

National Examinations – December 2014

07-Mec-A4, Design and Manufacture of Machine Elements

3 Hours Duration

Notes, please read carefully:

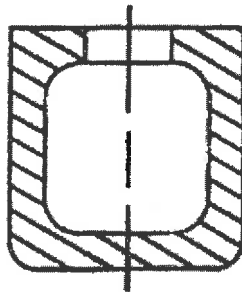
1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is an open book examination. Candidates may use any non-communicating calculator.
3. There are 6 questions on the following pages, divided 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) questions from part A.**Q1**

A part with undercut shape (shown in Figure) is to be cast. As part of your preliminary design, determine if it can be cast into

- (a) a sand mold and
- (b) a permanent mold.

To justify your answers, make sketches to show the cores and the limitations on shape.

**Q2**

Recovery and recrystallization are two processes to change the properties of strain hardened materials.

- (a) Explain the difference between the two in terms of the operative atomic mechanism.
- (b) Draw two diagrams, side by side, to show the effects of recovery and recrystallization on yield strength, tensile strength, and total elongation.

Q3

A steel is cut on a lathe with HSS tooling. It is now proposed to increase production rates by 30%. There is argument whether increased production should be obtained with increased (a) speed, (b) feed, or (c) depth of cut. Settle the argument by determining the change in tool life for the three cases, using the constants $n_1=0.1$, $n_2=0.18$ and $n_3=0.45$ in extended Taylor equation:

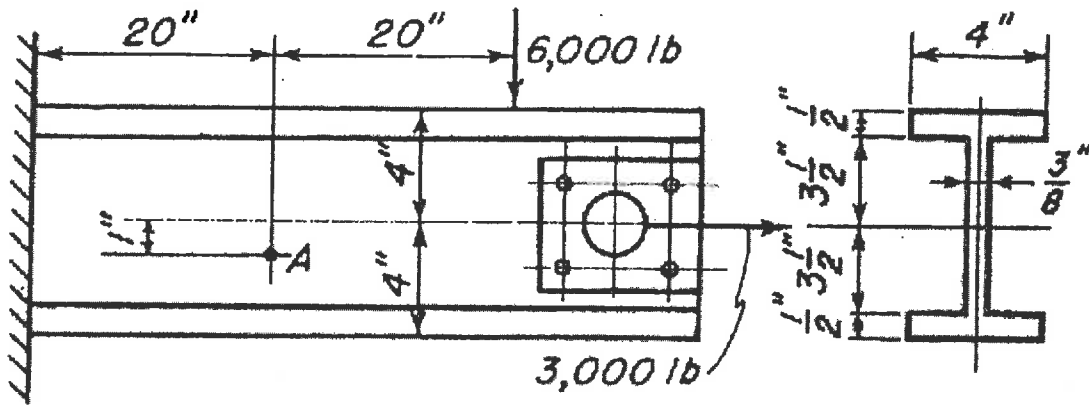
$$t = \frac{K}{v^{1/n_1} f^{1/n_2} w^{1/n_3}}$$

(For clarity, take $K = 100$ arbitrary units, and initial values of $v = f = w = 1$.)

- (d) Make a recommendation on which variable should be increased first and which last.

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

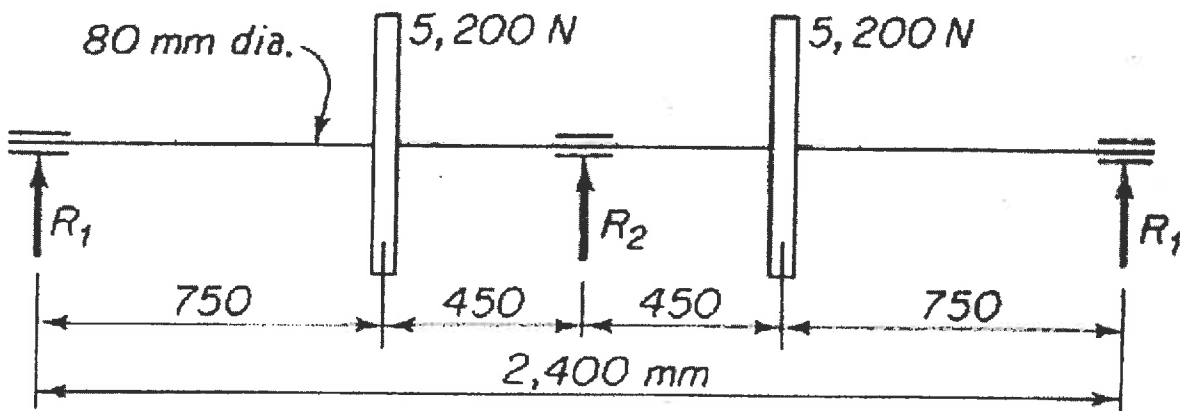
- Q4 Make a drawing for the element at A of the beam in Figure with horizontal and vertical sides, and show the stresses acting on it. Construct the corresponding Mohr circle. Draw the element for the principal stresses correctly oriented and show the stresses acting on it. Do the same for the element of maximum shear stress.



Q5

In Figure the three bearings are all at the same elevation.

- (a) When all bearings are on solid supports find the value of R_2 .
- (b) When the center bearing is 1 mm lower than the other two find the value of R_2 .
- (c) Suppose the center bearing is resting on an elastic support that could be represented by a spring of constant equal to 5,200 N/mm. Find R_2 .



Q6

If the permissible value for p_a in the brake shown in figure is 0.70 MPa, find (a) the corresponding value of P , and (b) the friction power that the brake will absorb; $\mu = 0.25$.

