Faculté de génie
Génie mécanique

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Faculty of Engineering
Mechanical Engineering

Name:_____ ID_____ Section_____

MCG 1100 - Dissection Lab 7 - Work Sheet
(To be handed in at the end of the lab period)

A. Double Reduction Gearbox (note: this has metric screws)

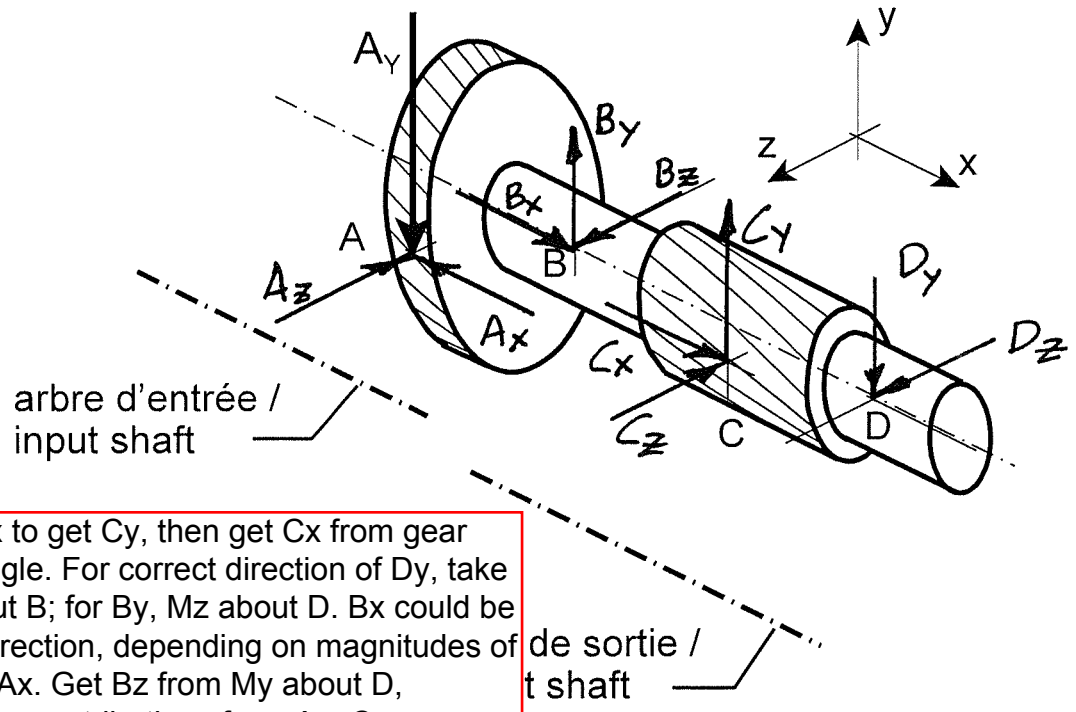
1. Determine the overall speed reduction ratio of the gearbox by counting gear teeth. How fast will the output shaft turn if the input is turned by an electric motor at 1750 rpm? (The input is the hollow shaft at one end.)

Gear ratio 1: 54:19 Gear ratio 2: 54:15 = 18:5

Overall gear ratio: 972:95 = 10.2:1 Output speed 172 rpm
(Some of the gear reducers have a ratio of 15.7:1 instead)

Check your calculation of the overall speed ratio by seeing how many turns of the input shaft you need to produce one turn of the output.

2. Complete the free body diagram of the intermediate shaft, assuming that the couple driving the input gear results in a y-component force at A as shown. Assume frictionless contact between the gear teeth. B can act as a thrust bearing, but D cannot.



Sum Mx to get Cy, then get Cx from gear tooth angle. For correct direction of Dy, take Mz about B; for By, Mz about D. Bx could be either direction, depending on magnitudes of Cx and Ax. Get Bz from My about D, assuming contributions from Ax, Cx are small. Direction of Dz cannot be found.

3. By looking at the x-component forces at the gear teeth (A and C) in your FBD, explain why the teeth on the two gears are angled in the same direction.

The x component forces are opposed and therefore roughly balance each other, reducing the axial load on the bearings. By correct selection of the tooth angle, one could make them exactly balance.

4. Identify the kinds of bearings used in the gearbox.

All are ball bearings. Some are sealed units - cannot easily tell what is inside, but they are not deep enough to be roller bearings.

5. Give a complete specification of the screws used to hold the end plate in place (diameter, thread pitch, length, head style).

M6 x 1 x 16 mm, Allen (or hex socket) head

6. Identify the material and manufacturing processes used to make the following components:

(a) Gearbox case: Material aluminium: lightweight, non-magnetic

Manufacturing processes

Probably sand cast - surface is rough, although smoother and with more small details than some sand castings. Large internal cavity indicates sand casting - hard to produce with other processes. Then machined: some flat surfaces are face milled (machining marks), some faced in a lathe, bearing seats are bored out, probably using a boring tool in a milling machine.

(b) Shafts: Material steel - magnetic

Why is this material used for most shafts and other components in machinery?

Steel is very strong (stronger than most metals), but also very cheap and readily available. It is also possible to produce steels with widely varying properties by alloying and heat treatment.

Manufacturing processes:

Raw material is hot rolled or cold rolled steel bar. Finished by machining (turning in a lathe). Some shafts are further finished by precision grinding (very smooth surface finish, no machining marks).

7. Assembly:
(a) How is the large gear on the output shaft fixed to its shaft?

The large gear is a press fit on the shaft - forced on in a press.

(b) How is the large gear on the intermediate shaft attached to the shaft?

The gear is held in place by a square key and by a spring clip.

B. Worm Gear Reducer (Note: this unit has inch (American) system screws.)

1. Determine the speed reduction ratio of the gearbox. How fast will the output shaft turn if the input is turned by an electric motor at 1750 rpm?

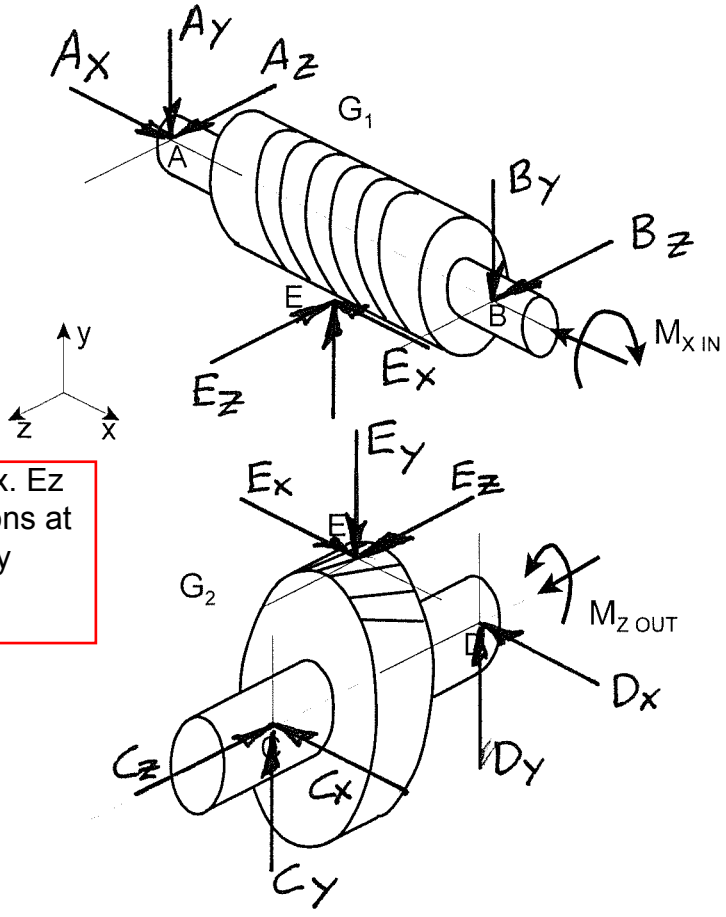
No. of threads on worm: 2 ; no. of teeth on gear 40

Gear ratio: 2:40 = 1:20 Output speed 87.5 rpm

2. Give a complete specification of one of the screws used to hold the cover plates in place.
5/16" - 18 x 3/4" hex head screw

3. What kinds of bearings are used in the drive? Why are different kinds used on the worm shaft and the gear shaft? How are the bearings and the gearbox case sealed against dirt?
worm shaft - ball bearings
gear shaft - tapered roller bearings
The loads on the gear shaft are much larger, and tapered roller bearings are a better choice for heavy loads.

4. Complete the free body diagram of parts of the drive, given an input couple $M_{X\,IN}$ and an output reaction couple $M_{Z\,OUT}$ as shown. Assume frictionless contact between the gear teeth. You will find it easier if you do the gear first, then transfer the tooth forces to the worm using Newton's third law. Assume that A can act as a thrust bearing. Note from the construction of the bearings at C and D that either one (bot not both) can act as a thrust bearing depending on the direction of forces at E.



FB = gear: sum Mz for Ex. Ez from tooth angle. Reactions at C, D by taking Mx and My about D and C.

5. Materials: State which materials are used for the following parts:

Worm material steel: magnetic

Gear material bronze: colour

Why are the worm and gear made of different materials?
two different metals have a lower coefficient of friction than two pieces of the same metal.