National Examinations – May 2019

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

In a surface grinding operation, the grade of the only available grinding wheel is "T" (hard). During grinding, the workpiece surface shows discoloration indicating the burning of the surface. The shop foreman suggest using a softer wheel.

(a) Is this a sound advice? Why?

It turns out no other grinding wheels are available. The same foreman states that the wheel can be made to behave softer if cutting conditions are changed.

(b) Is the foreman right? If yes which cutting condition and how?

Q2

An automotive part formed by pressing fails in production. The part is formed by almost pure stretching, using drawbeads in the dies. (a) What would you do to analyze the problem? (b) What is the likely strain state at the point of fracture (use forming limit diagram). (c) Indicate in the FLD two possible remedies, keeping the shape of the pressing unchanged. (d) If none of this works, what else could be attempted?

Q3

A small lever-type precision component of a camera must be bent to exactly 90° angle and the angle must always be the same. (a) State what variations in strip material can be expected in a production batch. (b) It is suggested that the desired 90° angle will always be assured by overbending to a smaller angle. Do you agree? Why? (c) If not, sketch one possible process that will always deliver exactly 90°.

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

Q4

Figure shows the hollow input shaft of the crane gear box, supported in the gear box by bearings A and B and driven by an electric motor. Determine

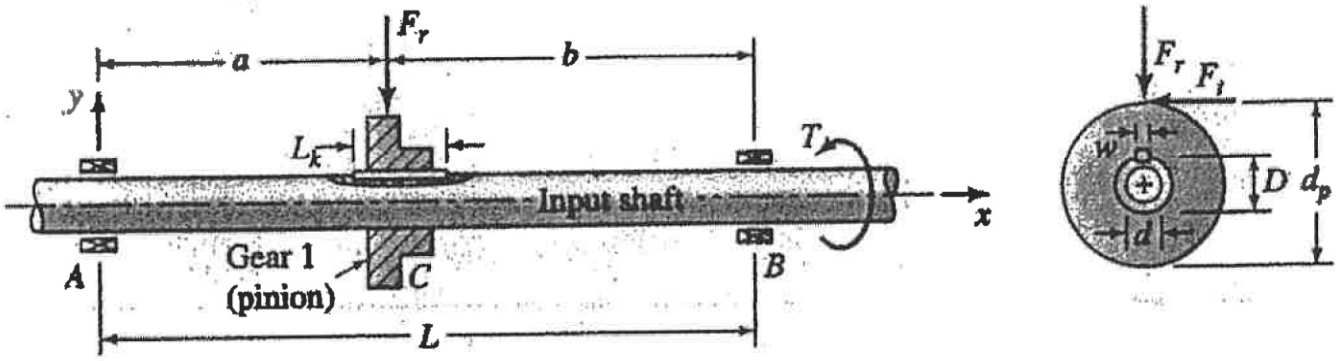
(a) The factor of safety n for the shaft using the maximum energy of distortion theory incorporated with the Goodman criterion.

(b) The rotational displacements or slopes at the bearings.

(c) The stresses in the shaft key.

$F_t = 206$ N, $F_r = 75$ N, T= 2.06 N• m, a =66 mm, b=84 mm, L=150 N•m, d= 6 mm, w= 2.4 mm, $d_P = 20$ *mm*, $L_k = 25$ *mm*, $D = 12$ *mm*

The operating environment is room air at a maximum temperature of 50°C.



Part B- Cont'd

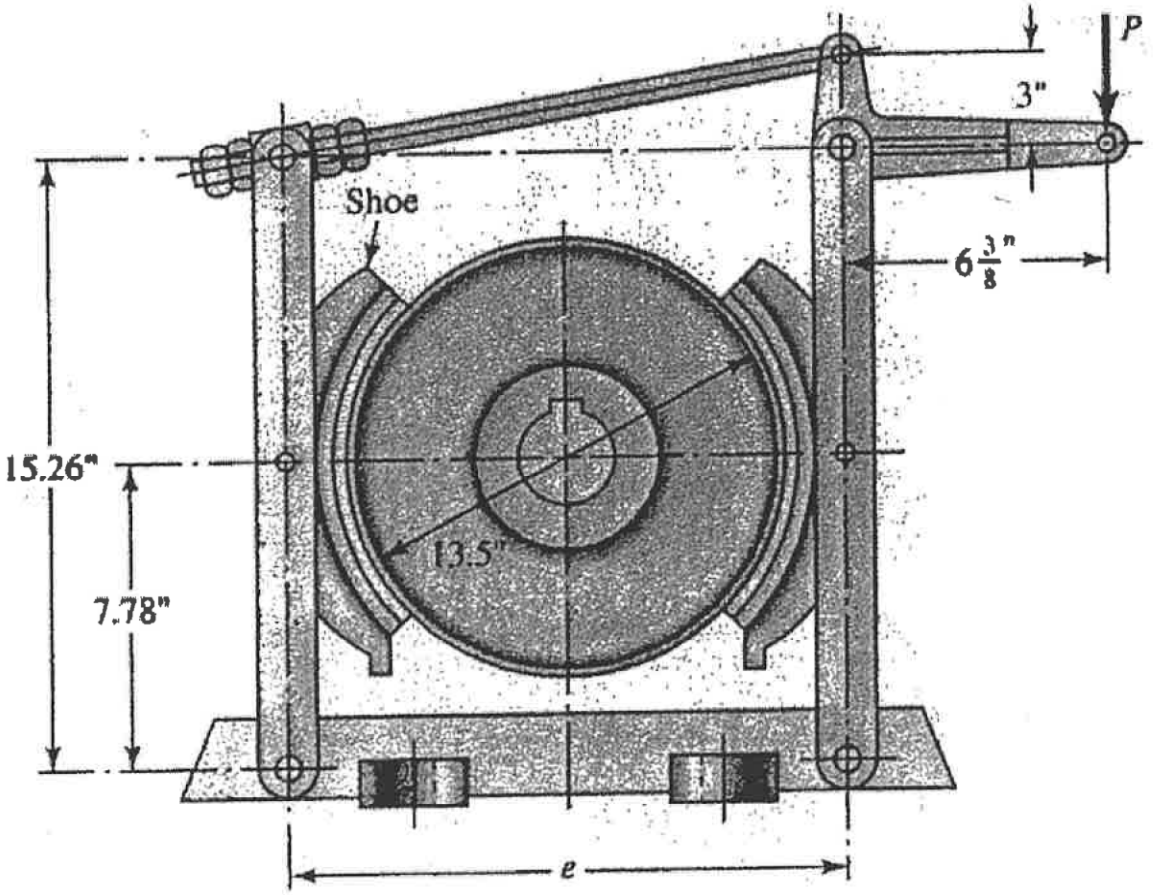
Q5

The shoes on the brake depicted in the Figure subtend a 90° arc on the drum of this external pivoted-shoe brake. The actuation force P is applied to the lever. The rotation direction of the drum is counterclockwise, and the coefficient of friction is 0.30.

(a) What should the dimension e be?

(b) Draw the free-body diagrams of the handle lever and both shoe levers, with forces expressed in terms of the actuation force P.

(c) Does the direction of rotation of the drum affect the braking torque?



Part B- Cont'd

Q6 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.