WORCESTER POLYTECHNIC INSTITUTE
MECHANICAL ENGINEERING DEPARTMENT

DESIGN OF MACHINE ELEMENTS
ME-3320, B'2024

Design Project. Introduction, cont'ed

October 2024

Design project for this course

Indoor exercise machine for a wheelchair racer

Norton's Problem 9-17

Design projects are developed in teams of 3-4 students.

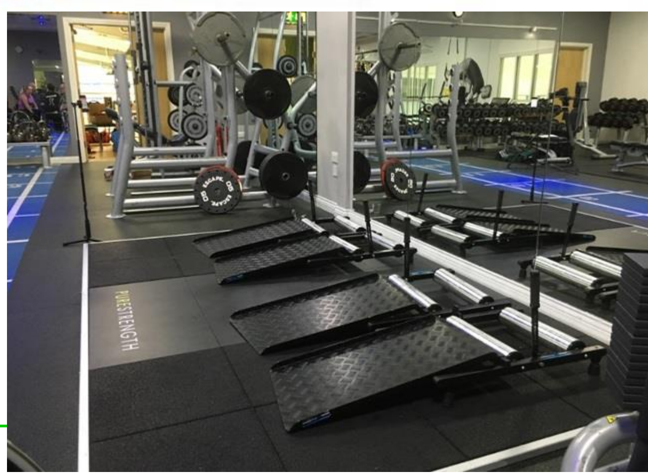
Each team will be evaluated based on individual member efforts and on overall team outcomes and collaboration.

- Hand-in/email each *team <u>name</u> and <u>roster</u>* by Monday, October 28, 2024 – or earlier

Design project for this course

Indoor exercise machine for a wheelchair racer

Norton's Problem 9-17



Wheelchair exercise equipment is important for people to maintain their health and well-being. *Related exercise equipment comes in many varieties that can be tailored to user's needs*

Typical configuration

Reference:
https://howirollsports.com

Design project for this course

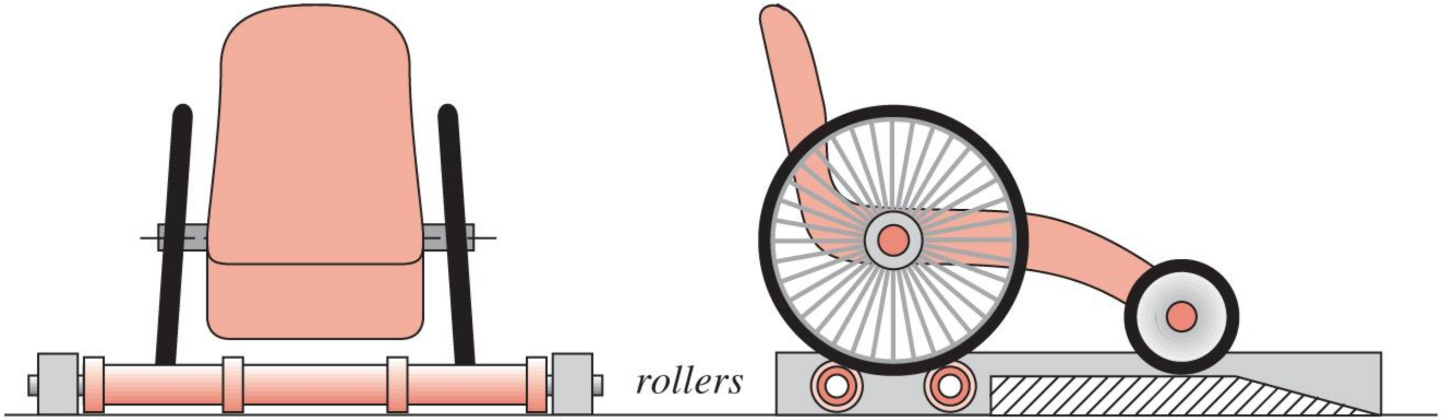
Indoor exercise machine for a wheelchair racer

Norton's Problem 9-17

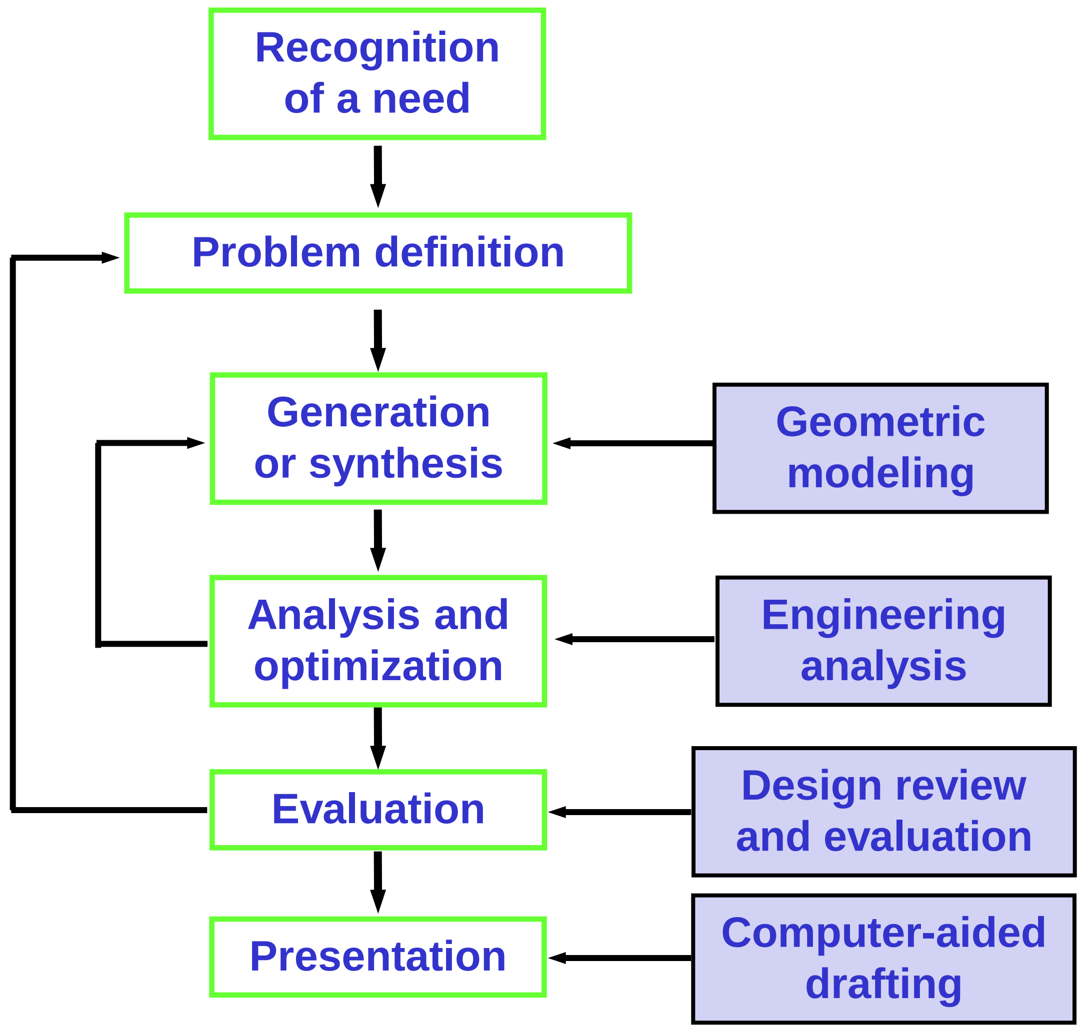
Need: design an indoor bicycle exerciser with a *general configuration as shown*. The concept is to provide twin rollers to support the rear wheels and a single roller for the front wheel of a specific wheelchair.

Some **performance specifications**:

- The rear rollers to be attached in some kinematic fashion (to be designed) to a DC generator whose output is shunted through an electrical load that can be varied by the rider to provide a dynamometric resistance.
- All needed necessary components to have suitable geometries and materials to survive for infinite life and maintain safety.



Engineering design methodology



Design of machine elements: a very general procedure

- Do background research and structure the unstructured problem!
- Fully define: **objectives and constraints; mechanical configurations…**
- Analysis:
  - Application of equilibrium conditions: **static and dynamic (FBD's)**
  - Identify critical sections: **stress and strain analyses**
  - Identify and consider: **effects of stress concentrations, residual stresses, material characteristics, etc…**
  - Apply design criteria: **safety factors, failure theories, fatigue life, vibrations, deformations, etc…**
- Select component geometry/dimensions/materials that satisfy objectives and constrains: **design iterations**
- Design review and presentation

Design project: schedule

- Do background research and structure the unstructured problem!
- Fully define: **objectives and constraints; mechanical configurations…**
  - **Monday, Nov 04.** ***Report #1 and team presentations/briefings***
- Static failure theories and safety factors: dimensions and materials
  - **Monday, Nov 18.** ***Report #2 and team presentations/briefings***
- Fatigue failure theories and safety factors: dimensions and materials
  - **Monday, Dec 02.** ***Report #3 and team presentations/briefings***
- Selection of all components and design integration. **Proposed solution**
  - **Friday, Dec 13.** ***Report #4 and team presentations***

Design of machine elements: design project. Report #1

- Do background research and structure the unstructured problem!
- Fully define: **objectives and constraints; mechanical configurations…**
- Analysis:
  - Application of equilibrium conditions: **static and dynamic (FBD's)**
  - Identify critical sections: **stress and strain analyses**
  - Identify and consider: **effects of stress concentrations, residual stresses, material characteristics, etc…**
  - Apply design criteria: **safety factors, failure theories, fatigue life, vibrations, deformations, etc…**
- Select component geometry/dimensions/materials that satisfy objectives and constrains: **design iterations**
- Design review and presentation

Design of machine elements: design project. Report #1

Work with your design team.

Do background research, including technical specification of the machine of interest:

structure the unstructured problem!

Fully define mechanical configurations, objectives, constrains…
FBD's (overall structure)
FBD's (of individual components)

Review project schedule:

project report & team presentations #1
Due M, Nov 04, at lecture time

Design of machine elements: design project

Report #1 specs and format:

Use a Memorandum format:

- No word/length limit to describe structured design problem(s)
- Add figures to describe concepts. Quantitative in nature as much as possible
- Add graphs and equations, as necessary
- Format figures, graphs, equations following ASME formats