ESPECIALIZACIÓN EN ESTRUCTURAS
ANÁLISIS ESTRUCTURAL AVANZADO

INTERACCIÓN ENTRE SAP2000 Y MATLAB

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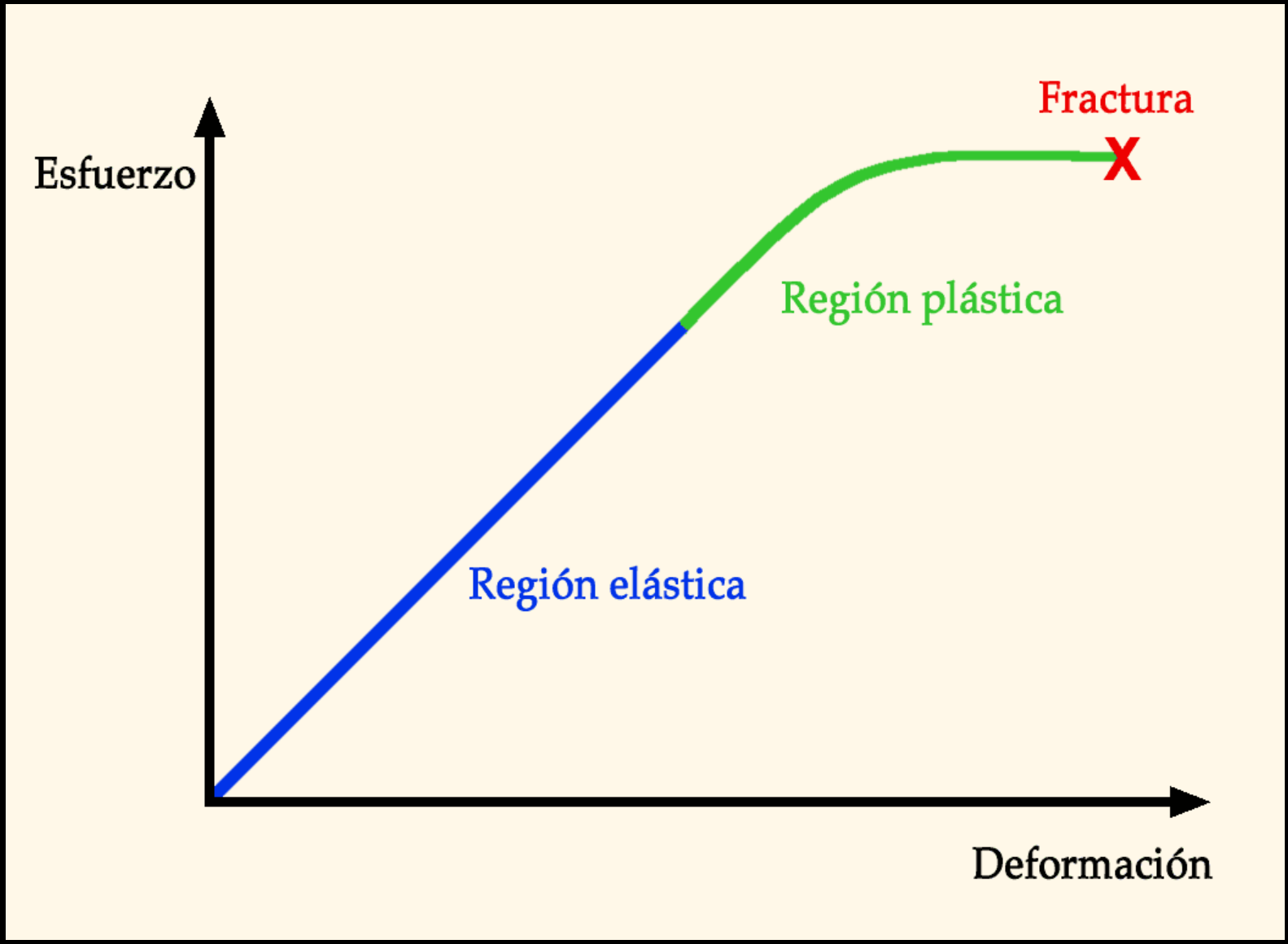
INTERACCIÓN SAP Y MATLAB

1. Generalidades.
2. OAPI.
3. Ajuste de modelos.
4. Algoritmos.
5. Maximización o minimización.

1. GENERALIDADES

1. GENERALIDADES



1. GENERALIDADES

¿Porqué?

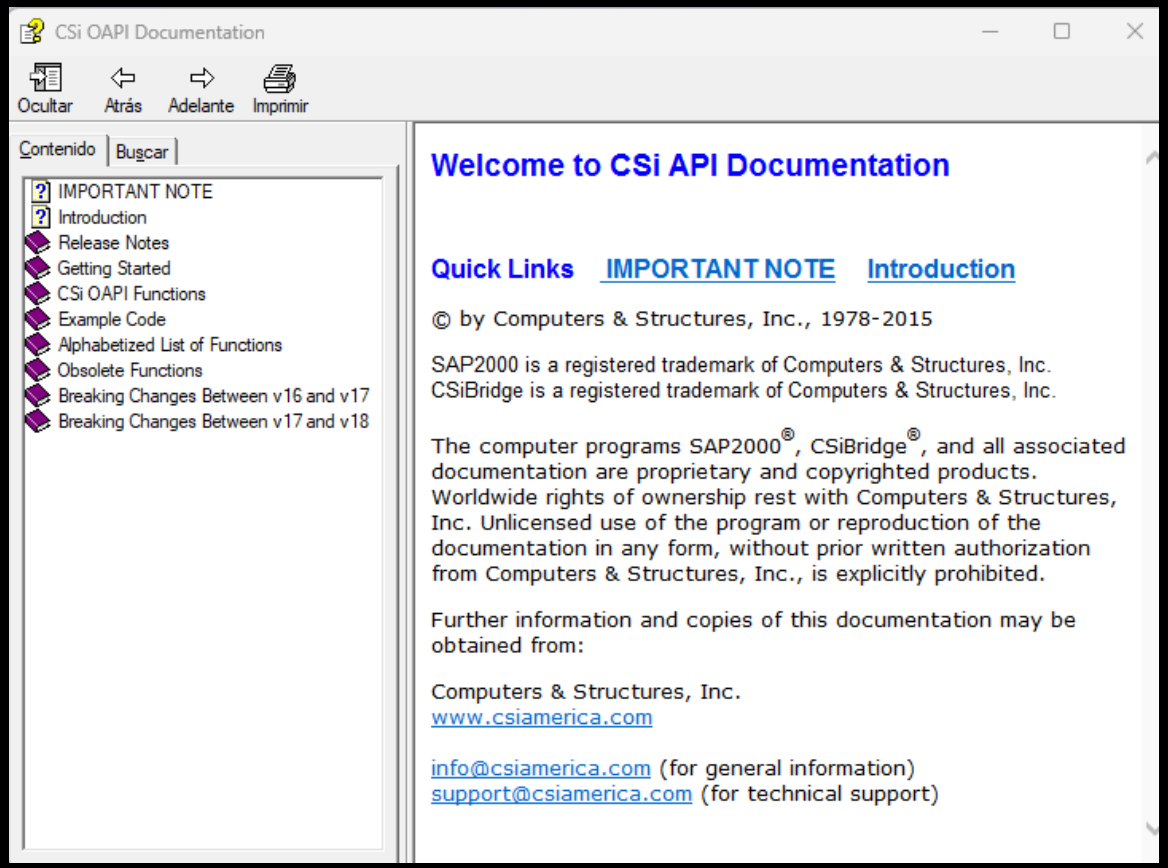
1. GENERALIDADES

Minimización se secciones

2. OAPI

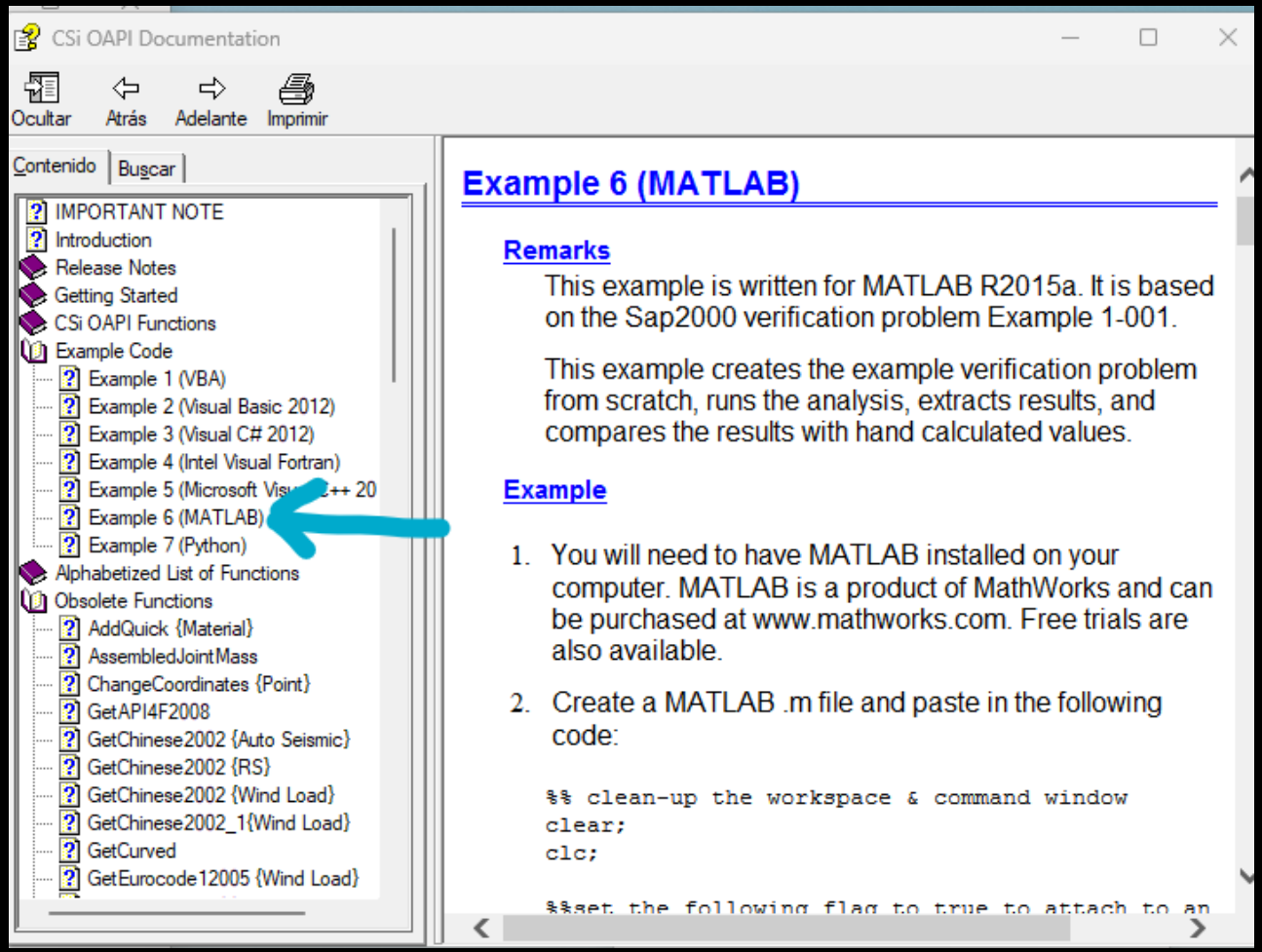
CSI_OAPI_Documentation.chm

Open Application Programming Interface (OAPI)



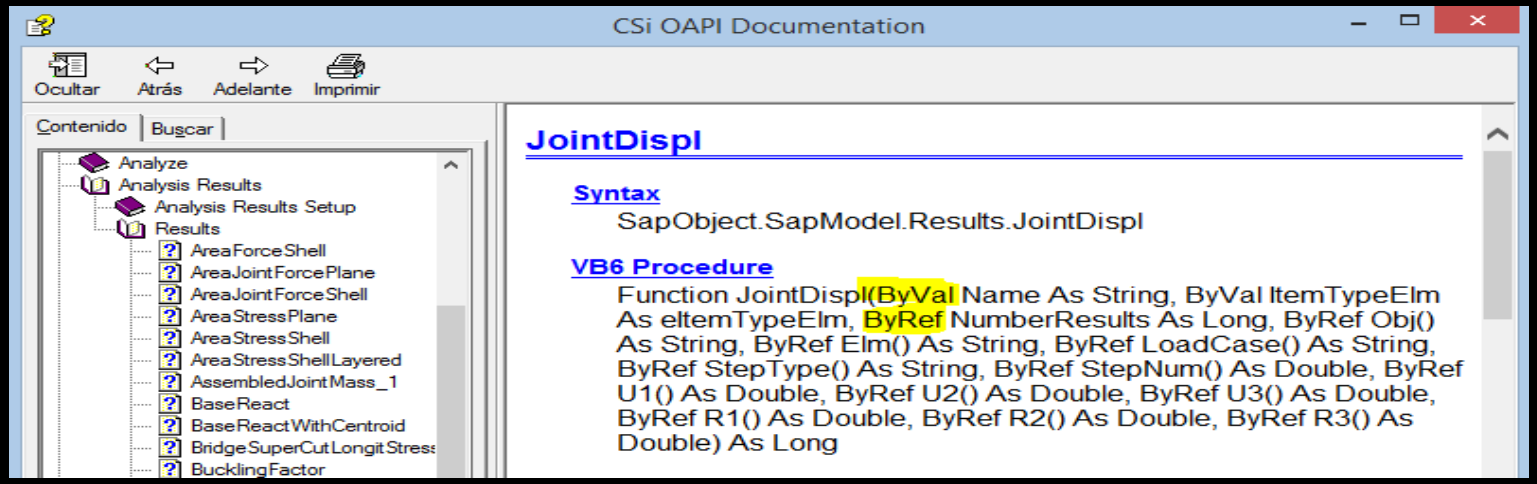
2. OAPI

CSI_OAPI_Documentation.chm



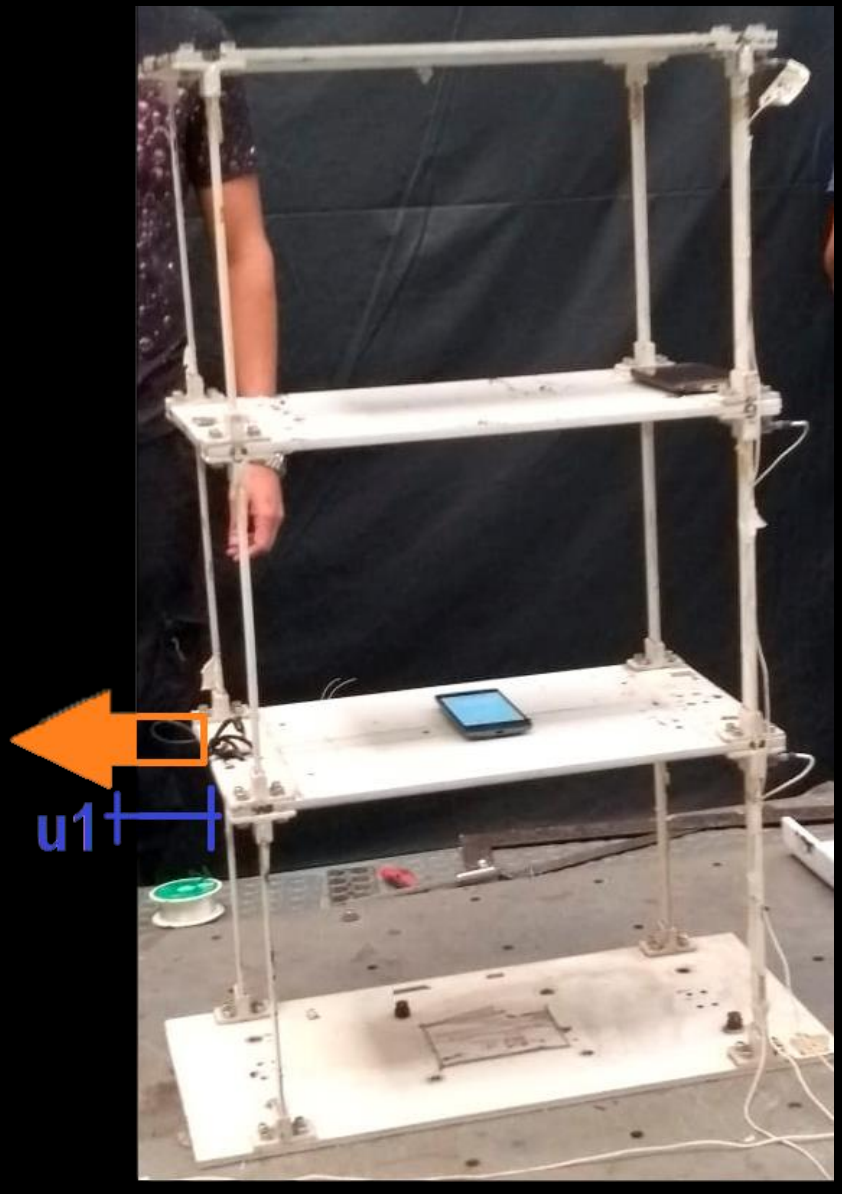
2. OAPI

CSI_OAPI_Documentation.chm

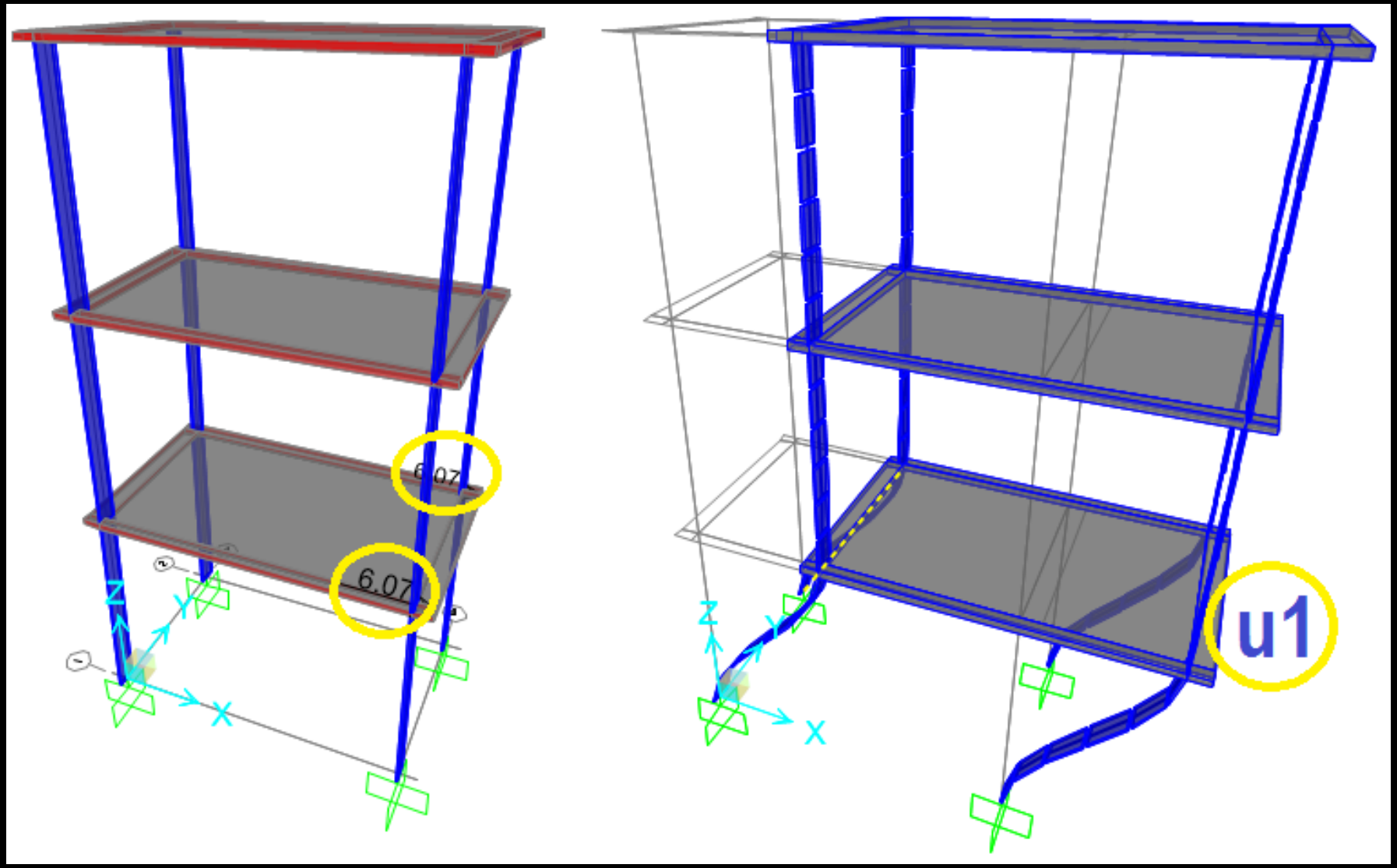



```
[ret, NumberResults, Obj, Elm, ACase, StepType, StepNum,...
   U1, U2, U3, R1, R2,R3] = ...
   Results.JointDispl(nud, ...
                      GroupElm,...
                      NumberResults,...
                      Obj,...
                      Elm,...
                      LoadCase,...
                      StepType,...
                      StepNum,...
                      U1, U2, U3, R1, R2, R3);
```

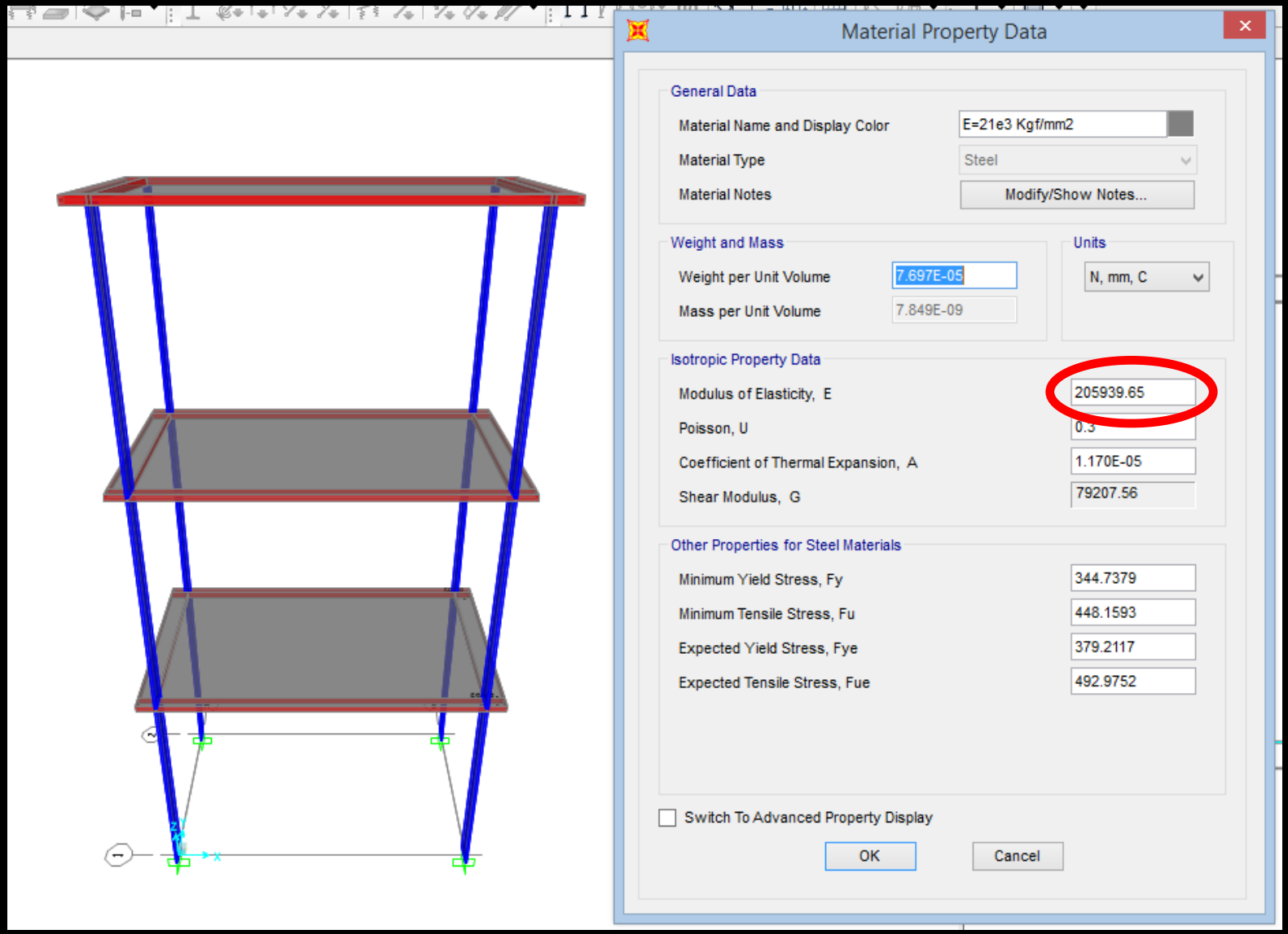
3. AJUSTE DE MODELOS



3. AJUSTE DE MODELOS



3. AJUSTE DE MODELOS



3. AJUSTE DE MODELOS

```
%% object SAP

pathDir='C:\Program Files\Computers and Structures\SAP2000 19\';
ProgramSap=strcat(pathDir,'SAP2000.exe');
APIDLL=strcat(pathDir,'SAP2000v19.dll');

a = NET.addAssembly(APIDLL); % Microsoft® .NET Framework
helper = SAP2000v19.Helper;
helper = NET.explicitCast(helper,'SAP2000v19.cHelper');

%creating an instance of the Sap2000 object
SapObject = helper.CreateObject(ProgramSap);
SapObject = NET.explicitCast(SapObject,'SAP2000v19.cOAPI');
helper = 0;

SapModel = NET.explicitCast(SapObject.SapModel,'SAP2000v19.cSapModel');
File = NET.explicitCast(SapModel.File,'SAP2000v19.cFile');
PropFrame = NET.explicitCast(SapModel.PropFrame,'SAP2000v19.cPropFrame');
PropMaterial =
NET.explicitCast(SapModel.PropMaterial,'SAP2000v19.cPropMaterial');
Analyze = NET.explicitCast(SapModel.Analyze,'SAP2000v19.cAnalyze');
Results = NET.explicitCast(SapModel.Results,'SAP2000v19.cAnalysisResults');
ResultsSetup =
NET.explicitCast(Results.Setup,'SAP2000v19.cAnalysisResultsSetup');
```

3. AJUSTE DE MODELOS

```
%% start of aplication
SapObject.ApplicationStart;
ret = SapModel.InitializeNewModel;

%% opening data file

% Example of task 6
pathModel='D:\Google
Drive\DOCTORADO\Asignaturas\2\Dinámica Estructural\Ajuste
de modelos\Modelo SAP2000\';
ModelName=strcat(pathModel,'Tarea6.sdb');

ret = File.OpenFile(ModelName);
ret =
SapModel.SetPresentUnits(SAP2000v19.eUnits.Ton_mm_C); %
Unidades
```

3. AJUSTE DE MODELOS

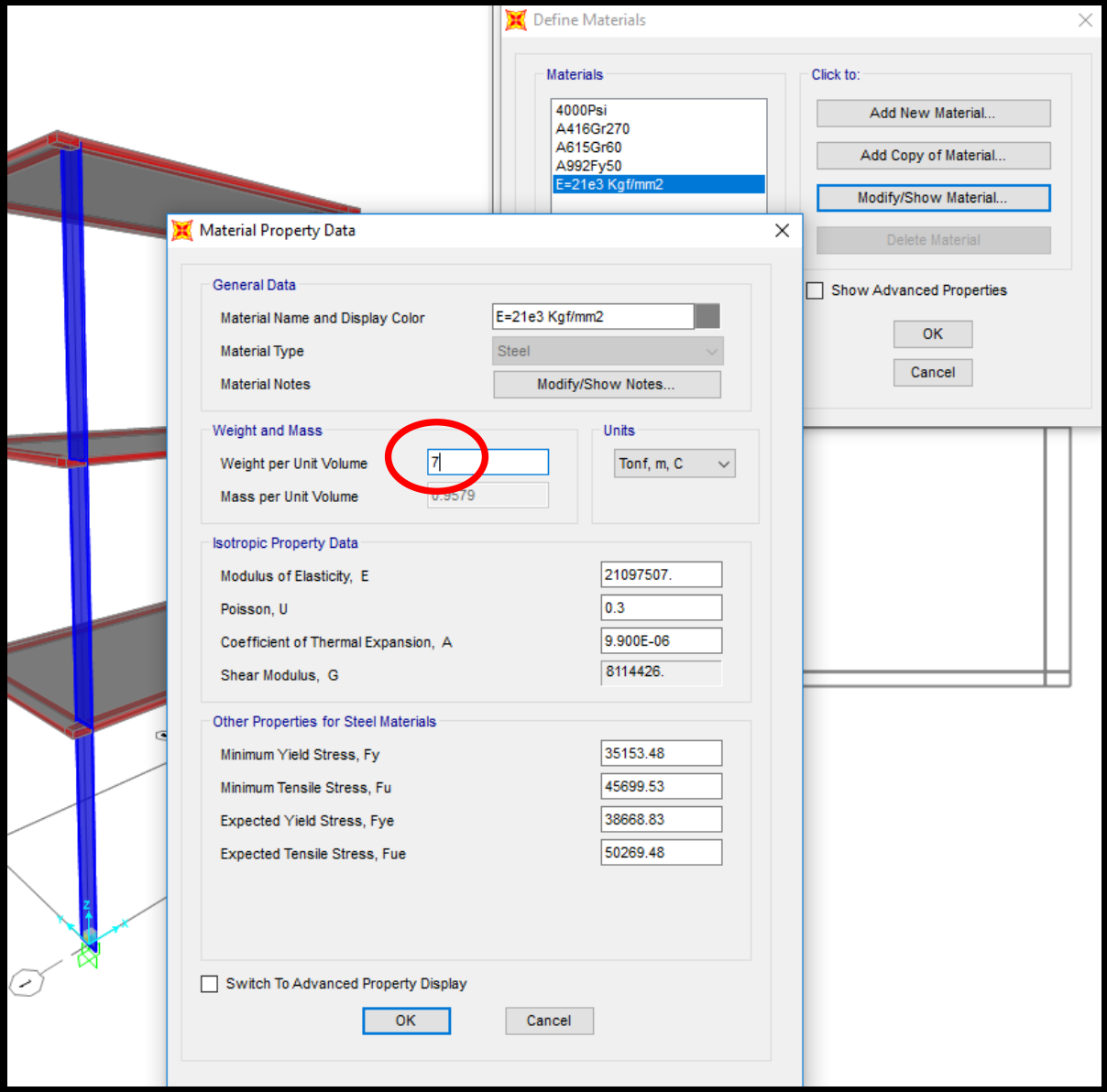
```
%% Ciclo en Sap2000

Ec = 9.5; %Tnf/mm2
U1_obj=2.4; %measured in laboratory 2.4mm. It's the target in task 6
Dif=+inf;
maxSteps=50;
Dif_obj=U1_obj*.01; %1% of objetive-value
step=1;

mod=Ec;
while Dif>Dif_obj && step<=maxSteps
   % Desbloquea el modelo
   ret = SapModel.SetModelIsLocked(false);
   ret=PropMaterial.SetMPIsotropic('E=21e3 Kgf/mm2', mod, 0.3, 9.900E-06);

   % Corre modelo
   ret=Analyze.RunAnalysis;
   % Selecciona el CASE del cual desea obtener los datos
   ret = ResultsSetup.DeselectAllCasesAndCombosForOutput;
   ret = ResultsSetup.SetCaseSelectedForOutput('F-rigidez');
   nud='248';
   NumberResults = 0;
   GroupElm=SAP2000v19.eItemTypeElm.ObjectElm;
   Obj = {''}; Elm = {''};
   LoadCase = {''};
   StepType = {''};
   StepNum = 0;
   U1 = 0;   U2 = 0;   U3 = 0;   R1 = 0;   R2 = 0;   R3 = 0;

   [ret, NumberResults, Obj, Elm, ACase, StepType, StepNum,...
   U1, U2, U3, R1, R2,R3] = ...
   Results.JointDispl(nud, GroupElm, NumberResults, Obj, Elm, LoadCase, StepType, StepNum, U1, U2, U3, R1, R2, R3);
   Dif=U1(1)-U1_obj;
   if abs(Dif)>Dif_obj
       mod=mod+mod*.5*Dif/U1_obj;
   end
   disp(strcat('step ',num2str(step),' u1=',num2str(U1(1)),' dif=',num2str(Dif)))
   step=step+1;
end
```

3. AJUSTE DE MODELOS

step:1 E=15.3444 u1=5.353 dif=2.953
step:2 E=18.2666 u1=3.3141 dif=0.91412
step:3 E=19.7277 u1=2.7839 dif=0.38394
step:4 E=20.4583 u1=2.5778 dif=0.17775
step:5 E=20.8236 u1=2.4857 dif=0.085702
step:6 E=21.0062 u1=2.4421 dif=0.0421
step:7 E=21.0975 u1=2.4209 dif=0.020867
step:8 E=21.0975 u1=2.4104 dif=0.010388
Ec (Tonf/mm^2) = 21.0975

```
%% Best way to close SAP2000
%set the objects to Nothing
%at the end of your program ALWAYS terminate
the objects in this manner
ret = SapObject.ApplicationExit(false());
SapModel = 0;
SapObject = 0;
```

3. AJUSTE DE MODELOS



3. AJUSTE DE MODELOS

```
RoW=0;RoM=0;
[ret,RoW,RoM]=PropMaterial.GetWeightAndMass('E=21e3 Kgf/mm2',RoW,RoM);
%frecuency 3
f1_obj=14.5; %measured in laboratory Hz. It's the target in task 6

Dif=+inf;
maxSteps=50;
Dif_obj=max(f1_obj)*.01/100; %0.1% of objetive-value
step=1;

mod=RoW;
while Dif>Dif_obj && step<=maxSteps
   % Desbloquea el modelo
   ret = SapModel.SetModelIsLocked(false);

   ret=PropMaterial.SetWeightAndMass('E=21e3 Kgf/mm2',... %name
                                     1,... %option weight (2=mass)
                                     mod); %value of weight
   % Corre modelo
   ret=Analyze.RunAnalysis;
   % Selecciona el CASE del cual desea obtener los datos
   ret = ResultsSetup.DeselectAllCasesAndCombosForOutput;
```

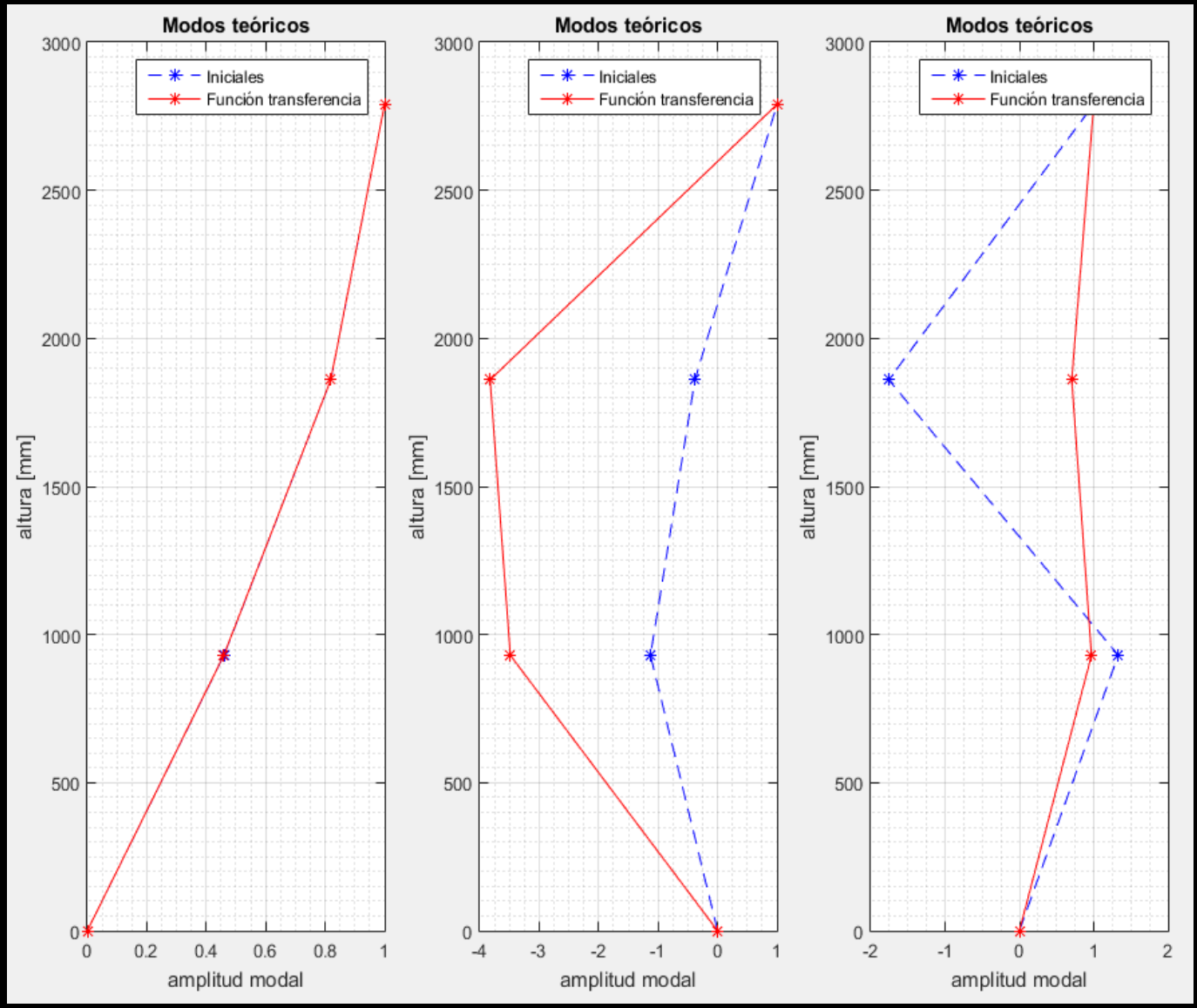
3. AJUSTE DE MODELOS

```
    ret = ResultsSetup.SetCaseSelectedForOutput('MODAL');
    NumberResults = 0;
    GroupElm=SAP2000v19.eItemTypeElm.ObjectElm;
    Obj = {''}; Elm = {''}; LoadCase = {''}; StepType = {''}; StepNum = 0;
    Period=0; Frequency=0; CircFreq=0; EigenValue=0;

    [ret, NumberResults,LoadCase,StepType,StepNum,...
                          Period,Frequency,CircFreq,EigenValue] = ...
     Results.ModalPeriod(NumberResults, LoadCase, StepType, StepNum,...
                          Period, Frequency, CircFreq, EigenValue);
     F=[Frequency(1) Frequency(2) Frequency(3)];
     Dif=max(F(3)-f1_obj);
     disp(strcat('step:',num2str(step),' W=',num2str(mod),' F=',num2str(F),...
                 ' dif=',num2str(Dif)))
     if abs(Dif)>Dif_obj
         mod=mod+mod*.5*Dif/max(f1_obj);
     end
     step=step+1;
end
```

3. AJUSTE DE MODELOS

step:1	W=7	F=4.2327	11.6297	16.2975	dif=1.7975
step:2	W=7.4339	F=4.12829	11.3489	15.9218	dif=1.4218
step:3	W=7.7983	F=4.04631	11.1283	15.6257	dif=1.1257
step:4	W=8.101	F=3.9818	10.9545	15.3921	dif=0.89208
step:5	W=8.3502	F=3.93095	10.8175	15.2075	dif=0.7075
step:30	W=9.3923	F=3.73758	10.2958	14.5023	dif=0.0023211
step:31	W=9.3931	F=3.73745	10.2955	14.5018	dif=0.0018475
step:32	W=9.3937	F=3.73735	10.2952	14.5015	dif=0.0014706
step:33	W=9.3942	**F=3.73727**	**10.295**	**14.5012**	dif=0.0011705

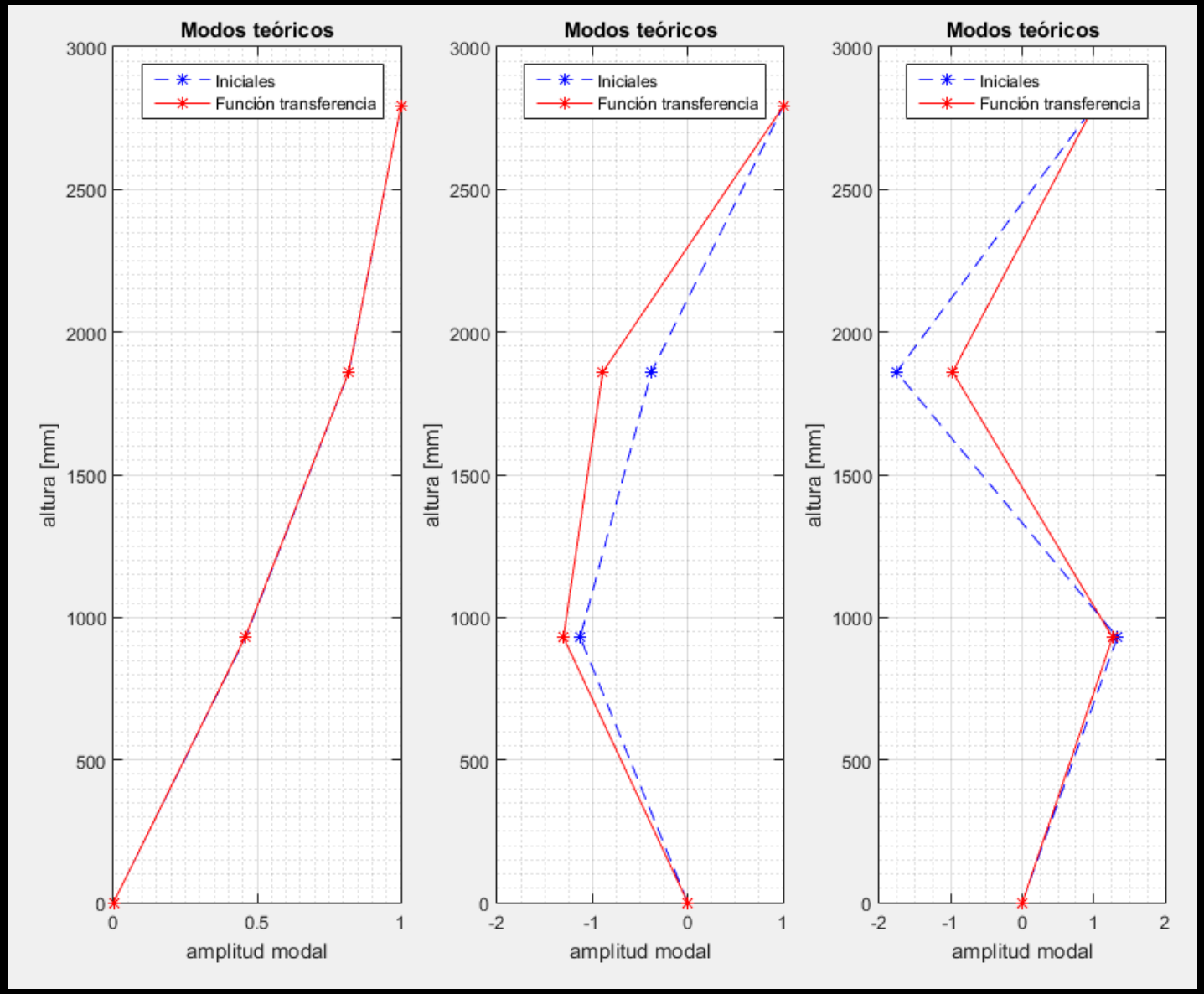
3. AJUSTE DE MODELOS



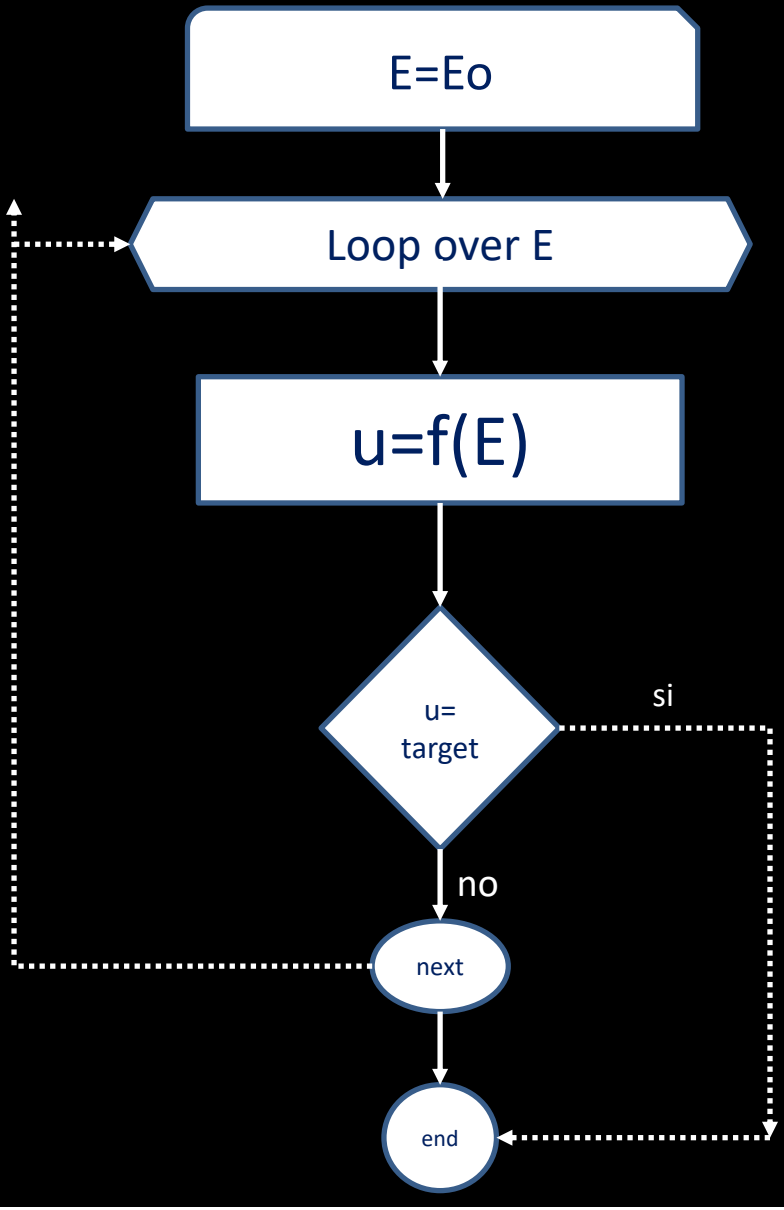
3. AJUSTE DE MODELOS

```
%ajuste de la inercia para acercarse a la 1a frecuencia de 3.5 Hz
dif_obj=0.00001*3.5;
dif=+inf;
I=I_ini;
iteracion=1;
while ((dif>dif_obj) && (iteracion<200))
    K=(E*I/h^3)*[24   -12     0;
                 -12    24   -12;
                  0    -12    12];
    Kmed=mean(abs(K(find(reshape(K,size(K,1)*size(K,2),1)~=0))));
    [phi,wn2]=eig(K,M); % Vectores y valores propios
    f=wn/(2*pi); % Frecuencias (Hertz)
    dif=3.5-f(1,1);
    if abs(dif)>abs(dif_obj)
       I=I+.1*dif*I;
    end

disp(strcat(num2str(iteracion),';',num2str(f(1,1)),';',num2str(I)));
    iteracion=iteracion+1;
end
```

3. AJUSTE DE MODELOS

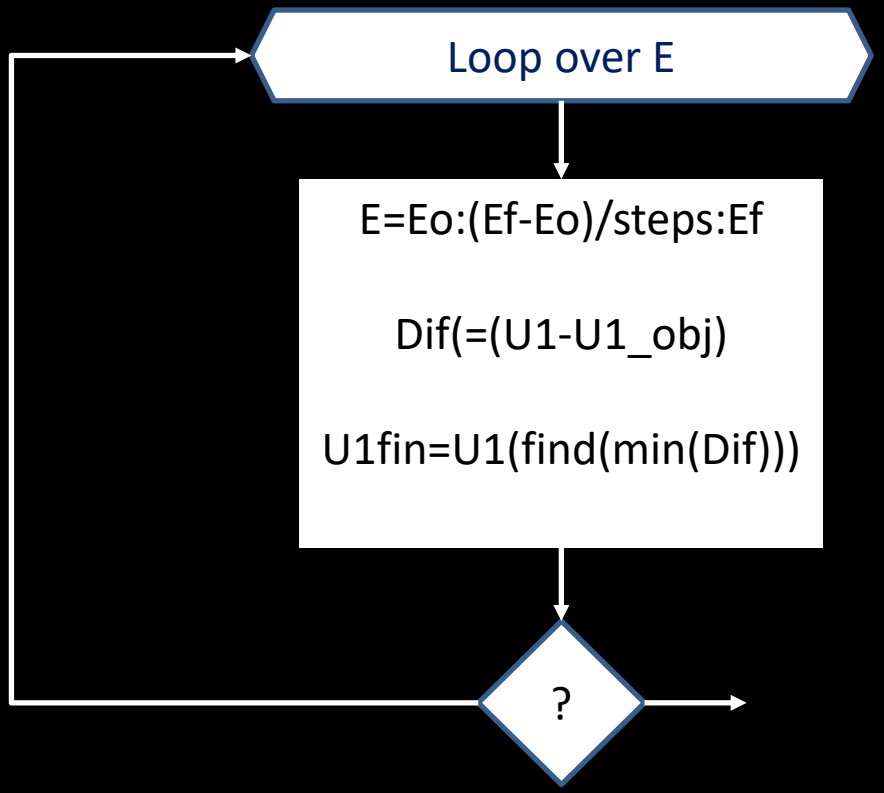


4. ALGORITMOS



4. ALGORITMOS

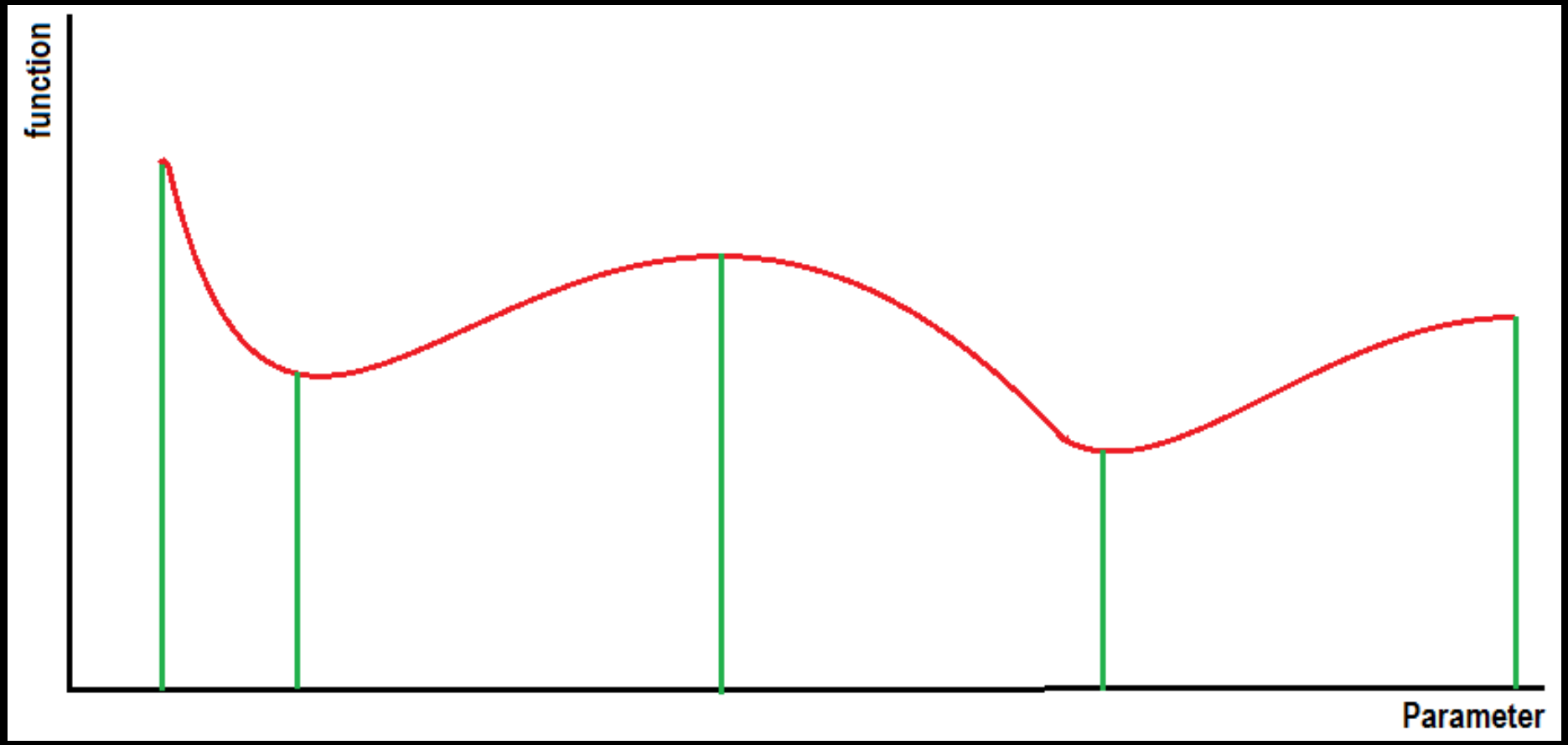
Most simple loop:



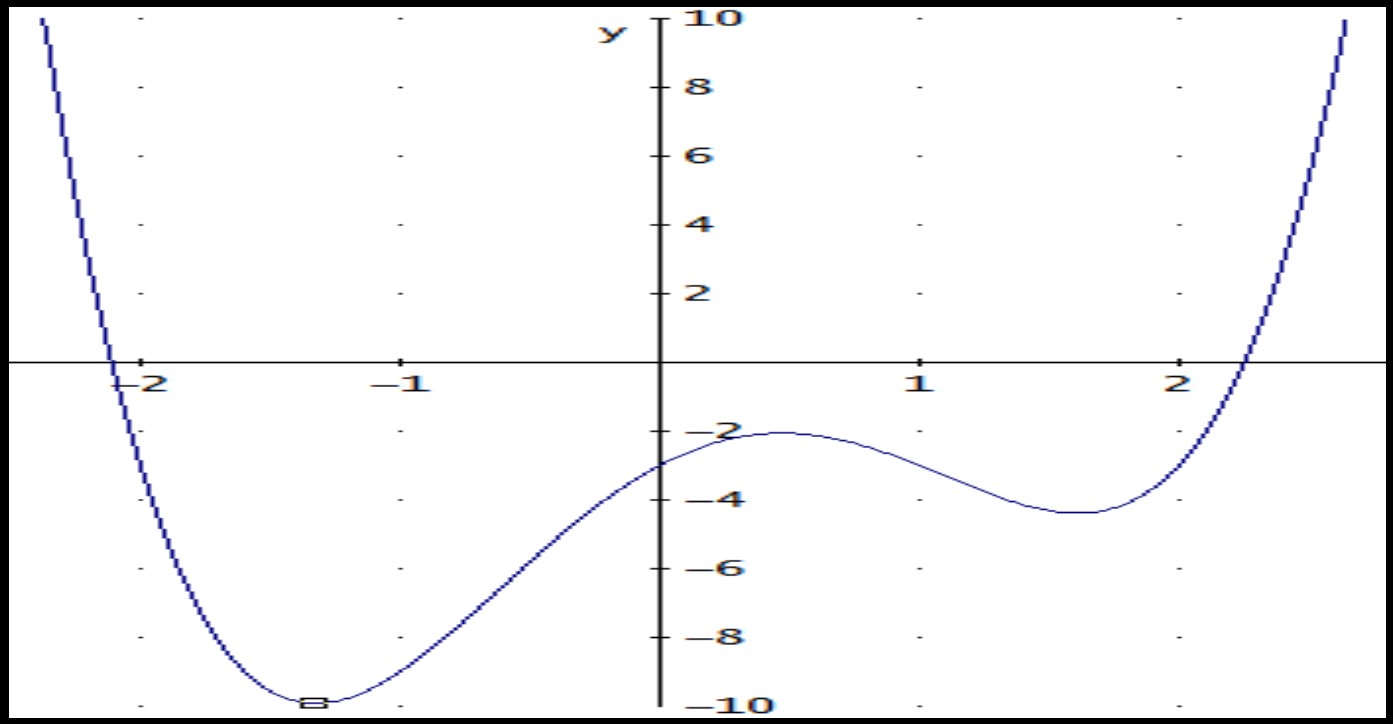
Slower,

But not necessarily most precise

5. MAXIMIZACIÓN O MINIMIZACIÓN

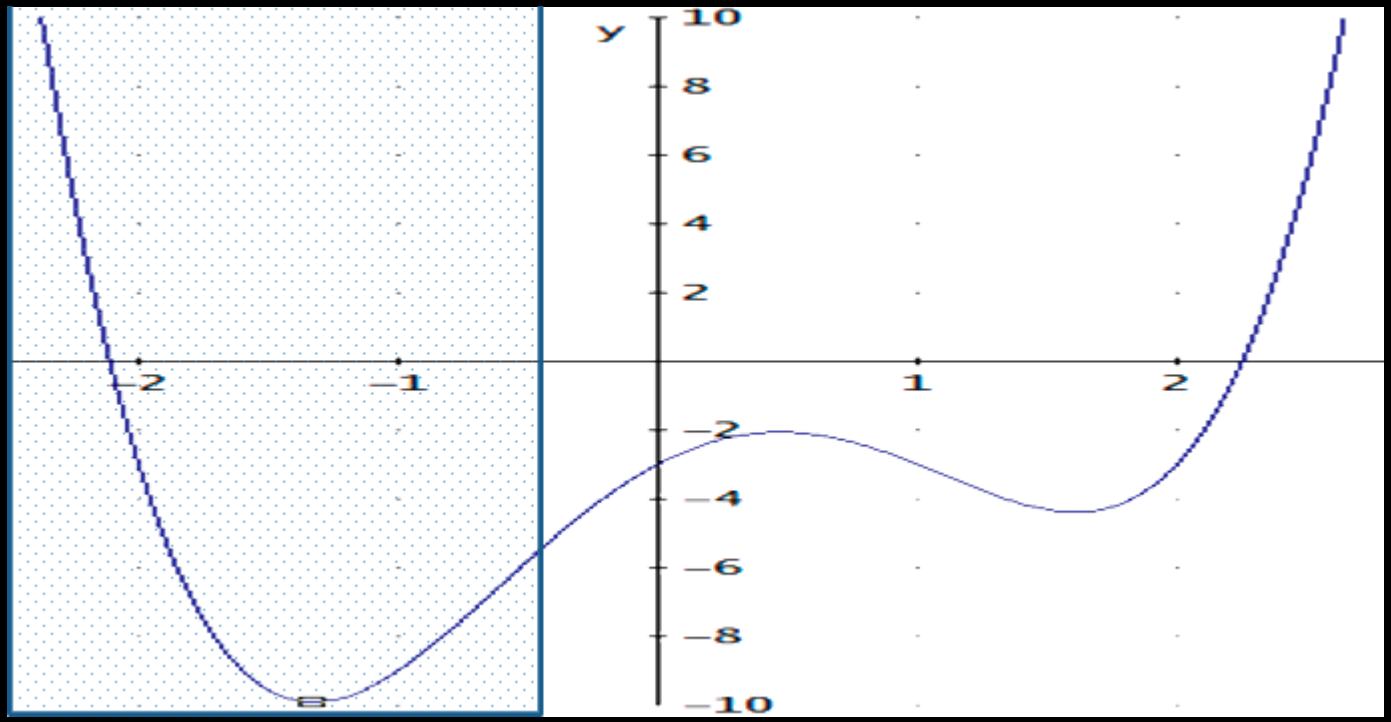


5. MAXIMIZACIÓN O MINIMIZACIÓN



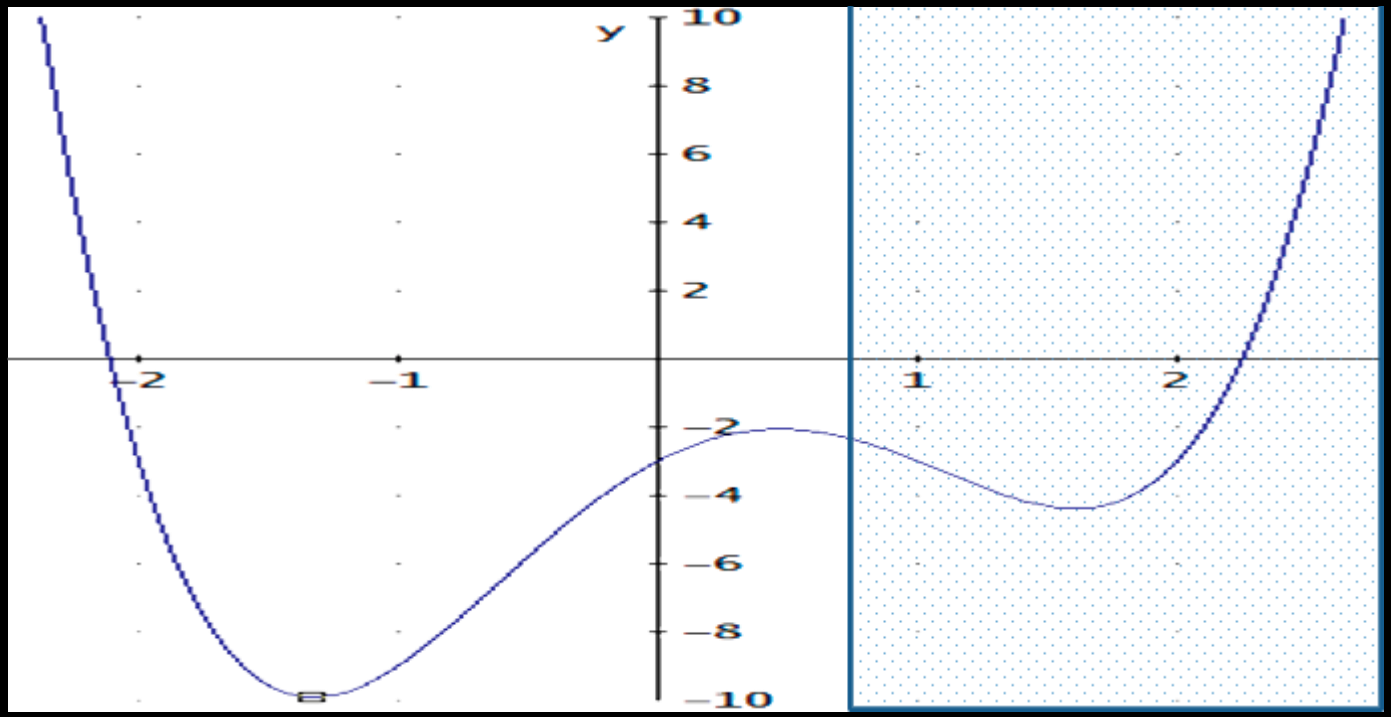

```
fun='x^4-x^3-4*x^2+4*x-3'
x = fmincon(fun,x0,A,b)
A*x ≤ b.x0
```

5. MAXIMIZACIÓN O MINIMIZACIÓN



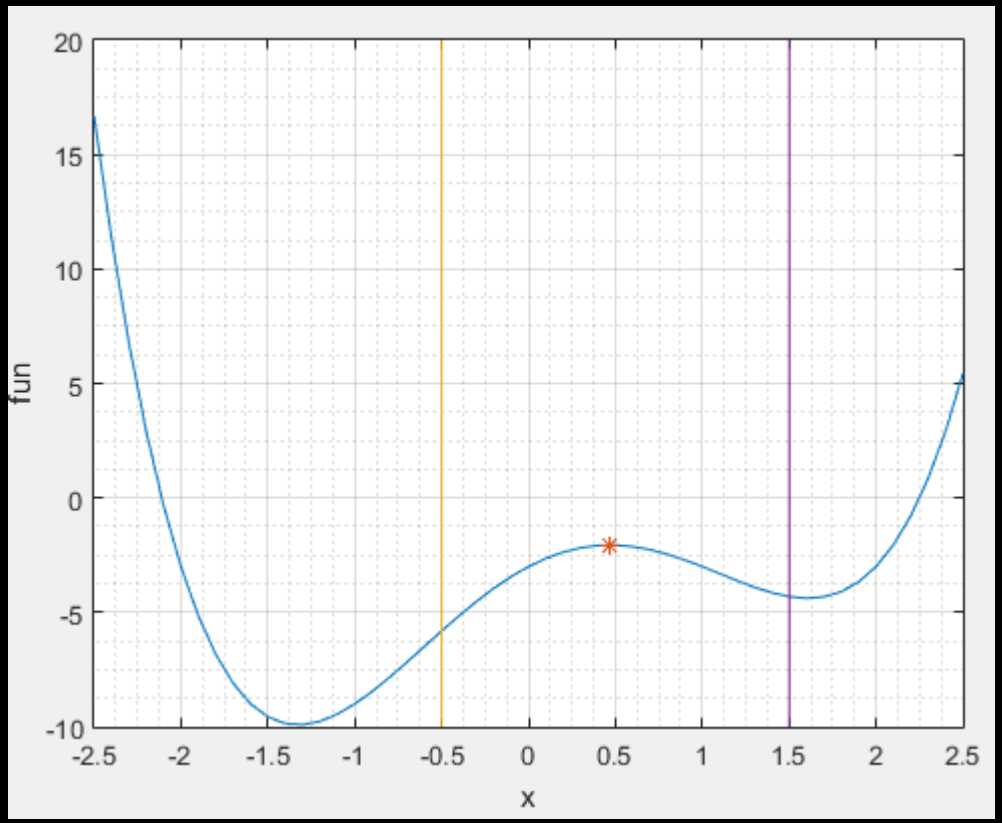

```
fun='x^4-x^3-4*x^2+4*x-3'
X0=-10;A=1; b=1/20; %A*x≤b.x0
x = fmincon(fun,x0,A,b)
x = -1.3263
```

5. MAXIMIZACIÓN O MINIMIZACIÓN



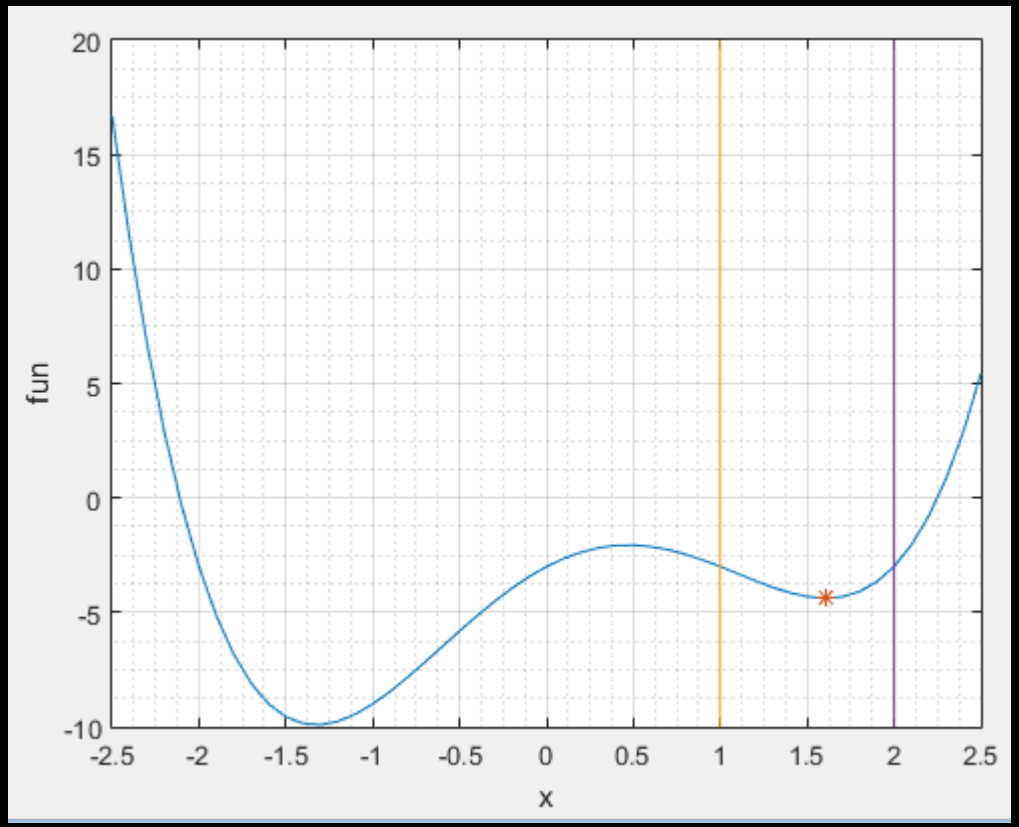

```
fun='x^4-x^3-4*x^2+4*x-3'
X0=0.8;A=-1; b=1; %A*x≤b.x0
x = fmincon(fun,x0,A,b)
x = 1.6073
```

5. MAXIMIZACIÓN O MINIMIZACIÓN




```
fun='x^4-x^3-4*x^2+4*x-3'
nfun=['-(',fun,')'];
x = fminmax(nfun,x0,A,b,Aeq,beq,lb,ub)
A=[]; b=[]; Aeq=[]; beq=[]; lb=-0.5; b=1.5;
x = 0.4691
```

5. MAXIMIZACIÓN O MINIMIZACIÓN




```
fun='x^4-x^3-4*x^2+4*x-3'
x = fminmax(fun,x0,A,b,Aeq,beq,lb,ub)
A=[]; b=[]; Aeq=[]; beq=[];
lb=1; ub=2;
x = 1.6073
```

5. MAXIMIZACIÓN O MINIMIZACIÓN

- fgoalattain
- fmincon
- fminimax
- fminunc
- fseminf
- fsolve
- intlinprog
- linprog
- lsqcurvefit
- lsqlin
- lsqnonlin
- particleswarm
- quadprog

Gracias

Créditos a:
https://openai.com/dall-e-2 - https://aminoapps.com/ - https://miprofe.com/ - https://www.youtube.com/@EASYCTE -

Michel Bolaños Guerrero, Ing. C., Esp., Mag.

Candidato a Doctor en Ingeniería – Énfasis en Mecánica de Sólidos

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