UNIVERSITY OF DELHI

MASTER OF SCIENCE

(Mathematics Education)

Revision Under CBCS scheme

Scheme of Study and Examination

(2019)

Cluster Innovation Centre

CONTENTS

About Cluster Innovation Centre

Inspired by National Innovation Council (GoI) initiatives, in September 2011, University of Delhi started the first academic Cluster Innovation Centre in India. Cluster Innovation Centre, or CIC as it is popularly known, has been designed to seek and derive innovations from industrial clusters, village clusters, slum cluster and educational clusters. It is an endeavour to harness the passion and dedication of bright young minds with some of the major challenges of India and civil society. We strive to stream relevant ideas and programmes stemming from the above mandate into its learning and research programmes. The hallmark of the CIC is "out of the box" thinking and action with hands on" applications through a trans-disciplinary route. The CIC has pioneered the concept of a Meta College as well as a Meta University and runs highly innovative state of art learning and research programmes. The centre also has an active Design Innovation Centre, funded by MHRD which provides support to translate innovative ideas into practice.

Aims

- To provide a platform for the University and its partners to forge mutually beneficial linkages to initiate and assist innovation activities and act as a catalyst and facilitator.
- To create an ecosystem that connects and facilitates various stakeholders on all aspects of the innovation process including training and support
- To promote innovations, channel various incentives that benefit the cluster and act as an incubating body managing the growth of innovation in the ecosystem.

Broad Objectives

- Connecting research with application for the benefit of society.
- Support application oriented research to solve real world problems.
- Focus on developing affordable innovations that can benefit a large number of people and at the same time commercially viable and sustainable.

About Meta University Program

The first Meta University based program, Master of Mathematics Education (renamed as M.Sc. Mathematics Education as per UGC guidelines) was started at Cluster Innovation Centre and AJK Mass Communication and Research Centre, JMI, by joint collaboration between University of Delhi and Jamia Millia Islamia in January 2013.

Under the concept of Meta University, M.Sc. (Mathematics Education) is a joint degree two year postgraduate programme jointly offered by University of Delhi and Jamia Millia Islamia. Cluster Innovation Centre (CIC), University of Delhi, administratively manages the program. The program aims to give the students some theoretical inputs and substantial hands-on experience in knowledge-making. The Degree course reflects a trans-disciplinary approach and promotes fresh viewpoints, making the learning and teaching process joyful and productive.

Introduction to CBCS (Choice Based Credit System)

Choice Based Credit System:

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill-based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Grading system provides uniformity in the evaluation and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations which enables the student to move across institutions of higher learning. The uniformity in evaluation system also enable the potential employers in assessing the performance of the candidates.

Definitions:

(i) 'Academic Program' means an entire course of study comprising its program structure, course details, evaluation schemes etc. designed to be taught and evaluated in a teaching Department/Centre or jointly under more than one such Department/ Centre

(ii) 'Course' means a segment of a subject that is part of an Academic Program

(iii) 'Program Structure' means a list of courses (Core, Elective, Open Elective) that makes up an Academic Program, specifying the syllabus, Credits, hours of teaching, evaluation and examination schemes, minimum number of credits required for successful completion of the program etc. prepared in conformity to University Rules, eligibility criteria for admission

(iv) 'Core Course' means a course that a student admitted to a particular program must successfully complete to receive the degree and which cannot be substituted by any other course

(v) 'Elective Course' means an optional course to be selected by a student out of such courses offered in the same or any other Department/Centre

(vi) 'Open Elective' means an elective course which is available for students of all programs, including students of same department. Students of other Department will opt these courses subject to fulfilling of eligibility of criteria as laid down by the Department offering the course.

(vii) 'Credit' means the value assigned to a course which indicates the level of instruction; One-hour lecture per week equals 1 Credit, 2 hours practical class per week equals 1 credit. Credit for a practical could be proposed as part of a course or as a separate practical course

(viii) 'SGPA' means Semester Grade Point Average calculated for individual semester.

(ix) 'CGPA' is Cumulative Grade Points Average calculated for all courses completed by the students at any point of time. CGPA is calculated each year for both the semesters clubbed together.

(x) 'Grand CGPA' is calculated in the last year of the course by clubbing together of CGPA of two years, i.e., four semesters. Grand CGPA is being given in Transcript form. To benefit the student a formula for conversation of Grand CGPA into %age marks is given in the Transcript.

M.Sc. (Mathematics Education) Program Details

Program Objectives

The M.Sc. (Mathematics Education) Programme would make the students competent various facets of Mathematics Education, including curriculum development, pedagogy and instructional resources (both hands on and technology based). The course will develop essential skill set in students to address the issues in Mathematics Education from multiple perspectives.

Program Learning Outcomes (PLO)

PLO1 To move away from the conventional pedagogy of teaching mathematics especially at school level and to include methods of facilitating learning such as storytelling, projects, group work and participative learning.

PLO2 To use technology as significant aid in learning.

PLO3 To impart knowledge of some basic concepts and principles of the discipline.

PLO4 To establish inter-disciplinarily approach between Mathematics and other subjects from Humanities and the Social Sciences.

PLO5 To encourage collaborative learning through group activities and hands-on learning.

PLO6 To provide in-service training for school teachers.

PLO7 To learn to apply mathematics to real life situations and help in problem solving.

Program Structure

The M.Sc. (Mathematics Education) program is a two-year course divided into four-semester. A student is required to earn 96 credits for the completion of course and the award of degree.

		Semester	**Semester**
Part – I	First Year	Semester I	Semester II
Part – II	Second Year	Semester III	Semester IV

Year Semester	**Core Courses**			**Elective Courses**			**Open Elective Courses**			**Total Credits**
	No. of papers	Credits Th/P/T	**Total Credits**	No. of papers	Credits Th/P/T	**Total Credits**	No. of papers	Credits Th/P/T	**Total Credits**	
1st year Semester I	05	15+0+3	**18**	01	0+4+0	**04**	0	0	**00**	**22**
1st year Semester II	06	15+4+5	**24**	00	0+0+0	**00**	01	02	**02**	**26**
2nd Year Semester III	05	15+0+5	**20**	01	0+4+0	**04**	01	02	**02**	**26**
2nd Year Semester IV	03	09+0+2	**11**	03	6+4+1	**11**	00	00	**00**	**22**
Total credits to be earned by the student in two years	**73**			**19**			**04**			**96**

* For each Core and Elective course there will be 4 lecture hours of teaching per week.

*For each Open Elective course there will be 2 lecture hours of teaching per week.

* Student has to earn total of 96 credits to successfully complete the course that includes:

73 credits from core courses;
19 credits from Elective courses;
4 credits from Open Elective course.

* Duration of examination for each 100 marks paper shall be of 3 hours and for each 50 marks paper will be of 2 hours.

* Each 100 marks paper will be divided into 75 marks of theory (external exam) and 25 marks of internal assessment. Each 50 marks paper will be divided into 35 marks of theory (external exam) and 15 marks of internal assessment.

Teaching:

- The faculty of the Cluster Innovation Centre is primarily responsible for conducting all kinds of teaching exercises. Teaching to the course will take place in different formats, lectures, tutorial, lab work, field work, projects, internships and research dissertation. Internships in schools and in various educational organizations will be supervised by the CIC faculty in addition to external mentors from the organizations.
- Innovation projects are an integral part of the course. Students can work in a group of maximum three or individually also. Each project/practicum will be closely

supervised by faculty of DU/JMI and Mentors who may be from outside the host institutions.

- Students can also choose project outside CIC which can be jointly guided by CIC/JMI faculty and external mentor.
- Tutorial will be conducted in small groups and each tutorial group will consists of maximum 10 students.
- Practical/ lab work will be done individually or in small groups under the guidance of the concerned faculty.
- One-hour lecture, tutorial, field work, project is equal to one credit.
- Two hour practical /lab work is equal to one credit.
- There shall be 90 instructional days excluding examination in a semester.

Eligibility criteria:

Graduate degree in any discipline provided the applicant has done at least two full-fledged papers in Mathematics at the undergraduate level.

Admission Procedures:

Admission will be through Entrance Test to be conducted by University of Delhi.

Number of Seats & Reservation Policy:

Twenty (20) Seats, reservation as per rules of the two institutions, wherever the student is admitted.*

University of Delhi: 10

(In odd year: General: 5, OBC: 2, SC: 2, ST: 1)

(In even year: General: 5, OBC: 3, SC: 1, ST: 1)

Jamia Millia Islamia: 10

(General: 5, General Muslim: 3, Muslim OBC/Muslim ST: 1, Muslim Woman: 1)

- This will change as per EWS reservation as and when applicable.

Per Semester Fee:

To be determined mutually by partner universities i.e. University of Delhi and Jamia Millia Islamia. Presently fee is Rs.5000/- per semester.

Assessment of Students' Performance and Scheme of Examinations:

1. English shall be the medium of instruction and examination.
2. Assessment will be based on Learning Outcomes for the course
3. Assessment of students' performance shall consist of:

Type of course	Assessment Scheme
Core course (Theory)	Internal assessment: 25 marks End term theory exam: 75 marks Duration of theory exam: 3 hours
Elective course (Theory)	Internal assessment: 25 marks External theory exam: 75 marks Duration of theory exam: 3 hours
Open Elective course (Theory)	Internal assessment: 12 marks External theory exam: 38 marks Duration of theory exam: 2 hours
Innovation Project (Semester I)	Planning phase presentation: 20 marks Mid phase (term) presentation: 20 marks Final presentation and viva voce exam: 30 + 30 marks
Innovation Project (Semester II)	Lesson planning: 30 marks Classroom teaching: 40 marks Viva voce exam: 30 marks
Innovation Project (Semester III)	a) ***Internship in school (Small project taken up in school)*** Internal Mentor: 30 marks External mentor: 30 marks Final presentation and viva voce exam: 40 marks b) ***Internship in Educational organization*** Internal Mentor: 30 marks External mentor: 30 marks Final presentation and viva voce exam: 40 marks
Innovation Project (Semester IV)	Synopsis presentation: 10 marks Mid- term presentation: 10 marks Marks by supervisor: 40 marks Final presentation and viva-voce exam: 40 marks

Assessment for papers taught at Jamia Millia Islamia will be done by JMI only. It will be transferred/added in the final result.

Examination and result:

The examination for papers studied by students at JMI will be conducted at JMI. *
The examination for papers studied by students at DU will be conducted at DU.
Declaration of semester-wise result and issuing of Mark-sheets carrying logo of both DU and JMI shall be the responsibility of Examination Branch University of Delhi.
* JMI examination branch will provide result of these papers to DU.
Elaborated examination scheme is given later in this document.

Joint Degree of DU & JMI:

On successful completion of the program, joint degree will be awarded to students enrolled in Meta University concept course M.Sc. (Mathematics Education). The joint degree shall carry the logo and signatures of competent authorities of both DU & JMI. The degree shall be in three languages: English, Hindi and Urdu.

Coordination Committee for M.Sc. (Mathematics Education):

As per UGC guidelines, there shall be a coordination committee constituted by participating universities for each Program.

The participating universities shall be responsible for deciding

(a) Duration of Programme
(b) Number of course required for the programme
(c) Fee structure for the program
(d) Number of students in the programme
(e) Infrastructure requirements
(f) (i) Framing syllabus
    (ii) Number of Lectures and associated activities for the course
    (iii) Number of credits for the course
    (iv) Evaluation procedure
(g) Any other related matter

The Coordination Committee shall ensure timely decision on the above issues and other related issues.

The composition of the Coordination Committee for Meta University concept program of DU & JMI namely M. Sc. (Mathematic Education) shall be:

1. The Director, Cluster Innovation Centre, DU **(Chairman)**
2. The Joint Director, Cluster Innovation Centre, DU (member)
3. Coordinator, Meta University Program, DU (**Member Secretary**)
4. Three nominated members from field of Education/Mathematics Education/ Mathematics/Media, DU (Members) (To be nominated by the Vice Chancellor, DU on the recommendation of the Director, Cluster Innovation Centre, DU)
5. Coordinator, Meta University Program, JMI*
6. Three nominated members* from field of Education/Mathematics Education/ Mathematics/Media, JMI (Members) (To be nominated by the Vice Chancellor, JMI)

   * One of the members from JMI will be designated as **Co-Chairman**.

Assessment of Students' Performance and Scheme of Examinations:
Pass Percentage & Promotion Criteria:

Key: CC: Core Course: EC: Elective Course; OEC: Open Elective Course

Semester I							
S. No.	Paper Title	Offering Centre	CC/ EC/ OEC	Credits	Total Marks	Marks Breakup	Pass Percentage
MME411CC	Calculus: Role in real life	CIC,DU	CC	4	100	Internal assessment (IA): 25 marks End term theory exam: 75marks	**40% in Total** 40% in Theory
MME412CC	Perspectives in Mathematics Education	CIC,DU	CC	4	100	Internal assessment (IA) : 25 marks End term theory exam: 75 marks	**40% in Total** 40% in Theory
MME413CC	Paper 1 from JMI*	AJKMCRC, JMI	CC	3	**100**	As per JMI guidelines	
MME414CC	Paper 2 from JMI*	AJKMCRC, JMI	CC	3	**100**	As per JMI guidelines	
MME415CC	Curriculum and Evaluation in Mathematics	CIC,DU	CC	4	**100**	Internal assessment (IA) : 25 marks End term theory exam: 75marks	**40% in Total** 40% in Theory
MME416EC	Innovation Project-I: Interlinkin	CIC,DU/ JMI	EC	4	**100**		**40% in Total**

	g Mathematics & real world problems						
Semester II							
MME421CC	Demystifying the power of data: Probability & Statistics	CIC,DU	CC	4	100	Internal assessment (IA) : 25 marks End term theory exam: 75marks	**40% in Total** 40% in Theory
MME422CC	Theories of Learning	CIC,DU	CC	4	100	Internal assessment (IA) : 25 marks End term theory exam: 75marks	**40% in Total** 40% in Theory
MME423CC	ICT in Mathematics Education	CIC,DU	CC	4	100	Internal assessment (IA) : 25 marks End term theory exam: 75marks	**40% in Total** 40% in Theory
MME424CC	Learning Ways of Mathematical Writing	CIC,DU	CC	4	100	Internal assessment (IA) : 25 marks End term theory exam: 75marks	**40% in Total** 40% in Theory
MME425CC	Art of Teaching Mathematics	CIC,DU	CC	4	100	Internal assessment (IA) : 25 marks End term theory exam: 75marks	**40% in Total** 40% in Theory
MME426CC	Innovation Project: School Internship	CIC,DU	CC	4	100	Internal assessment (IA) : 25 marks	**40% in Total** 40% in Theory

						End term theory exam: 75marks	
MME427OEC	***OEC Option I:*** Innovation in Education ***OEC Option II:*** Mathematical Visualization	CIC,DU	OEC	2	50	Internal assessment (IA) : 12 marks End term theory exam: 38 marks	**40% in Total** 40% in Theory
Semester III							
MME531CC	Discretizing and understanding Real Life Situations Through a Mathematical Lens	CIC,DU	CC	4	100	Internal assessment (IA) : 25 marks End term theory exam: 75marks	**40% in Total** 40% in Theory
MME532CC	Pedagogical Intervention in Mathematics Classroom	CIC,DU	CC	4	100	Internal assessment (IA) : 25 marks End term theory exam: 75marks	**40% in Total** 40% in Theory
MME533CC	Digital Technology in Mathematics Education	CIC,DU	CC	4	100	Internal assessment (IA) : 25 marks End term theory exam: 75marks	**40% in Total** 40% in Theory
MME534CC	Research Methodology in Education	CIC,DU	CC	4	100	Internal assessment (IA) : 25 marks End term theory exam: 75marks	**40% in Total** 40% in Theory

MME535CC	Statistics in Educational Research	CIC,DU	CC	4	100	Internal assessment (IA) : 25 marks End term theory exam: 75marks	**40% in Total** 40% in Theory
MME536EC	Innovation Project-III: Internship in Educational Setting	CIC, DU/ JMI	CC	4	100		**40% in Total**
MME537OEC	***OEC Option I:*** Education Entrepreneurship for social change ***OEC Option II:*** Education for Sustainable Future	CIC,DU	OEC	2	50	Internal assessment (IA): 12 marks End term theory exam: 38 marks	**40% in Total** 40% in Theory
Semester IV							
MME541CC	Understanding mathematical language of ordinary differential	CIC,DU	CC	4	100	Internal assessment (IA) : 25 marks End term theory exam: 75marks	**40% in Total** 40% in Theory
MME542CC	Research Investigation in Mathematics Education	CIC,DU	CC	4	100	Internal assessment (IA) : 25 marks End term theory exam: 75marks	**40% in Total** 40% in Theory
MME543CC	Paper 3 from JMI*	JMI	CC	3	100	As per JMI guidelines	
MME544.1EC	Paper 4 from JMI*	JMI	EC	3	100	As per JMI guidelines	

MME545.1EC	***Option EC I:*** Experimental Research Design ***Option ECII:*** Descriptive Research Design	CIC,DU	CC	4	100	Internal assessment (IA): 25 marks End term theory exam: 75marks	**40% in Total** 40% in Theory
MME546EC	Innovation Project: Research Dissertation	CIC,DU/ JMI	CC	4	100	Internal assessment (IA) : 25 marks End term theory exam: 75marks	**40% in Total** 40% in Theory

* Refer to the list of courses to be opted from AJKMCRC, JMI.

Note: The decision to offer specific courses from the list or any other course approved by Academic Council of JMI varies from semester to semester. Syllabus of the papers to be opted from JMI presently is as per approved syllabi of AJKMCRC.

Part I to Part II Progression:

The passing percentage in any course shall be 40%. A student passing in at least 50% of courses in Semesters I and II combined shall be promoted to the second year of the Programme. A student who has at least 40% marks in the aggregate of all the required courses in the four semesters and has passed individually in courses accounting for at least 96 credits shall qualify for the award of the M.Sc. degree

Conversion of Marks into Grades:

As per University Examination rule

Grade Points:

Grade point table as per University Examination rule

CGPA Calculation:

As per University Examination rule.

SGPA Calculation:

As per University Examination rule.

Grand SGPA Calculation:

As per University Examination rule.

Conversion of Grand CGPA into Marks:
As per University Examination rule.

Division of Degree into Classes:
As per University Examination rule.

Attendance Requirement:
As per University rules

Span Period:
As per University rules

Semester I				
Number of Core courses: 05				
Credits in each core course	Theory	Practical	Tutorial	Credits
MME411CC Calculus: Role in Real life	03	00	01	04
MME412CC Perspectives in Mathematics Education	03	00	01	04
MME413CC Paper 1 from JMI*	As per the course approved by JMI			03
MME414CC Paper 2 from JMI*	As per the course approved by JMI			03
MME415CC Curriculum and Evaluation in Mathematics	03	00	01	04
Total Credits in Core Courses: 18	**15**	**00**	**03**	**18**
Total Number of Elective courses: 01				
Credits in each Elective course	Theory	Practical	Tutorial	Credits
MME416CC Innovation Project: Interlinking Mathematics and Real life Problems		04		04
Total Credits in Elective Courses: 04				
Total Number of Open Elective courses: Nil				
Total Credits in Semester I: 22				

Note

- The student will study 3 core courses at CIC and 2 core courses (MME413CC & MME414CC) at JMI.
- For paper MME416CC, the student will study theoretical underpinning of issues concerned with Math learning and its application at elementary, secondary and senior secondary level of schooling and further propose innovative solutions after real time field testing. The paper will be taught in project mode.

Semester II				
Total number of Core courses: 06				
Credits in each Core course	**Theory**	**Practical**	**Tutorial**	**Credits**
MME421CC Demystifying the power of data: Probability & Statistics	03	00	01	04
MME422CC Theories of Learning	03	00	01	04
MME423CC ICT in Mathematics Education	03	00	01	04

MME424CC Learning Ways of Mathematical Writing	03	00	01	04
MME425CC Art of Teaching Mathematics	03	00	01	04
MME426CC Innovation Project: School Internship	00	04	00	04
Total Credits in Core Courses: 24	**15**	**04**	**05**	**24**
Total Number of Elective courses: Nil				
Total Number of Open Elective courses: One				
Credits in each Open Elective course	Theory	Practical	Tutorial	Credits
MME427OEC Option I: Innovation in Education Option II: Mathematical Visualization	02	00	00	02
Total number of credits in Semester II: 26 Note • The student will study all core courses at CIC. • The student will do School Internship which will continue till the month of July, semester III. School Internship will be guided, supervised and reviewed by the CIC faculty. • The student can take one Open Elective Course (MME427OEC) out of the two given options.				

Semester III				
Total number of Core courses: 05				
Credits in each Core course	**Theory**	**Practical**	**Tutorial**	**Credits**
MME531CC Discretizing and Understanding Real Life Situations Through a Mathematical Lens	03	00	01	04
MME532CC Pedagogical Interventions in Mathematics Classroom	03	00	01	04
MME533CC Digital Technology in Mathematics Education	03	00	01	04

MME534CC Research Methodology in Education	03	00	01	04
MME535CC Statistics in Educational Research	03	00	01	04
Total Credits in Core Courses: 22	**15**	**00**	**05**	**20**
Total Number of Elective courses: 01				
MME536EC Innovation Project: Internship in Educational Setting	00	04	00	04
Total Number of Open Elective courses: 02				
MME537OEC Option I: Education Entrepreneurship for Social Change Option II: Education for Sustainable Future	02	00	00	02
Total number of minimum credits in Semester III: 26 Note: • Students will study all 5 core courses at CIC. • For MME516EC, the student will do internship under the following themes: Hands-on: Minds-on Math learning tools; ICT embedded Math learning platform; Data as a resource for strengthening Math learning; Accessible Math curriculum for all • The student can take one Open Elective Course (MME517OEC) out of the two given options.				
Semester IV				
Total number of Core courses: 03				
Credits in each Core course	**Theory**	**Practical**	**Tutorial**	**Total Credits**
MME541CC Understanding mathematical language of ordinary differential equations and complex analysis	03	00	01	04
MME542CC Research Investigation in Mathematics Education	03	00	01	04

MME543CC Paper 3 from JMI*	03	00	00	03
Total Credits in Core courses: 11	**09**	**00**	**02**	**11**
Total Number of Elective Courses: 03				
Number of credits each Elective course	Theory	Practical	Tutorial	Total Credits
Elective course from JMI				
MME544EC Paper 4 from JMI*	As per the course approved by JMI			03
Elective course in Research Design				
MME545EC Option I: Experimental Research Design Descriptive Research Design Option II: Innovation Project: Research Dissertation	03	00	01	04
MME546EC: Innovation Project: Research Dissertation	00	04	00	04
Total number of credits in Elective courses: 11	**06**	**04**	**01**	**11**
Total number of credits in Semester IV: 22 **Note:** • The student will take 2 Core courses & 2 Elective courses at CIC and 1 Core course (MME523CC) & 1 Elective course (MME524EC) at JMI. • The student can take any of the Elective course (MME525EC) out of the two given optional papers.				

- Elective courses offered in the course fall under the following categories: Innovation Project, Field based Internship, Special Theory courses and Dissertation.
- Elective courses are compulsory optional courses. Elective courses are offered in Semester I, III and IV.
- Open Elective courses are choice based optional courses. A student has to choose any two Open Elective courses from the basket of four Open Elective courses offered in Semester II and III.
- The list of Elective courses offered, including open electives, may change from year to year depending upon the availability of faculty.

Course Wise Content Details for M. Sc. Mathematics Education
Master of Science in Mathematics Education
(Courses taught at Cluster Innovation Centre, University of Delhi)

Semester I
MME411CC: Calculus: Role in Real life
Core course
Number of credits: 4
Marks: 100

Course Objectives

Calculus is the most powerful tool in mathematics with widespread applications. The pedagogy of this paper is "think and then do". The paper builds up on the topics, namely limits and continuity, differentiation and integration and then move on to more advanced applications in real life problems.

Course content

Unit I: Continuous compounding of interest, finding the circumference of circle from an n polygon inscribed in it, calculating the value of pi through limits, understanding of the ideas of limits and continuity graphically, calculating limits at infinity, indeterminate forms, special limits involving exponential and logarithmic functions, asymptotes; Improved facility in algebraic manipulation, graphing of quadric surfaces; Comparing the graphs of a function, its first derivative and its second derivative, sketching curves, solving optimization problems, fluency in differentiation, concavity and inflexion points, how derivatives affect the shape of the graph.

Unit II: Modeling average speed of traffic, temperature, population, etc., computing future value of a continuous income flow, flow of blood through an artery, fluency in integration, integration as a limit of a sum, volume of a frustum of a cone, cap of a sphere, volume of earth (not as a sphere but as an oblate spheroid). Staggered start of a race, Gabriel's horn (finite volume but infinite surface area), parametric equations of curves, arc length and surface area.

Unit III: Path of a projectile, Kepler's laws of planetary motion, and introduction of Vector valued functions, differentiation and integration of vector valued functions; Derivation of Newtonian formula of kinetic energy from Einstein's special theory of relativity, modeling of a simple pendulum, understanding the ideas of sequences, infinite series including Taylor approximations.

Unit IV: Topographic maps, isothermal surfaces, functions of several variables, level curves and surfaces, limits and continuity of functions of two and three real variables, partial differentiation (two variables), partial derivative as a slope, partial derivative as a rate.

Course Learning Outcomes:

- A good understanding of application of Calculus to daily life problems
- Able to understand the basic concepts of calculus.

- Create projects using fundamental knowledge in order to provide a hands-on experience of the same.
- Able to plot and manipulate the curves on CSA

Reading list

- T. M. Apostol Calculus, Volumes 1 and 2, Wiley Eastern, 1980.
- Hughes-Hallett et al., Calculus - Single and Multivariable, John-Wiley and Sons, 2003.
- James Stewart, Calculus, , Thomson, 2003.
- G. B. Thomas and R. L. Finney, Calculus and Analytic Geometry, Addison-Wesley, 1998.

Semester I
MME412CC: Perspectives in Mathematics Education
Core course
Number of credits: 4
Marks: 100

Course Objectives:

Mathematics is a discipline of multiple perspectives. Mathematics helps us to understand and organize things around us. Mathematics influences every aspect of human life but the way mathematics is taught in schools does not reflect the necessity, utility and aesthetics in Mathematics teaching. The beauty of Mathematics lies in its simplicity and freedom. The field of Mathematics Education looks into the pertinent gap between Essence of Mathematics and Teaching of Mathematics. The paper discusses the foundations of Mathematics and evolution of Mathematics Education in historical and socio-cultural perspectives.

Course Content:

Unit I: Nature, Philosophy and Foundation of Mathematics

Study of dual Nature of Mathematics: from cognitive to social, Principals of Mathematics, Pure vs Applied Mathematics, Paradoxes in Mathematics, Philosophy of Mathematics and Mathematics Education, History and culture of Mathematics

Philosophy of Mathematics Education, Mathematics Education in Social and Political context, Mathematics as an intellectual property vs Mathematics as a humanistic discipline, History of Mathematics in and for the curriculum, Mathematics and symbolization, Mathematics in popular culture, knowing in Mathematics

Unit II: Structuration in Mathematics: Axiom, Postulate, Mathematical Statement, Language, Theorem and Proof

Nature of mathematical ideas, Kinds of Mathematical statement, Mathematical Statements and proofs, Relation of Mathematics to logic, mathematical concepts and conceptual diversity, Primitive prepositions in Mathematics, Geometries and contradictions

Unit III: Origin and development of Mathematical Ideas

Evolution of numbers, Quantity and measurement, birth of algebra, emergence of calculus and beyond; beyond numbers: set theory; Infinity, Infinitesimal and Continuity

Unit IV: School Mathematics in the changing world

School Mathematics as social classification, Issues of equality and excellence in school mathematics, Gender stereotypes in Mathematics, Mathematics for future vs

Mathematics for appreciation, principles and Standards for school Mathematics, Mathematics literacy and Mathematics for all

Practicum:

1) Open House discussion on Strands and Contemporary Issues in School Mathematics
2) Education/ Review of one book from the suggested reading list

Course Learning Outcomes

- to develop sound understanding of foundations of nature of Mathematics;
- to develop understanding of philosophical, historical and sociological facets of Mathematics Education;
- able to identify various kinds of mathematical statements;
- able to trace developmental timeline of important mathematical concepts;
- able to discuss and analyze issues in school math education w.r.t cultural and social perspective.

Essential Readings

- *An Introduction to the History of Mathematics*, Third Edition by Howard Eves, Publisher: Cengage Learning (1990).
- *The Foundations of Mathematics* by Ian Stewart and David Tall, Oxford University Press (1977).
- *Mathematics: The Science of Patterns* By Keith Devlin, Scientific American Library (1997).
- National Curriculum Framework 2005

Suggested Readings

- *The Calculus Gallery, Masterpieces from Newton to Lebesgue* by William Dunham (Princeton University Press) (2008).
- *The Man Who Knew Infinity* by Robert Kanigel, Little Brown Book Group (1992).
- *What is Mathematics Really?* By Reuben Hersh, Oxford University Press (1999).
- *Does God Play Dice?* by Ian Stewart, Blackwell Publishing (1989).
- *A Concise History of Mathematics* by By Dirk Jan Struik, Courier Dover Publications (1987).
- *Universal History of Numbers* by Georges Ifrah, John Wiley & Sons (2000).
- *A Mathematician's Apology* by G.H. Hardy The Mathematical Experience by Philip J. Davis & Reuben Hersh, Cambridge University Press (2004).

Semester I
MME413CC: Core Courses from Jamia Millia Islamia
Number of Credits: 3
Marks: 100
***Refer to the list of courses to be opted from AJKMCRC, JMI**

Semester I
MME414CC: Core Courses from Jamia Millia Islamia
Number of Credits: 3
Marks: 100
***Refer to the list of courses to be opted from AJKMCRC, JMI**

Semester I
MME415CC: Curriculum and Evaluation in Mathematics
Core course
Number of credits: 4
Marks: 100

Course Objectives

The broad aim of this course is to develop holistic understanding of "Education" as a developmental force and how the purpose of education conceptualizes the idea of curriculum selection and legitimization of formal curriculum content. It further facilitates the students' understanding on social influences on the aims of education and its' impact on the curriculum planning and implementation with focus on school Mathematics Curriculum. The course focuses on understanding aims of teaching Mathematics as continuum from narrow aims to higher aims; organization of Mathematics Curriculum (in the light of latest NCF, Position Paper on Teaching of Mathematics with special focus on twin premises of learning mathematics and universalization of schooling)

Course Content

Unit I: Perspectives in Curriculum with reference to society, power and knowledge selection

Analysis of curriculum as intent and as reality; curriculum as the reflection of educational ideas and aspirations to be operationalized; curriculum as means to provide experiences to realize educational proposal into practice, Analysis of assumptions: the nature of knowledge, the nature of the child and the nature of the society, Debate on selection of knowledge, Debate on competing conception of balance and development of individual needs and the needs of the society.

Unit II: Process of curriculum development

Analysis of models: 'Objective model' and Process model', approaches to curriculum development: Role of central and state governments of India, Centralized and de-centralized curriculum development, Evaluation of curriculum as a whole.

Unit III: Concept of a National Curriculum Framework vs National Curriculum

Concept of curriculum framework, Kinds of curriculum framework, Curriculum in a democratic setup, Curriculum to facilitate and respect diversity, Concept of a National Curriculum Framework rather than a National Curriculum to help establish uniformity of democratic and secular norms, with the flexibility of approach and local contextually

Unit IV: Understanding aims of teaching mathematics as continuum from narrow aims to higher aims

Organization of Mathematics Curriculum (in the light of latest NCF, Position Paper on Teaching of Mathematics with special focus on twin premises of learning mathematics and universalization of schooling)

Practicum: Time line on development of reforms in Mathematics Education in India/ Comparative analysis of International Mathematics Curriculum

Course Learning Outcomes

- able to understand theoretical constructs of curriculum development;
- able to analyze curriculum development models;
- able to understand the role of various organizations in curriculum development process;
- able to conceptualize the idea and need of National Curriculum Framework;
- able to differentiate between narrow and higher aims of teaching Mathematics.

Essential Readings

- *The Curriculum: Theory and Practice* by A.K. Valley, Sage Publication (2009).
- *Contemporary Issues in Curriculum (6th Edition)* by Allan C. Ornstein , Edward F. Pajak, Stacey B. Ornstein , Published by Pearson (2014).
- Mathematics Curriculum in School Education by Li**,** Yeping, Lappan**,** Glenda (Eds.)Springer Publishers, (2014).
- Perspectives on the Design and Development of School Mathematics Curricula Paperback by National Council of Teachers of Mathematics, (2007).

Suggested Readings

- *Curriculum: From Theory to Practice* by Wesley Null Rowman & Littlefield, Rowman & Littlefield Publishers (2011)
- Mathematics Curriculum: Issues, Trends, and Future Directions (Seventy-second Yearbook, by Barbara J. Reys, Robert E. Reys Rheta Rubenstein, Published by NCTM, (2010).
- Critical Issues in Mathematics Education Edited by: Paul Ernest, Brian Greer, Bharath Sriraman, Information Age Publishing (2009).

Semester I

MME416CC Innovation Project: Interlinking Mathematics and Real life Problem

Core course

Number of credits: 4

Marks: 100

Course objectives

Student will study theoretical underpinning of issues concerned with Math learning and its application at elementary, secondary and senior secondary level of schooling and further propose innovative solutions after real time field testing. The paper will be taught in project mode.

Students need to identify and work on real time Math classroom problems or Math content related problems that can be solved through mathematical modeling and problem solving.

Option I: Solving real time problem/context that can be translated into mathematical model.

Option II: Concretizing abstract mathematical concepts using manipulative or technology.

Option III: Developing innovative Mathematics teaching learning resources.

Student can choose any one option and carry out the Innovation project out under the guidance of a mentor/mentors. Students can work in group of minimum two or maximum four.

Course Learning Outcomes

- able to identify math classroom problems faced by teachers and students;
- able to develop mathematical models around the problems;
- able to plan need based solution to the identified problems;
- able to test and analyze the solutions in real time setting.

Semester II

MME421CC Demystifying the Power of Data: Probability & Statistics

Core course

Number of credits: 4

Marks: 100

Course Objectives:

Uncertainty prevails in decision making, in testing compatibility of samples, and everywhere in day-to-day life. This paper aims to provide the basic understanding of the subject and the tools used to understand these uncertainties. The student will be able to fit, interpret, diagnose and predict simple real life models involving probability and statistics.

Course Content:

Unit I: Sampling distributions, hypothesis testing, interval estimation, likelihood, analysis of categorical

Unit II: Data, joint, marginal and conditional distributions, ANOVA and regression.

Unit III: Computer program R and its application to simple models, Statistical procedures and their implementation through the statistical package R

Unit IV: Sampling distributions and randomness, likelihood analysis, bivariate, marginal and conditional distributions, curve fitting, linear regression, test statistic and their significance.

Course Learning Outcomes:

- A good understanding of application of Statistics to daily life problems
- Able to understand the basic concepts of statistics
- Create projects using fundamental knowledge in order to provide a hands-on experience of the same.
- Able to work on statistical package R

Reading List

- B. Bowker and G.J. Liberman, Engineering Statistics, Asia, 1972.
- R.V. Hogg and E.A. Tanis, Probability and Statistical Inference, Macmilan, 1983.
- N.L. Johnson and F.C. Xeen Leone, Statistics and Experimental Design in Engineering and the Physical Sciences, Vol. I and II, , Wiley Inter science, 1977.

Semester II
MME4212CC: Art of Mathematics Teaching and Evaluation
Core course
Number of credits: 4
Marks: 100

Course objectives

The context of learning plays an important role to foster creativity, logic and concept building. The humanistic and realistic approach developed through the paper is rooted in belief that leaners construct the knowledge on their own in a stimulating environment. The role of teacher is to organize socially relevant and resourceful learning environment for active participation if learners. The paper emphasis on develop pedagogical and assessment paradigms to facilitate math learning for all.

Course content

Unit I: Theories of Teaching and learning of Mathematics

Styles and strategies for teaching mathematics, theories of learning (Dewey, Bruner, Piaget, Denies, Vygotsky) connecting theory and practice in mathematics teaching, facilitating culture of learning in mathematics classroom

Unit II: Addressing Pedagogical Concerns in Mathematics classroom

Critical content of school mathematics: Numbers, Algebra, Geometry, Probability and Statistics, Calculus, limits and continuity with emphasis on research in teaching and learning

Unit III: Assessment for Active Mathematics learning

Models of assessment, Assessment for learning and assessment of learning, assessment for teaching, interpreting assessment, developing assessment plan for diverse learners

Unit IV: Resources for Mathematics Teacher across Curriculum

Mathematics as a discipline of interdisciplinary approach, creative ways of developing mathematical ideas across curriculum; Learning Mathematics through Minds on and Hands on, facilitating learning using active use of resources, developing innovative resources to develop mathematical ability (games, puzzles, models, hands on kits)

Practicum: Focused Discussion Forum to initiate dialogue and sharing on School Internship Experiences

Course Learning Outcomes

- able to understand theoretical framework for theories of teaching of Mathematics;
- able to learn the strategies to facilitate the culture of learning in math classroom;
- able to identify critical content areas in math classroom and to relate it to the research practices;
- able to understand different approaches of assessment;
- able to develop and interpret assessment plans for diverse abilities learners;
- able to develop content specific resources for math teachers.

Essential Readings

- Skemp R. (1987). The Psychology of Learning Mathematics. Lawrence E Hillsdale.
- Black P., Harrison C., Lee C. Marshall B. Wiliam. D (2003): Assessment for Learning: Putting it into Practice, Open University Press.
- Inside the Black Box: Raising Standards Through Classroom Assessment (2005) by Dylan Wiliam, Published by NFER Nelson.
- Mitchelmore M. & White P.(2010) Teaching Mathematical Concepts: Instruction for Abstraction. Australian Catholic University National, Sidney Australia.

Suggested Readings

- Hiebert & Lefevre (1986). Conceptual and Procedural Knowledge in Mathematics: An Introductory Analysis by J. Hiebert (eds.) Conceptual and Procedural Knowledge: The case of mathematics. pp.1-27.
- Davis R. B. (1983). Complex Mathematical Cognition In H. P. Ginsburg (eds.) The Development of Mathematical Thinking. New York: Academic press. pp. 253-290.
- Resnick, L. B., & Ford, W. W. (1981). The Psychology of Mathematics for Instruction. NJ: Lawrence Erlbaum.
- Cobb P. (1994). Where Is the Mind? Constructivist and Socio-cultural Perspectives on Mathematical Development. Educational Researcher, Vol. 23(7), pp. 13-20.
- John-Steiner V. & Mahn H.(1996). Socio Cultural Approaches to Learning and Development: A Vygotskian Framework. Educational Psychologist.
- Bell E. T. (1940): The Development of Mathematics, New York, McGraw Hill.

Semester II
MME423CC: ICT in Mathematics Education
Core course
Number of credit: 4
Marks: 100

Course objectives

Technology has changed the course of education. Effective use of technology can do a lot to benefit learners. The paper focuses on developing appropriate understanding, well coordinate and sound pedagogical knowledge to make judicious uses of technological tools for teaching mathematics beyond boundaries.

Course content

Unit I: Potentials of ICT in Mathematics Education

ICT as a change agent, Place and purpose of technology in the curriculum, Means of ICT, technology embedded pedagogy

Unit II: ICT for enhanced learning

Content planning using ICT, Role of ICT in content differentiation, ICT and self-paced learning, Use of ICT in inclusive classroom

Unit III: Safety issues in use of ICT

Technology in the hands of teacher and student, connectivity through ICT on campus and off campus, learning space, e-content versus authentic information

Course Learning Outcomes

- able to understand the scope of ICT in education;
- able to identify means of ICT;
- able to learn and use ICT tools in teaching;
- able to use ICT to support inclusion in classroom;
- sensitized towards the misuse of ICT in learning situations.

Essential Readings

- Introduction to Information and Communication Technology in Education (2005) E-book by David Moursund , Teacher Education, University of Oregon
- ICT in Primary Education: Analytical survey(2012) by UNESCO
- Research on e-Learning and ICT in Education(2012) by Jimoyiannis**,** Athanassios (Ed.), published by Springer
- Teaching Mathematics Using ICT 3rd Edition (2010) by Adrian Oldknow Ron Taylor Linda Tetlow , published by Continuum International Publishing Group.

Suggested Readings

- ICT: Changing Education (2001) by Chris Abbott, Psychology Press.
- Technology, Innovation, and Educational Change: A Global Perspective: A Report of the Second Information Technology in Education Study, Module 2 (2003) by Robert B. Kozma published by International Society for Technology in Education.
- Teaching Secondary Mathematics with ICT (2004) by,Sue Johnston-Wilder, David Pimm, McGraw-Hill International.
- Teaching Mathematics Using ICT 3rd Edition (2010) by Adrian Oldknow Ron Taylor Linda Tetlow , published by Continuum International Publishing Group.

Semester II

MME424CC: Learning Ways of Mathematical Writing
Core course
Number of credit: 4
Marks: 100

Course Objectives

Mathematics is a sophisticated language written with lots of precision and accuracy. It follows certain rules which need to be followed by people who would like to write good mathematical content. The paper focuses on the art of mathematical writing to enable students to write quality content that is conceptually and pedagogically sound. The paper will focus on learning of software on mathematical writing.

Unit I: Mathematics as a language and expression

Exploring mathematical ideas from language lens, features of mathematical language, evaluation of algebraic symbolism

Unit II: Basics of mathematical writing

Essential rules of mathematical writing, technical aspect of mathematical writing, adding creativity in mathematical content

Unit III: Mathematical writing software

Writing on computer using software, namely, LateX, MathWriter,MathType

Unit IV: Learning through exemplary pieces of mathematical writings

Critical analysis of mathematical content in textbooks, reference books and research based books, Review of exemplary pieces of mathematical writing

Course Learning Outcomes

- able to understand structure of mathematics as a language;
- able to differentiate between good and poor definition of a mathematical concept;
- learn the way of effective mathematical writing;
- able to appreciate creativity in mathematical writing;
- learn to use math writing software, Latex and others.

Essential Readings

- Introduction to Mathematical Writing by Franco Vivaldi, School of Mathematical Sciences, The University of London, 2014.
- Handbook of *Writing* for the *Mathematical* Sciences (1998) by Nicholas J. Higham, Published by The Society of Industrial and Applied Mathematics.
- Steven G. Krantz, *A primer of mathematical writing: being a disquistion on having your ideas recorded, typeset, published, read and appreciated*, American Mathematical Society, 1997.

Suggested Readings

- David K Pugalee, Writing, mathematics, and metacognition: Looking for connections through students' work in mathematical problem solving, *School Science and Mathematics*, May 2001.
- Donald E. Knuth, Tracy Larrabee, and Paul M. Roberts, *Mathematical writing*, Mathematical Association of America, 1989.
- John Meier and Thomas Rishel, *Writing in the Teaching and Learning of Mathematics*, Mathematical Association of America, 1998.
- Candia Morgan, *Writing Mathematically : The Discourse of 'Investigation'* (Studies in Mathematics Education), Falmer Press, 1998.

Semester II
MME425CC: Theories of learning
Core course
Number of credits: 4
Marks: 100

Course objectives

The students will be able to:

- understand the relevance of psychological perspective of learning;
- get acquainted with the process of learning in children;
- understand the dynamics of learning with reference to education;
- apply the learning principles in classroom situations.

Course content

Unit I: Psychology of learning

- Learner and Learning - Nature, meaning and scope

Unit II: Approaches to learning

- Behavioristic, Cognitive and Humanistic

Unit II: Theories of learning

- Pavlov's, Skinner's and Gestalt theories of learning.
- The Social Cognitive Theory with special reference to Bandura, Dollard and Miller.
- Transformative Learning Theory with special reference to Jack Mezirow
- Social Development theory (Vygotsky), Discovery Learning
- Experiential Learning theory (Kolb),
- Cognitivist Learning Theories: Attribution theory (Weiner), Metacognition (Flavell), E-Learning Theory, Gamification in Education, The Information Processing Theory with special reference to Ausubel and Bruner.

Unit IV: Constructivism and Learning

Meaning and scope of constructivism; learning styles and their relevance to learning

Essential Reading

- Olson,M.H. & Hergenhann (2013).Theories of Learning; New Delhi: PHI Learning Pvt. Ltd.
- Schunk,H.Dales.(2014).Learning Theories: An Educational Perspective. Harlow, England; Pearson Publisher.

Suggested Reading

- Bates.Bob. (2016). Learning Theories Simplified and how to apply them to teaching. New Delhi; Sage Publication.

Semester II
MME426CC: Innovation Project: School Internship
Core course
Number of credits: 4
Marks: 100

This project will be carried out in schools as Integrated School Internship Project to experience Mathematics teaching and learning, understanding classroom behavior and

issues in assessments. School Internship will be guided, supervised and reviewed by the CIC faculty. Internship will include planning discourse, classroom engagement and reflection practices.

Semester II
MME427OEC (Option I): Innovation in Education
Open Elective Course
Number of credit: 2
Marks: 50

Course Objectives:

Innovation in Education is important to solve many contemporary challenges faced by the country today. The course aims to develop an insight into the process of developing innovative ideas; how to deconstruct standardized procedures and think more open, creative and out of box ideas to target realistic problems of education.

Unit I: Understanding concept of Innovation

Conceptualizing innovation in in terms of: Learning; Teaching; Society; Industry; Essentials of innovation; Innovation as an idea, product or process; Innovation and need of society; Innovation and technology

Unit II: Creating an environment for Innovation

Factors responsible for innovation; Need identification and working for innovation; Support system to promote innovation; Implementing changes for promoting innovation; Innovation by practice

Course Learning Outcomes

- able to conceptualize the idea of innovation;
- able to identify factors responsible for innovation;
- able to understand the need and scope of innovation in educational practices.

Essential Readings

- Education for Innovation and Independent Learning by by David Scott and Ronaldo Mota; published by Elsevier, 2014.
- Creating Innovators: The Making of Young People Who Will Change the World by Tony Wagner; published by Simon & Schuster Audoi 2012.

Suggested Readings

- Where Good Ideas Come from: The Natural History of Innovation by Steven Johnson, Riverhead Books, 2010.

Semester II

MME427OEC (Option II): Mathematical Visualization

Open Elective Course

Number of credits: 2

Marks: 50

Course objectives:

To increase an awareness of patterns and the Mathematics that pervades the world around us.

Course content:

Unit I: Symmetry

Geometrical definition of symmetry; Symmetry around us; Symmetry of finite plane figures; Symmetry of wall paper patterns; Symmetry groups; Symmetry in monuments and ornamental art.

Unit II: Linear Perspective and Projection

Mathematical principles of linear perspective and projection; One, two and three point linear perspective; Vanishing points; Duplicating simple geometric figures (circle and polygons) in one and two point perspective; Finding the viewing point of a painting in one point perspective.

Course Learning Outcomes:

- Understanding symmetries present in various art forms and architecture
- Appreciate paintings from a Mathematical point of view
- Able to draw simple geometrical figures in perspective

Essential Reading

- Mark Frantz and Annelisa Crannell, *Viewpoints: Mathematical Perspective and Fractal Geometry in Art*, Princeton University Press, 2011.
- Dan Pedoe, *Geometry and the Visual Art,* New York: Dover Publication, 2011.
- Bagai,S.,Habib,A. & Venkataraman,G. A Bridge to Mathematics, Sage Publications, 2017.

Suggested Readings

- David W Farmer, *Groups and Symmetry,* India: University Press, 1998.
- Marcus Du Sautoy, *Symmetry: A journey into the patterns of nature*, USA harper Collins, 2008.

Semester III

MME531CC: Discretizing and Understanding Real Life Situations through Mathematical Lens

Core Course

Number of credits: 4

Marks: 100

Course objectives

In modern world, most jobs involve interaction with computers. The computing and embedded systems technologies break additional barriers; even the day to day life and common activities now involve interacting with a computing device.

Course content

Unit I: Graphs (bipartite, Euler, Hamiltonian, Planar), Euler's V-E+F=2 Theorem, subdivisions, Kuratowski's Theorem,

Unit II: Matching, Hall's Marriage Theorem, assignment problems, counting sets, subsets, multisets, inclusion/exclusion, applications

Unit III: Vectors and geometry, Systems of linear equations, echelon form, Gaussian elimination, linear independence.

Unit IV: Matrices, multiplication, transpose, inverses, linear maps. Intro to subspaces and bases, Rank, Eigenvalues and eigenvectors, Determinants

Course Learning Outcomes:

- Understanding of basic concepts and application of Graph theory
- Able to understand the geometrical concepts of Linear Algebra
- Create projects using fundamental knowledge in order to provide a hands-on experience of the same.
- Able to work on CAS

Reading list

- Linear Algebra and its Applications, D. C. Lay, Addison Wesley, 2005.
- A Modern Introduction, David Poole, Linear Algebra, Brooks Cole, 2011.
- Discrete and Combinatorial Mathematics, Ralph Grimaldi, International Edition, 2003.
- Discrete Mathematics and Its Applications, K. H. Rosen, McGraw-Hill, 2008

Semester III

MME532CC: Pedagogical Intervention in Mathematical Classroom

Core Course

Number of credits: 4

Marks: 100

Course objectives

The course aims to enable students to use/develop need based pedagogical strategies and teaching learning resources for an inclusive classroom. It will focus on learning needs of differently abled learners.

Course content

Unit I: Framework for inclusive classroom

Diversity in Mathematics classroom; Mathematics for all; Accessible curriculum.

Unit II: Fundamentals of pedagogical intervention

Pedagogical intervention as a process; Pedagogical intervention vs Instructional strategy; Pedagogical intervention vs Accommodation.

Unit III: Need and scope of Differentiation

Strategies for differentiation and student engagement; Strategic grouping and collaborations; Purposeful use of technology to support learning.

Unit IV: Bridging the achievement gap

Need based leaching resources using visual; tactile; auditory; kinematic; Curriculum for advanced learner using acceleration and enrichment.

Course Learning Outcomes

- able to understand meaning of diverse ability learners
- conceptualize framework of an inclusive classroom
- able to learn strategies of differentiation in an inclusive classroom
- able to develop need based resources for differently abled learners, including double exceptional

Essential Readings

- Riccomini, P. J. (2009). Response to Intervention in Mathematics. Corwin Publisher.
- Hudson, P.P. and Peterson Miller, S. (2005). Designing and Implementing Mathematics Instruction. Pearson, 2005.
- Alisopp, D. Kyger , M. & L. H. Louann. (2007). Teaching Mathematics Meaningfully: Solution for reaching struggling learners (2nd Edition). Brookers Publishing.
- Boaler, J. and Dweck, C. (2015). Mathematical Mindsets: Unleashing Students' Potential through Creative Mathematics, Inspiring Messages and Innovative Teaching. Jossey-Bass Publishers.

Suggested Readings

- Principles to Actions: Ensuring Mathematical Success for All. (2014). National Council of Teachers of Mathematics.
- Chinn, S. (2017). The Routledge International Handbook of Dyscalculia and Mathematics Learning. Routledge Publishers.

Semester III
MME533CC: Digital Technology in Mathematics Education
Core Course
Number of credits: 4
Marks: 100

Course objectives

Technology including multimedia is an asset to expand the reach of classroom teaching. The paper builds up pedagogical orientation to integrate use of digital technologies into mathematics classroom. The paper gives an opportunity to develop creative resources using available technology such as software & applets to foster critical thinking in learning Mathematics.

Course content

Unit I: ICT embedded Mathematics Pedagogy

Content specific mathematics pedagogies using digital resources, web-based innovations

Unit II: Digital Technology in Mathematics Classroom

Designing web-based learning environment (web-site, blogs, virtual classroom etc)

Unit III: Exploring Mathematics through online resources

Learning software for mathematics teaching and content design (CMAP, Geometer, Sketchpad, Geogebra, Graphing Calculator 3D, Captivate, Photoshop, Coral Design)

Unit IV: Content development

Preparing E-content/E-resource/E-assessment/web-based classroom

Essential Reading List

- The Mathematics Teacher in the Digital Era (Vol II) (2014) by **Clark-Wilson**, Alison, **Robutti**, Ornella, **Sinclair**, Nathalie (Eds.), Published by Springer.
- Mathematics Education with Digital Technology (2011) by*:* Adrian Oldknow, Published by Continuum.

Suggested Readings

- Research on e-Learning and ICT in Education (2012) by **Jimoyiannis**, Athanassios (Ed.), published by Springer.

Semester III

MME534CC: Research Methodology in Education

Core Course

Number of credits: 4

Marks: 100

Course objectives

The paper focuses on idea of research in education and various research designs highlighting the quantitative and qualitative methods of data collection and data analysis. It also sensitizes students into the challenges of carrying out research in the field of education. Students are expected to do micro research project in educational setting to connect theory into practices.

Course content

Unit I: Introduction to Educational Research

Research as source of inquiry, role of research in the field education, qualitative and quantitative paradigms of research, Types of research (experimental, descriptive and action research); Role of theory in research.

Unit II: Research Paradigms and Design

Research design in educational research, sampling and techniques in data collection and data analysis, objectivity, reliability, validity and statistical inferences.

Unit III: Understanding Research Processes

Steps in carrying out research, research planning, writing proposal, review of literature, hypothesis, tools design, data collection and analysis, report writing.

Unit IV: Learning to write research proposal

Writing and defending a research proposal/ Micro research project

Course Learning Objectives

Essential Reading

- Best, J. and Kahn, J. (2012). Research in Education (10th Edition). PHI learning Private Limited.
- Reason, P. & Bradbury, H. (Eds) (2006). Handbook of action research: Concise paperback edition: Thousand Oaks, CA: Sage.
- Research Methods in Education (5th Edition) 2000 by **Louis Cohen** ,**Lawrence Manion** ,**Keith Morrison** by Routledge Falmer
- Clive Opie (2004). Doing Educational Research- A Guide for First time researchers. New Delhi: Vistar Publications.
- Cohen ,Manion & Morrison (2003) Research Methods in Education (V Edition) , Published by Taylor & Francis

Suggested Readings

- Fraenkel, J.R., Wallen, N.E. (1996). How to Design and Evaluate Research in Education. New York: McGraw Hill.
- Stake, Robert E. (1995). The Art of Case Study Research. Thousand Oaks: C.A: Sage.

- Reason, P. & Bradbury, H. (Eds) (2006). Handbook of action research: Concise paperback edition: Thousand Oaks, CA: Sage.
- Christensen, L. (2007). Experimental Methodology. Boston: Allyn & Bacon.
- Borg, W.R. and Gall, M.D. (1983). Educational Research – An Introduction, New York: Longman, Inc.
- Sharma, S.R. (2003). Problems of Educational Research. New Delhi: Anmol Publications Pvt. Ltd.

Semester III

MME535CC: Statistics in Educational Research

Core Course

Number of credits: 4

Marks: 100

Course objectives

The course will focus on descriptive & inferential statistics and quantitative & qualitative data analysis. It enables students to apply statistical methods in educational research.

Course content

Unit I: Meaning and scope of Statistics

Measurement scales; Parametric and Nonparametric Data; Descriptive and Inferential Analysis.

Unit II: Descriptive Statistics

Representing data (Frequency distribution; Cumulative distribution and Histogram) ; Measurement of Central Tendency and its 'interpretation, Measure of dispersion (Variance and Standard Deviation) and its' interpretation; Standard Scores (Z score; T Score, Percentile score and Percentile rank); Normal Probability curve and its 'applications; Measure of correlation (Product movement correlation and Rank order correlation) Scatter-gram and Regression line; Interpreting coefficient of correlation and making prediction using standard error of estimate

Unit III: Inferential Statistics

The central limit theorem; Testing null hypothesis; Significance of difference between the means; level of significance; Degree of freedom; One sample Z test; Significance of difference between means of two small and independent samples; Significance of difference between means of two matched or correlated groups (non- independent samples); Statistical significance of coefficient of correlation.

Unit IV: Data analysis and interpretation

Using case studies with real time data from education setting and making inferences

Essential Readings

- Best, J. and Kahn, J. (2012). Research in Education (10th Edition). PHI learning Private Limited.
- Pyrczak, F. (2014). Making sense of statistics: A conceptual overview (6th Edition). Routledge.
- Garrett, H. E. (2006). Statistics in Psychology and Education. Cosmo Publication.
- Creswell, W.J. and Creswell, J. D. (2018). Research Design: Qualitative, Quantitative and Mixed Methods. Sage Publications.

Suggested Readings

- Evergreen, S. (2016). Effective Data Visualization. Sage Publication.
- Mills, G. E. and Gay, E. R. (2018). Educational Research: Competencies for Analysis and Applications (12th Edition). Pearson.
- Coladarci, T. and Cobb, C.D. (2013). Fundamentals of Statistical Reasoning in Education (4th Edition). Wiley Publishers.

Semester III

MME536EC. Innovation Project: Internship in Educational Setting

Elective Course

Number of credits: 4

Marks: 100

The course will be carried out as an internship project in government educational organization/ schools/ special schools/ alternate educational organization to experience developmental perspectives in mathematics education under the following themes: Hands-on: Minds-on Math learning tools; ICT embedded Math learning platform; Data as a resource for strengthening Math learning; Accessible Math curriculum for all. The project will be carried out under the guidance of mentor.

Semester III

MME537OEC (Option I): Education Entrepreneurship for Social Change

Open Elective Course

Number of credits: 2

Marks: 50

Course objectives

The course aims to develop entrepreneurship skills among students to turn educational challenges into social impact initiatives. The skills include: identifying opportunities for educational change; planning the framework and evaluating the plans for practical feasibility.

Course content

Unit I: Meaning and scope of Education Entrepreneurship

Definition of Education Entrepreneurship; social impact models of entrepreneurship; skills for entrepreneurship

Unit II: Opportunities for Education entrepreneurship

Issues and challenges in education; developing viable entrepreneur models to create educational opportunities for disadvantaged section of society; entrepreneurship using technology and localized resources.

Course Learning Outcomes

- able to define education entrepreneurship;
- able to analyse social impact models of entrepreneurship;
- able to understand the scope and challenges in education entrepreneurship.
- able to understand the role of education in sustainable development;
- able to appreciate the need and scope of curriculum for a sustainable future.

Essential Readings

- Handbook of Research in Entrepreneurship Education: **International Perspectives by** Alain Fayolle, Edward Elgar Publishing Limited, 2010.
- Entrepreneurship Education: Experiments with Curriculum, Pedagogy and Target Groups by Mathew J. Manimala, Princy Thomas, Springer Singapore, 2017.

Suggested Readings

- Social Entrepreneurship as a catalyst for social change edited by Charles Wankel, Ph.D., .Larry E. Pate, Information Age Publishing, 2013
- Education in Emerging Indian Society: Challenges and Issues ny Sunada Ghosh and Radha Mohan (2nd Edition), PHI learning private limited, 2015.

Course Code:
MME537OEC (Option II): Education for Sustainable Future
Open Elective Course
Number of credits: 2
Marks: 50

Course objectives

The course aims to sensitize students for the need of sustainable future and the role of education in developing knowledge, skills and values for sustainable development for all.

Course content

Unit I: Education as catalysts for a sustainable future

Environmental sustainability; Economic sustainability; Social sustainability; Aims and objectives for sustainable future.

Unit II: Curriculum for sustainable future

Diversifying curriculum around critical areas for interventions to achieve sustainable development goals; Pedagogical strategies to meet the curriculum needs; Practicing sustainability.

Course Learning Outcomes

- able to understand the role of education in sustainable development;
- able to appreciate the need and scope of curriculum for a sustainable future.

Essential Readings

- Education for Sustainable Development: Challenges, Strategies and Practices in a Globalizing World Edited by: Anastasia Nikolopoulou; Taisha Abraham and Farid Mirbagheri, published by Sage Publication, 2018.
- Textbooks for Sustainable development by UNESCO, MGIEP, 2017.

Suggested Reading

- Teaching Education for Sustainable Development at University Level by Leal Filho, Walter, Pace, Paul (Eds.), Springer, 2016.

Semester IV

MME541CC: Understanding Mathematical language of Ordinary Differential Equations and Complex Analysis
Core Course
Number of credits: 4
Marks: 100

Course objectives

Modeling is the process through which real life problems are converted to the mathematical language. This paper aims to develop techniques required to study the models involving differential equations. The methodology will be to first analyze and understand the problem, then write down the governing equations, solve them and then analyze the solution. The problems will be picked up from engineering, ecology, medicine, etc.

Course content

Unit I: Application of first order differential equation to draining a tank, harvesting of renewable natural resource, indoor temperature oscillation, flight trajectory, survivability with aids.

Unit II: System of linear differential equations applied to mechanical systems, electrical network, drug assimilation into the blood, solution of a linear system (in non-degenerate cases) using Eigen pairs, Modeling two-axle automobile, earthquake induced vibrations of a multistory building, evaluation and application of matrix exponential (in non-degenerate cases)

Unit III: Planar autonomous linear systems with graphical representation (in non-degenerate cases), Planar non-linear system applied to ecological models, wildlife conservation preserve, mechanical systems, epidemic models, determination of stability and classification of equilibrium of a planar nonlinear system by linearization.

Unit IV: Complex numbers and their geometrical interpretation, polar forms, powers and roots.

Course Learning Outcomes:

- Able to explain and formulate real life problems as ODEs
- Understand the concepts of ordinary differential equations to solve physical models, biological models and ecological models.
- Able to understand the stability of systems of equation

- Visualise the qualitative behavior of the solutions of ODE
- Understand and visualise the geometrical interpretation of complex numbers

Reading list:

- T. M. Apostol Calculus,, Volume 2, Wiley Eastern, 1980.
- W. E. Boyce and R. DiPrima, Elementary differential equations, John Wiley, 2005.
- C.H. Edwards and D.E. Penny, Differential equations and boundary value problems:
- Computing and modeling, Pearson education (Singapore), Pte. Ltd., 2005.
- E. Kreyszig, Advanced engineering mathematics, John Wiley, 1999.

Semester IV

MME542CC: Research Investigations in Mathematics Education

Core Course

Number of credits: 4

Marks: 100

Course objectives

The paper highlights the significant features of mathematics education as a dynamic research field. It lays emphasis on developing critical understanding on issues and investigations in mathematics curriculum, pedagogy and assessment.

Course content

Unit I: Trends and Issues in Mathematics Education Research

Mathematics Educations as a dynamic field with growing input from research, place and purpose of mathematics education research, trends in mathematics education, ethical issues in mathematics education research

Unit II: Interdisciplinary Research in Mathematics Education

Exploring potential research area, research design in Mathematics Education; Debates in Mathematics Education

Unit III: International Organizations working in Mathematics Education

Comparative, Collaborative and Cross cultural research in Mathematics Education

Unit IV: Learning from existing research practices

Reviewing seminal research work in Math education

Essential Readings

- Keith L (2013) Vital Directions for Mathematics Education Research, Published by Springer
- Clements, M.A.(Bishop, A., Keitel-Kreidt, C., Kilpatrick, J.,Leung (2013) Third International Handbook of Mathematics Education
- Journal for Research in Mathematics Education
- Journal of Research in Mathematics
- Mathematics Teaching

Suggested Readings

- Lyn D (Ed) (2008): Handbook of International Research in Mathematics Education, Published
- School Science and Mathematics
- The Mathematics Matter

Semester IV
Courses MME543CC
Core course
Number of credits: 3
Marks: 100
***To be taken from list of papers offered by AJKMCRC, JMI**

Semester IV
Courses MME544EC
Elective course
Number of credits: 3
Marks: 100
***To be taken from list of papers offered by AJKMCRC, JMI**

Semester IV

Elective course in Research Design
MME545EC (Option I): Experimental Research Design
Elective course
Number of credits: 4
Marks: 100

Course objective

The course will equip the students with foundations of experimental research design including its need and feasibility. Students will be able to learn about different types of experimental designs and constraints of experimental designs in educational setting.

Course content

Unit I: Fundamentals of experimental research

Randomization, Control and Manipulation; Experimental and control group; Independent and dependent variable; Confounding variables (intervening and extraneous variables); controlling extraneous variables; Experimental variability and threats to experimental validity.

Unit II: Pre-Experimental Design

One shot case design; One group pretest-posttest design; Static group comparison design; limitations of pre-experimental design.

Unit III: True experimental design

Posttest (equivalent group) design; Pretest-posttest (equivalent group) design; The Solomon four-group design; Crossover design; Advantages and disadvantages of true experimental research design.

Unit IV: Quasi- experimental design

Pretest-posttest (Non- equivalent group) design; Time series design; The equivalent Time-Sample Design; Equivalent materials- Pretest-posttest design; Counterbalanced design; Advantages and disadvantages of true experimental research design.

Course Learning Outcomes

- able to understand fundamentals of experimental research design;
- able to plan one shot case design, one group pretest-posttest design, static group comparison design;
- able to design true experimental design;
- able to design quasi experimental design.

Essential Readings

- Stanley, J. C. and Gage, N.L. (1963). Experimental and Quasi Experimental Designs for Research. Boston: Houghton Miffin.
- Creswell, W.J. and Creswell, J. D. (2018). Research Design: Qualitative, Quantitative and Mixed Methods. Sage Publications.
- Kerlinger, F. N. (2017). Foundations of Behavioural Research. Surjeet Publications.
- Best, J. and Kahn, J. (2012). Research in Education (10th Edition). PHI learning Private Limited.

Suggested Readings

- Kirk,R.E. (2012). Experimental Design: Procedures for Behavioural Sciences (4th Edition). Sage Publication.
- Kennedy, C. (2004). Single Case Design for Educational Research. Pearson.

Semester IV

Elective course in Research Design

MME545EC (Option II): Descriptive Research Design

Elective course

Number of credits: 4

Marks: 100

Course objectives

The course will equip the students with foundations of descriptive research design including its need and feasibility. Students will be able to learn about different types of descriptive designs and constraints of descriptive designs in educational setting.

Course content

Unit I: Fundamentals of descriptive research:

Features and characteristics and scope of descriptive research.

Unit II: Different kinds of descriptive research designs (Part: I)

- Casual- comparative research design;
- Correlational research design;
- Longitudinal research design;

Unit III: Different kinds of descriptive research designs (Part: II)

- Ethnographic research design;
- Case study design;
- Document analysis design.

Unit IV: Advantages and disadvantages of descriptive research

Course Learning Outcomes

- able to understand fundamentals of descriptive research design;
- able to justify the feasibility of different kinds of descriptive research designs;
- able to plan different kinds of descriptive research designs;
- able to analyze the limitations of descriptive research designs

Essential Readings

- Creswell, W.J. and Creswell, J. D. (2018). Research Design: Qualitative, Quantitative and Mixed Methods. Sage Publications.
- Best, J. and Kahn, J. (2012). Research in Education (10th Edition). PHI learning Private Limited.

Suggestive Readings

- Boudah, D. J. (2010). Conducting Educational Research: Guide to Completing a Major Project. Sage Publication.
- Cohen, L. and Manion, L. (2002). Research Methods in Education (7th Edition). Routledge.

Semester IV

Elective course

MME546EC: Innovation Project: Research Dissertation

Number of credits: 4

Marks: 100

Each student will take up a research problem from the field of Education/ Mathematics Education and will carry out small scale research using appropriate research methodology under the guidance of a supervisor and finally write a detailed research report.

***List of the papers offered by AJKMCRC, Jamia Millia Islamia**

1. English for media communication
2. Advertising
3. Contemporary India and the world we live in
4. Development Journalism
5. Media Management
6. Public Relations and Corporate Communication
7. Media Laws and Ethics
8. Mass Communication Theory
9. Media Research
10. Advanced Gaming and Animation Scripting
11. The Science of Screenplay Writing & Production
12. Advertising Communication: Process & Planning
13. Street Theatre
14. Puppetry
15. Gaming and Animation Scripting
16. Introduction to South Indian Cinema
17. Basic Gaming
18. Social Media for Development Communication
19. Film Appreciation
20. Intensive English Communication
21. Introduction to Radio
22. MOOC and E-Learning