MATLAB and Simulink Italian Academic Forum

Insegnare con MATLAB e Simulink

UNIVERSITÀ DELLA CALABRIA

Prof. Antonio Bilotta
Università della Calabria

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La mia esperienza didattica

- Corso di Laurea in Ingegneria Civile (UNICAL): *Statica, Scienza delle costruzioni, Teoria delle strutture, Meccanica computazionale, Dinamica delle strutture, Analisi inelastica delle strutture* (2002-2014)

- Corso di Laurea in Ingegneria Civile (UNIBAS): *Introduzione al FEM, Formulazioni FEM per l'analisi strutturale, seminari e corsi di specializzazione sui metodi di analisi strutturale* (2002-2007)

- Corso di Laurea in Tecnologie per il restauro (UNICAL): *Scienza delle costruzioni* (2014-2017)

- Corso di Laurea in Ingegneria Alimentare e Chimica UNICAL: *Meccanica dei solidi* (2018-Oggi)

MATLAB Courseware

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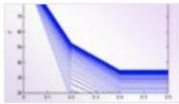
Mechanical and Aerospace Engineering

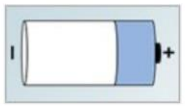
Mass-Spring-Damper Systems

Interactive courseware module that addresses the fundamentals of mass-spring-damper systems taught in mechanical engineering courses



Heat Transfer with MATLAB

Professor Tien-Mo Shih
Xiamen University

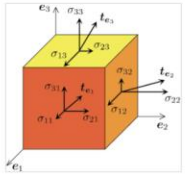


Model-Based Design Series: Battery Systems

Donald Docimo
Mohammad Ghanaatpishe
Professor Hosam Fathy
Pennsylvania State University

Teaching System Dynamics with Arduino, MATLAB, and Simulink

Professor Robert Webster
Vanderbilt University
Professor Jenna Gorlewicz
Southern Illinois University



A First Course on Solid Mechanics (English and Italian)

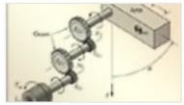
Professor Antonio Bilotta
University of Calabria

Model-Based Design Series: Basic Component Modeling

By Professor Doug Nelson
David Ord
Virginia Polytechnic Institute and State University

Model-Based Design Series: Supervisory Control & Fault Diagnosis

Professor Shawn Midlam-Mohler
Eric Gallo
The Ohio State University



System Dynamics with Simscape

Professor William J. Palm, III
University of Rhode Island

https://www.mathworks.com/academia/courseware.html#mechanical

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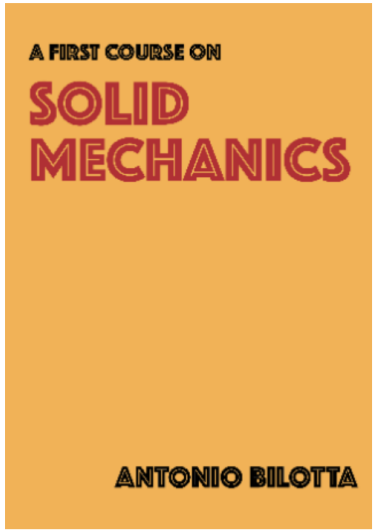
"A First Course on Solid Mechanics" Courseware



Course Materials Include:

- 5 chapters
- Video lessons
- Animations
- MATLAB exercises

Access free courseware for *A First Course on Solid Mechanics* from the University of Calabria.

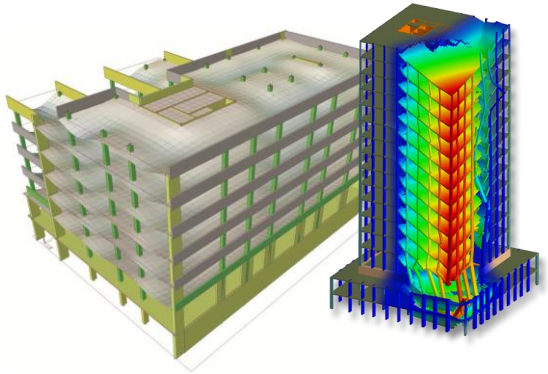
Access course materials (English)

Access course materials (Italian)

https://www.mathworks.com/academia/courseware/a-first-course-on-solid-mechanics.html

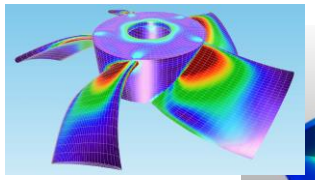
A cosa serve la “Meccanica dei solidi”

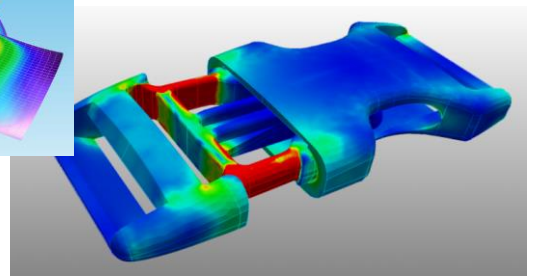
CONTESTI APPLICATIVI “TRADIZIONALI”

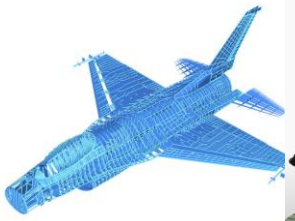


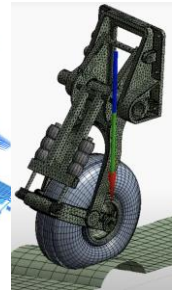
Ingegneria Civile

Ingegneria Meccanica



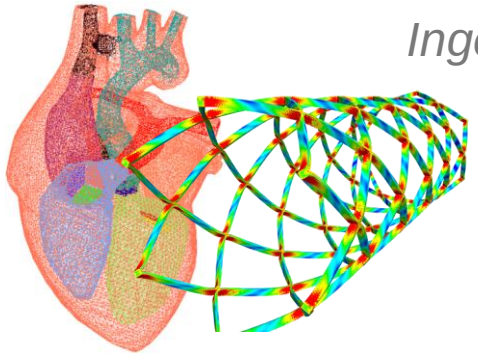




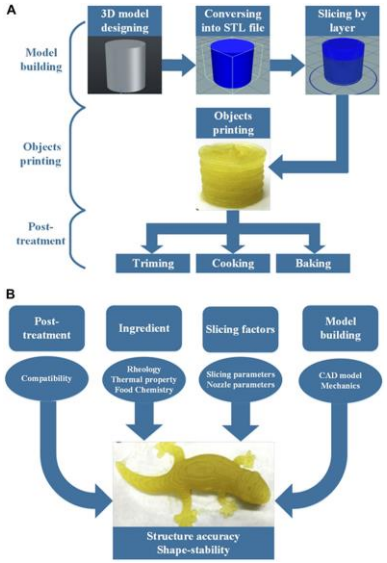


Ingegneria Aeronautica

CONTESTI APPLICATIVI EMERGENTI

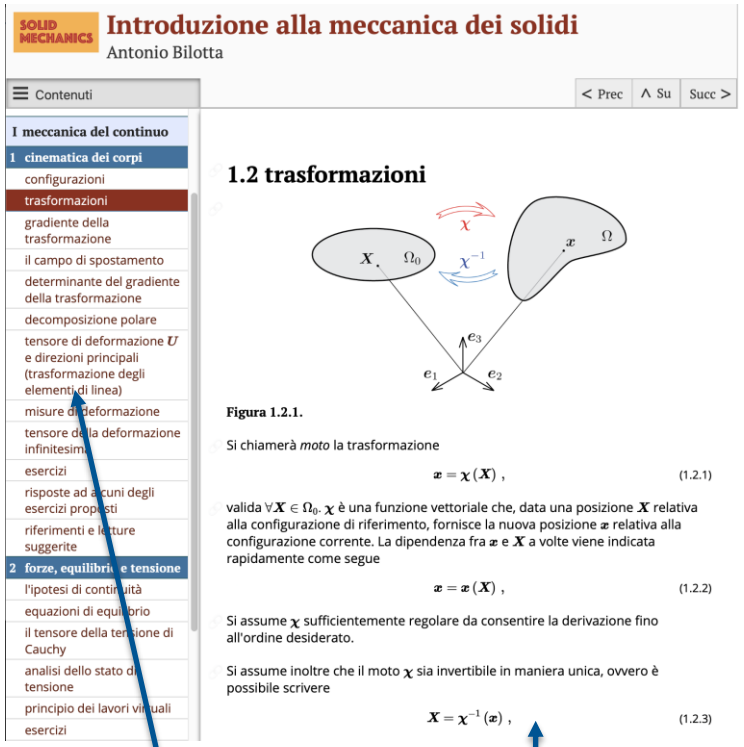


Ingegneria Biomedica



Food Engineering

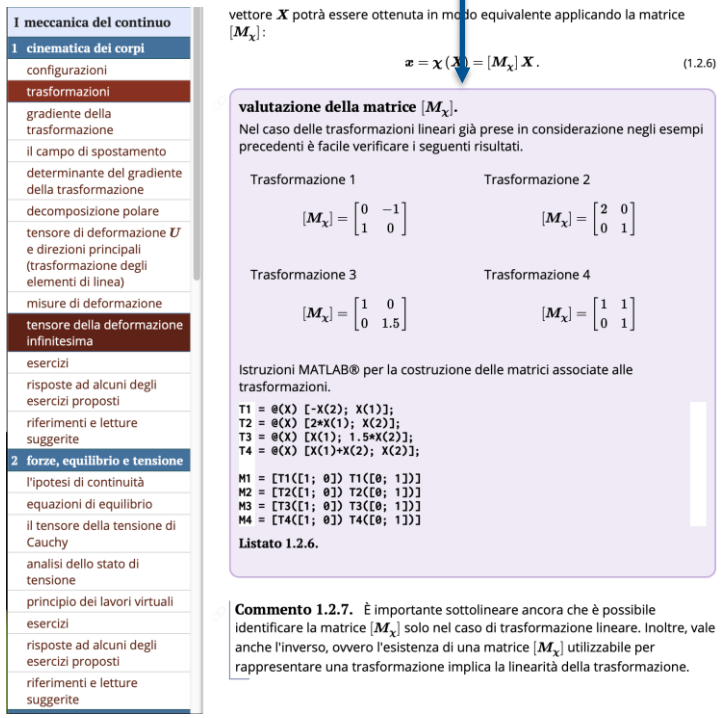
La struttura del “web-book”

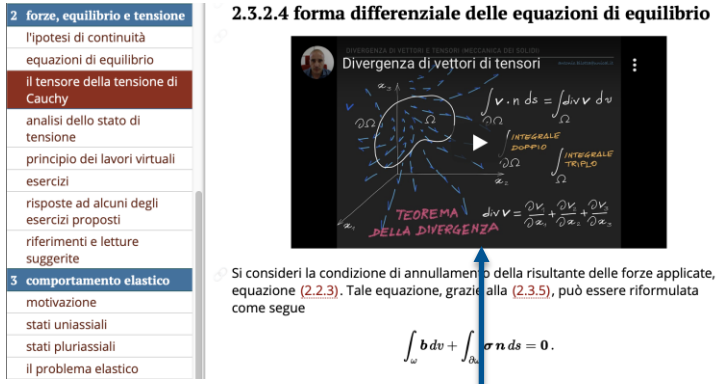


Menù per l’accesso alle sezioni ed ai capitoli

Parti descrittive in stile “libro standard”

Aree dedicate ad approfondimenti ed esercizi con codice MATLAB

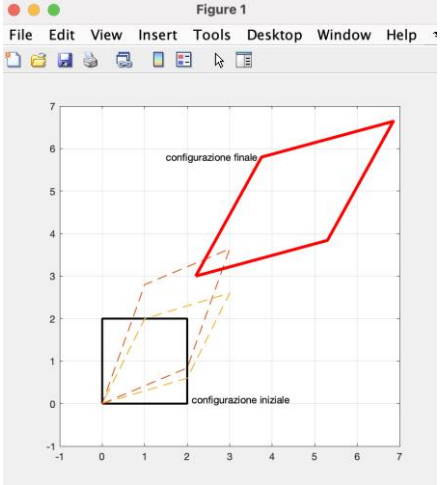




Brevi registrazioni video con richiami di geometria ed analisi

L’utilizzo di MATLAB, alcuni esempi

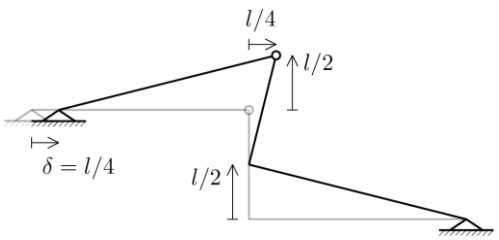
TRASFORMAZIONI




```
e1 = [1; 0]; e2 = [0; 1];
Txy = @(X) [X(1)+X(2)*0.5;...
    X(2)+X(1)*0.3 ];
Mxy = [Txy(e1) Txy(e2)];

A = [0; 0]; B = [2; 0];
C = [2; 2]; D = [0; 2];
a = Mxy*A; b = Mxy*B;
c = Mxy*C; d = Mxy*D;

figure
x = [A(1) B(1) C(1) D(1) A(1)];
y = [A(2) B(2) C(2) D(2) A(2)];
plot(x,y,'-','LineWidth',2,...
    'Color','black')

x = [a(1) b(1) c(1) d(1) a(1)];
y = [a(2) b(2) c(2) d(2) a(2)];
hold on
plot(x,y,'--','LineWidth',1,...
    'Color','#EDB120')
```

- *Vettori*
- *Manipolazione di vettori mediante function handles*
- *Matrici associate alle trasformazioni lineari*
- *Rappresentazione grafica dei risultati*

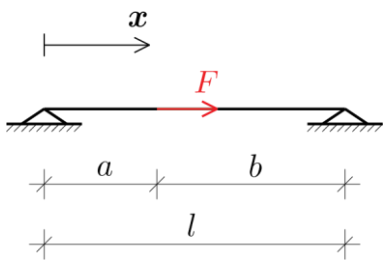
ANALISI CINEMATICA E STATICA DI SISTEMI RIGIDI




```
rigidDispl = ...
    @(u0, phi0, X0, X)...
    [u0(1)-phi0*(X(2)-X0(2));...
     u0(2)+phi0*(X(1)-X0(1))];

POLO = A;
syms phiA;
phi0 = phiA;
u0 = sym('uA', [2 1]);
uA = rigidDispl(u0, phi0, POLO, A);
uB = rigidDispl(u0, phi0, POLO, B);
uC = rigidDispl(u0, phi0, POLO, C);

eqns=[uA(2)==0, uB(2)==0, uC(1)==0];

[A,d] = equationsToMatrix(eqns,...
    [uA(1), uA(2), phiA]);
```

- *Utilizzo di variabili simboliche*
- *Equazioni di vincoli*
- *Sistema lineare associato*
- *Condizioni di solvibilità del sistema*

SOLUZIONE DEL PROBLEMA ELASTICO PER SISTEMI DI TRAVI



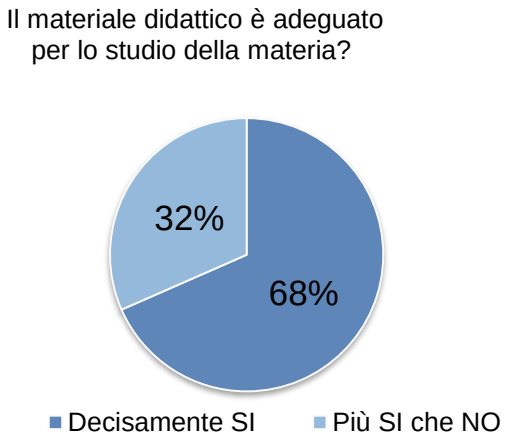

```
syms ua(x) ub(x) EA F l a;
Dua = diff(ua);
Dub = diff(ub);
ode1 = EA*diff(ua,x,2) == 0;
ode2 = EA*diff(ub,x,2) == 0;
odes = [ode1; ode2];
cond1 = ua(0) == 0;
cond2 = ub(l) == 0;
cond3 = ua(a) == ub(a);
cond4 = EA*Dua(a) - EA*Dub(a) == F;
conds = [cond1 cond2 cond3 cond4];
sols = dsolve(odes,conds);
```

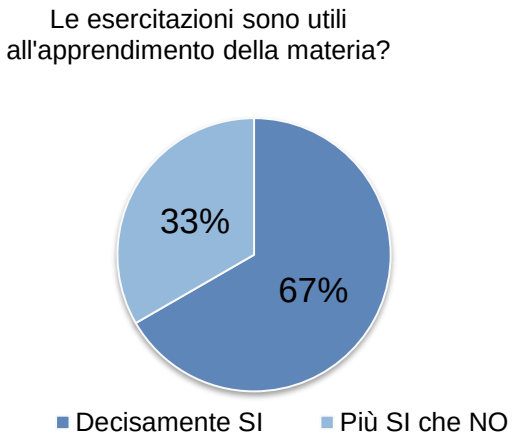
- *Sistemi di equazioni differenziali*
- *Condizioni al contorno*
- *Soluzione in forma simbolica*

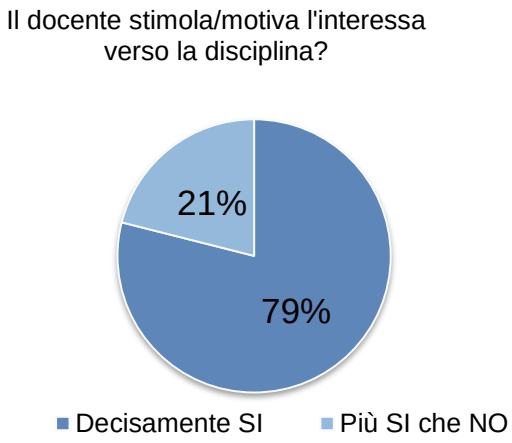
Conclusioni

- *La "Meccanica dei solidi" spesso viene insegnata utilizzando **"linguaggi" differenti** che disorientano lo studente*
- *MATLAB ha consentito l'individuazione di un **linguaggio unico***
- *L'utilizzo di MATLAB, anche se sperimentato in contesti semplici, è facilmente **scalabile** ai contesti applicativi più complessi*
- *La manipolazione diretta delle formule con MATLAB e il ricchissimo framework offerto dell'applicazione, **"concretizzano" la comunicazione** evidenziandone immediatamente l'utilità*
- *La **curiosità e l'interesse** da parte degli studenti sono stati incrementati oltre le attese*

Opinioni studenti dopo il primo anno di sperimentazione (2019-2020)







Grazie per l’attenzione

https://antoniobilotta-structuralengineer.github.io/MyWebSite/

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