BENGALURU NORTH UNIVERISTY

Curriculum for B Sc Degree & B Sc Honors with Mathematics as a Major/ Minor Subject

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Framed According to the National Education Policy (NEP 2020)

B. Sc., MATHEMATICS SYLLABUS

(III & IV Semesters)

DEPARTMENT OF MATHEMATICS

Bengaluru North University

Tamaka, Near NH 75 in Kolar

KARNATAKA

AUGUST - 2022

BENGALURU NORTH UNIVERSITY
Department of Mathematics

Date: 27-08-2022

PROCEEDING OF THE BOS (UG) MATHEMATICS

The meeting of the Board of Studies in UG Mathematics for the year 2022-23 was held on Saturday, **27th August 2022** at 11.00am in the Department of Mathematics, Jnanabharathi Campus, Bengaluru University, Bengaluru-56. The following members attended the meeting:

1.	Dr. B. Chaluvaraju	Chairman	
2.	Prof. Madhulatha Moses	Member	
3.	Dr. Shivasharanappa Sigarkanti	Member	
4.	Prof. Nagaraddi B. Y.	Member	
5.	Prof. Mariya Khibthiya	Member	
6.	Prof. Kemparaju R.	Member	
7.	Dr. Abraham V. M	Member	
8.	Dr. Kemparaju S	Member	
9.	Prof. Suguna H. G.	Member	

Agenda and Resolution:

1. Final draft of the BNU-NEP-UG-Mathematics (III & IV Semester B. Sc.,) was checked and discussion held. The suggestions given by the BOS members and subject experts were incorporated.
2. The syllabus framed as per NEP-2020 and Karnataka State Higher Education Council guidelines. The syllabus prepared by teachers with a practical component (Mathematics practical with FOSS tools for programming). The BOS also resolved to change the list of practical experiments each year. Finally, the syllabus was approved by all the members.
3. The committee approved the updated panel examiners of UG (Mathematics).

The Chairman thanked the members for their cooperation.

27/08/2022

[Dr. B. CHALUVARAJU]
CHAIRMAN
BNU-BOS in UG-Mathematics

Dr. B. CHALUVARAJU
M.Sc. Ph.D
Professor
Department of Mathematics
Bangalore University, Jnanabharathi
BENGALURU - 560 056.

Copy to:

1. The Registrar, Bengaluru North University, Bengaluru
2. The PS to the Vice-Chancellor, Bengaluru North University, Bengaluru

PREAMBLE

The subject wise expert committee to draft model curriculum contents in Mathematics constituted by the Department of Higher Education, Government of Karnataka, Bangalore vide GO No. ED 260 UNE 2019 (PART-1) DATED 13.08.2021 is pleased to submit its partial report on the syllabus for the First Year (First & Second Semesters) B.Sc. (Basic/Honors) Mathematics and detailed Course Structure for B.Sc.(Honors) Mathematics and M.Sc. (One Year) Mathematics.

The committee discussed various models suggested by the Karnataka State Higher Education Council in its joint meetings with the Chairpersons of Board of Studies of all state universities in Karnataka and resolved to adopt Model IIA (Model Program Structure for the Bachelor of Science (Basic/Hons.) for the subjects with practical's with Mathematics as Major/Minor.

To achieve the core objectives of the National Education Policy 2020 it is unanimously resolved to introduce computer based practical's for the Discipline Core (DSC) courses by using Free and Open Source Software's (FOSS) tools for implementation of theory based on DSC courses as it is also suggested by the LOCF committee that the papers may be taught using various Computer Algebra System (CAS) software's such as Mathematica, MATLAB, Maxima, Python and R to strengthen the conceptual understanding and widen up the horizon of students' self-experience. In view of these observations the subject expert committee suggested the software's Phython /R / Maxima/ Scilab/ Maple/MatLab/Mathematica for hands on experience of implementation of mathematical concepts in computer based lab.

The expert committee suggests the implementation this curriculum structure in all the Departments of Mathematics in Universities/Colleges in Karnataka. The subject expert committee designed the Course Learning Outcome (CO) to help the learners to understand the main objectives of studying the courses by keeping in mind of the Programme outcomes (PO) of the graduate degree with honors in Mathematics or a graduate degree with Mathematics as a major subject.

As the Mathematics subject is a vast with several branches of specializations, it is difficult for every student to learn each branch of Mathematics, even though each paper has its own importance. Hence the subject expert committee suggests number of elective papers (for both Discipline electives and Open Electives) along with Discipline Core Courses. The BoS in Mathematics of universities may include additional electives based on the expertise of their staff and needs of the students'.

A student can select elective paper as per her/his needs and interest. The subject expert committee in Mathematics suggests that the concerned Department/Autonomous Colleges/Universities to encourage their faculty members to include necessary topics in addition to courses suggested by the expert committee.

MISSION AND VISION OF THE NEW SYLLABUS IN MATHEMATICS

Mission

- Improve retention of mathematical concepts in the student.
- To develop a spirit of inquiry in the student.
- To improve the perspective of students on mathematics as per modern requirement.
- To initiate students to enjoy mathematics, pose and solve meaningful problems, to use abstraction to perceive relationships and structure and to understand the basic structure of mathematics.
- To enable the teacher to demonstrate, explain and reinforce abstract mathematical ideas by using concrete objects, models, charts, graphs, pictures, posters with the help of FOSS tools on a computer.
- To make the learning process student-friendly by having a shift in focus in mathematical teaching, especially in the mathematical learning environment.
- Exploit techno-savvy nature in the student to overcome math-phobia.
- Propagate FOSS (Free and open source software) tools amongst students and teachers as per vision document of National Mission for Education.
- To set up a mathematics laboratory in every college in order to help students in the exploration of mathematical concepts through activities and experimentation.
- To orient students towards relating Mathematics to applications.

Vision

- To remedy Math phobia through authentic learning based on hands-on experience with computers.
- To foster experimental, problem-oriented and discovery learning of mathematics.
- To show that ICT can be a panacea for quality and efficient education when properly integrated and accepted.

- To prove that the activity-centered mathematics laboratory places the student in a problem solving situation and then through self-exploration and discovery habituates the student into providing a solution to the problem based on his or her experience, needs, and interests.
- To provide greater scope for individual participation in the process of learning and becoming autonomous learners.
- To provide scope for greater involvement of both the mind and the hand which facilitates cognition?
- To ultimately see that the learning of mathematics becomes more alive, vibrant, relevant and meaningful; a program that paves the way to seek and understand the world around them. A possible by-product of such an exercise is that math-phobia can be gradually reduced amongst students.
- To help the student build interest and confidence in learning the subject.

Support system for Students and Teachers in understanding and learning FOSS TOOLS:

As a national level initiative towards learning FOSS tools, IIT Bombay for MHRD, Government of India is giving free training to teachers interested in learning open source software's like scilab, maxima, python, octave, geogebra and others.

(Website: http://spoken-tutorial.org ; email: contact@spoken-tutorial.org ; info@spokentutorial.org)

B.Sc. MATHEMATICS (HONORS)

Programme Outcomes (PO)

By the end of the program the students will be able to:

PO 1	**Disciplinary Knowledge** : Bachelor degree in Mathematics is the culmination of in-depth knowledge of Algebra, Calculus, Geometry, differential equations and several other branches of pure and applied mathematics. This also leads to study the related areas such as computer science and other allied subjects.
PO 2	**Communication Skills**: Ability to communicate various mathematical concepts effectively using examples and their geometrical visualization. The skills and knowledge gained in this program will lead to the proficiency in analytical reasoning which can be used for modeling and solving of real life problems.
PO 3	**Critical thinking and analytical reasoning:** The students undergoing this programme acquire ability of critical thinking and logical reasoning and capability of recognizing and distinguishing the various aspects of real life problems.
PO 4	**Problem Solving** : The Mathematical knowledge gained by the students through this programme develop an ability to analyze the problems, identify and define appropriate computing requirements for its solutions. This programme enhances students overall development and also equip them with mathematical modelling ability, problem solving skills.
PO 5	**Research related skills:** The completing this programme develop the capability of inquiring about appropriate questions relating to the Mathematical concepts in different areas of Mathematics.
PO 6	**Information/digital Literacy**: The completion of this programme will enable the learner to use appropriate softwares to solve system of algebraic equation and differential equations.

PO 7	**Self – directed learning**: The student completing this program will develop an ability of working independently and to make an in-depth studyof various notions of Mathematics.
PO 8	**Moral and ethical awareness/reasoning:** : The student completing this program will develop an ability to identify unethical behavior such as fabrication, falsification or misinterpretation of data and adopting objectives, unbiased and truthful actions in all aspects of life in general and Mathematical studies in particular.
PO 9	**Lifelong learning**: This programme provides self directed learning and lifelong learning skills. This programme helps the learner to think independently and develop algorithms and computational skills for solving real word problems.
PO 10	Ability to peruse advanced studies and research in pure and applied Mathematical sciences.

ASSESSMENT

Weightage for the Assessments (in percentage)

Type of Course	**Formative Assessment/ I.A.**	**Summative Assessment (S.A.)**
Theory	40%	60%
Practical	50%	50 %
Projects	40%	60%
Experiential Learning (Internship etc.)	--	--

Contents of B.Sc., (Basic/ Honors) with Mathematics as Major Subject (Model IIA)

Semester	Course No.	Theory/ Practical	Credits	Paper Title	Marks	
					S.A.	I.A.
I	MATDSCT1.1	Theory	4	Algebra - I and Calculus - I	60	40
	MATDSCP1.1	Practical	2	Theory based Practical's on Algebra -I and Calculus - I	25	25
	MATOET1.1	Theory	3	(A) Mathematics – I (B) Business Mathematics – I	60	40
II	MATDSCT2.1	Theory	4	Algebra - II and Calculus - II	60	40
	MATDSCP2.1	Practical	2	Theory based Practical's on Algebra - II and Calculus - II	25	25
	MATOET2.1	Theory	3	(A) Mathematics – II (B) Business Mathematics-II	60	40
Exit Option with Certificate						
III	MATDSCT3.1	Theory	4	Ordinary Differential Equations and Real Analysis-I	60	40
	MATDSCP3.1	Practical	2	Theory based Practical's on Ordinary Differential Equations and Real Analysis-I	25	25
	MATOET3.1	Theory	3	(A) Ordinary DifferentialEquations (B) Quantitative Mathematics (C) Vedic Mathematics	60	40
IV	MATDSCT4.1	Theory	4	Partial Differential Equations and Integral Transforms	60	40
	MATDSCP4.1	Practical	2	Theory based Practical's on Partial Differential Equations and Integral Transforms	25	25
	MATOET4.1	Theory	3	(A) Partial Differential Equations (B) Mathematical Finance (C) Mathematics for Social Sciences	60	40
Exit Option with Diploma						
V	MATDSCT5.1	Theory	3	Real Analysis and Complex Analysis	60	40
	MATDSCP5.1	Practical	2	Theory based Practical's on Real Analysis and Complex Analysis	25	25
	MATDSCT5.2	Theory	3	Ring Theory	60	40
	MATDSCP5.2	Practical	2	Theory based Practical's on Ring Theory	25	25
	MATDSET5.1	Theory	3	(A) Vector Calculus (B) Mechanics (C) Mathematical Logic	60	40
VI	MATDSCT6.1	Theory	3	Linear Algebra	60	40
	MATDSCP6.1	Practical	2	Theory based Practical's on Linear Algebra	25	25

	MATDSCT6.2	Theory	3	Numerical Analysis	60	40
	MATDSCP6.2	Practical	2	Theory based Practical's on Numerical Analysis	25	25
	MATDSET6.1	Theory	3	(A) Analytical Geometry in 3D (B) Number Theory (C) Special Functions (D) History of Bhârtîya Gaṇita	60	40
Exit Option with Bachelor of Arts, B.A./ Bachelor of Science, B.Sc. Degree						
VII	MATDSCT7.1	Theory	3	Discrete Mathematics	60	40
	MATDSCP7.1	Practical	2	Theory based Practical's on Discrete Mathematics	25	25
	MATDSCT7.2	Theory	3	Advanced Ordinary Differential Equations	60	40
	MATDSCP7.2	Practical	2	Theory based Practical's on Advanced Ordinary Differential Equations	25	25
	MATDSCT7.3	Theory	4	Advanced Analysis	60	40
	MATDSET 7.1	Theory	3	(A) Graph Theory (B) Entire and Meromorphic Functions (C) General Topology (D) Bhâratîya Trikoṇmiti Śâstra	60	40
	MATDSET 7.2	Theory	3	Research Methodology in Mathematics	60	40
VIII	MATDSCT8.1	Theory	4	Advanced Complex Analysis	60	40
	MATDSCT8.2	Theory	4	Advanced Partial Differential Equations	60	40
	MATDSCT8.3	Theory	3	Fuzzy Sets and Fuzzy Systems	60	40
	MATDSET 8.1	Theory	3	(A) Operations Research (B) Lattice theory and Boolean Algebra (C) Mathematical Modelling *(D) Aṅkapâśa (Combinatorics)*	60	40
	MATDSET 8.2	Research Project	6(3+3)	Research Project* OR Any Two of the following electives (A) Finite Element Methods (B) Cryptography (C) Information Theory and Coding (D) Graph Theory and Networking	120 OR 60 60	80 OR 40 40
Award of Bachelor of Science (B.Sc.,) Honors Degree in Mathematics						

CURRICULUM STRUCTURE FOR UNDERGRADUATE DEGREE PROGRAM

Name of the Degree Program : B.Sc. (Honors)
Discipline/Subject : Mathematics
Starting Year of Implementation : 2021-22

PROGRAM ARTICULATION MATRIX

Semester	Course No.	Programme Outcomes thatthe Course Addresses	Pre-Requisite Course(s)	Pedagogy*	Assessment**
I	MATDSCT1.1	PO 1, PO 2, PO 3	- ----	MOOC	CLASS TESTS
II	MATDSCT2.1	PO 1, PO 2, PO 3, PO 8	MATDSCT1.1	PROBLEM SOLVING	
III	MATDSCT3.1	PO 1, PO 4, PO7, PO 8	-----	SEMINAR	SEMINAR
IV	MATDSCT4.1	PO 1, PO 4, PO7, PO 8	MATDSCT3.1	PROJECT BASED LEARNING	QUIZ
V	MATDSCT5.1	PO 1, PO 2, PO 3, PO 5	----		ASSIGNMENT
V	MATDSCT5.2	PO 3, PO 4, PO 7, PO10	MATDSCT2.1	ASSIGNMENTS	
VI	MATDSCT6.1	PO 6, PO 7, PO 10.	MATDSCT5.2	GROUP DISCUSSION	
VI	MATDSCT6.2	PO 3, PO 4, PO 5, PO 8, PO 9, PO 10.	MATDSCT1.1 & MATDSCT2.1		TERM END EXAM
VII	MATDSCT7.1	PO 3, PO 4, PO5, PO 7, PO 9.	MATDSCT1.1 & MATDSCT2.1		
VII	MATDSCT7.2	PO 2, PO 4, PO 5, PO 10	MATDSCT3.1		
VII	MATDSCT7.3	PO 2, PO 4, PO 5, PO 10	MATDSCT3.1		
VIII	MATDSCT8.1	PO 2, PO 4, PO 5, PO 10	MATDSCT5.1		
VIII	MATDSCT8.2	PO 2, PO 4, PO 5, PO 10	MATDSCT4.1		VIVA-VOCE
VIII	MATDSCT8.3	PO 2, PO 4, PO 5, PO 10	MATDSCT7.3		

** Pedagogy for student engagement is predominantly Lecture. However, other pedagogies enhancing better student engagement to be recommended for each course. This list includes active learning/ course projects / Problem based or Project based Learning / Case Studies / Self Study like Seminar, Term Paper or MOOC.

*** Every Course needs to include assessment for higher order thinking skills (Applying/ Evaluating / Creating). However, this column may contain alternate assessment methods that help formative assessment (i.e. assessment for Learning).

B.Sc., (Basic/Honors) with Mathematics as a Minor in the 3rd Year

Semester	Course No.	Theory/ Practical	Credits	Paper Title	Marks	
					S.A.	I.A.
V	MATDSCMT5.1	Theory	3	Complex Analysis	60	40
	MATDSCMP5.1	Practical	2	Theory based Practical's on Complex Analysis	25	25
VI	MATDSCMT6.1	Theory	3	Numerical Analysis	60	40
	MATDSCMP6.1	Practical	2	Theory based Practical's on Numerical Analysis	25	25

Abbreviation for MATDSCMT5.1 / MATDSCMP 5.1: MAT – Mathematics; **DSC** – Discipline Core; **M** – Minor; **T** – Theory /**P** – Practical;**5** – Fifth Semester; **.1** – Course 1

Credit Distribution for B.Sc., (Basic/Honors) with Mathematics as Major in the 3rd Year (For Model IIA)

Subject	Semester	Major/ Minor in the 3rd Year	Credits					
			Discipline Specific Core (DSC)	Open Elective(OE)	Discipline Specific Elective (DSE)	AECC & Languages	Skill Enhancement Courses (SEC)	Total Credits
Mathematics	I - IV	Major	4 Courses (4+2)x 4=24	4 Courses 3 x 4 = 12	---	(4+4=8) Courses 8x(3+1)=32	2 Courses 2x(1+1)= 4	72
Other Subject		Minor	24	--	--	--	--	24
								96
Mathematics	V & VI	Major	4 Courses 4x(3+2)=20	-----	2 Courses 2 x 3 = 06	---	2 Courses 2 x 2 = 4	30
Other Subject		Minor	10	--	--	--	--	10
								(96+40)**=136**
Mathematics	VII & VIII	Major	2 Courses 2x(3+2)=10 3 Courses 3 x 4 = 12 1 Course 1 x 3 = 3 Total=25	-----	2 Courses 2 x 3 = 6 Res.Meth 1 x 3 = 3 2 Courses 2 x 3 = 6 Total= 15	----	-----	40
Total No. of Courses			14	04	07	08	04	
								136+40**=176**

Syllabus for B.Sc. with Mathematics as Major Subject & B.Sc. (Hons) Mathematics as Minor Subject

SEMESTER–III

(2022-23 onwards)

MATDSCT 3.1: Ordinary Differential Equations and RealAnalysis–I	
Teaching Hours: 4Hours/Week	**Credits:4**
Total Teaching Hours: 56Hours	**Max. Marks:100 (SEE−60+I.A.−40)**

Course Learning Outcomes: This course will enable the students to:

- To model problems in nature using Ordinary Differential Equations.
- Formulate differential equations for various mathematical models / methods.
- Apply these techniques to solve and analyze various mathematical models.
- Understand the fundamental properties of the real numbers that lead to define sequence and series, the formal development to real analysis.
- Learn the concept of Convergence and Divergence of a sequence and series.
- Able to handle and understand limits and their use in sequences, series, differentiation, and integration.
- Apply the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series.

Ordinary Differential Equations:

Unit I: Recapitulation of Differential Equations of first order and first degree, Exact Differential equations, Necessary and sufficient condition for the equations to be exact. Differential equations of the first order and higher degree: Equations solvable for p, x, y. Clairaut's equation and singular solution. Orthogonal trajectories of Cartesian and polar curves. **14hrs**

Unit II: Linear differential equations of the nth order with constant coefficients. Complementary function, Particular Integrals when the RHS is of the form e^{ax}, $sin(ax+b)$, $cos(ax+b)$, x^n, $e^{ax}V$ and xV, where V is a function of x. Cauchy – Euler equations, Method of variation of parameters. Second order ordinary linear differential equations with variable coefficients: (i) When a part of complementary function (CF) is given, (ii) Change of dependent variable, (iii) Change of independent variable, and (iv) Method of variation of parameters. Total and Simultaneous differential equations. **14hrs**

Real Analysis – I:

Unit III: Sequences: Sequences of real numbers, Supremum and infimum of a sequences. Bounded sequences. Limit of a sequence, convergent, divergent, and oscillatory sequences. Algebra of convergent sequences. Monotonic sequences and its properties. Nature of standard sequences. Cauchy's general principle for convergence of a sequence.

14hrs

Unit IV: Infinite Series: Definition of convergent, divergent and oscillatory series. Series of non-negative terms. Geometric series, P-series (Harmonic series). Comparison tests for positive term series. D'Alembert's ratio test, Raabe's test, Cauchy's Root test. Alternating series. Leibnitz's theorem. Absolute convergence and conditional convergence of a series. Summation of series: Binomial, exponential and logarithmic. **14hrs**

Reference Books:

1. M. D. Raisinghania, Ordinary Differential Equations & Partial Differential Equations, S. Chand & Company, New Delhi, 2013.
2. J. Sinha Roy and S. Padhy: A course of Ordinary and Partial Differential Equation, Kalyani Publishers, New Delhi, 2018.
3. D. Murray and Daniel Alexander, Introductory Course in Differential Equations, Orient Blackswan, India, 1967.
4. W. T. Reid, Ordinary Differential Equations, John Wiley, New Delhi, 2010.
5. M. L. Khanna, Differential Equations, Jai Prakash Nath & Co. Meerut, 1997.
6. S. L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, 1984.
7. R. G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rdEd., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2000.
8. Gerald G. Bilodeau, Paul R. Thie, G. E. Keough, An Introduction to Analysis, 2ndEd., Jones & Bartlett, 2010.
9. K. A. Ross, Elementary Analysis: The Theory of Calculus (2nd Ed), Springer, 2013.
10. S. K. Berberian, A First Course in Real Analysis Springer Verlag, NewYork, 1994.
11. T. M. Apostol, Mathematical Analysis, Narosa Publishing House, 2002.
12. M. L. Khanna and L. S. Varhiney, Real Analysis, Jai Prakash Nath & Co. Meerut, 2014.
13. E. Kreyzig, Advanced Engineering Mathematics, John Wiley and Sons, Singapore, 1993.

Web Resources:

1. http://www.nptelvideos.in/2012/11/mathematics.html
2. https://www.my-mooc.com/en/categorie/mathematics
3. http://ocw.mit.edu/courses/mathematics/

PRACTICAL

MATDSCP3.1: Practical's on Ordinary Differential Equations and Real Analysis–I	
Teaching Hours:4Hours/Week	**Credits:2**
Total Teaching Hours:56Hours	**Max.Marks:50 (SEE-25+I.A.–25)**

Course Learning Outcomes: This course will enable the students to gain hands on experience of

- To model problems in nature using Ordinary Differential Equations.
- Solving exact differential equations.
- Plotting orthogonal trajectories.
- Finding complementary function and particular integral of linear and homogeneous differential equations.
- Acquire knowledge of applications of real analysis and differential equations.
- Verification of convergence/divergence of different types of series.

Practical's/Lab Work to be performed in Computer Lab: Use open-source software (FOSS) to executive the practical problems. Maxima/Scilab/MatLab/Mathematica/Python).

1. Fundamentals of Ordinary differential equations and Real analysis using FOSS.
2. Test for exactness of differential equation and solving.
3. Plot orthogonal trajectories for Cartesian and polar curves.
4. Solutions of differential equations that are solvable for x, y, p.
5. To find the singular solution by using Clairaut's form.
6. Finding the complimentary function of linear homogeneous differential equations with constant coefficients.
7. Finding the particular integral of linear homogeneous differential equations with constant coefficients.
8. Solution of second order ordinary linear differential equations with variable coefficients by the method of variation of parameters.
9. Test the convergence of sequences
10. Test the convergence of series using partial sums.
11. Test the convergence of series by using D'Alembert's ratio Test
12. Test the convergence of series by using Raabe's Test
13. Convergence of alternating series using Leibnitz's theorem.
14. Summation of series.

Open Elective Course

(For students of Science stream who have not chosen Mathematics as one of the Core Course)

MATOET3.1(A) Ordinary Differential Equations	
Teaching Hours:3Hours/Week	**Credits:3**
Total Teaching Hours: 42Hours	**Max.Marks:100 (SEE-60+I.A.–40)**

Course Learning Outcomes: This course will enable the students to:

- To model problems in nature using Ordinary Differential Equations.
- To solve first -order ordinary differential equations.
- Identifying the exactness of differential equation and solve.
- Identifying the homogeneous and non-homogeneous differential equations.
- Acquire knowledge of applications of differential equations.
- To find the solution of higher-order linear differential equations.

Unit I: Recapitulation of Differential Equations of first order and first degree, Exact Differential equations, Necessary and sufficient condition for the equations to be exact. **14hrs**

Unit II: Differential equations of the first order and higher degree: Equations solvable for p, x, y. Clairaut's equation and singular solution. Orthogonal trajectories of Cartesian and polar curves. **14hrs**

UnitIII: Linear differential equations of the n^{th} order with constant coefficients. Complimentary function, Particular Integrals when the RHS is of the form e^{ax}, sin(ax+b), cos(ax+b), x^n ,$e^{ax}V$ and xV, where V is a function of x. **14hrs**

Reference Books:

1. M. D. Raisinghania, Ordinary Differential Equations & Partial Differential Equations, S. Chand & Company, New Delhi, 2013.
2. J. Sinha Roy and S. Padhy, A course of Ordinary and Partial Differential Equation, Kalyani Publishers, New Delhi, 2018.
3. D. Murray and Daniel Alexander, Introductory Course in Differential Equations, Orient Blackswan, India, 1967.
4. W. T. Reid, Ordinary Differential Equations, John Wiley, New Delhi, 2010.
5. M. L. Khanna, Differential Equations, Jai Prakash Nath & Co. Meerut, 1997.
6. S. L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, 1984.

Web Resources:

1. http://www.nptelvideos.in/2012/11/mathematics.html
2. https://www.my-mooc.com/en/categorie/mathematics
3. http://ocw.mit.edu/courses/mathematics/

Open Elective Course
(For students of other than Science stream)

MATOET3.1(B): Quantitative Mathematics	
Teaching Hours:3Hours/Week	**Credits:3**
Total Teaching Hours:42Hours	**Max. Marks: 100(SEE-60+IA-40)**

Course Outcomes: This course will enable the students to:

- Understand number system and fundamental operations.
- Understand the concept of linear, quadratic, and simultaneous equations and their applications in real life problems.
- Understand and solve the problems based on Age.
- Solve speed and distance related problems.

Unit-I: Number System

Numbers, Operations on Numbers, Tests on Divisibility, HCF and LCM of numbers. Decimal Fractions, Simplification, Square roots and Cube roots - Problems thereon. Surds and Indices. Illustrations thereon. **14 Hrs**

Unit-II: Theory of Equations

Linear equations, quadratic equations, simultaneous equations in two variables, simple application problems - Problems on Ages, Problems on conditional Age calculations, Present & Past age calculations. **14Hrs**

Unit-III: Quantitative Aptitude

Percentage, Average, Average speed-problems. Time and distance, problems based on trains, problems on-work and time, work and wages, clock and calendar. **14 Hrs**

Reference Books:

1. R. S. Aggarwal, Quantitative Aptitude, S. Chand & Com. Ltd., New Delhi, 2017.
2. Abhijit Guha, Quantitative Aptitude, 7th Edition, McGraw Hill Ed., 2020.
3. R. V. Praveen, Quantitative Aptitude and Reasoning , 3rd Edition, PHI Learning, 2016.
4. R. S . Aggarwal, Objective Arithmetic, S. Chand & Co Ltd., New Delhi, 2020.
5. Qazi Zameerddin, Vijay K Khanna and S K Bhambri, Business Mathematics, 2nd Ed., S. Chand & Co., New Delhi, 2009.
6. S. K. Sharma and Gurmeet Kaur, Business Mathematics, S. Chand & Co., New Delhi, 2019.
7. Hazarika Padmalochan, A Text Book of Business Mathematics for B. Com., and BBA Course, S. Chand & Co Ltd., New Delhi, 2017.
8. J. K. Thukrol, Business Mathematics, ABCI book, Ist Edition, 2011.
9. N. G. Das and J. K. Das, Business Mathematics and Stastistics, McGraw Hill Ed., 2017.

Web Resources:

1. http://www.nptelvideos.in/2012/11/mathematics.html
2. https://www.my-mooc.com/en/categorie/mathematics
3. http://ocw.mit.edu/courses/mathematics/

Open Elective Course

(For Students of other than Science Stream)

MATOET3.1(C): Vedic Mathematics	
Teaching Hours:3Hours/Week	**Credits:3**
Total Teaching Hours: 42Hours	**Max.Marks:100 (S.A.-60+I.A.–40)**

Course Outcomes: This course will enable the students to:

- Understand the Vedic methods of arithmetic's.
- Understand the Vedic methods of division with two/three digit divisor.
- Understand the Vedic methods of power and root power of two digit numbers.

Unit-I: Multiplication:

1. Ekadhikenpurven method (multiplication of two numbers of two digits).
2. Eknunenpurven method (multiplication of two numbers of three digits).
3. Urdhvatiragbhyam method (multiplication of two numbers of three digits).
4. Nikhilam Navtashchramam Dashtaha (multiplication of two numbers of three digits).
5. Combined Operations. **14 Hours**

Unit-II: Division and Divisibility

Part A: Division

1. Nikhilam Navtashchramam Dashtaha (two digits divisor)
2. Paravartya Yojyet method (three digits divisor)

Part B: Divisibility

1. Ekadhikenpurven method (two digits divisor)
2. Eknunenpurven method(two digits divisor) **14 Hours**

Unit-III: Power and Root Power:

1. Square(two digit numbers)
2. Cube (two digit numbers).

Root Power:

1. Square root (four digit number)
2. Cube root (six digit numbers).
3. Solution of linear, simultaneous equations. **14 Hours**

Reference Books:

1. Motilal Banarsi Das, Vedic Mathematics, New Delhi, 1965.
2. Vedic Ganita:Vihangama Drishti-1, Siksha Sanskriti Uthana Nyasa, New Delhi.
3. Vedic Ganita Praneta, Siksha Sanskriti Uthana Nyasa, New Delhi.
4. Vedic Mathematics: Past, Present and Future, Siksha Sanskriti Uthana Nyasa, New Delhi.
5. Leelavati, Chokhambba Vidya Bhavan, Varanasi.
6. Bharatiya Mathematicians, Sharda Sanskrit Sansthan, Varanasi.

Web Resources:

1. http://www.nptelvideos.in/2012/11/mathematics.html
2. https://www.my-mooc.com/en/categorie/mathematics
3. http://ocw.mit.edu/courses/mathematics/

SEMESTER–IV

MATDSCT4.1:Partial Differential Equations and Integral Transforms	
Teaching Hours: 4Hours/Week	**Credits:4**
Total Teaching Hours:56Hours	**Max.Marks:100 (SEE – 60+I.A.–40)**

Course Learning Outcomes: This course will enable the students to

- Solve the Partial Differential Equations (PDE) of the first order and second order.
- Formulate, classify and transform partial differential equations into canonical form.
- Solve linear and non-linear partial differential equations using various methods; and apply these methods to solving some physical problems.
- Able to take more courses on wave equation and heat equations.
- Solve PDE by Laplace Transforms and Fourier Transforms.

Partial Differential Equations:

Unit I: Basic concepts–Formation of a partial differential equations by elimination of arbitrary constants and functions, Solution of partial differential equations: Lagrange's linear equations of the form Pp + Qq = R , Standard types of first order non-linear partial differential equations, Charpit's method. **14Hrs**

Unit II: Homogeneous and non-homogeneous linear partial differential equations with constant coefficients, Partial differential equations of the second order. Classification of second-order partial differential equations, canonical forms. Solutions of the Heat equation and Wave equation (using Fourier series). **14Hrs**

Integral Transforms:

UnitIII: Laplace Transforms: Definition**,** Basic Properties. Laplace transforms of some standard functions. Laplace transform of Periodic functions. Laplace transform of derivative and integral of a function. Heaviside function. Dirac-delta function. Convolution theorem. Inverse Laplace transforms and its properties. Solution of differential equations by using Laplace transforms. **14Hrs**

Unit IV: Fourier Series and Transforms: Periodic functions. Fourier Coefficients. Fourier series of functions with period 2π and period 2L. Fourier series of even and odd functions. Half range Cosine and Sine series. Fourier Transforms - Finite Fourier Cosine and Sine transform. Transforms of derivates**.** **14Hrs**

Reference Books:

1. D. A. Murray, Introductory Course in Differential Equations, Franklin Classics Pub., 2018
2. H. T. H. Piaggio, Elementary Treatise on Differential Equations and their Applications, CBS Publisher & Distributors, Delhi, 1985.
3. G. F. Simmons, Differential Equations, Tata McGraw Hill Publishing Company, 1974
4. S. L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, India, 2007.
5. M. D. Raisinghania, Ordinary Differential Equations & Partial Differential Equations, 20th Ed., S. Chand & Company, New Delhi, 2013.
6. K. Sankara Rao, Introduction to Partial Differential Equations: PHI, 3rd Edition, 2015.
7. I. N. Sneddean, Elements of Partial differential equations, McGraw-Hill International Editions, 1986.
8. Murray R. Spiegall,, Laplace Transforms, Schaum's Series,1965.
9. J. K. Goyal and K. P. Gupta, Laplace Transform, Pragati Prakashan Meerut, 30th Ed., 2017.
10. Sudhir Kumar, Integral Transform Methods in Science and Engineering, CBS Engineering Series, 2017.
11. Murray R. Spiegall, Fourier Analysis, Schaum's Series, 1974.
12. Earl David Rainville and Philip Edward Bedient–A short course in Differential Equations, Prentice Hall College Div, 6thEdition, 1974.
13. Sathya Prakash, Mathematical Physics, Sultan Chand & Sons, New Delhi, 2021.

Web Resources:

1. http://www.nptelvideos.in/2012/11/mathematics.html
2. https://www.my-mooc.com/en/categorie/mathematics
3. http://ocw.mit.edu/courses/mathematics/

PRACTICALS

MATDSCP4.1:Practical's on Partial Differential Equations and Integral Transforms	
Practical Hours:4Hours/Week	**Credits: 2**
Total Teaching Hours:56Hours	**Max.Marks:50 (S.A.-25+I.A.–25)**

Mathematics practical with Free and open-Source Software (FOSS) tools for computer programs:

Course Learning Outcomes: This course will enable the students to

- Learn Free and Open Sources of software (FOSS) tools or computer programming.
- Solve problems on Partial Differential Equations and Integral Forms.
- To find Laplace transform of various functions.
- To find the Fourier Transform of periodic functions.
- To solve differential equations by using Integral transforms.

Programs using Scilab/Maxima/Python:

1. Elements of Partial differential equations and Integral transforms using FOSS.
2. Solutions of Linear Partial differential equations of Type-1 and Type-2.
3. Solutions of Linear Partial differential equations of Type-3 and Type-4.
4. Solution of Partial differential equation using Charpit's method.
5. Finding the complimentary function of second order homogenous partial differential equation with constant coefficients.
6. Finding the particular integral of second order homogenous partial differential equation with constant coefficients.
7. Solutions to Heat and Wave equations using Fourier series method
8. Finding the Laplace transform of some standard functions.
9. Finding the inverse Laplace transform of some simple functions.
10. Verification of Convolution Theorem.
11. To solve ordinary linear differential equation using Laplace transform.
12. To find the Fourier series of some simple functions with period 2π and 2L.
13. To find Cosine Fourier transforms
14. To find Sine Fourier transforms

Open Elective Course

(For students of Science stream who have not chosen Mathematics as one of the Core Course)

MATOET4.1(A):Partial Differential Equations	
Teaching Hours:3Hours/Week	**Credits:3**
Total Teaching Hours: 42Hours	**Max. Marks: 100(SEE-60+I.A.–40)**

Course Learning Outcomes: This course will enable the students to

- Solve the Partial Differential Equations (PDE) of the first order and second order.
- Formulate, classify and transform partial differential equations into canonical form.
- Solve linear and non-linear partial differential equations using various methods; and apply these methods to solving some physical problems.
- Able to take more courses on wave equation and heat equations.

Unit I: Basic concepts–Formation of a partial differential equations by elimination of arbitrary constants and functions, Solution of partial differential equations: Lagrange's linear equations of the form Pp + Qq = R. **14Hrs**

UnitII: Standard types of first order non-linear partial differential equations, Charpit's method. Homogeneous and non-homogeneous linear partial differential equations with constant coefficients. **14Hrs**

Unit III: Partial differential equations of the second order. Classification of second-order partial differential equations, canonical forms. Solutions of the Heat equation and Wave equation (using Fourier series). **14Hrs**

Reference Books:

1. D. A. Murray, Introductory Course in Differential Equations, Franklin Classics Pub., 2018
2. H. T. H. Piaggio, Elementary Treatise on Differential Equations and their Applications, CBS Publisher & Distributors, Delhi, 1985.
3. G. F. Simmons, Differential Equations, Tata McGraw Hill Publishing Company, 1974
4. S. L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, India, 2007.
5. M. D. Raisinghania, Ordinary Differential Equations & Partial Differential Equations, 20th Ed., S. Chand & Company, New Delhi, 2013.
6. K. Sankara Rao, Introduction to Partial Differential Equations: PHI, 3rd Edition, 2015.
7. I. N. Sneddean, Elements of Partial differential equations, McGraw-Hill International Editions, 1986.

Web Resources:

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3. http://ocw.mit.edu/courses/mathematics/

Open Elective Course
(For students of other than science stream)

MATOET4.1(B): Mathematical Finance	
Teaching Hours:3Hours/week	**Credits:3**
Total Teaching Hours:42Hours	**Max.Marks:100 (S.A-60+I.A.-40)**

Course Learning Outcomes: This course will enable the students to

- Understand how compute profit and loss, discount and Banker's discount.
- Understand the concept to Linear equations and inequalities and their use in the solving the Linear Programming Problems (LPP).
- Formulation of Transportation Problem and its application in routing problem.

Unit-I: Commercial Arithmetic

Bill of exchange, Bill of discounting procedure. Basic formula related to profit, loss, discount and brokerage, Successive discount, True discount, Banker's discount. **14 hrs**

Unit-II: Linear Programming

Linear equations and inequalities - rectangular coordinates, straight line, parallel and intersecting lines and linear inequalities, Introduction to linear programming, Mathematical formulation of LPP, Solution of a LPP by graphical method, special cases in graphical method. **14 hrs**

Unit-III: Transportation problem

Introduction, Formulation of Transportation problem, Initial basic feasible solution, Steps in solving a transportation problem, optimality check, special cases in Transportation problem. The Traveling salesman Problem (Routing Problem). **14Hrs**

Reference Books:

1. R. S . Aggarwal, Objective Arithmetic, S. Chand & Co Ltd., New Delhi, 2020.
2. A. Mizrahi and M. Sullivan, Mathematics for Business and Social Sciences: An Applied approach, John Wiley & Sons Inc, 1976.
3. Qazi Zameerddin, Vijay K Khanna and S K Bhambri, Business Mathematics, 2nd Ed., S. Chand & Co., New Delhi, 2009.
4. S. Kalavathy, Operation Research, 4th Edition, Vikas Publication House Pvt. Ltd. 2013.
5. M. Sreenivasa Reddy, Operation Research, 4th Edition, Sanguine Technical Publishers, Bangalore, 2013.
6. S. D. Sharma, Operation Research, Kedarnath Ramnath & Co Pub. 2002.

Web Resources:

1. http://www.nptelvideos.in/2012/11/mathematics.html
2. https://www.my-mooc.com/en/categorie/mathematics
3. http://ocw.mit.edu/courses/mathematics/

Open Elective Course

(For students other than science stream)

MATOET4.1(C):Mathematics for Social Sciences	
Teaching Hours:3Hours/Week	**Credits:3**
Total Teaching Hours:42Hours	**Max.Marks:100 (S.A.-60+I.A.–40)**

Course Learning Outcomes: This course will enable the students to

- Understand the mathematical concept to sets and counting problems.
- Understand the concept of Probability and its applications in social sciences.
- Understand the concept to limits and continuity of functions and its applications in business and social sciences.

Unit-I

Sets, counting, permutations, combinations, counting problems, binomial theorem and problems thereon. Probability–Introduction, sample space and assignment of probabilities, properties of the probability of an event, probability of equally likely events, conditional probability, Baye's theorem and examples of Baye's formula. **14 hrs**

Unit-II

Limit and continuity, Derivative-interpretation, derivative formulas, general derivatives for differentiation, composite functions, higher order derivatives and problems thereon. **14 hrs**

Unit-III

Applications of the derivative–Relative maxima and Relative minima, Absolute maximum and Absolute minimum, Applied problems, Concavity, Asymptotes, Marginal analysis, Models-Maximizing tax revenue, Optimal trade-in time, and minimizing inventory cost. **14 hrs**

Reference Books:

1. A. Mizrahi and M. Sullivan, Mathematics for Business and Social Sciences: An Applied approach, John Wiley & Sons Inc, 1976.
2. Carl P. Simon and Lawrence Blume, Mathematics for Economists, Viva Books Private Limited, New Delhi, 2015.
3. L. Peccati, M. D'Amico and M. Cigola, Maths for Social Sciences, Springer, 2018

Web Resources:

1. http://www.nptelvideos.in/2012/11/mathematics.html
2. https://www.my-mooc.com/en/categorie/mathematics
3. http://ocw.mit.edu/courses/mathematics/