National Examinations – Dec 2015

07-Mec-A4, Design and Manufacture of Machine Elements

3 Hours Duration

Notes, please read carefully:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is an open book examination. Candidates may use any non-communicating calculator.
3. There are 6 questions on the following pages, divided into **Part A** and **Part B**. Answer **two (2) questions from Part A** and **two (2) questions from Part B**. 4 (four) questions constitute a complete paper. Only the first four questions, as they appear in your answer book, will be marked. Clearly cross off any question you do not want marked.
4. All questions are of equal mark value (25%).

PART A: Choose any three (3) problems from part A.

Q1

A part resembling a connecting rod is cast in sand. Porosity is found in the shank and cavities in the heads. Show, with appropriate design sketches,

(a) a remedy for the heads and

(b) two possible remedies for the shank. Explain each remedy.

A large, flat machine-tool base is to be cast with intersecting stiffening ribs on both sides of the flat.
c) Show in a sketch the problem that may arise and suggest (in a separate sketch) at least one design modification to minimize the problem.
d) A part resembling a connecting rod is cast in sand. Porosity is found in the shank and cavities in the heads. Show; with appropriate design sketches, (I) a remedy for the heads and (II) two possible remedies for the shank. Explain each remedy in one sentence.

Q2

In principle, what kind of machine tool is likely to be most economical for producing rotationally symmetric parts of the following characteristics:

(a) requires turning, drilling, boring, and parting off, at production rates of 10 000 parts per month;

(b) as (a), but only 10 parts per month;

(c) a very slender high-precision part requiring turning and parting off, at production rates of 1000 parts per month;

(d) as (c), but only 10 parts per month;

(e) as (a) but with a transverse hole;

(f) as (b), but with a transverse hole.

Part A

Q3

Many bicycle frames are constructed of steel tubing joined to hollow fittings.

(a) Suggest a way of joining,

(b) describe the process,

(c) make a sketch of a joint indicating critical features.

An automotive pressing fails in production. The part is formed by almost pure stretching, using drawbeads in the dies.

(d) What would you do to analyze the problem?

(e) What is the likely strain state at the point of fracture (use a forming limit diagram).

(f) Indicate on the FLD two possible remedies, keeping the shape of the pressing unchanged.

(g) If none of this works, what else could be attempted?

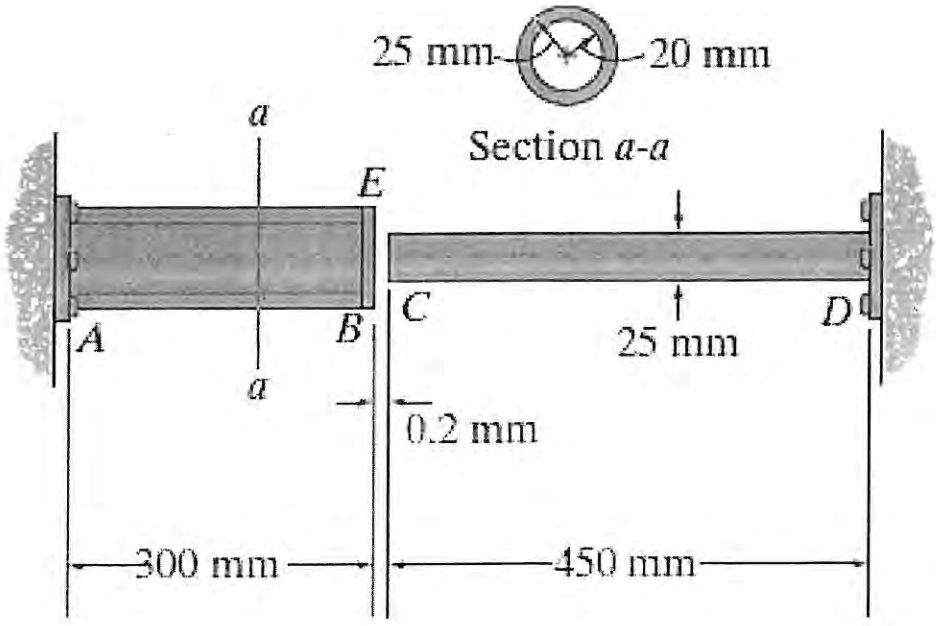
Part B

Q4

The AM1004-T61 magnesium alloy tube AB is capped with a rigid plate E. The gap between E and end C of the 6061-T6 aluminum alloy solid circular rod CD is 0.2 mm when the temperature is at 30° C. Determine the normal stress developed in the tube and the rod if the temperature rises to 80° C. Neglect the thickness of the rigid cap.

α_{al} =24(10^{-6})1/degree C), E_{al}= 68.9 GPa

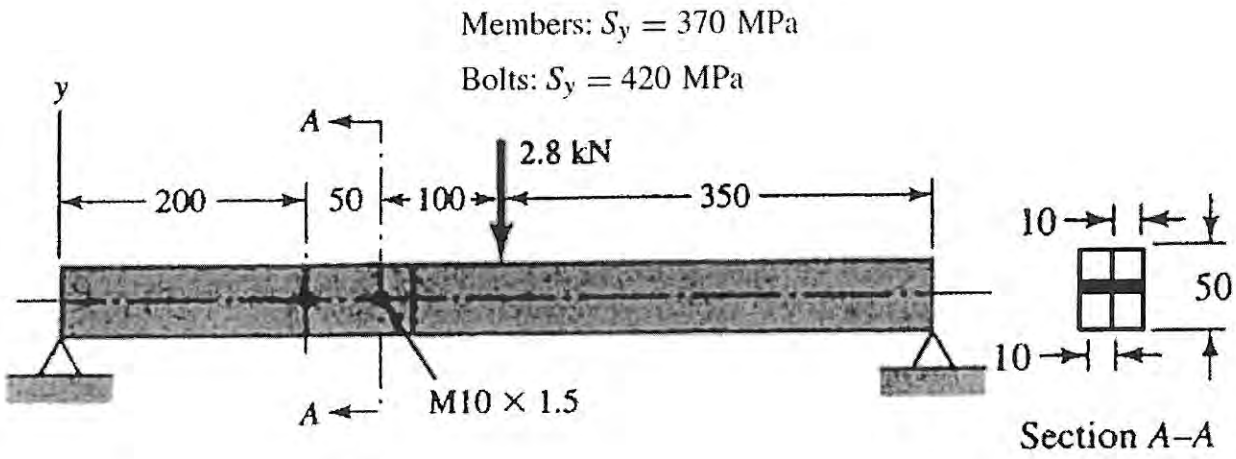
α_{mg} =26(10^{-6})1/degree C), E_{mg}= 44.7 GPa



Part B

Q5

A beam is made up by bolting together two cold-drawn bars of AISI 1018 steel as a lap joint, as shown in the figure. The bolts used are ISO 5.8. Ignoring any twisting, determine the factor of safety of the connection



Part B

Q6

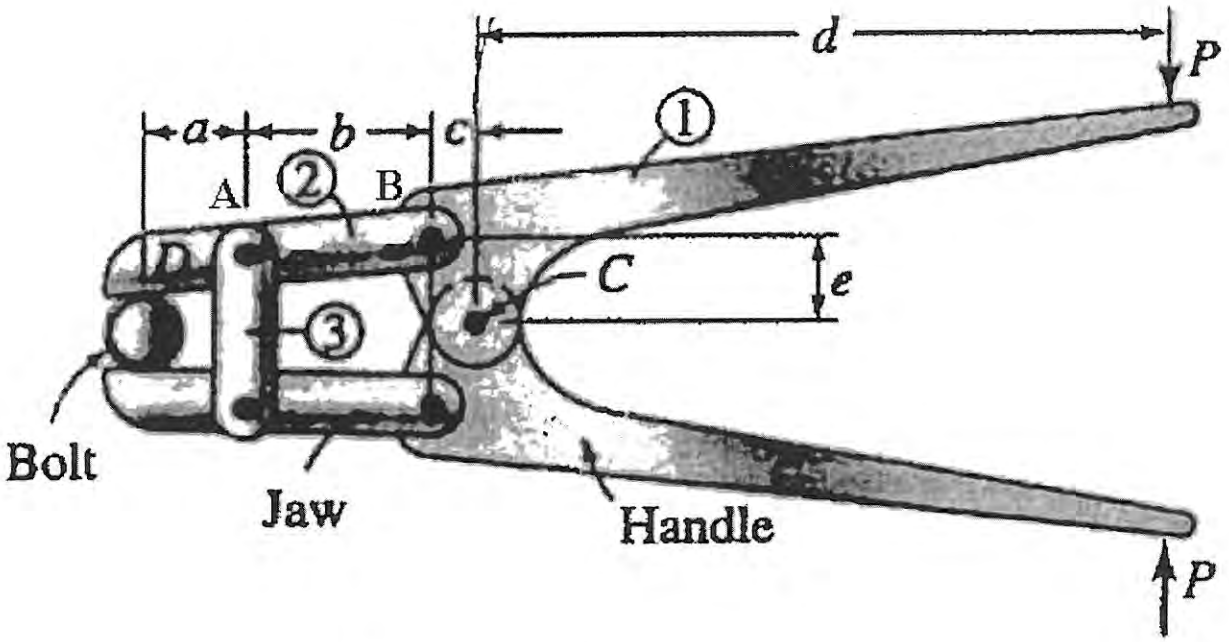
The figure shows a pin-connected tool in the closed position in the process of gripping its jaws into a bolt. The user provides the input loads between the handles, indicated as the reaction pairs P. Determine the force exerted on the bolt and the pins at joints A, B, and C. Find maximum stress for member 2 and 3. Material of all parts is AISI 1080 HR steel.

Given:

P= 2 *lb*, a= 1 *in.*, b= 3 *in.*, S_y = 60.9 *ksi*

c= 2 *in.*, *d*= 8 *in.*, *e*= *1 in.* S_{ys} =0.5 S_y = 30.45 *ksi*,

E= 30 x 10^6 psi



Bolt cutter.