MECE 3450, Mechanical Engineering Analysis II
Fall 2017

Lecture: Eng Building 1.300, MW 1:40-2.55 pm, Lab A: Acad Serv 2.158, MW 3:05 – 4:20 pm, and Lab B: Acad Serv 2.148, 4:30 – 5:45 pm


Prerequisites: A grade of ‘C’ or better in MECE 2450 and MECE 3449.

Professor: Dumitru Caruntu, PhD, PE, Phone: (956) 665-2079, Email: dumitru.caruntu@utrgv.edu - Lecture; and Ben Xu, PhD, Email: ben.xu@utrgv.edu - Labs A and B

Office: SCIE 3.124 Office hours: Monday 5:00 – 6:30 pm

Course Description: The course offers engineering students an in-depth look into the following topics: first-ordered ODEs, second-order linear ODEs, higher order ODEs and system of ODEs; series solutions of ODEs and special functions; Laplace transforms; Fourier series, integrals, and transforms; partial differential equations (PDEs); and numerics for ODEs and PDEs.

Learning Objectives/Outcomes for the Course: 1. Gain critical thinking and problem solving skills. 2. Translate a physical problem (examples: vibration, heat transfer) into a mathematical model (system of equations, differential or partial equations), and obtain the solution for that model. 3. Solve a mathematical model by selecting and applying suitable mathematical methods (analytical and numerical). 4. Understand the physical meaning and implications of the mathematical solution

Conduct of the Course: There will be a great deal of hands on and observed problem solving in the class. Regular attendance is necessary to be successful in the class. There are reading assignments, homework and computer projects, announced quizzes and pop quizzes, two midterm exams and a final examination.

Grading Policies: Homework and computer projects: 10%; Quizzes 30%; Exams 30%; Final Exam 30%

Grading Scale: A: 90 or higher B: 80-89.99% C: 70-79.99% D: 60-69.99% F: Below 59.99%

Examination Policy: All exams and quizzes are closed book and closed notes. Make-up exam(s) will not be given except for legitimate and unusual circumstances. Prompt notification and appropriate documentation will be required. The exams are strictly individual with no assistance to be given or received.

Scholastic Integrity: As members of a community dedicated to Honesty, Integrity and Respect, students are reminded that those who engage in scholastic dishonesty are subject to disciplinary penalties, including the possibility of failure in the course and expulsion from the University. Scholastic dishonesty includes but is not limited to: cheating, plagiarism (including self-plagiarism), and collusion; submission for credit of any work or materials that are attributable in whole or in part to another person; taking an examination for another person; any act designed to give unfair advantage to a student; or the attempt to commit such acts. Since scholastic dishonesty harms the individual, all students and the integrity of the University, policies on scholastic dishonesty will be strictly enforced (Board of Regents Rules and Regulations and UTRGV Academic Integrity Guidelines). All scholastic dishonesty incidents will be reported to the Dean of Students.

Homework Policy: Homework will be assigned daily. It must be submitted neatly on 8.5 x 11 in paper. It should be stapled in the top left corner. Grid engineering paper is preferred. Only one side of the paper will be used; the back side will be left blank. Final answers must be boxed or highlighted.

Attendance: Attendance will be taken every time the class meets. Any student arriving to class 5 minutes after the class has started will not be allowed in class. Students will be allowed a maximum of 5 absences for the whole semester for classes meeting three times a week, 3 absences for classes meeting twice a week, and 2 absences for classes meeting once a week. Five points will be deducted from the total (100%) for each absence exceeding the maximum allowable unless documentation justifying that absence is provided. Students are not permitted to leave the classroom during lectures and exams except for extreme emergencies.

Mandatory Course Evaluation Period: Students are required to complete an ONLINE evaluation of this course, accessed through your UTRGV account (http://my.utrgv.edu); you will be contacted through email with further instructions. Students who complete their evaluations will have priority access to their grades. Online evaluations will be available: Fall 2017 (full semester)… Nov. 15 – Dec. 6.

Important Dates: Exam #1 – Oct 11, Exam #2 – Nov 8, Final Exam – Dec 11.

### ORDINARY DIFFERENTIAL EQUATIONS (ODEs)

**Chapters 1: First-Order ODEs**

M Aug 28 Separable ODEs. Exact ODEs. Linear ODEs. Orthogonal Trajectories

*Applications: Cooling, Mixing, Torricelli’s law, Fluid Flow* 1.1 – 7

**Chapters 2: Second-Order ODEs**

W Aug 30 Homogeneous Linear ODEs. Differential Operators. 2.1 – 3
### MECE 3450-01 Syllabus

**Dumitru Caruntu, PhD, PE**

**Applications: Free Undamped and/or Damped Oscillations**

2.4

Euler-Cauchy Eqs. Solutions. Wronskian. Nonhomogenous ODEs

2.5 - 7

**Applications: Modeling Forced Oscillations, Electric Circuits**

2.8 - 9

| M | Sep 4 | ... | Labor Day Holiday |
| W | Sep 6 | Variation of Parameters | 2.10 |

**Chapters 3: Higher-Order ODEs**

Homogeneous and Nonhomogeneous Linear ODEs.

3.1 – 3

Applications: Elastic Beam under a Load

3.3 ………… Quiz #1

**Chapters 4: Systems of ODEs, Phase Plane, Qualitative Methods**


Applications: Mixing, Electrical Network, Mass-Spring System

W | Sep 13 | Qualitative Methods for Nonlinear Systems, Nonhomogeneous ODEs | 4.5 – 6... Matlab Project 1 |

Applications: Lotka-Volterra Model, Self-Sustained Oscillations

**Chapter 5: Series Solutions of ODEs, Special Functions**

Power Series. Legendre Eqs. Frobenius Method. Bessel Functions

5.1 – 6

Applications: Expansion.

5.7 – 8

**Chapter 6: Laplace Transforms**


Applications: Damped Vibrations, RLC-Circuit

W | Sep 27 | Partial Fractions. Convolution. Integral Equations | 6.5….. Matlab Project 2 |

Applications: Wave Equation, Hammerblow Response, RLC-Circuit, Damped Forced Vibrations

M | Oct 2 | Differentiation and Integration of Transforms. Systems of ODEs. Laplace Transform: General Formulas. Table of Laplace Transforms | 6.6-9 |

Applications: Mixing Problem, Electrical Network, Two Masses on Springs

**NUMERICAL ANALYSIS**

**Chapter 21: Numerics for ODEs and PDEs**


Methods for Parabolic PDEs. Methods for Hyperbolic PDEs | 21.6-7 |

W | Oct 11 | ... | EXAM #1 |

**FOURIER ANALYSIS. PARTIAL DIFFERENTIAL EQUATIONS (PDEs)**

**Chapter 11: Fourier Series, Integrals, and Transforms**

M | Oct 16 | Fourier Series. Periodic, Even, and Odd Functions. Complex FS | 11.1 – 4 |

Applications: Forced Oscillations.

11.5

Approximations. Fourier Integral. 11.6 – 7

W | Oct 18 | Fourier Transform. Discrete and Fast. Tables of Transforms. | 11.8-10 ……… Quiz #4 |

M | Oct 23 | Fourier Transform. Discrete and Fast. Tables of Transforms. | 11.8-10 |

**Chapter 12: Partial Differential Eqs (PDEs)**


W | Nov 1 | Solution by Separating Variables. Use of Fourier Series | 12.3 |

Applications: Vibrating Beam ………………………………… Quiz #5

M | Nov 6 | ………………………………………………………………………. Matlab Project 4, Matlab Project 5 |

W | Nov 8 | ………………………………………………………………………. EXAM #2 |

M | Nov 13 | D’Alembert Solution of Wave Eq., Characteristics, Heat Eq. | 12.4 – 6 |

Applications: Temperature in a Bar, Heat Flow in a Plate

W | Nov 15 | Applications: Membrane, 2-D Wave Equation | 12.7…… Matlab Project 6 |

M | Nov 20 | Applications: Rectangular Membrane: Double Fourier Series | 12.8 |

W | Nov 22 | Laplacian in Polar Coordinates. | 12.9…… Quiz #6 |

M | Nov 27 | Applications: Circular Membrane, Fourier-Bessel Series | 12.9 |

W | Nov 29 | Laplace Eq. in Cylindrical and Spherical Coordinates. Potential | 12.10 ... Matlab Project 7 |
Applications: Spherical Capacitor

M Dec 4  Solution of PDEs by Laplace Transforms.  Appl.: Semi-Infinite String  12.11
W Dec 6  Review
M Dec 11 ................................................................. 1:15 pm – 3:00 pm ……..FINAL EXAM

* Subject to revision

STUDENTS WITH DISABILITIES: Students with a documented disability (physical, psychological, learning, or other disability which affects academic performance) who would like to receive academic accommodations should contact Student Accessibility Services (SAS) as soon as possible to schedule an appointment to initiate services. Accommodations can be arranged through SAS at any time, but are not retroactive. Students who suffer a broken bone, severe injury or undergo surgery during the semester are eligible for temporary services. Brownsville Campus: Student Accessibility Services is located in Cortez Hall Room 129 and can be contacted by phone at (956) 882-7374 (Voice) or via email at ability@utrgv.edu. Edinburg Campus: Student Accessibility Services is located in 108 University Center and can be contacted by phone at (956) 665-7005 (Voice), (956) 665-3840 (Fax), or via email at ability@utrgv.edu.

SEXUAL HARASSMENT, DISCRIMINATION, and VIOLENCE: In accordance with UT System regulations, your instructor is a “Responsible Employee” for reporting purposes under Title IX regulations and so must report any instance, occurring during a student’s time in college, of sexual assault, stalking, dating violence, domestic violence, or sexual harassment about which she/he becomes aware during this course through writing, discussion, or personal disclosure. More information can be found at www.utrgv.edu/equity, including confidential resources available on campus. The faculty and staff of UTRGV actively strive to provide a learning, working, and living environment that promotes personal integrity, civility, and mutual respect that is free from sexual misconduct and discrimination.

Course Drops: According to UTRGV policy, students may drop any class without penalty earning a grade of DR until the official drop date. Following that date, students must be assigned a letter grade and can no longer drop the class. Students considering dropping the class should be aware of the “3-peat rule” and the “6-drop” rule so they can recognize how dropped classes may affect their academic success. The 6-drop rule refers to Texas law that dictates that undergraduate students may not drop more than six courses during their undergraduate career. Courses dropped at other Texas public higher education institutions will count toward the six-course drop limit. The 3-peat rule refers to additional fees charged to students who take the same class for the third time.

ABET: You should be aware that there is a national board (the Accreditation Board for Engineering and Technology (ABET)) that accredits engineering programs. The University of Texas-Rio Grande Valley, Mechanical Engineering degree program is ABET-accredited. It is important to you that the engineering program from which you graduate is ABET-accredited because that is one of the requirements in the process of obtaining a Professional Engineering (PE) license. ABET wants to be sure that graduates of its accredited programs meet 11 educational objectives.

Course Outcomes: Upon completion of this course, students shall demonstrate that they are able to:

1. classify and solve linear first order, second and higher order constant coefficient differential equations by a variety of methods (examples; Free and forced oscillations of a mass-spring-damper system) (H,Q,T)
2. model engineering problems by systems of differential equations and solve these systems; (H,Q,T)
3. use power series methods to solve differential equations; (H,Q,T)
4. use Fourier series and Fourier integral and their application; (H,Q,T)
5. solve partial differential equations by separation of variables (examples: wave and heat equations); (H,Q,T)
6. use the basic methods for the numerical solution of linear systems as well as ordinary differential equations; (H,Q,T)
7. code basic numerical methods into programs. (P)

Assessments Key: H–homework, Q-quiz, T–test, P-project.