National Examinations – May 2016

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 a clear statement of any assumptions made with the answer paper.

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 two (2) problems from part A.

Q1

i) List the two principal functions of cutting fluids at low cutting speeds and (b) discuss at least two mechanisms by which they fulfill these functions.

ii) List the two principal functions of cutting fluids at high cutting speeds and (b) discuss at least two mechanisms by which they fulfill these functions.

iii) In a lathe turning operation, chatter sets in during machining a particular part. (a) What will be its manifestation (list at least two) and (b) indicate the steps you would take to identify the cause of chatter.

iv)A surface turned with a tool of 1-mm nose radius has unacceptably high roughness. To improve the finish, suggest a change to the (a) process and (b) tool, and indicate the unintentional consequences of such changes (assume that no tool pickup affects roughness).

Q2

i) Solid-solution alloys of wide freezing range are generally regarded as poor casting alloys; (a) why? (b) They are extensively used in die casting. Provide an explanation.

ii) Sometimes it is preferred not to disturb the structure of a casting by machining its surface. Suggest a possible reason for this preference.

iii) (a) Draw a sketch of a part with hot tearing. (b) Explain, with the aid of appropriate sketches, the events leading to the problem.
(c) State what type of alloy is most prone to it.

Q3

i) An automotive pressing fails in production. The part is formed by almost pure stretching, using drawbeads in the dies.
(a) What would you analyze the problem?
(b) What is the likely strain state at the point of fracture (use forming limit diagram).
(c) Indicate in the FLD two possible remedies, keeping the shape of the pressing unchanged.
(d) If none of this works, what else could be attempted?

ii) What sheet' properties would you specify for
(a) bending without orange peel;
(b) bending to zero radius;
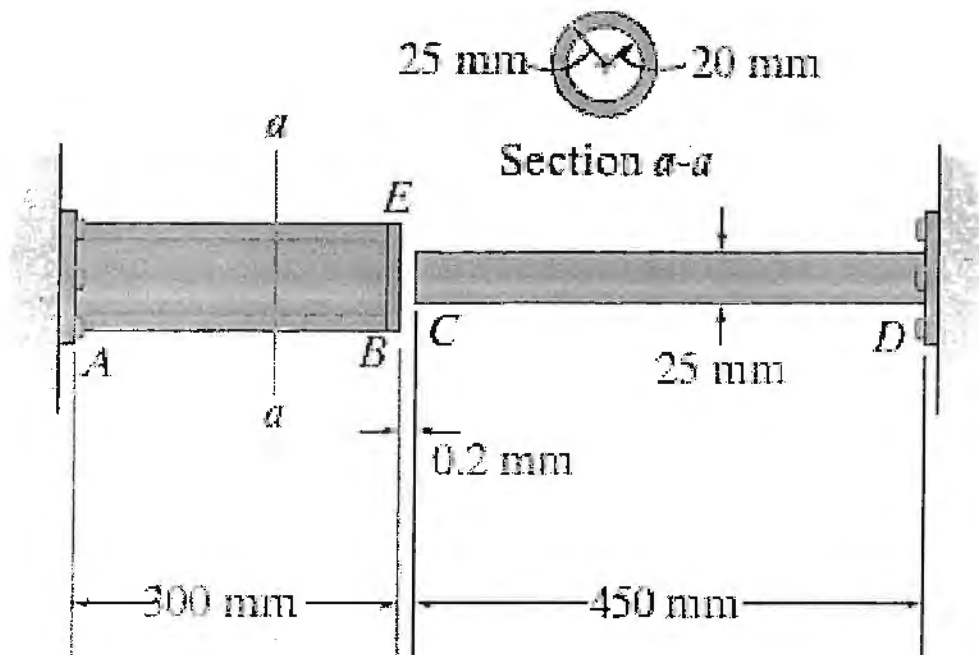(c) greatest resistance to permanent deformation in service. Justify the choices.

Part B: Choose any two (2) problems from 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.

$\alpha_{al} = 24(10^{-6})1/\text{degree C}), \quad E_{al} = 68.9 \text{ GPa}$

$\alpha_{mg} = 26(10^{-6})1/\text{degree C}), E_{mg} = 44.7 \text{ GPa}$

25 mm — 20 mm

Section a-a

E

C

25 mm

0.2 mm

A   B   D

300 mm   450 mm

Q5

(a) Find the reactions, and draw and dimension the bending moment diagram for the shaft shown in figure. All bearings are on immovable supports at the same elevation. Include the effect of the dead load of the shaft. For the shaft, E= 30 ksi, γ = 0.283 1b/in.^{3}.
(b) Find the values of the reactions if the bearing at C is 1/8 in. lower than the others. Include the effect of the dead load of the shaft.
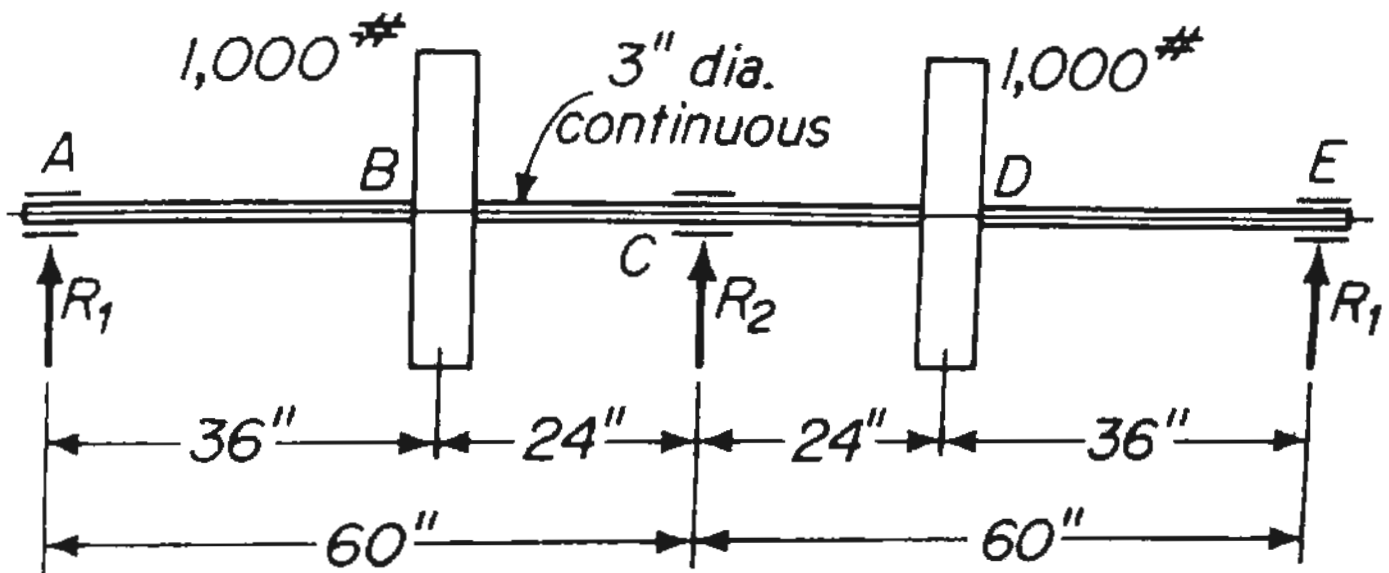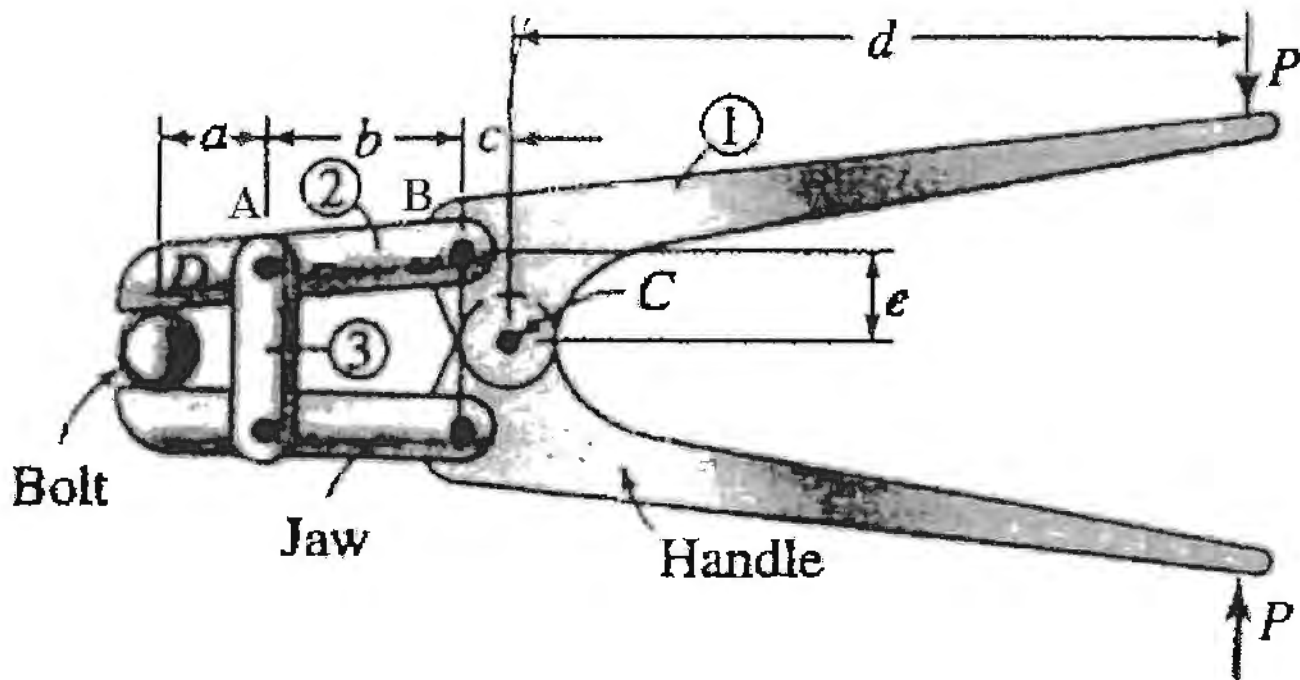
Q6

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.