**Pedagogy of Mathematics (Paper-I)**

**Vision of the syllabus**

The position paper from the Focus group on ‘Teaching of mathematics’ ( a part of the position papers for the development of the national curriculum framework initiated by the MHRD) says that lack of teacher preparation is one of the core areas of concern for mathematics education in India. The position paper points out that among all the school content areas, mathematics relies much more on the preparation that the teacher has, in her own understanding and in her ability to create appropriate pedagogic contexts in the class room. In the light of these recommendations, this syllabus aims at making a community of mathematics teachers which can engage with mathematics at various levels, a community which believes that every child has a right to and is capable of learning and doing meaningful mathematics (NCF 2005).

The current syllabus departs from the idea of teaching skills, methodologies or teaching techniques. It focuses on how to prepare teachers who can create an engaging mathematics classroom. For this purpose, we will revisit the foundational areas up to secondary mathematics along with their implications for pedagogy. This course encourages a prospective-teacher to participate in the processes like problem-solving, problem-posing, mathematical communication and to appreciate child’s diverse ways to learning mathematics. There is also an attempt to make a shift from assessment of learning to assessment for learning.

The vision of this syllabus is to motivate student-teachers in developing a democratic mathematics classroom where every debate and discussion around mathematical ideas is also looked at as a mathematical endeavour and a meaningful learning engagement. The syllabus attempts to develop a culture of mathematical communication among the student-teachers who in turn will motivate their students in communicating mathematics in an effective manner. We hope that this syllabus helps student-teachers become mathematics teachers who believe and can ensure that every child has an opportunity to learn and can engage with mathematics.

**Objectives of the syllabus**

1. To help the student-teacher appreciate the nature of the subject along with the historical and social evolution and location of the discipline in the lives of the children.
2. To develop an appreciation and understanding of the objectives of school mathematics.
3. To develop an understanding of the fundamental concepts and ideas of mathematics. Be able to feel empowered to do and enjoy mathematics.
4. To develop an insight about how children learn mathematics in diverse contexts and the challenges they face during the learning processes.
5. To enable student-teachers to recognise that children know and can do mathematics and be able to identify their knowledge to build on their understanding of mathematics, and to believe in every child’s capacities to engage in mathematics meaningfully.
6. To help the student-teacher to create a classroom culture that is an engaging space for every child.
7. To develop a culture of critically examining the mathematics curriculum and textbooks.
8. To help the student-teacher in becoming a more confident learner and teacher of mathematics.
9. To enable a student-teacher to use assessment both as a tool for reviewing children’s learning as well as a feedback for her instruction.
10. To help student-teacher explore different tools and techniques, including teaching-learning material, mental models and ICT, for the teaching and learning of mathematics.

**Pedagogy of Mathematics (Paper – I)**

**Unit 1: Mathematics a part of life and the nature of mathematics:**

This unit would help the student-teachers appreciate that mathematics is in all aspects of life and all children use it in some form. It would explore mathematics present in diverse everyday contexts and gives importance to connecting school mathematics with a child's lived experience

.It would then go on to discuss the aspects of formalizing mathematical knowledge. There would be exploration of ideas around

* Discussions on mathematics embedded in our everyday life practices, such as, work-contexts, economic transactions, cultural and traditional practices.
* Nature of mathematics with a view towards generalisation, symbolization and abstraction of mathematical ideas.
* Features of mathematics, mathematical statements, consistency and logic, patterns and relationships. Different ways of proving and try to understand why proofs are necessary in mathematics. The nature of mathematical language , use of symbols, generalised forms and reprentations.

**Readings**

* AMT 01 Block 1 Aspects of Teaching Mathematics
* Gowers T-. *Mathematics: A Very Short Introduction*. Oxford University Press.
* National Curriculum Framework, 1988, 2000, 2005
* LMT 01 Block 1 Unit 1 – Why learn mathematics ?
* LMT-01,Block 6 Unit-17: The essence of Mathematics
* *What are Mathematical Proofs and Why they are Important:* Goldberger
* Maths and purpose: Manil Suri
* Shashidhar Jagadeeshan (2010), *The Culture of Enjoying Mathematics* : Learning Curve

**Unit 2: Why teach mathematics and the mathematics syllabus from 6 to 10:**

There is a fear of school mathematics in the minds of the students and while it is considered to be very important it is also attempted to be limited to solving known problems and using known techniques. The unit would discuss the reasons for this and the need for widening the goals and purposes of learning and teaching mathematics. It would bring out that mathematical ideas and goals are both utiliterian and enriching and both these aspects must be reflected in the mathematical syllabi. The unit would include aspects like:

* + The role of school mathematics in society and status. The reason for people to be afraid and its distance from learners.
	+ Discussions on the aim and objectives of teaching and learning of mathematics given in NCF, SCF and Chhattisgarh textbooks.
	+ What are the specific areas of mathematics taught between 6 to 10
	+ Organisation of each of the areas and the sequence in which it is developed. Identifying the hierarchy of concepts
	+ analysing a few text book chapters and identifying the relationship with the specific objectives
	+ Relationship of mathematics to other subjects being learnt

**Readings**

* National Curriculum Framework, 2005
* State Curriculum Framework , Chhattisgarh
* Chhattisgarh Textbooks Classes 6 -10
* AMT - 01, Block 1 Aspects of Teaching Mathematics

**Unit 3: Understanding children’s learning of mathematics**

This unit aims to focus on children's learning processes in diverse contexts (both school and out-of-school) implicitly and explicitly. In this unit we will also discuss what learning mathematics means, talk about some models that can be created to understand learning. These would include the nature of the subject, what is to be learnt or the knowledge to be transacted, the understanding of the learner, the understanding of the learning process and what does it mean to know. This unit will also talk about participation of children in learning and use ideas on how children form their understanding using ideas that are from mathematics. The unit would also talk about the fact that children go through different routes to learn and express their ideas. These often are through stages where they make inappropriate generalizations as well. Using examples of works of children this would be explored. Exemplar chapters would be analysed by students on the the principles of the models and compared on the appropriateness.

The themes in this unit could be

* What kind of knowledge all children have from their context?
* What are the diversities in mathematical experiences and learnings?
* Understanding what does it mean to learn a mathematical idea?
* Mechanisms of learning and key aspects: learning in socio-cultural contexts individual learning, group learning
* Analysing constructed models of learning around the key principles
* understanding the development of certain concepts in children
* Analysing childrens' work and understanding the logic of their errors
* Equity issues: Beliefs about gender, caste, class, language and their connection to mathematics learning
* Understanding children with special needs and their mathematics abilities

**Readings**

* AMT - 01 Block 1 Aspects of Teaching Mathematics
* Boaler, J & Humphreys, C (2005) *Connecting Mathematical Ideas: Middle School Cases of Teaching & Learning*. Heinneman: Portsmouth.
* Carpenter, T., Franke, M., & Levi, L. (2003). *Thinking mathematically: Integrating arithmetic and algebra in the elementary school.* Portsmouth, NH: Heinemann.
* Lampert, M (2001). *Teaching problems and the problems of teaching*, New Haven: Yale
LMT-01 Block 1 Unit-1: Thinking about Learning
* LMT-01 Block 1 Unit-2: Thinking about the Learner
* Early childhood Teacher’s Misconception in Mathematics
* (<http://www.learningdomain.com/medhome3/ececurriculum/teachers.misconcep.maths.pdf>)
* K Subramaniam, *Culture in the Learning of Mathematics: Learning Curve(2010)*

**Unit 4: Nature and culture of mathematics classroom:**

Mathematics class-rooms of today are often criticised to be teacher centric, repetitive, un-interesting and focussed on giving explanations and definitions. They are also geared to one correct answer and one correct way. The attempt is to provide children with short cuts so that they are able to solve given problems. The unit discusses the nature and culture of effective mathematics classroom and focuses on the proposed shifts in the classroom norms for moving towards a mathematically discursive classroom culture. In this section we will also discuss how children’s prior knowledge can be used as classroom resources and how they affect learning. This would also discuss some class-rooms where children are participating, exploring, contributing their ideas to the discourse, attempting to solve new problems, learning from each other and are engaged in other ways that ensure that they form their ideas. The themes in this unit could be

* Culture of mathematics classroom(*socio mathematical norms, Communication and Use of language, Nature of tasks and Choice of examples*)
* Multi-lingual mathematics classrooms in the context of Chhattisgarh
* Discussions on how children’s prior knowledge can be used as a resource in teaching and learning of mathematics.
* What are the aspects of a engaging mathematics class-rooms
* Identifying from a variety of situations such features
* Constructing engaging classrooms using the text book chapters
* Including all children in the classroom tasks

**Support system**

1. Mathematics museum, mathematics club, learning recourses in modern education
2. Organising quiz programmes, puzzles, magic squares & short cut for solving examples in Vedic mathematics.
3. Use of computer teaching in mathematics

**Readings**

* Boaler, J & Humphreys, C (2005) Connecting Mathematical Ideas: Middle School Cases of Teaching & Learning. Heinneman: Portsmouth.
* Lampert, Magdalene (2001). Teaching *problems and the problems of teaching*, New Haven: Yale University Press
* Stigler, J. W. and Hiebert, J. (1999) *The Teaching Gap: Best Ideas from the World’s Teachers for Improving Education in the Classroom*, The Free Press.
* Yackel, E. and Cobb, P. (1996) *Sociomathematical norms, argumentation, and autonomy in mathematics*. Journal for Research in Mathematics Education, 22, 390-408.
* LMT-01 Block 2 Unit 5: Building Constructive Classrooms:
* LMT-01 Block 2, Unit 6: On Learning Mathematics
* Mathematics in Elementary Education: Diwan H K 2015

**Unit 5: Learning and Teaching of Mathematics – Numbers and Number-Systems:**

This unit takes us through the story of numbers. In this unit we will see how natural numbers and their operations were used to give a consistent definition for negative numbers. We will also work through the various reasons why students find negative numbers difficult and try to find ways to help them. We will work through contexts which might help us deal with negative numbers in a better way. Later in the unit we will talk about the powers and exponent and also explore areas children find difficult to understand. In this unit we will also look at some activities which might strengthen students’ understanding of some concepts like powers and exponents.

* Historical account of the development of number-systems
* Conceptual understanding of integers and operations on them. Exponential notion, meaning and law of exponents. Expressing number as a product of power of prime numbers.
* Children’s understanding (reasoning patterns and misconceptions)
* Teacher’s knowledge and challenges,
* Solving interesting problems based on these to develop a better understanding.
* Constructing engaging and inclusive class-rooms, exercises, problems, worksheets etc. for place value, exponents, divisibility rules.

**Readings**

* Dantzig, T. , & Mazur, J. (2005). *Number: The language of science*, New York: Pi Press
* Davis, P.J., & Hersh, R. (1982). The mathematical experience, Boston: Houghton Mifflin.
* Teaching Negative Numbers to school children-Jayashree Subramaniam(Ldwyh cPpksa dks \_.kkRed la[;k,¡ i<+kuk^ &t;Jh lqHkzefu;.k )

(<http://www.eklavya.in/pdfs/Sandarbh/Sandarbh_52/44-5%20Negative%20Number.PDF>)

* Vlassis, J. (2004). Making sense of the minus sign or becoming flexible in `negativity´.  Learning and Instruction, 14, 469-484.
* LMT-01 Block 5 Unit-16: Exploring Number System
* AMT-01 Block 3 Unit-9: Negative Numbers
* Shailesh Shirali; The Role of Pattern and Play in its Teaching; Learning Curve(2010)

**Unit 6: Planning and classroom management**

This unit will help a student-teacher to understand the curriculum and textbooks to distribute the content in a year plan following the curricular objectives. It will also help the student-teacher to organise her classroom and make the plan considering the classroom diversity, contents and available resources. Task designed in the classroom planning shall be based on learners’ previous knowledge, what needs to be taught and the approach. In this unit we will look at some examples where a teacher needs to adjust or change the context given in the textbooks to make it some suitable for her own students.

* Understanding syllabus, textbook and/to make a year plan. Understand the units, chapters in each unit, their connections and flow.
* Making connections of the subject content with learners’ prior knowledge and experiences. To identify key concepts and prerequisite of the topic. Designing tasks to understand, what do children know in a topic and what to discuss? And what they are expected to learn by the end of the year.
* Examples of contexts which need to be adjusted according to the students Classroom organisation and management: develop strategies, tasks and use other resources to organize a mathematics classroom by giving due consideration to various forms of diversity which exist in the classroom.

**Readings**

* AMT-01 Block 1 Unit -4 Classroom Practice
* LMT -01, Block 2 Encouraging learning in the classroom