UNIVERSITY OF PUNE, PUNE.
BOARD OF STUDIES IN MATHEMATICS
Syllabus for M.A. / M.Sc. Mathematics,
Semester 3 and 4 for affiliated colleges
(with effect from 2014-15)

Introduction:

University of Pune has decided to change the syllabi of various faculties from June,2013. Taking into consideration the rapid changes in science and technology and new approaches in different areas of mathematics and related subjects, Board of studies in Mathematics after a thorough discussion with the teachers of Mathematics from different colleges affiliated to University of Pune has prepared the syllabus of M.Sc./M. A. Mathematics course. The model curriculum as developed by U. G. C. is used as a guideline for the present syllabus.

Aims:

i) Strengthening the understanding of the students and substantiating the conceptual framework of the Graduates in Mathematics for furthering their potential and capabilities in the subject.
ii) Introducing advanced theories in the subject in an orderly manner with a clearly defined path of interdependence.
iii) Introducing the specializations in different areas of Mathematics and at the same time emphasizing the underlying interconnections in different branches of Mathematics.
iv) Generating more interest in the subject and motivating students for self learning beyond the realm of syllabi and examinations.
v) Inculcating the spirit of inquiry among the students and preparing them to take up the research in Mathematics.
vi) Exhibiting the wide range of applications of Mathematics and preparing students to apply their knowledge in diverse areas such as Physics, Astronomy, Biology, Social Sciences, etc.

Objectives:

(i) A student should be able to understand the proof techniques in Mathematics and importance of theorems for sorting out typical examples.
(ii) A student should acquire sufficient technical competence to solve the problems of varying difficulty levels and high notational complexity.
(iii) A student should be able to make observations, experimentation and pattern recognition which would stimulate the research potential
(iv) A student should acquire the communication skill to present technical Mathematics so as to take up a career in Teaching Mathematics at various levels including schools, colleges, universities, etc.

Eligibility: As per rules and regulations of the University of Pune.

Structure of the course:
1. There are five compulsory courses in semester I and five compulsory courses in semester II.
2. There are three compulsory courses and two departmental courses in semester III and three compulsory courses and two departmental courses in semester IV.
3. The list of compulsory as well as departmental courses is given below.
4. The evaluation pattern will be according to the credit system to be introduced at post-graduate centres in the affiliated colleges.

Medium of Instruction: English
Examination:
A) Pattern of examination: Semester
B) Standard of passing : As per credit system.
C) Pattern of question papers: As per credit system
D) External Students: Allowed.
E) Verification/Revaluation: Allowed for all courses

Semester III

Compulsory courses:
MT 701 Combinatorics
MT 702 Field Theory
MT 703 Functional Analysis

Departmental courses: (Any Two)
MT 704 Graph Theory
MT 705 Classical Mechanics
MT 706 Topics in Algebra
MT 707 Topics in Analysis
MT 708 Topics in Geometry
MT 709 Discrete Mathematics
MT 710 Applied Mathematics
MT 711 C language
MT 712 Mathematical Modelling

- The syllabi of first two departmental courses is provided by the university.

Semester IV
Compulsory courses:
MT 801 Number theory
MT802 Differential Geometry
MT 803 Fourier Analysis and boundary value problems

Departmental courses: (Any Two)
MT 804 Lattice Theory

MT805 Operations Research
MT 806 Topics in Algebra
MT807 Topics in Analysis
MT 808 Topics in Geometry
MT 809 Discrete Mathematics
MT 810 Applied Mathematics
MT 811 C++ language
MT 812: Mathematics Project

- The syllabi of first two departmental courses is provided by the University.

The syllabi for courses which have been approved as Departmental courses for the M.A. /M..Sc. course of the Department of Mathematics , University of Pune , will also be approved as Departmental courses for the affiliated Colleges of the Universty of Pune.

Detailed Syllabus

MT 701 Combinatorics

1. Counting principles, arrangements and selections, arrangements and selection with repetition, distributions, binomial identities
2. Generating function : Generating function models, calculating coefficients of generating functions, partitions, exponential generating functions, a summation method.
3. Recurrence Relations : Recurrence relation models, divide and conquer relations, solution of linear and inhomogeneous recurrence relation, solution with generating functions.
4. Inclusion-exclusion: Counting with Venn diagrams, inclusion – exclusion formula, restricted positions and Rook polynomials.

Prescribed Book :
1. Alan Tucker, Applied Combinatorics (fourth edition), John Wiley & sons , New York (1995)
sections 5.1-5.6, 6.1-6.5, 7.1-7.5, 8.1-8.3.
Reference books :
1.V. Krishnamurthy, Combinatorial, Theory and Applications, East West Press, New Delhi (1989) Scientific, (1996)
2.K.D. Joshi : Foundations of discrete mathematics, Wiley
3. Marshall Hall : Combinatorial theory ,Wiley.

MT 702 Field Theory

1. Field Extensions :
   Basic Theory of Field Extensions
   Algebraic Extensions
   Classical Straightedge and Compass Constructions
   Splitting Fields and Algebraic Closures
   Separable and Inseparable Extensions
   Cyclotomic Polynomials and Extensions

2. Galois Theory :
   Basic Definitions
   The Fundamental Theorem of Galois Theory
   Finite Fields
   Galois Groups of Polynomials
   Solvable and Radical Extensions: Insolvability of the Quintic

Prescribed Book :
Dummit and Foote, Abstract Algebra, 2nd Edition, Wiley Eastern Ltd.
Chapters : 13.1 to 13.6
14.1 to 14.3, 14.6 , 14.7 (statements only)
Reference Books :
1. O. Zariski and P. Sammuel, Commutative Algebra, Vol. 1, Van Nostrand.
2. P. Bhattacharya and S. Jain, Basic Abstract Algebra, Second Edition, Cambridge University Press.

MT 703 Functional Analysis

Hilbert spaces, operators on a Hilbert space, Banach spaces.

Prescribed book :
John B. Conway : A course in functional analysis. Springer (1997) Chapters 1,2,3.

Departmental courses: (Any Two)

MT 704 Graph Theory

Paths and cycles, trees, planarity, coloring, digraphs, matchings, marriage and Mengers theorem.

Prescribed Book :
R. J. Wilson, Introduction to graph theory, Pearson, (2003) Chapters 1 – 8.

MT 705 Classical Mechanics

1. Sec 1.1-1.6 Survey of Elementary Principles.
2. Sec. 2.1-2.7 Variational Principles & Lagrange`s Equation
3. Sec.3.1-3.7 Central Force problem

4. Sec. 4.1-4.10 Kinematics of rigid body motion
5. Sec. 8.1-8.2 Hamilton Equations of motion
6. Sec.9.1-9.9 Canonical Transformations

Prescribed Book :
Classical Mechanics by Goldstein, Poole and Safko (Third Edition) 2002, Person Education Inc.
Supplementary Reading (1) Rana & Joag Classical Machanics (Tata McGraw Hill)

Semester IV

Compulsory courses:

MT 801 Number theory

1. Revision :- Divisibility in integers, Division algorithm, G.C.D., L.C.M. Fundamental theorem of arithmetic. The number of primes. Mersene numbers and Fermat's numbers.

2. Congruences :- Properties of congruence relation. Resicle classes their properties Fermat'sand Euler's theorems. Wilson's Theorem. The congruence $x^2 \equiv -1 \ (mod\ p)$ has solution iff p is the form 4n+1 where p is prime. Linear congruences of degree one. Chinese remainder Theorem.

3. Arithmetic functions : Euler function, Greatest integer function, Divisor function d(n), Mobius function m(n). Properties and their inter relation.

4. Quadratic Reciprocity :- Quadratic residue, Legendre's symbol, Its properties, Quadratic reciprocity law, Jacobi symbol, Its properties. Sums of Two Squares.

5. Some Diophantine Equations :
The equation ax + by = c , simultaneous linear equations.

6. Algebraic Numbers :- Algebraic Numbers, Algebraic number fields. Algebraic integers, Quadratic fields. Units in Quadratic fields. Primes in Quadratic fields. Unique factorization Primes in quadratic fields having the unique factorization property.

Prescribed book : Ivan Niven & H.S. Zuckerman, An introduction to number theory (Wiley Eastern Limited)
Sections: 2.1 to 2.4, 3.1 to 3.3, 3.6, 4.1 to 4.3, 5.1, , and 9.1 to 9.9

Reference Books :-
1. T.M. Apostol, An Introduction to Analytical Number Theory
(Springer International Student's Edition)
2. David M Burton, Elementary Number Theory (Universal Book Stall, New Delhi)
3. S. G. Telang, Number Theory (Tata Macgrow Hill)

4. G. H. Hardy and E. M. Wright, Introduction to Number Theory
(The English language book society and oxford university press)

MT 802 Differential Geometry

Graphs and level sets, vector fields, tangent spaces, surfaces, vector fields on surfaces, orientation, gauss map, geodesics, parallel transport, Weingarten map, curvature, arc length and line integrals, curvature of surfaces, parametrised surfaces, local equivalence of surfaces and parametrised surfaces.

Prescribed Book :
John A. Thorpe : Elementary topics in differential Geometry , Springer (2004) Chapters : 1-12, 14, 15.

MT803 Fourier Analysis and boundary value problems

Fourier series, convergence of Fourier series, Fourier method, Boundary value problems, orthonormal sets, Sturm Liouville problems, Bessel functions , Legendre polynomials and applications,

Prescribed Book
R.V. Churchill and J. Brown.: Fourier Series and Boundary Value Problems (7th edition)(Publisher: Tata McGraw-Hill Book Company)(2011) Chapters 1,2,4,5, 7,8,9,10

Departmental courses: (Any Two)

MT 804 Lattice Theory

Two definitions of lattices, Hasse diagrams, homomorphism, isotone maps, ideals, congruence relations, congruence lattices, the homorphism theorem, product of lattices, complete lattice, ideal lattice, distributive –modular inequalities and identifies, complements, pseudo complements, Boolean lattice of pseudocomplements, join and meet-irreducible elements. Characterization theorems and representation theorems-Dedekind`s modularity criterion Birkhoff`s distributivity criterion, hereditary subsets, rings of sets, Stone theorems, Nachbin theorem, statements of Hashimoto's theorem. Modular lattices, isomorphism theorem, Upper and lower covering conditions, Kuros-Ore theorem, independent sets (Drops results involving projectivity and sublattice generated by sets / elements) Semimodular lattices Jordan-Holder chain condition, Modular pair, M-sysmmetric lattices.

Prescribed Book :

General Lattice Theory , G. Gratzer (Birkhauser, IInd Edition 1998)
Chap. 1 Section 1,2,3,4,6, Cha. 2 Section-1, Chap.3. Section –1,2.

MT 805 Operations Research

Unit I - Kuhn – Tucker conditions of Optimality – Quadratic Programming
(Sections 19.2.2B, 20.2.2)
Unit II - Inventory Models
(Sections 14.1 to 14.3)
Unit III - Queuing Models
(Section 15.1, 15.2, 15.4, 15.5)
Unit IV - Project Scheduling By PERT – CPM
(Sections 13.1 to 13.4)
Unit V - Simulation Modeling with SIMNET – II
(Sections 17.1 to 17.10)
Prescribed Book :
Hamy A.Taha, Operations Research, Fifth Edition, Prentice Hall of India

CREDIT SYSTEM (CS) (w.e.f. Academic Year 2013-14) For SEMESTER PATTERN Post Graduate (PG) Programs (Affiliated Colleges & Institutes)

1 .**Shortforms** used:
CS- Choice Based Credit System
ESE- End of Semester Examination
GPA- Grade Point Average
CGPA- Cumulative Grade Point Average
The authorities of the University of Pune are preparing the general rules and regulations for the implementation of the Credit System (Semester Pattern) to the postgraduate programs conducted at the affiliated colleges of the University of Pune.

2. Conduct of the Credit System

2.1 The post-graduate degree will be awarded to those students who earn the minimum number of credits as follows:

Name of the Faculty	Total credits	Average credits per semester
Science (M.Sc)Maths	100	25

• Except the credits for practical courses, wherever applicable, a student can register for less number of courses in a semester subject to the condition that such a student will have to complete the degree in a maximum of four (five) years for 2 years (3 years) program. This facility will be available subject to the availability of concerned courses in a given semester and with a maximum variation of 25 % credits (in case of fresh credits) per semester.

2.2 The proportion of Laboratory courses shall be around 40 % of the total credits of a PG program. Project work, if included, shall consist of NOT more than 10 % of the total number credits for PG programs in Science and 05 % of the total number of credits for other PG programs.

2.3 One credit will be equivalent to 15 clock hours of teacher-student classroom contact in a semester. There will be no mid-way change allowed from Credit System to Non-credit (external) System or vice versa.
2.4 A post graduate teacher in a subject shall be affiliated to only ONE post graduate center at any given time and for only one subject.

2.5 For the routine conduct of the CS, Dean of the concerned faculty shall be the Chairperson. The constitution of faculty wise committee shall be as follows:

1. Dean of the Faculty – Chairman
2. Two HoD's of the Post Graduate centers from the respective faculty nominated by the Hon.Vice Chancellor
3. One HoD/Professor/Subject expert from thePost Graduate Department of the University Campus nominated by Hon. Vice Chancellor
4. Director, BCUD – Coordinator

2.6 Among the minimum number of credits to be earned by a student to complete a Post Graduate degree program (100 credits), the student will have to earn minimum 75% credits from the parent Department (subject) and the remaining up to 25 % credits could be earned from the parent Department (subject) or any subject/s of any faculty conducted at other PG Department/ PG Center.
In any case, a student will have to earn compulsory credits from the parent Department (subject) over and above.

3. Examination Rules

3.1 Assessment shall consist of Continuous assessment (CA) and End of Semester Examination
(ESE). Each shall have an equal weightage of 50 %.

3.2 The teacher concerned shall announce at the beginning of the course about the mechanisms under which CA would take place. However, the ESE shall cover the entire syllabus prescribed for that course.

3.3 The CA towards 50% marks will be a continuous activity and at least two written tests must be conducted for a full course of 4/5 credits and the teacher should select a variety of mechanisms for evaluation such as:
i. Written Test (not more than one or two for each course as applicable)
ii. Term Paper
iii. Journal/Lecture/Library notes
iv. Seminar presentation

v. Short Quizzes
vi. Assignments
vii. Extension Work
viii. An Open Book Test (with the concerned teacher deciding which books are to be allowed for this purpose)
ix. Mini Research Project by an individual student or a group of students
The concerned teacher in consultation with the Head of the PG Department shall decide the nature of questions for a Written Test.
3.4 ESE for the remaining 50% marks will be conducted by the UoP.

3.5 A student has to obtain 40 % marks in the combined examination of CA and ESE with a minimum passing of 30 % in both these separately.

3.6 To pass the degree program, a student will have to obtain a minimum aggregate of 40% marks (E and above in grade point scale) in each course.

3.7 If a student misses an internal assessment examination he/she will have a second chance with the endorsement of the Principal in consultation with the concerned teacher. Such a second chance shall not be the right of the student.

3.8 CA marks will not change. A student cannot repeat CA. In case s/he wants to repeat CA, then he can do so only by registering the said course during the semester in which the course is conducted and up to 4 years (2 years program) or 5 years (3 years program) as the case may be,provided the student was failed in that course.

3.9 Students who have failed in a course may reappear for the ESE only twice in the subsequent period. The student will be finally declared as failed if she\he does not pass in all credits within a total period of four years. After that, such students will have to seek fresh admission as per the admission rules prevailing at that time.

3.10 A student cannot register for the third/fourth semester, if she/he fails to complete 50% credits of the total credits expected to be ordinarily completed within two semesters.

3.11 There shall be a revaluation of the answer scripts of ESE but not of CA as per Ordinance No.134 A & B.

3.12 While marks will be given for all examinations, they will be converted into grades. The semester end grade sheets will have only grades and final grade sheets and transcripts shall have grade points average and total percentage of marks (up to two decimal points). The final grade sheet will also indicate the PG Center to which the candidate belongs.

4. Assessment and Grade point average

4.1 The system of evaluation will be as follows: Each CA and ESE will be evaluated in terms of marks. The marks for CA and ESE will be added together and then converted into a grade and later a grade point average.

4.2 Results will be declared for each semester.

4.3 After the gain of minimum number of credits towards a completion of a PG program, a student will get a grade sheet with total grades earned and a grade point average.

4.4 Marks/Grade/Grade Point

Marks	Grade	Grade Point
100 to 75	O: Outstanding	06
74 to 65	A: Very Good	05
64 to 55	B: Good	04
54 to 50	C: Average	03
49 to 45	D: Satisfactory	02
44 to 40	E: Pass	01
39 to 0	F: Fail	00

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