# WRITTEN EXAMINATION

Course Machine Elements

Examination: Sub-course

Course code : MT507G

Credits for written examination 5 hp

Date: 2026-01-08

Examination time 14:15 - 18:30

Examination responsible : Tobias Andersson

Teachers concerned: Tobias Andersson, Mahdi Eynian and Andreas Andersson Lassila

Aid at the exam/appendices

- Schmid, SR, Hamrock, BJ and Jacobson, BO (2014) Fundamentals of Machine Elements. CRC Press, Boca Raton FL, USA. (Original hard copy, or chapter copies)
- Sundström, B. (red.) . Handbook of Solid Mechanics. Stockholm: Department of Solid Mechanics, KTH. Optional edition
- Formula sheet

Other

- Sundström, B. . Handbok och formelsamling i hållfasthetslära. Tekniska högskolan Stockholm: Institution för hållfasthetslära. Valfri upplaga
- An approved calculator according to "Allmänna riktlinjer gällande utbildning på Institutionen for ingenjörsvetenskap": (A detailed list is provided to exam invigilators.)
  - Casio Teknikräknare FX-82 all variants
  - Texas Instruments Tl-30 all variants o
  - Texas Instruments Tl-82, Tl-83, Tl-84
  - Casio FX-7400Gii, Fx-9750GII
- An English-Swedish-English ordbok or English-Spanish-English dictionary.

*No added notes are allowed in the texts used during the examination.*

Instructions

- ☒ Take a new sheet of paper when starting a new question.
- ☒ Write only on one side of the paper.
- ☒ Write your name and personal ID No. on all pages you hand in.
- ☒ Use page numbering.
- ☒ Don´t use a red pen.
- ☒ Mark answered questions with a cross on the cover sheet.

## Problem 1 (Springs/ Shrink fit)

An electric motor rotor is mounted on a hollow steel shaft using a shrink fit. The geometry and material/interface data are as follows:

Geometry

- Shaft inner diameter: 40 mm
- Shaft outer diameter (and rotor hub inner diameter, nominal): 56 mm
- Rotor outer diameter: 150 mm
- Axial interface length: 125 mm

Interface

- Coefficient of friction at the shaft–hub interface: $\mu = 0.1$

Material:

- Rotor: Magnetic Steel, E = 145 GPa, $\nu = 0.3$.
- Shaft: 1045 Steel, E = 207 GPa, $\nu = 0.3$

Operating condition

- Transmitted torque: 900 N·m
- Required safety factor (on torque) against slip: 1.6
- Low-speed operation (centrifugal effects neglected)

a) **Determine the required radial interference (in μm) between shaft and rotor hub to transmit the** required torque with the given safety factor.
b) Determine the temperature difference between rotor (heated) and shaft (cooled) required for **assembly such that, during assembly, a radial clearance of 20 μm exists.** At room temperature, the shaft outer radius must exceed the rotor inner radius by the interference calculated in part (a).
c) Calculate the maximum compressive hoop stress in the shaft after assembly.

(5p)

## Problem 2 (Threaded joints)

In the assembly shown below (with dimensions in mm), with a steel M8×1.25 bolt, preloaded to 90% of its proof load,

a) Calculate the stiffness of the bolt and the joint members and the dimensionless joint parameter ($c_k$).
b) Select a suitable grade (e.g. 4.6, 5.8, 8.8, ...) for the bolt so that the **assembly** can support an **external tensile load** of 10 kN with a safety factor larger or equal to 2.0.
c) What will be the safety factor guarding against separation of the members for the 10 kN external load?
d) draw the corresponding bolt diagram.

(5p)