BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani

Pilani Campus

First Semester 2018-2019
Instruction Division
Course Handout (Part II)

Date: 02/08/2018

In addition to Part I (General Handout for all courses appended to the Time Table), this portion gives further specific details regarding the course.

Course No. : **MATH F211**
Course Title : **Mathematics-III**
Instructor In-charge : **SANGITA YADAV**
Instructor(s) : **Ashish Tiwari, Balram Dubey, Bhupendra K Sharma, Devendra Kumar, Gaurav Dwivedi, Jitender Kumar, Krishnendra Shekhawat, Navin Singh, Pradeep Kr H Keskar, Rakhee, RR Mishra, Shivi Agarwal, Sumanta Pasari**

1. Course Description

This course reviews and continues the study of differential equations with the objective of introducing classical methods for solving boundary value problems. This course serves as a basis of the applications for differential equations, Fourier series and Laplace transform in various branches of engineering and sciences. This course emphasizes the role of orthogonal polynomials in dealing with Sturm-Liouville problems.

2. Scope and Objectives

- To understand the theory of first and second order ordinary differential equations and learn the methods to solve them.
- To understand the series solution of second order ordinary differential equations and their interval of convergence.
- To understand the Laplace transform, their properties and applications to solve IVPs and BVPs.
- To understand the Fourier series expansion of a function.
- To understand the concept of eigenvalues and eigenfunctions and to use them in solving heat and wave equations.

3. Text Book: Simmons G.F., Differential Equations with Applications and Historical Notes, Tata McGraw Hill, 2nd ed., 1991.

Reference Books:

1. Zill, Differential Equations, Thomson Learning, 5th ed., 2004

2. Shepley L. Ross: Differential Equations, John Willy & Sons, 3rd ed., 1984.

3. Edwards & Penney: Differential Equation and Boundary Value Problems, Pearson Education, 3rd ed., 2009.

4. Course Plan

Module Number	**Lecture session**	**Sections**	**Learning Outcome**
1. To introduce the classical methods to solve first order ordinary differential equations	Revision and self study	1-6	Students will be able to solve first order differential equations of various types.
	L1.1. First order equations	7	
	L1.2. Exact differential equations	8, 9	
	L 1.3. Linear differential equation	10	
	L1.4. Reduction of order	11	
2. To introduce the classical methods to solve second order ordinary differential equations	L2.1-2.2 General solutions of second order ordinary differential equations and some results on linearly dependent (L.D.) and independent (L.I.) solutions	14-15	Students will be able to solve homogeneous second order ordinary differential equations with the knowledge of theoretical details of solutions of differential equations and methods too.
	L2.3. Use of a known solution to determine another L.I. solution of differential equation	16	
	L2.4-2.5. Solving second order homogeneous linear ordinary differential equations	17	
3. To obtain particular solution of nonhomogeneous second order ordinary differential equations.	L3.1 Method of undetermined coefficients	18	Students will be able to obtain a particular solution of nonhomogeneous second order Linear ordinary differential equations.
	L3.2. Method of variation of parameters	19	
	L3.3-3.4. Operator method	23	
4. Properties of solutions	L4.1 Oscillations, Sturm Separation theorem and theorem on infinitely many positive zeros of solution	24	Students will be able to know the behavior of solution of second order ordinary differential equations without solving them.
	L4.2. Sturm comparison theorem	25	

5. To introduce Series solutions method to solve second order Linear differential equation with variable coefficients	L5.1-5.2 .Review of power series and series solution of first order ordinary differential equation, series solutions about ordinary point	26, 27, 28	Students will be able to solve second order Linear differential equations with variable coefficients by using series solution approach.
	L5.3-5.4 Series solutions about regular singular point	29, 30	
	L5.5-5.6 Hypergeometric equations	31	
6. Special functions arising from series solutions of second order Linear ordinary differential equation	L6.1-6.3 Legendre polynomials	44, 45	Students will be able to apply properties of Legendre polynomials and Bessel functions to solve various initial/boundary value problems in their respective engineering and science streams
	L6.4-6.6 Bessel functions	46, 47	
7. Introduction to Laplace Transform, its properties and applications	L7.1 Laplace transform and its existence, inverse Laplace transform	48,49	Students will be able to use properties of Laplace transform in solving initial value problems and boundary value problems.
	L7.2 Applications to differential equations.	50	
	L7.3 Derivatives and integrals of Laplace transforms	51	
	L7.4 Convolution theorem and applications	53	
8. To introduce system of first order ordinary differential equations.	L8.1 Theory on system of equations and introduction to linear system (without proof)	54, 55	Students will be able to solve linear system of first order differential equations with the knowledge of theory of system of first order differential equations.
	L8.2. Homogeneous linear systems with constant coefficients (including Q.5 on page-433 on variation of parameters approach)	56	
9. To introduce Fourier series	L 9.1 Fourier coefficients and problem of convergence	33-34	Students will be able to obtain Fourier series expansion of functions in a given interval, to know its convergence and apply it in
	L9.2 Even and odd functions, cosine and sine series	35	

	L9.3 Extension to arbitrary intervals	36	their respective streams such as getting solution of a vibrating string etc.
10. Boundary value problems.	L10.1 Eigenvalues and eigen functions	40	Students will be able to solve boundary value problems and using orthogonality property of eigenfunctions of Sturm Liouville problems to get eigenfunction expansion of a function.
	L10.2 Sturm Liouville problems	43	
11. To introduce separation of variables method to solve Partial Differential Equations.	L11.1. One dimensional wave equation	40	Students will be able to use separation of variable technique for solving some partial differential equations.
	L11.2 One dimensional heat equation	41	
	Laplace equation (Self study)	42	

***In common hours, practice problems will be done on topics covered in previous lectures.**

6. Evaluation Scheme:

Evaluation Component	**Weightage (Marks)**	**Date & Time**	**Remarks**
Mid-Sem.	35% (105)	12/10 11:00 - 12:30 PM	Closed Book
Comprehensive	45% (135)	8/12 AN	Closed Book/Open Book
Two Quizzes (Announced)	20% (60)	TBA	Closed Book

After completing this course the student will be able to

1) solve differential equations appearing in modeling of various processes in their respective engineering or science stream.
2) understand whether a given initial value problem is solvable or not.
3) understand the region in which the solution is valid (like in series solution approach).
4) solve the problems involving linear system of first order differential equations.
5) understand the eigenfunction expansion/Bessel series expansion of a function using respective orthogonality properties which can be further helpful in solving various problems in their engineering and science streams.

Closed Book Test: No reference material of any kind will be permitted inside the exam hall.

Open Book Exam: Use of textbook and original class notes will be permitted inside the exam hall. Any kind of loose sheets of paper will not be permitted. Computers of any kind will not be allowed inside the exam hall. Use of calculators will not be allowed in any exam. No exchange of any material will be allowed.

Chamber consultation hour: To be announced in the class.

Notices: All notices regarding MATH F211 will be displayed on NALANDA and the notice board of the Department of Mathematics.

Note: It shall be the responsibility of the individual student to be regular in maintaining the self study schedule as given in the course handout, attend lectures and common hours as per the schedule mentioned in time-table. Quizzes, mid Semester test and comprehensive examination are according to the evaluation scheme given in the respective course handout. If the student is unable to appear for the regular test/examination due to genuine exigencies, the student must refer to the procedure for applying for make-up test/examination.

(SANGITA YADAV)
Instructor In charge
MATH F211.