National Examinations – December 2018

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%).

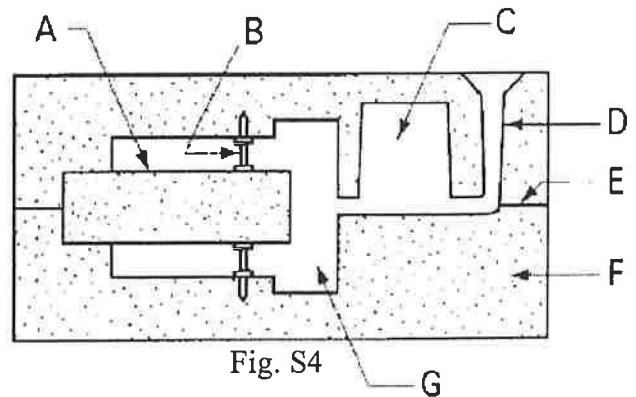**PART A: Choose any two (2) problems from part A.**

Q1

Figure shows the cross section of a sand casting mold.

Identify each of the labels (2 points)

A_____   B_____   C_____   D_____

E_____   F_____   G_____

Explain the purpose of C and B

Fig. S4

Q2

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).

(a)

20.0

5.0

F   A   F
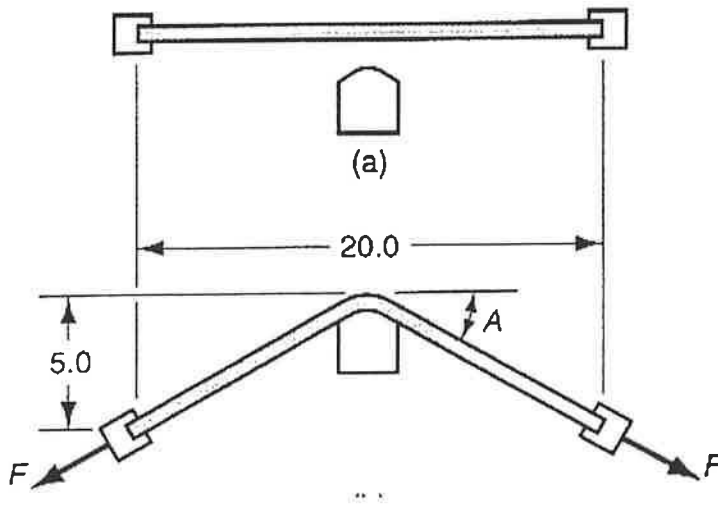
Q3

A cast iron, T-type fitting is being produced for the oil drilling industry, using an air-set or no-bake sand for both the mold and the core. Figure S3 shows a cross section of the mold with the core in place (Figure S3.a), and a cross section of the finished casting (Figure S3.b). Note that there are several significant defects. Gas bubbles are observed at one location in the base of the tee. A penetration defect is observed near the bottom of the inside diameter, and there is an enlargement of the casting at location "C".

(a)   Why are these gas bubbles present only at the location noted?

(b) What factors may have caused the penetration defect?

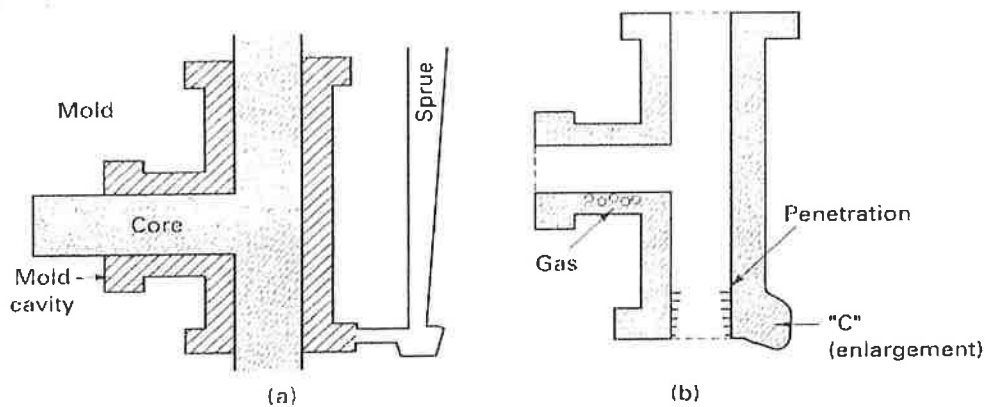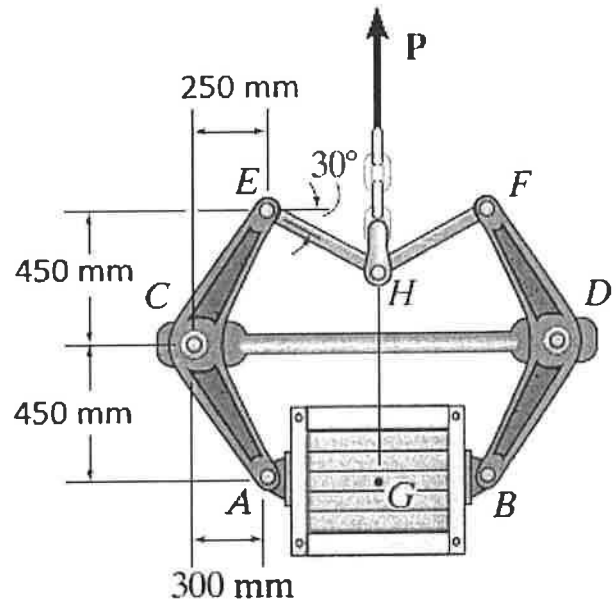(c) What factors led to the enlargement of the casting at point "C"?

Fig. S3

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

Q4

Pin joined tongs are used to lift the 125-kg crate, whose center of mass is at G. Determine the least coefficient of static friction at the pivot blocks so that the crate can be lifted.
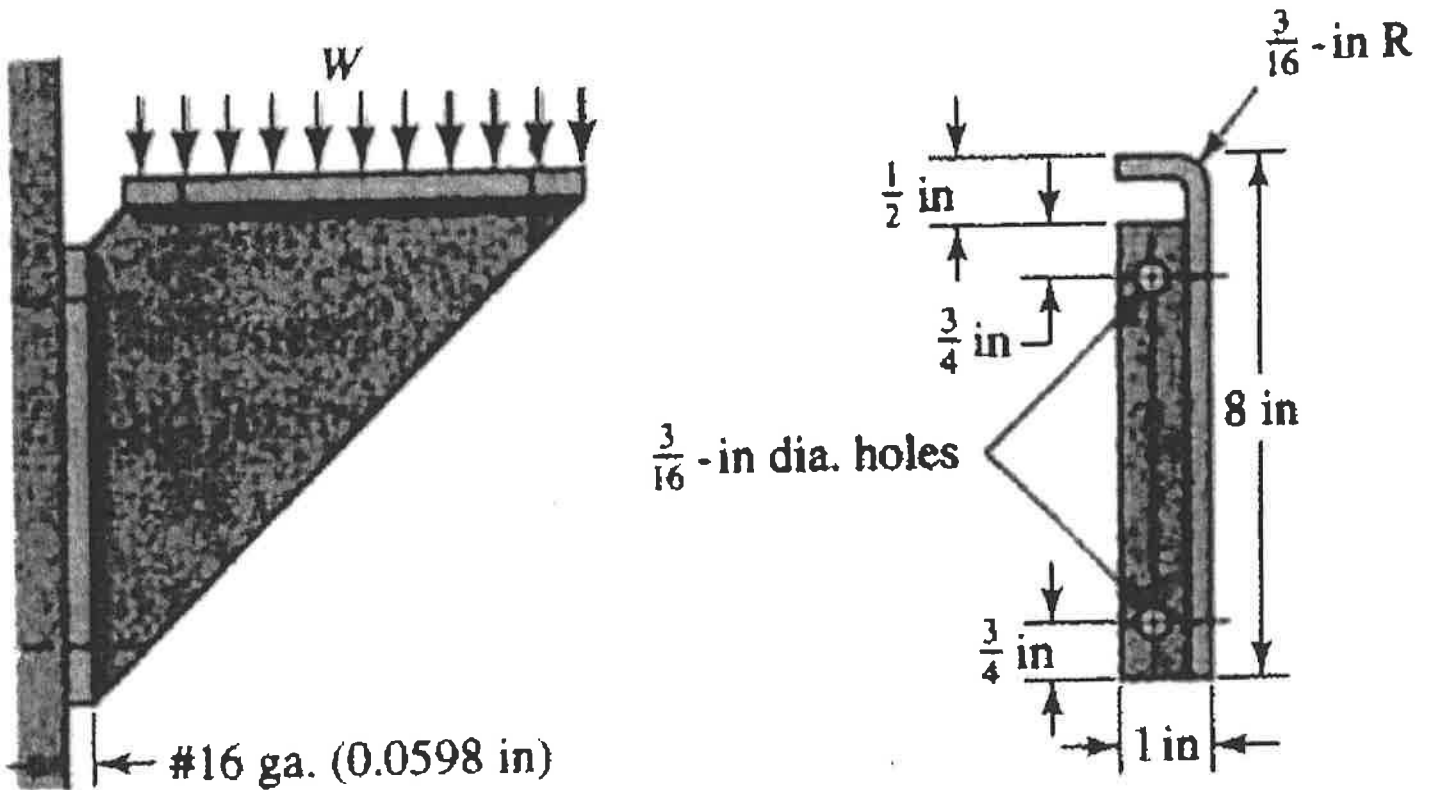
Appropriate free body diagram(s) required.

Part B- Cont'd

Q5

The figure shows a formed sheet-steel bracket. Instead of securing it to the support with machine screws, welding has been proposed. If the combined stress in the weld metal is limited to 850 psi, estimate the total load W the bracket will support. The dimensions of the top flange are the same as the mounting flange

$\frac{3}{16}$ -in R

$\frac{1}{2}$ in

$\frac{3}{4}$ in

$\frac{3}{16}$ -in dia. holes

8 in

$\frac{3}{4}$ in

1 in

#16 ga. (0.0598 in)

Part B- Cont'd

Q6

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 0.25 mm when the temperature is at 35° 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.

$\alpha_{al} = 24(10^{-6}) 1/\text{degree C})$

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