cele mai raspandite simulatoare din intreaga lume

□ Ultiboard

- Soft dedicat realizarii de circuite imprimante (PCB)
- Permite importarea circuitelor create in Multisim
- Ofera posibilitatea de vizualizare a circuitului 3D

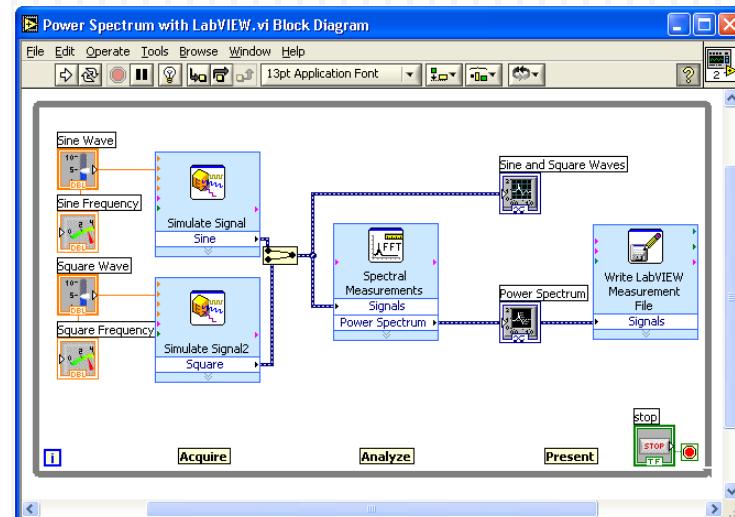


NI LabVIEW

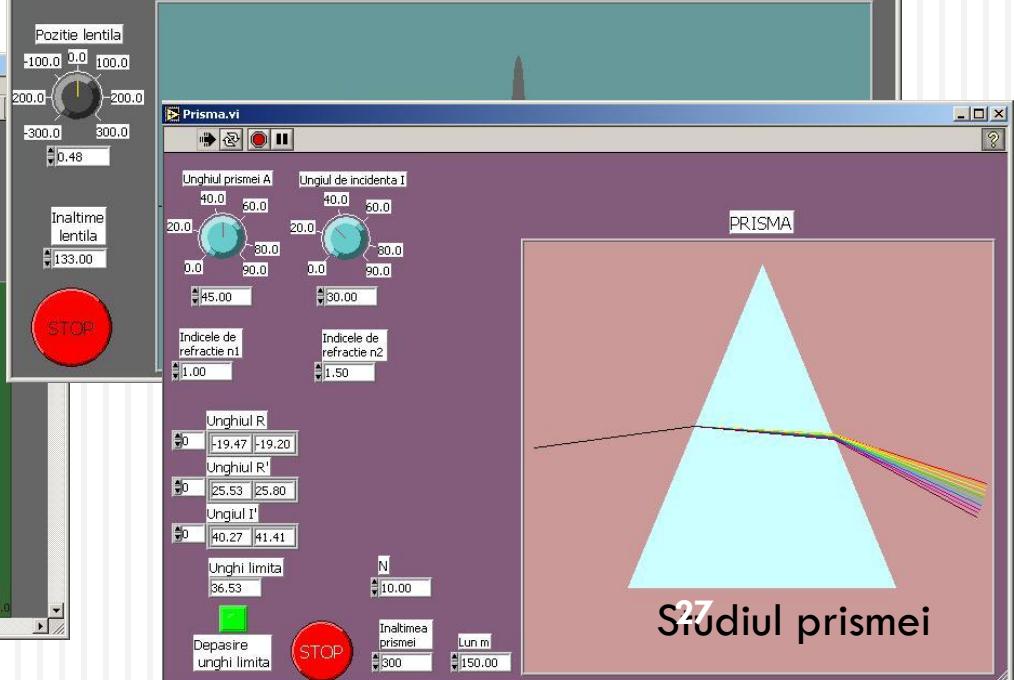
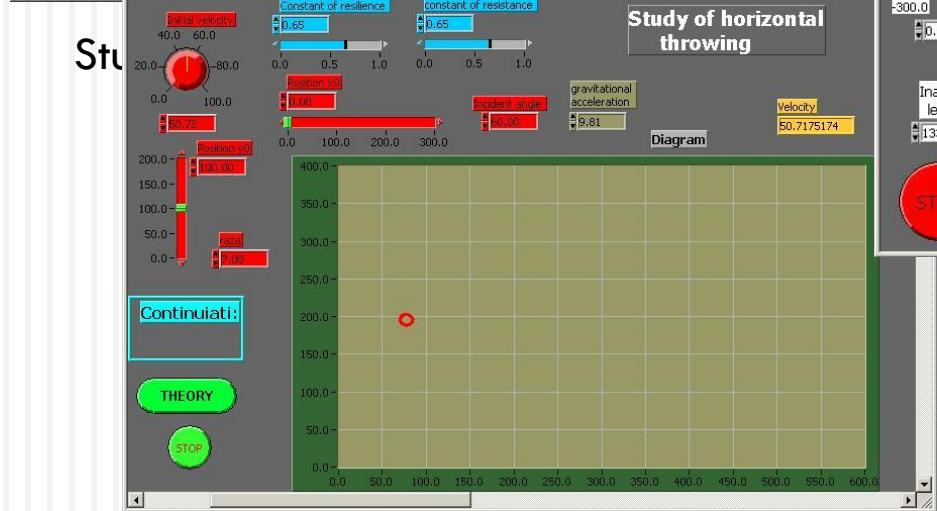
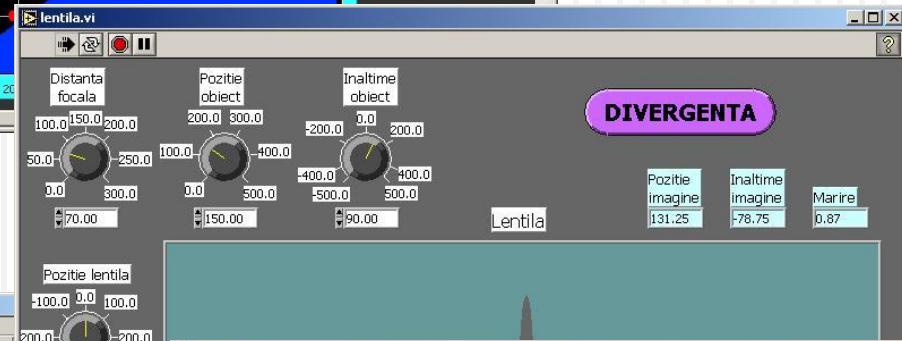
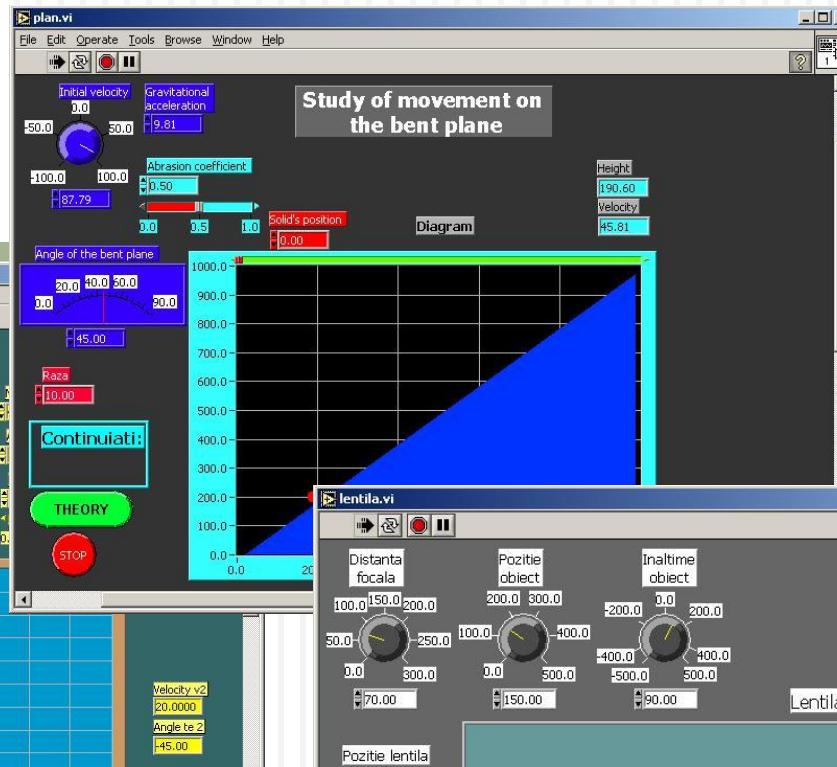
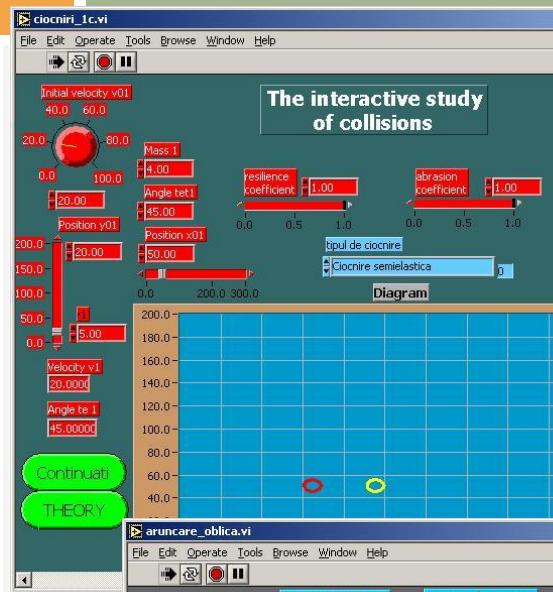
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- **Laboratory Virtual Instrumentation Engineering Workbench**

- este un limbaj de programare grafica ceea ce inseamna ca programarea se realizeaza pe baza de elemente grafice numite iconuri.
- Nucleu puternic pentru DAQ, control de echipamente, programare FPGA, ...



Simulare in fizica



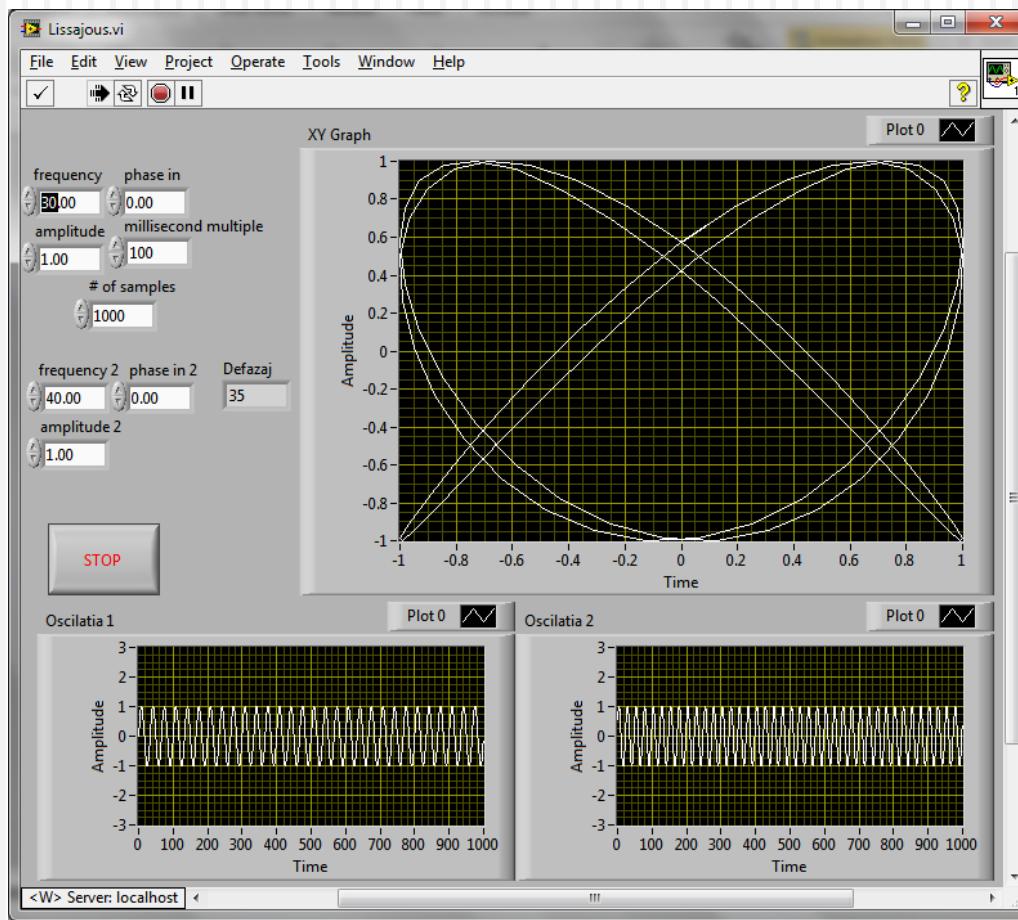
Studiul aruncării oblice

S27 Studiul prismei

NI LabVIEW Demo 1

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Compunerea oscilațiilor perpendiculare



Hardware

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- NI ELVIS
- myDAQ
- myRIO

Ce este NI ELVIS?

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- National**
- Instruments**
- Educational**
- Laboratory**
- Virtual**
- Instrumentation**
- Suite**

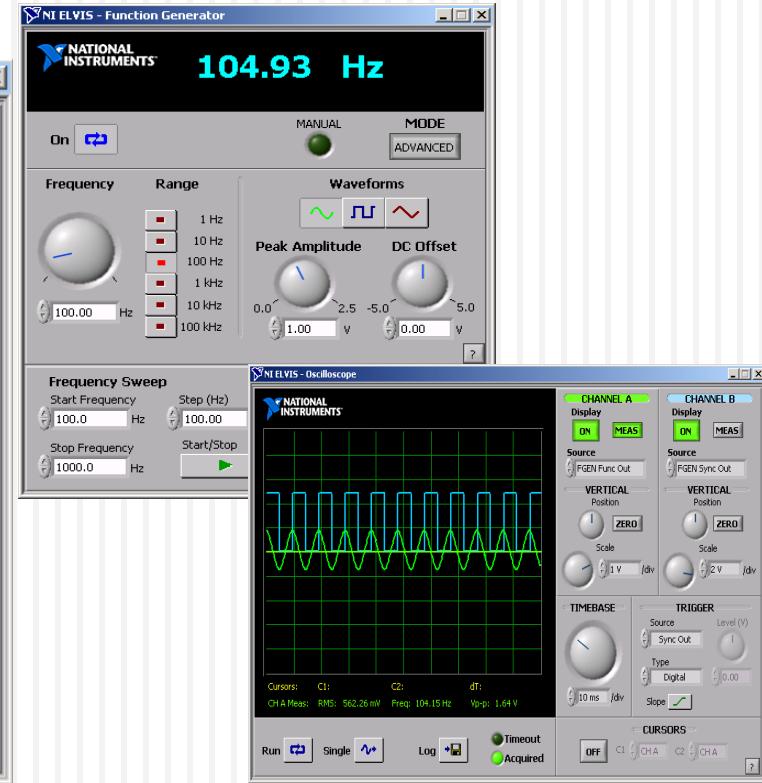
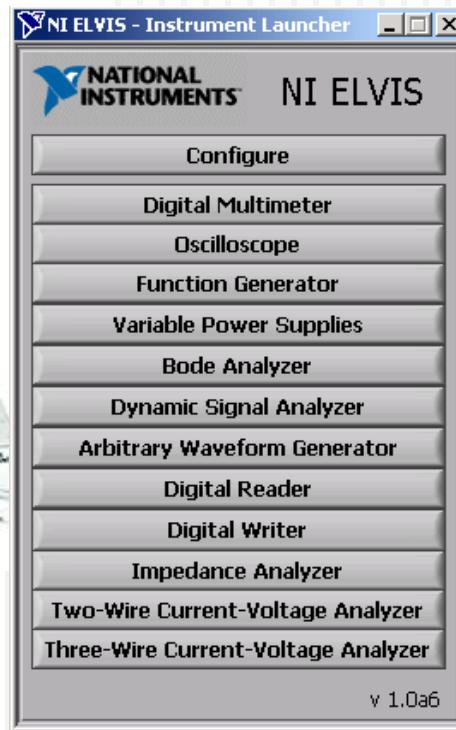
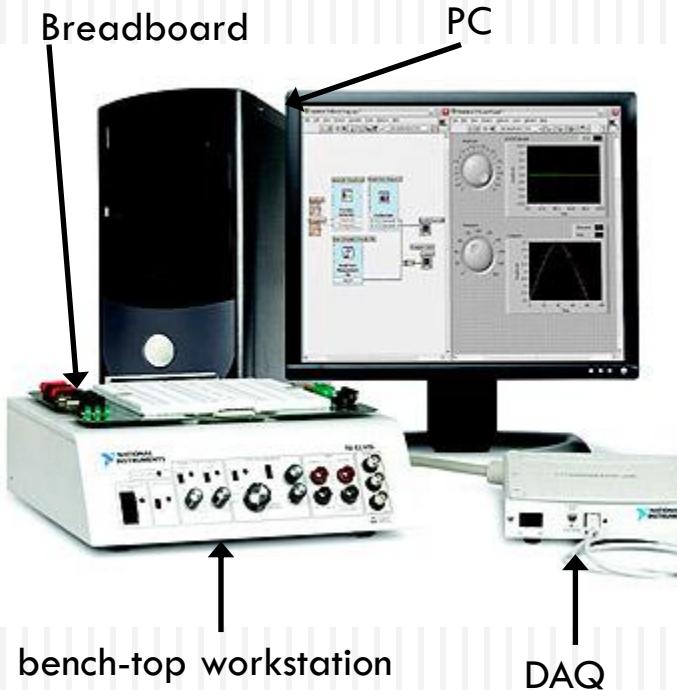


NI-ELVIS

NI-ELVIS I Platform

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- National Instruments-Educational Laboratory Virtual Instrumentation Suite (NI-ELVIS)



NI-ELVIS Platform

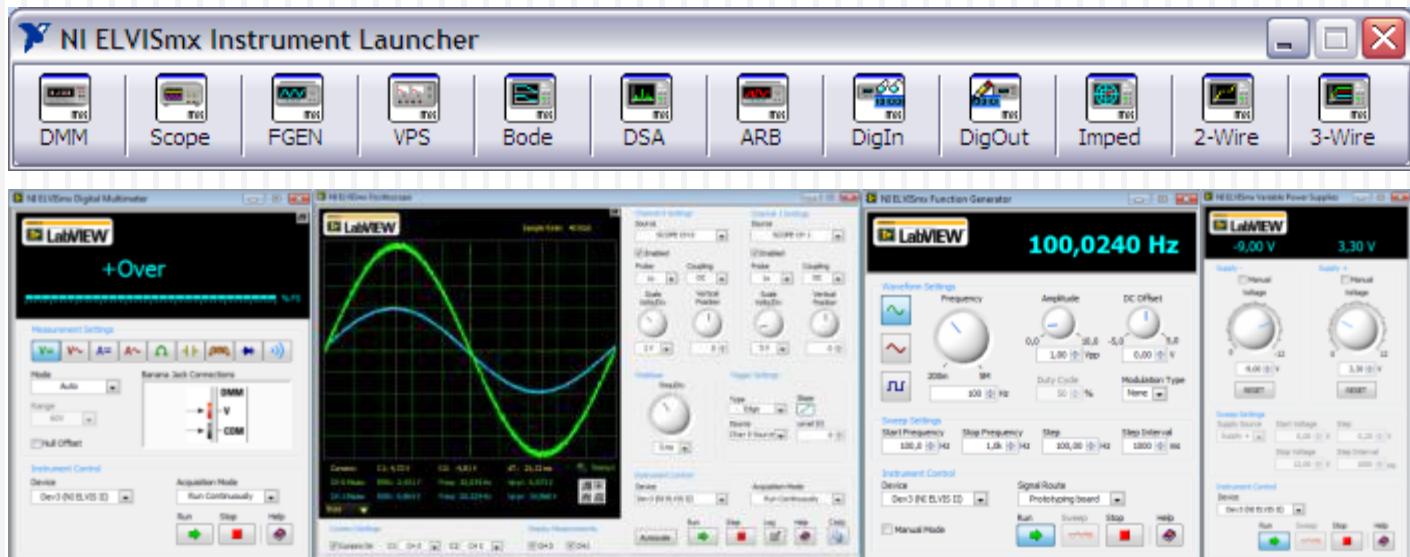
32

- NI ELVIS Evolution => NI ELVIS II



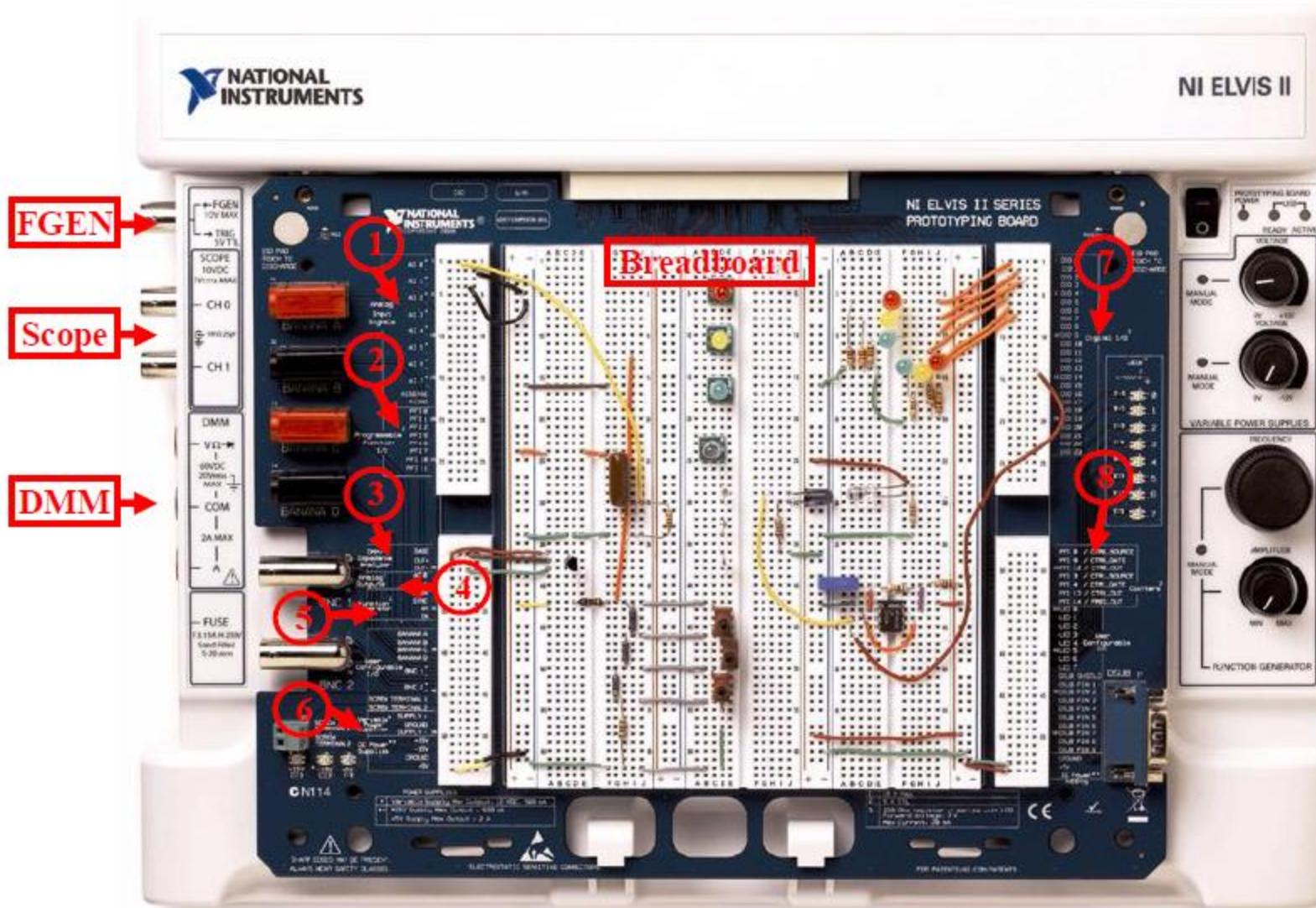
NI ELVIS II software

- 12 Instrumete cu Soft Front Panels
- Instrumente personalizabile



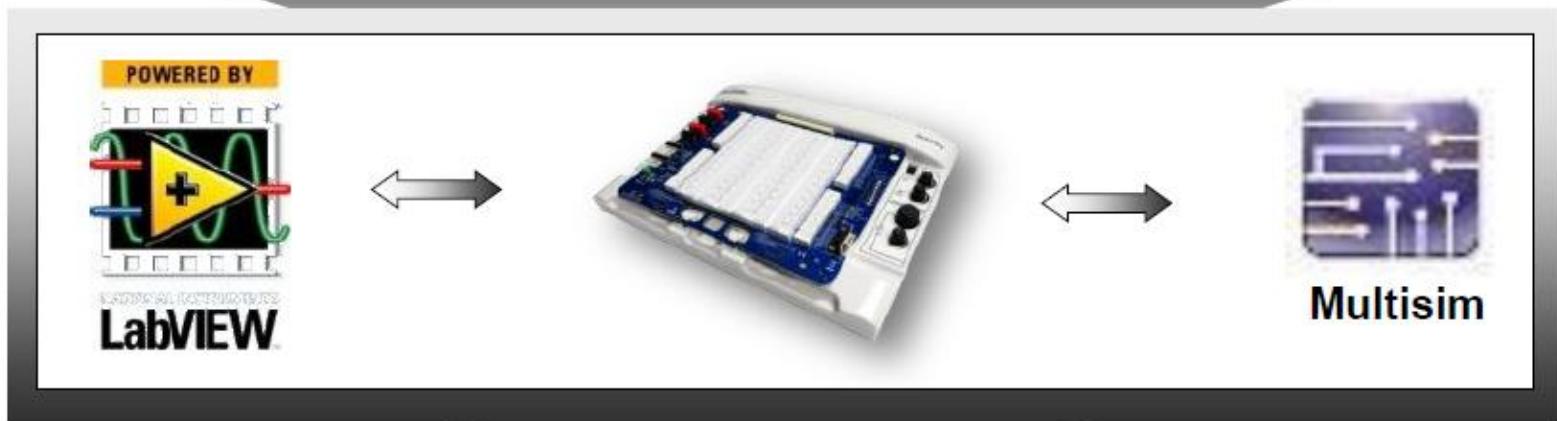
Structura placii de prototipaj

34



Ce se poate face cu NI ELVIS?

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Instrumentation

Circuits

Signal Processing

Control Design

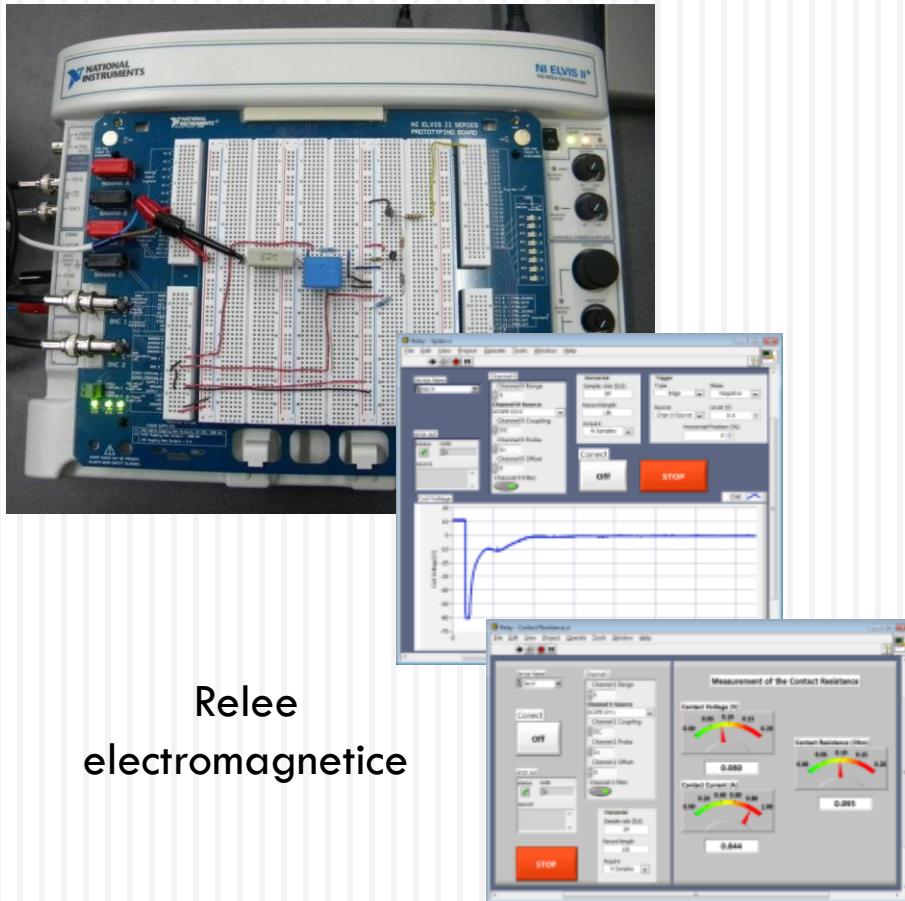
Communications

Mechatronics

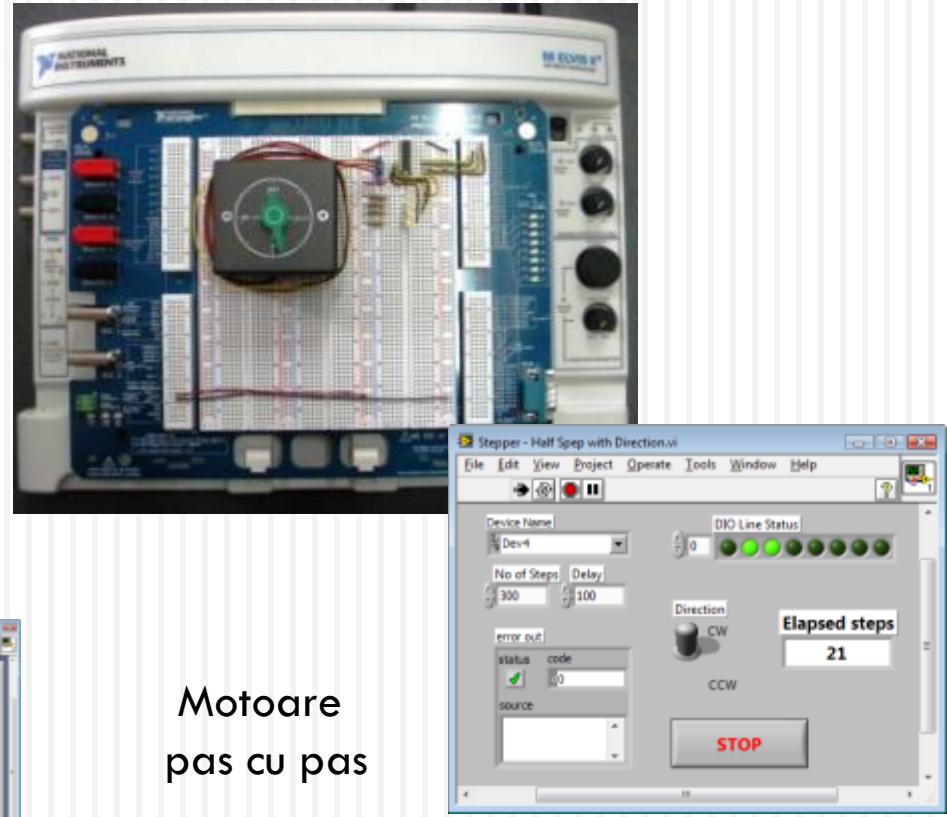
Ce se poate face cu NI ELVIS?

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□ Actuatori



Relee
electromagnetice

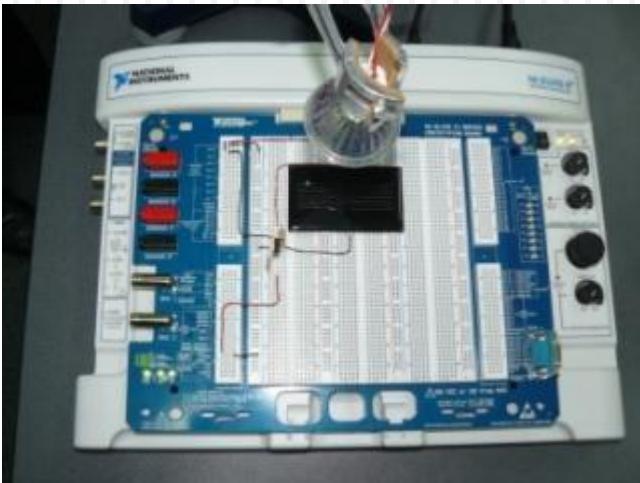


Motoare
pas cu pas

Ce se poate face cu NI ELVIS?

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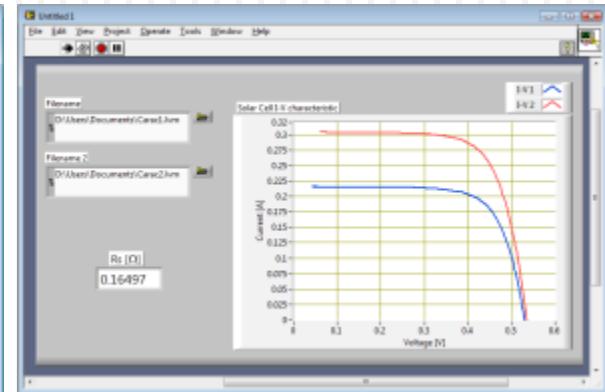
□ Studiul celulelor solare



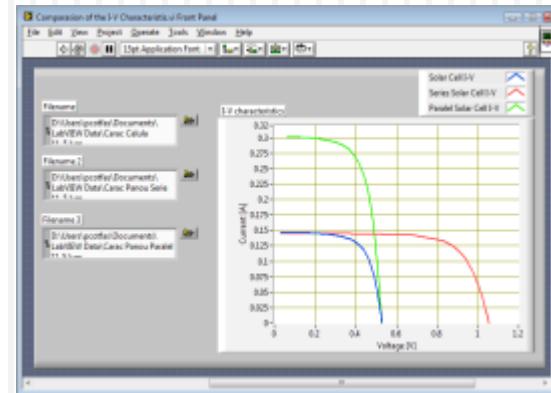
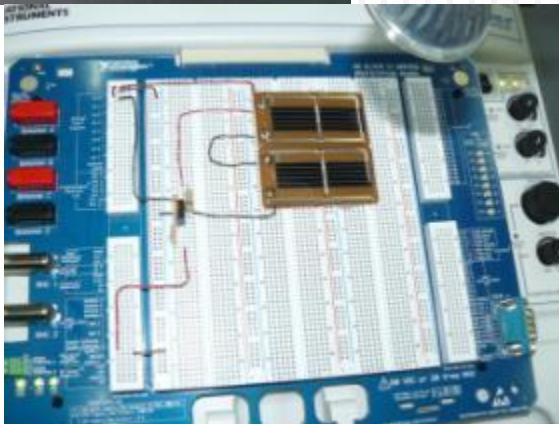
Studiul panourilor
solare



Masurarea caracteristicilor I-V



Masurarea R_s



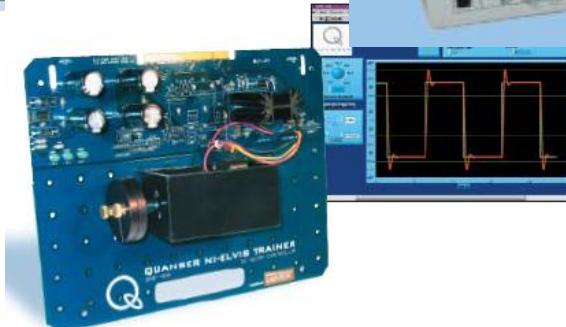
Caracteristicile I-V pentru conectarea serie paralel

De ce NI-ELVIS?

- Există un număr mare de placi add-on pentru NI ELVIS



Freescale

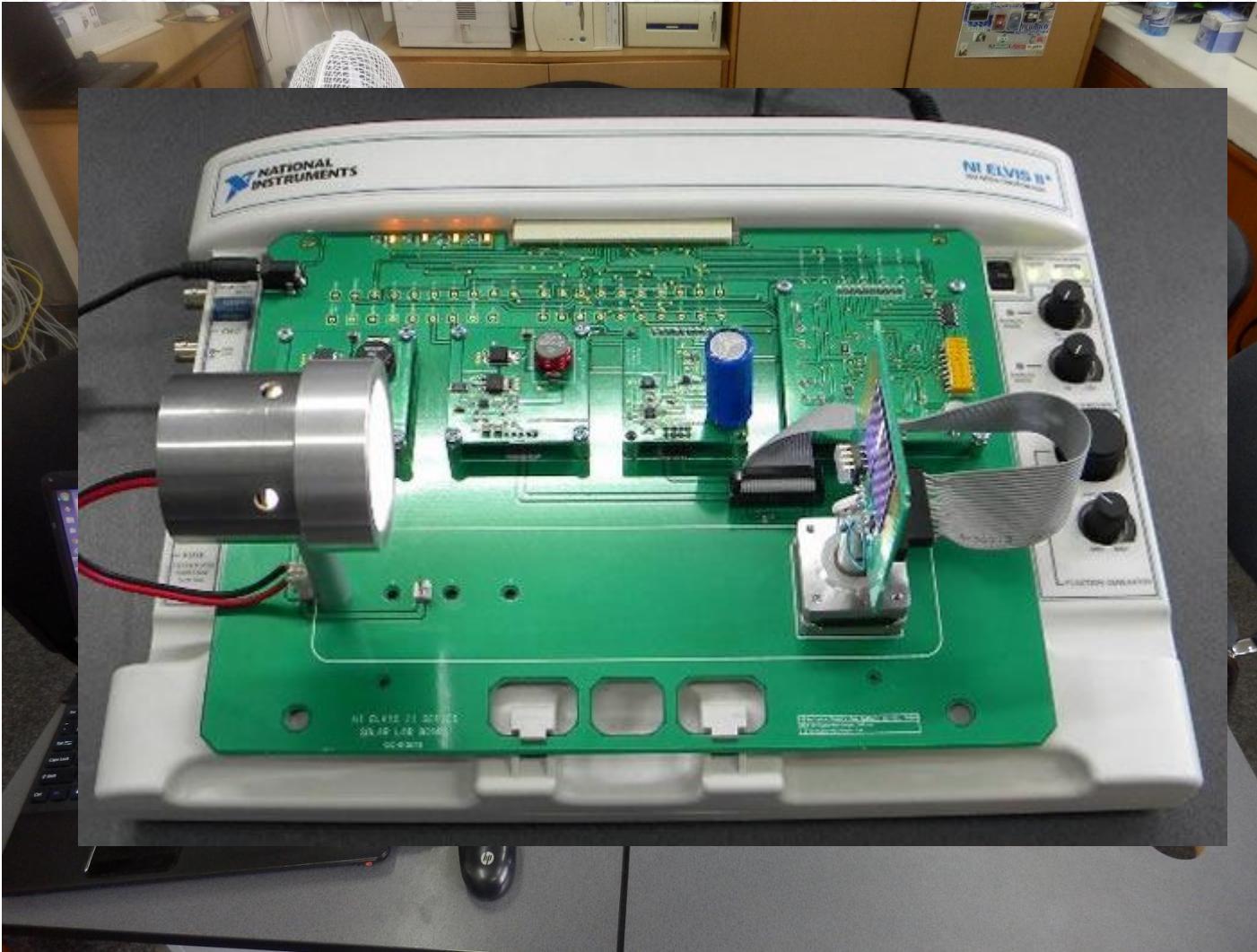


QUANSER ENGINEERING

DATEX - Digital Analog Telecommunications Experimenter

RELab

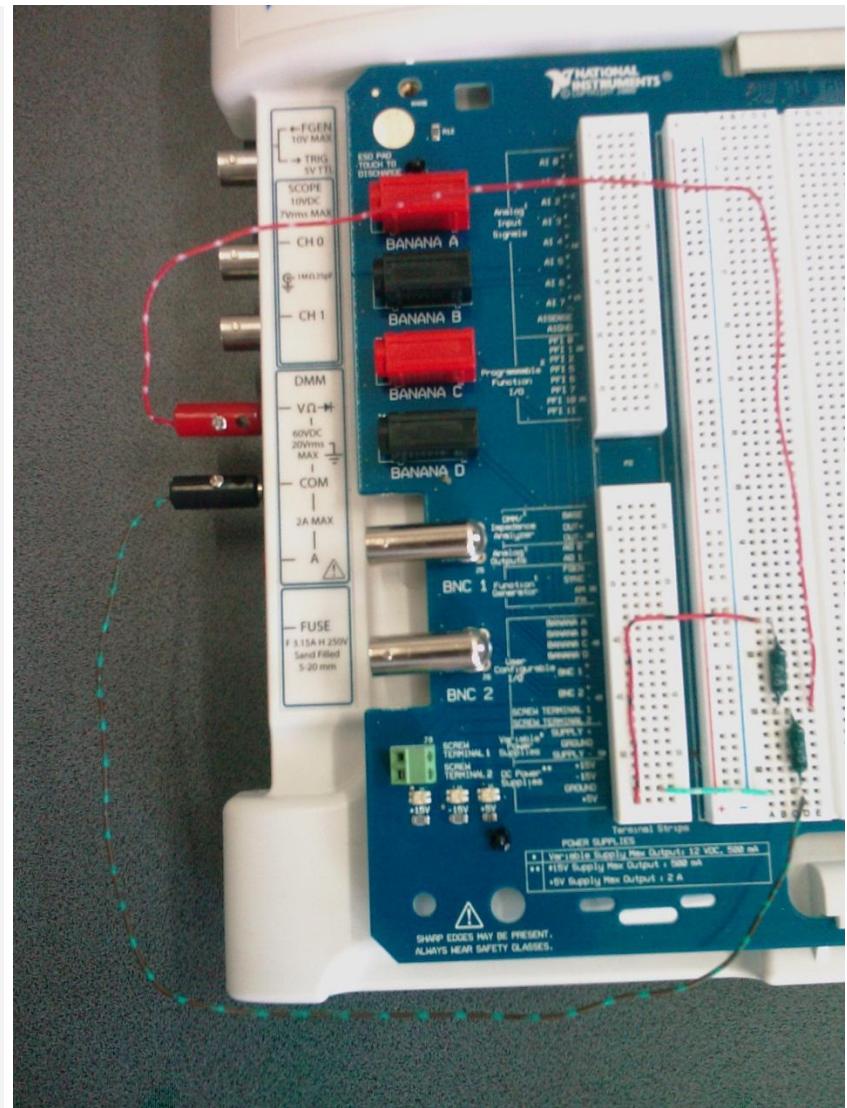
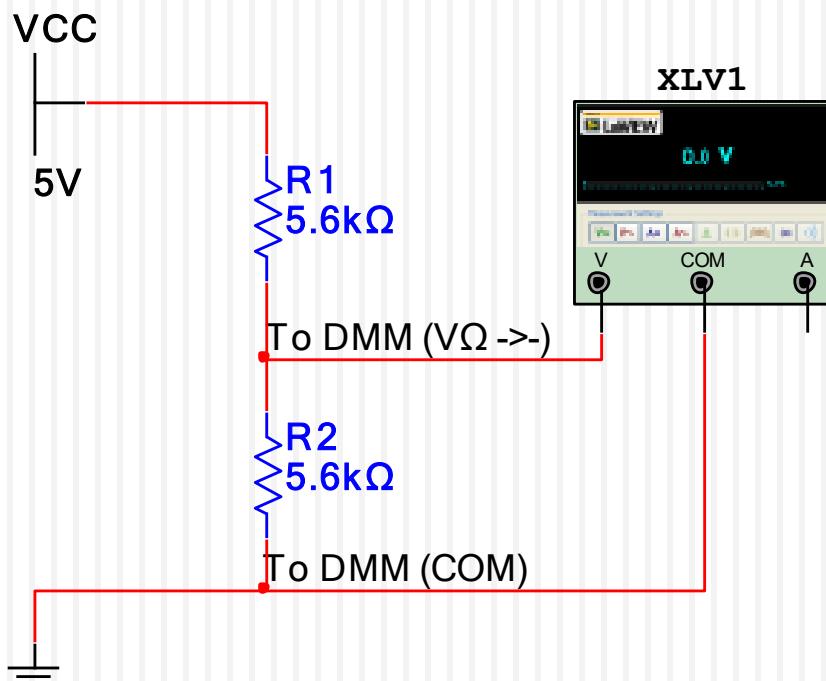
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Ex.1 Combinatie NI ELVIS, LabVIEW Multisim

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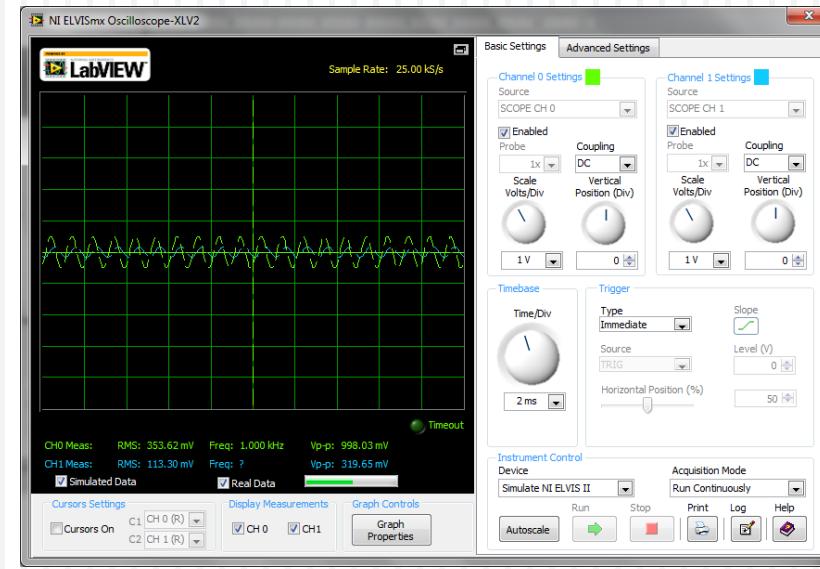
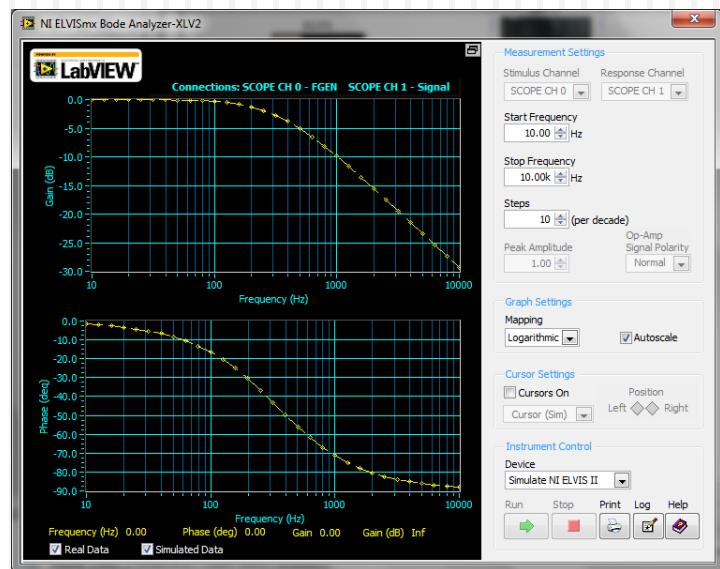
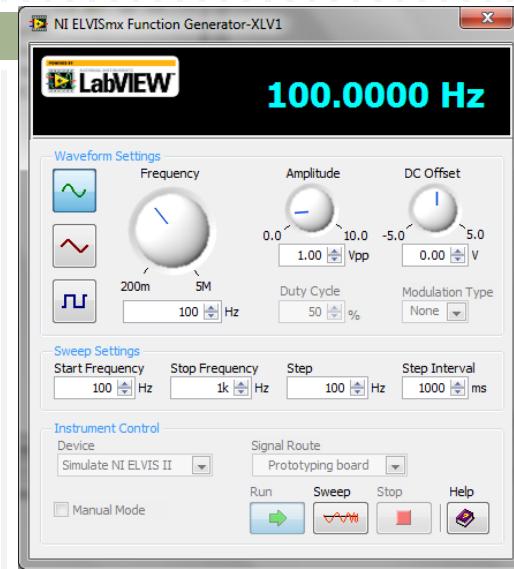
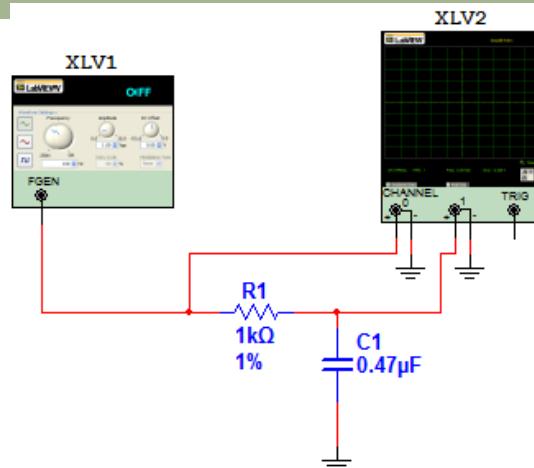
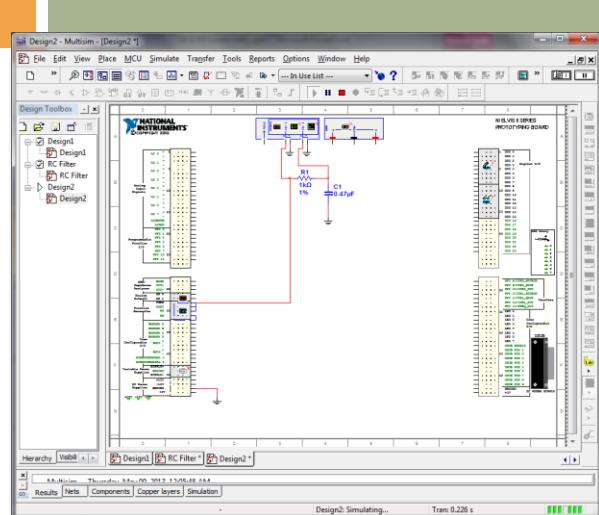
$$V_2 = \frac{R_2}{R_1 + R_2} V_{CC}$$



Ex.2 Combinatie NI ELVIS, LabVIEW

Multisim

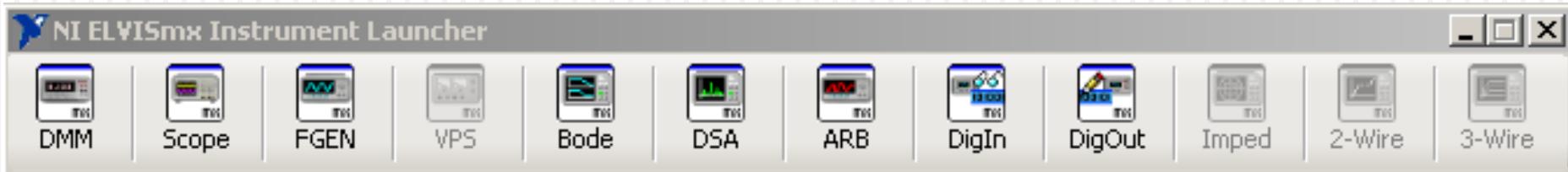
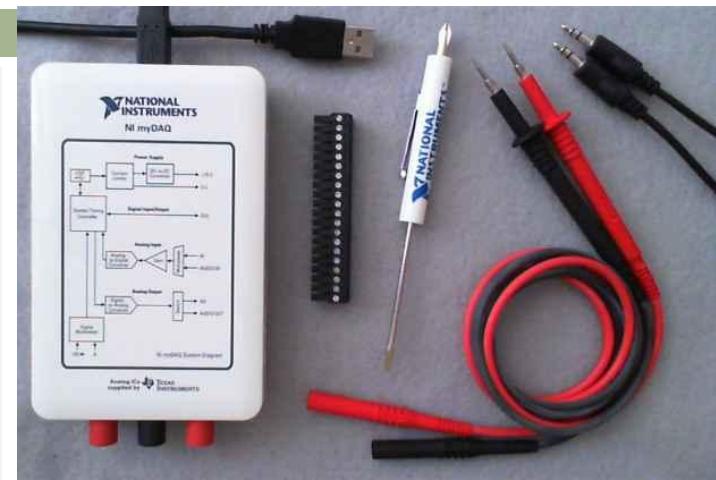
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myDAQ

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- Educatie orientata pe student
 - ▣ Laboratoare hands-on oriunde oricand
- Dispozitiv cu pret scazut
 - ▣ myDAQ este un NI ELVIS cu functionabilitate mai redusa
 - ▣ este dedicat studentilor
 - ▣ vine cu NI LabVIEW, NI Multisim,

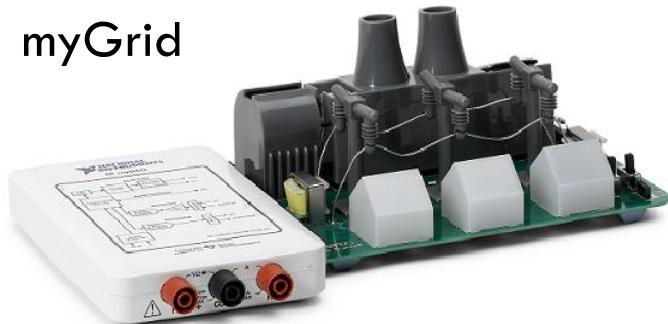


DAQ Hardware myDAQ

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□ Add-on-uri

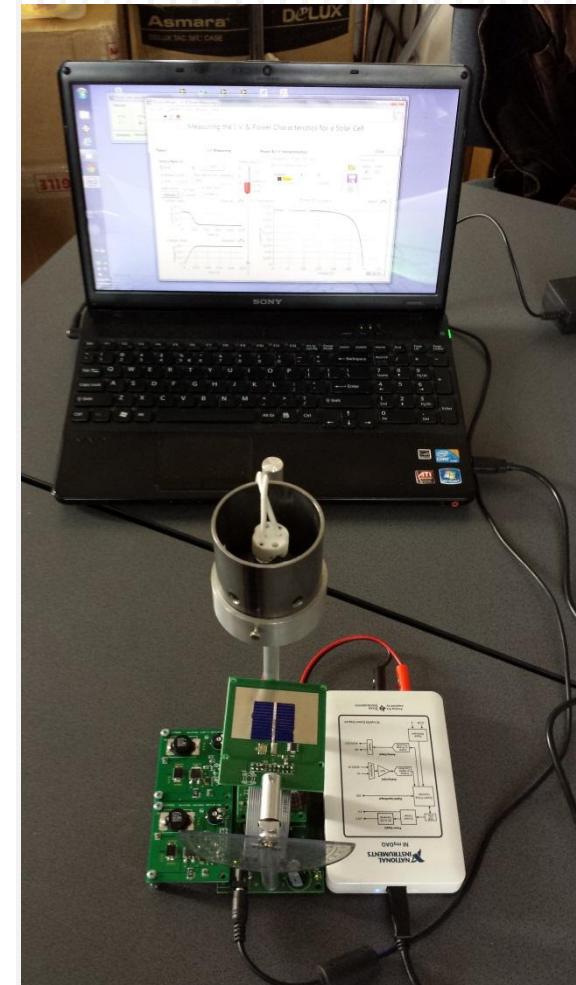
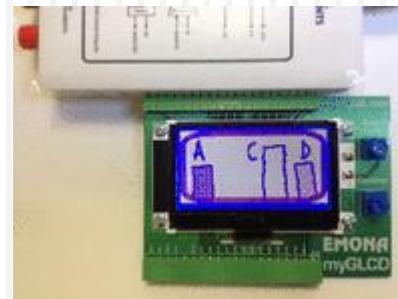
myGrid



myDSP



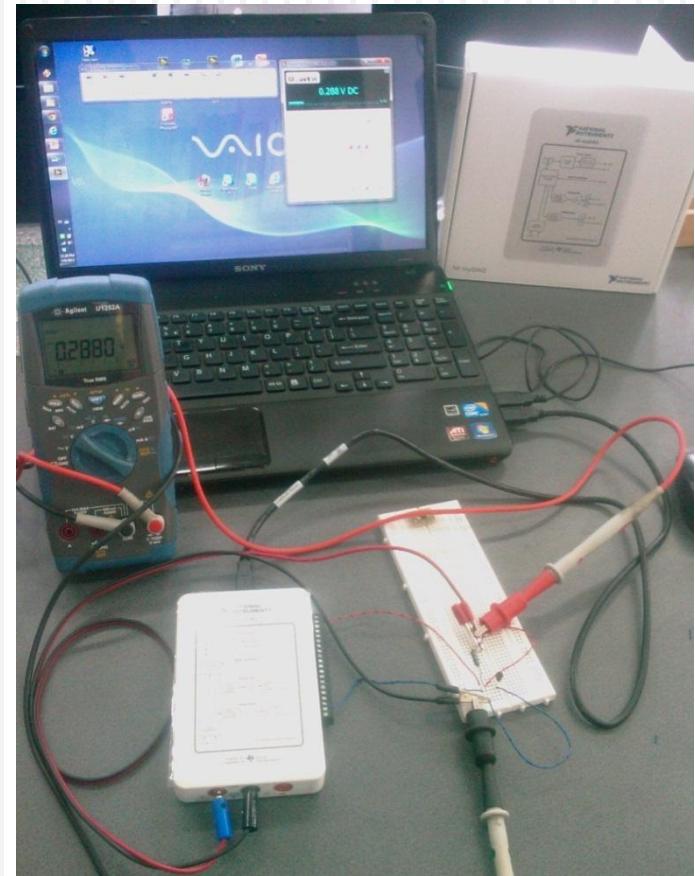
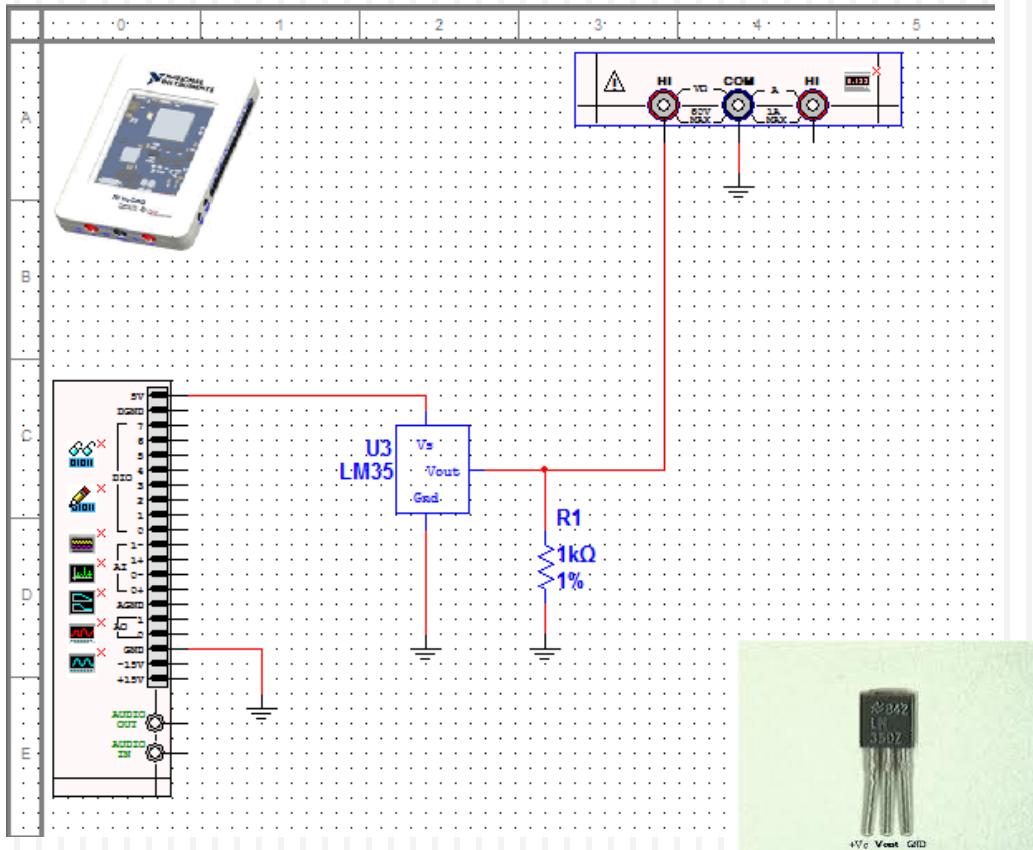
myGLCD



Ex.3 Masurarea temp. cu myDAQ

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- Masurarea temperaturii utilizand senzorul de temperatura LM35



myRIO

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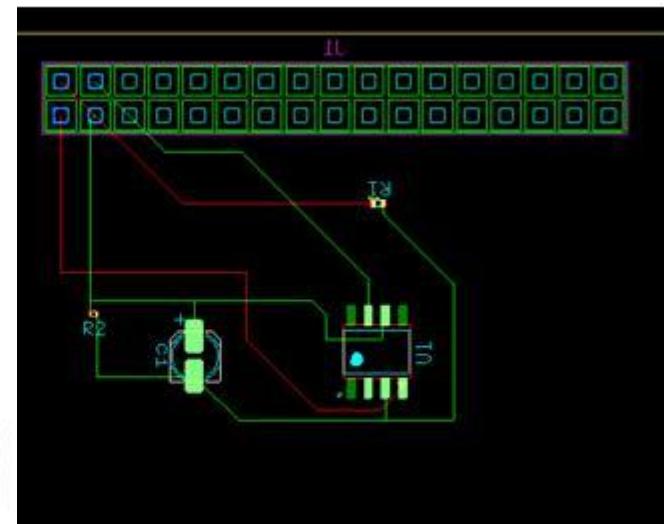
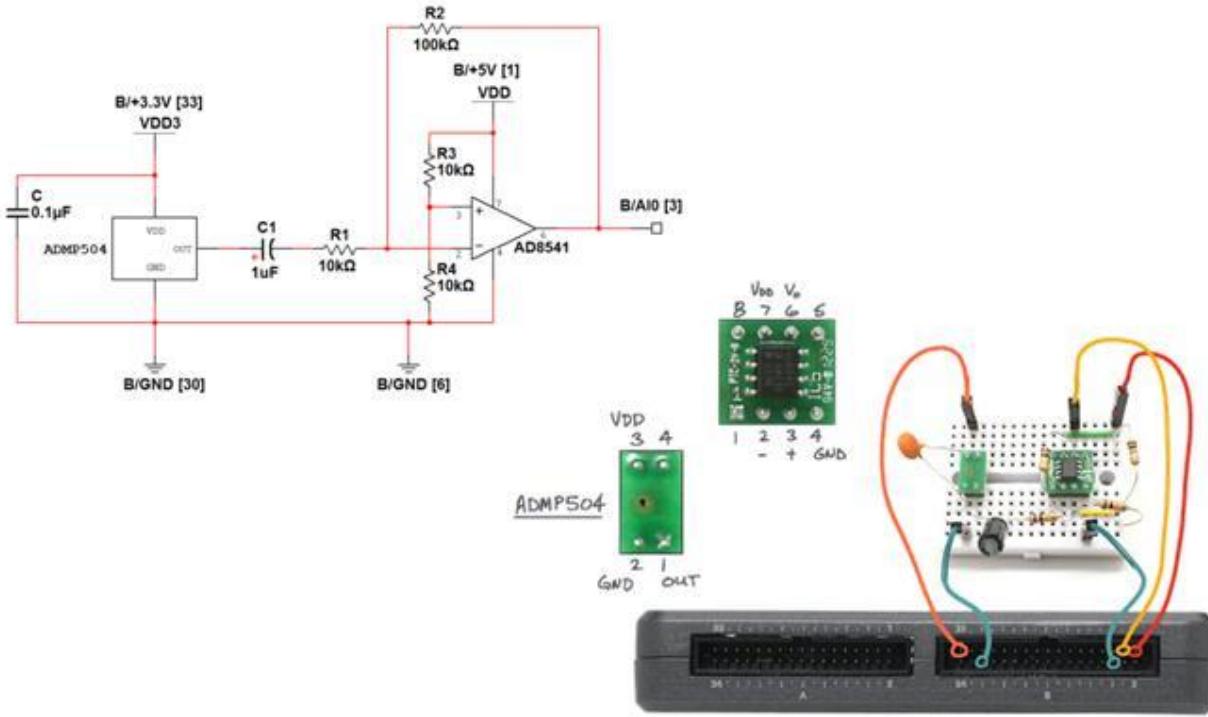
- “***The Ultimate Student Design Tool***
- *NI myRIO is an embedded hardware device designed specifically to help students design real, complex engineering systems more quickly and affordably than ever before.”*
- Tehologie reconfigurabila de I/O (RIO),
 - conexiune USB si wireless
 - Procesor real-time dual-core ARM
 - Xilinx FPGA
 - programabila din LabVIEW si C
 - 10 intrari analogice
 - 6 iesiri analogice
 - 40 linii digitale de I/O



myRIO

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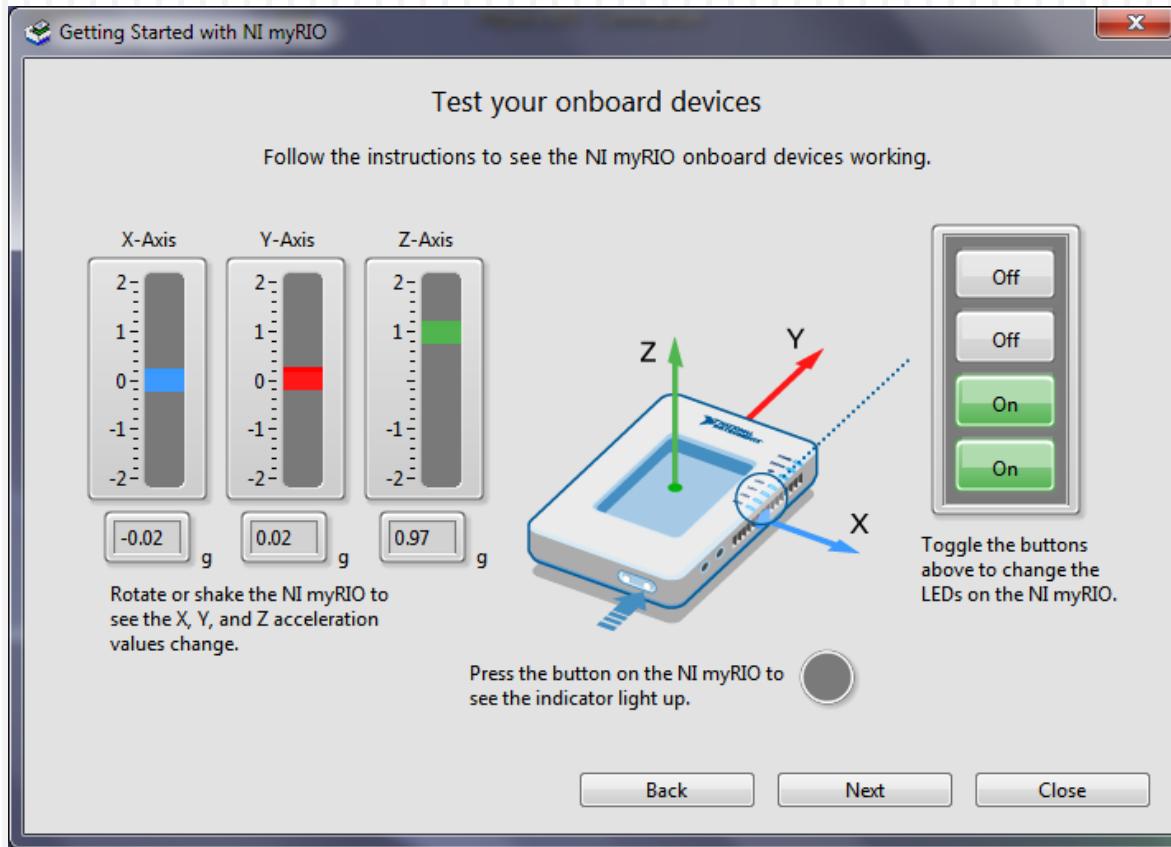
□ Împreună cu Multisim și Ultiboard



Ex.4 Utilizare myRIO

51

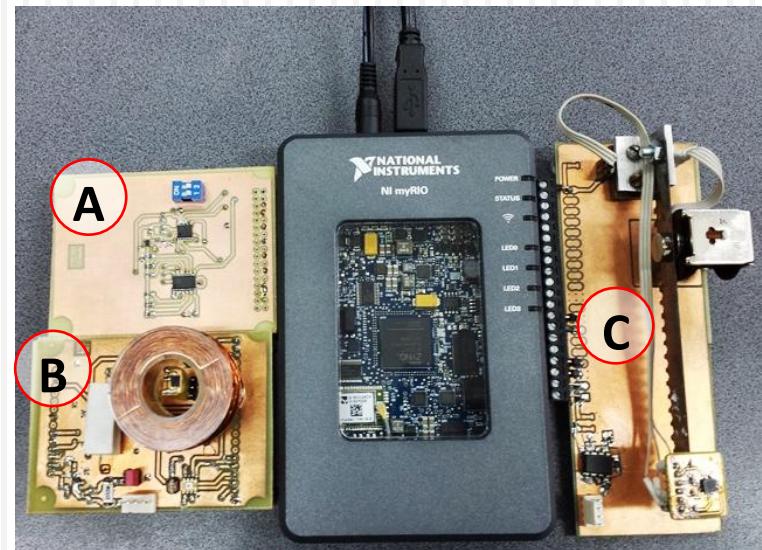
- Prima aplicatie in mai putin de 1 minut (10 secunde in functie de PC)



Utilizare myRIO

52

- A add-on
 - ▣ Studierea amplificatoarelor operationale in configuriile inversoare, neinversoare si repetor de tensiune (cu MCP6401)
- B add-on
 - ▣ Studierea inductiei magnetice si legea lui Joule
- C add-on
 - ▣ Studierea oscilatiilor amortizate si fortate



Laboratoare la distanta

53

Inverting OpAmp Application

Amplitude: 0.2

Frequency: 8 Hz

Rin: 1000

Rf: 4700

Results

Resulted Gain: 4.7

dt: 0.0001

Signals Amplitudes vs time

U [V]

Time [s]

Yin Yout

0.00011, 0.00024, 0.01033, 0.03227, 0.04801, 0.04804, 0.05431, 0.05814, 0.0809, 0.09506, 0.09555, 0.11315, 0.11568, 0.129, 23.0, 12151, 0.14028, 0.15339, 0.14318, 0.15551, 0.17113, 0.1

OpAmp.vi on Remote Lab.lvproj/NI-myRIO-1900-030536b5

File Edit View Project Operate Tools Window Help

OpAmp Schema

Measured signal

Gain setup

Rin: 1k
Rf: 4.7k

Input Sig. amplitude: 0.20
frequency: 80.00

OpAmp Gain

Gain: 4.6989

Config Inverting Amp STOP

Remote Lab.lvproj/NI-myRIO-1900-030536b5 < >

Laboratoare la distanta

□ Studierea celulelor solare

- Studierea efectului fotoelectric
- Pe baza placii RELab dezvoltata ca add-on pentru platforma NI ELVIS

$$I = I_{sc} - I_o \left(e^{\frac{q(V+IR_s)}{mkT}} - 1 \right) - \frac{V + IR_s}{R_{sh}}$$

- Utilizand placa RELab, caracteristicile I-V ale celulelor solare sunt masurate si analizate

