Carleton University
Department of Mechanical and Aerospace Engineering
MECH 5505 (MCG 5355): Theory of Stability and Application

Course Outline, Fall 2021

Instructor

Prof. Fred F. Afagh, Room 4309 CB; Tel. ext. 5705;
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Schedule:

MECH 5505 (MCG 5355): W 11:35-14:25 Nicol Bldg. 3020

Important Notices

1) This course will be offered using a HyFlex (Hybrid-Flexible) model. This means that you will have the option to attend the lectures either in person in the class or via Zoom. All lectures will also be video-taped.

2) Please be aware that by registering in this course you acknowledge that tests and examinations in this course will use a remote proctoring service provided by Scheduling and Examination Services (SES). You can find more information at https://carleton.ca/ses/e-proctoring/. These online proctoring tools could require you to identify yourself via webcam. Additionally, while you are completing a proctored exam, your activities will be monitored. This could include direct observation via webcam and through the use of screen recording software.

3) Any evidence of violation of Academic Integrity Policy of the Carleton University in especially during an exam or a quiz will be treated seriously. Please review this policy thoroughly at:

4) Since due to possible future development(s) of COVID 19 Pandemic the conditions of the delivery of this course may change requiring adjustments to the structure, delivery and evaluation of the course, the terms outlined below should be considered as conditional. Any such changes will be announced via the course site on BrightSpace platform.
Course Objective

- To introduce the general theory of system stability with specific attention to stability of dynamic mechanical systems.
- Fundamentals of modelling the motion of dynamic mechanical systems will be introduced and reviewed
- The fundamental theorems of stability such as Direct Liapunov method, stability in first approximation, Hurwitz’s criterion will also be presented.

Lectures Outline:


2. Fundamentals and common characteristics of stability definitions: equilibrium and asymptotic stability; stability in the large; conditional stability; equilibrium and equations of perturbed motion.

3. The direct Liapunov method for autonomous systems: Sylvester’s criterion; Liapunov functions; Liapunov’s theorem of stability; asymptotic stability; theorems of instability; methods to obtain Liapunov functions; applications.

4. Equilibrium states and stationary motions of conservative systems: Lagrange’s Theorem and its invertibility; cyclic coordinates; the Routh transform; stability of stationary motion; applications.

5. Stability in first approximation: general formulation of the problem; theorems of stability in first approximation; Hurwitz’s criterion; applications.

6. Linear autonomous systems: matrices and matrix operations; elementary divisors; stability of autonomous linear systems; stability of resonance.

7. Direct Liapunov method and stability of control systems: governing differential equations of perturbed motion of automatic control systems; canonical equations of perturbed motion; Liapunov functions; absolute stability.

8. The frequency method of stability analysis: transfer functions and frequency characteristics; Nyquist stability criterion; nonlinear systems; applications.
Suggested References: (on reserve at Carleton University Library - depending on the accessibility of library services)

4. Introduction to Dynamics and Control, by: Leonard Meirovitch, John Wiley and Sons, 1985

Course Evaluation:

Midterm Examination:-------------------------------------40%
Open Notes only
Wednesday Oct 20, 2021; 11:35-13:05

Final Examination:--------------------------------------60%
Open Notes/Assignments only
As scheduled by Examinations Scheduling Office or determined by general consensus of the class

Notes:

- The final examination is for evaluation purposes only and will not be returned to students.
- Assignment problems will be posted on Brightspace

Additional Information

- This course delivery type will be

IN-PERSON SECTION WITH FLEXIBLE ONLINE/ON CAMPUS ATTENDANCE (HYFLEX). In this Hybrid-flexible (HyFlex) model, a single section is offered simultaneously to both on campus and students studying online by the same instructor. Students may choose how they will attend each class, either in-person on campus or online via Zoom. Students attending online may actively participate in the course. Instructors may choose to record their course, but this is solely at their discretion. Note: online and on campus students are part of the same section.
• Office hour meetings will be with appointments through e-mail.
• Students must pass the final examination to pass the course.
• Due to a new regulation recently passed by the University Senate, students who withdraw from any course after the full fee adjustment date will have a WDN for that course appear on their official and unofficial Carleton University transcripts.

Academic Accommodation

You may need special arrangements to meet your academic obligations during the term. Carleton is committed to providing academic accessibility for all individuals. Please review the process for academic accommodation requests at

https://students.carleton.ca/course-outline/

For an accommodation request, the processes are as follows:

Fred F. Afagh
September 2021