Engineering Science 204

Numerical Methods in Engineering
First Semester AY 2023-2024
TZZQ2/SCDE2

COURSE DESCRIPTION: Roots of single equations, systems of linear and nonlinear equations; ordinary differential equations; partial differential equations. Prerequisite: ES 26 or equivalent. Credit: 3 units.

COURSE OBJECTIVES: The main purpose of this course is to introduce numerical methods of applied mathematics relevant to engineering and science problems. By the end of the semester, students should be able to do.

1. demonstrate knowledge and understanding of numerical techniques to solve mathematical problems,
2. analyze a given problem and determine which numerical technique can be used,
3. show logical thinking in translating a mathematical problem into algorithmic form,
4. write and implement a computer code based on an algorithm.

MODE OF DELIVERY:

1. **Delivery**

   This course will be delivered at least 50% F2F (TZZQ2) or remotely (SCDE2).

2. **Course Site**

   UVLe will be used as the learning management system.

3. **Online Resources**

   Throughout the duration of this semester, we will also use the following:

   (a) MATLAB (use your @up.edu.ph account)
   (b) Zoom (use your @up.edu.ph account)
   (c) Slido

   To request your outlook.up.edu.ph account, visit https://itdc.up.edu.ph/uis/microsoft-office-365-for-up.

4. **Communication Plan**
   In order to facilitate the smooth implementation of the course, I intend to communicate with you through the following means:

   (a) **Synchronous Session**
   We will have regular synchronous sessions primarily for lectures, consultations, clarifications, monitoring, updating, and feedback. These sessions will be conducted according to the CRS schedule.

   (b) **Email**
   You may contact me through my primary email (mrvasquez2@up.edu.ph). I will try to respond within 48 hours if my internet connection has no major problems.

(c) **Instant Messaging**
For urgent messages, I may be contacted via messenger or viber. We will also set up a class group chat so that we can also exchange messages through this platform. I will endeavor to respond within 24 hours if my internet and mobile connection are not having major problems.

If you prefer other modes, platform, or application that is more viable to you, please inform me immediately. Everyone is encouraged to regularly communicate with me and your classmates for updates. I want you to support each other to maximize your learning opportunities in this course.

CLASS POLICIES:

1. **Requirements**

   Students officially enrolled in this course will be required to submit machine exercises (MX), machine problems (MP), and submit one special topic project.

2. **Machine Problems**
   All MPs should be performed using MATLAB. MPs solved using other programming languages should be consulted with the instructor for approval.

3. **Machine Exercises**
   All MXs are short computational problems that will be given in class. Other assignments are also considered MX.

4. **Report**
   Toward the end of this semester, a report will be submitted based on a review of a published journal article approved by the instructor. Details will be provided separately.

5. **Attendance**
   Class attendance is required. When a student is absent more than **3** times, the student should drop the course, otherwise, a failing mark will be given.

6. **Dropping**
   A student may officially drop not later than the **last day of dropping** (01 December 2023, Friday).

7. **Course Materials**
   Course materials will be provided at the beginning of the semester. These will be available online.

8. **Grading Policy**
   The following scheme will be used to determine the general weighted average.

Machine Problems	60%
Machine Exercises	30%
Report	10%

9. **GRADING SCALE** is as follows:

FINAL GENERAL AVERAGE	FINAL GRADE	FINAL GENERAL AVERAGE	FINAL GRADE
92–100	1.00	75–below 80	2.25
89–below 92	1.25	70–below 75	2.50
86–below 89	1.50	65–below 70	2.75
83–below 86	1.75	60–below 65	3.00
80–below 83	2.00	below 60	5.00

10. **Academic Integrity**

    It is expected that the student follows the highest principles of academic honesty. Any form of work that will be submitted should be their own or should have the work of others clearly documented and acknowledged.

    All students must be committed to the principles of intellectual honesty and integrity. Once found responsible for an academic dishonesty violation (cheating, fabrication, plagiarism, sabotage, participation in academically dishonest activities, facilitating academic dishonesty), a student will be subjected to the University's rules and regulations which may result in a failing mark and expulsion from the university.

    UP Draft Student Code of Conduct 2012. Article III No. 14

    The definition of "intellectual dishonesty" is "any fraudulent act performed by a student to achieve an academic advantage or gain for oneself or others, including but not limited to: plagiarism, fabrication, copying or submission of the same work in two or more courses."

    Cheating in problem sets and exams, as well as academic dishonesty in general, will not be tolerated and will never be tolerated. Any attempt to cheat in any requirement will entail the student an automatic grade of 5.00, and the case will be forwarded to the Student Disciplinary Tribunal (SDT). Course withdrawals to avoid getting a grade of 5.0 will not be permitted.

11. **Data Privacy**

    The University of the Philippines (UP) processes personal and sensitive personal information to ensure academic freedom and quality education. UP complies with the Philippine Data Privacy Act of 2012 (RA 10173) and aims to protect your data privacy rights. UP collects your personal and sensitive information for academic purposes, including admissions, academic progress evaluation, quality assurance, and emergency response. Your information may also be shared with third parties only when required by law, for your benefit, or to promote your interests. UP takes measures to protect your data privacy and allows you to access and correct your information. You have rights under the Data Privacy Act and can withdraw consent for certain processing activities. For more details, please refer to the complete Privacy Notice [https://upd.edu.ph/studentnotice/].

12. **Special Services**

    If you are a student with special needs and require accommodations, you must be registered with the University's Office of Counselling and Guidance (OCG). Students must provide current documentation to OCG that identifies their special needs and need for accommodation(s). Students must meet Instructors with appropriate notification from OCG of the approved accommodation as early in the semester as possible. You may learn more about the services of the Office of Counselling and Guidance by visiting its office in the Vinzons Hall.

Instructor:
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COURSE OUTLINE:

1. Introduction
2. MATLAB Fundamentals
3. Data Visualization
4. Linear Equations
   (a) Gaussian elimination
   (b) LU decomposition
   (c) Jacobi iteration
   (d) Gauss-Seidel method
   (e) Successive overrelaxation (SOR)
   (f) Other methods
      i. SSOR
      ii. Steepest descent
      iii. Conjugate gradient
      iv. Thomas algorithm
5. Nonlinear Equations
   (a) Bisection
   (b) False-position (*Regula-falsi*)
   (c) Fixed point iteration
   (d) Newton-Raphson
   (e) Secant method
   (f) Systems of non-linear equations
      i. Fixed point iteration
      ii. Newton-Raphson

MACHINE PROBLEM 1

6. Interpolation and Data Fitting
   (a) Interpolation
      i. Direct method
      ii. Lagrange
      iii. Newton
   (b) Least Squares
      i. Linear
      ii. Non-linear
      iii. Quadratic
      iv. Cubic
      v. Linear bivariate
      vi. Quadratic bivariate
7. Numerical Calculus
   (a) Differentiation
   (b) Integration
      i. Trapezoidal rule
      ii. Simpson's rule
      iii. Boole's rule
      iv. Romberg integration
      v. Gaussian quadrature
      vi. Adaptive quadrature

MACHINE PROBLEM 2

8. Ordinary Differential Equations (Initial Value Problems)
   (a) Explicit methods
      i. Euler method
      ii. Adams-Bashforth
      iii. Runge-Kutta
   (b) Implicit methods
      i. Backward Euler
      ii. Adams-Moulton
      iii. Backward differentiation formulas
   (c) Predictor-corrector
9. Ordinary Differential Equations (Boundary Value Problems)
   (a) Shooting method
   (b) Finite difference methods
10. Partial Differential Equations
    (a) Elliptic
    (b) Parabolic
    (c) Hyperbolic
11. Monte Carlo methods (*if time permits*)

MACHINE PROBLEM 3

REFERENCES:

- C. F. Gerald and P. O. Wheatley, *Applied Numerical Analysis (7th Ed.)*
- S. C. Chapra and R. P. Canale, *Numerical Methods for Engineers (6th Ed.)*