Western University
Department of Mechanical & Materials Engineering

MME 3381a - "Kinematics and Dynamics of Machines"

COURSE OUTLINE – 2026-2027

CALENDAR DESCRIPTION:

Displacement, velocity and acceleration analysis of linkage mechanisms; inertia force analysis of mechanisms; balancing of reciprocating and rotating masses

COURSE INFORMATION:

Instructors: R. Tutunea-Fatan, PhD, PEng (Section 001)
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Schedule: Please check https://draftmyschedule.uwo.ca/

PREREQUISITES: MME 2213A/B or the former MSE 2213A/B, NMM 2270A/B
ANTIREQUISITE: The former MSE 3381A/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. This decision may not be appealed. You will receive no adjustment to your fees if you are dropped from a course for failing to have the necessary prerequisites.

CONSULTATION HOURS:

By appointment via email or drop in anytime when the instructor is available.

ACCREDITATION UNITS:

Engineering Science = 75%, Engineering Design = 25%

TOPICS:

- Introduction to mechanisms and machines
- Planar linkage design
- Graphical position, velocity, and acceleration analysis
- Linkages with rolling and sliding contacts, and joints on moving sliders
- Instant centers of velocity
- Computational analysis of linkages
- Static and dynamic force analysis of mechanisms
- Static and dynamic balancing of mechanisms

LEARNING OUTCOMES:

The Mechanical Engineering Program has been accredited by Canadian Engineering Accreditation Board (CEAB) of Engineers Canada. Accredited programs provide the academic requirements for licensure as a professional engineer in Canada. Western Engineering has defined indicators of the 12 Graduate Attributes (GAs) that the CEAB expects graduating engineering students to demonstrate. The connections between course learning outcomes and Western Engineering's GA Indicators are identified below:

Course Topics and Learning Outcomes (LOs)	**GAs**
<u>Introduction to mechanisms and machines</u> At the end of this section, students will be able to: a) Assess the functionality of a mechanism (KB3; quizzes, tutorial assignments, final exam) b) Develop kinematic schematics of mechanisms (KB3, PA1; quizzes, tutorial assignments, final exam) c) Determine the degrees of freedom (mobility) of planar and spatial mechanisms (KB3, PA1; quizzes, tutorial assignments, final exam)	KB3, PA1
<u>Planar linkage design</u> At the end of this section, students will be able to: a) Select or design a planar mechanism for a specific purpose (D1, D2; project)	D1, D2
<u>Graphical position, velocity, and acceleration analysis</u> 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**
<u>Linkages with rolling and sliding contacts, and joints on moving sliders</u> At the end of this section, students will be able to: a) Analyze the position, velocity, and acceleration of mechanisms involving rolling and sliding contacts. (KB3, PA1, PA2, ET2; quizzes, tutorial assignments, final exam) b) Analyze the position, velocity, and acceleration of mechanisms with joints located on moving sliders. (KB3, PA1, PA2, ET2; quizzes, tutorial assignments, final exam)	KB3, PA1, PA2, ET2
<u>Instant centers of velocity</u> At the end of this section, students will be able to: a) Locate the instant centers of velocity of planar mechanisms. (KB3, PA1, PA2; quizzes, tutorial assignments, final exam) b) Use instant centers to determine the velocities of points and angular velocities of links in planar mechanisms (KB3, PA1, PA2; quizzes, tutorial assignments, final exam)	KB3, PA1, PA2

Course Topics and Learning Outcomes (LOs)	**GAs**
<u>Computational analysis of linkages</u> At the end of this section, students will be able to: a) Analyze the position, velocity, and acceleration of linkages using computational methods. (KB3, PA1, PA2, ET2; quizzes, tutorial assignments, project, final exam)	KB3, PA1, PA2, ET2
<u>Static and dynamic force analysis of mechanisms</u> 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) b) Apply energy, power, and friction concepts to mechanism analysis (KB3, PA1, PA2; quizzes, tutorial assignments, final exam) c) Analyze the effect of flywheels on energy storage and speed fluctuation in machines (KB3, PA1, PA2; quizzes, tutorial assignments, final exam)	KB3, PA1, PA2, **ET2**
<u>Static and dynamic balancing of mechanisms</u> At the end of this section, students will be able to: a) Analyze and balance rotating and reciprocating masses (KB3, PA1, PA2; quizzes, tutorial assignments, final exam) b) Evaluate shaking forces and shaking couples in mechanisms (KB3, PA1, PA2; quizzes, tutorial assignments, final exam)	KB3, PA1, PA2

Course Level Learning Outcomes	**GAs**
<u>Integrated analysis of mechanisms and machines</u> After completing the course, students will be able to: a) Use hand calculations, computational methods, and experiments in the analysis of mechanisms and machines (I1, I2, PA1, PA2, ET1, ET2; quizzes, project, final exam, lab)	I1, I2, PA1, PA2, ET1, ET2
<u>Verification and interpretation of analysis results</u> After completing the course, students will be able to: a) Verify, compare, and interpret results obtained using different methods of analysis (I3, PA3, ET1, ET2, CS3; quizzes, project, final exam)	I3, PA3, ET1, ET2, CS3

Course Topics and Learning Outcomes (LOs)	GAs
<u>Model and analyze a mechanism using motion simulation software</u> After completing the course, students will be able to: a) Model and analyze a mechanism using motion simulation software (PA1, PA2, ET1, ET2; project) b) Identify potential errors associated with motion simulation (PA3, ET1, ET2; project)	PA1, PA2, PA3, **ET1, ET2**
<u>Teamwork and collaboration</u> After completing the course, students will be able to: a) Apply principles of effective team interaction, including organization, collaboration, task coordination, and contribution to shared deliverables (ITW3; tutorials, pre-project, project)	ITW3

GENERAL LEARNING OBJECTIVES

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

Notation: I, D, and A represent the content level codes 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).

CONTACT HOURS: 3 lecture hours, 2 tutorial hours, 0.5 laboratory hours, half course

RECOMMENDED TEXTBOOKS: Course notes and other instructional materials will be presented in class and/or made available on the OWL site.

No textbook is required for this course. Nonetheless, for those interested, the (text)book listed below could provide valuable information to complement the material presented in class. Its reading and/or consultation is, however, entirely optional and not required for the purpose of this course.

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

REQUIRED SOFTWARE

SIMULIA SolidWorks (for pre-project and project)

EVALUATION:

The final course grade will be determined according to the following weighting scheme:

Eight in-tutorial assignments (open book)	10%
Peer-graded assignment (take home)	5%
Pre-project (SolidWorks kinematics tutorials)	5%
Project (kinematic analysis of a mechanism)	15%
Laboratory session (mandatory)	5%
Two quizzes (closed book)	20%
Final examination (closed book)	40%

Course assessments will be carried out according to the following ***tentative*** schedule:

Evaluation Format	**Weight/ (CEAB GA)**	**Effort Type**	**Submission Type**	**Assigned**	**Due**
Eight in-tutorial assignments	10% (Average of best seven)	Team[a]	Individual	Weekly **except for** the first two Tuesdays of the term, Fall Reading Week, and days of the two quizzes.	End of tutorial session[e]
Pre-project	5%	Team[a]	Team	Week of Sep. 21	Week of Oct. 5[d]
Quiz 1	10%	Individual	Individual	Oct. 27[c]	
Project	15% (PA3)	Team[a]	Team	Week of Oct. 19	Week of Dec. 7[d]
Peer-Graded Assignment	5%	Team[a]	Team + Individual	Week of Nov. 2	Week of Nov. 23 [d]
Quiz 2	10% (I3)	Individual	Individual	Nov. 17[c] (Designated Assessment)	
Lab	5% (ET1, ET2)	Group[b]	Individual	Week of Nov. 23	Week of Nov. 30
				Makeup offered in the last week of the term	
Final exam	40% (ET2)	Individual	Individual	TBA (Dec. examination period)	

[a] Team is student-formed and normally remains the same throughout the 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 submission deadline; academic considerations will not be accepted because a 72-hour no-penalty submission window is provided.

[e] In-tutorial assignments use a best-seven-of-eight grading scheme and have a strict end-of-tutorial submission deadline; academic considerations will not be accepted.

COURSE POLICIES

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

Academic Considerations

- Academic relief for missed course assessments, where available under the course-specific policies below, requires approved academic consideration in accordance with the applicable Faculty and University policies.
- Academic considerations may be accompanied by supporting documentation or may be requested without supporting documentation, subject to the applicable University limits and eligibility requirements.
- Please note that - according to approved policies - academic considerations for undocumented absences are limited *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

- Some course deliverables have flexible submission deadlines, as indicated in the course schedule. For these deliverables, a 72-hour no-penalty submission window will apply immediately following the original deadline.
- Submissions made after the 72-hour no-penalty window will be subject to a late penalty of 20% per day.
- Because flexibility is already built into these submission deadlines, academic considerations, whether documented or undocumented, will not be accepted for deliverables with flexible submission deadlines.
- Academic considerations will also not be accepted for assessments that include built-in flexibility through a "best X out of Y" grading scheme. This applies to the in-tutorial assignments, for which the best seven of eight submissions will be used in calculating the final grade.
- Assessments with strict submission deadlines, including in-tutorial assignments and laboratory deliverables, are governed by the specific policies stated in their respective sections below.

Individual Contributions to Team/Group Deliverables

- The default assumption is that all team/group members contribute equitably to common deliverables, including the pre-project,

project, and peer-graded assignment, and therefore receive the same mark, except where individual requirements or adjustments are specified elsewhere in this outline.

- Where there is evidence that individual contributions were not equitably shared, individual marks may be adjusted at the discretion of the instructional team. Evidence may include instructor/TA observations, peer feedback, individual explanations of submitted work, or other information relevant to individual participation.
- In-tutorial assignments are governed by the separate policies described under the **In-Tutorial Assignments** policies below.

Laboratory sessions

- Students must attend the laboratory session for which they have signed up.
- Laboratory deliverables must be submitted by the end of the scheduled laboratory session. No late submissions will be accepted.
- *Students must obtain a mark of at least 50% on the laboratory component to pass the course. Failure to meet this requirement will result in automatic course failure.*
- One make-up laboratory session will be offered during the final week of the term for students who miss their scheduled laboratory session with approved academic consideration.
- Missing the laboratory session **without** academic consideration will translate into a zero mark for the laboratory session.
- Students who receive approved academic consideration for a missed laboratory session must contact the course instructor within three days of receiving the consideration to arrange attendance at the make-up session.
- 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 two quizzes will take place during the timetabled tutorial sessions
- Quizzes will be closed book.
- Quiz 2 is the designated assessment and as such will require supporting documentation to receive academic consideration.
- Each quiz will be approximately 1.5 hours long, with the remainder of the tutorial time used to discuss the solution.
- Students who miss a quiz **without** approved academic consideration will receive a mark of zero.
- For a quiz missed **with** approved academic consideration, the quiz weight will be transferred to the final examination. No make-up quizzes will be offered.
- For the purpose of determining the minimum final examination mark required to pass the course, a quiz that was not written will be treated as a quiz on which a mark of at least 50% was not

obtained, regardless of whether academic consideration was approved for the absence.
- 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.

Pre-project/Project

- Project teams will be formed in the first week of classes via OWL sign-up.
- *Students must obtain a mark of at least 50% on both the pre-project and the project. Failure to meet either requirement will result in automatic course failure.*
- The maximum team size will be three students, while the minimum team size will be two students.
- The same project team will also work on the eight in-tutorial assignments scheduled throughout the term.
- Once the team formation deadline has passed, team membership may be changed only with the permission of the course instructor.
- SolidWorks will be used for the kinematic analysis of the mechanism assigned for the project.
- 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 pre-project/project purposes.
- The instructor of the course will solve problems during the first tutorial hour. Similar problems will constitute the subject of the in-tutorial assignment assigned in the second hour of the tutorial.
- Each team member must submit their own solution to the in-tutorial assignment by the end of the tutorial. Although students may work collaboratively within their team, each student is responsible for submitting an individual solution.
- After the submission deadline, one submission will be selected at random from among the individual solutions submitted by the team. The mark assigned to that submission will become the base team mark for that week, subject to any individual adjustments described below. The identity of the selected team member will be announced only after the submission deadline. Nonetheless, a team member who does not submit an individual solution by the deadline will receive a mark of zero for that week, regardless of the mark assigned to the team.
- *In-tutorial assignments must be submitted by the end of the scheduled tutorial. No late submissions will be accepted.*
- Teams may receive problem-solving assistance from the instructor and teaching assistants present in the tutorial room. However, prior

knowledge on 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).
- *Students must attend and participate in the full two-hour tutorial to receive full credit for that week's in-tutorial assignment. Students who miss the first hour but attend and participate in the second hour will receive a maximum of 20% of the team mark for that week. Students who miss the second hour, including students who miss the entire tutorial, will receive a mark of zero for that week's in-tutorial assignment.*
- 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 peer-graded assignment consists of two interconnected parts. In Part 1, each team will complete and submit the required deliverable(s). Part 1 will be evaluated through peer grading by the class.
- In Part 2, each student must individually review and rank/grade the assigned Part 1 submissions from other teams. Part 2 does not carry a separate mark but is a mandatory component of the assignment.
- Students who do not submit their individual Part 2 evaluation by the end of the 72-hour no-penalty submission window will receive an individual late penalty of 20% per day on their peer-graded assignment mark, regardless of whether their team submitted Part 1 on time.

Term work

- Students must obtain an overall term-work average of at least 50%. For the purpose of this requirement, term work includes the in-tutorial assignments, peer-graded assignment, pre-project, project, quizzes, and laboratory component. Failure to obtain at least 50% on the combined term work will result in automatic course failure, regardless of the mark obtained on the final examination.
- When the weight of a missed quiz is transferred to the final examination following approved academic consideration, that quiz will be excluded from the calculation of the student's term-work average.
- Whenever possible, students will be warned if they are at risk of not meeting the minimum term-work requirement. However, since some of the course deliverables will be submitted in the final instructional days of the term, it is possible that accurate term work calculations will not be possible until all term deliverables have been graded.
- Students are strongly encouraged to monitor their academic progress throughout the term, as the term-work requirement will be applied when final grades are calculated.

Final Examination Passing Requirements

- Students who write both quizzes and obtain a mark of at least 50% on each quiz must obtain a mark of at least 40% on the final examination to be eligible to pass the course.
- Students who obtain a mark of at least 50% on only one of the two quizzes must obtain a mark of at least 50% on the final examination to be eligible to pass the course. This applies whether the other quiz was written and received a mark below 50%, or was not written, regardless of whether academic consideration (documented or undocumented) was approved for the missed quiz.
- Students who do not obtain a mark of at least 50% on either quiz must obtain a mark of at least 60% on the final examination to be eligible to pass the course. This includes students who receive marks below 50% on both quizzes, students who receive a mark below 50% on one quiz and do not write the other, and students who do not write either quiz, regardless of whether academic consideration (documented or undocumented) was approved for any missed quiz.
- Students who do not meet the applicable final-examination requirements will receive a final course grade no greater than 48%.

UNITS: Metric and US customary.

COURSE POLICY ON THE USE OF GENERATIVE AI (GENAI)

- GenAI is not required or recommended for this course. Students who choose to use GenAI tools must do so in accordance with the conditions below.
- The use of GenAI is not permitted during in-tutorial assignments, laboratory activities, quizzes, or the final examination. These restrictions are intended to ensure that students develop and demonstrate their own technical understanding and problem-solving abilities.
- For the pre-project, project, and peer-graded assignment, GenAI tools may be used provided that any use is fully disclosed. The disclosure must identify the GenAI tool used, date(s) of use, purpose of use, and what was independently verified or modified. Students remain fully responsible for the technical correctness, originality, and understanding of all submitted work, regardless of whether GenAI was used. Students must be able to explain and justify the methods, assumptions, calculations, designs, and conclusions contained in their submissions.
- Students who choose not to use GenAI have appropriate alternatives, including course notes, recommended textbook(s), and support from the instructor and teaching assistants.
- Violations of this policy, including undisclosed GenAI use, use of GenAI where prohibited, fabricated content, or misrepresentation of authorship, will be addressed in accordance with Western Engineering academic-integrity policies.

General Faculty / University Policies

The Faculty of Engineering and Western University have overarching policies that prescribe how undergraduate courses should run. The course-specific policies described above should be considered *in addition to* those overarching policies, or as course-specific interpretations of them. In the event of contradictions or confusion between course-specific policies above and general Faculty/University policies, please contact your course instructor for clarification.

Western Engineering's undergraduate policies can be found by navigating to:
https://www.eng.uwo.ca/undergraduate/academic-support-and-accommodations/policies.html
and then clicking the "*Engineering Undergraduate Policies framework*" link