UNIVESITY OF DELHI

Name of the Department: Mathematics
Course: B. Sc. (Hons.) Mathematics

Semester I	Calculus I	Concurrent- Credit Course I
	Analysis I	
	Algebra I	
Semester II	Diff. Eqn. I	Concurrent- Credit Course II
	Analysis II	
	Prob. And Stats.	
Semester III	Calculus II	Concurrent qualifying Course
	Num. Methods	
	Algebra II	
Semester IV	Diff. Eqn. II	Concurrent- Credit Course III .1
	Analysis III	
	Algebra III	
Semester V	Diff. Eqn. III	
	Analysis IV	
	Algebra IV	
	Linear Prog.	
Semester VI	Analysis V	Concurrent- Credit Course III .2
	Algebra V	
	Optional	

SEMESTER BASED UNDER-GRADUATE HONOURS COURSES

Distribution of Marks & Teaching Hours

The Semester-wise distribution of papers for the B.A. (Honours), B.Com. (Honours), B. Com., B.Sc. (Honours) Statistics and B.Sc. (Honours) Computer Science will be as follows:

Type of Paper	Max. Marks	Theory Exam.	I.A.	Teaching per week
Main Papers	100	75	25	5 Lectures 1 Tutorial
Concurrent Courses	100	75	25	4 Lectures 1 Tutorial
Credit Courses for B.Sc.(Hons.) Mathematics	100	75	25	4 Lectures 1 Tutorial

- Size of the Tutorial Group will be in accordance with the existing norms.
- The existing syllabi of all Concurrent/Credit Courses shall remain unchanged.
- The existing criteria for opting for the Concurrent /Credit Courses shall also remain unchanged.

Note: **The above distribution of marks and teaching hours, as resolved by the Academic Council overrides any information indicated in the enclosed syllabus in case of any variation between the two.**

PROPOSED SYLLABUS

B.Sc. (H) Mathematics

SEMESTER SCHEME

DEPARTMENT OF MATHEMATICS
UNIVERSITY OF DELHI
DELHI-110007

Proposed Syllabus of B.Sc. (H) Mathematics

Following will be the contents of proposed syllabus of B.Sc. (Hons.) Mathematics in the session 2011-12 and onwards.

There are 19 papers of Mathematics (Algebra 5, Analysis 5, Calculus 2, Differential Equations & Mathematical Modeling 3, Numerical Methods & Programming 1, Probability and Statistics 1, Linear Prog. & Theory of Games 1, Optional Paper 1).

The Mathematics Honors degree will consist of 2600 Marks. Each theory paper will be of 100 marks. All the theory and practical papers will have examination of 3 hours duration. Paper containing practical components will be of 150 marks. The practical paper is common for all the papers in a particular semester. There will be an external examiner in all the practical exams. There will be 5 lectures and one tutorial for all the papers. Two classes are allotted for the practical per student per week. A practical group will consists of at most 20 students. Use of Scientific Calculator is allowed.

Every college is advised to offer at least two optional courses in Mathematics out of four courses (Discrete Mathematics, Mathematical Finance, Mechanics and Number Theory) in Semester VI.

The semester-wise distribution of the papers is as follows:

:MESTER I	Calculus I	Analysis I	Algebra I	Credit course I
:MESTER II	Diff. Eqn. I	Analysis II	Prob. and Stats.	Credit course II
:MESTER III	Calculus II	Num. Methods	Algebra II	Qualifying paper
:MESTER IV	Diff. Eqn. II	Analysis III	Algebra III	Credit course III.1
:MESTER V	Diff. Eqn. III	Analysis IV	Algebra IV	Linear Prog. & Theory of Games
:MESTER VI	Analysis V	Algebra V	Optional	Credit course III.2

Along with the above mentioned papers, a student will have to opt for four credit courses from disciplines other than Mathematics and a qualifying paper. A student will have to choose one course each from Credit Course I in semester I , Credit Course II in semester II and Qualifying Course in Semester III .A student will have to opt for two courses from Credit Course III as Credit III.1 and Credit Course III.2 in semester IV and Semester VI respectively. In those subjects where more than one course is offered, the student shall opt for one of the course. But if a student opts for Physics-II he/ she may opt for Physics(Lab). The marks of Credit Course I, II, III.1 and III.2 shall count in the final result of the student.

Credit Course I

(i) Ethics in Public Domain
(ii) Environmental Issues in India
(iii) Reading Gandhi
(iv) The Individual and Society
(v) Hindi Language, Literature and Culture
(vi) Gender and Society
(vii) Financial Management
(viii) Chemistry
(ix) Physics-I

Note: (a) Courses (i)-(vi) are the interdisciplinary courses of the BA (Hons) Programme.

(b) Course (vii) is the elective course EL 210 (vi) of B.Sc Programme.

(c) Course (viii) is the Paper V being taught in First year Physics (Hons).

(d) Course (ix) is the Paper V being taught in First year Chemistry (Hons).

Credit Course II

(i) English
(ii) Hindi
(iii) Sanskrit
(iv) Chemistry
(v) Physics-I

(vi) Chemistry (Lab)
(vii) Physics (Lab)

Note: (a) Courses (i)-(iii) are the language credit courses of the BA (Hons) Programme.

(b) Course (iv) is the Paper V being taught in First year Physics (Hons). For students of Maths (Hons), only six out of the twelve experiments will have to be done. These experiments may be selected at the college level.

(c) Course (v) is the Paper V being taught in First year Chemistry (Hons).

(d) Course (vi) is the Paper VIII being taught in First year Physics (Hons).

(e) Course (vii) is the Lab II being conducted in First year Chemistry (Hons).

Qualifying Course

(i) English (Higher)
(ii) English (Lower)
(iii) Hindi (Higher)
(iv) Hindi (Lower)
(v) Sanskrit
(vi) Chemistry (Lab)
(vii) Physics (Lab)

Note: (a) Courses (i)-(v) are the language qualifying courses of the BA (Hons) Programme.

(b) Course (vi) is the Paper VIII being taught in First year Physics (Hons).

(c) Course (vii) is the Lab II being conducted in First year Chemistry (Hons).

MARKS:

* Each of the Credit I, Credit II and Qualifying courses are of 100 marks:

Semester examination 75 marks, internal assessment 25 marks.

* The pass mark for the credit courses is 40 percent.

* The pass mark for the qualifying courses is 36 percent. A student has to pass in the qualifying course to be eligible for an Honors degree. However, the marks in this course will not be counted in the final division awarded.

* Internal assessments will be held for the credit courses but not for the qualifying course.

NUMBER OF LECTURES:

* Four hours per week or four classes for Credit Course I , Credit Course II and Qualifying Course (i)-(v). For each of the credit courses, one tutorial will be held for students. Six hours for (vi) and (vii).

RULES:

* Every student must opt for at least one language. It can either be a credit course or a qualifying course. If they are opting for a language in both the credit as well as the qualifying course then these cannot be the same languages.

* A student offering Chemistry/ Physics-I as Credit Course I will not be allowed to offer the same as Credit Course II.

* A student offering Chemistry/ Physics-I as Credit Course I can opt for Chemistry (Lab)/ Physics (Lab) as Credit Course II but then they cannot opt for these courses as qualifying courses.

* A student will be allowed to take Chemistry (Lab)/ Physics (Lab) as a qualifying course if they have opted for Chemistry/Physics-I respectively as a credit course.

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Credit Course III

(i) Psychology for Living
(ii) Hindi Literature
(iii) Modern Indian Literature, Poems and Short Stories; Novel or Play
OR

Cultural Diversity, Linguistic Plurality and Literary Traditions in India.

(iv) Formal Logic/ Symbolic Logic
OR

Readings in Western Philosophy

OR

Theory of Consciousness

(v) Citizenship in Globalizing World
(vi) Culture in India: a Historical Perspective
OR

Delhi: Ancient, Medieval and Modern

OR

Religion and Religiosity in India

OR

Inequality or Difference in India

(vii) Sociology of Contemporary India
(viii) Principles of Geography
OR

Geography of India

(ix) Principles of Economics
(x) Financial Accounting
(xi) Green Chemistry
(xii) Biotechnology
(xiii) Physics- II
(xiv) Biophysics
(xv) Physics (Lab)

Note: (a) Courses (i)-(ix) are the discipline centred courses of the BA (Hons) Programme.

(b) Course (x-xii) are the elective courses EL 210 (v), EL 310 (i) and EL 310 (iii) of B.Sc Programme.

(c) Course (xiii) is the Paper XI being taught in Second year Chemistry (Hons).

(d) Course (xiv) is the Paper XXII (Option 2) being taught in Third year Physics (Hons).

(e) Course (xv) is Lab V being conducted in Second year Chemistry (Hons)

MARKS:

* Each course carries 100 marks: examination 75 marks, internal assessments 25 marks.
* The pass mark is 40 percent.

NUMBER OF LECTURES:

* Four hours per week or Four classes for courses (i-xiv). For each of these courses, one tutorial will be held for students.
* Six hours or Six classes for course (xv).

SEMESTER I

I.1 Calculus I

Total marks: 150
Theory: 75
Practical: 50
Internal Assessment: 25
5 Lectures, 2 Practicals, 1 Tutorial (per week per student)

Hyperbolic functions, higher order derivatives, Leibniz rule and its applications to problems of type $e^{ax+b}\sin x$, $e^{ax+b}\cos x$, $(ax+b)^n\sin x$, $(ax+b)^n\cos x$, concavity and inflection points, asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves, L'Hopital's rule, applications in business, economics and life sciences.

References:

[1]: Chapter 4 (Sections 4.3-4.5 (page 124-157), 4.7).

[2]: Chapter 7 (Section 7.8), Chapter 11 (Section 11.1).

Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin^n x\,dx$, $\int \cos^n x\,dx$, $\int \tan^n x\,dx$, $\int \sec^n x\,dx$, $\int (\log x)^n\,dx$, $\int \sin^n x \cos^m x\,dx$, volumes by slicing, disks and washers methods, volumes by cylindrical shells, parametric equations, parameterizing a curve, arc length, arc length of parametric curves, area of surface of revolution.

References:

[1]: Chapter 9 (Sections 9.4 (Pages 471-475 (excluding lines in R^3))).

[2]: Chapter 8 (Sections 8.2-8.3 (pages 532-538 (excluding integrating products of tangents and secants))), Chapter 6 (Section 6.2-6.5 (excluding arc length by numerical methods))

Techniques of sketching conics, reflection properties of conics, rotation of axes and second degree equations, classification into conics using the discriminant, polar equations of conics.

Reference:

[2]: Chapter 11 (Sections 11.4-11.6 (up to page 775 excluding sketching conics in polar coordinates)).

Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions, tangent and normal components of acceleration, modeling ballistics and planetary motion, Kepler's second law.

Reference:

[1] Chapter 9 (Section 9.3 (pages 468-469)), Chapter 10

Practical / Lab work to be performed on a computer:
Modeling of the following problems using *Motlab / Mathematica / Maple* etc.

(i) Plotting of graphs of function e^{ax+b}, $\log(ax+b)$, $1/(ax+b)$, $\sin(ax+b)$, $\cos(ax+b)$, $|ax+b|$ and be able to find the effect of a and b on the graph.

(ii) Plotting the graphs of polynomial of degree 4 and 5, the derivative graph, the second derivative graph and comparing them.

(iii) Any one of the following

(a) Sketching parametric curves (Eg. Trochoid, cycloid, epicycloids, hypocycloid)

(b) Obtaining surface of revolution of curves

(c) Tracing of conics in Cartesian coordinates/ polar coordinates

(d) Sketching ellipsoid, hyperboloid of one and two sheets, elliptic cone, elliptic paraboloid, hyperbolic paraboloid using Cartesian co-ordinates.

(iv) Any one of the following

(a) To find numbers between two real numbers.

(b) Plotting subsets of R to study boundedness /unboundedness and bounds (if they exist).

(c) Plotting of sets on R to discuss the idea of cluster points, lim sup, lim inf.

(v) Any one of the following

(a) Plotting of recursive sequences.

(b) Study the convergence of sequences through plotting.

(c) Verify Bolzano Weirstrass theorem through plotting of sequences and hence identify convergent subsequences from the plot.

(d) Studying the convergence / divergence of infinite series by plotting their sequences of partial sum.

(vi) Any one of the following

(a) Cauchy's root test by plotting n^{th} roots

(b) Ratio test by plotting the ratio of n^{th} and $n+1^{th}$ term.

(vii) Matrix operation (addition, multiplication, inverse, transpose)

REFERENCES:

1. **M. J. Strauss, G. L. Bradley** and **K. J. Smith**, *Calculus* (3rd Edition), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007.
2. **H. Anton, I. Bivens** and **S. Davis**, *Calculus* (7th Edition), John Wiley and Sons (Asia) Pte. Ltd., Singapore, 2002.

I.2 Analysis I

Total marks: 100
Theory: 75
Internal Assessment: 25
5 Lectures, 1 Tutorial (per week per student)

The algebraic and order properties of R, suprema and infima, the completeness property of R, the Archimedean property, density of rational numbers in R, characterization of intervals, neighborhoods, open sets, closed sets, limit points of a set, isolated points, closure, complements, idea of uncountability of R.

References:

[1]: Chapter 2 (Sections 2.1-2.4, 2.5 (up to 2.5.1)), Chapter 11 (Section 11.1 (up to 11.1.6 and 11.1.8)).

[2]: Chapter 1 (Sections 1-5).

Sequences, bounded sequence, limit of a sequence, convergent sequences, limit theorems, monotone sequences, monotone convergence theorem, subsequences, convergence and divergence criteria, existence of monotonic subsequences (idea only), Bolzano-Weierstrass theorem for sequences and sets, definition of Cauchy sequence, Cauchy's convergence criterion, limit superior and limit inferior of a sequence.

References:

[1]: Chapter 3 (Sections 3.1-3.5, up to 3.5.6).

[2]: Chapter 2 (Sections 7-12)

Definition of infinite series, sequence of partial sums, convergence of infinite series, Cauchy criterion, absolute and conditional convergence, convergence via boundedness of sequence of partial sums, tests of convergence: comparison test, limit comparison test, ratio test, Cauchy's nth root test (proof based on limit superior), integral test (without proof), alternating series, Leibniz test.

Reference:

[2]: Chapter 2 (Sections 14-15)

REFERENCES:

1. **R. G. Bartle** and **D. R. Sherbert**, *Introduction to Real Analysis* (3rd Edition), John Wiley and Sons (Asia) Pte. Ltd., Singapore, 2002.
2. **K. A. Ross**, *Elementary Analysis*: *The Theory of Calculus*, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

I3 Algebra I

Total Marks: 100
Theory: 75
Internal Assessment: 25
5 Lectures, 1 Tutorial (per week per student)

Polar representation of complex numbers, the nth root of unity, some simple geometric notions and properties, conditions in collinearity, orthogonality and concyclicity, similar triangles, equilateral triangles, some analytic geometry in the complex plane, the circle, statement of the fundamental theorem of algebra and its consequences, Descartes' rule of signs, bound on the real zeros, interpreting the coefficients of a polynomial.

References:

[1]: Chapter 2, Chapter 3.

[2]: Chapter 4 (Sections 4.4, 4.6 (4.6.1-4.6.8)), Chapter 5 (Sections 5.2.7, 5.2.12), Chapter 6 (Section 6.1)

Sets, binary relations, equivalence relations, congruence relation between integers, finite product of sets, functions, composition of functions, bijective functions, invertible functions, introduction of finite and infinite sets through correspondence, binary operations, principle of mathematical induction, well-ordering property of positive integers, division algorithm, statement of fundamental theorem of arithmetic.

References:

[3]: Chapter 0.

[4]: Chapter 2 (Sections 2.1-2.4), Chapter 3, Chapter 4 (Section 4.4 up to Def. 4.4.6).

Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation $Ax = b$, solution sets of linear systems, applications of linear systems, linear independence, introduction to linear transformations, the matrix of a linear transformation, inverse of a matrix, characterizations of invertible matrices, partitioned matrices, subspaces of R^n, bases and dimension of subspaces of R^n.

Reference:

[5]: Chapter 1 (Sections 1.1-1.9) and Chapter 2 (Sections 2.1-2.4, 2.8-2.9).

REFERENCES:

1. **Titu Andreescu** and **Dorin Andrica**, *Complex Numbers from A to .... Z*, Birkhauser, 2006.
2. **E.J. Barbeau**, *Polynomials*, Springer Verlag, 2003.

3. **Joseph A. Gallian,** *Contemporary Abstract Algebra* (4th Edition), Narosa Publishing House, New Delhi, 1999.
4. **Edgar G. Goodaire** and **Michael M. Parmenter,** *Discrete Mathematics with Graph Theory* (2nd Edition), Pearson Education (Singapore) Pvt. Ltd., Indian Reprint, 2003.
5. **David C. Lay,** *Linear Algebra and its Applications* (3rd Edition), Pearson Education Asia, Indian Reprint, 2007.

14 **Credit course I**

SEMESTER II

II.1 Differential Equations and Mathematical Modeling I

Total marks: 150
Theory: 75
Practical: 50
Internal Assessment: 25
5 Lectures, 2 Practicals, 1 Tutorial (per week per student)

Differential equations and mathematical models, order and degree of a differential equation, exact differential equations and integrating factors of first order differential equations, reducible second order differential equations, application of first order differential equations to acceleration-velocity model, growth and decay model.

References:

[2]: Chapter 1 (Sections 1.1, 1.4, 1.6), Chapter 2 (Section 2.3)

[3]: Chapter 2.

Introduction to compartmental models, lake pollution model (with case study of Lake Burley Griffin), drug assimilation into the blood (case of a single cold pill, case of a course of cold pills, case study of alcohol in the bloodstream), exponential growth of population, limited growth of population, limited growth with harvesting.

Reference:

[1]: Chapter 2 (Sections 2.1, 2.5-2.8), Chapter 3 (Sections 3.1-3.3)

General solution of homogeneous equation of second order, principle of superposition for a homogeneous equation, Wronskian, its properties and applications, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation, method of undetermined coefficients, method of variation of parameters, applications of second order differential equations to mechanical vibrations.

Reference:

[2]: Chapter 3 (Sections 3.1-3.5).

Equilibrium points, interpretation of the phase plane, predator-prey model and its analysis, competing species and its analysis, epidemic model of influenza and its analysis, battle model and its analysis.

Reference:

[1]: Chapter 5 (Sections 5.1, 5.3-5.4, 5.6-5.7), Chapter 6.

Practical / Lab work to be performed on a computer:
Modeling of the following problems using *Matlab / Mathematica / Maple* etc.

(i) Plotting second and third order solution families

(ii) Acceleration-velocity model

(iii) Growth and decay model (both exponential and logistic)

(iv) Any two of the following

(a) Lake pollution model (with constant/ seasonal flow and pollution concentration)
(b) Case of a single cold pill and a course of cold pills
(c) Case study of alcohol in the bloodstream (initial input/ continuous input on empty stomach and with substantial meal)
(d) Limited growth of population (with and without harvesting

(v) Any two of the following

(a) Predator prey model (basic Lotka volterra model, with density dependence, effect of DDT, two prey one predator)
(b) Epidemic model of influenza (basic epidemic model, contagious for life, disease with carriers, disease with re-infection, density dependent contact rate)
(c) Battle model (basic battle model, jungle warfare, with desertion, long range weapons)

(vi) Taylor and Maclaurin series of sin x, cos x, log $(1+x)$, e^x, $(1+x)^n$, maxima and minima, inverse of graphs.

REFERENCES:

1. **Belinda Barnes** and **Glenn R. Fulford**, *Mathematical Modeling with Case Studies, A Differential Equation Approach Using Maple*, Taylor and Francis, London and New York, 2002.
2. **C. H. Edwards** and **D. E. Penny**, *Differential Equations and Boundary Value Problems: Computing and Modeling*, Pearson Education, India, 2005.
3. **S. L. Ross**, *Differential Equations*, John Wiley and Sons, India, 2004.

II.2 Analysis II

Total marks: 100
Theory: 75
Internal Assessment: 25
5 Lectures, 1 Tutorial (per week per student)

Limits of functions, sequential criterion for limits, divergence criteria, review of limit theorems and one-sided limits, continuous functions, sequential criterion for continuity, discontinuity criterion, Dirichlet's nowhere continuous function (illustrations), combinations of continuous functions and compositions of continuous functions, continuous functions on intervals, boundedness theorem, the maximum-minimum theorem, location of roots theorem, Bolzano's intermediate value theorem, intermediate value property, preservation of interval property.

References:

[1]: Chapter 4 (Sections 4.1-4.3), Chapter 5 (Sections 5.1-5.3).

[2]: Chapter 3 (Sections 17, 18 and 20).

Uniform continuity, uniform continuity theorem, differentiation, derivative, combinations of differentiable functions, Caratheodory theorem, chain rule, derivative of inverse functions, interior extremum theorem, intermediate value property for derivatives (Darboux's theorem), review of Rolle's theorem, mean value theorem, Cauchy's mean value theorem.

References:

[1]: Chapter 5 (Section 5.4 up to 5.4.3), Chapter 6 (Sections 6.1-6.2, 6.3.2).

[2]: Chapter 3 (Section 19), Chapter 5 (Sections 28, 29)

Taylor's theorem with Lagrange and Cauchy form of remainders, binomial series theorem, Taylor series, Maclaurin series, expansions of exponential, logarithmic and trigonometric functions, convex functions, applications of mean value theorems and Taylor's theorem to monotone functions. Power series, radius of convergence, interval of convergence

References:

[1]: Chapter 6 (Sections 6.4 (up to 6.4.6)), Chapter 9 (Section 9.4 (page 271)).

[2]: Chapter 5 (Sections 31).

REFERENCES:

1. **R. G. Bartle** and **D. R. Sherbert**, *Introduction to Real Analysis* (3rd Edition), John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2. **K. A. Ross**, *Elementary Analysis: The Theory of Calculus*, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.