National Examinations – May 2012

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) Figure ***a*** shows the use of heating bands around the joints to be welded. Why are these bands Used?

HEATNIG
BANDS

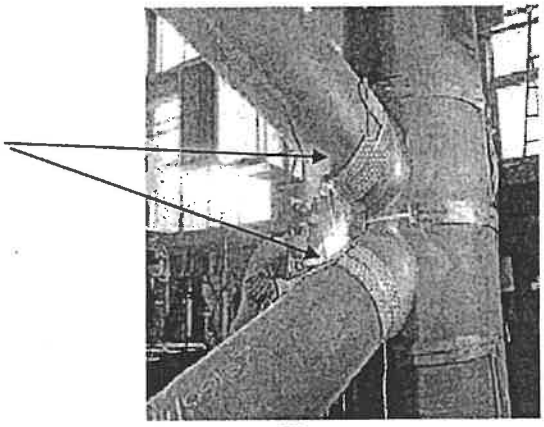


Figure ***a***

b) The crack shown in the figure ***b*** developed during the welding process. The parts are made of low carbon steel.
What is the most likely cause of this defect?

c) Suggest ways of preventing this defect from happening again.

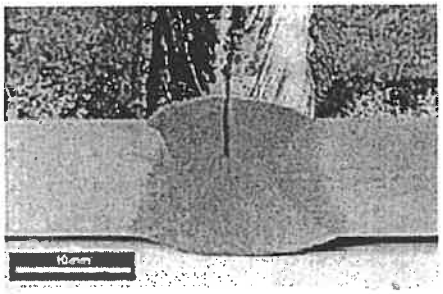
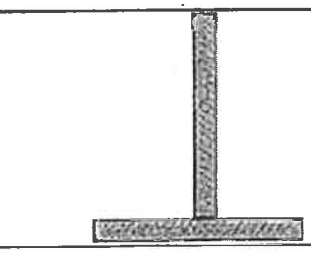


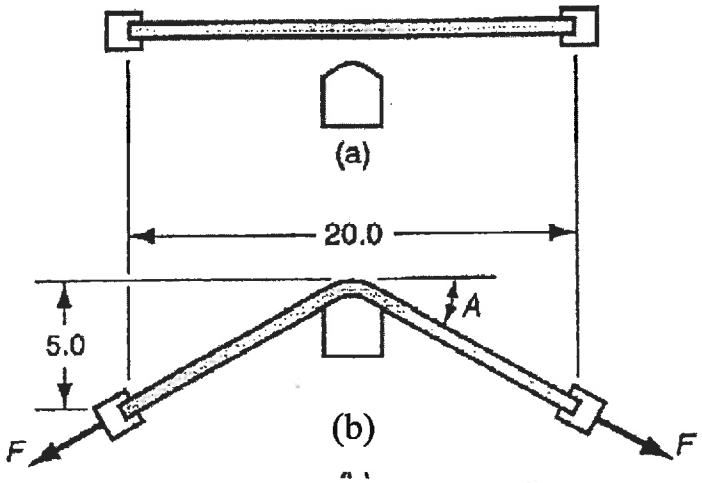
Figure ***b***

Q2 Redesign the three joints shown so that they are suitable for adhesive bonding.

	Redesign for Adhesive Bonding
	
	
	

Q3

A 20 inch long sheetmetal workpiece is stretched in a stretch forming operation to the dimensions shown in Figure (a). The thickness of the beginning stock t = 0.125 inch and the width = 10 inches. The metal has a flow curve defined by K = 70,000 lb/in2 and n = 0.25. (a) Find the stretching force F required near the beginning of the operation when yielding first occurs. Determine: (b) true strain experienced by the metal, (c) stretching force F, and (d) die force Fdie at the very end when the part is formed as indicated in Figure (b).



Q4

i) A part fails in the course of deep drawing.

(a)Fracture occurs toward the end of draw; identify a likely source of the problem and suggest a possible remedy.

(b)Fracture occurs earlier; identify a likely source of the problem and suggest as many possible remedies as you can.

ii) It is suggested that, for highest reduction in deep drawing, the punch and die radii should be as large as possible. Subject this suggestion to a critique, using a sketch to support your argument.

iii) Someone asserts that a blankholder is always needed in deep drawing. (a) Do you agree? (b) If not, state (qualitatively) the defining conditions.

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

Q5

In the double-reduction gear train shown, shaft a is driven by a motor attached by a flexible coupling attached to the overhang. The motor provides a torque of 2500 lbf.in at a speed of 1200 rpm. The gears have 20 degree pressure angles, with diameters shown on the figure. Use an AISI 1020 cold-drawn steel. Design shaft c with a design factor of 1.5 by performing the following tasks.

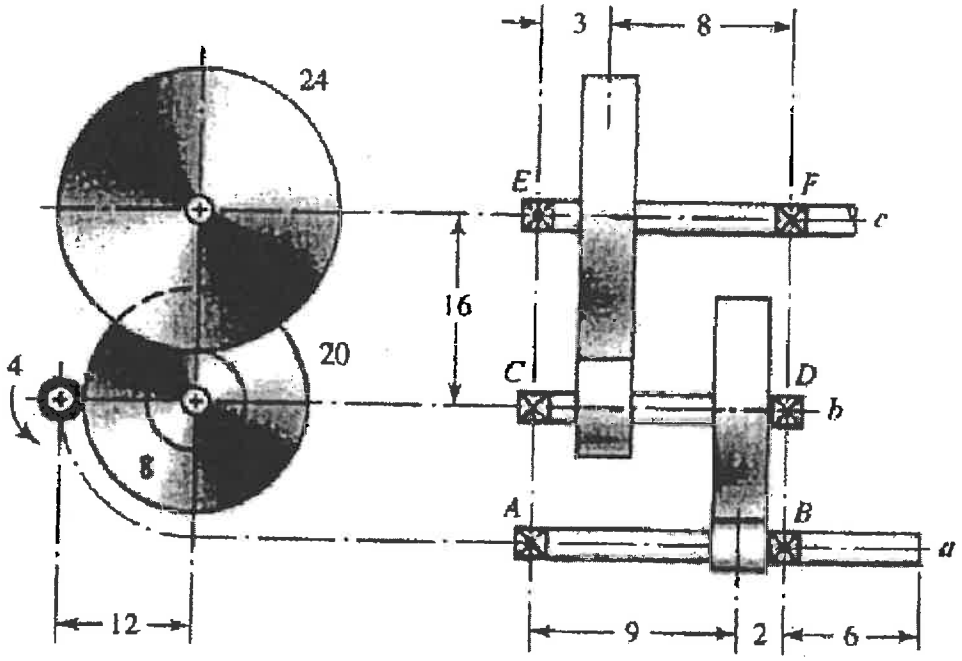
(a) Sketch a general shaft layout, including means to locate the gears and bearings, and to transmit the torque.

(b) Perform a force analysis to find the bearing reaction forces, and generate shear and bending moment diagrams.

(c) Determine potential critical locations for stress design.

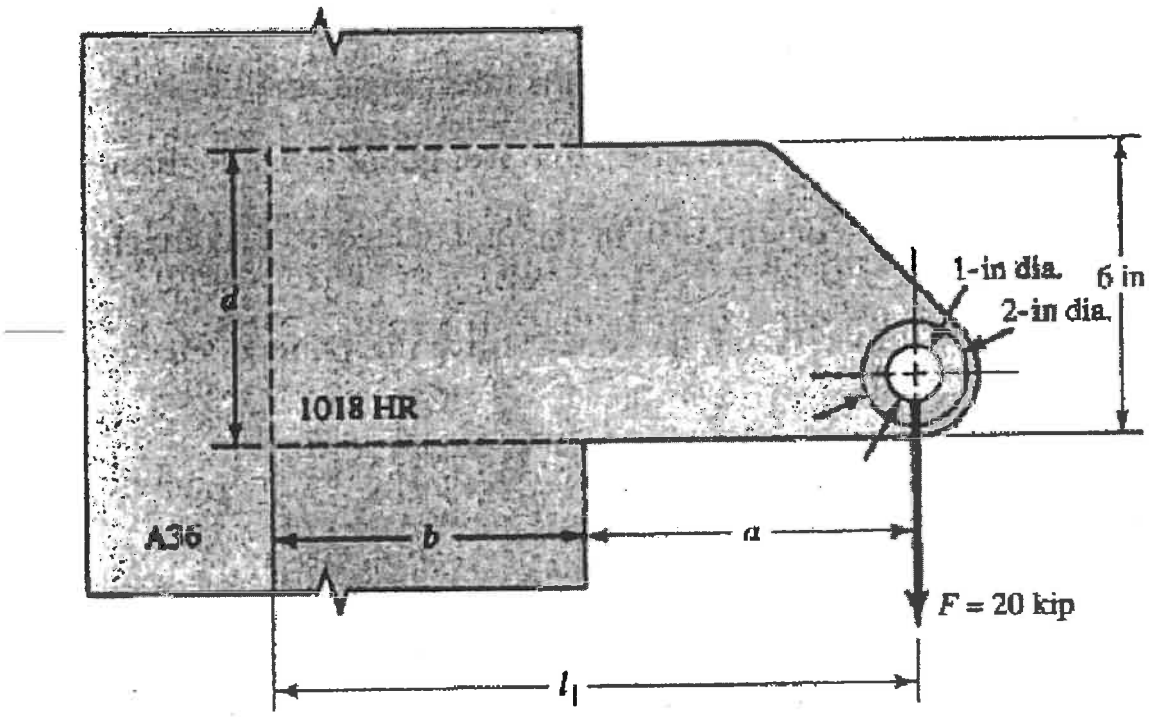
(d) Determine critical diameters of the shaft based on fatigue and static stresses at the critical locations.

Dimensions in inches.



Q6

A vertical column of A36 structural steel (S_y = 36 kpsi, S_{ut} = 58 kpsi) is 10 in wide. An attachment has been designed to the point shown in the figure. The static load of 20 kip is applied and the clearance a of 6.25 in has to be equaled or exceeded. The attachment is 1018 hot-rolled steel, to be made from ½ in plate with weld-on bosses when all dimensions are known. Specify the weldment (give the pattern, type of weld, length of weld bead, and leg size). Specify also the length l_1 for the attachment.

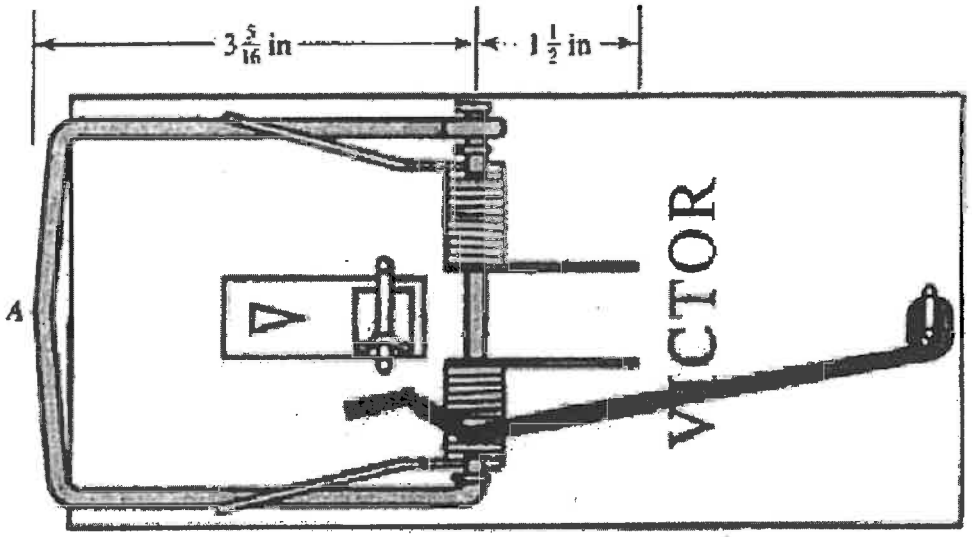


Q7

The rat trap shown in the figure uses two opposite-image torsion springs. The wire has a diameter of 0.081 in, and the outside diameter of the spring in the position shown is 1/2 in. Each spring has 11 turns. Use of a fish scale revealed a force of about 8 lbf is needed to set the trap.

(a) Find the probable configuration of the spring prior to assembly.

(b) Find the maximum stress in the spring when the trap is set.



Q8

The brake shown in the figure has a coefficient of friction of 0.30, a face width of 2 in, and a limiting shoe lining pressure of 150 psi. Find the limiting actuating force F and the torque capacity.