

**TAM 412: Intermediate Dynamics – Sections C, ONL, Spring 2024**  
**403 B2 Engineering Hall, MW 3-4:50 pm**  
**Canvas course web site: <https://canvas.illinois.edu/courses/43877>**

Instructor: Alexander F. Vakakis, [avakakis@illinois.edu](mailto:avakakis@illinois.edu)  
Office hours (3003 MEL): *Tuesdays 12noon-1pm* and *Thursdays 12noon-1pm*  
TA: Josh Tempelman, [jrt7@illinois.edu](mailto:jrt7@illinois.edu)  
Office hours (TA-Study rooms at LL of LuMEB): *Thursdays 4-5pm, Fridays 4-5pm*

Textbook: L. Meirovitch., 2001, *Fundamentals of Vibrations*, Waveland Press (*recommended – not required*).

Course resources:

- *Matrix Computations*, G.H. Golub, C.F. van Loan, The John Hopkins University Press, 1996.  
- *Fundamentals of Structural Dynamics*, R.R. Craig Jr, A.J. Kurdila, J. Wiley and Sons, 2006.  
Class lectures, reading material, and handouts will be posted on Canvas by the Instructor.

Accommodations for Disabilities: To obtain disability-related accommodations for this class, students with disabilities are advised to contact the instructor and the Division of Rehabilitation-Education Services (DRES) (<http://www.disability.illinois.edu/>) as soon as possible (see additional information below).

Equity and Diversity: This is an equal opportunity classroom environment. We value the diversity represented by the participants in this course. Our diversity is a primary source of ideas and perspectives. As you work through the course, practice using this diversity to your advantage.

Attendance policy (for on campus students): Attendance of lectures is mandatory. Missing a total of four or more lectures during the semester will result in no credit in class participation. Please make sure to sign in your name in the attendance sheet at the beginning of each lecture.

Grade breakdown: Class participation 5%, Midterm Exam: 20%, Final Exam: 50%, Homework: 25%

Homework Policy: There will be a series of homework assignments which the Instructor will be posting on the course's space on Canvas. Homework solutions will be due in class on the specified dates. Due to logistical constraints and reasons of fairness to your fellow students, late homeworks won't be accepted and won't be assigned any credit, unless there is a documented serious reason (e.g., medical). You are encouraged to collaborate and cooperate with your peers on these assignments, however, you should hand in your own original HW. Evidence of plagiarism will be dealt with seriously. To get full credit your HW solutions please need to show great attention to detail, show all steps of your derivations and written in a systematic and clear way; moreover, if the tasks involve numerical computations you'll need to include a list of your codes, and the computer-generated plots need to show attention to detail, e.g., there should be labels on the axes, correct depiction of vectors, etc.

Exams: Midterm Exam: *Thursday, March 7, 7-9pm*, 4100 LuMEB  
Final Exam: TBA

Please mark your calendars and plan accordingly, since due to logistical constraints and reasons of fairness to your fellow students no conflict exams will be given; the only exceptions could be for serious reasons (e.g., medical) supported by relevant documentation.

## Tentative List of Topics to be Covered

This course will focus on analytical dynamics and vibrations of mechanical systems. The course combines theoretical treatment of concepts and techniques with applications in mechanics and engineering. The course will consist of the following basic thematic units.

*Vectorial and Analytical Mechanics.* Newton's laws, work and energy, dynamics of systems of particles, dynamics of rigid bodies, generalized coordinates, the principle of virtual work, holonomic and non-holonomic constraints, D'Alembert's principle, Lagrange's equations, a brief introduction to variational methods in Mechanics, Hamilton's generalized principle, derivation of Lagrange's equations of systems with or without constraints, applications in mechanics and engineering

*Vibrations of Single-Degree-of-Freedom Systems.* The undamped harmonic oscillator, effect of viscous damping and Hamiltonian formulation, effect of dry friction, response to harmonic and periodic excitations, resonance, base excitation, vibration measurement equipment, structural damping and non-causality effects.

*Vibrations of Multi-Degree-of-Freedom Systems.* Linearization of Lagrange's equations, Betti-Maxwell's reciprocity theorem, vibrations of natural and non-natural systems, dynamics in moving frames, Foucault's pendulum, the eigenvalue problem and normal modes, orthogonality of vibration modes and modal analysis for systems with distinct or repeated eigenvalues, bi-orthogonality conditions for non-symmetric matrices and the bi-expansion theorem, solution of the initial value (Cauchy) problem, perturbation theory for eigenvalue problems with distinct, close or repeated eigenvalues, matrix iteration methods, special techniques for the eigenvalue problem

*Special Topics in Dynamics.* Introduction to nonlinear perturbation theory, nonlinear forced and internal resonances, parametric excitations and parametric resonances.

## Anti-Racism and Inclusivity Statement

There is the need to raise awareness of the ongoing threat of bias and racism and of the need to take personal responsibility in creating an inclusive learning environment.

The Grainger College of Engineering is committed to the creation of an anti-racist, inclusive community that welcomes diversity along a number of dimensions, including, but not limited to, race, ethnicity and national origins, gender and gender identity, sexuality, disability status, class, age, or religious beliefs. The College recognizes that we are learning together in the midst of the Black Lives Matter movement, that Black, Hispanic, and Indigenous voices and contributions have largely either been excluded from, or not recognized in, science and engineering, and that both overt racism and micro-aggressions threaten the well-being of our students and our university community.

The effectiveness of this course is dependent upon each of us to create a safe and encouraging learning environment that allows for the open exchange of ideas while also ensuring equitable opportunities and respect for all of us. Everyone is expected to help establish and maintain an environment where students, staff, and faculty can contribute without fear of personal ridicule, or intolerant or offensive language. If you witness or experience racism, discrimination, micro-aggressions, or other offensive behavior, you are encouraged to bring this to the attention of the course director if you feel comfortable. You can also report these behaviors to the Bias Assessment and Response Team (BART) (<https://bart.illinois.edu/>). Based on your report, BART members will follow up and reach out to students to make sure they have the support they need to be healthy and safe. If the reported behavior also violates university policy, staff in the Office for Student Conflict Resolution may respond as well and will take appropriate action.

## **Sexual Misconduct Reporting Obligation**

The University of Illinois is committed to combating sexual misconduct. Faculty and staff members are required to report any instances of sexual misconduct to the University's Title IX Office. In turn, an individual with the Title IX Office will provide information about rights and options, including accommodations, support services, the campus disciplinary process, and law enforcement options.

A list of the designated University employees who, as counselors, confidential advisors, and medical professionals, do not have this reporting responsibility and can maintain confidentiality, can be found here: [wecare.illinois.edu/resources/students/#confidential](http://wecare.illinois.edu/resources/students/#confidential).

Other information about resources and reporting is available here: [wecare.illinois.edu](http://wecare.illinois.edu).

## **Academic Integrity**

The University of Illinois at Urbana-Champaign Student Code should also be considered as a part of this syllabus. Students should pay particular attention to Article 1, Part 4: Academic Integrity. Read the Code at the following URL: <http://studentcode.illinois.edu/>.

Academic dishonesty may result in a failing grade. Every student is expected to review and abide by the Academic Integrity Policy: <https://studentcode.illinois.edu/article1/part4/1-401/>. Ignorance is not an excuse for any academic dishonesty. It is your responsibility to read this policy to avoid any misunderstanding. Do not hesitate to ask the instructor(s) if you are ever in doubt about what constitutes plagiarism, cheating, or any other breach of academic integrity.

## **Religious Observances**

Illinois law requires the University to reasonably accommodate its students' religious beliefs, observances, and practices in regard to admissions, class attendance, and the scheduling of examinations and work requirements. You should examine this syllabus at the beginning of the semester for potential conflicts between course deadlines and any of your religious observances. If a conflict exists, you should notify your instructor of the conflict and follow the procedure at <https://odos.illinois.edu/community-of-care/resources/students/religious-observances/> to request appropriate accommodations. This should be done in the first two weeks of classes.

## **Disability-Related Accommodations**

To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, you may visit 1207 S. Oak St., Champaign, call 333-4603, e-mail [disability@illinois.edu](mailto:disability@illinois.edu) or go to <https://www.disability.illinois.edu>. If you are concerned you have a disability-related condition that is impacting your academic progress, there are academic screening appointments available that can help diagnosis a previously undiagnosed disability. You may access these by visiting the DRES website and selecting "Request an Academic Screening" at the bottom of the page.

## **Family Educational Rights and Privacy Act (FERPA)**

Any student who has suppressed their directory information pursuant to Family Educational Rights and Privacy Act (FERPA) should self-identify to the instructor to ensure protection of the privacy of their attendance in this course. See <https://registrar.illinois.edu/academic-records/ferpa/> for more information on FERPA.

## Run > Hide > Fight

Emergencies can happen anywhere and at any time. It is important that we take a minute to prepare for a situation in which our safety or even our lives could depend on our ability to react quickly. When we're faced with almost any kind of emergency – like severe weather or if someone is trying to hurt you – we have three options: Run, hide or fight.



### Run

**Leaving the area quickly is the best option if it is safe to do so.**

- ▶ Take time now to learn the different ways to leave your building.
- ▶ Leave personal items behind.
- ▶ Assist those who need help, but consider whether doing so puts yourself at risk.
- ▶ Alert authorities of the emergency when it is safe to do so.



### Hide

**When you can't or don't want to run, take shelter indoors.**

- ▶ Take time now to learn different ways to seek shelter in your building.
- ▶ If severe weather is imminent, go to the nearest indoor storm refuge area.
- ▶ If someone is trying to hurt you and you can't evacuate, get to a place where you can't be seen, lock or barricade your area if possible, silence your phone, don't make any noise and don't come out until you receive an Illini-Alert indicating it is safe to do so.



### Fight

**As a last resort, you may need to fight to increase your chances of survival.**

- ▶ Think about what kind of common items are in your area which you can use to defend yourself.
- ▶ Team up with others to fight if the situation allows.
- ▶ Mentally prepare yourself – you may be in a fight for your life.

Please be aware of people with disabilities who may need additional assistance in emergency situations.

## Other resources

- ▶ [police.illinois.edu/safe](https://police.illinois.edu/safe) for more information on how to prepare for emergencies, including how to run, hide or fight and building floor plans that can show you safe areas.
- ▶ [emergency.illinois.edu](https://emergency.illinois.edu) to sign up for Illini-Alert text messages.
- ▶ **Follow the University of Illinois Police Department** on Twitter and Facebook to get regular updates about campus safety.