Name_____

ME 786/886
Fall 2022
Prof. I. Tsukrov

Homework #6
(Due 11/01/22)

Homework expectations: same as HW#1 and HW#2. Show all work and provide printouts!

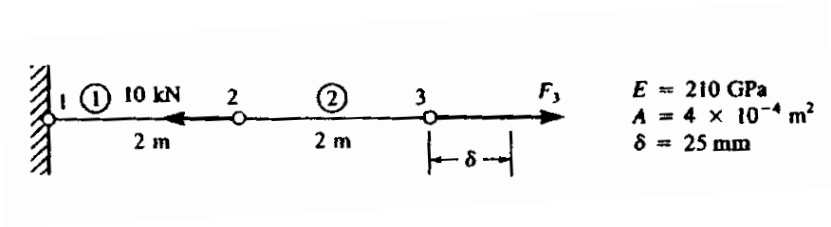
A. **Reading** (Text)

4th edition: 3.8 – Treatment of boundary conditions; 4.1-4.3, 4.5 – Trusses
5th edition: 3.7-3.9 – Boundary conditions; 5.1-5.4 – Trusses

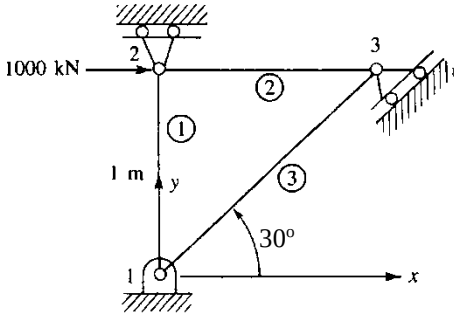
B. Problems (The problem numbers are for the 4th edition of the Text. See Canvas for a PDF file with the original problem formulations. But remember that the original formulations are modified as stated below).)

B. Solve the following problems longhand (use calculator/computer, but no FEA software).

B-1 (20 pts) For this assembly of two one-dimensional bar elements find u_2 and F_3 if the force at node 2 and displacement of node 3 are prescribed.



B-2 (40 pts) For the plane truss shown below, determine the displacements and reactions. Let $E = 240$ GPa, $A = 1\times10^{-4}$ m^2 for elements 1 and 2, and $A = 3\times10^{-4}$ m^2 for element 3.



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C. Use finite element program MARC to solve the following problems. Present the "deformed and original" truss pictures with numerical values of displacement shown (one picture for x-displacement, one picture for y-displacement). Present pictures with the values for x- and y-components of the reaction forces if asked. Also, include the printout of the fragment of the **.out** file where the nodal displacements and element stresses are shown. Don't include the entire printout! Underline or circle the answers. Annotate them properly (as u_x, σ, *etc.*) and specify units.

C-1 (20 points, Text, p. 142) Use finite element program MARC to solve problem **4.10**. Report displacements, stresses and reaction forces. All members of the truss are made of 0.2%C HR steel. **Include the self-weight of steel**. Model the entire structure, don't use symmetry.

C-2 (20 points, Text, p. 147) Use finite element program MARC to solve problem **4.20**. Find nodal displacements, stresses and reaction forces. Note that the truss consists of 11 members, so the inclined members are not attached to each other. All members of the truss are made of Stainless 302 CR. **Neglect the self-weight of steel**. Ignore the question on buckling. Model the entire structure, don't use symmetry.

TYPICAL PHYSICAL PROPERTIES OF SOME MATERIALS

Material	Density kg/m^3	Ultimate Strength Tension MPa	Ultimate Strength Comp. MPa	Yield strength MPa	Modulus of elasticity E GPa	Poisson's ratio	Coef. of thermal exp. 10^{-6}/°C	Thermal conductivity W/m °C
Aluminum 2014-T6	2800	470		410	72	0.33	23	210
(alloy) 6061-T6	2800	228		131	70	0.33	23	210
Brass cold rolled	8470	540		420	105	0.35	19	105
annealed	8470	330		100	105	0.35	19	105
Bronze Manganese	8800	450		170	100	0.34	20	58
Cast Iron								
Gray	7200	170	650		95	0.25	12	45
Malleable	7200	370		250	170	0.25	12	45
Concrete								
Low strength	2400	2	20		22	0.15	11	1
Medium strength	2400	3	41		32	0.15	11	1
High strength	2400	4	62		40	0.15	11	1
Copper hard-drawn	8900	380		330	120	0.33	17	380
Glass Silicon	2400	80	400		70	0.17	8	0.8
Magnesium 8.5% Al	1800	350		250	45	0.35	26	160
Steel 0.2%C HR	7850	410		250	200	0.30	12	42
0.2%C CR	7850	550		350	200	0.30	12	42
0.6%C HR	7850	690		370	200	0.30	12	42
0.8%C HR quenched	7850	830		700	200	0.30	12	42
Stainless 302 CR	7920	860		600	194	0.30	17	18
Titanium 6% Al 4% V	4460	900		830	110	0.34	9	14

Properties vary widely depending on changes in composition, temperature, and treatment conditions.
CR = Cold rolled HR = Hot rolled