



Estd. 1962  
NAAC 'A' Grade

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Ref./SU/BOS/ 6785

Date: 04/07/2019

To,

1) The Principal, All Concerned Affiliated Colleges/Institutions Shivaji University, Kolhapur	2) The Head, All Concerned Department Shivaji University, Kolhapur.
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**Subject:** Regarding Syllabi of M.Phil/Ph.D. Course work Mathematics Paper  
III : Sturm Liouville Theory under the Faculty of Science and Technology.

Sir/Madam,

With reference to the subject mentioned above, I am directed to inform you that the University authorities have accepted and granted approval to the revised syllabi of **M.Phil/Ph.D.Course work Mathematics Paper III : Sturm Liouville Theory** under the Faculty of Science and Technology.

This syllabi shall be implemented from the academic year 2019-2020 (i.e. from June 2019) onwards. A soft copy containing the syllabus is attached herewith and it is also available on university website [www.unishivaji.ac.in](http://www.unishivaji.ac.in))

You are, therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking you,

Yours faithfully,

Dy Registrar

Copy to:

1	The Dean, Faculty of Science & Technology	7	Appointment Section
2	The Chairman BOS	8	Computer Centre
3	B.Sc/M.Sc Section	9	Affiliation Section (U.G.)
4	O.E. II, Section	10	Affiliation Section (P.G.)
5	Eligibility Section	11	P.G.Admission Section
6	P.G.Seminar Section		

**SYLLABUS FOR**  
**M. Phil. / Ph.D. Course Work**  
(Introduced from June 2019 onwards)

(i) Paper - III

ii) Title of Paper: **Sturm Liouville Theory**

(iii) **Specific Objectives:** The objective of the paper is to introduce basic Sturm Liouville theory. In this course students will be acquainted with Bessel equations and Bessel functions, Legendre equations and Legendre polynomials, existence and uniqueness of solutions of initial and boundary value problems, Dependence of solutions on initial conditions. Nature of zeros of solutions of Sturm Liouville problems.

(iv) **UNITS:** 4

**Unit I:** Power-series solution of ODEs , The method of Frobenius, The basic method, The two special cases ,The Bessel equation and Bessel functions , First solution , The second solution, The modified Bessel equation, Generating functions, Legendre polynomials , Hermite polynomials, Bessel functions.

**Unit II :** An introduction to Sturm-Liouville theory: Introduction and Background ,The second-order equations, The boundary-value problem ,Self-adjoint equations , The Sturm-Liouville problem: the Real Simple eigen values, the eigen functions ,The fundamental oscillation theorem , Orthogonality, Eigen function expansions, Inhomogeneous equations

**Unit III:** Second-Order Equations , Zeros of Solutions , Self-Adjoint Differential Operator, The Sturm–Liouville Problem, Existence of Eigen functions, Completeness of the Eigen functions , The Singular SL Problem.

**Unit IV:** Existence and Uniqueness Problems : First Order Systems, Existence and Uniqueness of Solutions, Variation of Parameters ,The Gronwall Inequality, Bounds and Extensions to the End points , Continuous Dependence of Solutions on the Problem ,Differentiable Dependence of Solutions on the Data, Adjoint Systems,  
Scaler initial value problems: Existence and Uniqueness, Continuous Extensions to the End points ,Continuous Dependence of Solutions on the Problem, Differentiable Dependence of Solutions on the Data, Sturm Separation and Comparison Theorems.

(v) **Recommended Reading :**

a) Basic Reading: Coddington: Ordinary Differential Equation.

b) Additional Reading: Pinsky :Pratial Differential Equations and Boundry Value Problems

3) **References Books:**

1) R.S. Johnson : Second-order ordinary differential equations:Special functions, Sturm-Liouville theory and transforms, R.S. Johnson & Ventus Publishing ApS 2012

2) M.A. Al-Gwaiz: Sturm-Liouville Theory and its Applications . Springer 2008

3) Anton Zettl: Sturm Liouville Theory. American Mathematical Society 2005