MECH 5501: ADVANCED DYNAMICS

Tentative Course Outline – Winter 2017

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Overview

The focus of this course is on developing and using equations of motion for dynamic systems to address engineering problems. A brief historical perspective is first provided. Next, methods for developing governing equations of motion for discrete systems are developed. Newton-Euler and Lagrangian formulations are emphasized with only brief introduction given to other methods. Attention next focuses on using the resulting equations of motion. Topics covered include extraction of dynamic equilibrium configurations, linear stability analysis, frequency response analysis, and generation of transient time-domain responses using both direct numerical integration and modal superposition techniques. Next, an introduction to classical methods for deriving equations of motion for continuous systems motivates a more thorough treatment of the finite element method demonstrated using beam elements. Widely used numerical methods associated with course topics will be discussed. Time permitting, the course concludes with an introduction to advanced topics such as simulation, multibody dynamics, and/or nonlinear phenomena. Class examples and assignment problems will be drawn from a variety of engineering applications and current research areas.

Outline

1. Historical perspective on major developments in dynamics

2. Formulation of governing equations of motion for discrete systems
   2.1 Newton-Euler equations
   2.2 Lagrange's equation
   2.3 Alternative formulations (e.g., Hamilton, Kane, d'Alembert)

3. Application of governing equations
   3.1 Equilibrium
   3.2 Linear stability
   3.3 Frequency response
   3.4 Transient time-domain response

4. Formulation and solution of equations for continuous systems
   4.1 Classical methods
   4.2 Finite element approach

5. Advanced topics (if time permits)

Recommended Texts

Essential course material will be presented in lectures. If students wish to purchase a reference book, one of the following is recommended.

1. J. H. Ginsberg, Advanced Engineering Dynamics, 2nd ed., Cambridge, 1998.

2. S.-J. Ying, Advanced Dynamics, AIAA, 1997.

3. H. Baruh, Analytical Dynamics, McGraw-Hill, 1999.

4. T. D. Burton, Introduction to Dynamic Systems Analysis, McGraw-Hill, 1994.

Additional References

1. D. T. Greenwood, Classical Dynamics, Dover, 1997 (orig. 1971).

2. H.C. Corben and P. Stehle, Classical Mechanics, 2nd ed., Dover, 1994 (orig. 1950).

3. J. H. Ginsberg, Mechanical and Structural Vibrations Theory and Applications, John Wiley & Sons, 2001.

4. H. Goldstein, Classical Mechanics, Second Ed., Addison-Wesley, 1980.

5. B. J. Torby, Advanced Dynamics for Engineers, CBS College Publishing, 1984.

6. J. S. Torok, Analytical Mechanics, John Wiley & Sons, 2000.

7. J. H. Williams, Fundamentals of Applied Dynamics, John Wiley & Sons, 1996.

8. K. J. Bathe, Finite Element Procedures, Prentice-Hall, 1996.

9. R. D. Cook, Finite Element Modeling for Stress Analysis, John Wiley & Sons, 1995.

10. M. Paz, Structural Dynamics Theory and Computation, Van Nostrand Reinhold, 1991.

11. J. L. Meriam and L. G. Kraige, Dynamics, Fourth Ed., John Wiley & Sons, 1998.

12. R. C. Hibbeler, Engineering Mechanics: Dynamics, Ninth Ed., Prentice Hall, 2001.

13. B. I. Sandor, Engineering Mechanics: Dynamics, Prentice Hall, 1983.

Evaluation

Course evaluation will be based on two projects (30%), completion of a series of unmarked assignments (10%), and a final exam (60%). The final exam is for evaluation purposes only and will not be returned to students.

Academic Accommodation

You may need special arrangements to meet your academic obligations during the term. For an accommodation request the processes are as follows:

Pregnancy obligation: write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details see the Student Guide (http://www2.carleton.ca/equity/accommodation/academic/students/).

Religious obligation: write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details see the Student Guide (http://www2.carleton.ca/equity/accommodation/academic/students/).

Academic Accommodations for Students with Disabilities: The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your Letter of Accommodation at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website for the deadline to request accommodations for the formally-scheduled exam (if applicable).