Syllabus for the First Degree Programme in Mathematics
of the University of Kerala

Semester VI
Real Analysis-II

Code: MM 1641 Instructional hours per week: 5
No. of credits: 4

This part of the course builds on the first course and concentrates on real valued functions. We discuss the three properties of continuity, differentiability and Riemann integrability.

Module 1 Continuity must be first intuitively introduced as the geometric notion of an un-broken curve and then the discussion should gradually lead to the -δ definition, as an effort to make this notion formal and rigorous. The connection between continuity and existence of limit should be emphasized. The material contained in Sections 5.1–5.4, excluding 5.4.14 of the textbook, forms the core of this part of the course.

Module 2 Differentiation and integration are extensively discussed in an earlier Calculus course, with a strong emphasis on computation. Here we take another look at these from a conceptual point of view. Chapter 6 of the textbook, excluding the last part on convex functions, forms the contents of differentiation and Sections 7.1–7.3 of Chapter 7, that of integration. The history of how calculus developed must also be discussed. (See en.wikipedia.org/wiki/History_of_calculus, for example.)

Module 3 Since students have already seen and studied integration as anti-differentiation in earlier courses, the differences between anti-differentiation and Riemann's theory of integration should be stressed. The historical evolution of the ideas leading to Riemann integral can be found in the web-page en.wikipedia.org/wiki/Integral#History. Section 7.3 of the textbook must be seen as establishing the links between anti-differntiation and Riemann integra-tion, Examples 7.3.2(e) and 7.3.7(a), (b) are significant in this context.

Text: Robert G Bartle: Introduction to Real Analysis, Third Ed., John Wiley & Sons

References

1. A. D. Alexandrov et al., Mathematics:Its Content, Methods and Meaning, Dover
2. R. Dedekind, Essays on The Theory of Numbers, available as a freely dowloadable e-book at http://www.gutenberg.org/etext/21016)
3. W. Rudin, Principles of Mathematical Analysis, Second Edition, McGraw-Hill
4. A. E. Taylor, General Theory of Functions and Integration, Dover

Distribution of instructional hours:

Module 1: 30 hours; Module 2: 30 hours; Module 3: 30 hours

Syllabus for the First Degree Programme in Mathematics
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Semester VI
Linear Algebra

Code: MM 1642 — Instructional hours per week: 4
No. of Credits: 3

Module 1 A review of algebra of matrices is followed by some applications of matrices to conic sections, systems of linear equations, equilibrium-seeking systems and difference equations.

Systems of linear equations: elementary matrices, the process of Gaussian elimina-tion, Hermite or row-reduced echelon matrices. Linear independence of columns, Row equivalent matrices, Rank of a matrix, Column rank, Normal form, Consistent systems of equations.

Module 2 Invertible matrix: Left and right inverse of a matrix, Orthogonal matrix, Vector spaces, Subspaces, Linear combintion of vectors, Spanning set, Linear indepen-dence, Basis.

Linear mappings: Linear transformations, Kernel and range, Rank and Nullity, Linear isomorphism.

Module 3 Matrix connection: Ordered basis, Matrix of f relative to a fixed ordered basis, Transition matrix from a basis to another, Nilpotent and index of nilpotency.

Determinants: Determinantal if multilinear, alternating and 1-preserving, Trans-position, Signum of a permutation, Laplace expansion along the i^{th} row, Adjoint.

Eigen values and eigen vectors: Characteristic equation, Algebraic multiplicities, Eigen space, Geometric multiplicities, Eigen vector, diagonalisation, Tridiagonal matrix.

Text: T S Blyth and E F Robertson: Linear Algebra, Springer, Second Ed.

References:

1. R Bronson and G B Costa: Linear Algebra, Academic Press, Seond Ed.
2. David C Lay: Linear Algebra, Pearson
3. K Hoffman and R Kunze: Linear Algebra, PHI

Distribution of instructional hours:

Module 1: 24 hours; Module 2: 24 hours; Module 3: 24 hours

Syllabus for the First Degree Programme in Mathematics
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Semester VI: Vector Analysis

Code: MM 1643 Instructional hours per week: 3
No. of credits: 3

Overview: The students are already aware of the concepts of a vector in three dimen-sional space and their dot, cross and triple products, as well as of derivatives of vector-valued functions, from the earlier semester. This course deals with advanced topics in vector calculus and covers Chapter 16 of the text. The authors claim that this chapter takes the student back to the roots of Calculus. The main theme is the concept of a flow and we analyse mathematically various types of flows.

Module 1 Vector fields, graphical representation, inverse square field, gradient fields, con-servative fields and potential functions, divergence and curl, the r operator, the Laplacian, r^2.

Line integrals, evaluation of line integrals, line integrals in 3-space, mass of a wire as a line integral, arc length as a line integral, line integral with respect x, y andz, line integral along piecewise smooth curves, change of parameter in a line integral, reversing the direction of integration, work as a line integral, work done by a vector field, work expressed in scalar form.

Module 2 Work integrals, independence of path, the fundamental theorem of work integrals, work integrals along closed paths, a test for conservative vector fields, conservative vector fields in 3-space, conservation of energy.

Green's theorem, finding work using Green's theorem, finding areas using Green's theorem, Green's theorem for multi-connected regions.

Surface integrals: definition, evaluation of surface integrals over $z = g(x, y)$, $y = g(x, z)$ and $x = g(y, z)$, mass of curved lamina as a surface integral, surface area as a surface integral.

Module 3 Application of surface integrals: flow fields, oriented surfaces, orientation of a smooth parametric surface, flux, evaluation of flux integrals, orientation of non-parametric surfaces.

Orientation of piecewise smooth closed surfaces, the Divergence theorem, using the Divergence theorem to find flux, divergence viewed as flux density, sources and sinks, Gauss' law for inverse square fields, Gauss' law in electrostatics.

Relative orientation of curves and surfaces, Stokes' theorem, using Stokes' theorem to calculate work, relationship between Green's theorem and Stokes' theorem, curl viewed as circulation.

Text: Howard Anton, et al: Calculus, Seventh Edition, John Wiley

References:

1. Thomas and Finney, Calculus and Analytic Geometry, Ninth Edition, Addison-Wesley.
2. Kreyzig, Advanced Engineering Mathematics, 8th edition, John Wiley.
3. Peter V. O' Neil, Advanced Engineering Mathematics, Thompson Publications, 2007
4. Michael D. Greenberg, Advanced Engineering Mathematics, Pearson Education, 2002.

Distribution of instructional hours:

Module 1: 18 hours; Module 2: 18 hours; Module 3: 18 hours

Syllabus for the First Degree Programme in Mathematics
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Semester VI
Graph Theory

Code: MM 1644 Instructional hours per week: 3
No. of credits: 3

Overview of the Course: The course has been designed to build an awareness of some of the fundamental concepts in Graph Theory and to develop better understanding of the subject so as to use these ideas skillfully in solving real world problems.

Module 1 A brief history of Graph Theory: The K¨onigsberg bridge problem, the history of the Four Colour Theorem for maps, Contributions to Graph Theory by Euler, Kirchoff, Cayley, Mobius, De Morgan, Hamilton, Erd¨os, Tutte, Harary, etc. (A maximum of three hours may be allotted to this sub-module. In addition to sections 1.2 and 1.6 of the text, materials for this part can be had from other sources including the internet.)

Graphs: Definition of graph, vertex, edge, incidence, adjacency, loops, parallel edges, simple graph. Representation of graphs, diagrammatic representation, ma-trix representation (adjacency* matrix and incidence matrix only). Finite and in-finite graphs, Definition of directed graphs, illustrative examples, Directed graphs, Applications of graphs. [sections 1.1, 1.2, 1.3, 1.4, 7.1, 9.1, 9.2]

Degree of a vertex, odd vertex, even vertex, relation between sum of degrees of vertices and the number of edges in a graph, and its consequence: number of odd vertices in a graph is even. Isolated vertex, pendant vertex, null graph, complete graphs [page 32], bipartite graphs [page 168], complete bipartite graph [page 192-prob 8.5], regular graph, complement* of a graph, graph isomorphisms, self complementary* graphs, illustrative examples. [sections 1.4, 1.5, 2.1]

Sub-graphs, edge disjoint sub-graphs, spanning sub-graphs*, induced subgraphs [sections 2.2]

The decanting problem and its graph model [no solution at this point]. The puzzle with multicolour cubes [problem 1.8 and section 2.3].

Module 2 Walks, open walks, closed walks, paths, circuits, end vertices of a path, path joinig two vertices, length of a path, connected and disconnected graphs. Components of a graph. [sections 2.4, 2.5]

Euler line, Euler graph, unicursal line, unicursal graph, characterisaion of Euler graph, Concept of Euler digraph [section 2.5, 9.5], Solution of the decanting prob-lem. The K¨onigsberg problem, the Chinese postman problem* and the Teleprinter's problem, their graph models and solutions. [problem 1.8 and sections 2.3, 1.2, 9.5]

Module 3 Trees- properties of trees, distance, eccentricity, center, radius, diameter, spanning tree, illustrative examples. [sections 3.1, 3.2, 3.3, 3.4, 3.7]

Planar graphs examples of planar and non-planar graphs, different representations of a planar graph. Regular polyhedra, Euler's polyhedral formula. [Theorem 5.6, without proof] . Illustrative examples, Kuratowski's graphs and their importance in the theory of planar graphs, forbidden sub-graph, characterisaion of planar graph [Kuratowski's theorem, Theorem 5.9, without proof], illustrative examples-both planar and non-planar. [sections 5.2, 5.3, 5.4, 5.5] Graph theoretic version of the Four Colour Theorem, without proof.

Text: Narsingh Deo: Graph Theory with applications for Engineering and Computer Science, Prentice Hall of India Pvt. Ltd., 2000.

References:

1. BalakrishnanR and Ranganatahan: A Text Book of Graph Theory, Springer
2. Body J A and Murthy U S R:Graph Theory with Applications, The Macmillan Press
3. Harary F: Graph Theory, Addison-Wesley
4. Vasudev C: Graph Theory with Applications
5. West D B: Introduction to Graph Theory, Prentice Hall of India Pvt. Ltd.

Note: Generally, the references are from NARSINGH DEO. Those marked with an asterisk are found elsewhere.

Distribution of instructional hours:

Module 1: 18 hours; Module 2: 18 hours; Module 3: 18 hours

Syllabus for the First Degree Programme in Mathematics
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Semester VI
Computer Programming-II (Practicals)

Code: MM1645

Instructional hours per week: 5
No.of credits: 4

Module 1 LaTeX Programming (30 hrs)

Basic, document, biblography, biblographic data base, table of contents, displayed text, row and columns, typesetting mathematics, typesetting theorems, several kinds of boxes, floats, cross references in LaTeX, footnotes, marginpars and end-notes.

Text: Indian TEXUsers Group, Trivandrum, India - LaTeXTutorials-
A Primer, Chapters 1 to 13 (free download www.sarovar.org)

Module 2 Python (30 hours)

Whetting your appetite, using the Python interpreter, An informal introduction to Python, More control flow tools, data structures, modules, input and output

Text: Guido van Rossum Fred L. Drake, Jr., editor Python Tutorial- Release 3.1.1 Sections 1 to 7

Module 3 Python (continued) (30 hours)

Errors and exceptions, classes, brief tour of the standard library, brief tour of the standard library Part II, interactive input editing and history substitution, floating point arithmetic: issues and limitations.

Text: Guido van Rossum Fred L. Drake, Jr., editor Python Tutorial- Release 3.1.1 Sections 8 to 14

About the examination

(a) This paper has only a practical examination of duration 3 hours. There shall be one external examiner and one internal examiner for the practical examination.

(b) The maximum number of students allowed per batch for the practical examination shall be 20.

(c) Out of a total of 100 marks, 75 marks shall be for the practical (external) examination and 25 for internal assessment (15 for theory and 10 for practical record.)

(d) Each student shall submit a lab record consisting of at least thirty programs based on modules 1, 2 and 3. (This may include problems from other course work).

(e) The internal assessment for theory shall be based on a written (internal) examination.

Syllabus for the First Degree Programme in Mathematics
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Semester VI
Fuzzy Mathematics (Elective)

Code: MM 1651 Instructional hours per week: 3
No. of credits: 2

Module 1 From crisp sets to fuzzy sets: a paradigm shift.

Introduction-crisp sets: an overview-fuzzy sets: basic types and basic concepts of fuzzy sets, Fuzzy sets versus crisp sets, Additional properties of cuts, Representa-tion of fuzzy sets.

Module 2 Operations on fuzzy sets and Fuzzy Arithmetic:

Operations on fuzzy sets-types of operations, fuzzy complements, fuzzy intersec-tions, t-norms, fuzzy unions, t-conorms, combinations of operations, aggregation operations.

Fuzzy numbers, Linguistic variables, Arithmetic operations on intervals, Arithmetic operations on fuzzy numbers, Lattice of fuzzy numbers, Fuzzy equations.

Module 3 Fuzzy relations and Fuzzy logic:

Crisp versus fuzzy relations, projections and cylindric extensions, Binary fuzzy re-lations, Binary relations on a single set, Fuzzy equivalence relations, Fuzzy com-patability relations, Fuzzy morphisms.

Classical logic: an overview-multi-valued logics-Fuzzy propositions, Fuzzy quanti-fiers, Lingistic hedges, Inference from conditional fuzzy propositions.

Text: George J Klir and Yuan: Fuzzy sets and fuzzy logic: Theory and applications, Prentice Hall of India Pvt. Ltd., New Delhi, 2000.

Chapter 1: Sections 1.1 to 1.4

Chapter 2: Sections 2.1 and 2.2

Chapter 3: Sections 3.1 to 3.6

Chapter 4: Sections 4.1 to 4.6

Chapter 5: Sections 5.1 to 5.8

Chapter 8: Sections 8.1 to 8.6

References:

1. Klir G J and T Folger: Fuzzy sets, Uncertainty and Information, PHI Pvt.Ltd., New Delhi, 1998

2. H J Zimmerman: Fuzzy Set Theory and its Applications, Allied Publishers, 1996.

3. Dubois D and Prade H: Fuzzy Sets and Systems: Theory and Applications, Ac.Press, NY, 1988.

Distribution of instructional hours:

Module 1: 18 hours; Module 2: 18 hours; Module 3: 18 hours

Syllabus for the First Degree Programme in Mathematics
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Semester VI
Mechanics (Elective)

Code: MM 1651 | Instructional hours per week: 3
No. of credits: 2

Part A: STATICS

Module 1 Introduction, composition and resolution of forces, parallelogram law of forces, triangle law of forces, Lami's theorem, polygon of forces, λ−μ theorem, resultant of a finite number of coplanar forces acting upon a particle, conditions of equilibrium, parallel forces, resultant of two parallel forces acting upon a rigid body, moments, moments of a force about a point and about an axis, generalized theorem of moments.

Module 2 Couples, equilibrium of a rigid body acted on by three coplanar forces, general conditions of equilibrium of a rigid body under coplanar forces, friction, laws of friction, limiting friction, coefficient of friction and simple problems.

Part B : DYNAMICS

Module 3 Velocity, relative velocity, acceleration, parallelogram laws of acceleration, motion under gravity, Newtons laws of motion and their applications to simple problems.

Impulse, work, energy, kinetic and potential energies of a body, principle of con-servation of energy.

Module 4 Projectiles, Range on an inclined plane, Collision of elastic bodies, Newton's ex-perimental law, Impact of sphere on a plane, Direct and oblique impact of two spheres, Loss of kinetic energy by impact, Simple harmonic motion, Examples of simple harmonic motion, Simple pendulum.

Text: by S.L. Loney, The Elements of Statics and Dynamics, Part-I and Part-II, AITBS Pub-lications and distributions (Regd), Delhi

Distribution of instructional hours:

Module 1: 15 hours; Module 2: 12 hours; Module 3: 15 hours, Module 4: 12 hours