Western Engineering

Western University
Faculty of Engineering
Mechatronic Systems Engineering Program

MSE 3381 — Kinematics and Dynamics of Machines

Course Outline Fall 2025

COURSE DESCRIPTION: This course is an introduction to the kinematics and dynamics of machines and will focus mainly on the calculation of the position, velocity, and acceleration of components of a given mechanism, the identification of the degrees of freedom of given mechanisms, the synthesis of simple mechanisms to achieve specific motions and/or velocity profiles, and finally the dynamic effect of inertial loads on mechanical systems. At the end of this course, you will be able to perform such analyses and synthesize a simple mechanism and calculate the dynamic loads acting on the components.

ACADEMIC CALENDAR:
https://westerncalendar.uwo.ca/Courses.cfm?CourseAcadCalendarID=MAIN_027028_1&Keywords=3381&SelectedCalendar=Live&ArchiveID=

Displacement, velocity, and acceleration analysis of linkages; static and dynamic force analysis of mechanisms; balancing of reciprocating and rotating masses; special-purpose joints and mechanisms.

PRE OR COREQUISITES: MME 2213A/B or MSE 2213A/B, NMM 2270A/B or the former Applied Mathematics 2270A/B.

Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you will be removed from this course and it will be deleted from your record.

ANTIREQUISITES: MME 3381A/B.

CEAB ACADEMIC UNITS: Engineering Science: 75%, Engineering Design: 25%

CONTACT HOURS:

Lectures occur weekly.

LECTURE:	3 hours/week
LAB:	One lab session, 3hrs
TUTORIAL:	Weekly, 2hrs, starting in Week 3

RECOMMENDED/REQUIRED TEXT: No textbook is required for this course, however the textbook listed below provides valuable information to complement the material presented in class.

Waldron K.J., Kinzel G.L., Agrawal S.K., Kinematics, Dynamics, and Design of Machinery, 3rd Edition, Wiley, 2016. Available for purchase at the Western Bookstore and other sources (hardcover or ebook format).

RECOMMENDED/ REQUIRED SOFTWARE: SIMULIA SolidWorks 2024/2025 (for project)

RECOMMENDED RESOURCES/REFERENCES: None

GENERAL LEARNING OBJECTIVES (CEAB GRADUATE ATTRIBUTES)

Knowledge Base	D	Engineering Tools	D	Impact on Society	I
Problem Analysis	D	Individual & Teamwork	D	Ethics and Equity	
Investigation	I	Communication	D	Economics and Project Mgmt.	
Design	I	Professionalism		Life-Long Learning	

Notation: x represents the content level code as defined by the CEAB. blank = not applicable; I = introduced (introductory); D = developed (intermediate) and A = applied (advanced).

Rating: I – The instructor will introduce the topic at the level required. It is not necessary for the student to have seen the material before. D – There may be a reminder or review, but the student is expected to have seen and been tested on the material before taking the course. A – It is expected that the student can apply the knowledge without prompting (e. g. no review).

COURSE MATERIALS: Weekly content and guides for the laboratories will be available on the course OWL site. The material for this course will be taught in both lectures and labs; therefore, it is imperative that you attend each lecture and lab.

UNITS: SI

COURSE TOPICS AND SPECIFIC LEARNING OUTCOMES:

The following table summarizes the course learning outcomes along with CEAB GAIs where the GAIs in bold indicate ones to be measured and reported annually.

COURSE TOPICS AND SPECIFIC LEARNING OUTCOMES	(CAEB) Graduate Attribute
1. Planar linkage design At the end of this section, students will be able to: **a.** Understand and assess the functionality of a mechanism (KB3; quizzes, assignments, final exam, project) **b.** Select or design a mechanism for a specific purpose (D1, D2; project)	KB3, D1, D2
2. Graphical position, velocity, and acceleration analysis At the end of this section, students will be able to: **a.** Analyze the position, velocity, and acceleration of a linkage using graphical methods (KB3, PA1, PA2, ET2; quizzes, tutorial assignments, project, final exam)	KB3, PA1, PA2, **ET2**
3. Techniques in geometric constraint programming At the end of this section, students will be able to: **a.** Analyze the position, velocity & acceleration of a linkage using computational approaches (KB3, PA1, PA2, ET2; quizzes, tutorial assignments, project, final exam)	KB3, PA1, PA2, **ET2**
4. Model and analyze a mechanism using motion simulation software At the end of this section, students will be able to: **a.** Model and analyze a mechanism using motion simulation software (PA1, PA2, ET1, ET2; project) **b.** Understand the potential errors associated with this method	PA1, PA2, **ET1**, **ET2**
5. Fundamentals of mechanisms and machines At the end of this section, students will be able to: **a.** Perform design and analysis of cam- and gear-based mechanisms **b.** Use hand calculations, simulation, and experiments in designing and analyzing machines (I1, I2, I3, PA1, PA2, ET1, ET2; quizzes, project, final exam, lab) **c.** Verify, compare, interpret differences between results obtained through different analyses (I3, PA3, ET1, ET2, CS3; quizzes, project, final exam)	I1, I2, **I3**, PA1, PA2, **PA3**, **ET1**, **ET2**, CS3

d. Evaluate the implications of an incorrect mechanism design (PA3; project)	
6. Static and dynamic force analysis of mechanisms At the end of this section, students will be able to: **a.** Perform static and dynamic force analysis of mechanisms (KB3, PA1, PA2, ET2; quizzes, tutorial assignments, project, final exam)	KB3, PA1, PA2, **ET2**
7. Course Project: Design of a Planar Mechanism **a.** Manage and apply the principles of effective team interaction: organization, management, and motivation (ITW3; project)	ITW3

EVALUATION:

Quizzes, projects and laboratories will be carried out according to the following *tentative* schedule:

Name	**% Worth**	**Effort Type**	**Assigned**	**Due Date**	**CEAB GAs ASSESSED**
Eight in-tutorial assignments	10% (Average of best 7)	Team[a]	Weekly **except for** the first two Thursdays of the term, Fall Reading Week, and days of the two quizzes.	End of tutorial hour in which assigned[e]	
Pre-project	5%	Team[a]	Week of Sep. 15	Oct. 3[d]	
Quiz 1	10%	Individual	Oct. 16[c]		
Project	15%	Team[a]	Week of Oct. 6	Week of Dec. 1[d]	PA3
Assignment (peer-graded, includes Part 1 and Part 2)	5%	Team[a]	Week of Oct. 13	Week of Nov. 24[d]	
Quiz 2	10%	Individual	Nov. 13[c] (Designated Assessment)		I3
Lab	5%	Group[b]	Week of Nov. 17	Week of Nov. 24	ET1, ET2
			Makeup Offered Final Week of Term		
Final Exam	40%	Individual	TBA (Dec. examination period)		ET2

[a] Team is student-formed (same team throughout the entire course).

[b] Group is instructor-formed (applies just to the lab session).

[c] These dates are tentative and might shift to avoid conflicts with other term tests. Final dates will be announced after the start of classes.

[d] Deliverable with a flexible deadline.

[e] Flexible assignment (average of best seven in-tutorial assignments) but not flexible submission deadline; self-attestations are not accepted for in-tutorial assignments.

Note that the dates listed above are **tentative** and may be adjusted if needed. Marks will be assigned based on method of analysis and presentation, correctness of solution, clarity and neatness.

COURSE POLICIES:

The following course-specific policies will be enforced throughout the course:

Academic Considerations

- For academic consideration to be granted for being absent in a laboratory session, for failing to submit a course deliverable (assignment, project report) on time, or for writing the final exam, according to the official schedule issued by the Office of the Registrar, students must obtain approved academic considerations.
- Academic considerations can be of two types: i) accompanied by supporting documentation (the 'old' or 'traditional' type) and ii) unaccompanied by supporting documentation. Those in the latter category are also called self-attestations (the 'new' type, introduced in September 2024).
- According to approved policies, academic considerations for self-attestations/undocumented absences can be granted up to one per term and per course.
- For more information on this topic (including on the process of requesting academic relief via academic considerations), please review the general policies appended at the end of this outline and/or posted on relevant faculty/university webpages.

Deliverable Deadlines

- As shown in the tentative course schedule, some deliverables have a flexible submission deadline, which in this course is constituted by a 72-hour window immediately following the original deadline of the deliverable in which the deliverable can be submitted without late penalties. This submission deadline flexibility implies that self-attestations will not be accepted for any of these course deliverables.
- Once the 72 hour no-late-penalty window has passed, late penalties of 20% per day will be applied to late submissions.
- Self-attestations will also not be accepted for flexible assessments that are not included in the calculation of the final grade (in-tutorial assignments).

Laboratory session

- All students are to attend the laboratory session to which they signed up.
- Failure to pass the laboratory component of the course will result in automatic course failure.
- Passing of the laboratory component is equivalent with obtaining more than 50% on the laboratory component of the course.
- A maximum of **one** make-up session will be offered to students who have missed a laboratory session **with** academic consideration.
- All approved make-up laboratory sessions will be offered in the final week of the term.
- Missing a laboratory session **without** academic consideration will translate into a zero mark for that laboratory session.
- When academic consideration has been obtained for a particular laboratory session, it is student's responsibility to contact the course instructor in a *timely manner* (*i.e.*, within a maximum of three days after consideration has been obtained from the Engineering Undergraduate Services Office) to seek alternate arrangements for the missed laboratory session.
- The default assumption is that everyone contributes equally to the lab team effort and hence everyone should receive the same mark for the common team submission. Please note that whenever individual contributions to the team are not equitably shared by the team members, individual adjustments of the marks might occur at the discretion of the instructional team of the course (i.e., course instructor and teaching assistants).

- Students are required to contact the instructor of the course for any other circumstances that appear to not be covered by the non-exhaustive list above.

Quizzes

- The quizzes will take place during the scheduled tutorial sessions.
- Quizzes will be closed book.
- Quiz 2 is the designated assessment and as such will require medical documentation for academic consideration.
- Each quiz will be approximately 1.5 hours long with the reminder of tutorial time used to discuss the quiz solution.
- Missing a quiz **without** academic consideration will translate into a zero mark for that quiz.
- **No make-up quizzes will be offered** to students who have missed any of the scheduled quizzes **regardless of academic consideration**.
- The weighting of missed quizzes will automatically be shifted to the final exam.
- Academic consideration for quizzes (greater than or equal 10% weight) can be obtained from Engineering Undergraduate Services.
- Students are required to contact the instructor of the course for any other circumstances that appear to not be covered by the non-exhaustive list above.

Project & Pre-Project

- Project teams will be formed in the first week of classes via OWL sign-up.
- Failure to pass the project component of the course will result in automatic course failure.
- The maximum team size will be three students, while the minimum team size will be two students.
- Students who do not choose a team will be assigned to one.
- SolidWorks will be used for the kinematic analysis of the mechanism generated for project purposes.
- The default assumption is that everyone contributes equally to the team effort (*i.e.*, project and labs) and hence everyone should receive the same mark for the common team submission.
- Please note that whenever individual contributions to the team effort are not equitably shared by the team members, individual adjustments of the marks might occur at the discretion of the instructional team of the course (*i.e.*, course instructor and teaching assistants).
- Students are required to contact the instructor of the course for any other circumstances that appear to not be covered by the non-exhaustive list above.

In-Tutorial Assignments

- **In-tutorial assignments will take place during the second hour of the tutorials.**
- The assignments will consist of problems to be solved by the same team formed for project-solving purposes.
- The instructor of the course will solve problems during the first tutorial hour. Problems like them will constitute the subject of the in-tutorial assignment for the following week.
- Teams will receive problem solving assistance from the TA and instructor who will be in the tutorial room. However, prior knowledge of problems assigned (like the ones solved by the instructor in the preceding week) will be highly beneficial.
- No make-up sessions will be offered for those missing the in-tutorial assignment (irrespective of the reason).
- If the in-tutorial assignment is missed **with** academic consideration, the weighting allotted to in-tutorial assignments will be calculated as the average of the remaining assignments.

- If the in-tutorial assignment is missed **without** academic consideration, then the mark for the missed assignment will be zero.
- Academic consideration for in-tutorial assignments (under 5% individual weight) can be obtained from the MSE Undergraduate Coordinator.
- The default assumption is that everyone contributes equally to the in-tutorial assignment team effort and hence everyone should receive the same mark for the common team submission.
- Please note that whenever individual contributions to the team effort are not equitably shared by the team members, individual adjustments of the marks might occur at the discretion of the instructional team of the course (*i.e.*, course instructor and teaching assistants).
- Students are required to contact the instructor of the course for any other circumstances that appear to not be covered by the non-exhaustive list above.

Peer-Graded Assignment

- The assignment will consist of two separate, but interconnected parts: Part 1 will require the team to work together and complete the required deliverable(s) whereas Part 2 will require each team member to review and grade/rank the deliverables submitted by all other teams in the class.
- Part 1 will be graded by the rest of the class ("peer-graded assignment").
- Part 2 will not receive any marks, but those who do not submit their ranking of Part 1 submissions in a timely manner will incur individual late penalties of 20% per day for the peer-graded assignment (even if Part 1 was submitted on time by the team).
- The default assumption is that everyone contributes equally to the project team effort and hence everyone should receive the same mark for the common team submission.
- Please note that whenever individual contributions to the team effort are not equitably shared by the team members, individual adjustments of the marks might occur at the discretion of the instructional team of the course (*i.e.*, course instructor and teaching assistants).
- Students are required to contact the instructor of the course for any other circumstances that appear to not be covered by the non-exhaustive list above.

Term work

- If a minimum of 60% is not obtained on term work (quizzes, pre-project, project, in-tutorial assignments, and laboratory sessions), the student will fail the course irrespective of the mark obtained in the final examination.
- Please note that whenever possible, due warning on this topic will be given. However, since the term project (15% weight) is due in the final day of classes, it is possible that accurate calculations will not be possible until final grades are calculated.
- No appeals on this topic will be accepted, such that students are strongly encouraged to self-monitor their academic progress in the course throughout the term.

Final examination

- Only non-programmable calculators will be allowed during the final examination.
- If a minimum of 50% is not obtained on the final examination, the student cannot receive a final mark greater than 48%.

Submissions

- In-tutorial assignments are due at the end of the tutorial hour in which they were assigned. No late submissions will be accepted.

- Lab reports will be due at the end of the lab session in which data was provided and was processed. No late submissions will be accepted.
- Late submissions of the pre-project tutorials will be penalized with 20% per day.
- Late submissions of the project will be penalized with 20% per day.
- Students are required to contact the instructor of the course for any other circumstances that appear to not be covered by the non-exhaustive list above.

FACULTY OF ENGINEERING POLICIES:

Students must familiarize themselves with the policies of the Faculty of Engineering https://www.eng.uwo.ca/electrical/pdf/2025-UG-Policy-and-Procedures.pdf