National Examinations – December 2019

16-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

(a) Describe the process shown in Figure S1.

(b) What are the advantages of this process?

(c) Industrial implementation of this process has been difficult, why?

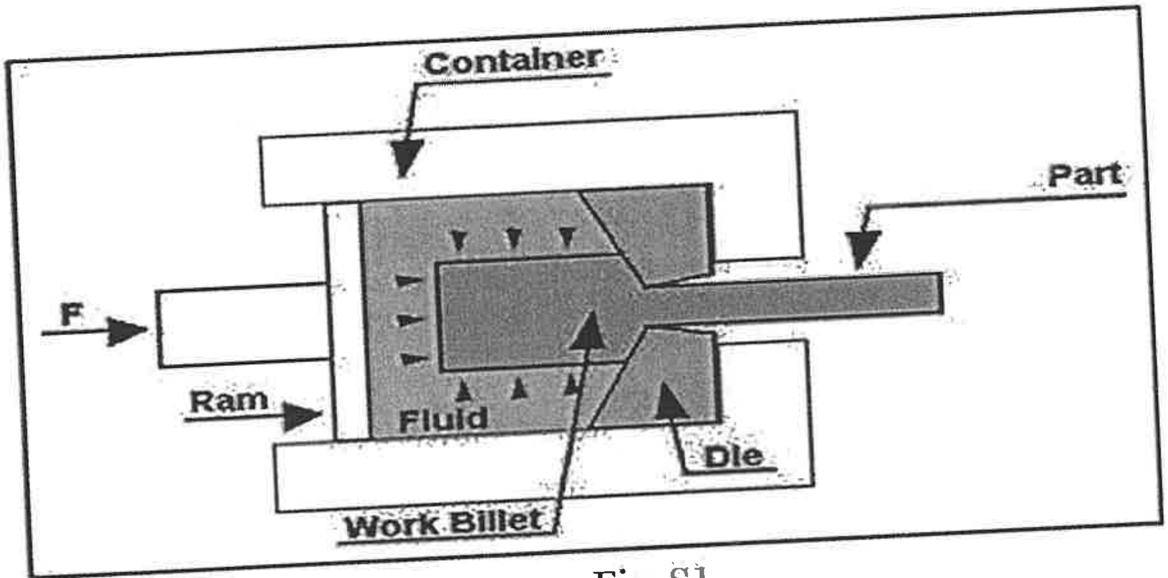


Fig. S1

Q2

The Figure S2 shows the setup for fine blanking.

(a) Describe the process,

(b) Describe the main feature of sheet metal parts produced using this process ,

(c) How is this feature achieved ?

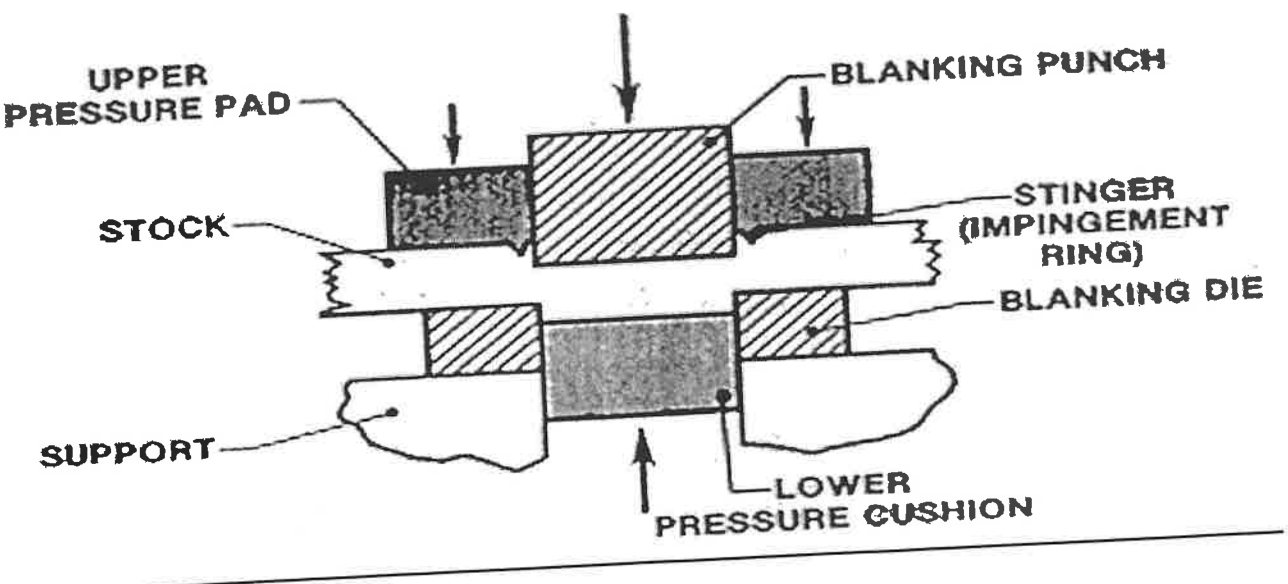


Fig. S2

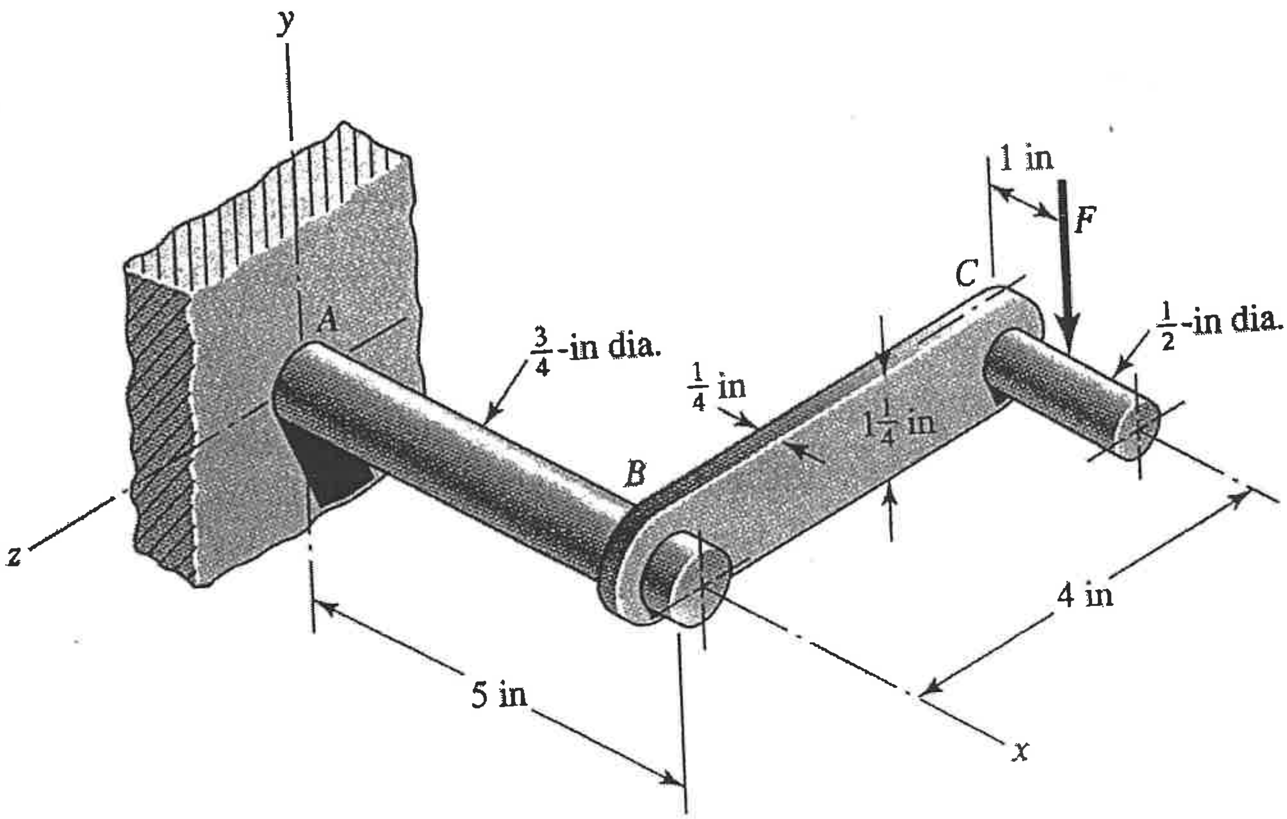
Part A

Q3

A lever-shaped component is made by bending a blanked form. In the middle of a large production run, it is noted that a number of parts fracture, partially or fully, during bending. (a) Suggest the most likely cause, assuming that all blanks are sheared from the same batch of material, and suggest remedies in the (b) blanking and (c) bending operation.

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

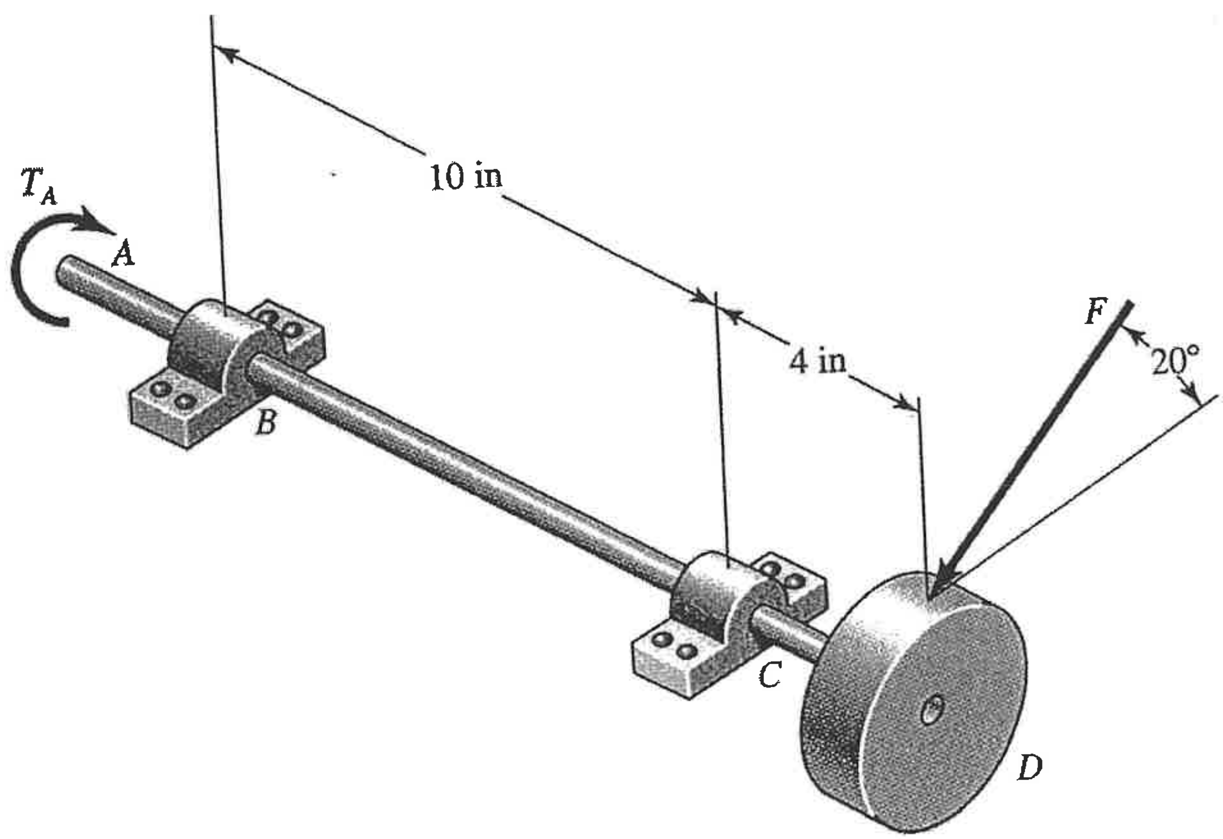
Q4
The Figure shows a crank loaded by a force F=290 lbf which causes twisting and bending of the ¾-in-diameter shaft fixed to a support at the origin of the reference system. The material of the shaft AB is hot-rolled AISI 1 steel (yield strength $S_y = 30\ kpsi$ and tensile strength $S_{ut} = 50$ kpsi). Using the maximum-shear-stress theory, find the factor of safety based on the stress at point A.



Part B

Q5

The rotating solid steel shaft in Figure is simply supported by bearings at points B and C and is driven by a gear (not shown) which meshes with the spur gear at D, which has a 6-in pitch diameter. The force F from the drive gear acts at a pressure angle of 20 degrees. The shaft transmits a torque to point A of $T_A = 3500\ lbf.in.$ The shaft is machined from steel with $S_y = 65\ kpsi$ and $s_{ut} = 75\ kpsi$. Using a factor of safety of 2.0, determine the minimum allowable diameter of the 10 in section of the shaft based on (a) a static yield analysis using the distortion energy theory and (b) a fatigue-failure analysis. Assume sharp fillet radii at the bearing shoulders for estimating stress concentration factors.



Part B

- **Q6**
- Without bracing, a machinist can exert only about 100 lbf on a wrench or tool handle. The lever shown in the Figure S7 has t= 0.5 in and w = 2 in. We wish to specify the fillet-weld size to secure the lever to the tubular part at A. Both parts are of steel, and the shear stress in the weld throat should not exceed 3000 psi. Find a safe weld size.

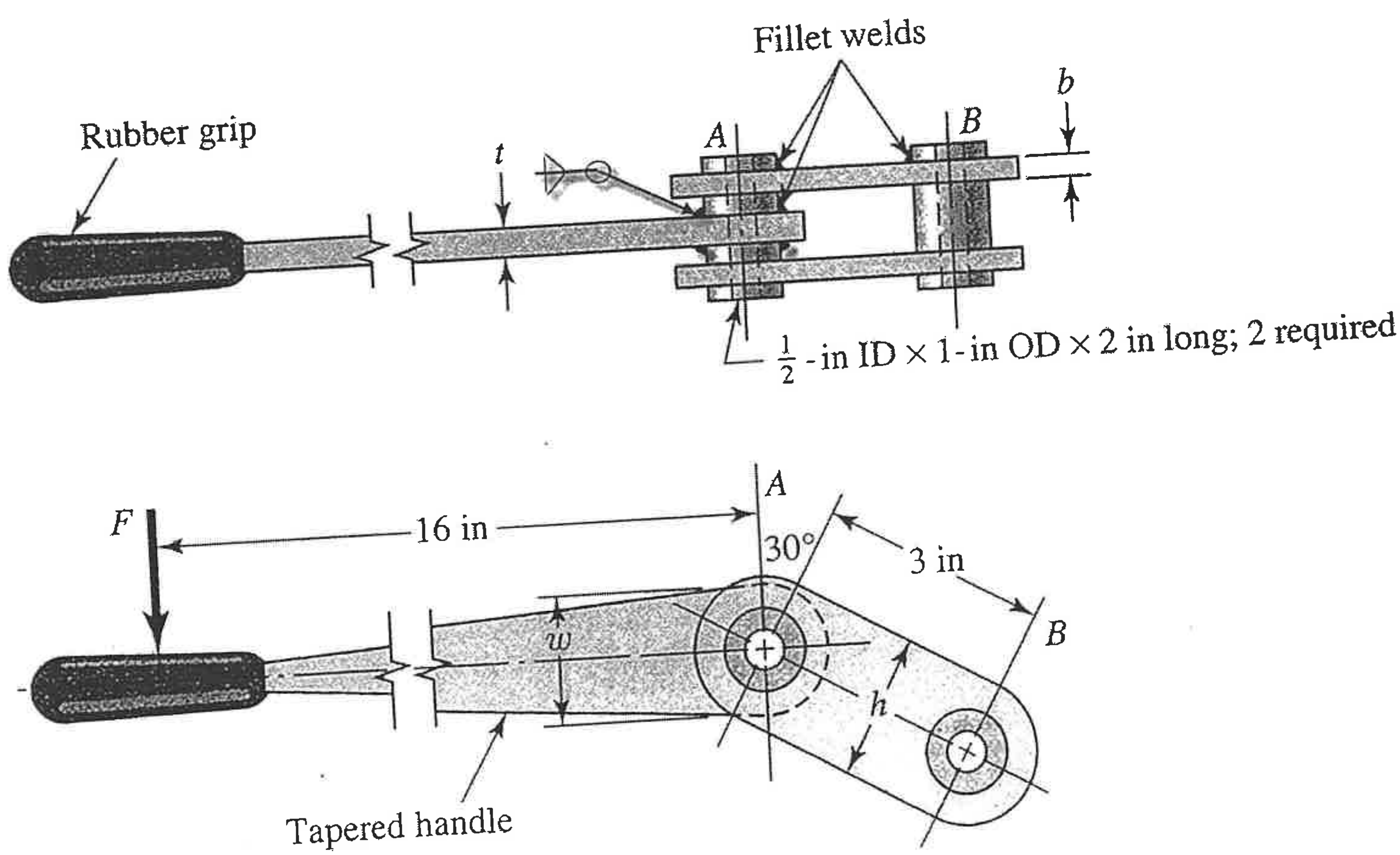


Fig. S7