Math 115 - Mathematical modeling

Spring 2020 - Section 44740

Lecturer	Louis Komzsik
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Lectures	M-W-F 9:00-9:50, MTSB 122
Discussions	Tu-Th, 9:00-9:50, MTSB 122

Scope

Introduction to mathematical modeling by using a calculus of variations foundation foundation. After introducing the basic tools of calculus of variations we will derive, review and analyze classical models for gravitational, orbital motions, and simple mechanical systems. In the second half we will focus on creating mathematical models for physical and engineering phenomena, such as buckling and bending, vibrations and waves, dissipation and diffusion. Finally models from biology and economy will be discussed.

Recommendation

Attending the lectures is highly recommended as they are organized to provide a foundation for future modeling activities in your respective areas of interest and details not covered in the text will be presented.

Text book

Komzsik L.: Applied calculus of variations for engineers, 3rd edition; Taylor and Francis, 2019

Prerequisite classes

Linear algebra (3A), ordinary differential equations (3D), partial differential equations (112).

Assigments, testing and grading

There will be two quizzes ($2 \cdot 20$), a midterm test (25) and final test (35) totaling of 100 points. Wireless equipment (cellphones, tablets) cannot be used in exams, but a 4 by 6 formula card with formulae on both sides is allowed for each of the tests. There will be no make-up opportunities unless

justified by a reason accepted by the department. Grading is on the standard department scale of 90, 80, 70, 60 % for A, B, C, D.

Rules and regulations

All school rules regarding adds, drops and waitlists are applicable. The academic integrity policies of UCI will be enforced and students found in violation will be subject to penalties ranging from a grade of F to the possibility of suspension or probation.

Schedule

Week	Lecture	Topic	Text
1	1	Introduction to mathematical modeling	
	2	Introduction to calculus of variations	1.4.1, 2.3.1
	3	Modeling with calculus of variations	1.4.1, 2.3.1
2	4	Multivariate functionals	3.1-3.2
	5	Higher order derivatives	4.1-4.2
	6	Constraint on derivatives	4.3-4.4
3	7	Hamilton's principle and Newton's law	10.2, 10.3.2
	8	Newton's model of gravity	2.3.2
	9	Dynamic gravitational phenomena	1.4.4
4	10	Orbital motions	10.5
	11	Angular momentum	10.5.1
	12	The 3-body problem	10.5.2
5	13	Lagrange's equations of motion	10.4
	14	Modeling of mechanical systems	10.4.1
	15	Midterm test	
6	16	Modeling of elasticity	12.2
	17	The buckling phenomenon	11.4
	18	The bending phenomenon	11.3
7	19	Oscillating phenomena	11.1
	20	The wave equation	11.2
	21	Dimensional analysis of wave equation	11.4.1, 11.5.1
8	22	The diffusion phenomenon	11.6
	23	Modeling of heat conduction	11.6
	24	Numerical analysis of heat solution	11.6.1
9	25	Linear population models of biology	* 11.1
	26	Nonlinear (logistic) model	* 11.2
	27	Memorial Day Holiday	
10	28	Modeling financial growth	* 13.1-2
	29	The amortization model	
	30	Review	

* sections from Wan, F. Y. M.: Mathematical models and their analysis, SIAM, 2018