University of Alberta
Department of Mathematical & Statistical Sciences

MATH538: Techniques of Applied Mathematics
Winter 2018

Instructor:	Prof. Rouslan Krechetnikov
Office:	3-267 CCIS
Phone:	(780) 492-1926
E-mail:	krechet@ualberta.ca
Personal Web Page:	http://www.math.ualberta.ca/∼rkrechet/

Office Hours: Tue 1:00-3:00 pm

Lecture Room & Time: Tue/Thu 11:00-12:20 at CAB 273,
beginning with January 9 and ending on April 12

Course Web Page: www.math.ualberta.ca/∼ rkrechet/files/teaching/current/

Course Description:
Regular and singular perturbations. Complex variable analysis. Integral transforms. WKBJ and multiple scales analysis. Renormalization techniques. Asymptotic analysis of integrals: steepest descent and stationary phase methods. Modern linear and nonlinear stability theory. Hamiltonian perturbation techniques. Center-manifold theory. Applications to ODEs and PDEs.

Course Prerequisites:
MATH 438. Also basic knowledge in multivariable calculus, real and complex analyses, intermediate ODEs and PDEs is expected. It is important to prepare yourself for this course through a review of the prerequisite material. Students who do not have the required prerequisites at the time of taking this course should not expect supplementary professorial tutoring from the instructor.

Course Objectives and Expected Learning Outcomes:
Course goals are to (1) introduce to the basic ideas of the classical as well as modern asymptotic and perturbation analyses via intuitive and physically motivated examples, and then (2) build up a coherent methodology for solving research-type problems.

Suggested Textbooks:

- J.W. Brown and R.V. Churchill, Complex variables and applications, McGraw-Hill 2002

- M. Van Dyke, Perturbation methods in fluid mechanics, Parabolic Press 1975

- M.H. Holmes, Introduction to Perturbation Methods, Springer 1995

- C.M. Bender and S.A. Orszag, Advanced Mathematical Methods for Scientists and Engineers, McGraw-Hill 1978

- J. Kevorkian, J.D. Cole, Perturbation Methods in Applied Mathematics, Springer 1996

- J. Carr, Applications of Centre Manifold Theory, Springer 1982

- G.I. Barenblatt, Scaling, Self-similarity, and Intermediate Asymptotics, Cambridge University Press 1996

- L. Debnath and D. Bhatta, Integral Transforms and Their Applications, Taylor & Francis 2007

Grade Evaluation:
The course mark will be calculated based on the following breakdown:

Course Component	Weight of Total Mark	Due date
Assignments	30%	1/30, 2/27, 3/27 at 11:00
Midterm	20%	3/1
Final assignment	20%	4/10 at 11:00
Final Exam	30%	TBD

The final letter grade will be determined from the course mark as follows. An overall course mark of 50% or more guarantees a passing grade of at least D. An overall course mark of 90% or more guarantees a grade of at least A.

Grades are unofficial until approved by the Department and/or Faculty offering the course.

Assignments:
There will be four assignments to be posted on the web on January 16 (due January 30), February 13 (due February 27), March 13 (due March 27), and March 27 (due April 10).

Policy: collaboration on homework assignments is allowed. However all solutions that are handed in should reflect your understanding of the subject matter at the time of writing. All written work should be of the individual student. The homeworks are due by 11:00 (right before the class) on Tuesday's lecture. The final assignment is due on April 10 by 11:00 (right before the class). No late homework papers will be accepted.

Lecture Schedule & Assigned Readings:

Week	Dates	Topic	Readings
1	January 9	Order symbols and uniformity	KC §1, H §1
	January 11	Asymptotic expansions of functions and algebraic equations	KC §1, H §1
2	January 16	Complex variables: analytic functions	BC §§1-3
	January 18	Complex variables: integrals and series	BC §§4-5
3	January 23	Complex variables: residues	§§6-7
	January 25	Fourier transform: theory	DB §2
4	January 30	Discussion of HW1	
	February 1	Fourier transform: applications	DB §2
5	February 6	Laplace transform: theory	DB §3
	February 8	Laplace transform: applications	DB §4
6	February 13	Asymptotic approximation of integrals: stationary phase	H §A.2, BO §6.1-6.5
	February 15	Asymptotic approximation of integrals: steepest descent	BO §6.6
7	February 20	Reading week	
	February 22	Reading week	
8	February 27	Discussion of HW2	
	March 1	Midterm	
9	March 6	Regular perturbations for ODEs: strained coordinates/multiple scales	BO §7.3, H §3, KC §4
	March 8	Singular perturbations for ODEs: asymptotic matching principles	H §2, BO §7.4
10	March 13	Singular perturbations for ODEs: asymptotic matching principles	H §2, BO §7.4
	March 15	WKBJ method	H §4, BO §10
11	March 20	Method of averaging and Hamiltonian perturbations	
	March 22	Stability theory and center manifolds	H §6, C §1
12	March 27	Discussion of HW3	
	March 29	Renormalization techniques, intermediate asymptotics	B
13	April 3	Singular perturbations for PDEs: theory	KC §3
	April 5	Singular perturbations for PDEs: applications	H §2.6, BO §9
14	April 10	Singular perturbations for PDEs: applications	H §2.6, BO §9
	April 12	Discussion of HW4	

Exam Aids:
closed-book, no collaboration is allowed; the use of calculators and computers is not permitted in the examinations.

Excused Absence Where the Cause is Religious Belief:
For an excused absence where the cause is religious belief, a student must contact the instructor(s) within two weeks of the start of Fall or Winter classes to request accommodation for the term (including the final exam, where relevant). Instructors may request adequate documentation to substantiate the student request.

Missed Term Work
A student who cannot write a midterm or complete a term assignment due to incapacitating illness, severe domestic affliction or other compelling reasons can apply for an excused absence. To apply for an excused absence, a student must inform the instructor within two working days following the scheduled date of the term work or term exam missed, or as soon as the student is able, having regard to the circumstances underlying the absence. In all cases, instructors may request adequate documentation to substantiate the reason for the absence at their discretion.

There will be no make-up/deferred midterm exam. In case when a student misses an exam due to a substantiated reason, the weight of the midterm will be transferred to the final.

An excused absence is a privilege and not a right; there is no guarantee that an absence will be excused. Misrepresentation of Facts to gain an excused absence is a serious breach of the *Code of Student Behaviour.*

Missed Final Examination:
A student who cannot write the final examination due to incapacitating illness, severe domestic affliction or other compelling reasons can apply for a deferred final examination. Students who failed at the start of term to request exam accommodations for religious beliefs are expected to follow the normal deferred final examination process. Such an application must be made to the student's Faculty office within two working days of the missed examination and must be supported by a Statutory Declaration (in lieu of a medical statement form) or other appropriate documentation (Calendar section 23.5.6). Deferred examinations are a privilege and not a right; there is no guarantee that a deferred examination will be granted. Misrepresentation of Facts to gain a deferred examination is a serious breach of the *Code of Student Behaviour.*

Re-examination:
A student who writes the final examination and fails the course may apply for a re-examination. Re-examinations are rarely granted in the Faculty of Science. These exams are governed by University (Calendar section 23.5.5) and Faculty of Science Regulations (Calendar section 192.5.3). Misrepresentation of Facts to gain a re-examination is a serious breach of the *Code of Student Behaviour.*

STUDENT RESPONSIBILITIES

Academic Integrity:
The University of Alberta is committed to the highest standards of academic integrity and honesty. Students are expected to be familiar with these standards regarding academic honesty and to uphold the policies of the University in this respect. Students are particularly urged to familiarize themselves with the provisions of the *Code of Student Behaviour* (online at www.governance.ualberta.ca) and avoid any behaviour which could potentially result in suspicions of cheating, plagiarism, misrepresentation of facts and/or participation in an offence. Academic dishonesty is a serious offence and can result in suspension or expulsion from the University.

All forms of dishonesty are unacceptable at the University. Any offense will be reported to the Senior Associate Dean of Science who will determine the disciplinary action to be taken. Cheating, plagiarism and misrepresentation of facts are serious offenses. Anyone who engages in these practices will receive <u>at minimum</u> a grade of zero for the exam or paper in question and no opportunity will be given to replace the grade or redistribute the weights. As well, in the Faculty of Science the sanction for **cheating** on any examination will include **a disciplinary failing grade** (NO EXCEPTIONS) and senior students should expect a period of suspension or expulsion from the University of Alberta.

Exams:
Your student photo I.D. is required at exams to verify your identity. Students will not be allowed to begin an examination after it has been in progress for 30 minutes. Students must remain in the exam room until at least 30 minutes has elapsed. Electronic equipment cannot be brought into examination rooms.

Cell Phones:
Cell phones are to be turned off during lectures, labs and seminars. Cell phones are not to be brought to exams.

Audio or Video Recording:
Audio or video recording, digital or otherwise, of lectures, labs, seminars or any other teaching environment by students is allowed only with the prior written consent of the instructor or as a part of an approved accommodation plan. Student or instructor content, digital or otherwise, created and/or used within the context of the course is to be used solely for personal study, and is not to be used or distributed for any other purpose without prior written consent from the content author(s).

Students Eligible for Accessibility-Related Accommodations (students registered with Specialized Support & Disability – SSDS):
Eligible students have both rights and responsibilities with regard to accessibility-related accommodations. Consequently, scheduling exam accommodations in accordance with SSDS deadlines and procedures is essential. Please note adherence to procedures and deadlines is required for U of A to provide accommodations. Contact SSDS (www.ssds.ualberta.ca) for

further information.

Student Success Centre:
Students who require additional help in developing strategies for better time management, study skills, or examination skills should contact the Student Success Centre (2-300 Students Union Building).

Decima Robinson Support Centre for Mathematical & Statistical Sciences:
Students who require additional help with assignments or have questions about the course material in general are encouraged to visit the Decima Robinson Support Centre (528 Central Academic Building). Graduate students will be available to provide one-on-one help. In order to get maximum help during each visit, students are asked to be specific about the problem with which they are seeking help. The Centre is open Monday to Friday, 9:00–15:00.

Policy about course outlines can be found in section 23.4(2) of the University Calendar.

Disclaimer:
Any typographical errors in this Course Outline are subject to change and will be announced in class.

Copyright:
Dr. Rouslan Krechetnikov, Department of Mathematical & Statistical Sciences, Faculty of Science, University of Alberta (2015).