

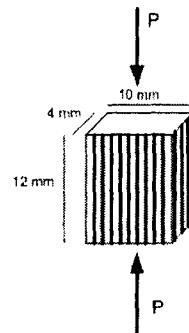
**TUT / Plastics and Elastomer Technology**  
**MOL-5526 Advanced Course on Composites**

Mid-term examination 14.03.2011 / Jyrki Vuorinen, Olli Orell and Asta Luukkonen

Max 30 points in total! Saa vastata myös suomeksi.

Answer to three (3) questions only!

1. Off-axis moduli of UD and 0/90 laminates. Also sketch and compare the results for E-glass/epoxy and SM carbon/epoxy (in both cases 50 vol-% of fibers). (10p.)
2. Strength and fracture behavior of UD laminate in bending. Effect of span length and different fibers. (10p.)
3. A) Determination of the fiber-matrix adhesion. (3p.)  
 B) Reversible strains caused by temperature of a fiber reinforced laminate. Compare the behavior of glass and carbon fiber reinforced thermoset composite. (3p.)  
 C) A UD E-glass/epoxy sample of dimensions (12x10x4) mm is compressed by a force of 2400 N along the fiber direction. The displacement of the grips of the testing machine is then -0.0200 mm. Calculate the fiber volume fraction by using appropriate material values for fiber and matrix. (Hint,  $E(\text{steel}) \approx 210 \text{ GPa}$ ,  $E(\text{aluminum}) \approx 70 \text{ GPa}$ ,  $E(\text{HDPE}) \approx 1 \text{ GPa}$ ) (4p.)



4. A) Describe the tensile test procedure for composites. (5p.)  
 B) Suppose a UD carbon/epoxy composite, which fibers are oriented at  $+20^\circ$  with respect to the  $+x$ -axis, is under a stress state of  $\sigma_x = 450 \text{ MPa}$  and  $\tau_{xy} = -90 \text{ MPa}$ . The laminate is free to deform in the  $y$ -direction. Which of the in-plane stresses is the most critical considering the failure of the laminate according to the maximum stress criterion? Does the failure occur? (5p.)

