National Examinations – May 2011

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

3 Hours Duration

Notes:

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 8 questions on the following 6 pages, divided into Part A and Part B. Answer three (3) questions from Part A and two (2) questions from Part B. 5 (five) questions constitute a complete paper. Only the first five 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 (20%).

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.

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.

Q3

Many bicycle frames are constructed of steel tubing joined to hollow fittings. (a) Suggest a way of joining, (b) define the process, (c) make a sketch of a joint indicating critical features.

Q4

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

PART B: Choose any two(2) problems from part B.

Q5

A vertical channel 152 x 76 has a cantilever beam bolted to it as shown in Figure S6. The channel is hot-rolled AISI 1006 steel. The bar is of hot-rolled AISI 1015 steel. The shoulder bolts are M12 x 1.75 ISO 5.8. For a design factor of 2.8, find the safe force F that can be applied to the cantilever.

Use the following information:

Bolts; Sp= 380 Mpa, Sy=420 Mpa

Channel: t = 6.4 mm, Sy=170 Mpa

Cantilever: Sy= 190 MPa

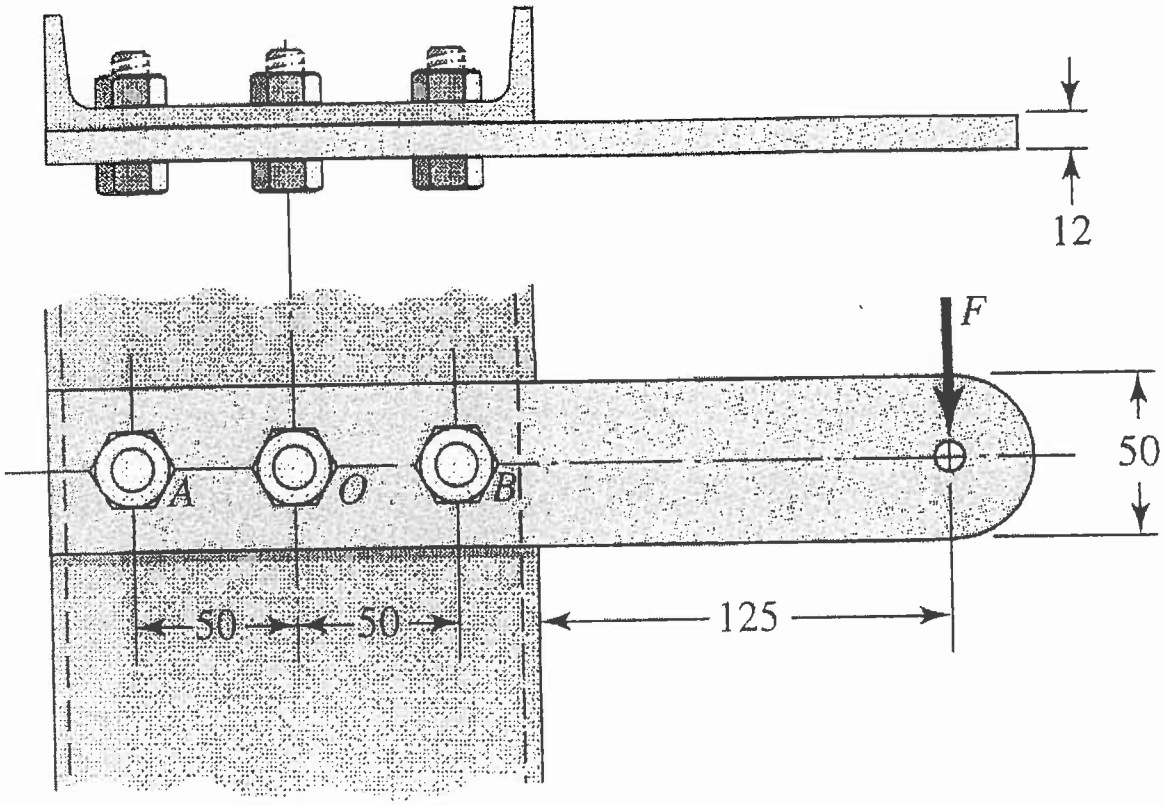


Fig. S6

Q6

The Figure S4 shows a crank loaded by a force F=190 lbf which causes twisting and bending of the ¾-in-diameter shaft fixed to a support at the origin of the reference system. The material of the shaft AB is hot-rolled AISI 1 steel (yield strength S_y = *32 kpsi* and tensile strength S_{ut} = 58 kpsi). Using the maximum-shear-stress theory, find the factor of safety based on the stress at point A.

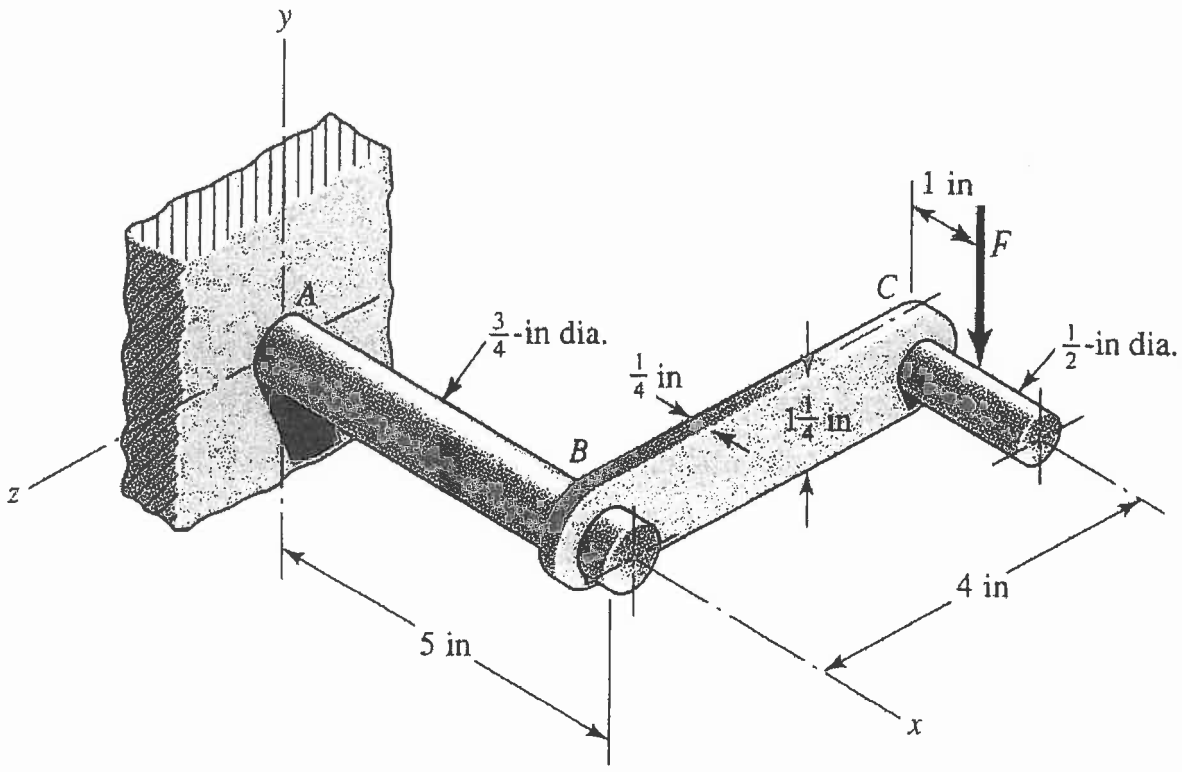


Fig. S4

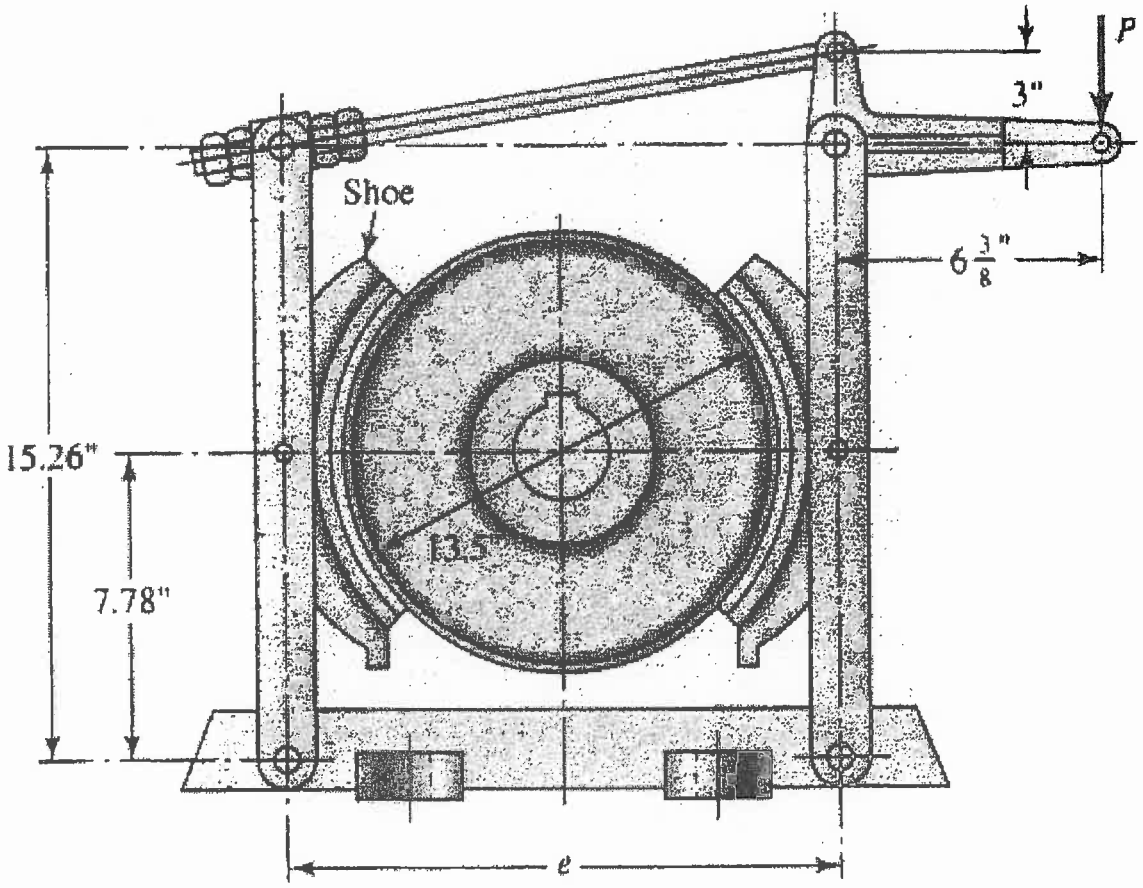
Q7

The shoes on the brake depicted in the Figure subtend a 90° arc on the drum of this external pivoted-shoe brake. The actuation force P is applied to the lever. The rotation direction of the drum is counterclockwise, and the coefficient of friction is 0.30.

(a) What should the dimension e be?

(b) Draw the free-body diagrams of the handle lever and both shoe levers, with forces expressed in terms of the actuation force P.

(c) Does the direction of rotation of the drum affect the braking torque?

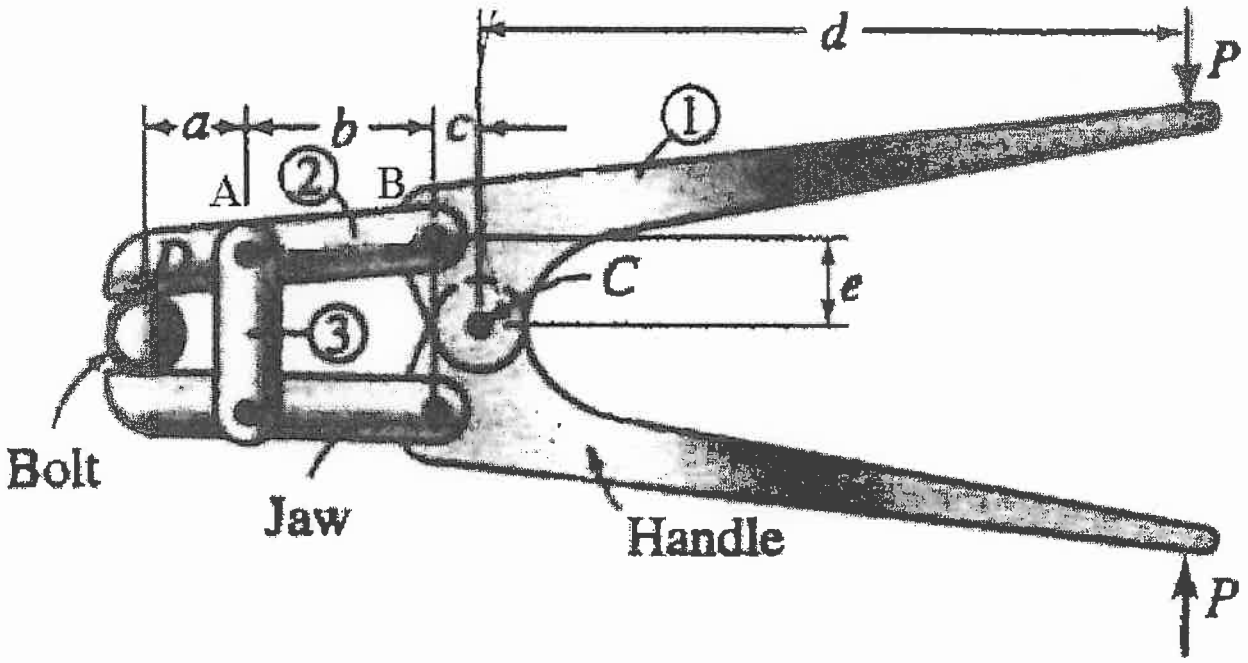


Q8

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.