Time Scales Calculus

Spring 2016

MTH 690 Section 201, CRN 4110

**T,R 9:30 – 10:45, DA Lab Smith Hall 614**

(Tentative 1/10/2016)

# Instructor: Dr. Bonita A. Lawrence

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Office Hours: 10:00 A.M. – 11:00 A.M M,W

 11:00 A.M. – 12:00 P.M. T,R

**General University**

**Policies:** By enrolling in this course, you agree to the University Policies presented below. You can read the full text of these important policies online using the following path: Marshall Home Page - Course Catalogs – Undergraduate Catalogs. At this point, choose the catalog you started under (or any catalog after that).

**University Attendance**

 **Policy**: The University Policy that describes excused absences can be found in the Marshall University 2015– 2016 Undergraduate Catalog on pages 85 – 86. Also, see attached document.

**Academic Dishonesty Policy:** I expect you to do your own work. You can certainly discuss the homework problems with your colleagues but what you present to me for any type of assessment must be your own. The University’s policy concerning academic dishonesty can be found in the Marshall University 2015 – 2016 Undergraduate Catalog on pages 71 - 73.

**Policy for Students with Disabilities:** Marshall University is committed to equal opportunity for all. Students with physical, learning or psychological disabilities should contact the Office of Disabled Students Services (DSS) in Prichard Hall Room 117, 304 696-2271 and provide documentation of their disability. After consultation the DSS coordinator will send a letter to the student’s instructors describing the accommodations the student will need. For more information, go to <http://www.marshall.edu/disabled> or call or visit the office in Prichard Hall.

**Affirmative Action Policy:** In the spirit of equal opportunity for all, Marshall University has an Affirmative Action Policy. This can be found in the Marshall University 2015 – 2016 Undergraduate Catalog on p. 68.

**Inclement Weather Policy:** In the event of bad weather that may prevent us from coming to school, Marshall has a policy that describes how things will be handled. (Prior to last year, during my time at Marshall, the University was only shut down for 1.5 days. However, last spring it was more than a week!) The policy can be found on pp. 69 -70 of the Marshall University 2015 – 2016 Undergraduate Catalog.

**Textbook:** Dynamic Equations on Time Scales: An Introduction with Applications

Martin Bohner and Allan Peterson, Birkhauser, Boston.

This is the best book in print for the study of Time Scales Calculus. Although the fundamental theory Time Scale Calculus was developed by Stephan Hilger in his Ph.D. dissertation, this book, known among time scales researchers as “the green book”, is a compilation of research done by many in our field. (Note the list of references in the bibliography!)

**Course Prerequisites:** There is no formal prerequisite for this course. I will assume that you have successfully completed the first course in Advanced Calculus and that you have had a proof techniques course or some experience writing proofs using the commonly used techniques. If this is not the case, please come to talk to me about your previous training.

**Course Objectives:** In E. T. Bell’s book Men of Mathematics, the author states “The major task of mathematics today is to harmonize the continuous and the discrete, to include them in one comprehensive mathematics, and to eliminate obscurity from both.” This book was published in 1937, not that long ago if we consider how long our mathematics has been developing. In the late 1980’s, Dr. Stefan Hilger, in his Ph.D. dissertation, created time scale calculus with the goal of developing a structure to do precisely what Dr. Bell had in mind, unifying and “harmonizing” the discrete and the continuous. We will start with a discussion of the motivation for the development of this field and then move to expanding our ideas of calculus to this new structure.

Success in the course will be measured by your ability to meet the following learning outcomes.

 The ability to

1. Exhibit an understanding of the motivation for this field of study.

Skill Development: Reading assignments and class discussions of the origins of the field that include examples that exhibit a need for these studies. Daily exercises with review the following day.

Assessment: Review of written and oral presentations of examples that show the link that time scales offers in the unification of the discrete and the continuous for depth of understanding.

1. Exhibit an understanding of the relationships between our usual calculus, difference calculus and time scale calculus.

Skill Development: Group discussions (lead by you or one of you colleagues) of definitions and theorems that make up the structure of time scale calculus and their link to calculus on the real line and on a discrete set. Daily homework exercises with review the following day.

Assessment: Review of written and oral analyses of definitions and theorems, complete with proof, that make up the structure of time scale calculus and how they are related to similar results in continuous and discrete dynamics for conceptual understanding and relationships between ideas. Additionally, a similar review of this process in reverse.

1. Construct formal proofs of propositions that address concepts discussed during the course of the semester.

Skill Development: Peer lead discussions that include the construction of proofs of propositions that develop the structure of time scales calculus. Daily homework exercises with review the following day.

Assessment: Review of all written and oral presentations of proofs for proper construction and clarity of fundamental theorems and other propositions discussed during the course of the semester.

1. Present your work clearly and concisely in both written and oral form. Organization and logical flow will be the secrets to success in meeting this objective.

Skill Development: Peer lead discussions that include the creation of clear and concise proofs of stated theorems and propositions. Daily homework exercises with review the following day.

Assessment: Review of all written assignments and oral presentations at the board for clarity and understanding.

1. Recognize and appreciate various approaches to the same problem.

Skill Development: Peer lead discussions of various approaches to the same problem.

Assessment: Review of written and oral exercises requiring the use of more than one approach to the proof of a proposition for proper construction and clarity of process.

**Grading Procedure:** You grade will be calculated using the following percentages:

 Homework: 20%

 Boardwork: 20%

 Midterm Exam: 30%

 Final Exam: 30%

I want to contribute to your quest to be a lifelong learners. To achieve this goal, I have planned the following format for our class time.

This will be a seminar class. You will be learning the material from the green book and discuss the ideas with your peers and me! Each of you will be assigned certain topics that we will use to develop the structure of time scales calculus. You will lead your colleagues and me in interesting and engaging discussions of these topics. (At your level, I find that this is one of the best ways to study mathematics. It will prepare you for advanced studies of mathematics as well as other topics.) I will oversee the discussion and make comments. My comments will have purpose so take note. You will have homework exercises that you will submit regularly.

There will be two tests during the semester, a midterm and a final exam **Tuesday, May 11, 8:00 A.M. – 10:00 A.M**. In the event you are not able to take the exam on the scheduled date because of very serious circumstances, (see http://www.marshall.edu/academic-affairs/policies/) please contact me before the scheduled exam time so that we can plan a time for you to take the exam early.

Your final grade will be determined using the following scale:

90% - 100% A

80% - 89% B

70% - 79% C

60% - 69% D

0% - 59% F

My best advice (It’s free!) is for you to keep up with your reading and homework assignments.

**Attendance Policy:** I expect you to be in class every day you are physically able. It is your responsibility to determine what you missed in the event you are unable to attend class. Requesting notes from a colleague would be wise. I am happy to give you information about any assignments you missed. If you miss an exam or a deadline for an assignment and your absence is excused (See University Attendance Policy, page 1 of this document), you have one week after the date of the excused absence to make it up.

**Have a great semester and let me know if I can help you. If I can’t answer your question, I’ll find someone who can!**

**Cheers!**

**Dr. Lawrence**

**Tentative Program of Events for MTH 690**

**Class Days Topics and Events**

**Week 1 Motivation for the study of Time Scale**

**January 12, 14 Calculus**

 **The structure of a time scale and its operators and related examples**

**Week 2 Induction on a time scale with proof**

**January 19, 21 The definition of the delta derivative and related examples.**

 **Properties of the delta derivative with proof**

**Week 3 Properties of the delta derivative with**

**January 26, 28 proof (cont.)**

**The delta derivative of constant multiples, sums, products and quotients of differentiable functions with proof**

**Week 4 The delta derivative of products**

**February 2,4 and quotients of differentiable functions with proof**

 **Leibniz Formula with proof**

**Week 5 Examples and Applications of functions**

**February 9, 11 on a variety of time scales**

**A biological application and an electrical circuit**

**Week 6 The Cantor Set as a time scale**

**February 16, 18 Regulated and rd-continuous functions and the relationship between them with proof**

**Week 7 Predifferentiable functions**

**February 23, 25 Properties of regulated functions**

**The Mean Value Theorem with proof**

**Week 8 The Mean Value Theorem, cont.**

**March 1, 3 Midterm Exam**

University Class Attendance Policy (Approved by the Faculty Senate, Spring 2015)

Students are expected to attend punctually all class meetings, laboratory sessions and field experiences and to participate in all class assignments and activities as described in the Course Syllabus. Absences are counted from the first class meeting after the student registers. Students registering late are expected to make up all missed assignments in a manner determined by the instructor. Students should be aware that excessive absences, whether excused or unexcused, may affect their ability to earn a passing grade. The instructor of each class shall establish a policy on class attendance and make-up work, and provide the policy to students in the Course Syllabus. This policy must not conflict with university policies, including this policy. Class attendance may be a criterion in determining a student’s final grade in the course if the instructor provides a statement to this effect in the course syllabus.

Students must promptly consult with their instructors about all class absences. Instructors will work with students to identify appropriate documentation and discuss any missed class time, tests, or assignments. A student may not be penalized for an excused absence, provided that the student, in a manner determined by the instructor, makes up the work that has been missed.

Instructors are required to honor University Excused Absences and to provide reasonable and equitable means for students to makeup work missed as a result of those absences. Academic obligations that cannot be made up should be addressed by the course instructor in consultation with the student to ensure that continued enrollment is feasible while there is still an opportunity to drop the course within the established withdrawal period.

This policy excludes academic endeavors that require the completion of a specific number of clock hours, such as clinical experiences, practica, and internships. For those courses, the department chair or program supervisor will determine the maximum number of absences. This policy does not supersede program accreditation requirements.

This policy also excludes laboratory courses that require significant preparation and monitoring. For such courses, departments will determine the minimum number of laboratories a student must complete to pass the course. If a student cannot complete this number of labs, the instructor may recommend that the student withdraw from the class.

If the instructor believes that the number of absences accrued under the terms of this policy (whether excused or unexcused) is such that a student cannot fulfill the learning experience and mastery that a course requires, the instructor may recommend that the student withdraw from the class.