



UNIVERSITY
OF SKÖVDE

Course Machine Elements
Sub-course

Course code MT507G

Date 2025-11-20

Available teacher

School of Engineering

*Cover sheet with information
to the invigilator*

Credits for written examination: 5 hp

Examination time 8:15-12:30

Available on phone number:

0720070325(ME), 0500-448572 (TA)

Visiting the examination ☒ Yes, at 9:30
☐ No

Aids and other information for invigilators

Calculator ☒ Provided by the University
☒ Student's own calculator
☐ Not allowed

If you copy the exam papers yourself, provide the number of copies 25

Instructions to examinations responsible

All examination documents are to be handed in at Reprocentralen.

- **For copying of examination papers** the originals must be handed in no later than 6 workdays before the examination. The number of copies is filled in by Reprocentralen in the field below.
- **Copied examination papers** must be handed in no later than 3 workdays before the examination. Please notify the examination administration in due time when the papers will be handed in. Examination papers are to be handed over directly to the staff at Reprocentralen (not through mail). If you copy the exam papers yourself, provide the number of copies in the field above.

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Detailed list of approved and unapproved calculators

TI-84 Plus Silver Edition
TI-84 Plus C Silver Edition
TI-84 Plus CE-T
TI-84 Plus CE-T python edition
TI-85
TI-86
TI-Nspire
TI-Nspire 2.0
TI-Nspire CX
TI-BA II Plus
Galaxy 4

Banned Texas Instruments models

TI-89
TI-92
TI-InterActive
TI-Nspire CX II-T
TI-Nspire CX CAS
TI-Nspire CAS
TI-Voyage 200

Approved HP models

HP 6S
HP 9S
HP 10B
HP 10S+
HP 11C
HP 15C
HP 17bII+
HP 19B 2
HP 20S
HP 21S
HP 30S
HP 32SII
HP 33s
HP 35s
HP 41 C
HP 41 CX
HP 42S RPN scientific

Banned HP models

HP 28S

HP 38G
HP 39g+
HP 40G
HP 48G
HP 48G+
HP 48GX
HP 48GII
HP 48S
HP 48SX
HP 49G
HP 50G
HP Prime

Approved Canon models

F-58
F-73
F-715S
F-802P

Approved Citizen models

SR 270 X

Approved Jenkinsbird models

Jenkinsbird BT-600

Approved TRULY models

SC187B

Approved Karce models

KC-010

Other banned calculators

Numworks

WRITTEN EXAMINATION

Course Machine Elements

Examination: Sub-course

Course code : MT507G

Credits for written examination 5 hp

Date: 2025-11-20

Examination time 8:15-12:30

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 TI-30 all variants o
 - Texas Instruments TI-82, TI-83, TI-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

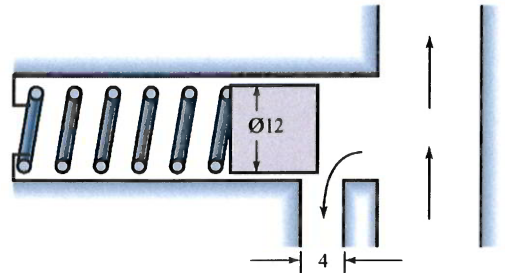
- ☒ Take a new sheet of paper when starting a new question.
- ☒ Write only on one side of the paper.
- ☒ Write your name and personal ID No. on all pages you hand in.
- ☒ Use page numbering.
- ☒ Don't use a red pen.
- ☒ Mark answered questions with a cross on the cover sheet.



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Problem 1 (Springs/ Shrink fit)

a) An overflow valve, shown in the sketch, has a piston diameter of 12 mm and a slit length of 4 mm. The spring has a mean coil diameter of $D = 10$ mm and a wire diameter of $d = 1.25$ mm. The valve should open at 2.5 bar (0.25 MPa) pressure and be totally open at 4 bar (0.4 MPa) pressure when the spring is fully compressed. Calculate the number of active coils, the free length, and the pitch of the spring. The shear modulus for the spring material is $G = 80$ GPa. The spring ends are squared and ground.

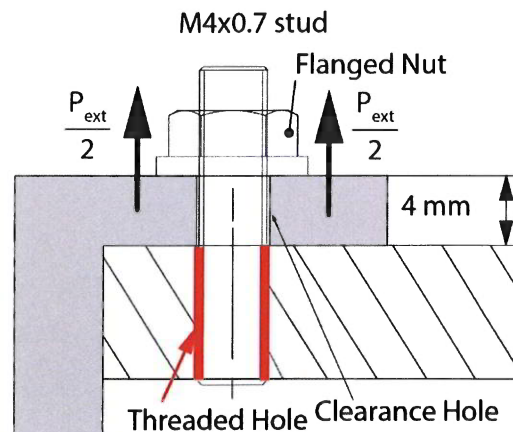


(3p)

b) Determine the maximum shear stress for this geometry. Use Wahl's factor to account for the effect of curvature on shear stress. (2p)

Problem 2 (Threaded joints)

A flange, holding a bearing and a geared shaft assembly in a gearbox is connected to the gearbox housing with M4×0.7 studs and flanged nuts, of grade 8.8 (steel, $E = 207$ GPa) as shown in the figure. The studs are mounted on threaded holes of the housing as shown in figure.



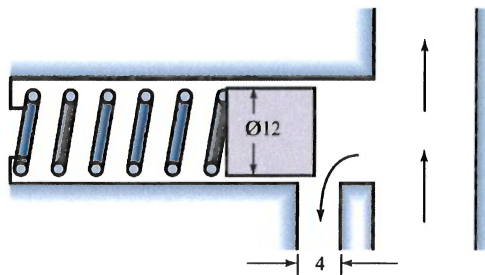
The flange thickness is 4 mm (as shown) and it is made of an aluminum alloy.

- Calculate the proof strength of each stud.
 - Calculate the joint stiffness k_j , using Wileman's equation.
 - Assume that the stud was wholly threaded and evaluate the stiffness of each stud in the joint.
 - Calculate required tightening torque to create a 3.5 kN preload. Assume a collar diameter of 5.2 mm and coefficient of friction of 0.15 between all surfaces.
- $$T_{tightening} = P(0.161p + 0.577 d_p \mu + 0.5 d_{collar} \mu_{collar}),$$
- $$d_p = d_c - 0.6495p$$
- Calculate the mean stress and amplitude of stress, when external force changes between 0 and 2.5 kN (for each stud).
 - With the 3.5 kN preload, if the external load keeps increasing, which happens first? joint separation, or studs reaching their proof strength? Find the maximum external force that the joint can tolerate without separation or reaching studs proof strength.
 - Draw the corresponding bolt diagram (and show conditions e and f on it).

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Problem 1 (Fjädrar / Krympförband)

a) En överströmningsventil, illustrerad i skissen, har en kolv diameter på 12 mm och en spaltlängd på 4 mm. Fjädern har en medelspiraldiameter $D = 10$ mm och en tråddiameter $d = 1,25$ mm. Ventilen ska öppna vid ett tryck på 2,5 bar (0,25 MPa) och vara helt öppen vid 4 bar (0,4 MPa) när fjädern är fullt sammanpressad. Beräkna antalet aktiva varv, den fria längden och fjäderstigningen.



Skjuvmodulen för fjädermaterialet är $G = 80$ GPa. Fjäderändarna är slipade och planslipade.

(3p)

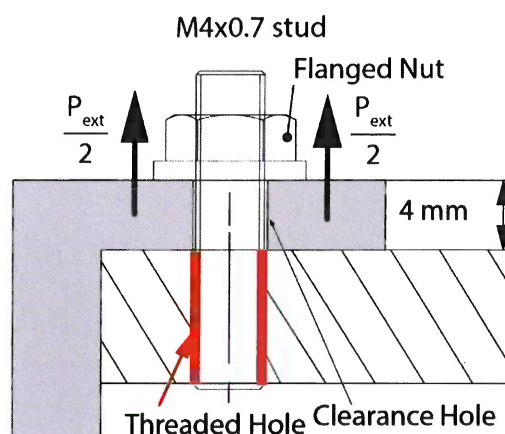
b) Bestäm den maximala skjuvspänningen för denna fjädergeometri. Använd Wahls faktor för att beakta krökningens inverkan på skjuvspänningen.

(2p)

Problem 2 (Gängförband)

En fläns som håller ett lager och en kugghjulsaxel i en växellåda är fastsatt vid växellådshuset med $M4 \times 0,7$ -pinnskruvar och flänsmuttrar av hållfasthetsklass 8.8 (stål, $E = 207$ GPa), enligt figuren. Pinnskruvarna är monterade i gängade hål i huset.

Flänsens tjocklek är 4 mm och materialet är en aluminiumlegering.



- Beräkna provlasten (proof strength) för varje pinnskruv.
- Beräkna förbandets styvhet (k_j) med Wilemans ekvation.
- Antag att pinnskruvarna är fullt gängade och bestäm styvheten hos varje pinnskruv i förbandet.
- Beräkna det erforderliga åtdragningsmomentet för att erhålla en förspänning på 3,5 kN. Antag en kragdiameter på 5,2 mm och en friktionskoefficient på 0,15 mellan alla kontaktytor.

$$T_{\text{tightening}} = P(0.161p + 0.577d_p\mu + 0.5, d_{\text{collar}}\mu_{\text{collar}}),$$

$$d_p = d_c - 0.6495p$$

- Beräkna medelspänningen och spänningsamplituden i varje pinnskruv när den yttre lasten varierar mellan 0 och 2,5 kN.
- Avgör vad som inträffar först om lasten (P_{ext}) fortsätter att öka: förbandets separation eller att pinnskruvarna når sin provlast. Bestäm den maximala kraft (P_{ext}) som förbandet kan uppta utan separation eller att pinnskruvarna överskrider sin provlast.
- Rita motsvarande skruvdiagram och markera villkoren e och f i diagrammet.