

Homework 3

Name: _____

Due October 20th at class start (12:00 pm) on Canvas. Create a single PDF that includes concise, clear answers to the questions with plots. Paste your MATLAB code, Python code, and any other documents as the last pages of your assignment, and together with all your files, upload as a .zip file.

Q1: Design and laser cut or 3D print a lattice flexure. Your flexure should have an overall width of 30 mm and an overall length of 100 mm. You can use any lattice design (many provided on Canvas\Files for Lecture\Lecture), in addition to the straight lattice. You should provide the .DXF / .STL for your lattice, as well as a picture of it flexing and your rationale for the dimensions.

Q2: What are three different kinds of joints used in prototyping with a laser cutter?

Q3: There are a few key benefits to using a water jet cutter:

- Because the water jet cuts with water / abrasive garnet, there is no _____ used in the process, thereby preventing undesired material hardening, etc.
- Because water jet cutters use such high pressure / garnet, they are able to cut _____ dimensions, where a laser cutter would be unable.
- What materials can be cut on a water jet?

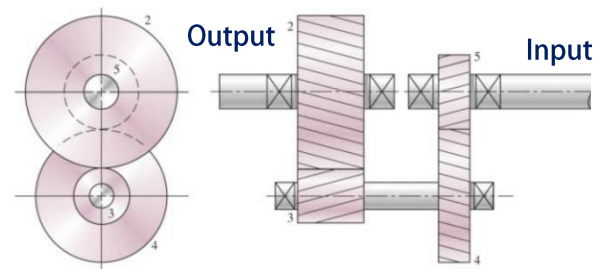
Q4: What is the purpose of tabbing? How large are tabs typically when used with a water jet cutter?

Q5: A gear has a diametral pitch of 200 teeth/m, and a pitch radius of 100 m. How many teeth does the gear have?

Q6: Design a parallelogram four-bar linkage and specify the transmission ratio, configuration, and a potential application for your linkage. Provide a figure of the configuration, description of linkage (lengths / angles), and a plot of the transmission ratio as a function of the input angle in MATLAB or Python. You have flexibility to design the linkage for an application / geometry you desire.

Q7: You are designing a compound transmission with two helical spur gear stages (right). The overall ratio you would like is 15:1. The first stage is 3:1. The input pinion has a pitch radius of 50 mm and 20 teeth and the diametral pitch is equivalent between the gears.

- What is the ratio of the second stage?
- What is the distance between the shafts?
- How many teeth are on the output gear?



Q8: If you were designing a ball-bot with a different α angle (all other dimensions are the same), what would be the radius of the wheel contact circle be for $\alpha = 30^\circ$?

Q9: The virtual wheels in the X-Z and Y-Z planes provide 20 N of contact force on the surface of the ball, with the Z-axis force equal to zero. What are torques required for each real wheel?

Q10: During motion, the angular velocity of the ball-bot's chassis is 0.7 rad/s and the virtual wheels are rotating at 2 rad/s. Using the ball / wheel measurements, what is the angular velocity of the ball at this instant?