Rayat Shikshan Sanstha's

Yashavantrao Chavan Institute of Science, Satara (Autonomous)

Undergraduate Programme

B. Sc. in Mathematics

Syllabi of the course

Choice based credit system syllabus

(To be implemented from academic year 2018-21)

Department of Mathematics

CONTENT

Syllabus for B.Sc. I (Mathematics)

Preamble:

The present syllabus has been designed in accordance to meet the emerging needs of all categories of undergraduate students.

Students learn Mathematics as a separate subject from B.Sc. I. The syllabus is motivating the topics from real life situations and other subject areas; the greater emphasis has been laid on application of various concepts.

The new syllabus aims to enable students to use mathematical knowledge in the field of business, economic and social sciences. It also promotes appreciation of mathematical power and simplicity for its countless applications in diverse fields.

The syllabus is prepared after discussion at length with number of faculty members of the subject and experts from industries and research fields.

B.Sc. Programme objectives

The units of the syllabus are well defined, taking into consideration the level and capacity of students.

1. To nurture academicians with focus and commitment to their subject.
2. To shape good and informed citizens from the students entering into the programme.
3. To create a skilled workforce to match requirements of the society.
4. To impart knowledge of science is the basic objective of this programme.
5. To develop scientific attitude is the major objective so as to make the students open Minded, critical and curious.
6. To develop skill in practical work, experiments and laboratory materials and equipments along with the collection and interpretation of scientific data to contribute to science.

B.Sc. Programme outcomes :

1. The students will graduate with proficiency in the subject of their choice.
2. The students will be eligible to continue higher studies in their subject.
3. The students will be eligible to pursue higher studies abroad.

4. The students will be eligible to appear for the examinations for jobs in government organizations.
5. The students will be eligible to apply for jobs with a minimum requirement of B.Sc. programme.

Program Specific Objectives of the Course:

1. The students are expected to formulate and develop mathematical arguments in a logical manner.
2. The practical work will help students to take decisions at intellectual, organizational and personal from different perspectives of life using analysis.
3. It is expected to be well grounded in the basic manipulative skills.
4. To develop the power of appreciations, the achievements in science and role in nature and society.
5. To enhance the critical thinking of the students.

Program Specific Outcomes:

After successful completion of B.Sc. Mathematics Course student will be able to:

1. demonstrate basic manipulative skills in algebra, geometry, trigonometry and beginning calculus.
2. investigate and apply mathematical problems and solutions in variety of context related to science, technology, business and industry. Illustrate solutions using numeric or graphical methods.
3. work and plan effectively, both individually and as a part of team, making use of appropriate investigative methods.
4. develop programming skills and practical to further mathematical understanding and solve mathematical problem.
5. perform job in various fields' like science, engineering, education, banking, business and public service, etc. or be an entrepreneur with precision, analytical mind, innovative thinking, clarity of thought , expression, and systematic approach.

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B. Sc. Part - I

1. **Title:** Mathematics
2. **Year of Implementation:** The syllabus will be implemented from June, 2018 onwards.
3. **Duration:** The course shall be a full time.
4. **Pattern:** Semester examination.
5. **Medium of Instruction:** English.
6. **Structure of Course:**

B.Sc. - I Semester - I

Sr. No.	Paper Title	Theory			Practical		
		Paper Code	Lectures per week	Credits	Paper Title	Lectures per week	Credits
1	Differential Calculus I	BMT101	5	2	Practical Paper-I : BMP103	4	2
2	Differential Equations I	BMT102		2			

B.Sc. - I Semester - II

Sr. No.	Paper Title	Theory			Practical		
		Paper Code	Lectures Per week	Credits	Paper Title	Lectures Per week	Credits
1	Differential Calculus II	BMT201	5	2	Practical Paper – II : BMP203	4	2
2	Differential Equations II	BMT202		2			

B: B.Sc. M: Mathematics T: Theory, P: Practical

3. Titles of papers of B.Sc. course: B.Sc. - I - Semester - I

Theory: 36 lectures, 30 hours (for each paper)

BMT101: **Differential Calculus I**

BMT102: **Differential Equations I**

Practical: 40 lectures: 32 hours

BMP103: **Practical I**

B.Sc. – I Semester – II

Theory: 36 lectures: 30 hours (for each paper)

BMT201: **Differential Calculus II**

BMT202: **Differential Equations II**

Practical: 40 lectures: 32 hours

Practical: BMP203: **Practical II**

B. Sc. Part - I : Semester - I

BMT101: Differential Calculus - I (Credits : 02)

Course Objective : Students should

1. learns basic concepts in Mathematics and also geometrical figures & Graphical displays.
2. perform Mathematical operations.
3. develop mathematical curiosity and use inductive and deductive reasoning while solving problems.
4. get adequate exposure to global and local concerns that explore them many aspects of Mathematical science.

Unit -1 : Limits and continuity of Real Valued functions [10]

1.1 $\varepsilon - \delta$ definition of limit of function of one variable, Left hand Side and Right Hand Side limits.

1.2 Properties of limits. (Statements Only)

1.3 Continuous Functions:

1.3. 1 Definition: Continuity at a point and Continuous functions on interval

1.3. 2 Theorem: If f and g are continuous functions at point x = a , then f + g , f - g fg and $\frac{f}{g}$ are continuous at point. (Without Proof)

1.3. 3 Theorem: Composite function of two continuous functions is continuous.

1.3. 4 Examples on continuity.

1.4 Classification of Discontinuities (First and second kind), Removable Discontinuity, Jump Discontinuity.

1.5 Definition : Bounded sets, Least Upper Bound (Supremum) and Greatest Lower bound (infimum).

1.5. 1 Least Upper Bound axiom, Greatest Lower bound axiom and its Consequences.

Unit - 2 : Properties of continuity of Real Valued functions [8]

2.1 Theorem : If a function is continuous in the closed interval [a, b] then it is bounded in [a, b]

2.2 Theorem: If a function is continuous in the closed interval [a, b], then it attains its bounds at least once in [a, b].

2.3 Theorem: If a function f is continuous in the closed interval [a, b] and if f (a) and f (b) are of opposite signs then there exists $c \in (a,b)$ such that f (c) = 0.

2.4 Theorem: If a function f is continuous in the closed interval [a, b] and if $f(a) \neq f(b)$ then f assumes every value between f (a) and f (b).

Unit - 3 : Differentiation [6]

3.1 Definitions : Differentiability at a point, Left Hand derivative, Right Hand Derivative, Differentiability in the interval.

3.2 Examples on derivative.

3.3 Geometrical interpretation of a derivative.

3.4 Theorem : Continuity is necessary but not a sufficient condition for the existence of a derivative.

3.5 Darboux's Theorem on derivative

Unit - 4 : Successive Differentiation [12]

4.1 Introduction.

4.2 Order derivative of some standard functions : $(ax+b)^m, e^{mx}, \frac{1}{ax+b}, \log(ax+b),$

$\sin(ax+b), \cos(ax+b), e^{ax}\sin(bx+c), e^{ax}\cos(bx+c).$

4.3 Examples.

4.3 Leibnitz's Theorem.

4.4 Examples on Leibnitz's Theorem.

Course Outcomes:

Unit – I : **After completion of the unit, Students are able to :**

1. define limit of a function, Bound of a set
2. understand and compute limit and bounds of a functions.

Unit – II : **After completion of the unit, Students are able to :**

1. understand the continuity and importance of properties
2. explain the properties

Unit – III: **After completion of the unit, Students are able to:**

1. define derivative and compute a derivative of a given function
2. give a real life examples involving application of derivative.

Unit – IV : **After completion of the unit, Students are able to :**

1. understand and explain Leibnitz's Theorem
2. apply Leibnitz's Theorem to function and calculate higher order derivative.

REFERENCE BOOKS :

1. **Calculus and Analytical Geometry**,, G. B. Thomas and R. L. Finney, Pearson Education, 2007.

2. **Differential Calculus,** Shanti Narayan, S. Chand and Company, New Delhi. 2004.

3. **Calculus**, H. Anton, I. Birens and Davis,John Wiley and Sons, Inc. third edition2002.

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B. Sc. Part - I : Semester - I
BMT102 : Differential Equations - I (Credits : 02)

Course Objectives : Students should :

1. study differential equations that are encountered in the real world.
2. work with differential equations in various situation and use correct mathematical terminology notation and symbolic processes in order to solve the problem
3. study the multiple approaches and judge if the result are reasonable. Interpret and clearly communicate the result.
4. study concept of solution of differential equation.

Unit - 1 : Differential Equations of first order and first degree [10]

1.1 Revision : Definition of Differential equation, order and degree of Differential equation.
1.2 Definition : Exact Differential equations.
1.2. 1 Theorem: Necessary and sufficient condition for exactness.
1.2. 2 Working Rule for solving an exact differential equation.
1.2. 3 Integrating Factor (I.F.) by using rules (without proof).
1.2. 4 Examples.
1.3 Linear Differential Equation: Definition.
1.3. 1 Method of solution.
1.3. 2 Examples.
1.4 Bernoulli's Differential Equation : Definition.
1.4. 1 Method of solution.
1.4. 2 Examples.
1.5 Orthogonal trajectories: Cartesian and polar co-ordinates.
1.5. 1 Examples.

Unit - 2 : Differential Equations of first order but not of first degree (8)

2.1 Introduction.
2.2 Equations solvable for p : Method and Examples.

2.3 Equations solvable for x : Method and Examples.

2.4 Equations solvable for y : Method and Examples.

2.5 Definition : Clairaut's equation.

2.5. 1 Method of solution and Examples.

2.6 Equations Reducible to Clairaut's form by substitutions and examples.

Unit - 3 : Linear Differential Equations with constant Coefficients – I [9]

3.1 Introduction

3.1. 1 Definition : Complementary function (C.F.) and particular integral (P.I.), operator D.

3.1. 2 Property : (D-a) (D - b) y = (D - b) (D - a) y

3.2 General Solution of f(D) y = 0 .

3.2. 1 Solution of f(D) y = 0 when A.E. has non-repeated roots.

3.2. 2 Solution of f(D) y = 0 when A.E. has repeated roots.

3.2. 3 Solution of f(D) y = 0 when A.E. has non-repeated roots real and complex roots.

3.3 Examples.

Unit - 4 : Linear Differential Equations with constant Coefficients –II [9]

4.1 Meaning of symbol $\frac{1}{f(D)}$

4.2 General Solution of f(D) y = X.

4.3 Theorem : $(A)\ \frac{1}{D-a}X = e^{ax}\int Xe^{-ax}dx$

$(B)\ \frac{1}{D+a}X = e^{ax}\int Xe^{-ax}dx$

4.4 General Methods to find Particular Integral and Examples.

4.5 Theorem : $\frac{1}{(D-a)^n}e^{ax} = \frac{x^n}{n!}e^{ax};\ n \in Z^+$

4.6 Short methods to find Particular Integrals when X is in the form $e^{ax}, \sin ax, \cos ax, x^m, e^{ax}V, xV$ (V is function of x).

4.7 Examples.

Course Outcomes :

Unit - I : After completion of the unit, Students are able to :

1] define differential equation , order, degree.

2] understand working rule for solving differential equation :

Unit - II : After completion of the unit, Students are able to :

1] state the various type of differential equation depending upon method of solution.

2] understand method of solution and compute the solution.

Unit - III : After completion of the unit, Students are able to :

1] define complementary function and particular integral.

2] state difference between C. F. and P. I. compute C.F. and P.I.

Unit - IV : **After completion of the unit**, **Students are able to:**

1] define general solution of differential solution.

2] compute general solution of differential equation.

Reference Books :

1. **An Introduction to Differential Equations**, R. K. Ghosh and K. C, Maity, Seventh Edition, 2000; Book and Allied (P) Ltd
2. **Differential Equation**, Sharma and Gupta, Krishna Prakashan, Media co., Meerut
3. **Differential Equations**, Shepley L. Ross, John Wiley and Sons, 3rd Ed .1984
4. **Ordinary and Partial Differential Equations**, M.D. Raisinghania, S.Chand Publications

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Practical : BMP103: Practical : I (Credits: 2)

Course Objectives : Students should

1. learn computational skills in practical.
2. determine continuity of a function.
3. understand the solution of differential equation and types of solutions.
4. understand orthogonal trajectories.

Experiments :

1. Continuity of function
2. Successive Differentiation: n^{th} order derivative
3. Leibnitz's theorem
4. Linear Differential Equations
5. Bernoulli's Differential Equations
6. Orthogonal trajectories: Cartesian co-ordinates
7. Orthogonal trajectories: polar co-ordinates
8. Clairaut's Form and Equations Reducible to Clairaut's Form
9. Linear Differential Equations with constant Coefficients-I
10. Linear Differential Equations with constant Coefficients- II

Course Outcomes :

After completion of the practical's students are be able to:

1] identify continuous functions and discontinuous functions.
2] find n^{th} derivative of functions.
3] use Leibnitz theorem to obtain n^{th} derivative of product of two functions.
4] solve linear differential equations.
5] solve Examples on Bernoullis differential equations.
6] find Orthogonal trajectories: for given Cartesian equation of curves
7] find Orthogonal trajectories: for given polar equation of curves
8] solve clairauts equation and equations reducible to clairauts form.
9] solve the differential equations with constant coefficients (for $X = e^{ax}$, sin ax, cos ax)
10] solve the differential equations with constant coefficients (for $X = x^m$, $e^{ax}V$, xV)

REFERENCE BOOKS:

1. **Calculus**, H. Anton, I. Birens and S. Davis, John Wiley and Sons, Inc., 2002
2. **Differential Equations,** Shepley L. Ross, 3rd Ed., John Wiley and Sons, 3rd Ed. 1984
3. **Differential Calculus**, Shanti Narayan.

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B.Sc. - I : Semester - II

Sr. No.	Paper Title	Theory			Practical		
		Paper Code	Lectures Per week	Credits	Paper Title	Lectures Per week	Credits
1	Differential Calculus II	BMT201	5	2	Practical Paper – II : BMP203	4	2
2	Differential Equations II	BMT202		2			

B: B.Sc. M : Mathematics T : Theory, P : Practical

BMT201 : Differential Calculus - II

(Credits: 2)

Course Objectives : Students should

1. use the fact that the derivative is the slope of the tangent line to the curve at a given point.
2. understand the series expansion of various function.
3. study partial differential equation and its solution.
4. study the extreme values of a function.

Unit - 1 : Mean Value Theorems [9]

3.1 Rolle's Theorem

3.1.1 Geometrical interpretation

3.1. 2 Examples on Rolle's theorem

3.2 Lagrange's Mean Value Theorem

3.2.1 Geometrical interpretation of, Lagrange's Mean Value Theorem

3.2.2 Examples

3.3 Cauchy's Mean Value Theorem

3.3. 1 Examples

Unit - 2 : Series Expansion and Indeterminate Forms [8]

2.1 Taylor's Theorem with Lagrange's and Cauchy's form of remainder (statement only)

2.2 Maclaurin's Theorem with Lagrange's and Cauchy's form of remainder (statement only)

2.3 Maclaurin's Series for e^x, sinx, cosx, log (1+x), log (1-x), $(1+x)^n$, $\frac{1}{1+x}$, $\frac{1}{1-x}$

2.4 Examples on Taylor's series and Maclaurin's series

2.5 Indeterminate Forms : L'hospital's rule ((statement only).

The Forms $\frac{0}{0}, \frac{\infty}{\infty}\ 0 \times \infty,\ \infty - \infty\ 0^0,\ \infty^0,\ 1^\infty$ and Examples

Unit - 3 Partial Differentiation **[10]**

3.1 Introduction: Functions of two variables, Limit and Continuity of functions of two variables,

3.2 Partial derivative, partial derivative of higher orders, Chain Rule (Statement only) and its Examples

3.3 Homogeneous functions: Definition with illustrations

3.4 Euler's theorem on homogenous functions

3.4. 1 If f (x, y) and f (x, y) is a homogenous function of x, y of degree n, then

$$x^2\frac{\partial^2 f}{\partial x^2} + y\frac{\partial^2 f}{\partial x \partial y} + y^2\frac{\partial^2 f}{\partial y^2} = n(n-1)f.$$

3.4.2 If F (u) = f (x, y) and f (x, y) is a homogenous function of x, y of degree n, then

$$x\frac{\partial f}{\partial x} + y\frac{\partial f}{\partial y} + \frac{F(u)}{F'(u)}$$

3.4.3 If F (u) = f (x, y) and f (x, y) is a homogenous function of x, y of degree n, then

$$x^2\frac{\partial^2 f}{\partial x^2} + y\frac{\partial^2 f}{\partial x \partial y} + y^2\frac{\partial^2 f}{\partial y^2} = n\ (n-1)f$$

Unit - 4 : Extreme Values **[9]**

4.1 Maxima and Minima for function of two variables : Definition of Maximum, Minimum and Stationary values of function of two variables

4.2 Conditions for maxima and minima (Statement Only) and Examples

4.3 Lagrange's Method of undetermined multipliers of two variables and Examples on it

Course Outcomes :

Unit - I : After completion of the unit, Students are able to

1. understand Rolle's theorem, Lagrange's mean value theorem and Cauchy's mean value theorem.
2. solve the examples on these theorems.

Unit - II : After completion of the unit, Students are able to

1. understand Taylor's theorem, Maclaurin's Theorem, Maclaurin's series, and indeterminate forms.
2. compute limit of a indeterminate form.

Unit - III : After completion of the unit, Students are able to

1. understand function of two variables, limit and continuity of function of two variables
2. understand partial differentiation, Euler's theorem on homogeneous function.

Unit - IV : After completion of the unit, Students are able to

1. define extreme values of a function.
2. compute extreme values of a function.

Reference Books:

1. **Calculus**, G.B. Thomas and R.L. Finney, Pearson Education, 2007
2. **A Course of mathematical Analysis**, Shanti Narayana and P. K. Mittal , S. Chand and Company, New Delhi. 2004.
3. **Differential Calculus**, Maity and Ghosh, New Central Book Agency (P) limited, Kolkata, India. 2007
4. **Mathematical Analysis**, S. C . Malik and Savita arora, (second Edition), New Age International Pvt. Ltd., New Delhi, Pune, Chennai.

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BMT202 : Differential Equations - II
(Credits : 2)

Course Objectives : Students should

1. study different types of differential equation.
2. understand various methods to find the solution of differential equation.
3. apply concepts to models of real world problems.
4. analyze the validity of the solution obtained.

Unit - 1 : Homogeneous Linear Differential Equations [8]

1.1 General Form of Homogeneous Linear Differential Equation
1.2 Method of Solution and Examples
1.3 Equations Reducible to Homogeneous Linear Form
1.4 Examples

Unit - 2 : Second Order Linear Differential Equations [14]

2.1 General Form
2.2 Complete solution when one integral is known: Method and Examples
2.3 Transformation of the equation by changing the dependent variable and Examples (Removal of First Order Derivative)
2.4 Transformation of the equation by changing the independent variable and Examples
2.5 Method of Variation of Parameters and Examples

Unit - 3 Ordinary Simultaneous Differential Equations [6]

3.1 Simultaneous Linear Differential Equation of the form $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$
3.2 Method of solving Simultaneous Linear Differential Equation
3.3 Geometrical Interpretation
3.4 Examples

Unit-4 Total Differential Equations [8]

4.1 Total differential Equation Pdx + Qdy + Rdz = 0
4.2 Necessary Condition for Integrability of Total Differential Equation
4.3 Method of solving Total Differential Equations :
a] Method of Inspection
b] One variable regarding as constant
4.4 Geometrical Interpretation

4.5 Geometrical Relation Between Total Differential Equation and Simultaneous Linear Differential Equation

4.6 Examples

Course Outcomes :

Unit - I : After completion of the unit, Students are able to :

1. understand homogeneous linear differential equation and methods of solution.
2. identify the type of differential equation.

Unit - II : After completion of the unit, Students are able to

1. understand the higher order differential equations.
2. solve second order differential equation.

Unit - III : After completion of the unit, Students are able to

1. understand ordinary simultaneous differential equations.
2. define the geometrical interpretation.

Unit - IV : After completion of the unit, Students are able to

1. understand condition for Integrability of $Pdx + Qdy + Rdz = 0$.
2. solve the total differential equations. They come know the geometrical interpretation

Reference Books:

1. **Differential Equation**: Sharma and Gupta, Krishna Prakashan, Media co., Meerut.
2. **Introductory course on Differential Equations** : D.A. Murray, Orient Longman, (India),1967.
3. **An Introduction to Differential Equations** : R. K. Ghosh and K. C, Maity; book and allied Seventh Edition, 2000; Book and Allied (P) Ltd.
4. **Ordinary and Partial Differential Equations**, : M.D. Raisinghania, S.Chand Publication

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Practical : BMP203 : Practical - II
(Credits:2)

Course Objectives : Students should

1. develop practical skills.
2. verify theorems using examples in practical.
3. solve differential equations of second order.
4. identify the indeterminate form and solve .

Experiments :

1. Lagrange's Mean Value Theorem
2. Cauchy's Mean Value Theorem
3. Indeterminate forms
4. Extreme values
5. Lagrange's undetermined multiplier method
6. Homogeneous Linear Differential Equations and Reducible to Homogeneous Linear Differential Equations
7. Second Order Linear Differential Equations(One solution is known)
8. Second Order Linear Differential Equations(By Changing Dependent Variable)
9. Second Order Linear Differential Equations(By Changing Independent Variable)
10. Total Differential Equations

Course Outcomes:

After completion of the practical's students are able to

1] solve examples on Lagranges Mean Value Theorem.

2] solve examples on Cauchy's Mean Value Theorem.

3] identify indeterminate forms and can find their limits.

4] determine maximum and minimum values

5] find stationary values by Lagrange's method.

6] solve Examples on homogeneous linear differential equations and reducible to homogeneous differential equation form.

7] solve Examples on second order linear differential equations when one solution is known.

8] solve second order linear differential equations by changing dependent variable.

9] solve second order linear differential equations by changing independent variable.

10] solve examples on total differential equations.

REFERENCE BOOKS:

1. Calculus,

H. Anton, I. Birens and S. Davis, John Wiley and Sons, Inc., 2002.

2. Differential Equations,

Shepley L. Ross, 3rd Ed., John Wiley and Sons, 1984.

3. Calculus and Differential Equations,

H.V. Kumbhojkar, Dattar and Bapat, Nirali Prakashan.

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