UNIVERSITY
OF SKÖVDE
School of Engineering

WRITTEN EXAMINATION

Course Machine Elements

Sub-course

Course code MT507G

Credits for written examination 5 hp

Date 2025-01-10

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. (Sticky notes with dots or letters are allowed in the book but no text is allowed on the sticky notes)
- 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":
  - 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.

Calculator ☒ Provided by the University

☒ Student's own calculator

☐ Not allowed

Writing paper ☐ Lined

☒ Squared

Instructions

☐ Take a new sheet of paper for each teacher.

☒ Take a new sheet of paper when starting a new question.

UNIVERSITY
OF SKÖVDE

- ☒ 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.

Grade points The solution of each problem of the written exam is first assessed and graded based on the following guidelines:

Points	**General description**
5	EXCELLENT - outstanding results with only minor deficiencies. High level of knowledge. Good analytical ability. Can use the knowledge independently.
4	VERY GOOD - above average standards but with some shortcomings. Good overview of the field of knowledge. Can use the knowledge independently.
3	GOOD - generally good work with some shortcomings. Can account for the most important parts of the subject. Can largely use the knowledge independently.
2	SATISFACTORY - pretty good but with significant shortcomings. Can account for the most important parts of the subject. Can to some extent use the knowledge independently
1	SUFFICIENT - The result meets the minimum requirements but not more. The overview of the most important parts of the subject is inadequate. To a limited extent, use the knowledge independently.
0	FAIL - more work required before credit can be given.

If any of the four problems is graded fail (0), the written exam is graded fail (F). Otherwise, the final grade is given by the sum points according to:

Sum	Grade
≥4	E
≥7	D
≥10	C
≥14	B
≥18	A

Examination results should be made public within 18 working days

Good luck!

Total number of pages 4

UNIVERSITY
OF SKÖVDE

Problem 1 (Springs/ Shrink fit)

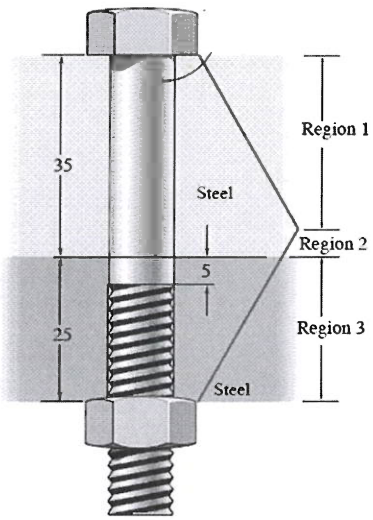
A vehicle has individual wheel suspension in the form of helical springs. The free length of the spring is l_f = 600 mm, the solid length is l_s = 240 mm, the wire diameter is 15 mm and the inner diameter of the spring is 135 mm. The shear modulus of the spring material is G = 80 GPa. The spring ends are squared and ground.

Calculate the shear stress of the spring wire when the spring is compressed to a length of 300 mm (considering dynamic loading). Also, investigate if buckling is possible for this spring. (5p)

Problem 2 (Threaded joints)

1. An M12×1.5 bolt, with head marking of 8.8 and a corresponding hexagonal nut keep two steel machine parts together as shown in the sketch, with a 40 kN preload. Determine the following

   a) The maximum external load that could be supported with a safety factor of 3 against both the joint separation and bolt breakage.
   b) Calculate the total extension of the bolt and the total compression of the steel machine parts (in micrometers) when an external load of 20 kN pulls the upper part away from the lower part. Draw the corresponding bolt diagram.

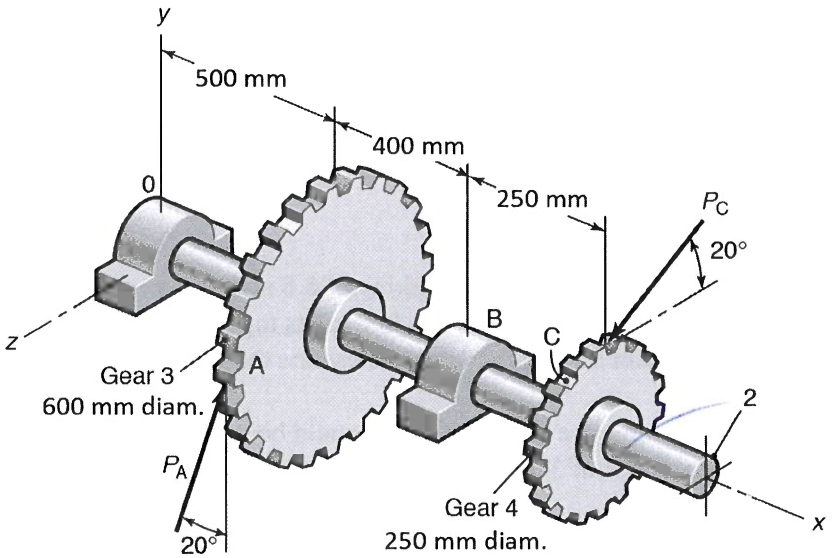


use Wileman's method to calculate the stiffness of the clamped machine parts and use E = 206.8 GPa as the modulus of elasticity of steel if it was needed. (5p)

UNIVERSITY
OF SKÖVDE

Problem 3 (Bearings)

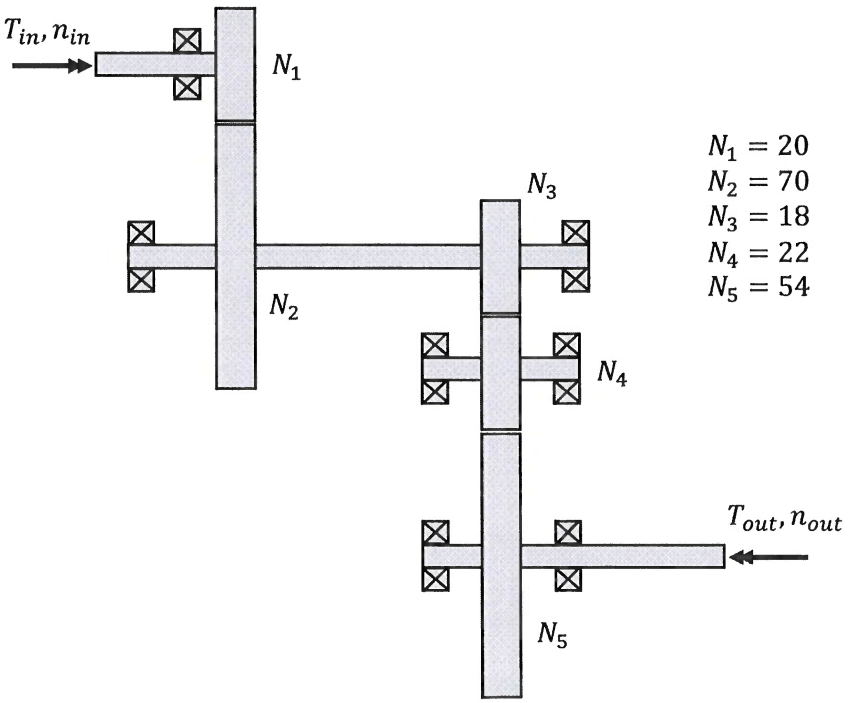
Select a pair of radial ball-bearings for the shaft shown below if the shaft rotates at 2000 rpm. Consider the case where the shaft is operated year round (24 hours per day, 365 days per year) for 3 years, with a reliability of 99%, and suitable, very clean lubricant is maintained throughout the bearing life. P_A = 1200 N.



Problem 4 (Gears)

For the gear system below, the output shaft should deliver a torque of T_{out} = 8.3 kNm and rotate with a rotational speed of n_{out} = 3940 rpm. If the power loss due to friction is 2% at each gear contact, calculate:

a) The rotational speed of the input shaft (2p).
b) The required torque delivered to the input shaft (3p).



$N_1 = 20$
$N_2 = 70$
$N_3 = 18$
$N_4 = 22$
$N_5 = 54$