**MEC-E1050 Finite Element Method in Solids; Formulae**

**LINEAR ELASTICITY**

**Coordinate systems:** 

**Strain-stress:** , ,  or

, 

****, ****

**Strain-displacement:** , 

**ELEMENT CONTRIBUTION (constant load)**

**Bar (axial):** 

****, in which ****

**Bar (torsion): **

**Beam (*xz*): **

**Point loads: **, ****

**PRINCIPLE OF VIRTUAL WORK**

, ****, 

**Bar:** , 

**Torsion:** , 

**Beam bending (*xz*-plane):** , 

**Beam bending (*xy*-plane):**  , 

**Beam (Bernoulli):**

,



**Thin slab (plane-stress):**

****, 

**Thin slab (plane-strain):**

****, ****

**Kirchhoff plate:**

, 

**Reissner-Mindlin plate:**

****,



**Body: **,  or

****

**APPROXIMATIONS (some) **, ****

**Quadratic line: **,  (bar)

**Cubic line: **,  (beam bending)

**Linear: **, ****, ****

**VIRTUAL WORK EXPRESSIONS**

**Force:** 

**Bar: **, 

**Torsion: **, 

**Beam bending (*xz*-plane):**

****, 

**Beam bending (*xy*-plane):**

****, 

**CONSTRAINTS**

**Frictionless contact:** 

**Joint:** 

**Rigid body (link):**  , .