

## Physics 3151 B – Classical Mechanics Course Outline

### 1. Course Information

**Course:** Physics 3151B, Classical Mechanics, 2023-2024 Winter Term

3 hours per week, IN PERSON INSTRUCTION.

**Prerequisite(s):** (Physics 1028A/B or 1301A/B or 1401A/B or 1501A/B) and (Physics 1029A/B or 1302A/B or 1402A/B or 1502A/B), or the former Physics 1020 or 1024 or 1026; Calculus 2303A/B or 2503A/B, Applied Mathematics 2402A or 2270A/B or the former Applied Mathematics 2411 or 2413.

**Antirequisite(s):** Applied Mathematics 3151A/B.

Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you may 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.

### 2. Instructor Information

Instructors	Email	Office	Phone	Office Hours
Prof. Giovanni Fanchini (Course Instructor)	<a href="mailto:gfanchin@uwo.ca">gfanchin@uwo.ca</a>		519-661-2111 ext. 86238	By e-mail appointment
Mr. Noah Stocek (Teaching Assistant)	<a href="mailto:nstoczek@uwo.ca">nstoczek@uwo.ca</a>			By e-mail appointment

Students must use their Western (@uwo.ca) email addresses when contacting their instructors, as messages from other providers may be treated as spam.

### 3. Course Syllabus, Schedule, Delivery Mode

This course provides students with the tools to tackle more complex problems than those covered in introductory mechanics courses. These topics will include variational principles, principle of least action, Lagrangian mechanics, Hamiltonian mechanics, central force motion, rigid bodies, non-inertial reference frames and Lagrangian formulation for coupled oscillations.

**Learning outcomes:** We expect you know the course learning outcomes and agree with them if you are taking this course. Please refer to <https://owl.uwo.ca/x/pvcekr>

### **Approximate topic timeline**

See Appendix A.

### **Key sessional dates**

Classes begin: January 8, 2024;

Winter reading week: February 17 – 25, 2024

Classes end: April 8, 2024

Exam period: April 11 – 30, 2024

### **Contingency plan for in-person instruction pivoting to 100% online learning**

In the event of a COVID-19 resurgence during the course that necessitates the course delivery moving away from face-to-face interaction, all remaining course content will be delivered entirely online, either synchronously (i.e., at the times indicated in the timetable) or asynchronously (e.g., through pre-recorded lectures and slides, posted on OWL for students to view at their convenience) as circumstances will recommend. The grading scheme will not change. Any remaining assessments will also be conducted online as determined by the course instructor.

## **4. Course Material**

*This course provides students with the tools to tackle more complex problems than those covered in introductory mechanics courses. These topics will include variational principles, principle of least action, Lagrangian mechanics, Hamiltonian mechanics, central force motion, rigid bodies, non-inertial reference frames and Lagrangian formulation for coupled oscillations.*

### **Course textbook:**

S.T. Thornton and J.B. Marion, Classical Dynamics of Particles and Systems, 5th edition (Brooks/Cole) available at the Campus Bookstore. Note: you will require a hard copy of this (or other) textbook if you wish to carry them to the open-book tutorials, midterm, and final exam.

### **Other Classical Mechanics textbooks** (optional, for additional reading and consultation):

*At the advanced undergraduate level:*

L.N. Hand and J.D. Finch, Analytical Mechanics (Cambridge University Press)

H. Goldstein, J. Safko and C. Poole, Classical Mechanics, 3rd edition (Addison-Wesley)

*At the graduate level:*

V.I. Arnold, Mathematical Methods of Classical Mechanics, 2<sup>nd</sup> edition (Springer).

**Students** are responsible for checking the course OWL site (<http://owl.uwo.ca>) on a regular basis for news and updates. This is the primary method by which information will be disseminated to all students in the class. Note that this syllabus may be updated during the course. In this case, the updated version is available on the course OWL site.

All course material will be posted to OWL: <http://owl.uwo.ca> (normally: in the RESOURCE section)

If students need assistance with the course OWL site, they can seek support on the OWL Help page. Alternatively, they can contact the Western Technology Services Helpdesk. They can be contacted by phone at 519-661-3800 or ext. 83800.

### Technical Requirements

In anticipation of a possible COVID-19 resurgence during the course that necessitates the course delivery moving online, the following technology is required: stable internet connection, computer with working microphone and webcam, and access to ZOOM.

## 5. Methods of Evaluation

The overall course grade will be calculated as listed below:

- **Midterm Exam:** **35%**

The Midterm (1h45' duration) is scheduled **IN PERSON** during lecture time (**9.30-11.20 AM, room PAB-150**) on the first Friday after Reading Week (i.e., **November 11**) and will include two numerical problems not dissimilar from those presented at the tutorials. The midterm covers all of the course material before Reading Week. The midterm is open book (see sect 8, "Academic Policies" for more detailed policies)

- **Final Exam:** **35%**

The final (3h00' duration) will be **IN PERSON** at a date/time scheduled by the Office of Registrar. It will include three numerical problems not dissimilar from those presented at the tutorials. The final exam covers the entire course program (i.e., it is also including all of the subjects covered at the midterm). The final is open book (see sect 8, "Academic Policies" for more detailed policies).

- **Assignment:** **6%**

This assignment will be **available on "OWL Assignment" on March 8** and is **due on OWL March 25 (12-noon)**. The assignment will be a relatively "long" problem requiring derivations, math work, and possibly calculations. Collaboration among students is possible, but each student is asked to post on OWL their full work (including reasoning, intermediate derivation and math steps, and final analytical and numerical results) in their own PDF file. It is expected that solving this assignment requires 4 days or less, thus the more than 2-week timeline accounts for any possible absences or unpredictable circumstances.

- **Weekly tutorial tests:** **4% each (24% max)**

These open-book tutorial tests (1 tutorial test per week, 10 in total) will be **started in class each Wednesday** except for the first week of the course and Reading Week. Tutorial tests will include a numerical problem covering material from the previous Friday classroom and the corresponding online set of quizzes. The tutorials are meant as practice for the Midterm and Final exams. The first tutorial ("tutorial 0", Appendix A) is just for practice and will **not** be graded. The best other 6 (of 10) weekly tutorial marks count towards the final course grade, for a maximum of  $4\% \times 6 = 24\%$ . Normally, two options for taking the weekly tutorial tests are available:

a) "Classroom mode" - You can solve the tutorial test open-book in 45' in class and return the solved test sheet to the instructor, **by 12.20 pm at the end of the class**. With this option, the maximum grade you can receive for a perfect test is **4.0%**.

b) "Assignment mode" - You can take the tutorial test home, solve it as an assignment, and upload on OWL a scanned copy of the test sheet **by 10.30 pm same day** (i.e. if the test is given in class at 11.30 am on Jan-19, Friday, you will have to post it on OWL by 10.30 pm, Jan-19, Friday). Only tests started in class and test sheets converted in portable document format (PDF) will be accepted. With this option, the maximum grade you can receive for a perfect test is **3.0%** (except for special accommodations).

In exceptional cases, the Department of Physics and Astronomy may adjust the final course grades in order to conform to Departmental policy.

## 6. Student Absences

If you are unable to meet a course requirement due to illness or other serious circumstances, please follow the procedures below.

### **Assessments worth less than 10% of the overall course grade:**

\* **No make-ups will be offered for weekly tutorial tests** as only 6 of 11 count towards the final course grade (i.e., this is designed to also make-up for occasional absences). If a student misses more than 5 tutorial tests or on-line quizzes (all of them covered by a medical or other documented excuse requiring academic consideration) then this course component will be reweighted (i.e., if you have taken only 5 weekly tutorial tests because you have valid medical and/or other excuses for the other 6, the total mark of your remaining 5 sets of tutorial tests will be multiplied by 6/5; etc.). In this case, the student will provide specific documentation (medical or otherwise) for such absences to the Dean's Office Counselling unit.

\* **Assignment.** It is expected that solving this assignment requires 4 days or less, thus the 2-week timeline accounts for any possible absences or other circumstances. Only in case of long absences that will extend for over 10 of 14 days in the relevant period of the assignment (March 8-25) one of these two options will be offered, at the discretion of the course instructor: either the assignment grade will be reweighted over all of the other course components, or another assignment of similar difficulty will be offered later on to the affected student(s). Either way, the student will provide specific documentation (medical or otherwise) for such long absences to the Dean's Office Counselling unit.

### **Assessments worth 10% or more of the overall course grade:**

\* **If a student misses the Midterm** because of medical or other documented circumstances requiring academic consideration, one of these two options will be offered, at discretion of the course instructor: either the midterm grade will be re-weighted to the final exam, or a make-up midterm will be offered at a date to be determined. The same policy applies if a student misses their make-up midterm, or the make-up of the make-up, etc.

For work totaling 10% or more of the final course grade, you must always provide valid medical or supporting documentation to the Academic Counselling Office of your Faculty of Registration as soon as possible. For further information, please consult the University's medical illness policy at

[https://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/accommodation\\_medical.pdf](https://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_medical.pdf).

The Student Medical Certificate is available at

[https://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/medicalform.pdf](https://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf).

\* **Absences from Final Examination.** If you miss the Final Exam, please contact the Academic Counselling office of your Faculty of Registration as soon as you are able to do so. They will assess your eligibility to write the Special Examination (the name given by the University to a make-up Final Exam).

You may also be eligible to write the Special Exam if you are in a “Multiple Exam Situation” (e.g., more than 2 exams in 23-hour period, more than 3 exams in a 47-hour period).

If a student fails to write a scheduled Special Examination, the date of the next Special Examination (if granted) normally will be the scheduled date for the final exam the next time this course is offered. The maximum course load for that term will be reduced by the credit of the course(s) for which the final examination has been deferred. See the Academic Calendar for details (under [Special Examinations](#)).

#### **Note**

Missed work can *only* be excused through one of the mechanisms above. Being asked not to attend an in-person course requirement due to potential COVID-19 symptoms is **not** sufficient on its own.

## **7. Accommodation and Accessibility**

### **Religious Accommodation**

When a course requirement conflicts with a religious holiday that requires an absence from the University or prohibits certain activities, students should request accommodation for their absence in writing at least two weeks prior to the holiday to the course instructor and/or the Academic Counselling office of their Faculty of Registration. Please consult University's list of recognized religious holidays (updated annually) at

<https://multiculturalcalendar.com/ecal/index.php?s=c-univwo>.

### **Accommodation Policies**

Students with disabilities work with Accessible Education (formerly SSD) providing recommendations for accommodation based on medical documentation or psychological and cognitive testing. The policy on Academic Accommodation for Students with Disabilities can be found at:

[https://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/Academic Accommodation\\_disabilities.pdf](https://www.uwo.ca/univsec/pdf/academic_policies/appeals/Academic_Accommodation_disabilities.pdf),

## 8. Academic Policies

The website for Registrarial Services is <http://www.registrar.uwo.ca>.

In accordance with policy available at

[https://www.uwo.ca/univsec/pdf/policies\\_procedures/section1/mapp113.pdf](https://www.uwo.ca/univsec/pdf/policies_procedures/section1/mapp113.pdf),

the centrally administered e-mail account provided to students will be considered the individual's official university e-mail address. It is the responsibility of the account holder to ensure that e-mail received from the University at his/her official university address is attended to in a timely manner.

Tutorial tests, midterms, and final exams in this course are **open-book and open-notes**. However, **no electronic devices** (i.e. no pads, no laptops, no mobile phones, etc.) will be permitted on tutorial tests in classroom, midterms, and final exams **except for a non-programmable pocket calculator**. Mobile phones cannot be used on tutorial tests in classroom, midterms, and exams, not even as watches and/or calculators, and must be turned off during the entire time of tests, midterms and final exams.

**Scholastic offences** are taken seriously, and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site:

[http://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/scholastic\\_discipline\\_undergrad.pdf](http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf).

All required papers may be subject to submission for textual similarity review to the commercial plagiarism detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in 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>).

In the event of a COVID-19 resurgence during the course that necessitates the course delivery moving away from face-to-face interaction, and in any other similar circumstances that will require to do so, tests and examinations in this course will be conducted using a remote proctoring service **if and when the course instructor deems it appropriate**. By taking this course, you are consenting to the use of remote proctoring software and acknowledge that you may be required to provide **personal information** (including some biometric data) and the session may be **recorded**. Completion of this course may require you to have a reliable internet connection and a device that meets the technical requirements for these services. More information about this remote proctoring service, including technical requirements, is available on Western's Remote Proctoring website at:

<https://remoteproctoring.uwo.ca>.

## 9. Support Services

Please visit the Science & Basic Medical Sciences Academic Counselling webpage for information on adding/dropping courses, academic considerations for absences, appeals, exam conflicts, and many other academic related matters: <https://www.uwo.ca/sci/counselling/>.

Please contact the course instructor if you require lecture or printed material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Accessible Education at (519) 661-2147 if you have any questions regarding accommodations.

Learning-skills counsellors at the Student Development Centre (<http://www.sdc.uwo.ca>) are ready to help you improve your learning skills. They offer presentations on strategies for improving time management, multiple-choice exam preparation/writing, textbook reading, and more. Individual support is offered throughout the Fall/Winter terms in the drop-in Learning Help Centre, and year-round through individual counselling.

Students who are in emotional and/or mental distress should refer to Mental Health@Western (<http://www.health.uwo.ca/mentalhealth>) for a complete list of options about how to obtain help.

Additional student-run support services are offered by the USC, <http://westernusc.ca/services>.

## Appendix A

### Course Schedule (Indicative, and subject to change)

Ch. 6	Jan 08 (M) Jan 10 (W)	Course Introduction (L1). Calculus of variations: Euler's equations (1 <sup>st</sup> and 2 <sup>nd</sup> form) (L2)
	<i>Jan 12 (F)</i>	<i>Tutorial 0 ("practice", not graded)</i>
Ch. 6 and 7	Jan 15 (M) Jan 17 (W)	Euler's equations when constraints are imposed Lagrange equations of motion (L3)
	<i>Jan 19 (F)</i>	<i>Tutorial 1</i>
Ch. 7	Jan 22 (M) Jan 24 (W)	Equivalence of Newtonian and Lagrangian mechanics Energy in Lagrangian mechanics (L4)
	<i>Jan 26 (F)</i>	<i>Tutorial 2</i>
Ch. 7	<b>Jan 29 (M)</b>	<b>No class on Jan 29</b>
	Jan 31 (W)	Hamilton equations of motion & Hamiltonian dynamics (L5)
	<i>Feb 2 (F)</i>	<i>Tutorial 3</i>
Ch. 8	Feb 5 (M) Feb 7 (W)	Canonical transformations of the Hamiltonian Hamilton-Jacobi equations (L6)
	<i>Feb 9 (F)</i>	<i>Tutorial 4</i>
Ch. 9	Feb 12 (M) Feb 14 (W)	Central force motion: angular momentum Central force motion: the Kepler's problem (L7)
	<i>Feb 16 (F)</i>	<i>Tutorial 5</i>
Ch. 10	<b>Feb 26 (M)</b>	<b>Midterm exam (930-1130)</b>
	Feb 28 (W)	Scattering problems (L7)
	<i>Mar 01 (F)</i>	<i>Tutorial 6</i>
Ch. 10	Mar 4 (M) Mar 6 (W)	Centre of mass Collisions (L8)
	<i>Mar 8 (f)</i>	<i>Tutorial 7</i>
Ch. 11	Mar 11 (M) Mar 13 (W)	Motion in noninertial frames (L9) Coriolis Forces
	<i>Mar 15 (F)</i>	<i>Tutorial 8</i>
Ch. 12 (+review of Ch. 3)	Mar 18 (M) Mar 20 (W)	Rigid bodies (L10) Tensor of Inertia
	<i>Mar 22 (F)</i>	<i>Tutorial 9</i>
Ch. 13	Mar 25 (M) Mar 27 (W)	Rigid bodies II (L11) Eulerian angles, spinning tops
	<b>Mar 29 (F)</b>	<b>No class on Mar 29 (Good Friday)</b>
Ch. 13	Apr 1 (M) Apr 3 (W)	"Jerky" mechanics (L12) (what would happen if $F = mx'' + nx'''$ instead of just $F = mx''$ )
	<i>Apr 5 (F)</i>	<i>Tutorial 10</i>
	Apr 8 (M)	Course Review

\*\* Chapters and subjects refer to the textbook (Thornton and Marion, see above)

(L1) ... (L12) refer to lecture files "lecture1.pptx" ... "lecture12.pptx" which will be made available on OWL > RESOURCES just prior to the corresponding class.