National Examinations – Dec. 2016

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 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

i) Small spur gears are to be made; the gear tooth surfaces must be parallel to the axis of the gear and must have a smooth finish. Blanking from a sheet is considered. (a) Is this a feasible proposition? (b) If the answer is yes, make a sketch Of a process (identifying the die elements) that assures the required quality. (c) Explain why the process works (if relevant, with the aid of another sketch).
ii) A hard steel plate is blanked on a mechanical press. In each cut, the press suddenly "snaps," with a loud bang. (a) Find an explanation for the phenomenon. (b) Suggest a way of minimizing it (the material cannot be changed).
iii) What sheet properties would you specify for (a) bending without orange peel; (b) bending to zero radius; (c) greatest resistance to permanent deformation in service. Justify the choices.

Q2

i) A casting of very intricate shape and good surface finish is to be cast. Suggest some suitable methods if the casting is (a) solid and if it is (b) hollow, with a cavity of complex shape.

ii) In a meeting you are asked to describe, very briefly, the essential features of the four principal die-casting processes. There are no facilities to make sketches. (Make Sure to clarify the method of filling the cavity.)

Q3

What kind of machine tool is likely to be most economical for producing rotationally symmetric parts of the following characteristics:

(a) requires turning, drilling, boring, and parting off, at production rates of 10 000 parts per month;

(b) as (a), but only 10 parts per month;

(c) a very slender high-precision part requiring turning and parting off, at production rates of 1000 parts per month;

(d) as (c), but only 10 parts per month;

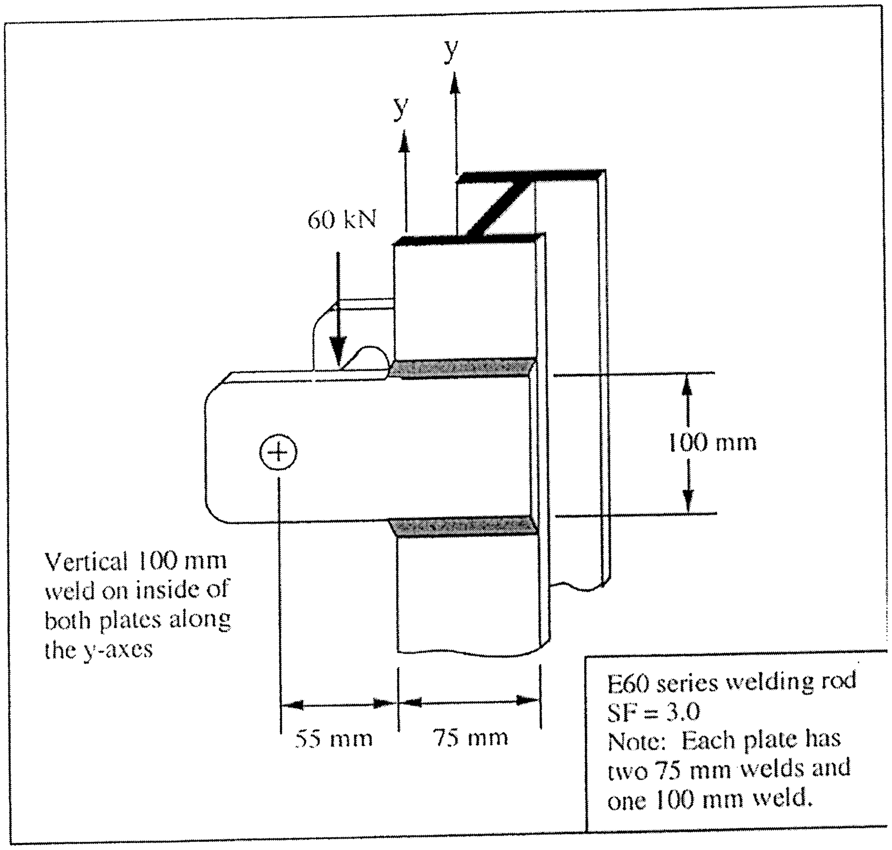
(e) as (a) but with a transverse hole;

(f) as (b), but with a transverse hole.

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

Q4

A bracket supports a total load of 60 kN. E60 series welding rods (Su=60 ksi) are used with a safety factor of 3.0.
Determine the weld size that should be specified.

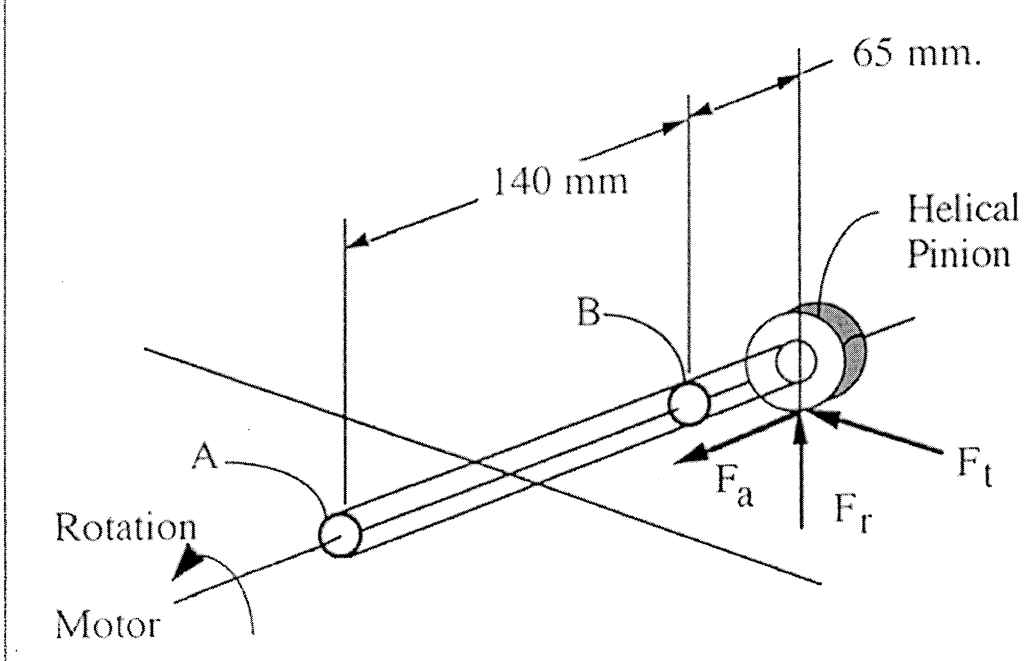


Part B

Q5

A helical pinion is mounted on a shaft that is overhung from two supporting bearings A and B. The left end of the shaft is driven by an electric motor while the right end closer to bearing B is free. Pinion tooth loads are already determined as shown in diagram.

a) Sketch load, shear force and bending moment diagrams for the shaft in the horizontal and vertical planes. Also, sketch shaft torsional and axial force diagrams.
b) Determine radial and axial loads applied to the bearings.
c) Make a preliminary scale drawing of the shaft with "reasonable" diameters, appropriate shoulders and provisions for axial retention.
d) Discuss the primary factors to be considered to determine the diameters.



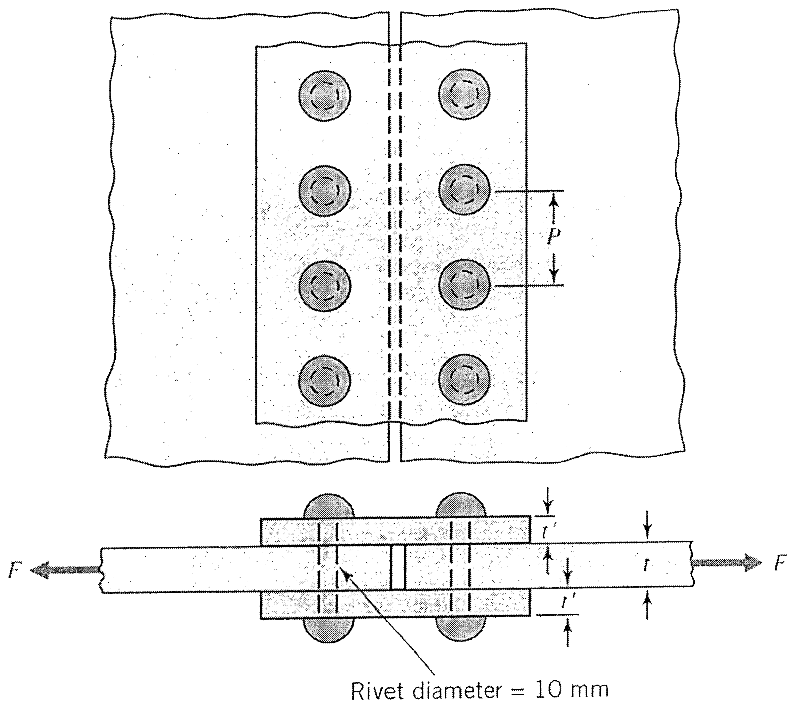
$F_a = 2235$ N, $F_r = 1702$ N
$F_t = 4092$ N, $d_p = 70$ mm

Part B

Q6

Two plates are joined with straps and a single row of rivets (or bolts).
Plates, straps, and rivets are made of ductile steel with known yield strengths shown.

(a) Calculate the force F that can be transmitted across the joint per pitch P, of joint width, based on the rivet shear strength.
(b) Determine minimum values of t, t' , and P that will permit the total joint to transmit this same force (thus giving a balanced design).
(c) Determine the efficiency of the joint (ratio of joint strength to strength of a continuous plate).



$S_{yt} = 300$ MPa
$S_{yc} = 300$ MPa
$S_{ys} = 170$ MPa