National Examinations – Dec 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) 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?

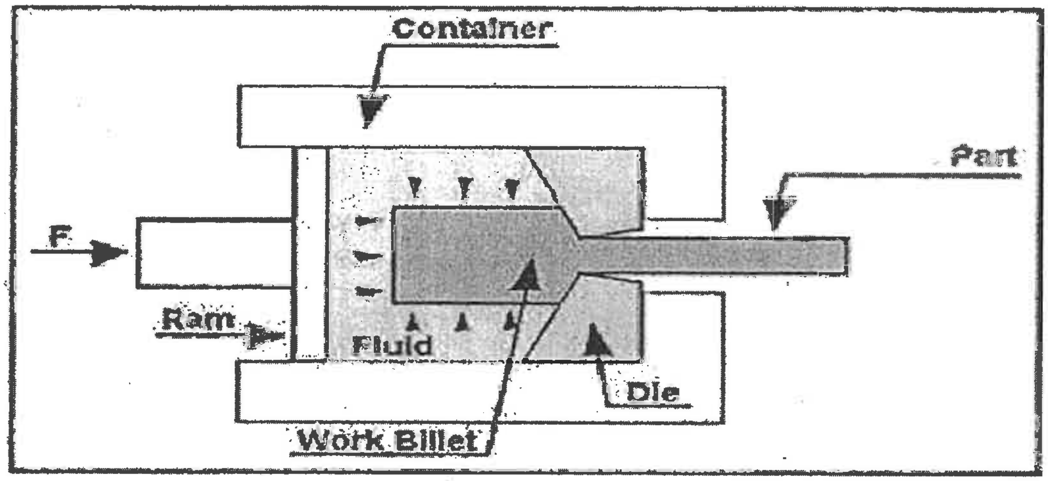


Fig. S1

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 ?

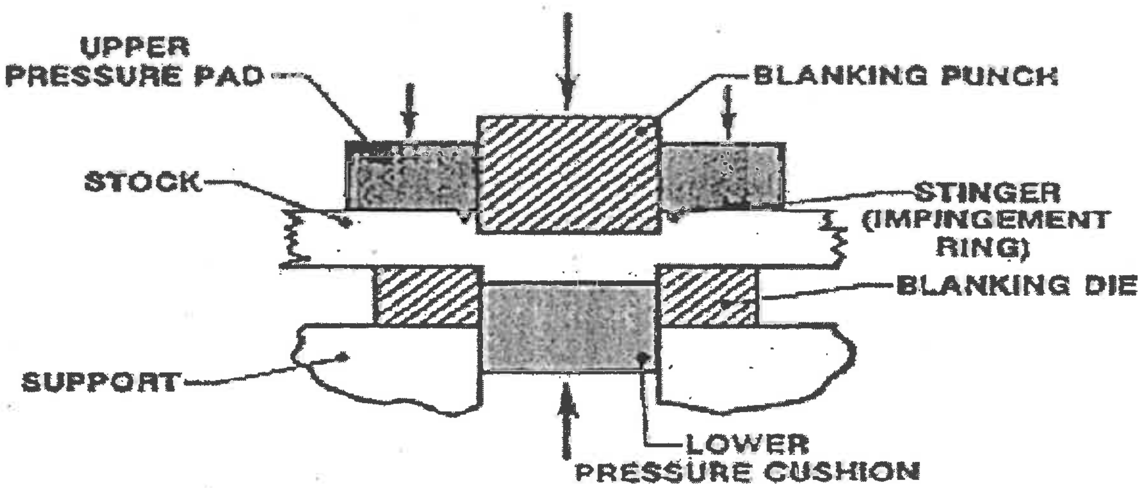
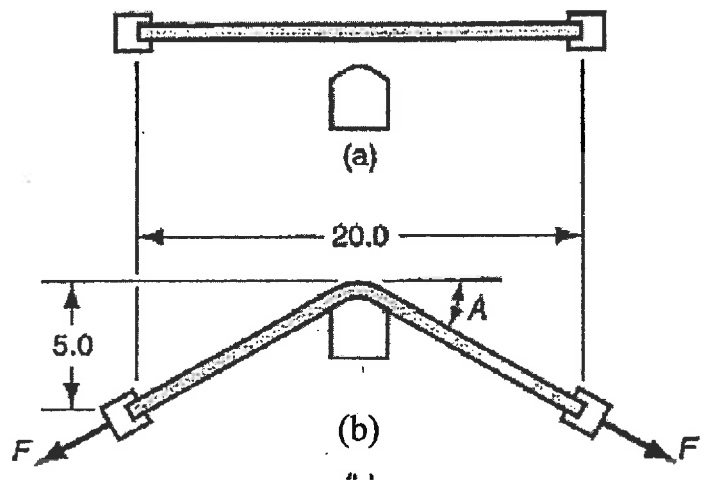


Fig. S2

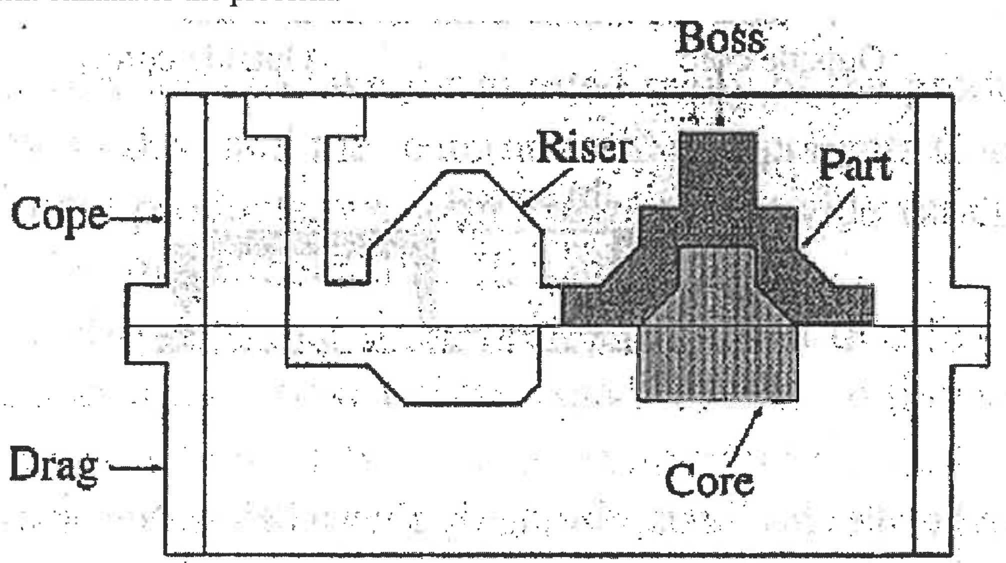
Q3

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

Porosity developed in the boss of the casting illustrated in the figure below. Show that by simply repositioning the parting line of this casting, this problem can be eliminated. Make a sketch to show the new arrangement for part, core, riser and other components of the mold and explain why the new arrangement eliminates the problem.



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

Q5

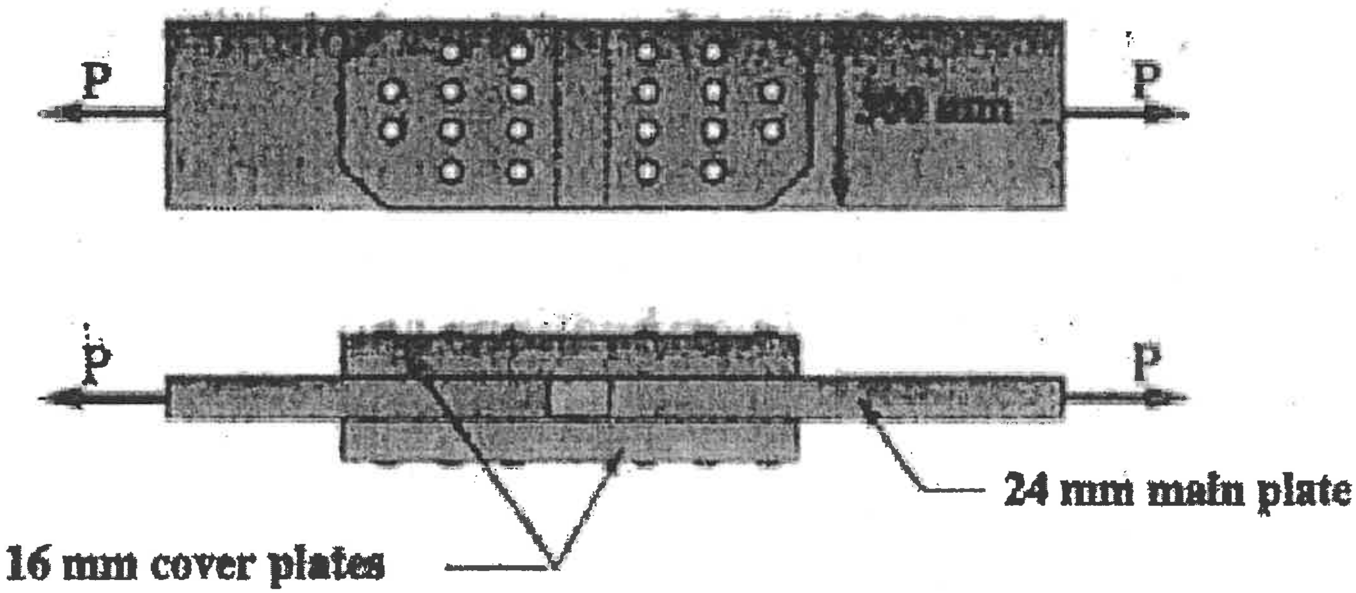
Two 24-mm thick, 300-mm wide main plates are fastened to two 16-mm thick cover plates with 20 rivets as shown in the figure shown. All rivets are nominally 24 mm in diameter and each rivet hole has a diameter of 26 mm. The design stresses for both the rivets and the plates are $(\sigma_{all})_{tension} = 160$ MPa, $(\tau_{all})_{shear} = 110$ MPa, and

$(\sigma_{all})_{bearing} = 350$ MPa. Determine the maximum allowable axial force P that can be applied to the main plates of the multi-riveted joint by considering failure due to:

a. Rivet shear

b. Bearing failure (in main and cover plates)

c. Tension failure (in main and cover plates)



Q6

A helical-coil compression spring is to be designed to exert a static force of 100 lb when the spring is compressed 2.0 inches from its free length, and it must fit inside a cylindrical hole 2.25 inches in diameter. The environment is laboratory air. Design a spring suitable for this application. Only five such springs are to be manufactured. A design safety factor of 2 is desired.

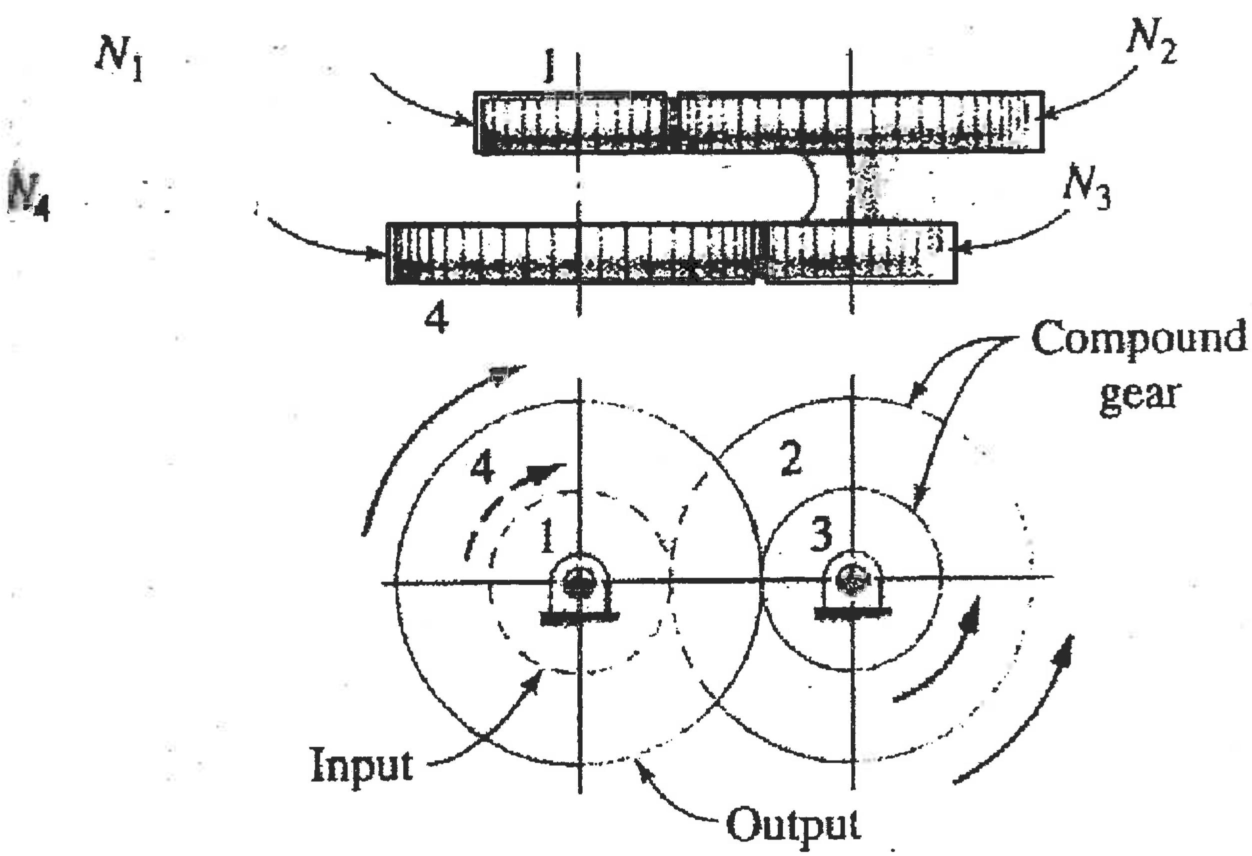
Q7

It is desired to examine a four-gear train similar to Figure ($N_1 = N_3 = 20$ teeth and $N_2 = N_4 = 32$ teeth), to establish preliminary estimates of the resistance to failure at the root fillets of gear no. 1, based on potential failure there due to tooth bending fatigue.

Additional specifications for this gear train are as follows :

1. The gear train is to drive a large industrial blender (stirring machine) which requires 5 horsepower at a steady-state operating speed of 1000 rev/min at output gear 4.
2. This preliminary calculation may be based on the assumption that friction losses are negligible for all bearings and gear meshes.
3. It is desired to use Grade 1 AISI 1020 low-carbon steel, if possible, for the gear blanks.
4. Gear teeth are to be standard 20° spur full-depth involute teeth.
5. An in-house gearing specialist has suggested that a diametral pitch of about 10 would probably be a good initial assumption for the iterative calculation.

If a very long life is desired for this gear, and a reliability of 99 percent is required, calculate the factor of safety for gear 4 based on tooth bending fatigue.



Q8

A 400-mm diameter drum has two internally expanding shoes, as shown in the Figure. The actuating mechanism produces the same actuating force F_a on each shoe (applied at points C and D). The width of each shoe is 75 mm, the coefficient of friction is $\mu = 0.24$, and the maximum pressure is $p_{max} = 1.0$ MPa. Determine the minimum required actuating force, and the friction torque, noting the drum may rotate either clockwise or counter clockwise.