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| Course Book |
| Ordinary Differential Equations |
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| Academic Year: 2011-20124 Hours per Week |

Ordinary Differential Equation

 *Soran University/College of Science/Mathematics Departments*

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 The Aim of the Course

 Differential equation is a topic which has numerous applications in many fields such as engineering, economic, actuarial sciences, and in mathematics itself.

The aim of the course is to enable the student to understand the reasons for such applicability and the student is expected to solve first order, equations of higher order, system of differential equations, use series to solve differential equations, integral equations, and Laplace transforms. The theoretical bases of differential equations should be understood by the students.

Course Description:

 Initially differential equation and related concepts such as orders, solution are introduced. Homogeneous, exact, linear, Lagrangean, and other first order equations are discussed. Linear second order and higher order equations, equations with constant coefficients, and non homogeneous equations are then followed. A lengthy chapter on solving differential equations by series in all cases is taught in full detail. Systems of linear and nonlinear equations, homogeneous and nonhomogeneous equations are the subject of the next chapter. Solving differential equations, systems of the equations, and integral equations are discussed in detail. Finally each lecture is ended by solving numerous problems by the students and lecturer.

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| 1st week | Definition of ODE, classification of ODE, solution of ODE in implicit andExplicit functions, proving related theorems, and solving problems |
| 2nd week | Defining homogeneous functions, homogeneous ODE, separable equations, Non homogeneous equations transferred into homogeneous ODE  |
| 3rd week | Definition of exact equation, necessary and sufficient condition theorem,Integrating factors in different cases. |
| 4th week | Problem solving sessions |
| 5th week | Integrating factors that are a function of x, or y, or xy, or x+y. IntegratingFactors by derivative formulas |
| 6th week  | Answering questions about the first exam.First examination |
| 7th week | First order linear equation, solving linear ODE, Bernoulli equation Problem solving |
| 8th week | Problem solving sessions |
| 9th week | Riccati equation, application of ODE in Brachistochrone curve and hangingChain, and pursuit curve.  |
| 10th week | Solving second order equations by reduction of orders in a case where independent variable is not appeared and in a case where dependent variableIs not appeared |
| 11th week | Answering questions about the second examSecond examination |
| 12th week | Second order linear ODE and proving seven theorems, introducing Wronskian determinant , the use of a known solution to find another one  |
| 13th week | Differential equations with constant coefficients and their solution. Method ofUndetermined coefficients to solve non homogeneous equations |
| 14th week | Method of variation of parameters to solve non homogeneous differentialEquations of order two and higher. Problem solving |
| 15th week | Euler differential equation. Introducing equations in the form of operatorsAnd solving them based on the derivative operator. |
| 16th week | Problem solving sessions |
| 17th week | Answering questions about the third exam.Third examination |
| 18th week | Introducing series and their convergence, radius of convergence, power series, analytical functions and theorems related to analyticity |
| 19th week | Problem solving sessions |
| 20th week | Defining ordinary points, singular points, and regular singular points, solvingFirst order equations by power series and solving second order equations byPower series about ordinary points |
| 21st week | Solving second order equations about non ordinary points. Solving LegenderEquation about a regular singular point, cases where both roots are equal |
| 22nd week | Answering questions about the forth examForth examination |
|  23rd week |  Introducing Bessel differential equation and solving Bessel ODE introducingGamma function to solve Bessel ODE in the general case. |
| 24th week | Beltrami–klein model, incidence axioms in Klein model, Proving Hilbert axioms in Poincare model, orthogonal lines in this model, inversion in circles. |
| 25th week | Introducing systems of differential equations. Solving systems of linear ODESystems by independent methods. Solving systems of general ODE systems by transforming them into one variable ordinary differential equation |
| 26th week | Introducing Laplace transform and Laplace formulas. Solving ordinary Differential equations by Laplace transforms, Solving systems of ODE byLaplace transforms. |
| 27th week | Problem solvingFifth examination |

*References:*

1. Simmons, G ,F.; " Differential equations with application and historical

 notes" Mc Graw Hill. 1993

1. Coddington, E.A. "An introduction to differential equations", Prentice

Hall, 1961

1. Diacu F. "An introduction to differential equations-order and Choas,

W.H. Freeman and Company, New York 2000

1. Edwards, C.H.. Penny, D.E. "Differential equations and Boundary value problems", 3rd edition, Pearson education, Inc. 2004