

National Examinations – May 2010

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 exam. Any non-communicating calculator is permitted.
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. Five (5) 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**

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

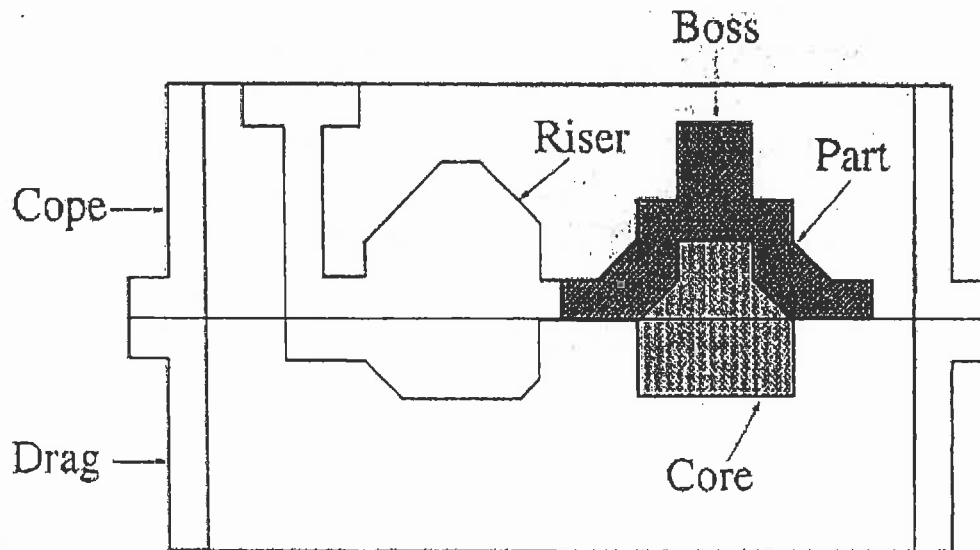
An automotive part formed by pressing pressing fails in production. The part is formed by almost pure stretching, using drawbeads in the dies. (a) What would you do to analyze the problem? (b) What is the likely strain state at the point of fracture (use forming limit diagram). (c) Indicate in the FLD 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° .

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.



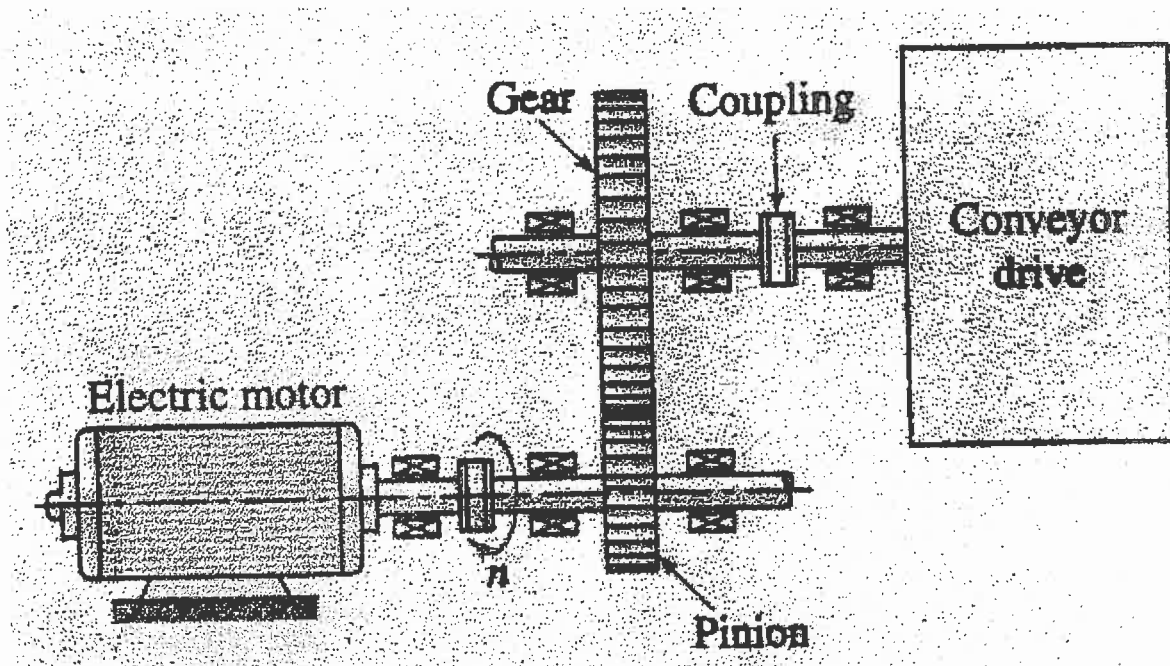
PART B: Choose any two(2) problems from part B.

Q5

A conveyor drive involving heavy-shock torsional loading is to be operated by an electric motor turning at a speed of n , as shown schematically in the Figure. The speed ratio of the spur gears connecting the motor and conveyor or speed reducer is to be $r_s = 1:2$. Determine the maximum horsepower that the gearset can transmit, based on bending strength and applying the AGMA formulas.

Both gears are of the same 300 Bhn steel and have a face width of $b = 1.5$ in.

Pinion rotates at $n = 1600$ rpm. $P = 10$ in.⁻¹ and $N_p = 18$.



Q6

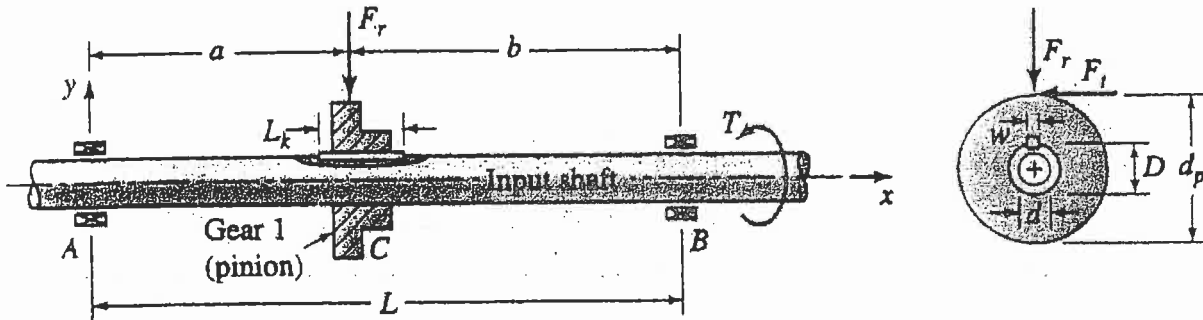
Figure shows the hollow input shaft of the crane gear box, supported in the gear box by bearings A and B and driven by an electric motor. Determine

- The factor of safety n for the shaft using the maximum energy of distortion theory incorporated with the Goodman criterion.
- The rotational displacements or slopes at the bearings.
- The stresses in the shaft key.

$$F_t = 206 \text{ N}, \quad F_r = 75 \text{ N}, \quad T = 2.06 \text{ N}\cdot\text{m}, \quad a = 66 \text{ mm}, \quad b = 84 \text{ mm}, \quad L = 150 \text{ N}\cdot\text{m},$$

$$d = 6 \text{ mm}, \quad w = 2.4 \text{ mm}, \quad d_p = 20 \text{ mm}, \quad L_k = 25 \text{ mm}, \quad D = 12 \text{ mm}$$

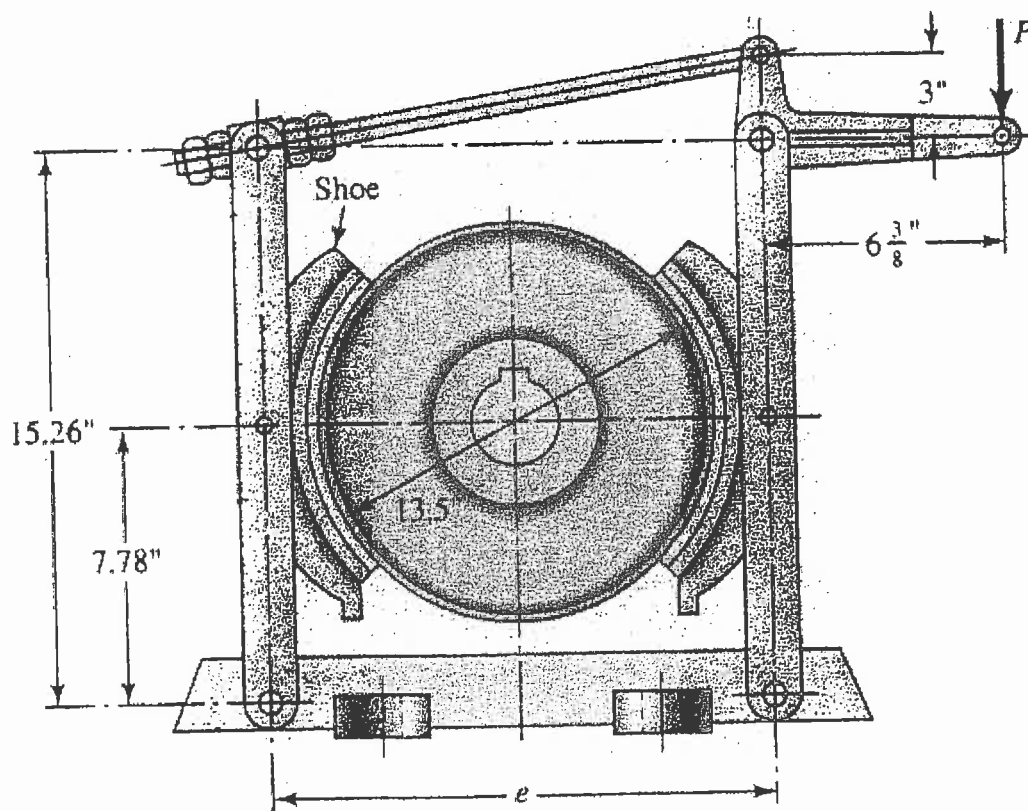
The operating environment is room air at a maximum temperature of 50°C .



Q7

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.

- What should the dimension e be?
- Draw the free-body diagrams of the handle lever and both shoe levers, with forces expressed in terms of the actuation force P .
- Does the direction of rotation of the drum affect the braking torque?



• Q8

An uncrowned straight-bevel pinion has 20 teeth, a diametral pitch of 6 teeth/in, and a transmission accuracy number of 6. Both the pinion and gear are made of through-hardened steel with a Brinell hardness of 300. The driven gear has 60 teeth. The gearset has a life goal of 10^9 revolutions of the pinion with a reliability of 0.999. The shaft angle is 90° ; the pinion speed is 900 r/min. The face width is 1.25 in, and the normal pressure angle is 20° . The pinion is mounted outboard of its bearings, and the gear is straddle-mounted. Based on the AGMA bending strength, what is the power rating of the gearset? Use $K_0 = 1$, $SF = 1$, and $S_H = 1$.

K_0 = overload factor, SF = bending safety factor, S_H = contact safety factor.