KANNUR UNIVERSITY

(Abstract)

B.Sc. Mathematics (Honours) Programme- Scheme and Syllabus of Core and Elective course under Choice Based Credit and Semester System (Outcome Based Education System -OBE) with effect from 2021 admission -Implemented-Orders issued

ACADEMIC C SECTION

Acad/C2/16588/Mathematic (Honours)/2021 Dated: 06.11.2021

Read:-1. The Minutes of the XX meeting of Academic Council held on 30.06.2021 Resolution vide item No. 4 (iii).
2. U.O No. Acad/C2/429/2017 Vol.II dated 03.06.2019
3. The Minutes of the meeting of Board of Studies in Mathematics UG held on 15.09.2021
4. Letter dtd 19-10-2021 from the Chairperson,Board of Studies,Mathematics(UG), along with the Syllabus of B.Sc. Mathematics (Honours) Programme

ORDER

1. As per paper read (1) above, the Academic Council resolved to revise the Syllabus of B.Sc. Mathematics (Honours) Programme.
2. The Revised Regulation for UG Programmes in Affiliated Colleges under Choice Based Credit and Semester System (in OBE- Outcome Based Education System) was implemented w.e.f 2019 admission as per paper read (2).
3. Accordingly, the Board of Studies in Mathematics (UG) finalized the Scheme and Syllabus for Core and Elective Course of B.Sc. Mathematics (Honours) programme, in tune with the Regulations for UG Programmes under CBCSS-OBE w.e.f 2019, for implementation with effect from 2021 admission, as per paper read (3) above.
4. Subsequently,as per the paper read as (4) above, the Chairperson, Board of Studies in Mathematics (UG) submitted the Scheme and Syllabus of the B.Sc. Mathematics (Honours) programme for implementation w.e.f 2021 admission at Govt. Brennen College, Thalassery.
5. The Vice Chancellor after considering the matter in detail and in exercise of the powers of the Academic Council conferred under Section 11(1), Chapter III of Kannur University Act 1996, accorded sanction to implement the Scheme & Syllabus for Core and Elective Course of the B.Sc. Mathematics (Honours) Programme under Choice Based Credit and Semester System (in OBE- Outcome Based Education System) offered at Govt. Brennen College, Thalassery w.e.f 2021 admission, subject to reporting to the Academic Council.
6. The Scheme & Syllabus for Core and Elective papers of the B.Sc. Mathematics (Honours) Programme CBCSS-OBE applicable w.e.f 2021 admission are uploaded in the University website (www.kannuruniversity.ac.in).

Orders are issued accordingly.

sd/-
BALACHANDRAN V K
DEPUTY REGISTRAR (ACAD)
For REGISTRAR

To: 1.The Principal, Govt. Brennen College, Thalassery
2.Chairman,BoS,Mathematics (UG)

Copy To: 1. The Examination Branch (through PA to CE)
2. PS to VC/PA to PVC/PA to Registrar
3. DR/AR-I Academic
4. The Web manager (for uploading in the website)
5. SF/DF/FC

KANNUR UNIVERSITY CIVIL STATION P.O. KANNUR Pin-670 002 THAVAKKARA

Forwarded / By Order

SECTION OFFICER

KANNUR UNIVERSITY

BOARD OF STUDIES, MATHEMATICS (UG)

SYLLABUS FOR
B.Sc. MATHEMATICS (HONOURS)

CHOICE BASED CREDIT SEMESTER SYSTEM

(2021 ADMISSION ONWARDS)

KANNUR UNIVERSITY

VISION AND MISSION STATEMENTS

Vision

To establish a teaching, residential and affiliating University and to provide equitable and just access to quality higher education involving the generation, dissemination and a critical application of knowledge with special focus on the development of higher education in Kasargode and Kannur Revenue Districts and the Manandavady Taluk of Wayanad Revenue District.

Mission

- ➢ To produce and disseminate new knowledge and to find novel avenues for application of such knowledge.
- ➢ To adopt critical pedagogic practices which uphold scientific temper, the uncompromised spirit of enquiry and the right to dissent.
- ➢ To uphold democratic, multicultural, secular, environmental and gender sensitive values as the foundational principles of higher education and to cater to the modern notions of equity, social justice and merit in all educational endeavours.
- ➢ To affiliate colleges and other institutions of higher learning and to monitor academic, ethical, administrative and infrastructural standards in such institutions.
- ➢ To build stronger community networks based on the values and principles of higher education and to ensure the region's intellectual integration with national vision and international standards.
- ➢ To associate with the local self-governing bodies and other statutory as well as non-governmental organizations for continuing education and also for building public awareness on important social, cultural and other policy issues.

KANNUR UNIVERSITY
PROGRAMME OUTCOMES (PO)

PO 1. Critical Thinking

1.1. Acquire the ability to apply the basic tenets of logic and science to thoughts, actions and interventions.

1.2. Develop the ability to chart out a progressive direction for actions and interventions by learning to recognize the presence of hegemonic ideology within certain dominant notions.

1.3 Develop self-critical abilities and also the ability to view positions, problems and social issues from plural perspectives.

PO 2. Effective Citizenship

2.1. Learn to participate in nation building by adhering to the principles of sovereignty of the nation, socialism, secularism, democracy and the values that guide a republic.

2.2. Develop and practice gender sensitive attitudes, environmental awareness, empathetic social awareness about various kinds of marginalisation and the ability to understand and resist various kinds of discriminations.

2.3. Internalise certain highlights of the nation's and region's history. Especially of the freedom movement, the renaissance within native societies and the project of modernisation of the post-colonial society.

PO 3. Effective Communication

3.1. Acquire the ability to speak, write, read and listen clearly in person and through electronic media in both English and in one Modern Indian Language.

3.2. Learn to articulate, analyse, synthesise, and evaluate ideas and situations in a well-informed manner.

3.3. Generate hypotheses and articulate assent or dissent by employing both reason and creative thinking.

PO 4. Interdisciplinarity

4.1. Perceive knowledge as an organic, comprehensive, interrelated and integrated faculty of the human mind.

4.2. Understand the issues of environmental contexts and sustainable development as a basic interdisciplinary concern of all disciplines.

4.3. Develop aesthetic, social, humanistic and artistic sensibilities for problem solving and evolving a comprehensive perspective.

PREFACE

Mathematics is a fundamental part of human thought and logic. Mathematics provides an effective way of building mental discipline and encourages logical reasoning and mental rigor. In addition, mathematical knowledge plays a crucial role in understanding the contents of other disciplines. It has to cater to the requirements of the expanding world of knowledge and information. Research studies in Basic Sciences, especially in Mathematics is to be encouraged in our country. Novel developments in the field of Mathematics are to be incorporated into the syllabus so as to cope with the challenges of ever growing field of knowledge.

For B.Sc. Mathematics (Honours) programme, the UG Board of Studies in Mathematics has designed a syllabus that imparts essential knowledge in Mathematics with opportunities for specialization in all major areas of pure and applied mathematics. It helps the students to meet the current employment requirements and provides them ample scope for further study in the subject. This syllabus promotes self-learning through assignments, seminars and project work in addition to class room learning.

The syllabus and curriculum has been prepared after concerted efforts and deliberations at various levels and it meets the programme specific outcomes. The reference materials have been recommended after a thorough study. The Board of Studies puts forward this syllabus for implementation from 2021 admission onwards. We thank all those who have helped us by giving critical suggestions for improvement.

Dr. C.P. Santhosh
Chairman
UG Board of Studies in Mathematics
Kannur University

REGULATIONS, SCHEME & SYLLABUS
for
B.Sc. (HONOURS) MATHEMATICS
(A Six Semester Degree Programme Spread over 3 years)
(2021 Admission onwards)

1. INTRODUCTION

In this rapidly changing world, exposure to mathematics helps in developing an analytic mind and assists in better organization of ideas and accurate expression of thoughts. A common man is being increasingly dependent upon the application of science and technology in the day-to-day activities of life, and the role of mathematics has undoubtedly been redefined. Thus, those who understand and can do mathematics will have significantly enhanced opportunities and caliber for shaping the future of nation.

B.Sc. Mathematics (Honours) is a three year degree programme (six semesters of equal duration) in which more topics in Mathematical Sciences are covered than in any conventional B.Sc. Mathematics programme. This course provides in-depth knowledge about Algebra, Calculus, Vector Calculus, Differential Geometry, Graph Theory, Complex Analysis, Real Analysis, Differential Equations, Laplace Transforms, Statistics for Mathematics, Numerical Methods, Discrete Mathematics, etc. Keeping in mind and in tune with the changing nature of the subject, adequate emphasis has been given to core content, techniques and applications of Mathematics.

This programme is designed for students who aspire for higher studies that take them to career opportunities like Mathematician, Statistician, Actuary, Cryptographer, Economist, Financial planner, Data analyst, Investment analyst, etc. The syllabus and curriculum has been prepared after concerted efforts and deliberations at various levels and it meets the specific outcomes of the programme.

2. PROGRAMME SPECIFIC OUTCOMES

PSO 1: Understand the basic concepts and tools of Mathematical logic, Set theory, Number theory, Geometry, Calculus, Algebra, Abstract structures, Linear Algebra, Analysis, Laplace transforms, Fourier series, Graph theory, Optimization and methods of proofs.

PSO 2: Model real world problems into Mathematical problems and find solutions and understand the application of Mathematics in other Sciences and Engineering.

PSO 3: Develop a positive attitude towards creative research in Mathematical Sciences or allied disciplines.

3. ELIGIBILITY FOR ADMISSION

Those who have passed Plus Two or equivalent examinations in science with Mathematics as one of the subjects and secured an aggregate of 70% of marks will be eligible for admission. For those belonging to SC category, an aggregate of 60% marks and for ST, an aggregate of 55% is required.

4. DURATION OF THE PROGRAMME

The duration of the programme shall be three years spread over six semesters of 90 working days each with 5 hours per day and 5 days a week. Maximum duration for successful completion of the programme in the case of failed or discontinued candidates is 6 years. On completion of six years, the registration given to the candidate for the programme shall be cancelled and the candidate may re-register for the programme again in order to complete the programme. Such candidates should follow the then existing syllabus.

5. REQUIREMENT OF ATTENDANCE

A minimum of 75% of attendance is required for a candidate to appear for the end-semester examination in each course both in theory and practical. However, if there are genuine reasons, a student shall be permitted to condone the shortage of attendance as per the rules and regulations followed by Kannur University from time to time.

6. EXAMINATION - INTERNAL AND EXTERNAL

There shall be University examination at the end of each semester, written examination for all the courses except for the elective course 5B23B BMH. Programming using Scilab for which there will be external practical examination. For all the courses, the evaluation consists of two parts: End semester examination (ESE) for 60 marks conducted by the University and internal assessment (IA) for 15 marks conducted by the institution concerned. The end semester examination will be a written/practical examination of 3 hours duration. The pattern of question papers, generally, for all courses in Mathematical sciences (except for the course 5B23B BMH. Programming using Scilab) will be:

Part	No. of Questions	No. of Questions to be answered	Marks for each question	Total Marks
A	5	4	1	4
B	9	6	2	12
C	12	8	4	32
D	4	2	6	12
			TOTAL	**60 marks**

The structure for internal evaluation is as follows.

COMPONENT	MARKS	REMARKS
Test Paper	10	For each course, a student has to appear for at least two written tests. Average mark of best two tests is to be considered for internal mark.
Viva/Seminar/Assignment	5	For each course, a student has to submit one assignment/present one seminar/ attend one viva-voce
TOTAL	**15**	

External practical examination for the course 5B23B BMH. Programming using Scilab falling in the fifth semester of three hour duration shall be conducted for 60 marks. Internal evaluation for 15 marks can be done as per the following components.

COMPONENT	MARKS	REMARKS
Test Paper/Lab Experimental Test	10	A student has to appear for at least two tests (written/lab). Average mark of best two tests is to be considered for internal mark.
Viva/Seminar/Assignment	5	A student has to submit one assignment/ present one seminar/ attend one viva-voce
TOTAL	**15**	

For the practical external examination, two questions on computer programmes from the prescribed set of practical programmes given in the syllabus of this course shall be asked and the duration of practical examination shall be 3 hours. Each student should keep a record book of the prescribed practical works done and the same may be valued by external examiner(s) at the time of external practical examination.

For the external practical examination in the case of 5B23B BMH. Programming using Scilab, the marks are distributed as follows:

Practical Record – Maximum 10 marks
Writing source code of the programme in the answer sheet for the two given questions– Maximum 20 marks (10 marks each)
Practical work done in the computer – Maximum 20 marks (10 marks each) Correct output – Maximum 10 marks (5 marks each)

Total – 60 marks

Attending the external practical examination is **mandatory** and no student shall be declared to have passed in this course without appearing for the practical examination concerned.

7. PROJECT WORK

Regarding the individual project work, the following directions shall be followed:
Each student has to perform at least 20 (at least 5 from each category) practical works (whose theory is discussed in various courses in the syllabus) among a list given in Annexure III and report has to be prepared under the guidance of a faculty member of the Mathematics Department of the concerned institute where he/she studies.

The report should be neatly typewritten and the content should be spread into at least 30 pages. The project report should contain a brief description about the software used, detailed source code of the program and formatted output. The project report should adhere to the standard norms in which pages for certificate from the guiding supervisor, declaration by the student, acknowledgment and table of contents are to be essentially included.

Out of the total 75 marks earmarked for the individual project work, the internal evaluation will be for 15 marks and the remaining 60 marks will be on the basis of a short presentation by the student before a Board of examiners (Minimum two members) and a simultaneous viva-voce conducted by them. The student has to execute the program before the examiners on their demand. Though the students have to submit the project report to the University at the end of 6^{th} semester, they may start doing the work early at any point of the programme. 15 marks for internal evaluation of the individual project work are to be distributed as follows: A maximum of 9 marks for short presentations before the guiding supervisor on the topic of the project work and discussions thereof and a maximum of 6 marks for the project report prepared depending on the quality of its content, over all layout and methodology adopted. 60 marks earmarked for the external evaluation of the individual project are to be distributed as follows: A maximum of 30 marks for the short presentation of the project work, a maximum of 20 marks for the performance in the associated viva-voce examination and a maximum 10 marks for the project report submitted.

Among a list of Practicals, listed in Annexure III, at least 20 practical works are to be performed in the lab and report to be submitted as a Project Work. Practical Works may be carried out by using any software like Scilab, R, FreeMat, Geogebra, Sagemath, Python etc.

INDEX

WORK AND CREDIT DISTRIBUTION STATEMENT

Semester	Code	Course	Credits	Contact Hours	Max. Marks (Int+Ext)	Min marks for pass
Semester 1		English Course I	4	5 Hrs/week	15+60=75	30
	1B01BMH	Calculus I	4	5 Hrs/week	15+60=75	30
	1B02BMH	Foundations of Mathematics	4	5 Hrs/week	15+60=75	30
	1B03BMH	Logic, Sets and Probability Theory	4	5 Hrs/week	15+60=75	30
	1B04BMH	Two Dimensional Geometry	4	5 Hrs/week	15+60=75	30
Semester 2		English Course II	4	5 Hrs/week	15+60=75	30
	2B05BMH	Calculus II	4	5 Hrs/week	15+60=75	30
	2B06BMH	Distribution Functions and Combinatorics	4	5 Hrs/week	15+60=75	30
	2B07BMH	Theory of Numbers and Equations	4	5 Hrs/week	15+60=75	30
	2B08BMH	Ordinary Differential Equations	4	5 Hrs/week	15+60=75	30
Semester 3	3B09BMH	Real Analysis	4	5 Hrs/week	15+60=75	30
	3B10BMH	Calculus III	4	5 Hrs/week	15+60=75	30
	3B11BMH	Graph Theory	4	5 Hrs/week	15+60=75	30
	3B12BMH	Advanced Statistical Techniques I	4	5 Hrs/week	15+60=75	30
	3B13BMH	Numerical Analysis	4	5 Hrs/week	15+60=75	30
Semester 4	4B14BMH	Advanced Real Analysis	4 credits	5 Hrs/week	15+60=75	30
	4B15BMH	Introduction to Abstract Algebra and Linear Algebra	4 credits	5 Hrs/week	15+60=75	30
	4B16BMH	Introduction to Partial Differential Equations	4 credits	5 Hrs/week	15+60=75	30
	4B17BMH	Advanced Statistical Techniques II	4 credits	5 Hrs/week	15+60=75	30
	4B18BMH	Operations Research	4 credits	5 Hrs/week	15+60=75	30

Semester 5	5B19BMH	Advanced Abstract Algebra	4 credits	5 Hrs/week	15+60=75	30
	5B20BMH	Integral Transforms and Partial Differential Equations	4 credits	5 Hrs/week	15+60=75	30
	5B21BMH	Advanced Linear Algebra	4 credits	5 Hrs/week	15+60=75	30
	5B22BMH	Complex Analysis	4 credits	5 Hrs/week	15+60=75	30
	5B23---BMH	Elective I	4 credits	5 Hrs/week	15+60=75	30
Semester 6	6B24BMH	Differential Geometry	4 credits	5 Hrs/week	15+60=75	30
	6B25BMH	Topology	4 credits	5 Hrs/week	15+60=75	30
	6B26BMH	Measure Theory	4 credits	5 Hrs/week	15+60=75	30
	6B27---BMH	Elective II	4 credits	5 Hrs/week	15+60=75	30
	6B28BMH	Project Work	4 credits	5 Hrs/week	15+60=75	30
		Total	**120** credits		**2250**	**900**

WORKLOAD PER WEEK

Subject	I and II Sem	III and IV Sem	V and VI Sem
English	5 Hours	--	--
Mathematical Sciences	20 Hours	25 Hours	25 Hours
Total	**25 Hours**	**25 Hours**	**25 Hours**

Elective-I is to be chosen as one of the following courses

5B23A BMH. Calculus of Variations
5B23B BMH. Programming using Scilab
5B23C BMH. Mathematical Economics

Elective-II is to be chosen as one of the following courses

6B27A BMH. Discrete Fourier Analysis
6B27B BMH. Mathematical Finance
6B27C BMH. Fuzzy Mathematics
6B27D BMH. Automata Theory

(See the syllabi of these elective courses in Annexures I, II)

- **Use of Scientific Calculators below 100 functions (that is, upto fx 99) shall be permitted for all the above courses.**

SYLLABUS OF EACH COURSE

1B01 BMH: CALCULUS – I

Text

James Stewart, CALCULUS - Early Transcendentals (Eighth Edition), Cengage Learning, 2015.

MODULE I (25 Hours)

Quick review of Sections 1.1 to 1.3, 2.1 to 2.3, 2.7 & 2.8 (*No questions shall be asked from these sections for the End Semester Examination*)
Exponential functions, Inverse functions and logarithms, The precise definition of a limit, Continuity, Limits at infinity; Horizontal asymptotes. (Sections 1.4, 1.5, 2.4 to 2.6)

MODULE II (25 Hours)

Quick review of Sections 3.1 to 3.9 (*No questions shall be asked from these sections for the End Semester Examination*)
Linear approximations and differentials, Hyperbolic functions, Maximum and minimum values, The Mean value theorem, How derivatives affect the shape of a graph, Indeterminate forms and L' Hospital's rule, Summary of curve sketching. (Sections 3.10, 3.11, 4.1 to 4.5)

MODULE III (20 Hours)

Quick review of section 5.1 **(**Areas and Distances) (*No questions shall be asked from this section for the End Semester Examination*)
The Definite integral, The Fundamental theorem of Calculus, Indefinite integrals and the Net change theorem, Areas between curves, Volumes, Volumes by cylindrical shells, Work , Average value of a function (Sections 5.2 to 5.4 and 6.1 to 6.5)

MODULE IV (20 Hours)

Reduction formulas and corresponding problems from the exercise only, Trigonometric integrals, Improper integrals, Arc length, Area of a surface of revolution, Applications to Physics and Engineering (Sections 7.1, 7.2, 7.8, 8.1 to 8.3)

References

1. G.B. Thomas Jr., M.D. Weir and Joel R. Hass, Thomas' Calculus (Twelth edition), Pearson, 2009.
2. H. Anton, I. Bivens and S. Davis, Calculus (Tenth Edition), John Wiley & Sons Inc., 2012.
3. S.K. Stein, Calculus and Analytic Geometry, McGraw Hill, 1992.
4. G.F. Simmons, Calculus with Analytic Geometry (Second Edition), McGraw Hill, 1995.

1B02 BMH: FOUNDATIONS OF MATHEMATICS

Text

1. **Ajit Kumar, S. Kumaresan and Bhaba Kumar Sarma, A Foundation Course in Mathematics, Narosa Publishing House, 2018**
2. **Martin Anthony and Michele Harvey, Linear Algebra – Concepts and Methods, Cambridge University Press, 2012.**

MODULE I (15 Hours)

Functions: Basic definitions, One-one, onto functions and bijections, Composition of functions, Inverse of a function, Image of subsets under functions, Inverse image of subsets under functions (All sections in Chapter 3 of Text 1).

MODULE II (20 Hours)

Relations: Relations on sets, Types of relations, Equivalence relation, Equivalence classes and partitions of a set (All sections in Chapter 4 in Text 1).

Induction Principles: The induction principle, the strong induction principle, The Well-ordering principle, Equivalence of the three principles (All sections in Chapter 5 of Text 1).

MODULE III (25 Hours)

Vectors: Vectors in $\mathbb{R}^n$, Developing geometric insight – Lines – Planes in $\mathbb{R}^3$ – Lines and hyper planes in $\mathbb{R}^n$ (Sections 1.8 to 1.12 of Text 2).

MODULE IV (30 Hours)

Systems of Linear Equations: Systems of linear equations, Row operations, Gaussian elimination, Homogeneous systems and null spaces, Matrix inversion using row operations, The rank of a matrix, Rank and systems of linear equations, Range (Sections 2.1 to 2.8, section 3.1, sections 4.1 to 4.7 of Text 2).

References

1. James R. Munkres, Topology (Second edition), PHI, 2002.
2. Robert Gardner Bartle and Donald R. Sherbert, Introduction to Real Analysis (Fourth edition), Wiley & Sons, 2010.
3. Steven G. Krantz, The Elements of Advanced Mathematics (Fourth edition), Taylor & Francis, 2017
4. Stephen H. Friedberg, Lawrence E. Spence and Arnold J. Insel, Elementary Linear Algebra: A Matrix Approach (Second edition), Pearson India Inc., 2019.
5. Kenneth Hoffmann and Ray Kunze, Linear Algebra (Second edition), PHI, 2015.
6. Stephan Andrilli and David Hacker, Elementary Linear Algebra (Fifth edition), Elsevier, 2016.

1B03 BMH: LOGIC, SETS AND PROBABILITY THEORY

Texts

1. **Ajit Kumar, S. Kumaresan and Bhaba Kumar Sarma, A Foundation Course in Mathematics, Narosa Publishing House, 2018**
2. **S.C. Gupta and V.K. Kapur, Fundamentals of Mathematical Statistics (Tenth edition- revised), Sultan Chand & Sons, 2000.**

MODULE I (25 Hours)

Statements and logic: Statements, Statements with quantifiers, Compound Statements, Implications, Proofs in Mathematics (All sections in Chapter 1 of Text 1).
Sets: Basic terminologies, Operations on sets, Family of sets, Power sets, Cartesian Products of sets (All sections in Chapter 2 of Text 1).

MODULE II (20 Hours)

Random Variable, Distribution function, Discrete Random Variable, Continuous Random Variable, Joint Probability law.
[Chapter 5: Sections 5.1-5.5 of Text 2, *Quartiles omitted*]
(*All Proofs in this module are omitted*)

MODULE III (25 Hours)

Mathematical Expectation, Expectation of a function of a random variable, Addition theorem of Expectation, Multiplication theorem of Expectation, Expectation of a linear combination of a random variable, Covariance, Variance of linear combination of random variables, Jenson's Inequality (Sections 6.1 to 6.7 of Text 2).
(*All proofs in section 6.7 are omitted*)

MODULE IV (20 Hours)

Moment Generating Function, Cumulants, Characteristic function, Chebychev's inequality (Sections 6.10 to 6.13 of Text 2. *Sections 6.10.1, 6.10.3, 6.11.2, 6.12.3, 6.12.4 omitted*).

References

1. S. Lipschutz, Set Theory and Related Topics (Second edition), Schaum's Outline Series, Tata McGraw-Hill Publishing Company, New Delhi, 1998.
2. Dennis Wackerly, William Mendenhall III and Richard Scheaffer, Mathematical Statistics with Applications (Seventh edition), Duxbury Press, 2007.
3. Robert V. Hogg and Allen T. Craig, Introduction to Mathematical Statistics (Fifth edition), Higher education press,1978.
4. G. Shanker Rao, Probability and Statistics for Science and Engineering, University Press, 2011.

1B04 BMH: TWO DIMENSIONAL GEOMETRY

Text

P. K. Jain and K Ahmad, Text Book of Analytical Geometry (Third Edition), New Age International (P) Ltd., 2014.

MODULE 1 – Change of Axes and Pair of Lines (20 hours)

Quick Review: Cartesian Coordinates, Polar Coordinates, Transformation, and Locus.(Sections 1.1 to 1.5, *No questions shall be asked from these sections for the End Semester Examination*)

Translation of Axes, Rotation of Axes, General Transformation, Invariants, Homogenous Equation of Second Degree, General Second Degree Equation, Pair of Lines Joining the Origin to the Points of Intersection of a Curve and a Line. (Sections 3.1 to 3.5 and 4.1 to 4.4).

MODULE II – The Parabola (20 hours)

Parabola, Tangent and Normal, Tangents from a Point, Chord of Contact, Pole and Polar, Chord with Given Middle Point, Parametric Coordinates. (Sections 7.1 to 7.8).

MODULE III – The Ellipse and the Hyperbola (25 hours)

Definition, Circle and Parabola as the Limiting Cases of Ellipse, Some Important Results, Director Circle, Auxiliary Circle, Eccentric Angles, Propositions on Ellipse, Diameter, Definition, Some Important Results, Parametric Form of the Hyperbola, Asymptotes, Conjugate Hyperbola, Rectangular Hyperbola. (Sections 8.1 to 8.8 and 9.1 to 9.6).

MODULE IV – General Equation of the Second Degree: Tracing of Conics and Polar Equation of a Conic (25 hours)

Conic Section, Centre of a Conic Section, Principal Axes and Eccentricity of a Conic, Axis, Latus Rectum, Vertex and Focus of a Parabola, Tracing of Conics, Polar Equation of a Conic, Tracing of the Conic $\frac{1}{r} = 1 + e\cos\theta$, Chord Joining Two Points. (Sections 10.1 to 10.5 and 11.1 to 11.4).

References

1. C. Herbert Clemens, Two-Dimensional Geometries: A Problem-solving Approach, AMA, 2019.
2. Harbanslal and Satpal, A Textbook of Two Dimensional Geometry, New Age International (P) Ltd., 1996.
3. S.K.Stein, Calculus and Analytic Geometry, McGraw Hill, 1992.
4. G.F.Simmons, Calculus with Analytic Geometry (Second edition), McGraw Hill, 1995.

2B05 BMH: CALCULUS II

Text

James Stewart, Calculus - Early Transcendentals (Eighth edition), Cengage Learning, 2015.

MODULE I (15 Hours)

Curves Defined by Parametric Equations, Calculus with Parametric Curves, Polar Coordinates, Areas and Lengths in Polar Coordinates (Sections 10.1 to 10.4)

MODULE II (25 Hours)

Sequences, Series, The Integral Test and Estimates of Sums, The Comparison Tests, Alternating Series, Absolute Convergence and the Ratio and Root Tests, Strategy for Testing Series, Power Series, Representations of Functions as Power Series, Taylor and Maclaurin Series, Applications of Taylor Polynomials. (Sections 11.1 to 11.11)

MODULE III (25 Hours)

Equations of Lines and Planes, Cylinders and Quadric Surfaces, Vector Functions and Space Curves, Derivatives and Integrals of Vector Functions, Arc Length and Curvature, Motion in Space: Velocity and Acceleration (Sections 12.5, 12.6. 13.1 to 13.4)

MODULE IV (25 Hours)

Functions of Several Variables, Limits and Continuity, Partial Derivatives, Tangent Planes and Linear Approximations, The Chain Rule, Directional Derivatives and the Gradient Vector, Maximum and Minimum Values, Lagrange Multipliers. (Sections 14.1 to 14.8)

References

1. G.B. Thomas Jr., M.D. Weir and Joel R. Hass, Thomas' Calculus (Twelfth edition), Pearson, 2009.
2. H. Anton, I. Bivens and S. Davis, Calculus (Tenth Edition), John Wiley & Sons Inc., 2012.
3. S.K. Stein, Calculus and Analytic Geometry, McGraw Hill, 1992.
4. G.F. Simmons, Calculus with Analytic Geometry (Second Edition), McGraw Hill, 1995.

2B06 BMH: DISTRIBUTION FUNCTIONS AND COMBINATORICS

Texts

1. **S.C. Gupta and V.K. Kapur, Fundamentals of Mathematical Statistics, (Tenth edition- revised), Sultan Chand & Sons, 2000.**
2. **Ralph P. Grimaldi, Discrete and Combinatorial Mathematics: An Applied Introduction (Fifth edition), Pearson Education, Inc., 2004.**

MODULE I - Theoretical Discrete Probability Distribution (20 Hours)

Bernoulli distribution, Binomial Distribution, Poisson distribution, Geometric Distribution (Sections 7.1, 7.2, 7.3, 7.5 of Text 1) (*Sections 7.2.3-7.2.5, 7.2.10-7.2.12, 7.3.1, 7.3.3, 7.3.4, 7.3.9, 7.3.10 omitted*)

MODULE II - Theoretical Continuous Distribution (25 Hours)

Uniform Distribution, Normal Distribution, Central Limit Theorem
(Sections 8.1, 8. 2, 8.10 of Text 1) (*Sections 8.1.4, 8.1.5, 8.2.9, 8.2.10, 8.2.12 omitted*).

MODULE III - Combinatorics-I (20 Hours)

The Principle of Inclusion and Exclusion, Generalizations of the Principle, Derangements: Nothing Is in Its Right Place, Rook Polynomials, Arrangements with Forbidden Positions (Sections 8.1 to 8.5 of Text 2).

MODULE IV- Combinatorics-II (25 Hours)

Generating Functions - Introductory examples, Definition and Examples: Calculational Techniques, Partitions of Integers, The Exponential Generating Function (Sections 9.1 to 9.4 of Text 2).

References

1. Dennis D. Wackerly, William Mendenhall III and Richard L. Scheaffer, Mathematical Statistics with Applications (Seventh edition), Duxbury Press, 2007.
2. Robert V. Hogg and Allen T. Craig, Introduction to Mathematical Statistics (Fifth edition), Prentice Hall, 1994.
3. G Shanker Rao, Probability and Statistics for Science and Engineering, University press, 2011.
4. L. Lovász, et. al., Discrete Mathematics: Elementary and Beyond, Springer, 2003.

2B07 BMH: THEORY OF NUMBERS AND EQUATIONS

Texts

1. **David M. Burton, Elementary Number Theory (Seventh edition), McGraw Hill, 2010.**
2. **T.K. Manicavachagom Pillay, T. Natarajan and K.S. Ganapathy: Algebra Vol-1, S. Viswanathan printers and publishers, 2010.**

MODULE I (25 Hours)

The division algorithm, the greatest common divisor, The Euclidean algorithm, The Diophantine equation $ax + by = c$, the fundamental theorem of arithmetic, the sieve of Eratosthenes (Sections 2.2, 2.3, 2.4, 2.5, 3.1, 3.2 of Text 1).

MODULE II (30 Hours)

Basic properties of congruence, linear congruences and the Chinese remainder theorem, Fermat's little theorem and pseudo primes, Wilson's theorem, the sum and number of divisors (Sections 4.2, 4.4, 5.2, 5.3, 6.1 of Text 1).

MODULE III – Theory of Equations-I (35 Hours)

Basic concepts, Relation between roots and coefficients, Symmetric functions of roots, Sum of the powers of roots, Newton's Theorem on Sum of the powers of roots, Transformation of equations, reciprocal equations, Transformation in general, Descartes rule of Signs, Multiple roots, Sturm's theorem, Cardon's method.
(Chapters 6: Sections 1 to 16, 21, 24, 26, 27, 34.1 and 35 of Text 2)

References

1. C.Y. Hsiung, Elementary Theory of Numbers, Allied Publishers, 1995.
2. N. Robbins, Beginning Number Theory (Second edition), Jones & Bartlett, 2017.
3. G. E. Andrews, Number Theory, Dover Publications Inc., 1995.
4. M.D. Raisinghnia and R.S. Aggarwal, Algebra.
5. K.H. Rosen, Discrete Mathematics and its Applications (Sixth edition), Tata McGraw Hill Publishing Company, New Delhi, 2006.

2B08 BMH: ORDINARY DIFFERENTIAL EQUATIONS

Texts

1. **Erwin Kreyzig, Advanced Engineering Mathematics (Ninth edition), John Wiley, 2006.**
2. **S.S. Sastry, Introductory Methods of Numerical Analysis (Fourth edition), PHI, 2005.**

MODULE I (25 Hours)

First Order Differential Equations

Basic Concepts. Modeling, Separable ODEs. Modeling, Exact ODEs. Integrating Factors, Linear ODEs, Bernoulli Equation. Population Dynamics, Orthogonal Trajectories, Existence and uniqueness of solutions (Text 1: Sections 1.1, 1.3 to 1.7, *All proofs in Section 1,7 are omitted*)

MODULE II (25 Hours)

Second Order Linear Differential Equations

Homogeneous Linear ODEs of Second Order, Homogeneous Linear ODEs with Constant Coefficients, Differential Operators, Euler- Cauchy Equation, Existence and Uniqueness Theory (proof omitted), Wronskian, Nonhomogeneous ODEs, Solution by Variation of parameters (Text 1: Sections 2.1 to 2.3, 2.5 to 2.7 and 2.10)

MODULE III (15 Hours)

Higher Order Linear ODEs and Systems of Differential Equations

Homogeneous Linear ODEs, Homogeneous Linear ODEs with Constant Coefficients, Nonhomogeneous Linear ODEs, System of ODEs as models, Basic Theory of Systems of ODEs, Nonhomogeneous Linear Systems of ODEs (Text 1: Sections 3.1 to 3.3, 4.1,4.2 and 4.6)

MODULE IV (25 Hours)

Numerical Solutions of Ordinary Differential Equations

Introduction, Solution by Taylor's series, Picard's method of successive approximations, Euler's method, Modified Euler's Method, Runge-Kutta method (Text 2: Sections 7.1 to 7.5)

References

1. S.L. Ross, Differential Equations (Third edition), Wiley & Sons, 1984.
2. A.H. Siddiqi & P. Manchanda, A First Course in Differential Equation with Applications, Macmillan, 2006.
3. E.A. Coddington, An Introduction to Ordinary Differential Equation, PHI, 2009.

3B09 BMH: REAL ANALYSIS

Text

R. G. Bartle and D. R. Sherbert, Introduction to Real Analysis (Fourth edition), Wiley & Sons, 2010.

MODULE I (15 Hours)

Mathematical Induction, Finite and Infinite sets
[Sections 1.2, 1.3]

MODULE II (25 Hours)

The algebraic and order properties of $\mathbb{R}$, the absolute value and Real Line, the completeness property of $\mathbb{R}$, applications of the supremum property, intervals
[Sections 2.2 to 2.5(up to 2.5.4)]

MODULE III (25 Hours)

Sequence and their limits, Limit theorems, Monotone sequences, subsequences and Bolzano Weierstrass Theorem, The Cauchy Criterion
[Sections 3.1 to 3.4 (up to 3.4.9), 3.5]

MODULE IV (25 Hours)

Introduction to series, Absolute convergence, Tests for Absolute convergence, Tests for Nonabsolute convergence
[Sections 3.7, 9.1, 9.2, 9.3]

References

1. J.M. Howie, Real Analysis, Springer, 2007.
2. Ghorpade and Limaye, A Course in Calculus and Real Analysis, Springer, 2006
3. K.A. Ross, Elementary Analysis: The Theory of Calculus, Springer, 2013.
4. J.V. Deshpande, Mathematical Analysis and Applications, Alpha Science International Ltd., 2004.

3B10 BMH: CALCULUS III

Text

James Stewart, Calculus - Early Transcendentals (Eighth edition), Cengage Learning, 2015.

MODULE I (25 Hours)

Double Integrals over Rectangles, Double Integrals over General Regions, Double Integrals in Polar Coordinates, Applications of Double Integrals (Sections 15.1 to 15.4)

MODULE II (25 Hours)

Surface Area, Triple Integrals, Triple Integrals in Cylindrical Coordinates, Triple Integrals in Spherical Coordinates, Change of Variables in Multiple Integrals (Sections 15.5 to 15.9)

MODULE III (20 Hours)

Vector Fields, Line Integrals, The Fundamental Theorem for Line Integrals, Green's Theorem, Curl and Divergence (Sections 16.1 to 16.5)

MODULE IV (20 Hours)

Parametric Surfaces and Their Areas, Surface Integrals, Stokes' Theorem, The Divergence Theorem (Sections 16.6 to 16.9)

References

1. G.B. Thomas Jr., M.D. Weir and Joel R. Hass, Thomas' Calculus (Twelth edition), Pearson, 2009.
2. H. Anton, I. Bivens and S. Davis, Calculus (Tenth Edition), John Wiley & Sons Inc., 2012.
3. S.K. Stein, Calculus and Analytic Geometry, McGraw Hill, 1992.
4. G.F. Simmons, Calculus with Analytic Geometry (Second Edition), McGraw Hill, 1995.

3B11 BMH: GRAPH THEORY

Text

John Clark and Derek Allan Holton, A first look at Graph Theory, Allied Publishers, 1995.

MODULE I – An introduction to Graphs (30 Hours)

The definition of a graph, Graphs as models, more definitions, vertex degrees, sub graphs, paths and cycles, matrix representation of graphs, fusion (Fusion algorithm for connectedness omitted)
(Chapter 1: Sections 1.1 to 1.8)

MODULE II – Trees and Connectivity (15 Hours)

Definitions and simple properties, Bridges, Spanning Trees, cut vertices and connectivity.
(Chapter 2: Sections 2.1 to 2.3, 2.6)

MODULE III– Euler tours, Hamiltonian cycles and Matching (25 Hours)

Euler tours (Fleury's algorithm omitted), the Chinese Postman Problem (Statement only), Hamiltonian Graphs, the Travelling Salesman problem (Statement only), Matchings and augmenting paths, the marriage problem.
(Chapter 3: Sections 3.1 to 3.4, Chapter 4: Sections 4.1 to 4.2)

MODULE IV– Planar Graphs, Colouring (20 Hours)

Plane and Planar graphs, Euler formula, Kuratowski's theorem, vertex colouring, Critical graphs
(Chapter 5: Sections 5.1 to 5.2, 5.4, Chapter 6: Sections 6.1, 6.3)

References

1. R. Balakrishnan and K. Ranganathan, A text book of Graph Theory (Second edition), Springer, 2019
2. J. A. Bondy and U.S.R Murthy, Graph theory with applications, Macmillan, 1976.
3. J. A. Dossey et al., Discrete Mathematics, Pearson Education, 2005.
4. K. R. Parthasarathy, Basic Graph Theory, Tata McGraw Hill, 1994.

3B12 BMH: ADVANCED STATISTICAL TECHNIQUES – I

Text

S.C. Gupta and V.K. Kapur, Fundamentals of Mathematical Statistics, (Tenth edition-revised), Sultan Chand & Sons, 2000.

MODULE I – CURVE FITTING (15 Hours)

Curve Fitting, Conversion of Data to Linear Form
[Chapter 9: Sections 9.1, 9.3. *Section 9.1.4 omitted*]

MODULE II – CORRELATION AND REGRESSION (25 Hours)

Bivariate Distribution, Correlation, Scatter Diagram, Karl Pearson Coefficient of Correlation (Proof Omitted), Rank Correlation, Regression
[Chapter 10: Sections 10.1 to 10.3, 10.6, 10.7. *Sections 10.6.3 and 10.7.2 omitted*]

MODULE III - SAMPLING AND LARGE SAMPLE TESTS (20 Hours)

Sampling, Types of Sampling, Parameter and Statistic, Tests of Significance, Null Hypothesis, Errors in Sampling, Critical Region and Level of Significance, Test of significance for large samples
[Chapter 12: Sections 12.1 to 12.8]

MODULE IV- SAMPLING AND LARGE SAMPLE TESTS (30 Hours)

Sampling of Attributes, Sampling of Variables, Unbiased Estimate for Population Mean and Variance, Standard Error of Sampling Mean, Test of Significance for Single Mean, Test of Significance for Difference of Mean, Test of Significance for the Difference of Standard Deviation
[Chapter 12: Sections 12.9 to 12.15].

References

1. Dennis D. Wackerly, William Mendenhall III and Richard L. Scheaffer, Mathematical Statistics with Applications (Seventh edition), Duxbury Press, 2007.
2. Robert V. Hogg and Allen T. Craig, Introduction to Mathematical Statistics (Fifth edition), Prentice Hall, 1994.
3. G Shanker Rao, Probability and Statistics for Science and Engineering, University press, 2011.

3B13 BMH: NUMERICAL ANALYSIS

Text

S.S. Sastry, Introductory Methods of Numerical Analysis (Fifth edition), PHI, 2012.

MODULE I: Solution of Algebraic and Transcendental Equations (25 Hours)

Introduction, Bisection Method, Method of false position, Iteration method, Newton-Raphson Method, Ramanujan's method, The Secant Method (Sections 2.1 to 2.7)

MODULE II: Finite Differences (20 Hours)

Introduction, Forward differences, Backward differences, Central differences, Symbolic relations and separation of symbols, Differences of a polynomial
(Sections 3.1, 3.3.1 to 3.3.4, 3.5)

MODULE III: Interpolation (25 Hours)

Newton's formulae for intrapolation, Central difference interpolation formulae, Gauss' Central Difference Formulae, Interpolation with unevenly spaced points, Langrange's interpolation formula, Divided differences and their properties, Newton's General interpolation formula, Inverse interpolation.
(Sections 3.6, 3.7, 3.7.1, 3.9, 3.9.1, 3.10, 3.10.1, 3.11)

MODULE IV: Numerical Differentiation and Integration (20 Hours)

Introduction, Numerical differentiation (using Newton's forward and backward formulae), Numerical Integration, Trapezoidal Rule, Simpson's 1/3-Rule, Simpson's 3/8-Rule
(Sections 6.1, 6.2, 6.4, 6.4.1, 6.4.2, 6.4.3)

References

1. S. Sankara Rao, Numerical Methods of Scientists and Engineers (Third edition), PHI, 2007.
2. F.B. Hildebrand, Introduction to Numerical Analysis, Dover Publications, 2013.
3. J.B. Scarborough, Numerical Mathematical Analysis, Oxford and IBH, 2005.

4B14 BMH: ADVANCED REAL ANALYSIS

Texts

1. **R.G. Bartle, D.R. Sherbert, Introduction to Real Analysis (Fourth edition), Wiley & Sons, 2010.**
2. **R.R. Goldberg: Methods of Real Analysis, OXFORD and IBH publishing, 2020.**
3. **S. Narayanan and T. K. Manicavachagom Pillay: Calculus, Vol. II, Viswanathan, S. Printers & Publishers (P) Ltd., 2009.**

MODULE I (20 Hours)

Continuous function : A quick review (Section 5.1, *No questions shall be asked from this section for the End Semester Examination*)
Continuous functions on intervals, uniform continuity.
(Sections 5. 3, 5. 4 from text 1).

MODULE II (25 Hours)

Riemann Integral, Riemann integrable functions, the fundamental theorem, Substitution theorem and application
(Sections: 7.1, 7. 2, 7. 3(up to 7.39) from text 1)

MODULE III (25 Hours)

Point wise and uniform convergence, Interchange of limit and continuity, Interchange of limit and derivative, Interchange of limit and integral, Series of functions.
(Sections: 8.1.1-8.1.10, 8.2.1-8.2.4, 9.4.1-9.4.13 from text 1)

MODULE IV (20 Hours)

Improper Integrals (Sections: 7.9, 7.10 of text 2),
Beta and Gamma functions (Chapter IX, Sections: 2.1, 2.2, 2.3, 3, 4, 5 of text 3)

References

1. J.V.Deshpande: Mathematical Analysis and Applications, Alpha Science International Ltd., 2004.
2. Torence Tao: Analysis I, TRIM 37, Hindustan Book Agency, 2014.
3. K.A. Ross, Elementary Analysis: The Theory of Calculus, Springer, 2013.
4. K. G. Binmore : Mathematical Analysis: A straightforward approach, Cambridge University Press, 1982.

4B15 BMH: INTRODUCTION TO ABSTRACT ALGEBRA AND LINEAR ALGEBRA

Texts

1. **J.B. Fraleigh, A First Course in Abstract Algebra (7th Edition), Pearson Education Limited, 2014**
2. **M. Anthony and M. Harvey, Linear Algebra – Concepts and Methods, Cambridge University Press, 2012.**

MODULE I(25 Hours)

Binary Operations, Groups, Subgroups, Cyclic Groups.
(Sections 2, 3, 5 and 6 from Text 1)

MODULE II (20 Hours)

Groups of Permutations; Orbits, Cycles, and the Alternating Groups.
(Sections 8 and 9 from Text 1)

MODULE III (25 Hours)

Vector spaces: Vector spaces – Subspaces – Linear span – Linear independence – Bases – Coordinates – Dimension – Basis and dimension in R^n.
(Sections: 5.1 to 5.7, 6.1 to 6.9 from Text 2)

MODULE IV (20 Hours)

Linear Transformations and Change of Bases: Linear transformation – Range and null space – Coordinate change – Change of basis and similarity.
(Sections: 7.1 to 7.8 from Text 2)

References

1. I.N. Herstein, Topics in Algebra, Wiley India Pvt. Ltd., 2006.
2. M. Artin, Algebra (Second edition), Pearson Education India, 2015.
3. J.A. Gallian, Contemporary Abstract Algebra, Narosa, 2008.
4. Stephen H. Friedberg, Lawrence E. Spence and Arnold J. Insel, Elementary Linear Algebra: A Matrix Approach (Second edition), Pearson India Inc., 2019.
5. Kenneth Hoffmann and Ray Kunze, Linear Algebra (Second edition), PHI, 2015.
6. Stephan Andrilli and David Hacker, Elementary Linear Algebra (Fifth edition), Elsevier, 2016.

4B16 BMH: INTRODUCTION TO PARTIAL DIFFERENTIAL EQUATIONS

Text

A.C. Srivastava and P.K. Srivastava, Engineering Mathematics, Vol II, PHI Learning Pvt. Ltd., 2011.

MODULE I (25 Hours)

Introduction to PDE, formation of PDE, Solution of a first order PDE, General integral from complete solution, method for solving first order equations, Lagrange's method, Geometrical interpretation of Lagranges's linear equation, particular solution passing through a given curve.
(Sections 5. 1, 5. 1.1 to 5.1.7).

MODULE II (15 Hours)

Nonlinear first order PDE, Charpit's method, Jacobi's method.
(Sections 5.1.9 to 5.1.11)

MODULE III (20 Hours)

Linear PDE of second order, solution of second order partial differential equations by direct integration, the general method for solving second order equations-Monge's method, Monge's method for solving, classification of second order PDE.
(Sections 5.2, 5.2.1 to 5.2.4)

MODULE IV (30 Hours)

Linear PDE with constant coefficients, solution of linear homogeneous PDE with constant coefficients, shorter method for finding particular integral when $g(x, y) = \varphi(ax+ by)$, $g(x, y) = x^m y^n$, where m, n are non-negative integers, $g(x, y) = e^{ax+by} V(x, y)$, solution of linear nonhomogeneous equations
(Sections 5.2. 6 to 5.2.11)

References

1. Ian N Sneddon, Elements of Partial differential Equations, Dover Publications, 2006.
2. T. Amarnath, An elementary course in partial differential equations (second edition), Narosa, 2010.

4B17 BMH: ADVANCED STATISTICAL TECHNIQUES – II

Text

S.C. Gupta and V.K. Kapur, Fundamentals of Mathematical Statistics, (Tenth edition-revised), Sultan Chand & Sons, 2000.

MODULE I - CHI-SQUARE DISTRIBUTION (25 Hours)

Chi-Square Variate, Chi-Square Distribution (Derivation omitted), Moment Generating Function of Chi-Square Distribution, Applications of Chi-Square Distribution, Yate's Correction

[Chapter 13: Sections 13.1 to 13.3, 13.7, 13.8. *Section 13.3.4 omitted*]

MODULE II – EXACT SAMPLING DISTRIBUTIONS (25 Hours)

Student's t-Distribution (Derivative and Proof omitted), F- Statistic (Derivative omitted)

[Chapter 14: Sections 14.1, 14.2, 14. 5. (*Sections 14.2.11, 14.5.3, 14.5.6-14.5.11 omitted*)]

MODULE III – THEORY OF ESTIMATION (20 Hours)

Parameter Space, Characteristics of Estimators, Consistency, unbiasedness, efficient estimators [Chapter 15: Sections 15.1 to 15.5]

MODULE IV- THEORY OF ESTIMATION (20 Hours)

Sufficiency, Method of Maximum Likelihood Estimation, Confidence Interval and Confidence Limits

[Chapter 15: Sections 15.6, 15.11, 15.15]

References

1. Dennis D. Wackerly, William Mendenhall III and Richard L. Scheaffer, Mathematical Statistics with Applications (Seventh edition), Duxbury Press, 2007.
2. Robert V. Hogg and Allen T. Craig, Introduction to Mathematical Statistics (Fifth edition), Prentice Hall, 1994.
3. G Shanker Rao, Probability and Statistics for Science and Engineering, University press, 2011.

4B18 BMH: OPERATIONS RESEARCH

Text

K. Swarup, P.K.Gupta and M. Mohan, Operations Research (18th edition), Sulthan Chand and Sons.

MODULE I - Linear Programming Problem (30 hours)

Convex sets and their properties, Convex Functions, Local and Global Extrema, Quadratic Forms.

Linear Programming Problem – Mathematical formulation, Graphical solution, General Linear Programming Problem , Slack and Surplus Variables, Canonical and standard form of LPP, Insights into the simplex method.

Basic Solution, Degenerate Solution, Basic Feasible Solution, Associated cost vector, Improved basic Feasible solution, Optimum Basic Feasible Solution, Fundamental Properties of solution (Proof of theorems omitted), Simplex method – The computational Procedure, The Simplex Algorithm.

General Primal-Dual Pair, Formulating a dual problem (Sections 0:13, 0:15, 0:16, 0:17, 2:1, 2:2, 2:3, 2:4, 3:1, 3:2, 3:4, 3:5, 3:6, 4:1, 4:2, 4:3, 5:1, 5:2, 5:3of the Text).

MODULE II - Transportation Problem (25 hours)

LP formulation of the Transportation Problem, Existence of solution in T.P, Duality in Transportation problem, The Transportation Table, Loops in Trasportation Tables, Triangular basis in a T.P (proof of theorem Omitted), Solution of a Trasportation problem, North-west corner Method, Least –Cost Method, VAM, Test For Optimality, Degeneracy in TP, MODI Method.

(Sections 10:1,10:2,10:3,10:4,10:5,10:6,10:7,10:8,10:9,10:10,10:12,10:13 of the Text)

MODULE III - Assignment Problem and Sequencing Problem (20 hours)

Assignment Problem: Mathematical Formulation of Assignment Problem, Hugarian Assignment Method.

Sequencing Problem: Problem of sequencing, Basic terms used in sequencing, Processing 'n' jobs through '2' machines, Processing 'n' jobs through 'k' machines, Maintenance Crew Scheduling.

(Sections 11:1, 11:2, 11:3, 12:1, 12:2, 12:3, 12:4, 12:5, 12:7 of the Text)

MODULE IV - Games and Strategies (15 hours)

Two-person Zero-sum Games, Basic terms in Game theory, The Maximin-Minimax Principle, Solution of game with saddle point, Solution of 2x2 game without saddle point, Graphic solution of 2xn and mx2 games, Dominance Property, Modified Dominance Property, Arithmetic Method for nxn Games. (Proofs of all theorems in this unit are omitted).

(Sections 17:1, 17:2, 17:3, 17:4, 17:5, 17:6, 17:7, 17:8 of the Text)

References

1. J.K. Sharma, Operations Research - Theory and Applications, McMillan
2. H.A. Thaha, Operations Research, An Introduction (8th edition), Prentice Hall
3. G. Hadley, Linear Programming, Oxford & IBH Publishing Company.

5B19 BMH: ADVANCED ABSTRACT ALGEBRA

Text

J.B. Fraleigh, A First Course in Abstract Algebra (Seventh Edition), Pearson, 2003.

MODULE I (20 Hours)

Cosets and Theorem of Lagrange, Homomorphisms.
(Sections: 10 and 13)

MODULE II (25 Hours)

Factor Groups, Factor Group Computations and Simple Groups.
(Sections: 14 and 15)

MODULE III (25 Hours)

Rings and Fields, Integral domains, Fermat's and Euler's theorems.
(Sections: 18, 19 and 20)

MODULE IV (20 Hours)

Rings of Polynomials, Factorization of Polynomials over a Field.
(Sections: 22 and 23)

References

1. I.N. Herstein, Topics in Algebra, Wiley India Pvt. Ltd., 2006.
2. N.H. Mc Coy and R. Thomas, Algebra, Allyn & Bacon Inc. , 1977.
3. J. Rotman, An Introduction to the Theory of Groups, Allyn & Bacon Inc. , 1973.
4. Marshall Hall, The Theory of Groups. Chelsea Pub. Co. NY. ,1976
5. Allan Clark, Elements of Abstract Algebra, Dover Publications, 1984.
6. L.W. Shapiro, Introduction to Abstract Algebra, McGraw Hill Book Co. NY, 1975.

5B20 BMH: INTEGRAL TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS

Text

Erwin Kreyzig, Advanced Engineering Mathematics (Ninth Edition), John Wiley, 2006.

MODULE I – Laplace Transforms (25 Hours)

Laplace Transform, Inverse Transform, Linearity, s-Shifting, Transforms of derivatives and Integrals ODEs, Unit Step Function, t-Shifting, Short Impulses, Dirac's Delta Function, Partial fractions, Convolution, Integral Equations, Differentiation and Integration of Transforms, Systems of ODEs.
(Sections 6.1 to 6. 7)

MODULE II – Fourier series (20 Hours)

Fourier series, Functions of any period p=2L, Even and Odd functions, Half- Range expansion complex Fourier series.
(Sections 11.1 to 11. 4)

MODULE III – Fourier Integral and Transforms (20 Hours)

Fourier Integrals, Fourier Cosine and Sine Transforms, Fourier Transform (Exclude Discrete and Fast Fourier Transforms)
(Sections 11.7 to 11.9)

MODULE IV – Partial Differential Equations (25 Hours)

Basic Concepts, Modelling: Vibrating strings, Wave Equation, Separation of Variables, use of Fourier series, D'Alembert's solution of the Wave Equation, Heat Equation: Solution by Fourier Series, Heat Equation: Solution by Fourier Integrals and Transforms
(Sections 12.1 to 12. 6)

References

1. G. Birkhoff & G.C. Rota, Ordinary Differential Equations (Third edition), Wiley & Sons, 1978.
2. E. A. Codington, An Introduction to Ordinary Differential Equations, Prentice Hall of India, New Delhi, 1974.
3. Courant R and Hilbert D, Methods of Mathematical Physics, Vol. I, Wiley Eastern Reprint, 1975.
4. W.E. Boyce & R.C. Deprima, Elementary Differential Equations and boundary value problems (Second edition), John Wiley & Sons, NY, 1969.

5B21 BMH: ADVANCED LINEAR ALGEBRA

Text

Martin Anthony and Michele Harvey, Linear Algebra – Concepts and Methods, Cambridge University Press, 2012.

MODULE I - Diagonalisation (20 Hours)

Eigen values and eigen vectors, Diagonalisation of a square matrix, When is diagonalisation possible, Powers of matrices using diagonalsation.
(Sections: 8.1 to 8.7, 9.1)

MODULE II - Inner Products and Orthogonality (25 Hours)

Inner products, Orthogonality, Orthogonal matrices, Gram-Schmidt orthonormalisation process. **Orthogonal Diagonalisation and its Application:** Orthogonal diagonalisation of symmetric matrices, Quadratic forms.
(Sections: 10.1 to 10.8, 11.1 to 11.6)

MODULE III - Direct sums and projections (20 Hours)

Direct sum of two subspaces, Orthogonal complements, Projections, Characterising projections and orthogonal projections, Orthogonal projections onto the range of a matrix.
(Sections: 12.1 to 12.11 (*Excluding 12.6, 12.7 and corresponding activities and problems*))

MODULE IV - Complex matrices and Vector spaces (25 Hours)

Complex vector spaces, Complex matrices, Complex inner products, Hermitian conjugates, Unitary diagonalisation and normal matrices, Spectral decomposition.
(Sections: 13.2 to 13.11)

References

1. Stephen H. Friedberg, Lawrence E. Spence and Arnold J. Insel, Elementary Linear Algebra: A Matrix Approach (Second edition), Pearson India Inc., 2019.
2. Kenneth Hoffmann and Ray Kunze, Linear Algebra (Second edition), PHI, 2015.
3. Stephan Andrilli and David Hacker, Elementary Linear Algebra (Fifth edition), Elsevier, 2016.
4. Helson, Linear Algebra (Second Edition) – Hindustan Book Agencies, 1994.

5B22 BMH: COMPLEX ANALYSIS

Text

Erwin Kreyszig, Advanced Engineering Mathematics (Tenth edition), John Wiley, 2011.

MODULE I – Complex Functions , Complex differentiation (24 hours)

Derivative, Analytic Function, Cauchy–Riemann Equations, Laplace's Equation, Exponential Function, Trigonometric and Hyperbolic Functions, Euler's Formula, Logarithm, General Power, Principal Value (Sections 13.3- 13.7)

MODULE II– Complex Integration (24 hours)

Line Integral in the Complex Plane, Cauchy's Integral Theorem, Cauchy's Integral Formula, Derivatives of Analytic Functions (Sections 14.1 - 14.4)

MODULE III – Power Series, Taylor Series (18 hours)

Sequences, Series, Convergence, Power Series, Functions given by Power Series, Taylor and Maclaurin's Series (Proof of Taylor's theorem excluded) (Sections 15.1- 15.4)

MODULE IV - Laurent Series, Residue Integration (24 hours)

Laurent Series (Proof of Laurent's Theorem excluded), Singularities and Zeros, Infinity, Residue Integration Method (Sections 16.1-16.3).

References

1. J.W. Brown and R.V. Churchil, Complex Variables and Applications (Seventh edition), McGraw-Hill, 2004.
2. L.V. Ahlfors, Complex Analysis (Third edition), McGraw-Hill, 1980.
3. S. Ponnusamy, Foundations of Complex Analysis (Second edition), Alpha Science International Ltd., 2005.

5B23--- BMH : ELECTIVE - I

Elective - I is to be chosen as one of the following courses.

5B23A BMH. Calculus of Variations
5B23B BMH. Programming using Scilab
5B23C BMH. Mathematical Economics

(See the syllabi of these courses in Annexure I)

6B24 BMH: DIFFERENTIAL GEOMETRY

Text

John A. Thorpe, Elementary Topics in Differential Geometry, Springer, 1979.

MODULE I (30 Hours)

Graphs and Level Sets, Vector Fields, The Tangent Space
(Chapters 1, 2 & 3)

MODULE II (30 Hours)

Surfaces – Vector Fields on Surfaces; Orientation, Geodesics
(Chapters 4, 5 & 7)

MODULE III (30 Hours)

Parallel Transport, The Weingarten Map, Curvature of Plane Curves.
(Chapters 8, 9 & 10)

References

1. Manfredo P. Do Carmo, Differential Geometry of Curves and Surfaces (Second edition) Dover Publications, 2016.
2. Andrew Pressley, Elementary Differential Geometry (Second edition), Springer, 2010.
3. Barrett O' Neill, Elementary Differential Geometry (Second edition), Elsevier, 2006.
4. Erwin Kreyszig, Differential Geometry, Dover Publications, 1991.

6B25 BMH: TOPOLOGY

Text

1. **G.F. Simmons, Introduction to Topology and Modern Analysis, Tata McGraw Hill, 1963**
2. **J.R. Munkres, Topology (second edition), Prentice Hall, 2000.**

MODULE I - Metric Spaces (25 Hours)

Metric and Metric spaces, Open sets, Closed sets, Convergence and completeness, Continuous mappings.
Text 1 - Sections 9 to 13 (*Exclude Baire's Theorem*)

MODULE II - Topological Spaces (25 Hours)

Topological spaces, Basis for a topology, The product topology on $X \times Y$, The subspace topology, Closed sets and limit points, Continuous functions.
Text 2 - Sections 12, 13, 15, 16, 17, 18.

MODULE III - Connectedness and Compactness (20 Hours)

Connected spaces, Connected subspaces of the Real line, Compact spaces, Compact subspaces of the Real line.
Text 2 - Sections 23, 24, 26, 27.

MODULE IV - Countability and Separation axioms (20 Hours)

The countability axioms, the separation axioms, Normal spaces.
Text 2 - Sections 30, 31, 32.

References

1. Satish Shirali & Harikrishnan L. Vasudeva, Metric Spaces, Springer, 2006.
2. C.G.C. Pitts, Introduction to Metric Spaces, Oliver & Boyd Edinburgh, 1972.
3. K.D. Joshi, Introduction to General Topology, Wiley Eastern Limited, 1984.
4. C.W. Patty, Foundations of Topology, Jones & Bartlett, 2010.
5. Steven G. Krantz, Essentials of Topology with Applications, CRC Press, 2017.
6. J. Dugundji, Topology, Prentice Hall of India, 1975.
7. S. Willard, General Topology, Addison Wesley Pub Co., Reading Mass, 1976.
8. M.G. Murdeshwar, General Topology (Second edition), Wiley Eastern Ltd, 1990.
9. M.A. Armstrong, Basic Topology, Springer Verlag, New York, 1983.

6B26 BMH: MEASURE THEORY

Texts

1. **R.G. Bartle, The Elements of Integration and Lebesgue Measure, John Wiley& sons Inc., 1995.**
2. **H.L. Royden and P. M. Fitzpatrick, Real Analysis (Fourth Edition), Pearson, 2010.**

MODULE I (20 Hours)

Introduction: Reasons for the development of the Lebesgue integral, comparison with the Riemann integral, the extended real number system.
Measurable Functions: Measurable sets and functions, combinations, complex valued functions, functions between measurable spaces.
(Chapters 1, 2 of Text 1)

MODULE II (30 Hours)

Measures: Measures, measure spaces, almost everywhere, charges.
Lebesgue measure: Introduction, Lebesgue outer measure, the σ-algebra of Lebesgue measurable sets.
(Chapter 3 of Text 1 and Sections 2.1, 2.2, 2.3 of Text 2. *Proofs of Proposition 1 and Proposition 8 from text 2 are omitted*)

MODULE III (22 Hours)

The Integral: Simple Functions and their Integrals, the integral of a non-negative extended real-valued measurable function, the Monotone Convergence Theorem, Fatou's Lemma, Properties of the integral.
(Chapter 4 of Text 1).

MODULE IV (18 Hours)

Integrable Functions: Integrable real-valued functions, positivity and linearity of the integral, the Lebesgue Dominated Convergence Theorem.
(Chapter 5 of Text 1. *Dependence of parameter omitted).*

References

1. P. K. Jain and V. P. Gupta, Lebesgue measure and integration, John Wiley and sons, 1986.
2. Elais M .Stein and Rami Shakarchi, Real Analysis, Princeton University Press, 2005.
3. Walter Rudin, Principles of Mathematical Analysis, Mc Grow Hill International, 1976.

6B27--- BMH : ELECTIVE - II

Elective - II is to be chosen as one of the following courses:

6B27A BMH: Discrete Fourier Analysis
6B27B BMH: Mathematical Finance
6B27C BMH: Fuzzy Mathematics
6B27D BMH: Automata Theory

(See the syllabi of these Elective courses in Annexure II)

6B28 BMH: PROJECT WORK

(See Annexure III for details)

ANNEXURE I
Electives for the fifth semester

5B23A BMH: CALCULUS OF VARIATIONS

Text

L. Elsgolts, Differential Equations and Calculus of Variations, MIR Publishers, 1970

MODULE I - The Method of Variations in Problems with fixed boundaries (25 Hours)
Variation and its properties, Euler's Equation, Functionals Dependent on Several Dependent Variables, Functionals Dependent on Higher Order Derivatives, Functionals dependent on Several Independent Variables, Variational Problems in Parametric Form, Some Applications (Chapter 6: Sections 1 to 7)

MODULE II - Variational Problems with Moving Boundaries (25 Hours)
An Elementary Problem with Moving Boundaries, The Moving Boundary Problem for Functionals with Integrand of the form $F(x, y, z, y', z')$, Extremals with Corners, One Sided Variations (Chapter 7: Sections 1 to 4)

MODULE III - Sufficient Conditions for an Extremum (20 Hours)
Field of Extremals, The Function $E(x, y, p, y')$, Transforming the Euler Equations to the Canonical Form (Chapter 8: Sections 1 to 3)

MODULE IV - Variational Problems Involving Conditional Extremum (20 Hours)
Constraints of the Form $j(x, y_1, y_2, \ldots, y_n) = 0$, Constraints of the Form $j(x, y_1, y_2, \ldots, y_n, y_1', y_2', \ldots, y_n') = 0$, Isoperimetric Problems (Chapter 9: Sections 1 to 3)

References

1. M. Gelfand and S.V. Fomin , Calculus of Variations, Dover Publications Inc., 2000.
2. D. V. Widder, Advanced Calculus, Dover Publications Inc., 1989.
3. R. Weinstock, Calculus of Variations, Dover Publications Inc., 1974.

5B23B BMH: PROGRAMMING USING SCILAB

Text

Claude Gomez, C. Bunks, J.P. Chancelier, F. Delebecque, M. Goursat, R. Nikoukhah, S. Steer, Engineering and Scientific Computing With Scilab, Birkhauser Boston, 1999.

Introduction to Scilab: The general environment and the console, simple numerical calculations, the menu bar, the editor, variables assignment and display, supplements on matrices and vectors, loops, the graphics window: 2D and 3D plots, simple Scilab programs.

Part A

1. Program to convert a decimal number into its binary form
2. Program to reverse a given number
3. Program to generate first '*n*' Fibonacci numbers
4. Program to generate first '*n*' prime numbers
5. Program to generate prime numbers by Sieve of Eratosthenes
6. Program to generate first '*n*' perfect numbers
7. Program to solve a system of linear congruences by Chinese Remainder Theorem
8. Program to multiply two matrices without using Scilab matrix multiplication command
9. Program to solve a linear system by Cramer's rule
10. Program to solve a linear system of equations
11. Program to find a root of an algebraic/transcendental equation by iteration method
12. Program to find a root of an algebraic/transcendental equation by bisection method
13. Program to find a root of an algebraic/transcendental equation by Newton-Raphson method
14. Program to find a root of an algebraic/transcendental equation by Regula-falsi method
15. Program to sketch a surface of the type $z = f(x,y)$

Part B

16. Program to evaluate line integral by midpoint rule and find the error.
17. Program to evaluate line integral by trapezoidal rule and find the error.
18. Program to evaluate line integral by Simpson's 1/3-rule and find the error.
19. Program to evaluate line integral by Simpson's 3/8-rule and find the error.
20. Program for double integration with limits fixed both by programming and direct Scilab command
21. Program for double integration with limits varying
22. Program for triple integration with limits fixed
23. Program for triple integration with limits varying
24. Program for triple integration using Scilab commands
25. Program to evaluate the *y*-value at any point *x* by Lagrange's interpolation
26. Program to sketch the curve by Lagrange's interpolation
27. Program to evaluate the *y*-value at any point *x* by Newton's divided difference formula
28. Program to sketch the curve by Newton's divided difference formula

29. Program to evaluate the *y*-value at any point *x* by Newton's Forward Interpolation formula
30. Program to sketch the curve by Newton's Forward Interpolation formula
31. Program to evaluate the *y*-value at any point *x* by Newton's Backward Interpolation formula
32. Program to sketch the curve by Newton's Backward Interpolation formula
33. Program to evaluate the derivative for a set of tabulated data by Newton's Forward Interpolation formula
34. Program to evaluate the derivative of a function by Newton's Forward Interpolation formula
35. Program to evaluate the derivative for a set of tabulated data by Newton's Backward Interpolation formula
36. Program to evaluate the derivative of a function by Newton's Backward Interpolation formula
37. Program to sketch the solution curve of a first order IVP
38. Program to sketch the solution curves of a system first order IVPs
39. Program to solve a second order IVP
40. Program to sketch the solution curve of a second order IVP

References

1. The Scilab Consortium. Scilab. http://www.scilab.org.
2. Text Book Companion in https://scilab.in
3. Rajan Goyal and MansiDhingra, Programming in Scilab, Alpha Science Int. Ltd., 2019
4. Sandeep Nagar, Introduction to Scilab- For Engineers and Scientists, Apress, 2017.

5B23C BMH: MATHEMATICAL ECONOMICS

Text

Alpha C. Chiang and Kevin Wainwright, Fundamental Methods of Mathematical Economics, 4th Edition, 2005

MODULE I - Equilibrium Analysis in Economics (25 Hours)

3.1 The Meaning of Equilibrium
3.2 Partial Market Equilibrium- A linear Model
3.3 Partial Market Equilibrium- A non-linear Model
3.4 General Market Equilibrium
3.5 Equilibrium in National Income Analysis

MODULE II - Matrix Analysis (20 Hours)

5.6 Applications to Market and National Income Models
5.7 Leontif Input-Output Model

MODULE III - Further topics in Optimization (25 Hours)

13.1 Non-linear Programming and Kuhn-Tucker Conditions
13.2 The Constraint Qualification
13.3 Economic Applications
13.4 Sufficiency Theorems in Non-linear Programming

MODULE IV - Applications of Integration (20 Hours)

14.5 Some Economic Applications of Integrals
14.6 Domar Growth Model

References

1. Knut Sydsaeter, Peter Hammond, Atle Seierstad, and Arne Strom, Further Mathematics for Economic Analysis, Prentice Hall, 2008
2. Chiang, Alpha C., Fundamental Methods of Mathematical Economics, McGraw Hill, 2017
3. Rosser, Mike, Basic Mathematics for Economists, Routledge, Taylor & Francis Group, 2003.

ANNEXURE II

Electives for the sixth semester

6B27A BMH: DISCRETE FOURIER ANALYSIS

Text

M.W. Frazier, An Introduction to Wavelets through Linear Algebra, Springer, 1999.

MODULE I (20 Hours)

1. Definition and basic properties of Discrete Fourier Transform.
2. Translation invariant linear transformations.

(Chapter 2: Sections 1 and 2)

MODULE II (25 Hours)

1. Construction of First Stage Wavelets on Z_N.
2. The iteration step for Wavelets on Z_N.
3. Daubechies's D6 Wavelets on Z_N.

(Chapter 3: Sections 1 and 2 and example 3.35)

MODULE III (25 Hours)

1. Spaces l^2 (Z) and L^2 ([-π, π]) and Fourier series.
2. The Fourier Transform and Convolution on l^2 (Z).

(Chapter 4: Sections 1, 3 and 4)

MODULE IV (20 Hours)

1. First Stage Wavelets on Z.
2. The iteration step for Wavelets on Z.

(Chapter 4: Sections 5 and 6)

Reference

1. M.W.Wong, Discrete Fourier Analysis, Birkhauser, 2010.
2. A. Boggess, A First Course in Wavelets with Fourier Analysis, John Wiley 2009.

6B27B BMH: MATHEMATICAL FINANCE

Text

1. **Frank Verner and Yuri N Sotskov, Mathematics of Economics and Business, Routledge Publications, 2006.**
2. **Timothy J Biehler, The Mathematics of Money, The McGraw Hill Company, 2008.**
3. **Sheldon M. Ross, An elementary introduction to mathematical finance, Cambridge University Press, 2011**

MODULE I (25 Hours)

2.3 Finance (2.3.1 to 2.3.5 of Text 1)
5.6 Some Applications of Integration (5. 6.1 to 5.6.3 of Text 1)

MODULE II (20 Hours)

12.4 Linear difference equations (12.4.1 to 12.4.3 of Text 1)
10 Consumer Mathematics (10.1 to 10.4 of Text 2)

MODULE III (20 Hours)

6 The Arbitrage Theorem (6.1 to 6.3 of Text 3)
7 The Black–Scholes Formula (7.1 to 7.3 of Text 3)

MODULE IV (25 Hours)

10 Stochastic Order Relations (10.1 to 10.5 of Text 3)

References

1. Ales Cerny, Mathematical Techniques in Finance: Tools for Incomplete Markets, Princeton University Press, 2009
2. S. R. Pliska, Introduction to Mathematical Finance: Discrete Time Models, Blackwell Publishers Inc, 2002.

6B27C BMH: FUZZY MATHEMATICS

Text

George J. Klir and B.O. Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall, 1995.

MODULE I (25 Hours)

1.3 Fuzzy Sets: Basic Types
1.4 Fuzzy Sets: Basic Concepts
1.5 Characteristics and Significance of the Paradigm Shift
2.1 Additional Properties of alpha-Cuts

MODULE II (20 Hours)

2.2. Representations of Fuzzy Sets
2.3 Extension Principle for Fuzzy Sets
3.1 Types of Operations
3.2 Fuzzy Complements
3.3 Fuzzy Intersections: t-Norms

MODULE III (20 Hours)

3.4 Fuzzy Unions: t-Conorms
3.5 Combinations of Operations
3.6 Aggregation Operations

MODULE IV (25 Hours)

4.1 Fuzzy Numbers
4.2 Linguistic Variables
4.3 Arithmetic Operations on Intervals
4.4 Arithmetic Operations on Fuzzy Numbers

References

1. George J Klir and Tina A Folger, Fuzzy sets, Uncertainty and Information, Prentice Hall of India, 1988.
2. H. J. Zimmerman, Fuzzy Set theory and its Applications, 4^{th} Edition, Kluwer Academic Publishers, 2001.
3. Timothy J Ross, Fuzzy Logic with Engineering Applications, McGraw Hill International Editions.

6B27D BMH: AUTOMATA THEORY

Texts

1. **K. Krithivasan and R. Rama, Introduction to Formal Languages, Automata and Computation, Pearson Education, 2009.**
2. **A. Singh, Elements of Computation Theory, Springer (In: Texts in Computer Science Series), 2009.**

MODULE I (25 Hours)

Grammars and Languages: Language basics, Regular expressions, Regular grammars, Context free grammars, context-sensitive grammars, unrestricted grammars, Chomsky hierarchy.

MODULE II (20 Hours)

Automata: Finite automata, pushdown automata, Pumping Lemmas and Closure properties, Turing machines and recursively enumerable languages.

MODULE III (25 Hours)

Computability: Computable functions, non-recursively enumerable languages, Undecidability, Rice's theorem, Post's correspondence problem, Undecidability of validity problem of First Order Logic.

MODULE IV (20 Hours)

Complexity: Asymptotic order symbol, Space and Time complexity, Classes P and NP, NP completeness, Cook-Levin theorem, Other NP-complete problems.

References

1. J. Hopcroft, R. Motwani, and J. Ullman. Introduction to Automata Theory, Languages, and Computation, 3rd edition, Pearson/Addison-Wesley, 2007.
2. P. Linz., Introduction to Formal Languages and Automata, 6^{th} edition, Jones and Barlett, 2017

ANNEXURE III

6B28 BMH: PROJECT WORK

List of Practical Works

Among the following practical works, at least 20 (at least 5 from each category) are to be performed in Lab using any software like Scilab, R, FreeMat, Geogebra, Sagemath, Python etc. and report is to be submitted as project work.)

Category A

1. Plotting the graphs of the following functions: ax, e^{ax+b}, $[x]$, $sin(ax+b), cos(ax+b)$, $log(ax+b)$, $|sin(ax+b)|$, $|cos(ax+b)|$ etc. Observe and discuss the effect of changes in the real constants a and b on the graphs.
2. Plotting the graphs of polynomial of degree 4 and 5, and their first and second derivatives, and analysis of these graphs.
3. Tracing of conics in Cartesian coordinates/Polar coordinates
4. Sketching of Graph of hyperbolic functions.
5. Illustrating the geometric meaning of Rolle's theorem of any function.
6. Illustrating the geometric meaning of Lagrange's mean value theorem of any function.
7. Visualization by creating graphs: Taylor's polynomials – approximated up to certain degrees
8. Obtaining surface of revolution of curves.
9. Sketching and finding of level surfaces.
10. Sketching the tangent plane to the surfaces at the given point.

Category B

11. Finding critical points and identifying relative maxima, relative minima or saddle points of a surface
12. Growth & Decay model (exponential case only)
13. Solution of Differential equation and plotting the solution
14. Plotting of second order solution family of differential equation.
15. Finding complementary function and particular integral of constant coefficient second and higher order ordinary differential equations.
16. Solving systems of ordinary differential equations.

17. Solving second order linear partial differential equations in two variables with constant coefficient.
18. Solution of Cauchy problem for first order PDE.
19. Plotting the characteristics for the first order PDE
20. Plotting the integral surfaces of a given first order PDE with initial data.
21. Solution of Wave equation for the associated conditions
22. Solution of one-Dimensional heat equation for the associated conditions

Category C

23. Studying the convergence of sequences through plotting.
24. Studying the convergence/divergence of infinite series by plotting their sequences of partial sum.
25. Verifying Bolzano-Weierstrass theorem through plotting of sequences and hence identify convergent subsequences from the plot.
26. For any 5 convergent sequences (x_n) , given $\varepsilon = \frac{1}{2^m}$, $p = 10^j$, $m = 0,1,2 \dots, j = 1,2,3, \dots$, **f**ind $n \in N$ such that $|x_{n+p} - x_n| < \varepsilon$.
27. Let f be any function and L be any real number. For given a and $\varepsilon > 0$, find a $\delta > 0$ such that for all x satisfying $0 < |x - a| < \delta$, the inequality $0 < |f(x) - L| < \varepsilon$ holds.
28. Discuss the limit of the functions $\pm\frac{1}{x}, \sin\frac{1}{x}, \cos\frac{1}{x}, x\sin\frac{1}{x}, x\cos\frac{1}{x}, x^2\sin\frac{1}{x}, x^2\cos\frac{1}{x}$ when x tends to 0.
29. Discuss the limit of the functions $e^{\frac{1}{x}}, \sin\frac{1}{x}, x^2\sin\frac{1}{x}, \frac{x}{x+1}, \frac{e^x}{x}$ when x tends to infinity
30. Cauchy's root test by plotting n^{th} roots.
31. D'Alembert's ratio test by plotting the ratio of nth and $(n+1)^{th}$ term.

Category D

32. Image of the horizontal lines, vertical lines, half planes etc under the mapping $w = f(z)$.
33. To find zeros and Poles of a complex function.
34. To find a real root of an equation by Newton-Raphson Method.
35. Numerical Integration by Simpson's ⅓ Rule.

36. To solve numerically Initial Value Problems in ordinary differential equations by Euler's and Runke-Kutta (4^{th} order) Method.

37. Simplex Algorithm.

38. Optimization of the transportation problem.

39. Solution of assignment problem.

40. Linear regression algorithm.

41. Correlation and regression analysis for curve fitting.
