

**Western University
Faculty of Engineering
Mechatronic Systems Engineering Program**

MSE 2213B – Engineering Dynamics

Course Outline 2017-18

Description:

This course introduces the fundamentals of dynamics of particles and rigid bodies. The focus is on understanding and applying fundamental principles and methods to the solution of a variety of engineering dynamics problems.

Instructor:

Dr. R.O. Buchal, Ph.D., P.Eng.

SEB 2069C, 519-661-2111 ext.88454, rbuchal@uwo.ca

Consultation hours: Monday and Wednesday 2:30pm-3:30pm or by appointment

Academic Calendar Copy:

Topics include: rectilinear, angular and curvilinear motion; kinetics of a particle, a translating rigid body and a rigid body in pure rotation; definitions of different energies and energy balance; power and efficiency; and linear impulse and momentum.

Contact Hours:

3 lecture hours, 2 tutorial hours, half course.

Antirequisite:

MME 2213A/B

Prerequisites:

AM 2270A/B

Co-requisite:

None

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 in the event that you are dropped from a course for failing to have the necessary prerequisites.

CEAB Academic Units:

Science: 50%, Engineering Science: 50%.

Required Textbook:

Vector Mechanics for Engineers: Dynamics, ISBN 9781259679414, Ferdinand Beer and E. Russell Johnston, Jr., David Mazurek and Phillip Cornwell, 11th Edition, McGraw Hill, 2015

Required Software:

None.

Other Required References:

None.

Recommended References:

None.

General Learning Objectives (CEAB Graduate Attributes)

Knowledge Base	D	Use of Engineering Tools	I	Impact on Society and the Environment	
Problem Analysis	D	Individual and Team Work	I	Ethics and Equity	
Investigation		Communication Skills		Economics and Project Management	
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).

Topics and Specific Learning Objectives

Kinematics of Particles

At the end of this section, students will be able to:

- Describe the basic kinematic relationships between position, velocity, acceleration, and time.
- Solve problems using these basic kinematic relationships and calculus or graphical methods.
- Define position, velocity, and acceleration in terms of Cartesian, tangential and normal, and radial and transverse coordinates.
- Analyze the relative motion of multiple particles by using a translating coordinate system.
- Determine the motion of a particle that depends on the motion of another particle.
- Determine which coordinate system is most appropriate for solving a curvilinear kinematics problem.
- Calculate the position, velocity, and acceleration of a particle undergoing curvilinear motion using Cartesian, tangential and normal, and radial and transverse coordinates.

Kinetics of Particles: Newton's Second Law

At the end of this section, students will be able to:

- Explain the relationships between mass, force, and acceleration.
- Model physical systems by drawing complete free-body diagrams and kinetic diagrams.
- Apply Newton's Second Law to solve particle kinetics problems using different coordinate systems.
- Analyze central force motion problems using principles of angular momentum and Newton's Law of Gravitation.

Kinetics of Particles: Energy and Momentum Methods

At the end of this section, students will be able to:

- Calculate the work done by a force.
- Calculate the kinetic energy of a particle.
- Calculate the gravitational and elastic potential energy of a system.
- Solve particle kinetics problems using the principle of work and energy.
- Calculate the power and efficiency of a mechanical system.
- Solve particle kinetics problems using conservation of energy.
- Solve particle kinetics problems involving conservative central forces.
- Draw complete and accurate impulse-momentum diagrams.
- Solve particle kinetics problems using the principle of impulse and momentum.
- Solve particle kinetics problems using conservation of linear momentum.
- Solve impact problems using the principle of impact and momentum and the coefficient of restitution.
- Determine the appropriate principle(s) to apply when solving a particle dynamics problem.
- Solve multi-step dynamics problems using multiple kinetics principles.

Systems of Particles

At the end of this section, students will be able to:

- Apply Newton's second law to a system of particles.
- Calculate the linear momentum and the angular momentum about a point of a system of particles.
- Describe the motion of the center of mass of a system of particles.
- Determine the kinetic energy of a system of particles.
- Analyze the motion of a system of particles by using the principle of work and energy and the principle of impulse and momentum.
- Analyze the motion of steady streams of particles
- Analyze systems of particles gaining or losing mass.

Kinematics of Rigid Bodies

At the end of this section, students will be able to:

- Describe the five basic types of rigid body motion: translation, rotation about a fixed axis, general plane motion, motion about a fixed point, and general motion.
- Use angular kinematic relationships involving θ , ω , and α to determine the angular motion of a rigid body.
- Identify the directions of terms in the relative velocity and relative acceleration equations.
- Calculate the linear velocity and acceleration of any point on a rigid body undergoing translation, fixed axis rotation, or general plane motion.
- Solve planar rigid body kinematics problems using the relative velocity and relative acceleration equations.
- Determine the instantaneous center of rotation and use it to analyze the planar velocity kinematics of a rigid body.
- When appropriate, define a rotating coordinate frame and use it to solve planar and three-dimensional kinematics problems.
- Determine the angular velocity and angular acceleration of a body undergoing three-dimensional motion.
- Calculate the linear velocity and acceleration of any point on a rigid body undergoing three-dimensional motion.

Plane Motion of Rigid Bodies: Forces and Accelerations

At the end of this section, students will be able to:

- Discuss how the mass and mass moment of inertia affect the linear and angular accelerations of a rigid body.
- Model physical systems involving rigid bodies by drawing correct free-body diagrams and kinetic diagrams.
- Using rigid-body kinetics principles, determine whether a body slips or tips and if a wheel rolls with or without slip.
- Apply appropriate kinetic equations and kinematics relationships to solve kinetics problems for a rigid body undergoing translation, centroidal rotation, or general plane motion.
- Analyze systems of connected rigid bodies using appropriate kinetic and kinematic equations.
- Analyze constrained motion of rigid bodies, including fixed-axis rotation and rolling disks and wheels.

Plane Motion of Rigid Bodies: Energy and Momentum Methods

At the end of this section, students will be able to:

- Calculate the work done by a force or a moment on a rigid body.
- Calculate the kinetic energy of a rigid body in plane motion.
- Solve rigid body kinetics problems using the principle of work and energy.
- Solve rigid body kinetics problems using conservation of energy.
- Calculate the power of a mechanical system of rigid bodies.
- Draw complete and accurate impulse–momentum diagrams for problems involving rigid bodies.

- Solve rigid body kinetics problems using the principles of linear impulse and momentum and of angular impulse and momentum.
- Solve rigid body kinetics problems using conservation of angular momentum.
- Solve rigid body problems involving eccentric impact by using the principle of impulse and momentum and the coefficient of restitution.

Kinetics of Rigid Bodies in Three Dimensions

At the end of this section, students will be able to:

- Calculate the angular momentum and kinetic energy of a rigid body undergoing general three-dimensional motion.
- Define the inertia tensor, products of inertia, and principal axes of inertia.
- Apply the principle of impulse and momentum to solve three-dimensional rigid body kinetics problems.
- Solve three-dimensional rigid body kinetics problems, including fixed point rotation, fixed axis rotation, and gyroscopic motion.
- Describe the relationship between applied moment, precession, and spin of a gyroscope undergoing steady precession.
- Analyze the motion of a rotating axisymmetric body under no external forces.

Evaluation

Course Component	Weight
In-class tutorial exercises	20%
Midterm Examination	30%
Final Examination	50%

To obtain a passing grade in the course, a mark of 60% or more must be achieved on the final examination. A final examination mark < 60% will result in a final course grade of 48% or less.

Homework Assignments:

Regular homework assignments will be assigned, and solutions will be provided. These assignments will not be graded, but will prepare students for the graded tutorial exercises.

Tutorial Exercises:

There will be four open-book tutorial exercises. These will be scheduled during the tutorial period, and will be two-hours in duration.

Exercise 1: Week of January 29 (5%)

Exercise 2: Week of February 26 (5%)

Exercise 3: Week of March 19 (5%)

Exercise 4: Week of April 2 (5%)

Laboratory:

None.

Midterm Test

There will be a single, two-hour midterm test scheduled outside of class time. The date and time are TBA, but will be after reading week. The test will be limited open book. Chapter summaries from the textbook will be provided at the test. No other references are permitted. A standard scientific calculator is also permitted.

Final Examination:

The final examination will be take place during the regular examination period. The examination will be **LIMITED OPEN BOOK**. Chapter summaries from the textbook will be provided at the test. No other references are permitted. A standard scientific calculator is also permitted.

Use of English:

In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for improper use of English. Additionally, poorly written work with the exception of the final examination may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

Attendance:

Any student who, in the opinion of the instructor, is absent too frequently from class, laboratory, or tutorial periods will be reported to the Dean (after due warning has been given). On the recommendation of the department, and with the permission of the Dean, the student will be debarred from taking the regular final examination in the course.

Absence Due to Illness or Other Circumstances:

Students should immediately consult with the instructor or department Chair if they have any problems that could affect their performance in the course. Where appropriate, the problems should be documented (see the attached "Instructions for Students Unable to Write Tests or Examinations or Submit Assignments as Scheduled"). The student should seek advice from the instructor or department Chair regarding how best to deal with the problem. Failure to notify the instructor or department Chair immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

For more information concerning medical accommodations, see the relevant section of the Academic Handbook:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_medical.pdf

For more information concerning accommodations for religious holidays, see the relevant section of the Academic Handbook:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_religious.pdf

Missed Midterm Examinations:

If a student misses a midterm examination, the exam will not be rescheduled. The student must follow the Instructions for Students Unable to Write Tests and provide documentation to their department within 24 hours of the missed test. The department will decide whether to allow the reweighting of the test, where reweighting means the marks normally allotted for the midterm will be added to the final exam. If no reasonable justification for missing the test can be found, then the student will receive a mark of zero for the test.

If a student is going to miss the midterm examination for religious reasons, they must inform the instructor in writing within 48 hours of the announcement of the exam date or they will be required to write the exam.

Cheating and Plagiarism:

Students must write their essays and assignments in their own words. Whenever students take an idea or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. University policy states that cheating, including plagiarism, is a scholastic offence. The commission of a scholastic offence is attended by academic penalties, which might include expulsion from the program. If you are caught cheating, there will be no second warning.

All required papers may be subject to submission for textual similarity review to commercial plagiarism-detection software under license to the University for the detection of plagiarism. All papers submitted will be included as source documents on the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between the University of Western Ontario and Turnitin.com (<http://www.turnitin.com>).

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, in the relevant section of the Academic Handbook:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf

Use of Electronic Devices:

You are permitted to use electronic devices including smartphones, tablets and laptops during class for course-related activities only. This includes but is not limited to: viewing lecture PowerPoints, viewing other course documents, accessing OWL, posting questions, collaborating in group activities, and running SolidWorks.

Policy on Repeating All Components of a Course:

Students who are required to repeat an Engineering course must repeat all components of the course. No special permissions will be granted enabling a student to retain laboratory, assignment, or test marks from previous years. Previously completed assignments and laboratories cannot be resubmitted by the student for grading in subsequent years.

Internet and Electronic Mail:

Students are responsible for regularly checking their Western e-mail and the course web site (<https://owl.uwo.ca/portal/>) and making themselves aware of any information that is posted about the course. If the student fails to act on information that has been posted on these sites and does so without a legitimate explanation (i.e., those covered under the illness/compassionate form), then there are NO grounds for an appeal.

Accessibility:

Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 519-661-2111 ext. 82147 for any specific question regarding an accommodation.

Support Services:

Office of the Registrar, <http://www.registrar.uwo.ca/>

Student Development Centre, <http://www.sdc.uwo.ca/>

Engineering Undergraduate Services, <http://www.eng.uwo.ca/undergraduate/>

USC Student Support Services, <http://westernusc.ca/services/>

Students who are in emotional/mental distress should refer to Mental Health @ Western, http://www.health.uwo.ca/mental_health/, for a complete list of options about how to obtain help.

INSTRUCTIONS FOR STUDENTS UNABLE TO WRITE TESTS OR EXAMINATIONS OR SUBMIT ASSIGNMENTS AS SCHEDULED

IF, ON MEDICAL OR COMPASSIONATE GROUNDS, YOU ARE UNABLE TO WRITE TERM TESTS OR FINAL EXAMINATIONS OR COMPLETE COURSE WORK BY THE DUE DATE, YOU SHOULD FOLLOW THE INSTRUCTIONS LISTED BELOW. YOU SHOULD UNDERSTAND THAT ACADEMIC RELIEF WILL NOT BE GRANTED AUTOMATICALLY ON REQUEST. YOU MUST DEMONSTRATE TO YOUR DEPARTMENT (OR THE UNDERGRADUATE SERVICES OFFICE) THAT THERE ARE COMPELLING MEDICAL OR COMPASSIONATE GROUNDS THAT CAN BE DOCUMENTED BEFORE ACADEMIC RELIEF WILL BE CONSIDERED. DIFFERENT REGULATIONS APPLY TO TERM TESTS, FINAL EXAMINATIONS AND LATE ASSIGNMENTS. PLEASE READ THE INSTRUCTIONS CAREFULLY. (SEE THE 2017 UWO ACADEMIC CALENDAR).

A. GENERAL REGULATIONS & PROCEDURES

1. All first year students will report to the Undergraduate Services Office, SEB 2097, for all instances.
2. If you are an upper year student and you are missing a test/assignment/lab or exam that is worth MORE THAN 10% of your final grade, you will report to the Undergraduate Services Office, SEB 2097. Otherwise, you will report to your department office to request relief.
3. Check the course outline to see if the instructor has a policy for missed tests, examinations, late assignments or attendance.
4. Documentation must be provided as soon as possible. If no one is available in your Department office or the Undergraduate Services Office, leave a message clearly stating your name & student number and reason for your call. The department telephone numbers are given at the end of these instructions.
5. If you decide to write a test or an examination you should be prepared to accept the mark you earn. Rewriting tests or examinations or having the value of a test or examination reweighted on a retroactive basis is not permitted.

B. TERM TESTS

1. If you are in first year and you are unable to write a term test, contact the Undergraduate Services Office, SEB 2097 PRIOR to the scheduled date of the test.
2. If you are an upper year student and you are unable to write a term test, inform your instructor PRIOR to the scheduled date of the test. If the instructor is not available, leave a message for him/her at the department office. If the test is worth MORE THAN 10% of your final grade you will report to the Undergraduate Services Office, SEB 2097 to request relief. Otherwise, you will report to your department office to request relief.
3. Be prepared to provide supporting documentation to the Department Chair and/or the Undergraduate Services Office (see next page for information on documentation).
4. Discuss with the instructor if and when the test can be rescheduled. **N.B.** The approval of the Chair or the Undergraduate Services Office is required when rescheduling term tests.

C. FINAL EXAMINATIONS

1. If you are unable to write a final examination, contact the Undergraduate Services Office PRIOR TO THE SCHEDULED EXAMINATION TIME to request permission to write a Special Final Examination. If no one is available in the Undergraduate Services Office, leave a message clearly stating your name & student number.
2. Be prepared to provide the Undergraduate Services Office with supporting documentation (see next page for information on documentation) the next day, or as soon as possible (in cases where students are hospitalized). The following circumstances are not considered grounds for missing a final examination or requesting special examinations: common cold, sleeping in, misreading timetable and travel arrangements.
3. In order to receive permission to write a Special Examination, you must obtain the approval of the Chair of the Department **and** the Associate Dean and in order to apply you must sign a "Recommendation for a Special Examination Form" available in the Undergraduate Services Office. The Undergraduate Services Office will then notify the course instructor(s) and reschedule the examination on your behalf.

N.B. It is the student's responsibility to check the date, time and location of the Special Examination.

D. LATE ASSIGNMENTS

1. Advise the instructor if you are having problems completing the assignment on time (**prior** to the due date of the assignment).
2. Be prepared to provide documentation if requested by the instructor (see reverse side for information on documentation).
3. If you are granted an extension, establish a due date. The approval of the Chair of your Department (or the Associate Dean if you are in first year) is not required if assignments will be completed prior to the last day of classes.
4.
 - i) Extensions beyond the end of classes must have the consent of the instructor, the department Chair and the Associate Dean. Documentation is mandatory.
 - ii) A Recommendation of Incomplete Form must be filled out indicating the work to be completed and the date by which it is due. This form must be signed by the student, the instructor, the department Chair and the Associate Dean.

E. SHORT ABSENCES

If you miss a class due to a minor illness or other problem, check your course outlines for information regarding attendance requirements and make sure you are not missing a test, laboratory or assignment. Cover any readings and arrange to borrow notes from a classmate.

F. EXTENDED ABSENCES

If you are absent more than one week or if you get too far behind to catch up, you should consider reducing your workload by dropping one or more courses. (Note drop deadlines listed below). You may want to seek advice from the academic counsellor in your Department or Ms. Karen Murray in the Undergraduate Services Office, if you are in first year.

G. DOCUMENTATION

If you consulted an off-campus doctor or Student Health Services regarding your illness or personal problem, **you must provide the doctor with a Student Medical Certificate** to complete at the time of your visit and then bring it to the Department (or the Undergraduate Services Office). **This note must contain the following information: severity of illness, effect on academic studies and duration of absence. Regular doctor's notes will not be accepted; only the Student Medical Certificate will be accepted.**

In Case of Serious Illness of a Family Member: Provide a Student Medical Certificate to your family member's physician to complete and bring it to the Department (or the Undergraduate Services Office if you are in first year).

In Case of a Death: Obtain a copy of the death certificate or the notice provided by the funeral director's office. You must include your relationship to the deceased and bring it to the Department (or the Undergraduate Services Office if you are in first year).

For Other Extenuating Circumstances: If you are not sure what documentation to provide, ask the Departmental Office (or the Undergraduate Services Office if you are in first year) for direction.

Note: Forged notes and certificates will be dealt with severely. To submit a forged document is a scholastic offence (see below).

H. ACADEMIC CONCERNS

1. You need to know if your instructors have a policy on late penalties, missed tests, etc. This information may be included on the course outlines. If not, ask your instructor(s).
2. **You should also be aware of attendance requirements in some courses. You can be debarred from writing the final examination if your attendance is not satisfactory.**
3. If you are in academic difficulty, check out the minimum requirements for progression in the calendar. If in doubt, see your academic counsellor.

Calendar References: Check these regulations in your 2017 Western Academic Calendar available at www.westerncalendar.uwo.ca.

Absences Due to Illness: <http://westerncalendar.uwo.ca/2017/pg117.html>
Academic Accommodations for Students with Disabilities: <http://westerncalendar.uwo.ca/2017/pg118.html>
Academic Accommodations for Religious or Holy Days: <http://westerncalendar.uwo.ca/2017/pg119.html>
Course Withdrawals: <http://westerncalendar.uwo.ca/2017/pg157.html>
Examinations: <http://westerncalendar.uwo.ca/2017/pg129.html>
Scheduling of Term Assignments: <http://westerncalendar.uwo.ca/2017/pg135.html>
Scholastic Offences: <http://www.westerncalendar.uwo.ca/2017/pg111.html>
Student Medical Certificate: http://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf
Engineering Academic Regulations: <http://www.westerncalendar.uwo.ca/2017/pg1442.html>

Note: These instructions apply to all students registered in the Faculty of Engineering regardless of whether the courses are offered by the Faculty of Engineering or other faculties in the University.

Drop Deadlines:

First term half course (i.e. "A" or "F"):	November 5, 2017
Full courses and full-year half courses (i.e. "E", "Y" or no suffix):	November 30, 2017
Second term half or second term full course (i.e. "B" or "G"):	March 7, 2017

Contact Information:

Undergraduate Services Office:	SEB 2097	Telephone: (519) 661-2130	E-mail: engugrad@uwo.ca
Dept. of Chemical and Biochemical Engineering & Green Process Engineering:	TEB 477	Telephone: (519) 661-2131	E-mail: cbeugrad@uwo.ca
Dept. of Civil and Environmental Engineering:	SEB 3005	Telephone: (519) 661-2139	E-mail: civil@uwo.ca
Dept. of Electrical and Computer Engineering, Software Engineering & Mechatronics Engineering:	TEB 279	Telephone: (519) 661-3758	E-mail: eceugrad@uwo.ca
Dept. of Mechanical and Materials Engineering:	SEB 3002	Telephone: (519) 661-4122	E-mail: mmeundergraduate@uwo.ca