Department of Mathematics & Statistics, KFUPM

# Math 590/690 Syllabus (101)

**Dr. K. M. Furati**

**Course Title:** Fractional Differential Equations

**Course Description:** Related special functions and spaces. Definitions of fractional derivatives and integrals. Properties, mapping, and spaces of the fractional integral and differential operators. Transform methods for solving fractional differential equations. Applications.

**Prerequisite:** Graduate level

**Textbook:** Podlubny I., Fractional Differential Equations. Academic Press; 1999.

**Learning Outcomes:** To have basic knowledge on applying fractional calculus tools in research problems. In particular, students will learn analytical techniques for solving basic fractional order differential equations.

**Assignment:** Homework, exams, literature review and projects.

**Webpage** http://faculty.kfupm.edu.sa/math/kmfurati

| # weeks | Topic | Details | Chapter |
|---|---|---|---|
| 2 | Special Functions and Symbols | Gamma & Beta functions, Mittag Leffler function | 1.1, 1.2 |
| | Spaces of integrable and differentiable functions | Integrable, continuously differentiable, absolutely continuous, fundamental theorem of integral calculus | Notes |
| 5 | Fractional Integrals and Fractional Derivatives | Grunwald-Letnikov approach | 2.2 |
| | | Riemann-Liouville approach | 2.3 |
| | | Caputo derivatives. | 2.4.1 |
| | | Properties ( Formulas 2.202, 2.211, 2.217 only) | 2.7 |
| | | Geometric and physical interpretation | Handout |
| 1 | Transforms | Laplace, Fourier, and Mellin transforms | 2.8-2.10 |
| 2 | Existence and Uniqueness Theorems | Sequential Derivatives, equation of general form, existence and uniqueness, and stability. | 3 |
| 1 | Laplace transform method | Standard and sequential FDE | 4 |
| 2 | Other Methods | Mellin transform, power series, and Babenko's symbolic calculus method | 6.1-6.3 |
| 1 | Numerical Evaluation of Fractional Derivative | Fractional difference approach, short-memory principle, order of approximation | 7.1-7.4 |
| 1 | Applications: Projects | | 10 |