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DEVELOPMENT OF COURSEWARE MODULES FOR ENGINEERING MECHANICS EDUCATION

Education model

Our model involve ASDN system and LAB-3D module.

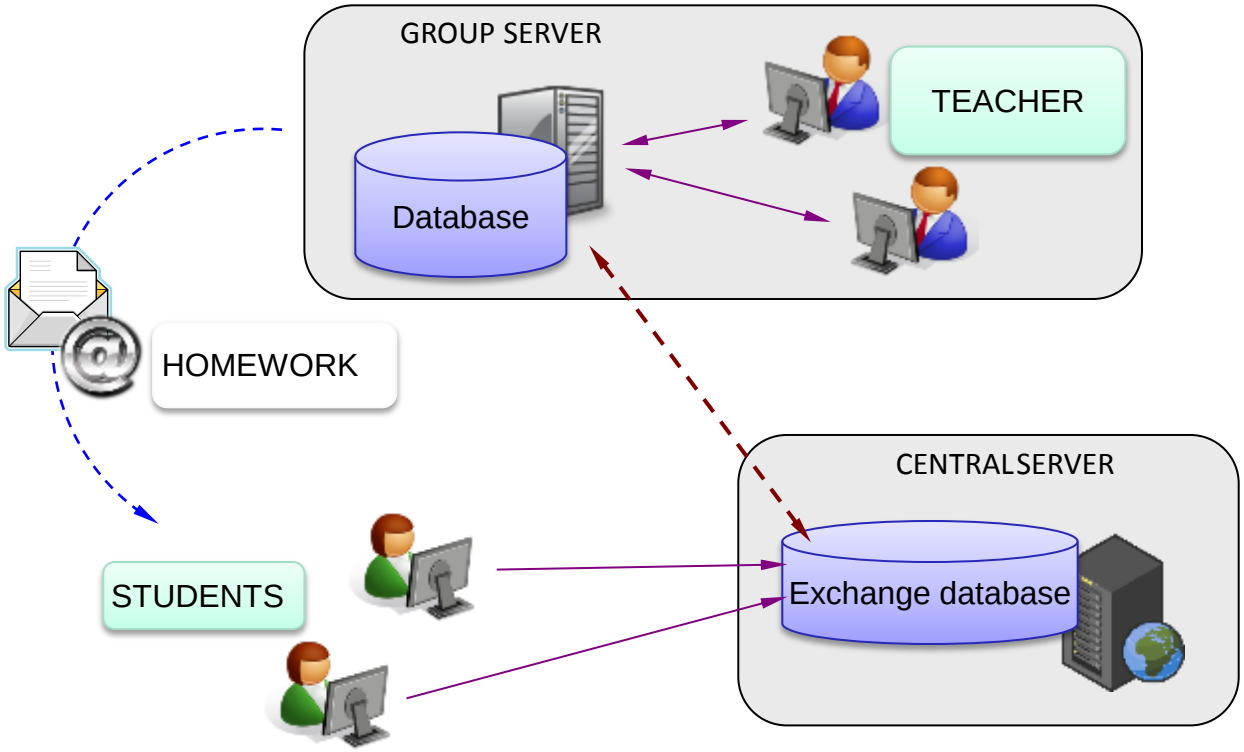
ASDN system enables:

- automatic generation of individual assignments,
- their distribution via e-mail,
- automatic collecting and processing of results.

LAB-3D module was developed for a better understanding of the numerical tasks involved in homework. This module enables web access to accompanying prerecorded laboratory experiments, in order to get a good visualization of the physical process under consideration.

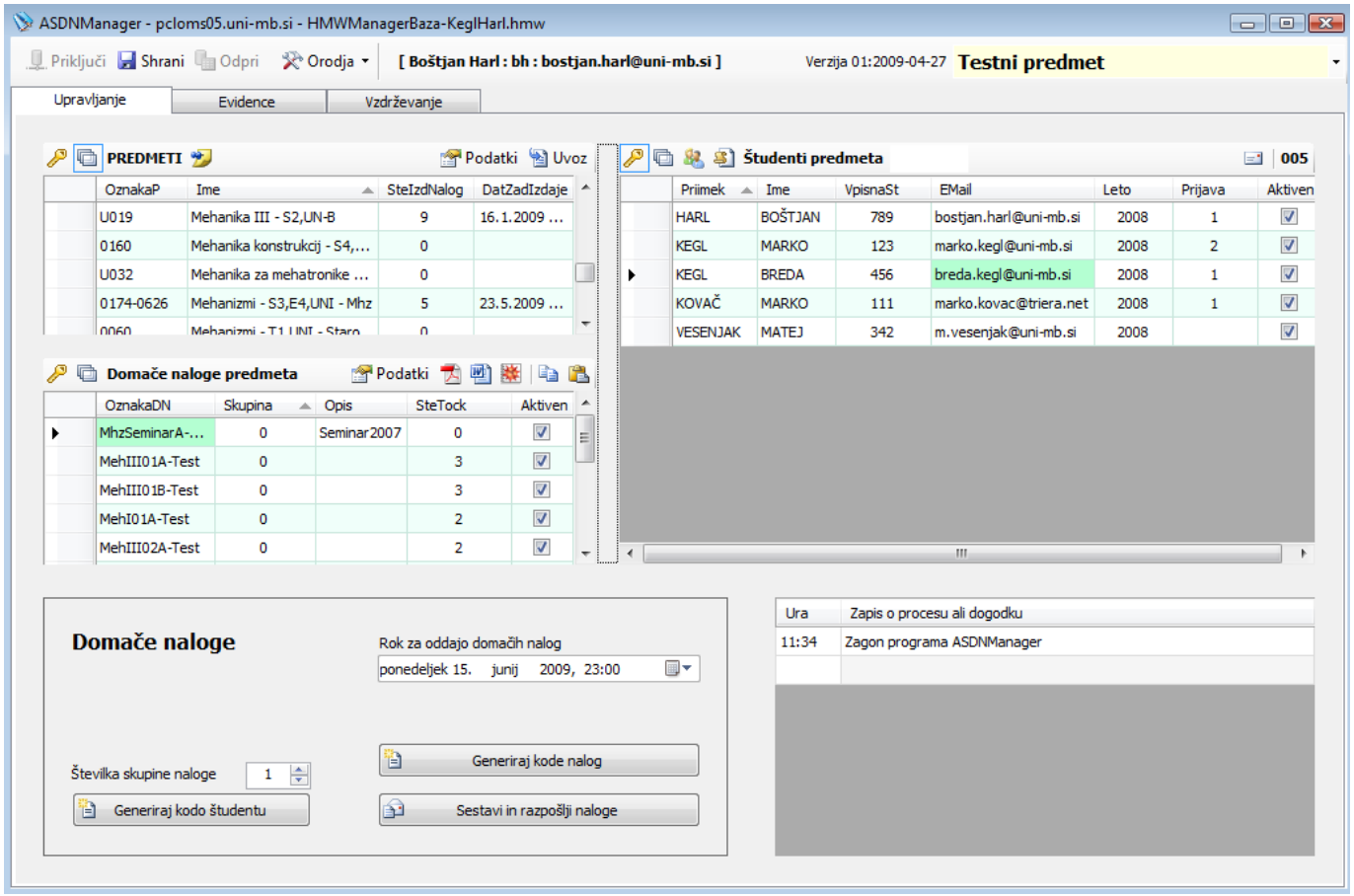
ASDN system

Functional scheme of the ASDN system



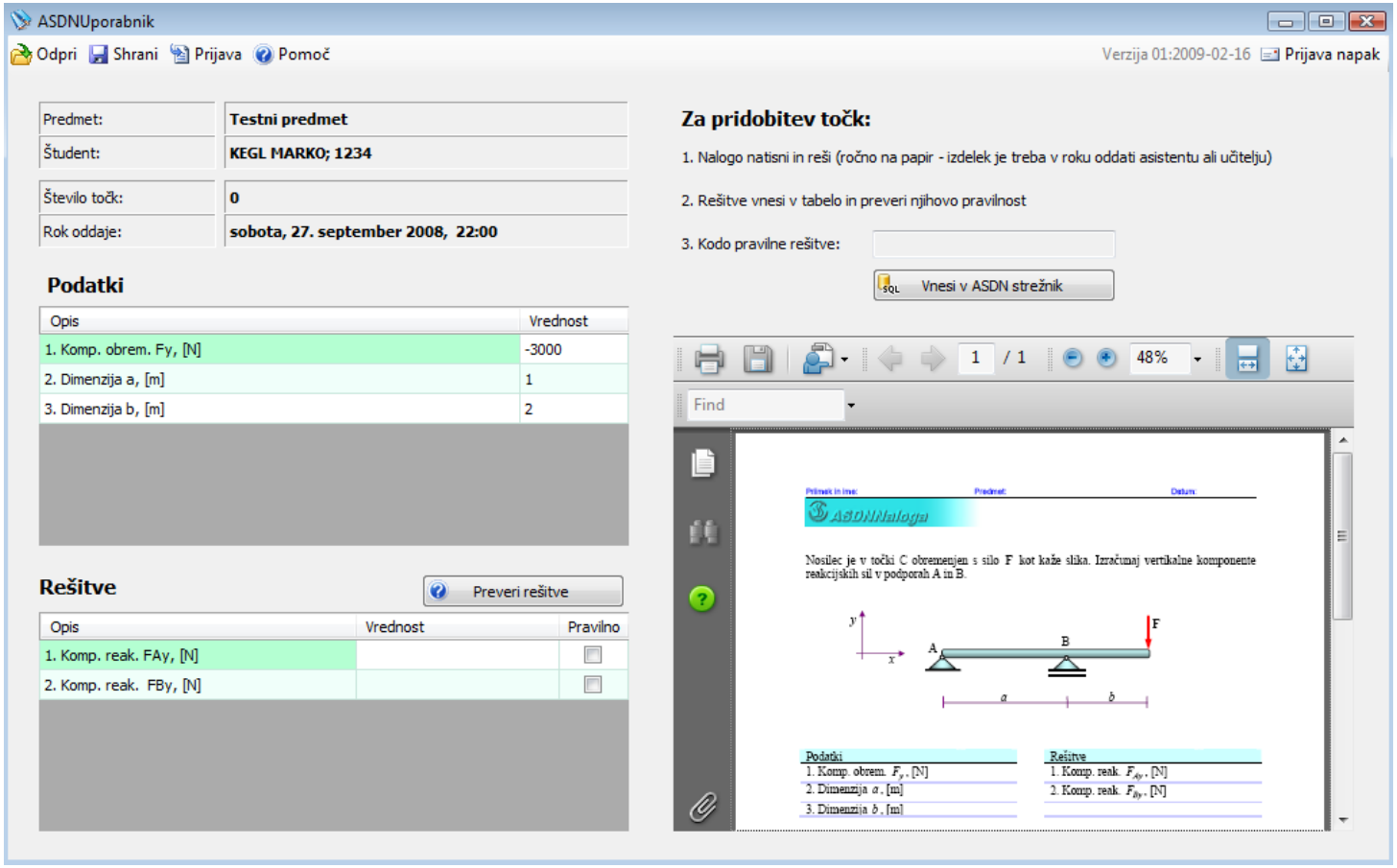
ASDN system

The main window of the *ASDNManager* application



ASDN system

Window of the *ASDNUporabnik* application



Preparing a homework

The homework assignment preparation consists basically of two steps:

- preparation of the PDF file of the assignment and
- coding of the solution algorithm with *Mathematice* - *AceGen* .

Mathematica ⇒ *AceGen* ⇒ *C# koda* ⇒ *ASDNSolver*

```
<< AceGen`
modul = "MehIII01A";
SMSInitialize[modul, "VectorLength" → 100];
SMSModule[modul];
p ⊨ Array[SMSReal[p$$[#]] &, 6];
{a, b, c, d, x, y} ⊨ p;
εyy ⊨ SMSD[uy, y];
εxy ⊨ 1/2 (SMSD[ux, y] + SMSD[uy, x]);
ε2 ⊨ (εxx + εyy)/2 - Sqrt[((εxx - εyy)/2)^2 + εxy^2];
sistem = {{εxx - ε1, εxy}, {εxy, εyy - ε1}}.{ex, ey};
r ⊨ {εxx, εyy, εxy, ε1, ε2, e1x, e1y, e2x, e2y, α1};
SMSExport[r, r$$];
SMSWrite[];
```

```
/*************************************************************
* AceGen    2.111 Windows (20 Sep 08)                        *
*           Co. J. Korelc  2007           23 Oct 08 10:05:22*
**************************************************************
User : Full professional version
Evaluation time                 : 1 s     Mode  : Optimal
Number of formulae              : 12      Method: Automatic
Subroutine                      : MehIII01A size :227
Total size of Mathematica  code : 227 subexpressions
Total size of C# code            : 637 bytes*/

private double Power(double a, double b){return Math.Pow(a,b);}

/******************* S U B R O U T I N E ********************/
void MehIII01A(ref double[] v)
{
v[12]=Math.Sin(2e0*p[4]*p[5]);
v[27]=p[0]-2e0*p[1]*v[12];
v[10]=p[5]*v[27];
```

Preparing a homework

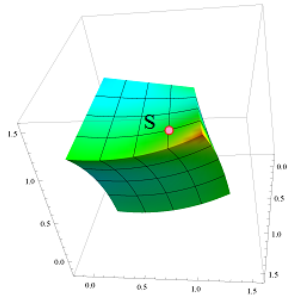
Example of the ASDN assignment

Priimek: **Ime:** **Vpisna št.:**

ASDNNaloga

V točki S konstrukcijskega dela, ki ga postopoma obremenjujemo, so trenutne deformacije enake $\varepsilon_{xx} = a$, $\varepsilon_{yy} = 0.002$, $\varepsilon_{zz} = b$, $\varepsilon_{xy} = c$, $\varepsilon_{yz} = d$ in $\varepsilon_{zx} = -0.001$, kjer so a, b, c in d znane konstante. Elastični modul materiala je $E = 70$ GPa, Poissonov količnik pa je enak $\nu = 0.3$. Izračunaj:

- Volumski $\boldsymbol{\sigma}_v$ in deviatorični $\boldsymbol{\sigma}_d$ del tenzorja napetosti.
- Drugo invarianto I_{d2} deviatoričnega tenzorja napetosti $\boldsymbol{\sigma}_d$.
- Začetno napetost tečenja σ_{y0}, če se je material v danem trenutku ravno začel plastificirati.



Podatki
1. Par. a, [-]
2. Par. b, [-]
3. Par. c, [-]
4. Par. d, [-]

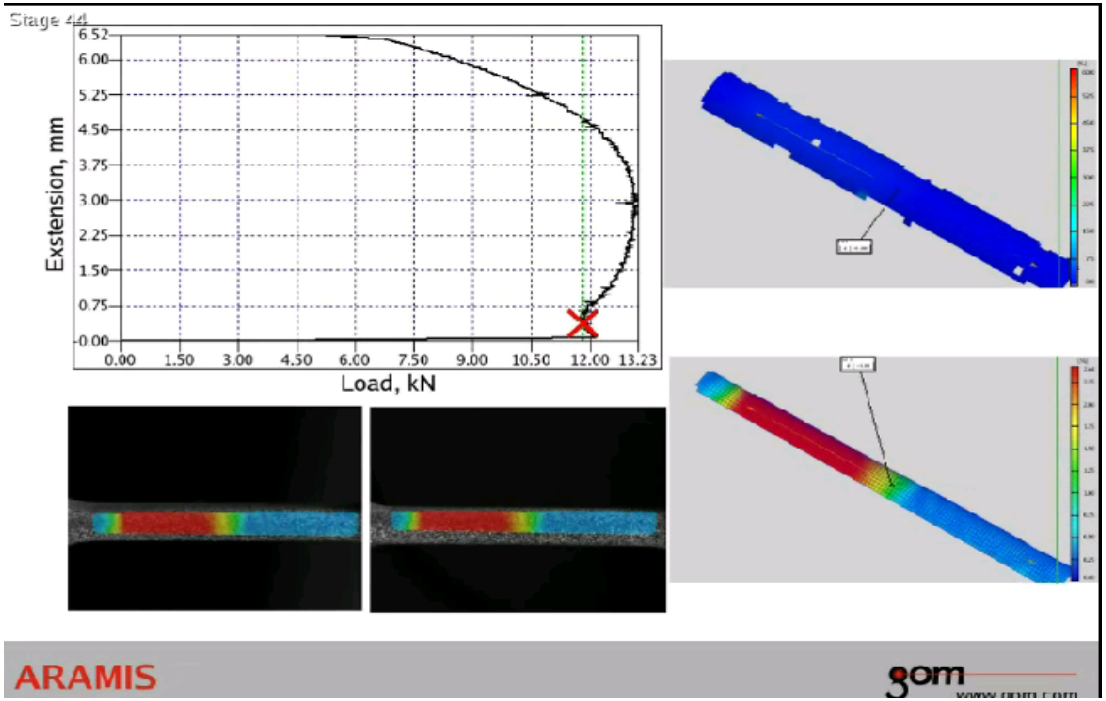
Rešitve
1. Komp. σ_{vxx}, [MPa]
2. Komp. σ_{dxx}, [MPa]
3. Komp. σ_{dyx}, [MPa]
4. Inv. I_{d2}, [MPa^2]
5. Nap. σ_{y0}, [MPa]

LAB-3D system

To provoke learners' interest in engineering mechanics as well as to enhance their understanding of the topics, the theoretical work is enriched by 3D video clips.

LAB-3D system

Additional explanation of stress-strain behavior is given by the application of the ARAMIS testing system. This test was done separately with two CCD cameras. The whole test was recorded and saved as an additional video clip file.



Conclusion

The pilot course focuses on regular and moderately complex homework assignments that are generated, distributed and analyzed fully automatically, requiring a minimal amount of work of the teacher.

The only serious work that has to be done is the code development for the solution algorithms.

Along with the system for homework assignments, another system was developed that enables virtual experimental work in the laboratory. This system comprises video materials for all interesting phases of the experimental work, short explanations, analysis and for comparison numerical analysis done by using commercial engineering programs.