DEPARTMENT OF MATHEMATICS
FACULTY OF SCIENCE AND HUMANITIES
SRM UNIVERSITY

17PMA103 – Ordinary Differential Equations

LECTURE SCHEME / PLAN

Many of the general laws of nature---in physics, chemistry, biology, astronomy etc. can be expressed mathematically in the form of differential equations. Differential equations also arise in many other areas of engineering, economics and other sciences.

Mathematical modelling is a pivotal process in engineering, economics, biology, medicine, environmental science, physics, chemistry, computer science and other fields that translates a physical situation into a "mathematical model" in the form of differential equations usually. Hence, it is very important to learn differential equations in order to tackle practical problems arising in the aforementioned areas.

Ordinary differential equations (ODEs) are differential equations that depend on a single variable. This subject will discuss about the basic concepts of differential equations; first order differential equation; their existence and uniqueness; second order differential equations; systems of ODEs; Series solutions of ODEs; Legendre polynomial; Bessel's function; Green's functions; Sturm-Liouville problems; etc.

<table>
<tr><th colspan="4">UNIT-I Existence and uniqueness of solutions</th></tr>
<tr><th>Lec. No.</th><th>Lesson schedule</th><th>Objectives</th><th>Cumulative hours</th></tr>
<tr><td>L.1.1</td><td>Introduction and motivation; Geometric view of differential equation</td><td rowspan="11">• To motivate the students for studying differential equations

• To familiarize them with the existence and uniqueness of solutions</td><td>1</td></tr>
<tr><td>L.1.2</td><td>Exact equations; integrating factors</td><td>2</td></tr>
<tr><td>L.1.3</td><td>Equations reducible to exact equations</td><td>3</td></tr>
<tr><td>L.1.4</td><td>Preliminaries to existence and uniqueness of solutions of IVPs</td><td>4</td></tr>
<tr><td>L.1.5,6</td><td>Cauchy-Peano existence theorem</td><td>5,6</td></tr>
<tr><td>L.1.7</td><td>Lipschitz condition; Uniqueness theorems</td><td>7</td></tr>
<tr><td>L.1.8</td><td>Picard's method of successive approximation</td><td>8</td></tr>
<tr><td>L.1.9</td><td>Examples on Picard's method</td><td>9</td></tr>
<tr><td>L.1.10</td><td>Convergence of Picard's method of successive approximation</td><td>10</td></tr>
<tr><td>L.1.11,12</td><td>Existence and uniqueness of systems</td><td>11,12</td></tr>
<tr><th colspan="4">UNIT-II Second order equations</th></tr>
<tr><td>L.2.1,2</td><td>General solution of homogeneous</td><td>• To learn the solution</td><td>13,14</td></tr>
</table>

	equations; theorems	techniques for second order ODEs	
L.2.3	Wronskian		15
L.2.4,5	Use of known solution to find another		16,17
L.2.6,7	Homogeneous equations with constant coefficients		18,19
L.2.8	Inhomogeneous equations		20
L.2.9,10	Method of undetermined coefficients		21,22
L.2.11,12	Method of variation of parameters		23,24
CYCLE TEST-I		**DATE:**	
	UNIT-III Boundary value problems		
L.3.1,2	Oscillations	• To understand the qualitative properties of the solutions • To understand the Sturm separation and comparison theorems	25,26
L.3.3,4,5	Sturm separation theorem		27,28,29
L.3.6,7,8	Sturm comparison theorem		30,31,32
L.3.9,10,11,12	Problems		33,34,35,36
	UNIT-IV Series solutions		
L.4.1	Introduction: Review of power series	• To know power series solution of an ODE • To familiarize the students with Sturm-Liouville problems and Green's functions • To know Legendre polynomials and Bessel functions	37
L.4.2	Series solutions of first order equations		38
L.4.3	Second order linear equations; ordinary points		39
L.4.4	Regular singular points		40
L.4.5,6	Sturm-Liouville problems		41,42
L.4.7,8	Green's functions		43,44
L.4.9	Legendre polynomials		45
L.4.10	Properties of Legendre polynomials		46
L.4.11	Bessel functions		47
L.4.12	Properties of Bessel functions		48
CYCLE TEST-II		**DATE:**	
	UNIT-V System of differential equations		
L.5.1,2,3	Algebraic properties of solution of linear systems	• To learn solution techniques for autonomous system of ODEs • To understand qualitative features of the solution of linear systems	49,50,51
L.5.4,5	Eigenvalues and eigenvector method of finding solutions		52,53
L.5.6,7,8,9,10	Two-dimensional autonomous systems		54,55,56,57,58
L.5.11	Case of complex eigenvalues		59
L.5.12	Case of equal eigenvalues		60
MODEL EXAMINATION		**DATE:**	
	Last working day		

References:

- E. A. Coddington and N. Levinson, Theory of Ordinary Differential Equations, McGraw-Hill New York, 1955.
- G. F. Simmons, Differential Equations with Applications and Historical Notes, 2nd Ed., McGraw- Hill, 1991.
- R. P. Agarwal and D. O'Regan, An Introduction to Ordinary Differential Equations, Springer- Verlag, 2008.
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- G. Birkhoff and G.-C. Rota, Ordinary Differential Equations, John Willey & Sons, 4th Ed., 1989.
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- M. Braun, Differential Equations and Their Applications, 3rd Ed., Springer-Verlag, 1983.
- Haynes Miller, and Arthur Mattuck. 18.03 Differential Equations. Spring 2010. Massachusetts Institute of Technology: MIT OpenCourseWare, https://ocw.mit.edu/courses/mathematics/18-03-differential-equations-spring-2010/video-lectures/.
- http://nptel.ac.in/courses/111104031/