UNIVERSITY OF MUMBAI
No. UG/ 138 of 2011

CIRCULAR:-

A reference is invited to the Ordinances, Regulations and syllabi relating to the B.Sc/B.A. degree course **vide** this office Circular No. UG/69 of 2011, dated 18th April, 2011, and the Principals of the affiliated colleges in Science and Arts are hereby informed that the recommendation made by the Board of Studies in Mathematics at its meeting held on 18th April, 2011, and by the Faculty of Arts at its meeting held on 13th May, 2011 and also by the faculty of Science at its meeting held on 29th April, 2011, has been accepted by the Academic Council at its meeting held on 25th May, 2011 **vide** item No. 4.25 and that, in accordance therewith, the revised syllabus and scheme of examination as per the Credit Based Semester and Grading System for First Year of B.Sc./B.A. Programmes in Mathematics are as per **Appendix** and that the same has been brought into force with effect from the academic year 2011–2012.

MUMBAI – 400 032
14th June, 2011

(Prin. (Dr.) M.S.Kurhade)
I/c. Registrar

Academic Council 25/05/2011
Item No. 4.25

UNIVERSITY OF MUMBAI

SYLLABUS for the F.Y.B.A/B.Sc.
Programme:B.A./B.Sc.
Course: Mathematics

(Credit Based Semester and Grading System with effect from the academic year 2011–2012)

Revised syllabus in Mathematics
As per credit based system
First Year B.A./B.Sc. 2011-12

Name of the Programme	Duration	Semester	Subject
B.Sc. in Mathematics	Six semesters	I	Mathematics (courses: USMT101,USMT102)
B.A. in Mathematics	Six semesters	I	Mathematics (course: UAMT101)
Course Code	Title	Credits	
USMT101,UAMT101	Calculus and Analytics Geometry I	3 for USMT101,USMT102,UAMT101	

Teaching Pattern

1. Three lectures per week per course (1 lecture/period is of 48 minutes duration).
2. One tutorial per week per batch per course. (The batches to be formed as prescribed by the University).
3. One assignment per week.

Prerequisites

(i) Limits of some standard functions as x approaches a ($a \in \mathbb{R}$), such as constant function, x, x^n, $\sin x$, $\cos x$, $\tan x$, $\frac{x^n - a^n}{x - a}$ $n \in \mathbb{Q}$ ($a > 0$), exponential and logarithmic functions, $\lim_{x\to 0}\frac{\sin x}{x}$, continuity in terms of limits.

(ii) Derivatives, Derivatives of standard functions such as constant function, x^n, trigonometric functions, e^x, a^x ($a > 0$), $\log x$.

Unit I. Limit and continuity of functions of one variable (15 Lectures)

(a) (i) Absolute value of a real number and the properties such as $|-a| = |a|$, $|ab| = |a||b|$ and $|a + b| \leq |a| + |b|$.

(ii) Intervals in R, neighbourhoods and deleted neighbourhoods of a real number, bounded subsets of R.

(b) (i) Graphs of functions such as $|x|$, $\frac{1}{x}$, $ax^2 + bx + c$, $\lfloor x \rfloor$ (flooring function), $\lceil x \rceil$ (Ceiling function), x^3, $\sin x$, $\cos x$, $\tan x$, $\sin \frac{1}{x}$, $x \sin \frac{1}{x}$ over suitable intervals.

(ii) Graph of a bijective function and its inverse. Examples such as x^2 and $x^{1/2}$, x^3 and $x^{1/3}$, $ax + b$ ($a \neq 0$) and $\frac{1}{a}x - \frac{b}{a}$ over suitable domains.

(c) (i) Statement of rules for finding limits, sum rule, diference rule, product rule, constant multiple rule, quotient rule.

(ii) Sandwich theorem of limits (without proof).

(iii) Limit of composite functions (without proof).

(d) $\varepsilon - \delta$ definition of limit of a real valued function, simple illustrations like $ax + b$, $\sqrt{x + a}$ ($a \geq 0$), x^2, $\sin x$, $\cos x$. (In general, evaluation of limits to be done using rules in (c)).
ε–δ definition of one sided limit of a real valued function. Formal definition of infinite limits, examples such as $\lim_{x\to 0^+} \frac{1}{x}$, $\lim_{x\to 0^-} \frac{1}{x}$.

(e) (i) Continuity of a real valued function at a point in terms of limits, and two sided limits. Graphical representation of continuity of a real valued function.

(ii) Continuity of a real valued function at end points of domain.

(iii) Removable discontinuity at a point of a real valued function and extension of a function having removable discontinuity at a point to a function continuous at that point.

(iv) Continuity of polynomials and rational functions.

(v) Constructing a real valued function having finitely many prescribed points of discontinuity over an interval.

(f) Continuity of a real valued function over an interval. Statements of properties of continuous functions such as the following:

 (i) Intermediate value property.

 (ii) A continuous function on a closed and bounded interval is bounded and attains its bounds.

 Elementary consequences such as if $f : [a,b] \to \mathbb{R}$ is continuous then range of f is a closed and bounded interval.

 Applications.

(g) Definition of limit as x approaches $\pm\infty$, examples. Limits of rational functions as x approaches $\pm\infty$.

Reference for Unit I: *Chapter Preliminaries*, *Section* 1 and *Chapter* 1, *Sections* 1.2, 1.3, 1.4, 1.5 *of* **Calculus and Analytic Geometry**, G.B. Thomas *and* R. L. Finney, *Ninth Edition*, *Addison-Wesley*, 1998.

Unit II. Diferentiability of functions of one variable (15 Lectures)

(a) Definition of derivative of a real valued function at a point, notion of differentiability, geometric interpretation of a derivative of a real valued function at a point, diferentiability of a function over an interval, statement of rules of diferentiability, chain rule of finding derivative of composite diferentiable functions, derivative of an inverse function (without proof). Intermediate value property of derivative (without proof) and its applications, implicit diferentiation.

(b) (i) Diferentiable functions are continuous, but the converse is not true.

 (ii) Higher order derivatives, examples of functions $x^n|x|$, $n = 0, 1, 2, \ldots$ which are diferentiable n times but not $(n + 1)$ times.

 (iii) Leibnitz Theorem for n^{th} order derivative of product of two n times diferentiable functions.

Reference for Unit II: *Chapter* 2, *Sections* 2.1, 2.2, 2.3, 2.5, 2.6 *of* **Calculus and Analytic Geometry**, G.B. Thomas *and* R. L. Finney, *Ninth Edition*, *Addison-Wesley*, 1998. and *Chapter* 4, *Section* 4.1 *of* **A Course in Calculus and Real Analysis**, Sudhir. R. Ghorpade *and* Balmohan V. Limaye, *Springer International Edition*.

Unit III. Applications of derivatives (15 Lectures)

(a) (i) Mean Value Theorems: Rolle's Mean Value Theorem, Lagrange's Mean Value Theorem, Cauchy's Mean Value Theorem. Applications such as L' Hospital's rule $\frac{0}{0}$ and $\frac{\infty}{\infty}$ form.

(ii) Taylor's polynomial and Taylor's Theorem with Lagrange's form of remainder.

(b) Extreme values of functions, absolute and local extrema, first derivative test, critical points, increasing and decreasing functions, the second derivative test for extreme values.

(c) Graphing of functions using first and second derivatives, the second derivative test for concavity, points of inflection.

Reference for Unit III: *Chapter* 3, *Sections* 3.1, 3.2, 3.4, 3.5 and *Chapter* 8, *Section* 8.9 *of* **Calculus and Analytic Geometry**, G.B. Thomas *and* R. L. Finney, *Ninth Edition*, *Addison-Wesley*, 1998. and *Chapter* 4, *Sections* 4.2, 4.3, 4.4 and *Chapter* 5, *Sections* 5.1, 5.2 *of* **A Course in Calculus and Real Analysis**, Sudhir. R. Ghorpade *and* Balmohan V. Limaye, *Springer International Edition*.

Note:

1. The scheme of lectures recommended is suggestive.
2. It is recommended that the concepts may be illustrated using computer softwares, and graphing calculators wherever possible.
3. Applications and mathematical modeling of concepts to be done wherever possible.

Recommended Books

1. G.B. Thomas and R. L. Finney, *Calculus and Analytic Geometry*, Ninth Edition, Addison-Wesley, 1998.
2. Sudhir. R. Ghorpade and Balmohan V. Limaye, *A Course in Calculus and Real Analysis*, Springer International Edition.

Additional Reference Books

1. Tom Apostol, *Calculus Volume 1, One variable calculus with an introduction to Linear Algebra*, Second Edition, Wiley Publications. (Evaluation copy available for instructors).

2. Deborah Hughes-Hallet, Andrew Gleason, Daniel Flath, Patti Frazer, Thomas Tucker, David Lomen, David Lovelock, David Mumford, Brad Osgood, Douglas Quinney, Karen Rhea, Jeff Tecosky-Fredman, *Calculus, Single and Multivariable*, Fourth Edition, Wiley Europe Higher Education, (Online version of textbook and online grade book available).

3. Satunio L. Salas, Garret J. Eigen, Einar Hille, *Calculus : One variable*, Wiley Europe Higher Education (online version and online grade book available).

Suggested topics for Tutorials/Assignments

(1) Graphs and functions.

(2) Limits of functions using $\varepsilon - \delta$ definition. (Simple functions recommended in the syllabus).

(3) Calculating limits using rules of limits and Sandwich theorem.

(4) Continuity over an interval (intermediate value property, maxima, minima over closed interval.

(5) Diferentiability, chain rule, implicit diferentiation.

(6) Higher order derivatives and Leibnitz theorem.

(7) Mean Value Theorems; Applications.

(8) Taylor's Theorem, Taylor's polynomials.

(9) Extrema; Local and absolute.

(10) Graphing of functions, Asymptotes.

Name of the Programme	Duration	Semester	Subject
B.Sc. in Mathematics	Six semesters	I	Mathematics (courses: USMT101,USMT102)
B.A. in Mathematics	Six semesters	I	Mathematics (course: UAMT101)
Course Code	Title	Credits	
USMT102	Discrete Mathematics I	3 for USMT101,USMT102,UAMT101	

Teaching Pattern

1. Three lectures per week per course (1 lecture/period is of 48 minutes duration).
2. One tutorial per week per batch per course. (The batches to be formed as prescribed by the University).
3. One assignment per week.

Prerequisites

(i) Set Theory: Set, subset, union and intersection of two sets, empty set, universal set, complement of a set, De Morgan's laws, cartesian product of two sets.

(ii) Relations, functions.

(iii) First Principle of finite induction.

(iv) Permutations and combinations, ${}^nC_r$, ${}^nP_r$.

(v) Complex numbers: Addition and multiplication of complex numbers, modulus, amplitude and conjugate of a complex number.

Unit I. Integers and divisibility (15 Lectures)

(a) (i) Statements of well-ordering property of non-negative integers.

(ii) Principle of finite induction (first and second) as a consequence of well-ordering property.

Binomial Theorem for non-negative exponents, Pascal Triangle. Recursive definitions.

(b) Divisibility in integers, division algorithm, greatest common divisor (g.c.d.) and least common multiple (l.c.m.) of two integers, basic properties of g.c.d. such as existence and uniqueness of g.c.d. of integers a and b and that the g.c.d. can be expressed as $ma + nb$ for some $m, n \in \mathbb{Z}$, Euclidean algorithm.

(c) Primes, Euclid's lemma, Fundamental Theorem of Arithmetic.

Reference for Unit I: *Chapter* 1, *Sections* 1.1, 1.2, *Chapter* 2, *Sections* 2.1, 2.2, 2.3, and *Chapter* 3, *Section* 3.1 *of* **Elementary Number Theory**, David M. Burton, *Second Edition*, *UBS, New Delhi*.

Unit II. Functions and Counting Principles (15 Lectures)

(a) (i) Review of functions, domain, codomain and range of a function, composite functions.

(ii) Direct image $f(A)$ and inverse image $f^{-1}(B)$ of a function f.

(iii) Injective, surjective, bijective functions. Composite of injective, surjective, bijective functions are injective, surjective and bijective respectively.

(iv) Invertible functions and finding their inverse. Bijective functions are invertible and conversely.

(v) Examples of functions including constant, identity, projection, inclusion.

(b) Binary operation as a function, properties, examples.

(c) (i) There is no injection from $\mathbb{N}_n$ to $\mathbb{N}_m$ if $n > m$, $\mathbb{N}_n = \{1, 2, \ldots, n\}$.

(ii) Pigeon Hole Principle and its applications.

(iii) Finite and infinite sets, cardinality of a finite set.

(iv) The number of subsets of a finite set having n elements is 2^n.

Reference for Unit II: *Chapter* 2 *of* **Discrete Mathematics**, Norman L. Biggs, *Revised Edition*, *Clarendon Press*, *Oxford* 1989.

Unit III. Integers and Congruences (15 Lectures)

(a) (i) The set of primes is infinite.

(ii) The set of primes of the type $4n - 1$ (or $4n + 1$ or $6n - 1$) is infinite.

(b) Congruences: Definition and elementary properties.

(c) Euler-ϕ function, invertible elements modulo *n*

(d) (i) Euler's Theorem (without proof).

(ii) Fermat's Little Theorem.

(iii) Wilson's Theorem.

(iv) Applications: Solution of linear congruences.

Reference for Unit III: *Chapter* 4, *Chapter* 5, *Sections* 5.2, 5.3, 5.4 and *Chapter* 7, *Sections* 7.1, 7.2, 7.3 *of* **Elementary Number Theory**, David M. Burton, *Second Edition*, *UBS, New Delhi*.

Recommended Books

1. Norman L. Biggs, *Discrete Mathematics*, Revised Edition, Clarendon Press, Oxford 1989.

2. David M. Burton, *Elementary Number Theory*, Second Edition, UBS, New Delhi.

3. Kenneth H. Rosen, Discrete Mathematics and its applications, Mc-Graw Hill International Edition, Mathematics Series.

4. G. Birkoff and S. Maclane, A Survey of Modern Algebra, Third Edition, Mac Millan,New York, 1965.

5. I. Niven and S. Zuckerman, Introduction to the theory of numbers, Third Edition, Wiley Eastern, New Delhi, 1972.

Additional Reference Books

1. K.D. Joshi, *Foundations in Discrete Mathematics*, New Age Publishers, New Delhi, 1989.

2. Graham, Knuth and Patashnik, *Concrete Mathematics*, Pearson Education Asia Low Price Edition.

Suggested topics for Tutorials/Assignments

(1) Mathematical induction (The problems done in F.Y.J.C. may be avoided).

(2) Division Algorithm and Euclidean algorithm, in Z.

(3) Primes and the Fundamental Theorem of Arithmetic.

(4) Functions (direct image and inverse image). Injective, surjective, bijective functions, finding inverses of bijective functions.

(5) Pigeon Hole Principle.

(6) Congruences and Euler ϕ-function.

(7) Fermat's Little Theorem, Euler's Theorem and Wilson's Theorem.

Name of the Programme	Duration	Semester	Subject
B.Sc. in Mathematics	Six semesters	II	Mathematics (courses: USMT201,USMT202)
B.A. in Mathematics	Six semesters	II	Mathematics (course: UAMT201)
Course Code	Title	Credits	
USMT201,UAMT201	Calculus and Analytics Geometry II	3 for USMT201,USMT202,UAMT201	

Teaching Pattern