Mechanisms and Machines
ENSC3001/MECH3001

(Dr Peter Whittaker, W/Prof Karol Miller)
Second Semester 2025
Group Programming Project
Deadline: Submitted on LMS by Wednesday, 8th of October, 11:59pm

To submit your group report, please use the submissions link in the 'Group Programming Project' folder on the ENSC3001/MECH3001 LMS page. IMPORTANT: Groups must submit both the video and the group report in a single zipped file. The zipped file must have the Group Number in its name. (Please, include a scan of a signed assignment cover sheet).

You also need to submit your "Summary of individual contributions" through a separate submission link. Please make sure that the file you are uploading has your name and group number in the file name.

Kinematics of a four-bar linkage

Project weighting: 10% of the total mark for the unit
Please work in the same groups you have formed for the group seminar presentations.

Your group report should be no longer than 900 words. Page and line numbers must be inserted.

Each of you will need to keep a professional diary that may be reviewed at any time during workshops.

Each group will need to produce a 5-minute video explaining their submission (videos over 6 minutes will be marked down). The video should point directly to pages and lines in the report.

The online tool **Feedback Fruits** will be used to assess individual contributions to team/group work. You will be required to provide feedback to, and receive feedback from, your team members. Further information about Feedback Fruits will be sent out later in the semester. You will have until 11:59 PM on the 15th of October to provide peer feedback using Feedback Fruits.

Each of you will also need to prepare a half-a-page summary of your individual contributions to the project, which will be reviewed together with the Feedback Fruits feedback. You will submit this summary of individual contributions through a separate link on LMS.

The aim of this project is to practice analytical methods of kinematic analysis of mechanisms, as well as to reinforce computer programming skills.

Assignment Problem

Four-bar linkages are a common and versatile class of mechanisms; several examples have already shown up in student-led Friday seminars. The lengths of the links in a four-bar linkage determine how the mechanism can move as well as how the mechanism is classified (Grashoff and non-Grashoff linkages and their subclassifications).

Your group is to write a program in a programming language of your choice (MATLAB or Python for instance) that will take as input: the lengths of the four linking bars, the necessary information to define a coupler point, off-set from the couple link and the assembly mode of the mechanism. The program should then classify the mechanism, calculate the motion limits ($\theta_{2_min}$and θ_{2_max}), issue a warning if the mechanism is impossible (for instance the dimensions of the mechanism are inconsistent with the geometry required by theta2).

The program should output the linkage classification as well as a plot of the coupler curve. For an example of a program that plots the coupler curve from the specified inputs, see this example at Geogebra: https://www.geogebra.org/m/xn9sjt4w

Unlike the Geogebra example your plot is not expected to be animated or to show all of the links.

Using your program, you are then to design a mechanism for which the coupler curve contains a substantial section of vertical, straight-line motion. Such a mechanism could be used as an oil pump, for instance, in which it is desirable to move the sucker-rod up and down inside a vertical well. Videos of such a mechanism are on LMS in the Group Programming Project folder.

It is very important that your program is well documented both in the code files and in the written report so that other people (for instance, the person marking the report) can run and check the program.

Guide for Project Work

The project work is an important component of this course. Working in teams on projects prepares you for professional work in any engineering discipline.

The most important unpredictable factor that affects nearly all engineering work is human behavior, particularly behavior within an engineering team. Learning how to manage this factor is the key to a successful engineering career. This project is intended to help you with necessary practical experience in team skills.

Your project work will be assessed based on your group's report and video, and your individual short summary of your contributions to the project. Individual marks will be adjusted using peer feedback collected with Feedback Fruits.

1. Project Assessment

The marks for the project will be made up as follows (10 available marks, or 10% of the unit total):

Project final report 5%

- Assessed on correctness, completeness and clear explanations. While formatting is not the focus of the assessment, poorly formatted reports will be penalized.

Video 5%

- Assessed on how well/clearly the report and code are explained and demonstrated. While video production skills are not the focus of the assessment, unusually poorly made videos will be penalized.

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2. Technical Project Diary

You must write a technical project diary while you are working on your project. This can be requested at any time during workshops. You must record the times you work on your project in your diary.

Why keep a diary?

First, your diary will record all your ideas, code specification notes, implementation notes and test results. This is normal professional practice. All professional engineers must work on the assumption that a replacement engineer may need to take over their work at short notice. No one is indispensable in any properly managed engineering project. Your diary is the key to this. It will enable another person to take over your work at any time.
Second, your diary will record the time you spent working at every aspect of this project.
Third, your diary will help you remember your mistakes and successes. Many ideas developed for a project end up being discarded. Sometimes they are not feasible, sometimes they are too expensive. However, they can come in useful in later projects, so you need to keep a record.

Ideas

Write your ideas down as they occur to you. Write the date and time at the top of every page or the start of a new section. Your ideas will develop with time: keeping records helps this development.

Is it worth all the time to write this down? Surely it is quicker just to get on with the work!

As an engineer, your skills may be needed elsewhere for something more important at a moment's notice. Therefore, it is essential that you document your work so someone else can take over when needed. Also, you need to prepare for future maintenance and enhancements. Documenting what you do is essential if you want to come back and improve it later. All this is 100% authentic engineering practice.

Importance of a Diary in Commercial Engineering Practice

In a commercial setting, your diary records would form the basis for auditing project accounts and expenditure records. If you have no evidence that you have spent time working on a specific project, your client may not pay you for the work completed. The records of design decisions, and testing results provide a *traceable* record of design and testing that forms an essential part of any quality assurance program.

Deliverables:

- A written report explaining your code and demonstrating how the code works. The report should be **no more than 900 words**, exclusive of the signed UWA assignment coversheet, title page and appendices. Font should be Times New Roman, size 12 with page margins of 1 inch or 2.54 cm on all sides and line spacing ≥ 1. Figures, tables, pages and lines must be numbered. The report should contain:
    1. Explanation of the classification of four-bar mechanisms
    2. Accurate sketch of your proposed mechanism for vertical line generation
    3. A brief description of the mechanism (lengths of links, motion limits, assembly mode, location of coupler point)
    4. A plot of the coupler curve for your mechanism
    5. In the Appendix, a printout of code files and documentation of how the code works/ how to run the code. Documentation must be clear enough so that a marker can run all code without difficulty. The appendix does not count against the word limit.
- A video explaining your groups report and code and demonstrating how the code works. The video should be about **5 minutes**. Videos over 6 minutes will be marked lower. The video should reference the report (by page and line number or figure number or table number)
- Original code files
- Statement of individual contribution

The report, video and code files should be submitted as a single .zip or .rar file and uploaded to the *Project Submission* link on LMS. It is permissible to include the signed assignment

coversheet as a separate file from the report within the zipped submission. The statement of individual contribution should be submitted to the *Individual Contribution* link on LMS. Both links can be found in the **Group Programming Project** folder on LMS, which is in the part of the **Assessments** group in the left-hand menu. The report file and statement of individual contribution should be submitted in .pdf format.

Other Important Issues

Back-Up Your Work

It is your responsibility to back-up your own computer work, both in the university laboratories and at home. Keep two separate back-ups. One back-up should be taken daily: the other should be taken weekly and kept in a safe location. Failure to keep adequate back-ups will not be allowed as an excuse for late work.

Sharing Designs and Software

We encourage students to share design work and software. This is normal industrial practice. However, as the copyright always rests with the original author, the permission of the original author must be obtained and the work of the original author must be clearly marked. The original author must be clearly identified everywhere it is used: in code comments, in the final report, in the list of references. A precise reference is required giving the original source of the code, not just the name of the person from whom it was obtained.

However all software code must be thoroughly tested, and the testing fully documented in the technical project diary.

Karol Miller and Peter Whittaker (Aug 2025)