

MAT 353 (Differential Equations) – Fall 2014

Melvin Royer

Description:	A study of ordinary differential equations including classification, theory and solution techniques of linear equations, basic numerical methods, stability, power series solutions, Laplace transform methods, linear systems, and applications.					
Objectives:	<ol style="list-style-type: none"> 1. Classify differential equations by type and explain the significance of the classification. 2. Understand the existence/uniqueness theory of solutions of linear differential equations. 3. Choose and apply appropriate solution techniques to a given ordinary differential equation or system of linear equations. 4. Model and solve selected problems from classical physics using appropriate differential equations. 					
Prerequisites:	<ol style="list-style-type: none"> 1. Calculus II (MAT 254 or equivalent) 2. Linear Algebra (MAT 280 or equivalent; can be taken simultaneously) 					
Materials:	<ol style="list-style-type: none"> 1. Text: <u>Differential Equations, 4/e</u>; Blanchard, Devaney, Hall; Cengage Learning 2011 2. Optional solutions manual available 3. Laptop computer with Maple or graphing calculator (TI-89 recommended) 4. 3-ring binder (for ease of collating notes) 					
Instructor Contacts:	Email: melvin.royer@indwes.edu		Office: Ott Hall 170-D			
	Ph: 677-2987 (Office), 662-1673 (Home, before 9:30 PM)		Website: http://myiwu.indwes.edu			
Office Hours: (or appointment or drop-in)		Monday	Tuesday	Wednesday	Thursday	Friday
	7:50			Office		
	8:55	Office	Office	Office	Office	Office
	10:00	Chapel	Office	Chapel	Office	Chapel
	11:15	MAT-113		MAT-113		MAT-113
	12:20	MAT-353		MAT-353		MAT-353
	1:25		Office		Office	
	2:30	MAT-223		MAT-223		MAT-223
3:35						

Tentative Schedule

Date	Day	Topics	Homework
Sept 1	M	Introduction	1.1 – 4,5,11,12,15
Sept 3	W	Modeling	1.1 – 17,18,21,22
Sept 5	F	Separation of Variables	1.2 – 1,2,5,10,15,20,25,30,35,43
Sept 8	M	Slope Fields	1.3 – 8,9,12,13,16,17
Sept 10	W	Euler's Method	1.4 – 3,5,6,11,14
Sept 12	F	Existence/Uniqueness	1.5 – 2,5,6,12,15,17
Sept 15	M	Equilibria and Phase Line	1.6 – To be determined
Sept 17	W	Equilibria and Phase Line	1.6 –
Sept 19	F	Linear Differential Equations	1.8 –
Sept 22	M	Integrating Factors for Linear Equations	1.9 –
Sept 24	W	Systems and Modeling	2.1 –
Sept 26	F	TEST 1 (Sect 1.1 – 1.9)	
Sept 29	M	Systems and Modeling	2.1 –
Oct 1	W	Direction Fields and Solution Curves	2.2 –
Oct 3	F	Direction Fields and Solution Curves	2.2 –
Oct 6	M	Damped Harmonic Oscillator	2.3 –
Oct 8	W	Analytic Methods for Special Systems	2.4 –
Oct 10	F	Euler's Method for Systems	2.5 –
Oct 13	M	Existence/Uniqueness for Systems	2.6 –
Oct 15	W	Properties of Linear Systems	3.1 –
Oct 17	R	TEST 2 (Sect 2.1 – 2.6)	
Oct 20	M	Properties of Linear Systems	3.1 –
Oct 22	W	Solutions Using Eigenvectors	3.2 –
Oct 24	F	Solutions Using Eigenvectors	3.2 –
Oct 27	M	Phase Planes for Real Eigenvalues	3.3 –
Oct 29	W	Complex Eigenvalues	3.4 –
Oct 31	F	Second Order Linear Equations	3.6 –
Nov 3	M	Second Order Linear Equations	3.6 –
Nov 5	W	Forced Harmonic Oscillators	4.1 –
Nov 7	F	Sinusoidal Forcing	4.2 –
Nov 10	M	Undamped Forcing and Resonance	4.3 –
Nov 12	W	Changing Variables and Linearization	Appendix A –
Nov 14	F	TEST 3 (Sect 3.1–3.4, 3.6, 4.1–4.3)	
Nov 17	M	Equilibrium Points of Nonlinear Systems	5.1 –
Nov 19	W	Equilibrium Points of Nonlinear Systems	5.1 –
Nov 21	F	Laplace Transforms	6.1 –
Nov 24	M	Laplace Transforms	6.1 –
Nov 26	W		THANKSGIVING
Nov 28	F		THANKSGIVING
Dec 1	M	Discontinuous Functions	6.2 –
Dec 3	W	Second Order Equations	6.3 –
Dec 5	F	Review	

Final Exam: Tues Dec 9, 1:00-2:50

Advice & Encouragement:

1. “To every thing there is a season, and a time to every purpose under the heaven . . . a time to keep silent and a time to speak . . .” Eccl 3:1, 7. Usually in a college math course, there is more problem with students keeping silent than with them speaking. Questions are appropriate and appreciated at any time. Giving answers to my questions is also appreciated (unless you just answered the last question; then giving another student the opportunity to answer would be appropriate.)
2. “Consider the path for your feet and let all your ways be established.” Prov 4:26. The schedule shows what we will be covering the next class period. The wise will have previewed the section(s) before coming to class; all the relevant studies in learning show that having some prior knowledge greatly increases the rate and level of comprehension.

Physical preparedness is also important. Your mind resides in a body that was created to sleep, eat nutritious meals, etc. If you are constantly only one step ahead of your next deadline, please consult with your advisor and/or a trusted friend about simplifying your life – a good college experience requires spiritual and academic reflection time.

3. “... Talk about [these commandments] when you sit at home and when you walk along the road, when you lie down and when you get up. Tie them as symbols on your hands and bind them on your foreheads. Write them on the doorframes of your houses and on your gates.” Deut 6:7-9. There is no substitute for consistently doing the homework. Mathematics has many characteristics of a foreign language. Your retention will be much better if you study every day than if you wait until the weekend or just before the exam to try to catch up.
4. “As iron sharpens iron, so one man sharpens another.” Prov 27:17. My observation has been that students perform better (often much better) when they make a serious effort to become part of the class “community.” Academic benefits of studying and socializing together include the following: extra feedback to get your misconceptions corrected, other perspectives on what the important issues really are, emotional energy when preparing for tests, an emergency contact when you forget what assignment is due...
5. “And unto one he gave five talents, to another two, and to another one...” Matt 25:15. There will probably be a wide range of backgrounds and abilities in the class. Be respectful of others. Compete against your own God-given ability, not against each other. Don’t be too embarrassed to ask “stupid” questions.
6. “Therefore, since I myself have carefully investigated everything from the beginning, it seemed good also to me to write an orderly account for you ...” Luke 1:3 Don’t wait until the exam to try to write an orderly account of what you think you know – you need prior feedback. If you don’t understand a homework or practice exam problem, unless I specifically say so, it would be less than wise to ignore it and hope it goes away. Your professors have office hours for a reason, but it must be you who makes the effort to make contact.
7. “For God so loved the world that He gave His one and only Son, that whoever believes in Him shall not perish but have eternal life.” John 3:16. Work hard and take the course seriously, but don’t neglect your spiritual life. Ultimately, the only mathematics you need to know is that God has only one Son, and that there are only two places to spend eternity.

Grading:

1. *Homework / Labs*

Homework will be assigned frequently; unless otherwise stated, my assumption is that you will have it completed by the next class meeting. Working together on the homework is strongly encouraged. Homework will be collected weekly; grading will be based half on quantity (percentage of assignment completed) and half on quality (a few randomly chosen problems graded for correctness). Answers are not sufficient; work must be shown on all problems that cannot be done entirely mentally. Working together on the homework is strongly encouraged; be sure you understand that “working together” and “borrowing solutions” are different activities. We may also have a few computer labs; if so, each will count as a homework score. All homeworks will be worth the same number of points. Your lowest score will be dropped before your homework percentage is computed.

Assignments must be submitted on the due date. No late homework will be accepted.

Exceptions to this policy will be made only upon submission of official university documentation of an illness or university sponsored function. Dropping your lowest score is my way of accounting for the fact that everyone has emergencies; do not waste your drop opportunity for preventable reasons. If you know you must miss a class, make arrangements with me ahead of time to turn in the homework early.

2. *Projects*

Several group projects will be assigned in which students will extend class material. Results will be presented in a formal written report.

3. *Class Participation*

During some classes, activities such as group discussion, student presentations, short worksheets, etc, will be held. These activities will be graded leniently but will not always be announced and may not be made up. Attending class is necessary to get these points.

4. *Tests*

Three tests will be given in class near the dates indicated on the schedule. (The exact date may be slightly different than indicated, but will be announced at least one week in advance). If you must miss a test and provide me with a legitimate reason at least 2 days in advance, you may take a makeup test without penalty. If you do not give me at least 2 days notice, you may not be allowed to take a makeup at all, or points may be deducted from your test score as a penalty. In case of a medical or family emergency, please notify me immediately by any of the contact means listed above. My willingness to accommodate your emergency will be related to your prompt efforts to notify and communicate with me.

5. *Final Exam*

The final exam will be comprehensive. It must be taken at the scheduled time unless you have more than two final exams on the same day. In this case, please make prior arrangements to take the final at another time (which must be later than the scheduled time). If your final exam percentage is higher than your lowest test score, I will replace that test score by your final percentage before assigning course grades.

6. *Professional Development*

Participation in any of the following out-of-class activities will add the indicated number of points to the student's point total as well as his/her points possible. For example, suppose Students #1 and #2 each earn 700 total class points, but Student #2 also earns 50 professional development points. Student #1 will then have a course average of $700/800 = 87.5\%$, while student #2 will have an average of $750/850 = 88.2\%$. A maximum of 50 professional development points is allowed.

<i>Activity</i>	<i>Points</i>
IWU MAC Meeting	10
IWU Math Colloquium (attending/presenting)	10/20
IWU Math Dept guest speaker presentation	20
Helping with IWU MAA Conference	20
Off-campus math conference (pre-approved by instructor)	50

7. *Weighting*

3 Tests	300 pts
Homework / Labs	200 pts
Projects	80 pts
Class Participation	70 pts
Comprehensive Final Exam	150 pts (See above "replacement" policy)
TOTAL	800 points

8. *Scale*

The following minimum percentages will guarantee the indicated grade. At the end of the course, the scale may be curved to be more lenient, but do not count on this.

Grade	Guaranteed Percentage	Grade	Guaranteed Percentage
A	93	C+	77
A-	90	C	73
B+	87	C-	70
B	83	D+	67
B-	80	D	60

Citizenship:

Attendance:

Enrolled students are responsible for attending all sessions of this class. Attendance may be taken without notice on any given class day and used as a homework score. Poor attendance has always been a leading cause of failure in math courses. Our mutual goal is your success in this course.

Distractions:

Tardiness is an unacceptable distraction to the other members of the class. Everyone occasionally runs a few minutes behind, but being tardy an excessive amount or an excessive number of times may result in denial of credit for work due that week.

Usage of cell phones, MP3 players, laptops (other than for note-taking or classwork), etc., during class is inappropriate and discourteous to other members of the class.

Dishonesty:

Cheating is defined as submitting work for academic evaluation that is not the student's own, copying answers from another student during an examination, using prepared notes or materials during an examination, or other misrepresentations of academic achievement submitted for evaluation and a grade. Plagiarism in research writing is considered cheating. Plagiarism is defined by the MLA Handbook as "the act of using another person's ideas or expressions in writing without acknowledging the source... to repeat as your own someone else's sentences, more or less verbatim."

It is the responsibility of each student to be aware of policies regulating academic conduct including definitions of academic dishonesty, the possible sanctions, and the appeals process. Any undergraduate student apprehended and charged with cheating, including plagiarism, during his or her college matriculation, shall receive the following discipline:

1. First incident of cheating: failure in paper, assignment, or exam.
2. Second incident of cheating: failure in the course involved.
3. Third incident of cheating: dismissal from the university.

Disabilities

If you have a disability for which you may need academic accommodation (including special testing, auxiliary aids, non-traditional formats), please inform the instructor as soon as possible and/or contact the Center for Student Success, Extension 2257.

Topics

1. First Order Differential Equations
 - a. Modeling
 - b. Separation of Variables
 - c. Slope Fields
 - d. Euler's Method
 - e. Existence/Uniqueness
 - f. Equilibria and Phase Lines
 - g. Linear Differential Equations and Integrating Factors
2. First Order Systems
 - a. Modeling with Systems
 - b. Direction Fields and Solution Curves
 - c. Damped Harmonic Oscillator
 - d. Analytic Methods for Special Systems
 - e. Euler's Method for Systems
 - f. Existence/Uniqueness for Systems
3. Linear Systems
 - a. Properties of Linear Systems
 - b. Solutions Using Eigenvectors
 - c. Phase Planes for Systems with Real Eigenvalues
 - d. Complex Eigenvalues
 - e. Second Order Linear Equations
4. Harmonic Oscillators -- Forcing and Resonance
 - a. Forced Harmonic Oscillators
 - b. Sinusoidal Forcing
 - c. Undamped Forcing and Resonance
5. Nonlinear Systems
 - a. Changes of Variable and Linearization
 - b. Equilibrium Point Analysis
6. Laplace Transforms
 - a. Laplace Transforms
 - b. Discontinuous Functions
 - c. Second Order Equations

Mathematics Department Program Outcomes

“The Department of Mathematics is committed to preparing students academically and spiritually for careers and/or advanced study. This preparation will occur through a Christian liberal arts curriculum developing solid foundations in mathematics content, technological skills, and critical analysis and problem solving ability. Communication, teamwork, and leadership skills will be developed through a multi-disciplinary philosophical approach in integrating faith, learning, and service.”

- 1) PROOF: ...understand and proficiently implement the logical role and methodology of rigorous proof in the axiomatic development of mathematics.
- 2) CONTENT: ...understand core mathematical content in standard areas of analysis, algebra, geometry, and probability.
- 3) NATURE: ...proficiently articulate the overall nature of mathematics including its history; current organization; and interfaces with Christian faith, philosophy, and other academic disciplines.
- 4) APPLICATION: ...proficiently analyze, model, and solve real-world problems using mathematical/statistical software as appropriate.
- 5) COMMUNICATION: ...proficiently communicate mathematics in both written and oral form

Project Specifications

A project paper should be written from the point of view of a consultant report to your contractor. In other words, an intelligent person, but someone who is unfamiliar with the situation, has hired you as experts in the area to investigate a situation and prepare a formal written document giving the background, analysis, and conclusions of your investigation.

Note that your employer is not interested in seeing the minute details of routine algebraic derivations and computations. Rather, s/he wants to clearly see an explanation of the problem statement, the approach you took to the problem, any and all assumptions you made, a statement of the exact mathematical model you arrived at, the general solution techniques you used, important intermediate results obtained along the way, and a clear explanation of what your results mean.

Requirements:

1. *Length*

At least 750 words (approximately 3 double-spaced pages of text).

2. *Style*

The paper, including its mathematical symbols, must be typed using, for example, Microsoft Equation Editor, Maple, or LaTeX. Graphs and tables must be computer generated and should be numbered (and referred to by number in the text). Graphs should be put near their associated text rather than at the end.

The writing style should be formal (though not stilted), clear and concise, and organized. Limited use of 1st person plural (“we”) is acceptable; 2nd person (“you”) must be avoided. Personal opinion should be minimized and clearly identified as such.

3. *Organization*

A title page should include your name, date, course name, and a descriptive title (e.g. “Ferocity Levels of Cat/Dog Interactions in Small Town Back Yards”). The remainder of the paper should be in topical sections, each preceded by a section heading. The last section should be a brief conclusion that ties any loose ends together and mentions any problems you encountered or related topics you know about that you feel are significant but chose not to cover.

4. *Level*

The paper should be written so that an upperclassman math major who had not taken this class would be able to understand most of what is being said, yet would learn something new and significant.

5. *References*

If you used outside sources (not a requirement unless otherwise specified), the paper should include a bibliography giving complete references.

6. *Grading Criteria*

Different projects may vary slightly in point values depending on difficulty.

Criteria	Points
Accuracy of mathematical content	50%
Readability (organization, clarity of explanation, helpful figures, etc)	25%
Appearance and mechanics (page layout, grammar, diction, concise style, etc.)	25%
TOTAL	100%