National Examinations – May 2017

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 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"?

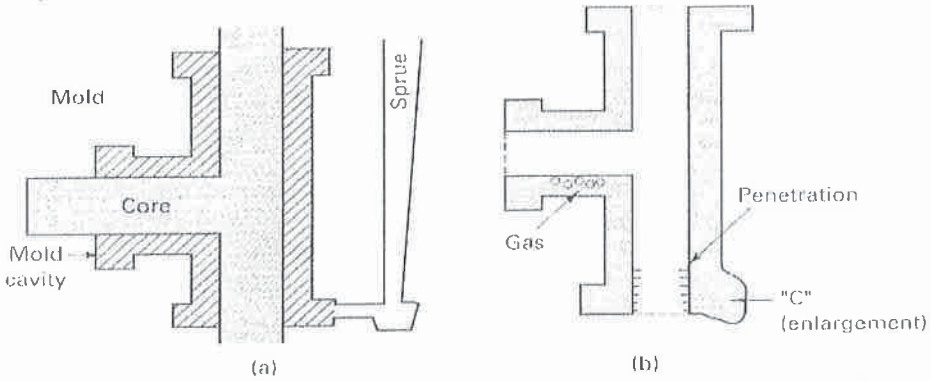


Fig. S3

Q2

a) In figure Ro1, which thread is made by rolling? Justify your answer.

b) In figure Ro2, which thread is made by rolling? Justify your answer.

c) What manufacturing process would you suggest for mass production of parts with cross section shown in Figure Pr1. Justify your answer.

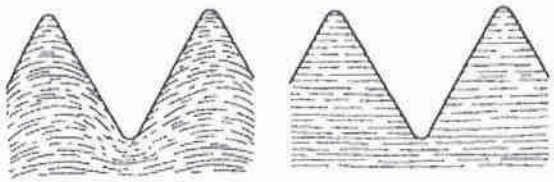


Figure Ro1

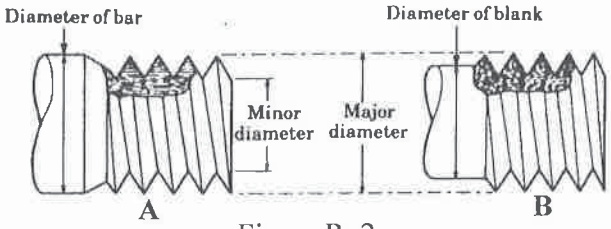


Figure Ro2

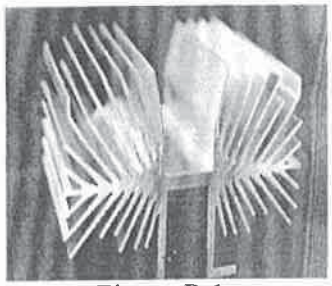


Figure Pr1

PART A (continued)

Q3

a) Assuming the cross sectional areas in figure ex1 are the same, which cross section requires more force to extrude? Why?

b) Figure ex2 shows an unbalanced cross section for a part to be extruded. What would happen if this problem is not addressed? What are other issues with this design as far as extrusion process is concerned?

c) What is the cause of the defect in flat rolling process shown in:

i) Figure Ro1

ii) Figure Ro2

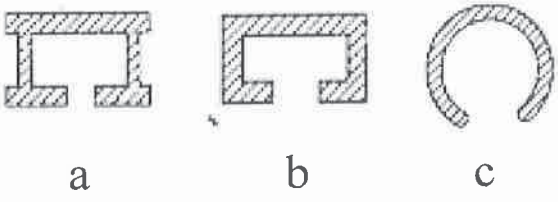


Figure ex1

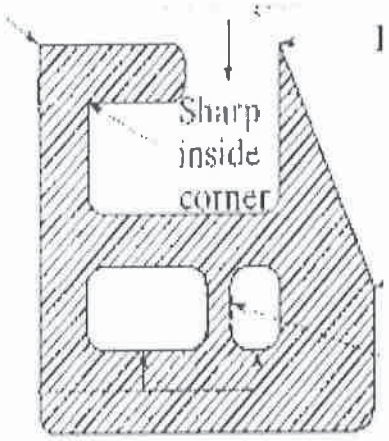


Figure ex2

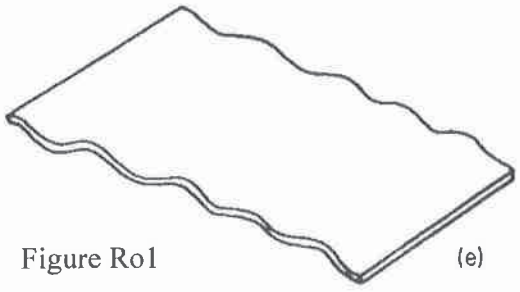


Figure Ro1

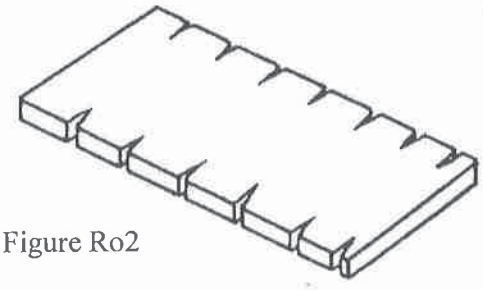


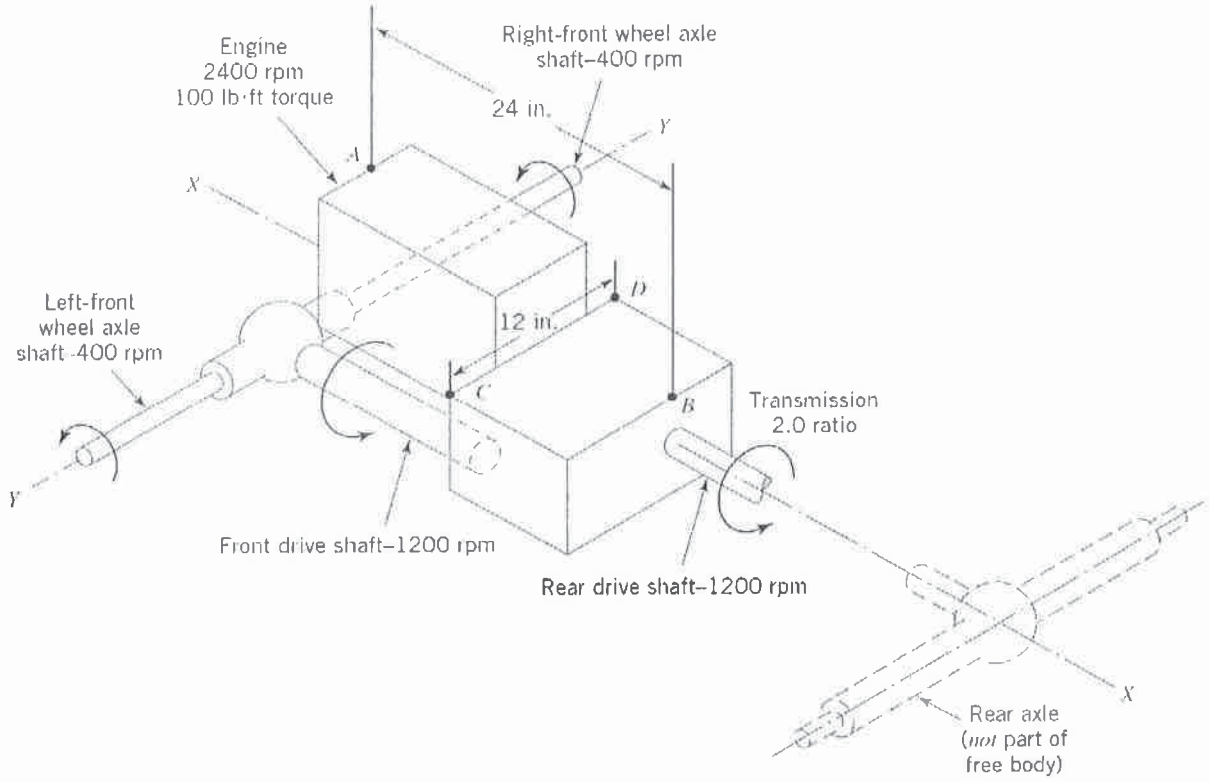
Figure Ro2

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

Q4

An engine rotates with a known angular velocity and delivers a known torque to a transmission which drives a front and rear axle.
Determine the forces at mounting points A, B, C, and D.

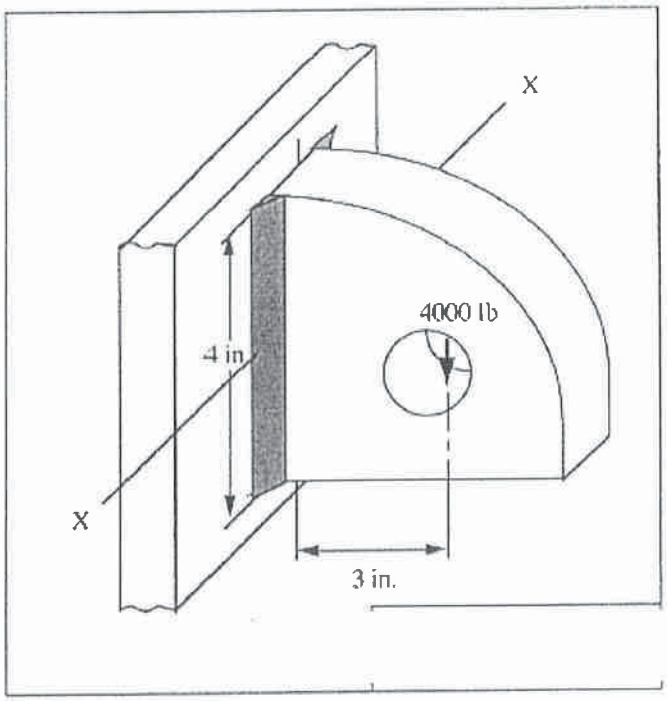
Assumptions:
1. The friction and gravity forces are negligible.
2. 'All mountings exert only vertical forces.
3. All four wheels have full traction.



Part B

Q5

A bracket supports a 40001b load. A fillet weld extends for the full 4 in. length on both sides. The welding rod used has a Sy= 48 ksi. The safety factor is 3.
Calculate the minimum weld size required.



Part B

Q6

An external drum brake is applied by a spring and released by a hydraulic cylinder. The coefficient of friction is specified.
(a) Draw free-bodies in equilibrium for each of the brake shoe and arm assemblies, the spring and the drum, showing forces in terms of spring force, Fs.
(b) Determine the force required to produce a braking torque of 1200 N.