

**National Examinations – December 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) A sheet-metal part is made by bending 1015 steel of 5-mm thickness on a sharp edge (zero radius). Many parts fail in service and, for increased strength, it is now proposed to change to 1045 steel. Make a quick engineering judgment whether this will be feasible.  $q_{1045}=0.45$  (  $q$  is reduction of area for the given material)

b) State the two mechanical properties of materials that are most important in influencing springback and whether springback increases or decreases with these properties.

c) It is suggested that, for highest production rate 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.

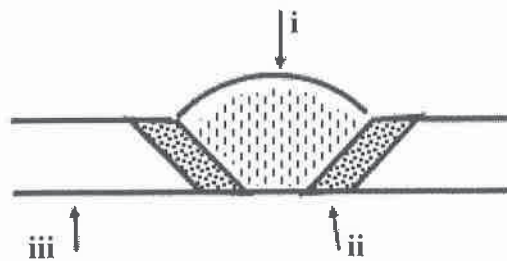
**Q2**

a) Name the three major areas of a weld as represented by the arrows in the weld cross section Fig. w2.

b) Which area in Fig. w2 would be the site of a solidification crack? How would you prevent it?

c) Which area in Fig. w2 would be the site of a hydrogen crack? How would you prevent it?

Fig. w2



**PART A (continued)****Q3**

Figure 1 shows a common problem in injection molded parts called weld line defect.

- Explain the reason for this defect
- Suggest some remedies?
- Of the two features shown in figure 2, which one is easier to produce in injection molding (A or B)?
- Why?

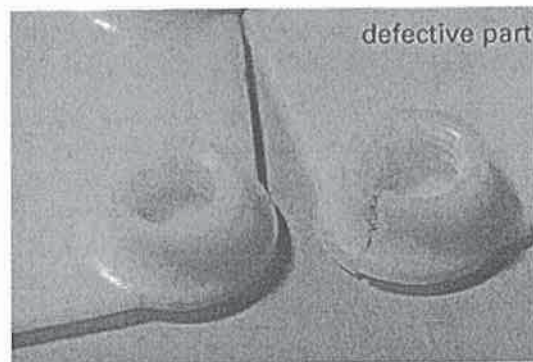


Figure 1

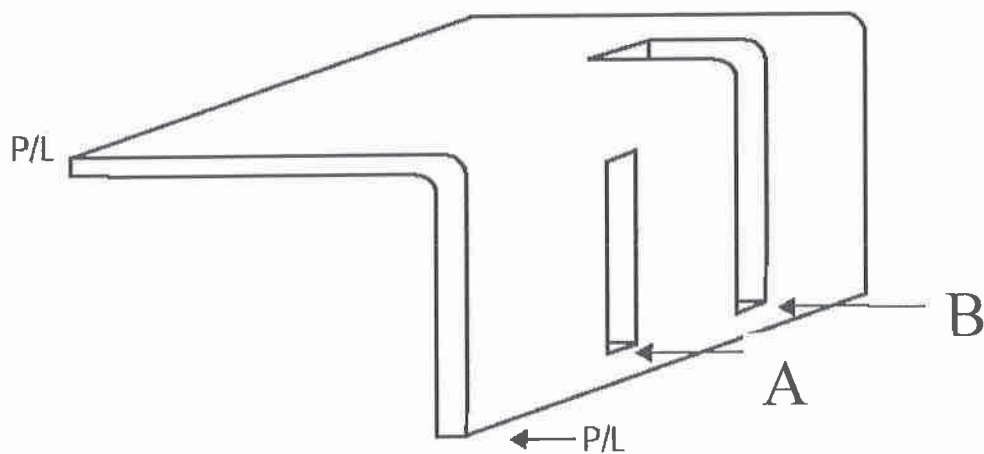


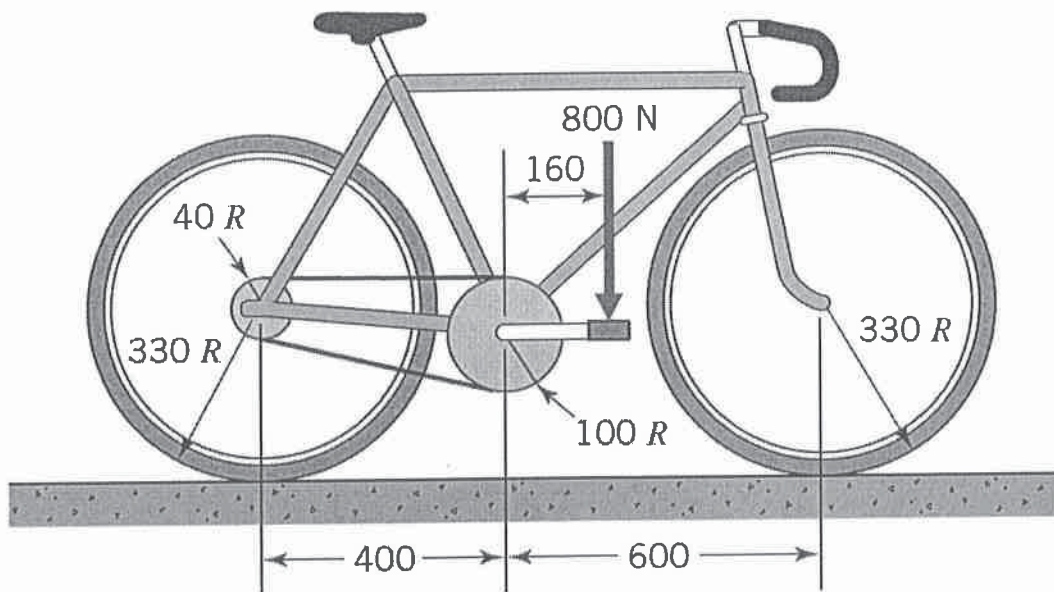
Figure 2

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

**Q4**

A rider is applying full weight (800 N) to one pedal of a bicycle.  
 Draw as free-bodies in equilibrium (a total of 4 free-body diagrams required):

- The pedal, crank, and pedal sprocket assembly.
- The rear wheel and sprocket assembly.
- The front wheel.
- The entire bicycle and rider assembly.

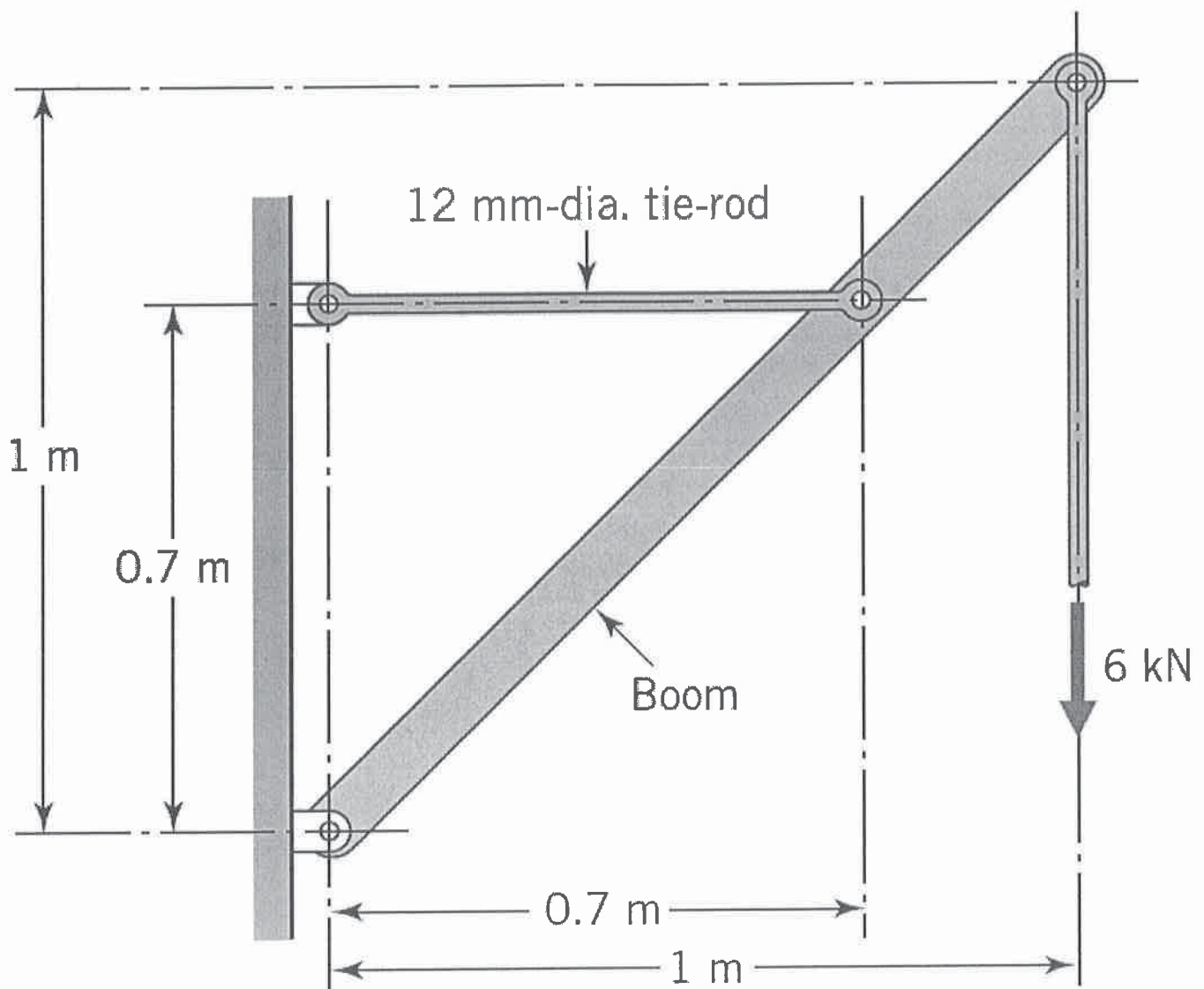


Part B

Q5

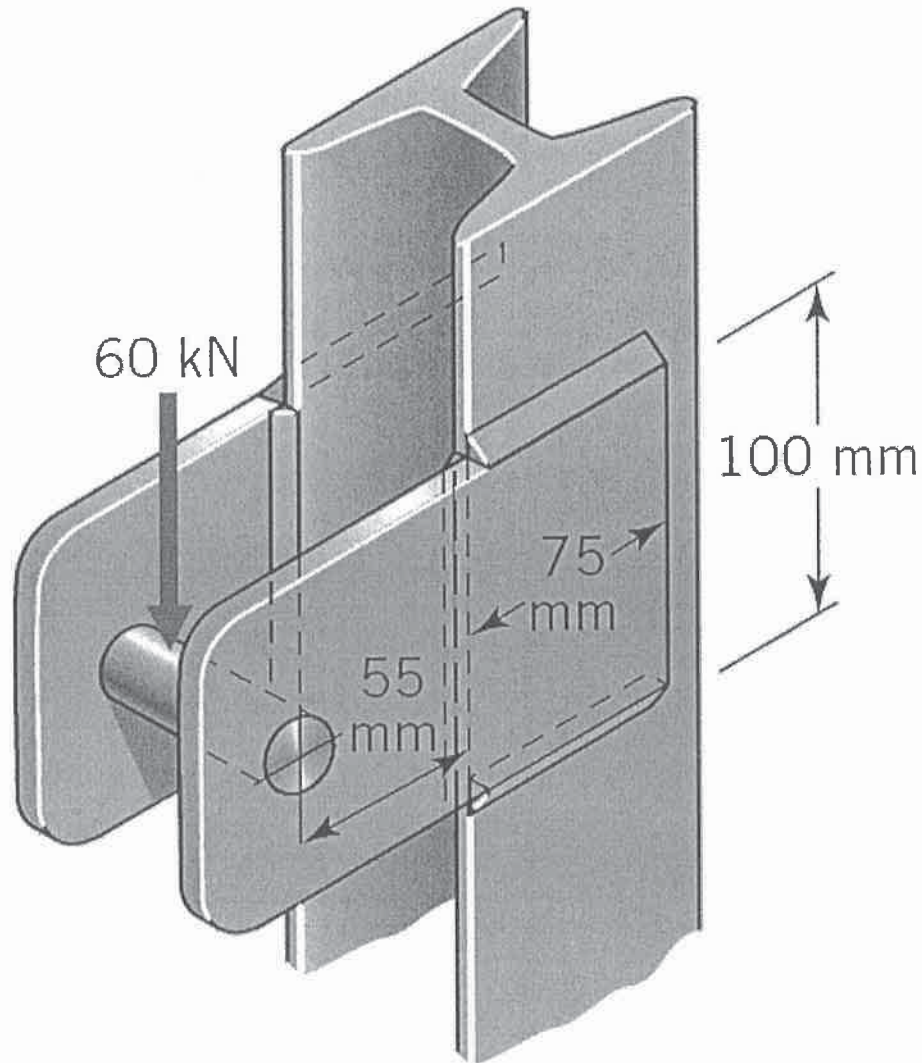
A boom and tie-rod arrangement is supporting a load of 6 kN. The tie-rod is made of steel having a tensile yield strength of 400 MPa.

- (a) Determine the safety factor of the tie-rod with respect to static yielding.
- (b) Determine the safety factor of the tie-rod if the vertical rod is rotated 180 so that the 6 kN load acts upward.
- (c) Draw a conclusion with respect to the relative desirability of designing machines with column members loaded in tension vs. loaded in compression.



Q6

A bracket supports a total load of 60 kN. E60 series welding rods are used with a safety factor of 3.0. Determine the weld size that should be specified. Assume that the throat length is  $t = 0.707 h$ .



Note: Each plate has two 75 mm welds and one 100 mm weld.