Karmaveer Bhaurao Patil University, Satara

Syllabus for

B. Sc. I Mathematics

Under

Faculty of Science and Technology

(As per NEP 2020)

Course Structure (Level 4.5)

Semester (Level)	Course-1 (Cr)	Course-II (Cr)	Course-III (Cr)	OE(Cr)	AEC/VEC/IKS (Cr)	Total Credits
I (4.5)	DSC-I (02)	DSC-I (02)	DSC-I (02)	OE-I (02)	IKS-I (02) (Generic)	**22**
	DSC-II (02)	DSC-II (02)	DSC-II (02)			
	DSC P-I (02)	DSC P-I (02)	DSC P-I (02)			
II (4.5)	DSC-III (02)	DSC-III (02)	DSC-III (02)	OE-II (02)	VEC-I (02)	**22**
	DSC-IV (02)	DSC-IV (02)	DSC-IV (02)			
	DSC P-II (02)	DSC P-II (02)	DSC P-II (02)			
Credits	**12**	**12**	**12**	**04**	**04**	**44**

Semester (Level)	Course-I	Course Code	Course Title	Credits	Contact Hours
I (4.5)	**DSC-I**	**BMT 111**	**Calculus**	02	30
	DSC-II	**BMT 112**	**Differential Equations**	02	30
	DSC P-I	**BMP 113**	**Practical-I**	02	60
II (4.5)	**DSC-III**	**BMT 121**	**Differential Calculus**	02	30
	DSC-IV	**BMT 122**	**Advanced Differential Equations**	02	30
	DSC P-II	**BMP 123**	**Practical-II**	02	60

Evaluation Structure

Assessment Category	Internal Evaluation			ESE	Total Marks	Credits
	CCE-I	CCE-II	Mid Sem			
Theory	**05**	**05**	**10**	**30**	**50**	**02**
Practical	**---**	**---**	**---**	**50**	**50**	**02**

SEMESTER I
BMT 111: Calculus

Course Objectives: Student should be able to…

1. learn limit and continuity of real valued functions.
2. understand properties of real valued continuous functions defined on closed and bounded interval.
3. study relationship between continuity and differentiability.
4. generalize differentiation of real valued functions.

Credits=2	**SEMESTER-I** **BMT 111: Calculus**	**No. of hours per unit**
UNIT I	**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 $x = a$. (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 II	**Properties of continuity of Real Valued functions**	**(05)**
	2.1 Theorem: If a function f is continuous in the closed interval [a, b] then it is bounded in [a, b] 2.2 Theorem: If a function f 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 III	**Differentiation**	**(05)**
	3.1 Definitions: Differentiability at a point, Left Hand derivative, Right Hand Derivative, Differentiability in the interval$[a, b]$. 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 IV	**Successive Differentiation**	**(10)**
	4.1 Introduction. 4.2 n^{th} order derivative of some standard functions: $(ax + b)^m$, e^{ax}, a^{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: Student will be able to…

1. classify discontinuities with the help of examples.
2. apply properties of continuous functions.
3. compare differentiability and continuity of real valued functions.
4. evaluate n^{th} order derivative of real valued functions.

Reference Books:

1. S. Narayan and P. K. Mittal, Differential Calculus, 15th edition, S. Chand Publishing, New Delhi, 2016.
2. S. C. Malik and S. Arora, Mathematical Analysis, 4th edition, New Age International Publishers, 2012.
3. G. B. Thomas and R. L. Finney, Calculus and Analytical Geometry, 14th edition, Pearson Education, 2007.
4. H. Anton, I. Birens and Davis, Calculus, third edition, John Wiley and Sons, Inc. ,2002.

BMT 112: Differential Equations

Course Objectives: Student should able to…

1. study linear differential equations of first order and first degree.
2. learns methods of solution of differential equations of first order but not first degree.
3. obtain auxillary equation of differential equations of type $f(D)y = 0$.
4. find general solution of differential equations of type $f(D)y = X$.

Credits=2	**SEMESTER-I** **BMT 112: Differential Equations**	**No. of hours per unit**
UNIT I	**Differential Equations of first order and first degree**	**(08)**
	1.1 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 II	**Differential Equations of first order but not of first degree**	**(06)**
	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 III	**Homogeneous Linear Differential Equations with constant Coefficients**	**(08)**
	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 IV	**Non-Homogeneous Linear Differential Equations with constant Coefficients**	**(08)**
	4.1 Meaning of symbol $\frac{1}{f(D)}$. 4.2 General solution of f(D) y=X. 4.3 Theorem: (A) $\frac{1}{D-a}X=e^{ax}\int X\,e^{-ax}dx$	

	(B) $\frac{1}{D+a}X = e^{-ax}\int X\, e^{ax}dx$ 4.4 General Methods to find Particular Integral and Examples. 4.5 Theorem: $\frac{1}{(D-a)^n}e^{ax} = \frac{x^n}{n!}e^{ax}; n \in \mathbb{Z}^+$. 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: Student will be able to…

1) classify differential equations of first order and first degree.
2) solve differential equations of first order but not first degree by various methods.
3) examine differential equation of type f(D)y=0 to obtain the solution.
4) construct complete solution of linear differential equation with constant coefficient.

Reference Books:

1. M. D. Raisinghania, Ordinary and partial differential equations, 18th revised edition, S. Chand and Company Pvt. Ltd., New Delhi, 2016.
2. Z. Ahasan, Differential Equations and Their Applications, 2nd edition, PHI, 2004.
3. R. K. Ghosh and K. C. Maity, An Introduction to Differential Equations, 7th edition, Book and Allied (P) Ltd., 2000.

BMP 113: Practical-I: LAB-I

Course Objectives: Student should be able to…

1. study the relationship between continuity and differentiation.
2. learn differential equations of special types.
3. understand applications of differential equations of first order.
4. study linear differential equations with constant coefficient.

Credits=2	**SEMESTER-I** **BMP 113: Practical-I: LAB-I**	**No. of contact hours (60)**
1	Computation of limit of a function.	4
2	Testing Continuity of function.	4

3	Computation of n^{th} order derivative.	4
4	Problems on Leibnitz's theorem.	4
5	Problems on Exact differential equations.	4
6	Problems on Linear Differential Equations.	4
7	Problems on Bernoulli's Differential Equations.	4
8	Computation of Orthogonal trajectories: Cartesian co-ordinates.	4
9	Computation of Orthogonal trajectories: polar co-ordinates.	4
10	Computation on Equations solvable for p.	4
11	Computation on Equations solvable for x.	4
12	Computation on Equations solvable for y.	4
13	Computation on Clairaut's Form and Equations Reducible to Clairaut's Form.	4
14	Problems on Linear Differential Equations with constant Coefficients of type f(D)y=0.	4
15	Problems on Linear Differential Equations with constant Coefficients of type f(D)y=X.	4

Course Outcomes: Student will be able to…

1. evaluate examples on continuity and differentiability of functions.
2. solve linear and Bernoulli's differential equations.
3. apply methods of solving differential equations to obtain orthogonal trajectories.
4. construct solutions of linear differential equations with constant coefficients.

Reference Books:

1. M. D. Raisinghania, Ordinary and partial differential equations, 18^{th} revised edition, S. Chand and Company Pvt. Ltd., New Delhi, 2016.
2. S. Narayan and P. K. Mittal, Differential Calculus, 15^{th} edition, S. Chand Publishing, New Delhi, 2016.
3. S. C. Malik and S. Arora, Mathematical Analysis, 4^{th} edition, New Age International Publishers, 2012.
4. G. B. Thomas and R. L. Finney, Calculus and Analytical Geometry, 14th edition, Pearson Education, 2007.

5. Z. Ahasan, Differential Equations and Their Applications, 2nd edition, PHI, 2004.
6. H. Anton, I. Birens and Davis, Calculus, third edition, John Wiley and Sons, Inc. ,2002.
7. R. K. Ghosh and K. C. Maity, An Introduction to Differential Equations, 7th edition, Book and Allied (P) Ltd., 2000.

SEMESTER II

BMT 121: Differential Calculus

Course Objectives: Student should be able to…

1. discuss mean value theorems and their geometrical interpretation.
2. study series expansion of functions and indeterminate forms.
3. learn partial differentiation of functions of two variables.
4. obtain extreme values of functions using Lagrange's method.

Credits=2	SEMESTER-II **BMT 121: Differential Calculus**	No. of hours per unit
UNIT I	**Mean Value Theorems**	**(08)**
	1.1 Rolle's Theorem 1.1.1 Geometrical interpretation 1.1.2 Examples on Rolle's theorem 1.2 Lagrange's Mean Value Theorem 1.2.1 Geometrical interpretation 1.2.2 Examples 1.3 Cauchy's Mean Value Theorem 1.3.1 Examples	
UNIT II	**Series Expansion and Indeterminate Forms**	**(06)**
	2.1Taylor's Theorem with Lagrange's and Cauchy's form of remainder (Statement only) 2.2Maclaurin's Theorem with Lagrange's and Cauchy's form of remainder (statement only) 2.3 Maclaurin's Series for $e^x, \sin x, \cos x, \log(1+x), \log(1-x), (1+x)^n$,	

	$\frac{1}{1+x}, \frac{1}{1-x}$ 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 III	**Partial Differentiation**	**(08)**
	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 $x\frac{\partial f}{\partial x} + y\frac{\partial f}{\partial y} = n\frac{F(u)}{F'(u)}$ 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 IV	**Extreme Values**	**(08)**
	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: Student will be able to

1. understand Mean value theorems and their application.
2. solve indeterminate forms and expand functions into series.
3. apply Eulers theorem for partial differentiation of Homogeneous functions.

4. evaluate Maxima and Minima of functions of two variables using Lagrange's method.

Reference Books:

1. S. Narayan and P. K. Mittal, Differential Calculus, 15th edition, S. Chand Publishing, New Delhi, 2016.
2. S. C. Malik and S. Arora, Mathematical Analysis, 4th edition, New Age International Publishers, 2012.
3. G. B. Thomas and R. L. Finney, Calculus and Analytical Geometry, 14th edition, Pearson Education, 2007.
4. H. Anton, I. Birens and Davis, Calculus, third edition, John Wiley and Sons, Inc. ,2002.

BMT 122: Advanced Differential Equations

Course Objectives: Student should be able to…

1.study homogeneous linear differential equations.

2.learn different methods for solving second order differential equations.

3.discuss ordinary simultaneous differential equation and its geometrical interpretation.

4.obtain necessary and sufficient condition of integrability of total differential equations.

Credits=2	**SEMESTER-II** **BMT 122: Advanced Differential Equations**	**No. of hours per unit**
UNIT I	**Homogeneous Linear Differential Equations**	**(06)**
	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 II	**Second Order Linear Differential Equations**	**(10)**
	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 III	**Ordinary Simultaneous Differential Equations**	**(06)**
	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 IV	**Total Differential Equations**	**(08)**
	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: Student will be able to…

1. examine homogeneous linear differential equation and its solution.
2. solve second order differential equations using various methods.
3. analyze ordinary simultaneous differential equations to obtain solution.
4. evaluate total differential equations by treating one variable constant.

Reference Books:

1. M. D. Raisinghania, Ordinary and partial differential equations, 18th revised edition, S. Chand and Company Pvt. Ltd., New Delhi, 2016.

2. Z. Ahasan, Differential Equations and Their Applications, 2nd edition, PHI, 2004.
3. R. K. Ghosh and K. C. Maity, An Introduction to Differential Equations, 7th edition, Book and Allied (P) Ltd., 2000.

BMP 123: Practical-II: LAB-II

Course Objectives: Student should be able to…

1. study applications of Mean Value theorems.
2. learn methods for finding extreme values of functions of two variables.
3. understand methods for solution of Linear differential equations.
4. gain knowledge of total differential equations and their solution.

Credits=2	**SEMESTER-II** **BMP 123: Practical II: LAB-II**	**No. of contact hours (60)**
1	Computation on Lagrange's Mean Value Theorem	4
2	Computation on Cauchy's Mean Value Theorem	4
3	Computation on Taylors series and Maclaurin's series.	4
4	Computation on Indeterminate forms.	4
5	Computation on Partial derivatives.	4
6	Application of Eulers theorem on Homogeneous functions.	4
7	Computation of Extreme values.	4
8	Computation on Lagrange's undetermined multiplier method.	4
9	Computation on Homogeneous Linear Differential Equations.	4
10	Computation on Equations Reducible to Homogeneous Linear Differential Equations.	4
11	Problems on Second Order Linear Differential Equations (One solution is known).	4
12	Problems on Second Order Linear Differential Equations (By Changing Dependent Variable).	4
13	Problems on Second Order Linear Differential Equations (By Changing Independent Variable).	4

14	Computation on Simultaneous differential equations.	4
15	Computation on Total Differential Equations.	4

Course Outcomes: Student will be able to…

1. examine indeterminate forms and then find solution.
2. apply Lagrange's method of undetermined multipliers to find extreme values.
3. solve linear differential equations with various methods.
4. construct solutions of total differential equations by treating one variable constant.

Reference Books:

1. M. D. Raisinghania, Ordinary and partial differential equations, 18th revised edition, S. Chand and Company Pvt. Ltd., New Delhi, 2016.
2. S. Narayan and P. K. Mittal, Differential Calculus, 15th edition, S. Chand Publishing, New Delhi, 2016.
3. S. C. Malik and S. Arora, Mathematical Analysis, 4th edition, New Age International Publishers, 2012.
4. G. B. Thomas and R. L. Finney, Calculus and Analytical Geometry, 14th edition, Pearson Education, 2007.
5. Z. Ahasan, Differential Equations and Their Applications, 2nd edition, PHI, 2004.
6. H. Anton, I. Birens and Davis, Calculus, third edition, John Wiley and Sons, Inc., 2002.
7. R. K. Ghosh and K. C. Maity, An Introduction to Differential Equations, 7th edition, Book and Allied (P) Ltd., 2000.

Open Elective (OE) Semester-I

BMTOE 1: Foundations of Logical Reasoning

Course Objectives: Student will be able to

1. understand the significance and basic concepts of logic
2. learn to create and interpret truth tables, recognize logical equivalence, and simplify logical expressions.
3. distinguish between valid and invalid arguments, recognize various logical fallacies, and understand the difference between formal and informal logic.

4. study direct proof and proof by contradiction to demonstrate logical relationships and validate arguments.

Credits = 02	SEMESTER-I BMTOE 1: Foundations of Logical Reasoning	No. of hours per unit
UNIT-I	**Introduction to Logic**	(08)
	1.1 Definition and significance of logic 1.2 Distinction between inductive and deductive reasoning 1.3 Basic terminology: statements, propositions, arguments	
UNIT-II	**Propositional Logic Basics**	(07)
	2.1 Logical connectives (and, or, not, if...then) 2.2 Truth tables 2.3 Logical equivalence and implications	
UNIT-III	**Basic Argument Forms**	(07)
	3.1 Identifying arguments 3.2 Valid vs. invalid arguments 3.3 Common logical fallacies	
UNIT-IV	**Introduction to Proofs**	(08)
	4.1 Basic proof techniques 4.2 Direct proof 4.3 Proof by contradiction	

Course Outcomes: Student should be able to
1. apply logical connectives to construct and simplify logical expressions
2. differentiate between valid and invalid arguments.
3. assess the validity of arguments using truth tables and logical equivalence.
4. develop logical arguments and validate them using appropriate proof techniques.

References:

1. Hurley, Patrick J. *A Concise Introduction to Logic*. Boston: Cengage Learning, 2014.
2. Copi, Irving M., and Carl Cohen. *Introduction to Logic*. 14th ed. Upper Saddle River, NJ: Pearson, 2011.

Open Elective (OE) Semester-II

BMTOE 2: Propositional Logic

Course Objectives: Student should be able to…
1. familiarize themselves with the symbols and notation used in propositional logic and learn to interpret truth assignments.
2. learn to create truth tables to evaluate logical expressions and understand logical equivalence, tautologies, and contradictions.
3. study the various logical connectives, such as conditional and biconditional statements,

and their properties.
4. practice formal proof techniques and strategies specific to propositional logic.

Credits = 02	SEMESTER-II BMTOE 2: Propositional Logic	No. of hours per unit
UNIT-I	**Propositional Logic Syntax and Semantics**	**(08)**
	1.1 Symbols and notation 1.2 Well-formed formulas (WFFs) 1.3 Interpretation and truth assignments	
UNIT-II	**Truth Tables and Logical Equivalence**	**(07)**
	2.1 Constructing truth tables 2.2 Logical equivalence, tautologies, contradictions 2.3 Simplifying logical expressions	
UNIT-III	**Logical Connectives in Depth**	**(08)**
	3.1 Conditional and biconditional statements 3.2 Converse, inverse, and contrapositive 3.3 De Morgan's laws	
UNIT-IV	**Methods of Proof in Propositional Logic**	**(07)**
	4.1 Formal proofs and rules of inference 4.2 Proof strategies 4.3 Common proof techniques	

Course Outcomes: Student will be able to…

1. apply logical connectives to construct well-formed formulas.
2. differentiate between tautologies, contradictions, and contingencies.
3. assess the validity of logical expressions using truth tables and equivalence transformations.
4. construct formal proofs using methods such as direct proof and proof by contradiction.

References:

1. Hausman, Alan, Howard Kahane, and Paul Tidman. Logic and Philosophy: A Modern Introduction. 12th ed. Belmont, CA: Wadsworth Publishing, 2012.
2. Hardegree, Gary M. *Symbolic Logic: A First Course*. New York: McGraw-Hill, 1999.