UNIVERSITY OF KERALA

Syllabus for the First Degree Programme in B.Sc. Mathematics and Computer Applications

(Double Main)

SEMESTER-I

Course Code	Course Title	Instr. hrs. per week			Credits
		Lecture/ Tutorial	Lab	Total	
	English-I	5	-	5	3
	Additional Language- I	5	-	5	3
MMC 1121	Environmental Studies (Foundation Course-I)	2	-	2	2
MMC 1131	Foundation of Mathematics	3	-	3	3
MMC 1132	Theory of Numbers	3	-	3	3
MMC 1141	Introduction to Computer Science	5	2 (LaTex)	7	4
Total		25			18

SEMESTER-II

Course Code	Course Title	Instr. hrs. per week			Credits
		Lecture/ Tutorial	Lab	Total	
	English-I	5	-	5	3
	Additional Language- I	5	-	5	3
MMC 1221	Informatics (Foundation Course-II)	3	-	3	3
MMC1231	Differential Equations	3	-	3	3
MMC 1232	Vector Calculus	3	-	3	3
MMC 1241	Python Programming	4	-	4	3
MMC 1241.1	Python Programming Lab	-	2	2	2
Total		25			20

SEMESTER-III

Course Code	Course Title	Instr. hrs. per week			Credits
		Lecture/ Tutorial	Lab	Total	
	English-III	5	-	5	3
MMC1331	Multi Variable Calculus and Vector Calculus	5	-	5	4
MMC 1332	Abstract Algebra – Group Theory	5	-	5	4
MMC 1341	Computer Graphics	3	2(Sage Maths)	5	5
MMC 1342	Operating System	5	-	5	4
Total		25			20

SEMESTER-IV

Course Code	Course Title	Instr. hrs. per week			Credits
		Lecture/ Tutorial	Lab	Total	
	English-IV	5	-	5	3
MMC 1431	Abstract Algebra – Ring Theory	5	-	5	3
MMC 1432	Linear Algebra	5	-	5	3
MMC 1441	Algorithms & Data Structures	4	-	4	4
MMC 1442	Web Programming	2	2	4	4
MMC 1441.1	Data Structures Lab	-	2	2	2
Total		25			19

SEMESTER-V

Course Code	Course Title	Instr. hrs. per week			Credits
		Lecture/ Tutorial	Lab	Total	
MMC 1531	Real Analysis – I	5	-	5	4
MMC 1532	Complex Analysis –I	5	-	5	4
MMC 1533	Project and Viva-I (Mathematics)	2	-	2	4
MMC 1551	Open Course	3	-	3	2
MMC 1541	Software Engineering	4	-	4	4
MMC 1542	DBMS	4	2	6	5
Total		25			23

SEMESTER-VI

Course Code	Course Title	Instr. hrs. per week			Credits
		Lecture/ Tutorial	Lab	Total	
MMC 1631	Real Analysis – II	5	-	5	4
MMC 1632	Complex Analysis-II	4	-	4	3
MMC 1633	Elective Course(Mathematics)	4	-	4	3
MMC 1641	Data Communication and Computer Networks	5	-	4	3
MMC 1642	Data Mining Techniques	3		3	3
MMC 1643	Project and Viva-II (Computer Applications)	-	5	5	4
Total		25			20

STRUCTURE OF CORE COURSES

Semester	Course Code	Course Title	Instr. Hrs per week			Credits
			Lecture	Lab	Total	
I	**MMC 1131**	Foundations of Mathematics	**3**		**3**	**3**
	MMC 1132	Theory of Numbers	**3**		**3**	**3**
	MMC 1121	Environmental Studies (Foundation Course-I)	**2**		**2**	**2**
	MMC 1141	Introduction to Computer Science	**5**	**2(LaTex)**	**7**	**4**
II	**MMC 1231**	Differential Equations	**3**		**3**	**3**
	MMC 1232	Vector Calculus	**3**		**3**	**3**
	MMC 1221	Informatics (Foundation Course -II)	**3**		**3**	**3**
	MMC 1241	Python Programming	**4**		**4**	**3**
	MMC1241.1	Python Programming (Lab)		**2**	**2**	**2**
III	**MMC 1331**	Multi Variable Calculus and Vector Calculus	**5**		**5**	**4**
	MMC 1332	Abstract Algebra – Group Theory	**5**		**5**	**4**
	MMC 1341	Computer Graphics	**3**	**2(Sage Maths)**	**5**	**5**
	MMC 1342	Operating System	**5**		**5**	**4**
IV	**MMC 1431**	Abstract Algebra – Ring Theory	**5**		**5**	**3**
	MMC 1432	Linear Algebra	**5**		**5**	**3**
	MMC 1441	Algorithms & Data Structure	**4**		**4**	**4**
	MMC 1442	Web Programming	**2**	**2**	**4**	**4**
	MMC 1441.1	Data Structures Lab		**2**	**2**	**2**
V	**MMC 1531**	Real Analysis – I	**5**		**5**	**4**
	MMC 1532	Complex Analysis – I	**5**		**5**	**4**
	MMC 1533	Project and Viva-I (Mathematics)	**2**	**-**	**2**	**4**
	MMC 1551	Open Course	**3**		**3**	**2**
	MMC 1541	Software Engineering	**4**		**4**	**4**
	MMC 1542	DBMS	**4**	**2**	**6**	**5**
VI	**MMC 1631**	Real Analysis – II	**5**		**5**	**4**
	MMC 1632	Complex Analysis – II	**4**		**4**	**3**
	MMC 1633	Elective Course- (Mathematics)	**4**		**4**	**3**
	MMC 1641	Data Communication and Computer Networks	**5**		**4**	**3**
	MMC 1642	Data Mining Techniques	**3**		**3**	**3**
	MMC 1643	Project and Viva-II (Computer Applications)	**-**	**5**	**5**	**4**

STRUCTURE of OPEN COURSES

Sem	Course Code	Course title	Instr. hrs. Per week	Credit
V	MMC 1551.1	DIGITAL MARKETING	3	2
V	MMC 1551.2	INTERNET AND WWW	3	2
V	MMC 1551.3	CYBER SECURITY	3	2

STRUCTURE of ELECTIVE COURSES

Sem	Course Code	Course title	Instr. hrs Per week	Credit
VI	**MMC 1633.1**	Graph Theory	**4**	**3**
VI	**MMC 1633.2**	Linear Programming with SageMath	**4**	**3**
VI	**MMC 1633.3**	Numerical Analysis with SageMath	**4**	**3**
VI	**MMC 1633.4**	Fuzzy Mathematics	**4**	**3**
VI	**MMC 1633.5**	Integral Transforms	**4**	**3**

Division of marks (Lab examination)

1. First program should be sufficiently simple –**25 marks**
   (Logic – 10 marks, Successful compilation – 10 marks, Result– 5 marks)
2. Second program should be based on advanced concepts **- 30 marks**
   (Logic – 15 marks, Successful compilation – 10 marks, result – 5 marks)
3. Viva Voce **- 15 marks**
4. Lab Record **- 10 marks**

Total Marks - 80 marks

MMC-1643 Project_Evaluation criteria(Computer Applications)

a. System analysis and design	20 marks
b. Output	20 marks
c. Candidate role and contribution in the project	20 marks
d. Demo& Presentation	20 marks
e. Viva	20 marks
Total	**100 marks**

SEMESTER-I
FOUNDATIONS OF MATHEMATICS

Code: MMC1131 **Instructional hours per week: 3**
No. of credits: 3

Course Outcomes: At the end of the Course, the Student will be able to

- **CO-1. Understand the derivative of a function.**
- **CO-2. Learn certain theorems on differentiation.**
- **CO-3. Learn various applications also the physical interpretations of differentiation (derivative of a function).**
- **CO-4. Understand the integration of a function and learn its physical interpretation through various examples.**
- **CO-5. Learn various applications of integration.**

Module I - Methods of Differential Calculus (18Hours)

Differentiating equations to relate rates, how derivatives can be used to approximate non-linear functions by linear functions, error in local linear approximation, differentials; Increasing and decreasing functions and their analysis, concavity of functions, points of inflections of a function and applications, finding relative maxima and minima of functions and graphing them, critical points, first and second derivative tests, multiplicity of roots and its geometrical interpretation, rational functions and their asymptotes, tangents and cusps on graphs; Motion along a line, velocity and speed, acceleration, Position - time curve, Rolle's, Mean Value theorems and their consequences; Indeterminate forms and L'Hôpital's rule;

The topics to be discussed in this module can be found in chapter 2, 3 and 6 of text [1] below.

Module II - Methods of Integral Calculus (36 Hours)

Finding position, velocity, displacement, distance travelled of a particle by integration, analysing the distance-velocity curve, position and velocity when the acceleration is constant, analysing the free-fall motion of an object, finding average value of a function and its applications; Area, volume, length related concepts: Finding area between two curves, finding volumes of some three dimensional solids by various methods like slicing, disks and washers, cylindrical shells, finding length of a plane curve, surface of revolution and its area; Work done : Work done by a constant force and a variable force, relationship between work and energy; Relation between density and mass of objects, center of gravity, Pappus theorem and related problems Fluids, their density and pressure, fluid force on a vertical surface. Introduction to Hyperbolic functions and their applications in hanging cables; Improper integrals, their evaluation, applications such as finding arc length and area of surface.

The topics to be discussed in this module can be found in chapter 4, 5, 6 and 7 of text[1] below.

Texts

Text-1 – H Anton, I Bivens, S Davis. Calculus, 10th Edition, John Wiley& Sons, 2012.

References

Ref. 1 – G B Thomas, R L Finney. Calculus, 9th Edition, Addison-Weseley Publishing Company

Ref. 2 – J Stewart. Calculus with Early Transcendental Functions, 7th Edition, Cengage India Private Limited

THEORY OF NUMBERS

Code: MMC 1132 **Instructional hours per week: 3**
No. of credits: 3

Course Outcomes: At the end of the Course, the Student will be able to

CO-1. Become familiar with various kinds of numbers.
CO-2. Understand the role of numbers in other branches of Mathematics, in particular Combinatorics, Set Theory and Algebra.
CO-3. Analyze different characters of number theoretic functions.
CO-4. Use number theoretical properties to solve real world problems.
CO-5. Applications of number theoretical concepts in various field and in particular Cryptography.

Module I - Divisibility in integers (24 Hours)

The topic of elementary number theory is introduced for further developing the ideas in abstract algebra. The following are the main topics in this module : The division algorithm, Pigeonhole principle, divisibility relations, inclusion-exclusion principle, base-b representations of natural numbers, prime and composite numbers, infinitude of primes, GCD, linear combination of integers, pairwise relatively prime integers, the Euclidean algorithm for finding GCD, the fundamental theorem of arithmetic, canonical decomposition of an integer into prime factors, LCM; Linear Diophantine Equations and existence of solutions, Euler's Method for solving LDE's The topics to be discussed in this module can be found in chapter 2 (except the topics the Egyptian method of multiplication, the Russian Peasant Algorithm & Egyptian method of division in Section 2.2, Section 2.3 and 2.4, A Number - Theoretic Function onwards in Section 2.5, Section 2.6 and 2.7) and chapter 3(except the topic A jigsaw puzzle onwards in Section 3.2, Factor Tree onwards in Section 3.3, The Monkey and Coconuts Puzzle on wards in Section 3.5) of text [1] below.

Module II - Congruence relations in integers (30 Hours)

Towards defining the congruence classes in Z, we begin with defining the congruence relation. Its various properties should be discussed, and then the result that no prime of the form 4n + 3 is a sum of two squares should be discussed. The other topics in this module are the following: Defining congruence classes, complete set of residues, modulus exponentiation, finding reminder of big numbers using modular arithmetic, cancellation laws in modular arithmetic, linear congruences and existence of solutions, solving Mahavira's puzzle, modular inverses, Pollard Rho factoring method; Certain tests for divisibility - The numbers here to test are powers of 2, 3, 5, 7, 9, 10, 11, testing whether a given number is a square;

Linear system of congruence equations, Chinese Remainder Theorem and some applications; Some classical results like Wilson's theorem, Fermat's little theorem, Pollard $p - 1$ factoring method, Eulers' theorem, The topics to be discussed in this module can be found in chapter 2 and 3 of text [1] below.

Texts

Text-1– **Thomas Koshy. Elementary Number Theory with Applications, 2nd Edition, Academic Press, 2007.**

References

Ref. – G .A. Jones, J .M. Jones. Elementary Number Theory, Springer, 2005.

ENVIRONMENTAL STUDIES
(Foundation Course-I)

Code: MMC 1121 **Instructional hours per week: 2**
No. of credits: 2

COURSE OUTCOMES: at the end of the Course, the Student will be able to -

CO1	Remember environmental policies
CO2	Understand different eco systems, environmental movements
CO3	Understand types of natural resources
CO4	Remember the causes and impacts of mining
CO5	Understand bio diversity and conservation
CO6	Understand environment pollution

COURSE CONTENT

Module 1: Introduction to environmental studies: Multidisciplinary nature of environmental studies; components of environment – atmosphere, hydrosphere, lithosphere and biosphere. Scope and importance; Concept of sustainability and sustainable development. **Ecosystems:** What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chain, food web and ecological succession.

Module 2: Natural Resources: Renewable and Non-renewable Resources: Land Resources and land use change; Land degradation, soil erosion and desertification. Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations. Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water, Heating of earth and circulation of air; air mass formation and precipitation, Energy resources: Renewable and non-renewable energy sources, use of alternate**,** energy sources, growing energy needs

Module 3: Biodiversity and Conservation: Levels of biological diversity: genetic, species and ecosystem diversity; Biogeography zones of India; Biodiversity patterns and global biodiversity hotspots**,** India as a mega-biodiversity nation; Endangered and endemic species of India**,** Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value. **Environmental Pollution:** Environmental pollution: types, causes, effects and controls; Air, water, soil, chemical and noise pollution, Nuclear hazards and human health risks, Solid waste management: Control measures of urban and industrial waste, Pollution case studies.

Module 4: Environmental Policies & Practices: Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture. Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act; International agreements; Montreal and Kyoto protocols and conservation on Biological Diversity (CBD). The Chemical Weapons Convention (CWC). Nature reserves, tribal population and rights, and human, wildlife conflicts in Indian context **Human Communities and the Environment**: Human population and growth: Impacts on environment, human health and welfares, Carbon foot-print, Resettlement and rehabilitation of project affected persons; case studies, Disaster management: floods, earthquakes, cyclones and landslides, Environmental movements: Chipko, Silent valley, Bishnios of Rajasthan, Environmental ethics: Role of Indian and other religions and cultures in environmental conservation, Environmental communication and public awareness, case studies

REFERENCES

- Carson, R. *2002. Silent Spring.* Houghton Mifflin Harcourt.
- Gadgil, M., & Guha, R.1993. This *Fissured Land:* An Ecological History of India. Univ. of California Press.
- Gleeson,B. and Low, N. (eds.) 1999. Global Ethics and Environment, London, Routledge.
- Gleick, P.H. 1993. Water in *Crisis*. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
- Groom, Martha J. Gary K. Meffe, and Carl Ronald carroll. *Principles of Conservation Biology.* Sunderland: Sinauer Associates, 2006.
- Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. Science, 339: 36-37.
- McCully, P.1996. *Rivers no more: the environmental effects of dams* (pp. 29-64). Zed Books.
- McNeil, John R. 2000. Something New Under the Sun: An Environmental History of the Twentieth Century.

Assignment/Field work

- Visit to an area to document environmental assets; river/forest/flora/fauna, etc.
- Visit to a local polluted site – Urban/Rural/Industrial/Agricultural.
- Study of common plants, insects, birds and basic principles of identification.
- Study of simple ecosystems-pond, river, Delhi Ridge, etc.

INTRODUCTION TO COMPUTER SCIENCE

Code: MMC 1141 **Instructional hours per week: 7 (5+2)**
No. of credits: 4

COURSE OUTCOMES: at the end of the Course, the Student will be able to -

CO1	Remember computer and software types
CO2	Understand system unit
CO3	Understand operating system and application software
CO4	Understand online communication and web basics
CO5	Remember network and internet basics
CO6	Create documents in LaTex

COURSE CONTENT

Module 1: Computer Basics: Understanding Information Systems, Identifying Computer Types, Understanding Software Types, Computer System Components, How Computers Communicate? **The System Unit:** Understanding CPUs, Understanding Memory, Understanding Motherboards, Understanding Power Supplies

Module 2: Introduction to Windows: Starting Up and Shutting Down, Running Applications, Managing Files, **Understanding Application Software:** Business Productivity Software, Graphics Software, Other Types of Software, Managing Your Applications

Module 3: Networking and Internet Basics: Public Telephone and Data Networks, Ways of Classifying Networks, Network Hardware, Understanding and Connecting to the Internet **Online Communication:** Internet Communication Types **Web Basics:** How the Web Works, Accessing the Web with a Browse, Using Web Search Tools

Module 4: LaTex: Word, sentence, paragraph, Commanding Latex, Comments and footnotes, Changing font characteristics, Line, Paragraph and pages, spaces, boxes, Inline formulas: Spacing rules, basic constructs, delimiters, operators, math accents, spacing of symbols, building new symbols, Displayed formulas: Columns, some general rules, aligned columns. Documents: main matter, back matter

TEXTBOOK

1. Faithe Wempen, Computing Fundamentals, Digital Literacy Edition, Wiley, 2014
2. George Gratzer, Practical LaTex, Springer, 2014

REFERENCES

1. E. Balaguruswamy, Fundamentals of Computers, McGraw hill, 2014 4.2
2. Dennis P Curtain, Information Technology: The Breaking wave, McGrawhill, 2014
3. Peter Norton, Introduction to Computers, McGrawhill, Seventh edition

LaTeX_Lab (No End Semester Lab Examination) [36 Hours]

LATEX for preparing a project report in Mathematics

Graphical User Interface (GUI)/ Editor like Kile or TeX studio should be used for providing training to the students.
The main topics in this module are following:

Typesetting a simple article and compiling it;

How spaces are treated in the document;

Document layout: various options to be included in the document class command, page styles, splitting files into smaller files, breaking line and page, using boxes (like, mbox) to keep text unbroken across lines, dividing document in to parts like frontmatter, mainmatter, backmatter, chapters, sections, etc, cross referencing with and without page number, adding footnotes;
Emphasizing words with \emph, \texttt, \textsl, \textit, \underline etc.

Basic environments like enumerate, itemize, description, flushleft, flusuright, center, quote, quotation Controlling enumeration via the enumerate package.

Tables: preparing a table and floating it, the longtable environment;

Typesetting mathematics : basic symbols, equations, operators, the equation environment and reference to it, the displaymath environment, exponents, arrows, basic functions, limits, fractions, spacing in the mathematics environments, matrices, aligning various objects, multi-equation environments, suppressing numbering for one or more equations, handling long equations, phantoms, using normal text in math mode, controlling font size, typesetting theorems, definitions, lemmas, etc, making text bold in math mode, inserting symbols and environments (array, pmatrixetc) using the support of GUIs;

Figures: Including JPG, PNG graphics with graphicx package, controlling width, height etc, floating figures, adding captions, the wrapfig package;

Adding references/bibliography and citing them, using the package hyperref to add and control hypertext links, creating presentations with pdf screen, creating new commands; Fonts : changing font size, various fonts, math fonts, Spacing : changing line spacing, controlling horizontal, vertical spacing, controlling the margins using the geometry package, full page package

Preparing a dummy project with title page, acknowledgement, certificates, table of contents (using \table of contents), list of tables, table of figures, chapters, sections, bibliography (using the bibliography environment).

This dummy project should contain at least one example from the each of the topic in the syllabus, and should be submitted for internal evaluation for 5 mark (assignment) before the end semester practical examination.

SEMESTER-II
DIFFERENTIAL EQUATIONS

CODE: MMC 1231 **Instructional hours per week: 3**
No. of credits: 3

Course Outcomes: At the end of the Course, the Student will be able to-

CO-1. Learn various methods to solve first order linear differential equations.
CO-2. Learn the existence and uniqueness theorem of first order ordinary differential equation.
CO-3. Learn various methods to solve certain nonhomogeneous second order ordinary differential equations with constant coefficients.
CO-4. Learn the applications of ordinary differential equations.

In this course, we discuss how differential equations arise in various physical problems and consider some methods to solve first order differential equations and second order linear equations. For introducing the concepts, text[1] may be used, and for strengthening the theoretical aspects, reference [1] may be used.

Module I - First order ODE (24 hours)

In this module we discuss first order equations and various methods to solve them. Sufficient number of exercises also should be done for understanding the concepts thoroughly. The main topics in this module are the following:
Modelling a problem, basic concept of a differential equation, its solution, initial value problems, geometric meaning (direction fields), separable ODE, reduction to separable form, exact ODEs and integrating factors, reducing to exact form, homogeneous and non-homogeneous linear ODEs, special equations like Bernoulli equation, orthogonal trajectories, understanding the existence and uniqueness of solutions theorem.
The topics to be discussed in this module can be found in chapter 1 of text [1] *below.*

Module II- Second order ODE (30 hours)

As in the first module, we discuss second order equations and various methods to solve them. Sufficient number of exercises also should be done for understanding the concepts thoroughly. The main topics in this module are the following:
homogeneous linear ODE of second order, initial value problem, basis, and general solutions, finding a basis when one solution is known, homogeneous linear ODE with constant coefficients (various cases that arise depending on the characteristic equation), differential operators, Euler-Cauchy Equations, existence and uniqueness of solutions w.r.t wronskian, solving nonhomogeneous ODE via the method of undetermined coefficients, various applications of techniques, solution by variation of parameters.
The topics to be discussed in this module can be found in chapter 2 of text [1] *below.*

Texts

Text-1– Erwin Kreyszig. *Advanced Engineering Mathematics*, 10th Edition, Wiley-India, 2011.

References

Ref.1–G.F. Simmons. *Differential Equations with applications and Historical notes*, Tata McGraw-Hill, 2003
Ref. 2 – H Anton, I Bivens, S Davis. *Calculus*, 10th Edition, John Wiley & Sons, 2012.
Ref. 3 – Peter V.O Neil. *Advanced Engineering Mathematics*, Thompson Publications, 2007.

VECTOR CALCULUS

Code: MMC 1232 **Instructional hours per week: 3**
No. of credits: 3

Course Outcomes: At the end of the Course, the Student will be able to

- **CO-1. Understand vectors and algebraic operations of vectors.**
- **CO-2. Learn to compute the vector equation of a line.**
- **CO-3. Understand the cylindrical and spherical coordinate systems.**
- **CO-4. Learn calculus of vector valued functions.**
- **CO-5. Understand the geometrical interpretation of Curvature and motion of a particle along a Curve through Calculus of Vectors.**

Module I – Introduction to vector calculus (24 Hours)

To begin with, the three dimensional rectangular co-ordinate system should be discussed and how distance is to be calculated between points in this system. Basic operations on vectors like their addition, cross and dot products should be introduced next. The concept of projections of vectors and the relation with dot product should be given emphasize. Equations of lines determined by a point and vector, vector equations in lines, equations of planes using vectors normal to be should be discussed. Quadric surfaces which are three dimensional analogues of conics should be discussed next. Various co-ordinate systems like cylindrical, spherical should be discussed next with the methods for conversion between various co-ordinate systems. The topics to be discussed in this module can be found in chapter 11 of text [1] below.

Module II - Vector valued functions (30 Hours)

Towards going to the calculus of vector valued functions, we define such functions. The other topics in this module are the following: Parametric curves in the three dimensional space, limits, continuity and derivatives of vector valued functions, geometric interpretation of the derivative, basic rules of differentiation of such functions, derivatives of vector products, integrating vector functions, length of an arc of a parametric curve, change of parameter, arc length parametrizations,

various types of vectors that can be associated to a curve such as unit vectors, tangent vectors, binormal vectors, definition and various formulae for curvature, the geometrical interpretation of curvature, motion of a particle along a curve and geometrical interpretation of various vectors associated to it, various laws in astronomy like Kepler's laws and problems. The topics to be discussed in this module can be found in chapter 12 of text [1] below.

Texts

Text -1– H Anton, I Bivens, S Davis. Calculus, 10th Edition, John Wiley & Sons, 2012.

References

Ref.1– GB Thomas, RL Finney. Calculus, 9th Edition, Addison-Weseley Publishing Company

Ref. 2 – J Stewart. Calculus with Early Transcendental Functions, 7th Edition, Cengage India Private Limited

INFORMATICS
(Foundation Course-II)

Code: MMC 1221 **Instructional hours per week: 3**
No. of credits: 3

CO 1: To introduce various online resources which will help students improve their teaching-learning experience.
CO 2: The students will also be able to utilize these web resources to enhance their career and academics.
CO 3: To provide awareness on cyber-crimes and cyber laws.

MODULE I: Introduction (10 Hours)
Informatics: Meaning and Scope, Information Networks- INFLIBNET, NICNET. E-Books, Audio Books, Blogs, Podcasts, Massive Open Online Courses (MOOCs); Statistical Software for social science Research (Features of SPSS, E-Views, Gretl and R software)

MODULE: II: Data analysis (10 Hours)
Spread sheet basics. Excel environment. Entering data. Excel tool bars. Analysis of data using Spread sheets - Creation and manipulation of charts and graphs. Manipulation of data. Importing and exporting data from excel. Mathematical and statistical calculations. Excel functions. Applications in economics using simple examples.

MODULE: III: The internet and E-Commerce. **(16Hours)**
Meaning and scope of the internet, Search techniques, search engines – browsers. Online shopping and e-business / e-commerce (concepts) - Challenges with internet security – malware, phishing Computer virus, Antivirus software and privacy.

MODULE: IV: Social informatics (18 Hours)
Digital Divide Methods to counter Digital Divide. Cyber crimes - Plagiarism, Software piracy, Cyber ethics, Cyber Laws. Computer – Ergonomics and health issues. Guidelines for proper usage of computers.

Reference

- Peter Norton, Introduction to Computers, McGraw Hill New Delhi.
- PK Sinha, Computer Fundamentals, BPB Publications
- Reema Thareja, Fundamentals of Computers. Oxford.
- Ramez Elmasri and Shamkant B Navathe, Fundamentals of data base Systems, Pearson
- V Rajaraman, Fundamentals of Computers, PHI publications
- Online resources (Tutorials on Excel)
- https://www.coursera.org/
- https://www.edx.org/
- https://www.swayam.gov.in
- http://www.learnerstv.com/
- http://www.inflibnet.ac.in
- http://www.bbc.co.uk/podcasts

PYTHON PROGRAMMING

Code: MMC 1241 **Instructional hours per week: 4**

No. of credits: 3

COURSE OUTCOMES: at the end of the Course, the Student will be able to -

CO1	Remember data types and operators
CO2	Understand decision making statements
CO3	Apply exceptions
CO4	Analyse different sorting methods
CO5	Understand GUI programming concepts
CO6	Create functions and modules

COURSE CONTENT

Module 1:Introduction to Python - Features of Python - Identifiers - Reserved Keywords - Variables Comments in Python – Input , Output and Import Functions - Operators – Data Types and Operations – int, float, complex, Strings, List, Tuple, Set, Dictionary - Mutable and Immutable Objects – Data Type Conversion - Illustrative programs: selection sort, insertion sort, bubble sort

Module 2: Decision Making -conditional (if), alternative (if-else), if-elseif.-else, nested if - Loops for, range() while, break, continue, pass; Functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum of an array of numbers, linear search, binary search, bubble sort, insertion sort, selection sort

Module 3: Built-in Modules - Creating Modules - Import statement - Locating modules - Namespaces and Scope - The dir() function - The reload function - Packages in Python Files and exception: text files, reading and writing files Renaming and Deleting files Exception handling, Exception with arguments, Raising an Exception - User defined Exceptions - Assertions in

Module 4: GUI Programming- Introduction – Tkinter Widgets – Label – Message Widget – Entry Widget – Text Widget – tk Message Box – Button Widget – Radio Button- Check Button – List box Frames _ Top-level Widgets – Menu Widget

TEXT BOOK

1. Jeeva Jose, Taming Python by Programming, Khanna Publishers, New Delhi, 2016.

REFERENCES

1. Kenneth A. Lambert, Fundamentals of Python: First Programs, CENGAGE Learning, 2012.

2. Paul Gries, Jennifer Campbell and Jason Montojo, Practical Programming: An Introduction to Computer Science using Python 3, Second edition, Pragmatic Programmers,LLC,2013.

3. Timothy A. Budd, Exploring Python, Mc-Graw Hill Education (India) Private Ltd.

PYTHON PROGRAMMING LAB

Code: MMC 1241.1 **Instructional hours per week: 2**

No. of credits: 2

SAMPLE LAB EXERCISES

The laboratory work will consist of 10- 15 Experiments

Part A: To write, test, and debug simple Python programs.

- To implement Python programs with conditionals and loops.
- Use functions for structuring Python programs.
- Represent compound data using Python lists, tuples, dictionaries.

Part B: Read and write data from/to files in Python.

- Programs to demonstrate creating and handling of modules and packages
- Programs involving a variety of Exception Handling situations
- GUI programming

SEMESTER- III
MULTI VARIABLE CALCULUS AND VECTOR CALCULUS

Code: MMC 1331 **Instructional hours per week: 5**
No. of credits: 4

Course Outcomes: At the end of the Course, the Student will be able to-

CO-1. Learn about functions of more than one variable.
CO-2. Understand the limit, continuity and differentiability of functions with more than one variable.
CO-3. Understand various applications of multivariable calculus.
CO-4. Learn the integration of vector valued function.
CO-5. Learn various applications of integration of vector valued functions.

Module I- Multivariable Calculus (45 Hours)

After introducing the concept of functions of more than one variable, the sketching of them in three dimensional cases with the help of level curves should be discussed. Contours and level surface plotting also should be discussed. The other topics in this module are the following: Limits and continuity of Multivariable functions, various results related to finding the limits and establishing continuity, continuity at boundary points, partial derivatives of functions, partial derivative as a function, its geometrical interpretation, implicit partial differentiation, changing the order of partial differentiation and the equality conditions; Differentiability of a multivariate function, differentiability of such a function implies its continuity, local linear approximations, chain rules - various versions, directional derivative and differentiability, gradient and its properties, applications of gradients; Tangent planes and normal vectors to level surfaces, finding tangent lines to intersections of surfaces, extrema of multivariate functions, techniques to find them, critical and saddle points, Lagrange multipliers to solve extremum problems with constrains, The topics to be discussed in this module can be found in chapter 13 of text [1]below.

Module II - Vector Calculus (45 Hours)

After the differentiation of vector valued functions in the last semester, here we introduce the concept of integrating vector valued functions. Some important theorems are also to be discussed here. The main topics are the following: Vector fields and their graphical representation, various type of vector fields (inverse- square, gradient, conservative), potential functions, divergence, curl, the 5 operator, Laplacian; Integrating a function along a curve (line integrals), integrating a vector field along a curve, defining work done as a line integral, line integrals along piece wise-smooth curves, integration of vector fields and independence of path, fundamental theorem of line integrals, line integrals along closed paths, test for conservative vector fields, Green's theorem and applications; Defining and evaluating surface integrals, their applications, orientation of surfaces, evaluating flux integrals, The divergence theorem, Gauss' Law, Stoke's theorem, applications of these theorems. The topics to be discussed in this module can be found in chapter 15 of text [1] below.

Texts

Text -1 – H Anton, I Bivens, S Davis. Calculus, 10th Edition, John Wiley & Sons, 2012.

References

Ref. 1 – G.B Thomas, R L Finney. Calculus, 9th Edition, Addison-Weseley Publishing Company

Ref. 2 – J Stewart. Calculus with Early Transcendental Functions, 7th Edition, Cengage India Private Limited.

ABSTRACT ALGEBRA – GROUP THEORY

CODE: MMC 1332 **Instructional hours per week: 5**

No .of credits: 4

Course Outcomes: At the end of the Course, the Student will be able to-

- **CO-1. Understand the definition of group and its various properties through examples.**
- **CO-2. Understand subgroups, cyclic groups and various properties of the same.**
- **CO-3. One will be able to understand permutation groups.**
- **CO-4. Learn the well-known Cayley's and Lagrange's theorem.**
- **CO-5. Learn certain applications of group theory.**

The aim of this course is to provide a very strong foundation in the theory of groups. The concepts in the course are to be supported by examples mainly from the references.

Module I (30 Hours)

The concept of group is to be introduced before rigorously defining it. The symmetries of a square can be a starting point for this. After that, definition of group should be stated and should be clarified with the help of examples. After discussing various properties of groups, finite groups and their examples should be discussed. The concept of subgroups with various characterizations also should be discussed. After introducing the definition of cyclic groups, various examples, and important features of cyclic groups and results on order of elements in such groups should be discussed.

The topics to be discussed in this module can be found in chapter 1, 2 3 and 4 of text [1] *below.*

Module II (24 Hours)

This module starts with defining and analyzing various properties permutation groups which forms one of the most important class of examples for non-abelian, finite groups. After defining operations on permutations, their properties are to be discussed. To motivate the students, the example of check-digit scheme should be discussed (This section on check-digit scheme is not meant for the examinations).Then we proceed to define the notion of equivalence of groups viz. isomorphisms. Several examples are to be discussed for explaining this notion. The properties of isomorphisms are also to be discussed together with special classes of isomorphisms like automorphisms and inner automorphisms before finishing the module with the classic result of Cayley on finite groups.

The topics to be discussed in this module can be found in chapter 5 and 6 of text [1] *below.*

Module III (18 Hours)

In this module we prove one of the most important results in group theory which is the Langrange's theorem on counting cosets of a finite group. The concept of cosets of a groupshouldbedefinedgivingmanyexamplesbeforeprovingtheLagrange'stheorem. As some of the applications of this theorem, the connection between permutation groups and rotations of cube and soccer ball should be discussed. The section on Rubik's cube and section on internal direct products need not be discussed.

The topics to be discussed in this module can be found in chapter 7 and 9 of text [1] *below.*

Module IV (18 hours)

Here the concept of group homomorphisms should be defined with sufficient number of examples. After proving the first isomorphism theorem, the fundamental theorem of isomorphism should be introduced **without proof**. Classifying groups based on the fundamental theorem should be discussed in detail.

The topics to be discussed in this module can be found in chapter 10 and 11 of text [1] *below.*

Texts

Text-1– Joseph Gallian, *Contemporary Abstract Algebra,* 8th Edn, Cengage Learning, 2013.

References

Ref. 1 – D .S. Dummit, R M Foote. *Abstract Algebra,* 3rd Edition, Wiley.

Ref. 2 – I. N. Herstein. *Topics in Algebra,* Vikas Publications

COMPUTER GRAPHICS

CODE: MMC 1341 **Instructional hours per week: 5 (3+2)**
No. of credits: 5

COURSE OUTCOMES: at the end of the Course, the Student will be able to -

CO1	Remember graphics primitives
CO2	Understand different transformations
CO3	Apply clipping algorithm to different models
CO4	Analyse different line drawing algorithms
CO5	Understand color illumination models
CO6	Understand types of projections

COURSE CONTENT

Module 1: Introduction: graphic data representation, concept of pixels, resolution, aspect ratio, Raster scan display, Random Scan display, video adapter, frame buffer, display technology-CRT, LCD, LED, smart devices (feature wise comparison only), Output Primitives: Straight Line, DDA algorithm, Bresenham's Line Algorithm, Circle- Mid Point Circle Algorithm, polygon filling algorithms- boundary fill, scan-line algorithm, Aliasing and Anti-aliasing.

Module 2: Two dimensional Transformations: Translation, scaling, fixed point scaling, rotation, reflection, transformation with respect to arbitrary points. Application of homogeneous coordinates for uniform matrix operations, composite transformations, Windowing and clipping: Window to viewport transformation, Clipping- Point clipping, Line Clipping, Cohen-Sutherland Line Clipping algorithms, Polygon Clipping-Sutherland-hodgeman algorithm.

Module 3: 3D Concepts and Techniques: 3D display techniques, 3D Transformations, 3D modelling schemes, Projection-parallel projections, perspective projection, Visible Surface Detection- Hidden Surface removal Algorithms-scan line method, Z-buffer method.

Module 4: Colour Illumination methods: colour models-RGB, HSI, CMYK, Illumination model and light sources, Specular reflection, Intensity attenuation, shadow, Polygon Shading methods, animation, morphing, tweening, warping, zooming, panning, rubber band lines (concepts only)

TEXT BOOK

1. Amarendra N Sinha and Arun D Udai, Computer Graphics, McGraw Hill publications

REFERENCES

2. Donald Hearn, M. Pauline Baker, Computer Graphics (C Version) 2/e, Pearson

SageMath_Lab (No End Semester Examination)[36 Hours]

Starting SageMath using a browser, how to use the sage cell server https://sagecell. sagemath.org/, how to use SageMathCloud, creating and saving a sage worksheet, saving the worksheet to an .sws file, moving it and re-opening it in another computer system; Using sagemath as a calculator, basic functions (square root, logarithm, numeric value, exponential, trigonometric, conversion between degrees and radians, etc.);

Plotting: simple plots of known functions, controlling range of plots, controlling axes, labels, gridlines, drawing multiple plots on a single picture, adding plots, polar plotting, plotting implicit functions, contour plots, level sets, parametric 2D plotting, vector fields plotting, gradients;

Matrix Algebra: Adding, multiplying two matrices, row reduced echelon forms to solve linear system of equations, finding inverses of square matrices, determinants, exponentiation of matrices, computing the kernel of a matrix; Defining own functions and using it, composing functions, multi variate functions;

Polynomials: Defining polynomials, operations on them like multiplication and division, expanding a product, factorizing a polynomial, finding gcd;

Solving single variable equations, declaring multiple variables, solving multi variable equations, solving system of non-linear equations

Internal Evaluation: Another practical record should be submitted the content of which should be problems and their outputs evaluated using SageMath. This record should be awarded a maximum of 5 marks (Assignment mark) which is earmarked for the internal evaluation examination.

OPERATING SYSTEM

CODE: MMC 1342 **Instructional hours per week: 5**

No. of credits: 4

COURSE OUTCOMES: at the end of the Course, the Student will be able to -

CO1	Remember functions, types and characteristics of operating systems
CO2	Understand process management
CO3	Apply CPU scheduling algorithms for different number of jobs
CO4	Analyse different deadlock situations, disk scheduling algorithms
CO5	Evaluate synchronization problems
CO6	Understand memory allocation methods

COURSE CONTENT

Module 1: Introduction to operating system: Operating system as the main component of system software; OS as a resource manager, Structure of OS- shell, utilities, resource management routines, kernel, evolution of OS, multiprogramming, time sharing, real-time systems, parallel systems, distributed systems, OS functions, Characteristics of modern OS; Process Management: Process description and control: process control block, Process states: operations on processes; concurrent process; threads; processes and threads; symmetric multiprocessing; micro Kernels. CPU Scheduling: Schedulers, Scheduling methodology, CPU Scheduling algorithms, performance comparison.

Module 2: Process synchronization- independent and concurrent processes, critical section, mutual Exclusion, Petersons solution, semaphore, classical synchronization problem-bounded buffer and reader/writer problem. Concept of inter-process communication. Deadlock- deadlock and starvation, conditions for deadlock, resource allocation problem, methods for handling deadlock-deadlock prevention, deadlock avoidance- Bankers algorithm, deadlock detection, deadlock recovery

Module 3: Memory Management & Protection: Concept of memory, address binding, Logical address, physical address, swapping, contiguous allocation- fixed partition, variable partition, fragmentation. Non-contiguous allocation– paging, segmentation. Virtual memory demand paging, page fault, replacement algorithms, thrashing. Protection and security – mechanisms and policies, threats, accidental data loss, protection mechanisms, user authentication, attacks from inside, virus, antivirus.

Module 4: I/O & File Management I/O management – I/O hardware, application I/O interface, kernel I/O subsystem. Disk I/O, disk scheduling, RAID, disk cache. File management file concept, access methods, directory structure, file system structure &implementation, directory implementation, allocation methods, free space management.

TEXT BOOK

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, Operating System Principles

REFERENCES

1. Achyut S Godbole, Operating systems, McGraw-Hill, Third Edition
2. www.aw.com/cs_supplements/nutt3/index.html
3. www.aw.com/cs_supplements/nutt/index.html
4. www.gnu.org, www.linux.org, www.linuxcentral.com

SEMESTER-IV
ABSTRACT ALGEBRA – RING THEORY

CODE: MMC1431 **Instructional hours per week: 5**
No. of credits: 3

Course Outcomes: At the end of the Course, the Student will be able to-

CO-1. Understand the definition, various properties of rings through examples.
CO-2. Understand the definition and various properties of prime ideal and maximal ideal.
CO-3. Understand the definition of ring homomorphism and various properties of the same.
CO-4. Learn polynomial rings, reducibility, irreducibility and the unique factorization of some polynomial rings.
CO-5. Learn divisibility properties of various integral domains.
CO-6. Learn unique factorization domains and Euclidean domains through examples.

After discussing the theory of groups thoroughly in the previous semester, we move towards the next higher algebraic structure rings. As in the last semester, all the new concepts appearing in the course is to be supported by numerous examples mainly from the references provided.

Module I (30 Hours)

The concept of rings, subrings with many examples should be discussed here. Next comes the definition and properties of integral domains, fields, and the characteristic of rings. Ideals, how factor rings are defined using ideals, should be explained next. The definition of prime and maximal ideals with examples should be discussed after that.

The topics to be discussed in this module can be found in chapter 12, 13 and 14 of text [1] *below.*

Module II (30 Hours)

After introducing the definition of ring homomorphisms, their properties should be discussed. The field of quotients of an integral domain should be discussed next. The next topic is the definition and various properties of polynomial rings over a commutative ring. Various results on operations on polynomials such as division algorithm, factor theorem, remainder theorem etc should be discussed next. The definition and examples of PID's should be discussed next, before moving to the factorization of polynomials. Tests of irreducibility and reducibility and the unique factorization of polynomials over special rings should be discussed.

The topics to be discussed in this module can be found in chapter 15, 16 and 17 of text [1] *below.*

Module III (30 Hours)

In the last module, we introduce more rigorous topics like various type of integral domains. The divisibility properties of integral domains and definition of primes in a general ring should be introduced. Unique factorization domains and the Euclidean domains should be discussed next with examples. Results on the special integral domains are also to be discussed.

The topics to be discussed in this module can be found in chapter 18 of text [1] *below.*

Texts

Text-1– **Joseph Gallian; *Contemporary Abstract Algebra*, 8th Edition, Cengage Learning, 2013.**

References

Ref. 1 – D S Dummit, R M Foote; *Abstract Algebra*, 3rd Edition, Wiley
Ref. 2 – I N Herstein, *Topics in Algebra*, Vikas Publications

LINEAR ALGEBRA

CODE: MMC 1432 **Instructional hours per week: 5**
No. of credits: 3

Course Outcomes: At the end of the Course, the Student will be able to-

CO-1. Learn the Gauss Elimination method also one will be able to find inverse of matrices by the elimination method.
CO-2. One will be able to solve a non-homogeneous linear system of equations.
CO-3. Understand the basis and dimension of a Vector space.
CO-4. Learn linear transformation on a vector space through certain examples.
CO-5. Understand the Eigen values of a matrix.
CO-6. Learn the diagonalization of a matrix.

The main focus of this course is to introduce linear algebra and methods in it for solving practical problems.

Module-I (25 Hours)

This module deals with a study on linear equations and their geometry. After introducing the geometrical interpretation of linear equations, following topics should be discussed: various operations on column vectors, technique of Gaussian elimination, operations involving elementary matrices, interchanging of rows using elementary matrices, triangular factorization of matrices and finding inverse of matrices by the elimination method.

The topics to be discussed in this module can be found in chapter 1 of text [1] *below. The section 1.7 may be omitted.*

Module-II (30 hours)

Towards the study of vector spaces, specifically R^n, we define them with many examples. Subspaces are to be defined next. After discussing the idea of nullspace of a matrix. The solving linear equations (which was one to some extent in the first module) and finding solutions to non-homogeneous systems from the corresponding homogeneous systems. After this, linear independence and dependence of vectors, their spanning, basis for a space, its dimension concepts are to be introduced. The column, row, null, left null spaces of a matrix is to be discussed next. When inverses of a matrix exists related to its column/row rank should be discussed. Towards the end of this module, linear transformations (through matrices) and their properties are to be discussed. Types of transformations like rotations, projections, reflections are to be considered next.

The topics to be discussed in this module can be found in chapter 2 of text [1] *below. The section 2.7 on graphs and networks may be omitted.*

Module-III (35hours)

This module is intended for making the idea and concepts of determinants stronger. Its properties like what happens when rows are interchanged, linearity of expansion long the first row etc. are to be discussed. Breaking a matrix into triangular, diagonal forms and finding the determinants, expansion in cofactors, their applications like solving system of equations, finding volume etc. are to be discussed next.

We conclude our analysis of matrices. The problem of finding eigen values a matrix is to be introduced first. Next goal is to diagonalize a matrix. This concept should be discussed first, and move to the discussion on the use of eigenvectors in diagonalization.

The topics to be discussed in this module can be found in chapter 4 and 5 of text [1] *below.*

Texts

Text -1– Gilbert Strang, *Linear Algebra and Its Applications*, 4th Edition, Cengage Learning

References

Ref. 1 – *Video lectures of Gilber Strang Hosted by MIT Open Courseware* available at https://ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/ video-lectures/

Ref. 2 – Thomas Banchoff, John Wermer; *Linear Algebra Through Geometry*, 2nd Edition, Springer

Ref. 3 – T S Blyth, E F Robertson: *Linear Algebra*, Springer, Second Edition.

Ref. 4 – David C Lay: *Linear Algebra*, Pearson

Ref. 5 – K Hoffman and R Kunze: *Linear Algebra*, PHI

ALGORITHMS AND DATA STRUCTURES

CODE: MMC 1441 **Instructional hours per week: 4**
No. of credits: 4

COURSE OUTCOMES: at the end of the Course, the Student will be able to -

CO1	Remember properties of a good algorithm
CO2	Understand operations of stack and queues
CO3	Apply pointer concept in linked list
CO4	Analyse different sorting algorithms
CO5	Evaluate different expressions
CO6	Create binary from a given infix notation

COURSE CONTENT

Module 1: Algorithm Analysis: Algorithm, Properties of a good algorithm, efficiency considerations, Complexity: time complexity, space complexity, Asymptotic notations: Big O notation, best case, worst case, average case, simple examples, recursion and its elimination-recursive and no-recursive algorithms for binary search.

Module 2: Sorting: Bubble sort, Selection sort, Quick Sort, Insertion Sort, Merge Sort; Arrays**:** operations on arrays insertion, deletion and traversing; Linked Lists: Concept of static versus dynamic data structures, implementation of linked lists using pointers, operations on linked lists: insertion, deletion and traversing. Doubly linked lists and circular linked lists, applications of linked lists.

Module 3: Stacks and Queues: FIFO and LIFO data structures – stacks using (i) pointers and (ii) arrays. Queues using (i) pointers and (ii) arrays, Operations on stack and queues; applications, polish notation.

Module 4: Trees: Concept of linear versus non-linear data structures, various types of trees – binary, binary search trees. Creating a binary search tree, traversing a binary tree (in-order, pre-order and post-order), operations on a tree –insertion, deletion and processing, expression trees, implementation using pointers, applications**;** Graphs, graph traversal- depth-first and breadth-first traversal of graphs, applications.

TEXT BOOK

1. A.K. Sharma, Data Structures Using C, Pearson, Second edition, 2011

REFERENCES

1. Nair A.S., Mahalekshmi, Data Structures in C, PHI, Third edition 2011.

WEB PROGRAMMING

CODE: MMC 1442 **Instructional hours per week: 2+2=4**

No. of credits: 4

COURSE OUTCOMES: at the end of the Course, the Student will be able to -

CO1	Remember tags in HTML
CO2	Understand linking of web pages and inclusion of frames
CO3	Apply style sheets in web pages
CO4	Understand stylesheet basics
CO5	Understand DHTML
CO6	Create a web site using HTML and javascript

COURSE CONTENT

Module 1: HTML - General Introduction to Internet and WWW; HTML: Structured language, Document types, Rules of html, Html tags, Head tags, Body tags, Headings, Divisions and Centering, Quotations, Preformatted text, Lists, Horizontal Rules, Block level elements, Text level elements, Character entities, Comments, Fonts, Tables: Table tags, Colors, Color names, Color values, Marquee.

Module 2: Advanced HTML - Linking in html: Anchor tags, Layer tags, Link relationships, URL: Relative, Absolute, Image, Image maps, Frames: Layouts, Targeting, No frame tag, Floating frames, Audio, Embed tag, Forms: form tag and its attributes, Get, Post, Form field elements, Form accessibility enhancements: Access key, Tooltips, Browser-specific form accessibility improvements.

Module 3: JavaScript - Introduction to JavaScript, Variables and data types, Declaring Variables, Operators, Control Structures, Conditional Statements, Loop Statements, Functions, Objects, Dialog Boxes, Alert Boxes, Confirm Boxes, Prompt Boxes, JavaScript with HTML, Events, Arrays, Predefined objects, DHTML, Page Redirect, Void Keyword, Page Printing, String Methods, Error Handling, Validations, Publishing your Site, Cookies

Module 4: CSS & XML: Style sheet Basics, Adding Style to a Document, CSS (Cascading Style Sheet) and HTML Elements, Selectors, Document Structure, and Inheritance.

TEXT BOOK

1. V.K. Jain, Advanced Programming in Web Design, Cyber Tech Publications

REFERENCES

1. Joel Sklar, Web Design Principles, Vikas, 5th Edition
2. The Complete Reference HTML & XHTML, Thomas A Powell, 4th Edition
3. H M Deitel, P J Deitel & A B Goldberg, Internet and WWW programming:, 3/e, Pearson

DATA STRUCTURES LAB

CODE: MMC 1441.1 **Instructional hours per week: 2**
No. of credits: 2

SAMPLE LAB EXERCISES

Part A

- Linked list: traversal, node deletion, node insertion in singly, doubly and circular lists
- Implementation of different searching techniques
- Implementation of different sorting techniques

Part B

- Stacks: matrix representation and linked list representation: Push, Pop
- Queues: matrix representation and linked list representation: Add, delete
- Circular queue implementation
- Evaluation of expression using stacks
- Tree traversal
- Evaluation of expression using binary trees.
- Infix to postfix and prefix conversion
- Creating and processing binary search tree

SEMESTER-V

REAL ANALYSIS –I

CODE: MMC 1531 **Instructional hours per week: 5**
No. of credits: 4

Course Outcomes: At the end of the Course, the Student will be able to-

- **CO-1. Understand sequence and series of real numbers.**
- **CO-2. Learn the existence of an irrational number in R, completeness property of R, density of rational numbers on R.**
- **CO-3. Learn uncountability and various cardinality results on R.**
- **CO-4. Learn the convergence of sequences and series of real numbers.**
- **CO-5. Learn certain important theorems namely the Bolzano - Weierstrass theorem, the Cauchy criterion for convergence of a sequence and the Monotone convergence theorem.**

In this course, we discuss the notion of real numbers, the ideas of sequence of real numbers and the concept of infinite summation in a formal manner. Many of the topics discussed in the first two modules of this course were introduced somewhat informally in earlier courses, but in this course, the emphasis is on mathematical rigor. A minimal introduction to the metric space structure of R is also included so as to serve as a stepping stone into the idea of abstract topological spaces. The course is mainly based on Chapters 1–3 of text [1].

All the chapters mentioned above contains a section titled *Discussions* in the beginning of the chapter. This section is intended only for motivating the students, and so should not be made as a part of the examination process.

Module-I (30 Hours)

This module introduces the basic concepts about the real number system with some introduction to sets, functions, and proof techniques. The following are the main topics to be discussed: existence of an irrational number, the axiom of completeness, upper lower bounds of sets in R, consequences of completeness like Archimedian property of real numbers, Density of Q in R, existence of square roots, countability of Q and uncountability of R, various cardinality results, Cantor's original proof for uncoubtability of R, and Cantor's theorem on power sets.

The topics to be discussed in this module can be found in chapter1 of text [1] *below. The first section 1.1 may be briefly discussed and is not meant for examination purposes.*

Module-II (36 hours)

Students must have already encountered the idea of infinite series through the example of geometric progression. After discussing the rearrangement concept of infinite series, the following topics are to be introduced rigorously: Limit of a sequence, diverging sequences, examples, algebraic operations on limits, and order properties of sequences and limits, the Monotone Convergence Theorem, Cauchy's condensation test for convergence of a series, various other tests for the convergence series, the Bolzano-Weierstrass theorem, the Cauchy criterion for convergence of a sequence, rearrangement of absolutely convergent series.

The topics to be discussed in this module can be found in chapter 2 of text [1] *below. The first section 2.1 may be briefly discussed and is not meant for examination purposes.*

Module-III (24 Hours)

This module is intended to be a beginner for learning abstract metric spaces. To motivate the students, the Cantor set should be constructed and shown in the beginning. Then move to the topics open and closed sets in **R**, and what about their completeness, Compactness of sets (defined using sequential convergence), open covers and compactness.

The topics to be discussed in this module can be found in chapter 3 of text [1] below. The first section 3.1 may be briefly discussed and is not meant for examination purposes. The sections 3.4 and 3.5 need not be discussed.

Texts

Text-1– Stephen Abbot. *Understanding Analysis*, 2nd Edition, Springer, 2015

References

Ref. 1 – R G Bartle, D Sherbert. *Introduction to Real Analysis*, 3rd Edition, John Wiley & Sons

Ref. 2 – W. Rudin. *Principles of Mathematical Analysis*, Second Edition, McGraw-Hill

Ref. 3 – Terrence Tao. *Analysis I*, Hindustan Book Agency

COMPLEX ANALYSIS –I

CODE: MMC 1532 **Instructional hours per week: 5**
No. of credits: 4

Course Outcomes: At the end of the Course, the Student will be able to-

CO-1.Understand the algebra of Complex numbers.
CO-2.Learn how to find the polar form of a complex number.
CO-3.Understand the limit, continuity and analyticity of Complex function.
CO-4.Learn Cauchy Riemann equations and Harmonic functions.
CO-5.Learn about certain elementary complex functions.
CO-6.Learn Contour integration of complex valued functions.

Here we go through the basic complex function theory.

Module-I (35 Hours)

Complex numbers : The algebra of Complex Numbers, Point Representation of Complex Numbers, Vectors and Polar forms, The Complex Exponential, Powers and Roots, Planar Sets

Analytic Functions: Functions of a complex variable, Limits and Continuity, Analyticity, The Cauchy Riemann Equations, Harmonic Functions

The topics to be discussed in this module can be found in chapter1, sections 1.1, 1.2, 1.3, 1.4, 1.5, 1.6 and chapter2, sections 2.1, 2.2, 2.3, 2.4, 2.5 of text [1] *below.*

Module-II (25 hours)

Elementary Functions: Polynomials and rational Functions (Proof of the theorem on partial fraction decomposition need not be discussed), The Exponential, Trigonometric and Hyperbolic Functions, The Logarithmic Function, Complex Powers and Inverse Trigonometric Functions.

The topics to be discussed in this module can be found in chapter 3, sections 3.1, 3.2, 3.3,of text [1]*below.*

Module-III (30 hours)

Complex Integration : Contours, Contour Integrals, Independence of Path, Cauchy's Integral Theorem (Section 4.4a on deformation of Contours Approach is to be discussed, but section 4.4 b on Vector Analysis Approach need not be discussed), Cauchy's Integral Formula and Its Consequences, Bounds of Analytic Functions

The topics to be discussed in this module can be found in chapter 4, sections 4.1, 4.2, 4.3, 4.4a, 4.5 and 4.6 of text [1] *below.*

Texts

Text-1– Edward B. Saff, Arthur David Snider. *Fundamentals of complex analysis with applications to engineering and science*, 3rd Edition, Pearson Education India.

References

Ref. 1– John H Mathews, Russel W Howell. *Complex Analysis for Mathematics and Engineering*, Jones and Bartlett Publishers

Ref. 2 – Erwin Kreyszig. *Advanced Engineering Mathematics*, 10th Edition, Wiley-India

Ref.3. James Brown, Ruel Churchill. *Complex Variables and Applications*, Eighth Edition, McGraw-Hill

PROJECT PREPARATION -
FROM SELECTING THE TOPIC TO PRESENTING THE FINAL REPORT

CODE: MMC 1533 **Instructional hours per week: 2**
No. of credits: 4

To complete the undergraduate programme, the students should undertake a project and prepare and submit a project report on a topic of their choice in the subject mathematics or allied subjects. The work on the project should start in the beginning of the5th semester itself, and should end towards the middle of the 6th semester. This course (without any examination in the 5^{th} semester, with a project report submission and project viva in the 6th semester) is introduced for making the students understand various concepts behind undertaking such a project and preparing the final report. Towards the end of this course the students should be able to choose and prepare topics in their own and they should understand the layout of a project report.

To quickly get into the business, the first chapter of text [1] may be completely dis- cussed. Apart from that, for detailed information, the other chapters in this book may be used in association with the other references given below. The main topics to discuss in this course are the following:

Quick overview: The structure of Dissertation, creating a plan for the Dissertation, planning the results section, planning the introduction, planning and writing the abstract, composing the title, figures, tables, and appendices, references, making good presentations, handling resources like notebooks, library, computers etc., preparing an interim report.

Topics in detail: Planning and Writing the Introduction, Planning and Writing the Results, Figures and Tables, Planning and Writing the Discussion, Planning and Writing the References, Deciding On a Title and Planning and Writing the Other Bits, Proofreading, Printing, Binding and Submission, oral examinations, preparing for viva, Taking the Dissertation to the Viva Layout : Fonts and Line Spacing, Margins, Headers, and Footers, Alignment of Text, Titles and Headings, Separating Sections and Chapters

Texts

Text 1 – Daniel Holtom, Elizabeth Fisher. *Enjoy Writing Your Science Thesis or Dissertation–A step by step guide to planning and writing dissertations and theses for undergraduate and graduate science students*, Imperial College Press

References

Ref. 1 – Kathleen McMillan, Jonathan Weyers. *How to write Dissertations & Project Reports*, Pearson Education Limited

Ref.2–Peg Boyle Single. *Demystifying dissertation writing: a streamlined process from choice of topic to final text*, Stylus Publishing, Virginia

SOFTWARE ENGINEERING

CODE: MMC 1541 **Instructional hours per week: 4**

No. of credits: 4

COURSE OUTCOMES: at the end of the Course, the Student will be able to -

CO1	Remember characteristics of software and process
CO2	Understand coding and testing methods
CO3	Apply object oriented design concepts
CO4	Analyse various software development process models
CO5	Evaluate cost and efforts
CO6	Create DFD of a software system

COURSE CONTENT

Module 1: Introduction : Characteristics of Software, Product and Process, Need for Software Process, Characteristics of a Software Process, Software Development Process models, Software Development Life Cycle Model: Waterfall Model, Prototyping, iterative development, Spiral Model, time-boxing model; Comparison of different Life Cycle Models, Software Project Management, Project Estimation Techniques, Software Requirements Analysis and Definition: Software Requirements, Overview of SA/SD Methodology, Requirements Specification: Need for SRS, Characteristics of an SRS, Components of an SRS, Specification Languages, Structure of a Requirements document. Functional Specification with Use cases, developing use cases, Structured Analysis, Metrics, quality metrics, Planning a project, effort estimation, COCOMO model, quality plan, risk management-assessment, control.

Module 2: Function oriented design: Problem partitioning, abstraction, modularity, Top-down and Bottom-up Strategies, coupling, cohesion, design notations-structure charts, structured design, Data Flow Diagrams, Developing the DFD Model of a system, Entity Relationship Diagram, Developing ERD of a system, Decision Trees, Decision Tables, Structured English, first-level factoring, factoring input, output and transform branches, transaction analysis, verification.

Module 3: Object-oriented design: Object-oriented design concepts, Comparison between Algorithmic Decomposition and Object Oriented Decomposition Unified Modelling Language, Object Oriented Design using UML, Class Diagram, Sequence Diagram, Collaboration Diagram; detailed design, PDL, algorithm design, state modelling of classes, design walkthroughs, critical design review, consistency checkers, other UML diagrams.

Module 4: Coding and testing: common coding errors, structured programming, coding standards, incremental coding process, test driven development, source code control and build, refactoring, verification- code inspections, static analysis, unit testing, combining different techniques. Testing- error, fault and failure, test oracles, test cases, Black Box Testing, Equivalence Class Partitioning, Boundary Value Analysis, Cause Effect Graphing, White Box Testing- control flow based and data-flow based testing, test plan, test case specifications, defect logging and tracking, Comparison of Different Techniques.

TEXT BOOK

1. Rajib Mall, Fundamentals of Software Engineering, Second Edition, PHI

REFERENCES

1. Pankaj Jalote, An Integrated Approach to Software Engineering, Narosa.
2. Waman S Jawadekar, Software Engineering, McGraw hill, 2013
3. http://courses.cs.vt.edu/csonline/SE/Lessons/
4. http://www.omg.org/gettingstarted/what_is_uml.htm
5. http://www.math-cs.gordon.edu/local/courses/cs211/ATM

DATABASE MANAGEMENT SYSTEMS

CODE: MMC 1542 **Instructional hours per week: 4+2=6**

No. of credits: 5

COURSE OUTCOMES: at the end of the Course, the Student will be able to -

CO1	Remember Evolution of Database system
CO2	Understand set operations on relations
CO3	Apply different normal forms in relational database
CO4	Understand design and maintenance issues
CO5	Understand Entity Relationship model
CO6	Create different queries in SQL

COURSE CONTENT

Module 1: Introduction: evolution of data base systems, overview of database management systems, Relational data model, mathematical definition, candidate, primary and foreign keys, set operations on relations, insertion, deletion and update operations, attribute domains.

Module 2: Relational algebra and relational calculus, Introduction to SQL, Table creation, selection, projection and join using SQL

Module 3: Functional Dependencies – Inference axioms, normalization, 1NF, 2NF, 3NF and Boyce-Codd Normal forms, Lossless and lossy decompositions.

Module 4: The E-R Model, Entities and attributes, 1-1 and many-1, many-many relationships. Security – Physical and Logical, Design and maintenance issues, integrity.

TEXT BOOK

1. Ramon A. Matatoledo and Pauline K. Cushman, Fundamentals of Relational Data Bases, Schaum Outlines, Tata McGraw Hill

REFERENCES

1. Atul Kahate, Introduction to Data Base Management Systems, Pearson Education
2. www.pearson.co.in/AtulKahate,
3. www.edugrid.ac.in/webfolder/courses/dbms/dbms_indEX.htm

DBMS LAB (No End Semester Lab Examination) - SAMPLE LAB EXERCISES

Part A

- SQL statement for creating, listing, dropping, checking, updating tables
- Record manipulation using-insert, delete, update
- Experiments that clarify the importance of keys (Except foreign key)
- Queries with an Expression and a column alias
- A simple query that aggregates (groups) over a whole table
- A query with a literal string in the SELECT list
- Queries with sub string comparison and ordering
- Query using the "IS NULL" syntax to list (compare '=NULL' instead of IS NULL")
- Finding values within a certain range
- Using the --"BETWEEN" keyword
- SQL functions (String, Numeric, Date functions)
- Aggregate Functions

Part B

- A Join between two tables (Natural Join, Theta Join etc.)
- Foreign Key
- Nested queries
- The EXISTS and UNIQUE function in SQL
- Renaming attributes and joined tables
- Statements related with VIEWs

DIGITAL MARKETING (OPEN COURSE)

CODE: MMC 1551.1 **Instructional hours per week: 3**
No. of credits: 2

COURSE OUTCOME

CO1	Remember core concepts in digital marketing
CO2	Understand E Banking approaches devices, benefits and drawbacks
CO3	Understand Encryption and decryption
CO4	Understand social media marketing
CO5	Understand search engine advertising
CO6	Understand Search engine optimization

COURSE CONTENT

Module I: Introduction: Nature, Scope and Importance of Digital Marketing; Evolution of Digital Marketing; Core Concepts-Inbound Marketing, Content Marketing, Email Marketing, Influential Marketing; Holistic Digital Marketing Concept, 10Ps of digital marketing; Digital Marketing Environment: Macro and Micro Environment.

Module II: E-banking: approaches, devices, services, benefits, drawbacks, Electronic payment systems-credit cards, debit cards, smart cards, credit accounts, cyber security, encryption, secret key cryptography, public key cryptography, digital signatures, firewalls

Module III: Digital Marketing: Search Engine Optimization (SEO), Social Media, Content Marketing; Email Marketing, Mobile Marketing. Challenges for Digital Marketing: Increased Security Risk, Cluttered Market, Less Focus on Keywords, More Ad Blockers, Increased Ad Costs**.**

Module IV: Digital Marketing: Pay per Click-Search Engine Advertising, Advantages, Factors, Conversion Rate Optimization (CRO); Digital Marketing- Web Analytic. Social Media Marketing: Face book, Pinterest, Twitter, LinkedIn, YouTube, Google Adwords, Google Analytics; Issues and Future enhancement of Digital Marketing.

TEXT BOOK

- Ian Dodson-*The art of Digital Marketing*, Wiley

REFERENCE

- Puneet Singh Bhatia- *Fundamentals of Digital Marketing*, Pearson Education

INTERNET AND WWW (OPEN COURSE)

CODE: MMC 1551.2 **Instructional hours per week: 3**
No. of credits: 2

COURSE OUTCOME

CO1	Remember network topologies
CO2	Understand modes of connecting internet
CO3	Understand WWW fundamentals
CO4	Understand browsers and search engines
CO5	Understand TCP/IP model
CO6	Remember benefits of web server

COURSE OUTCOME

Module I: Introduction to Network-Types of Network-Network Topologies, Intranet, Extranet-Advantages, Internet-History, Modes of Connecting to Internet-Dialup Access-Direct to dedicated connections, Internet Service Providers, Domain Name Service, Internet Addresses-Addressing Scheme-IPV6,Modems,Communication Software, Internet tool-File Transfer Protocols, Search Tools, Telnet.

Module II: Introduction to WWW-WWW and HTTP, Webpage, Introduction to Web Browser-Book Marks-Comparison, Directories, Search Engines-Search Fundamentals-Search Terminology-Search Strategies – Search Generalization-Search Specialization-Working.

Module III: Uniform Resource Locator (URL) Introduction to TCP/IP-TCP/IP Model, Email-Working with Email-Sending Mail-Reading Mail-Replying to Mail-Deleting Mail-Advantages and Disadvantages of Email, Basics of Chat Rooms, SMTP.

Module IV: Introduction to Web Server-Personal Web Server (PWS)-Internet Information Server (IIS)-Apache Webserver-Benefits of Web Server, Introduction to Security-Internet Security-Identifying Network Stations, Network Protocols-Internet Security Threats.

TEXT BOOK

- Dr.Surender Jangra, “Basics of Internet and Web”, Vayu Education of India. New Delhi 110002

REFERENCE

- Raymond Greenlaw, Ellen Hepp, “Fundamentals of Internet and the World Wide Web, McGraw-Hill.

CYBER SECURITY (OPEN COURSE)

CODE: MMC 1551.3 **Instructional hours per week: 3**
No. of credits: 2

COURSE OUTCOMES

CO1	Remember fundamental concepts of information systems
CO2	Understand Data security considerations
CO3	Understand social threats
CO4	Understand security policies
CO5	Understand information security standards
CO6	Remember cyber laws in India

COURSE CONTENT

Module I: Introduction to Information systems: Modeling business process, components, categories, Individuals in information system, Developing information systems; **Information Systems:** threats, Information assurance, cyber security and security risk analysis; **Application security:** Data Security considerations, security technology, intrusion detection access control

Module II: Security threats: Introduction to security threats, Network and services attack, security threats to e-commerce.

Module III: Security Policies: Introduction, Why we need security policies, Security policy development, Email security policies, Policy review process, corporate policy, sample template of cyber security policy.

Module IV: Information security standards: Why ISO, IT ACT 2000, copyright, Patent, Intellectual property right, Cyber laws in India, Software Licensing, Semi-conductor law and patent law.

TEXT BOOK

- Fundamentals of Cyber security, Mayank Bhushan, BPB publication, First Edition 2017

SEMESTER-VI
REAL ANALYSIS –II

CODE: MMC1631 **Instructional hours per week: 5**
No. of credits: 4

Course Outcomes: At the end of Course, the Student will be able to-

- **CO-1. Understand various version of definition of limits and continuity of real valued functions.**
- **CO-2. Understand the discontinuity criterion, uniform continuity, the intermediate value theorem and Monotone functions**
- **CO-3. Understand the definition of differentiability of functions and learn differentiability implies continuity.**
- **CO-4. Learn certain important theorems connecting differentiability of a function.**
- **CO-5. Learn Riemann integration.**

In the second part of the Real Analysis course, we focus on functions on R, their continuity, existence of derivatives, and integrability. The course is mainly based on Chapters 4, 5 and 7 of text[1].

All the chapters mentioned above contains a section titled *Discussions* in the beginning of the chapter. These sections are intended only for motivating the students, and so should not be made a part of the examination process.

Module-I (35 Hours)

Here we move towards the basic notion of limits of functions and their continuity. Various version of definition of limits are to be discussed here. The algebra of limits of functions and the divergence criterion for functional limits are to be discussed next. The other topics to be discussed in this module are the discontinuity criterion, composition of functions and continuity, continuity and compact sets, results on uniform continuity, the intermediate value theorem, Monotone functions and their continuity.

The topics to be discussed in this module can be found in chapter 4 of text[1] *below. The first section 4.1 maybe briefly discussed and is not meant for examination purposes. The subsection Preservation of connected sets may be omitted.*

Module-II (25hours)

Here we discuss the derivative concept more rigorously than what was done in the previous calculus courses. After (re)introducing the definition of differentiability of functions, we verify that differentiability implies continuity. Algebra and composing of differentiable functions should be discussed next. The interior extremum theorem and Darboux's theorem should be discussed after that. The mean value theorems should be discussed and proved, and the module ends with L'Hospitals results. A continuous everywhere but nowhere differentiable function should be discussed, but it is not meant for the examination. It may be in fact used for student seminars.

The topics to be discussed in this module can be found in chapter 5 of text [1] *below. The sections 5.1and 5.4 maybe briefly discussed and is not meant for examination purposes.*

Module-III (30 hours)

In the last module, the theory of Riemann integration is to be discussed. Main topics to be included in this module are defining the Riemann integral using upper, lower Riemann sums, and the integrability criterion, continuity and the existence of integral, algebraic

operations on integrable functions, (The results and examples on convergence of sequence of functions and integrability may be omitted), the fundamental theorem of calculus and its proof, Lebesgue's criterion for Riemann integrability.

The topics to be discussed in this module can be found in chapter 7 of text [1] *below. The first section 7.1 may be briefly discussed and is not meant for examination purposes.*

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Texts

Text 1– Stephen Abbot; *Understanding Analysis*, 2nd Edition, Springer, 2015.

References

Ref. 1 – R G Bartle, D Sherbert; *Introduction to real analysis*, 3rd Edition, John Wiley &Sons

Ref. 2 – W. Rudin, *Principles of Mathematical Analysis*, Second Edition, McGraw-Hill.

Ref. 3 – Terrence Tao; *Analysis I*, Hindustan Book Agency

COMPLEX ANALYSIS –II

CODE: MMC 1632 **Instructional hours per week: 4**
No. of credits: 3

Course Outcomes: At the end of the Course, the Student will be able to-

CO-1. Learn the well-known Cauchy's Integral Theorem.
CO-2.Learn the Cauchy's Integral formula
CO-3.Learn Taylor Series and Laurent series representations of analytic functions.
CO-4.Learn the Residue Theory of Complex functions.

Module-I (32 Hours)

Series Representations for Analytic Functions : Sequences and Series, Taylor Series, Power Series, Mathematical Theory of Convergence, Laurent series, Zeros and Singularities, The point at Infinity. *The topics to be discussed in this module can be found in chapter5, sections 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7 of* text [1] *below.*

Module-II (20 Hours)

Residue Theory: The Residue Theorem, Trigonometric Integrals over $[0, 2\pi]$, Improper integrals of Certain functions over $[-\infty, \infty]$, Improper integrals involving Trigonometric Functions, Indented Contours

The topics to be discussed in this module can be found in chapter 6, sections 6.1, 6.2, 6.3, 6.4, 6.5 of text [1] *below.*

Module III (20 Hours)

Conformal Mapping: Geometric Considerations, Mobius Transformations *The topics to be discussed in this module can be found in chapter 7, sections 7.2, 7.3, 7.4 of* text [1] *below.*

Texts

Text 1 – Edward B. Saff, Arthur David Snider. *Fundamentals of complex analysis with applications to engineering and science*, 3rd Edition, Pearson Education, India.

References

Ref. 1– John H Mathews, Russel W Howell. *Complex Analysis for Mathematics and Engineering*, 6th Edition, Jones and Bartlett Publishers

Ref.2– Murray R Spiegel. *Complex variables: with an introduction to conformal mapping and its applications*, Schaum's outline.

Ref. 3 – Erwin Kreyszig. *Advanced Engineering Mathematics*, 10th Edition, Wiley-India

Ref. 4 – James Brown, Ruel Churchill. *Complex Variables and Applications*, Eighth Edition, McGraw-Hill

GRAPH THEORY (ELECTIVE)

CODE: MMC1633.1 **Instructional hours per week: 4**
No. of credits: 3

Course Outcomes: At the end of the Course, the student will be able to-

CO-1. Understand the role of graphs in Mathematics, Other branches of Science and Social Sciences.
CO-2. Familiarize with many graphical parameters.
CO-3. Explain different properties of graphs and in particular about trees.
CO-4. Able to construct models of real life problems.
CO-5. Analyze various applications through graphs.

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-I (36 Hours)

Basics: The Definition of a Graph, Graphs as Mathematical Models, other basic concepts and definitions, Vertex Degrees, Subgraphs, Paths and Cycles, The Matrix Representation of Graphs, Fusing graphs (The fusion algorithm for connectedness need not be discussed).

Trees and Connectivity: Definitions and Simple Properties of trees, Bridges, Spanning Trees, Cut Vertices and Connectivity. *The topics in this module can be found in Chapter1, Sections 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7 and 1.8, Chapter2, Sections 2.1, 2.2, 2.3 and 2.6 of* text[1].

Module-II (36 Hours)

Euler Tours and Hamiltonian Cycles: Euler Tours (Fleury's algorithm need not be discussed), The Chinese Postman Problem (Only Statement of the problem is to be discussed) Hamiltonian Graphs, The Travelling Salesman Problem (Only Statement of the problem is to be discussed, The Two-Optimal Algorithm and The Closest Insertion Algorithm need not be discussed) Planar Graphs: Plane and Planar Graphs, Euler's Formula, The Platonic Bodies, Kuratowski's Theorem (Without proof).
The topics in this module can be found in Chapter3, Sections 3.1, 3.2, 3.3 and 3.4, Chapter 5, Sections 5.1, 5.2, 5.3 and 5.4 of text[1].

Texts

Text 1 – John Clark, Derek Allan Holton. *A first look at Graph Theory*, World Scientific.

References

Ref. 1 – R Balakrishnan, Ranganatahan. *A Text Book of Graph Theory*, 2nd Edition, Springer
Ref. 2 – V Balakrishnan. *Graph Theory*, Schaums Outline
Ref. 3 – J A Body, U S R Murthy. *Graph Theory with Applications*, The Macmillan Press
Ref. 4 – Robin J Wilson. *Introduction to Graph Theory* 5th edition, Prentice Hall

LINEAR PROGRAMMING WITH SAGEMATH (ELECTIVE)

CODE: MMC 1633.2 **Instructional hours per week: 4**
No. of credits: 3

Course Outcomes: At the end of the Course, the Student will be able to-

CO-1. Solve various types of problems by using Linear programming.
CO-2. Acquire knowledge on Optimization.
CO-3. Develop algorithms for linear programs.
CO-4. Analyze different types of solutions for Linear programming problems.
CO-5. Experience with various method to solve a linear programming problem.

This course is aimed at providing an introduction to linear programming and solving problems in it using very basic methods.

Note:
1. There should not be any problems to solve using the SageMath software in the End Semester Examination (ESE). The ESE should be based only on the theory and problems to be solved either manually or using a non-programmable scientific calculator.
2. Students may be permitted to use nonprogrammable scientific calculator in the end semester examination.
3. One of the internal evaluation examinations should be done using SageMath Soft- ware, as a practical examination.

Module-I (24 Hours)
This module is aimed at providing a strong introduction to various type of problems that can be solved via linear programming. Main topics in this module are the following: Introduction to linear programming through problems, basic underlying assumptions like Proportionality, Divisibility, Additivity, Certainty, more general problems, standard form of a linear program, conversion rules to arrive at such a form like Converting unrestricted variables, Converting inequality constraints, Converting maximization to minimization, their examples, standard linear programming terminology, examples on planning, transportation, assignment, workforce scheduling, portfolio optimization, Minimum Cost Flow Problem, Maximum Flow Problem.
The topics to be discussed in this module can be found in chapter 1 of text [1] *below.*

Module-II (24 hours)
This module begins with the geometry of linear programming and later proceeds to the Fundamental Theorem of Linear Programming which is a basis for algorithm development for linear programs. The main topics in this module are the following: Geometry of the Feasible Set, graphically representing the solution space, hyperplane, polyhedron, polytope, convex sets, geometry of optimal solutions, geometric characterization of optimality, extreme points and basic feasible solutions, generating basic feasible solutions, resolution theorem, fundamental theorem linear programming.
The topics to be discussed in this module can be found in chapter 2 of text [1] *below.*

Module-III (24 hours)
Here we introduce the simplex method, which is an important method to solve linear programming problems. The main topics in this module are the following:

Introducing the simplex method, examples, adjacent basic feasible solutions, checking optimality of a basic feasible solution, direction-step length theorem, its application in developing the steps of simplex method, examples, finite termination under non-degeneracy, generating an initial basic feasible solution using two phase and Big M method, degeneracy and cycling, anti-cycling rules like Bland's rule, and lexico graphic rules.
The topics to be discussed in this module can be found in chapter 3 of text [1] *below.*

All the problems in this course should be computationally also solved using the software SageMath. The references provided below, especially text[2] and chapter 4 of text[3]can be used mainly for this.

Texts

Text 1– Roy H Kwon. ***Introduction to Linear Optimization and extensions with MAT- LAB,*** **4th Edition, CRC Press, New York**
Text2 – ***Sage Reference Manual: Numerical Optimization, Release 7.6*** **by the Sage Development Team available online at http://doc.sagemath.org/pdf/en/reference/numerical/numerical.pdf**
Text 3 – Gregory V. Bard. ***Sage for Undergraduates,*** **American Mathematical Society, available online at http://www.gregorybard.com/Sage.html**

References

Ref. 1 – Frederick S Hillier, Gerald J Lieberman. ***Introduction to operations research,*** **10th Edition, McGraw Hill Education**
Ref. 2 – Paul R Thie, G. E. Keough. ***An introduction to linear programming and game theory,*** **3rd Edition, John Wiley & Sons**
Ref. 3 – Wayne L Winston, ***Operations Research Applications and Algorithms*****, 4th Edition, Cengage Learning**

NUMERICAL ANALYSIS WITH SAGEMATH (ELECTIVE)

CODE: MMC 1633.3 **Instructional hours per week: 4**
No. of credits: 3

Course Outcomes: At the end of the Course, the Student is able to-

CO-1. Familiar with getting approximate solutions to problems.
CO-2. Able to evaluate differential and integral equations numerically.
CO-3. Understand the principle of error and approximation.
CO-4. Analyze various methods and formula for solving equations f(x) = 0.
CO-5. Familiar with Numerical methods for ordinary differential equations and linear systems.

This course is aimed at providing an introduction to Numerical analysis with particular emphasize to finding approximate solutions to problems like finding roots of equations, numerically evaluating differential and integral equations, finding polynomials from values that approximate a given function, solving systems of linear equations etc. SageMath can be used as the software for supporting computations.

Note:

1. There should not be any problems to solve using the SageMath software in the End Semester Examination (ESE). The ESE should be based only on the theory and problems to be solved either manually or using a non-programmable scientific calculator.
2. Students may be permitted to use non-programmable scientific calculator in the end semester examination.
3. One of the internal evaluation examinations should be done using SageMath Soft- ware, as a practical examination.

Module I (36 Hours)

General concepts in Numerical analysis: Introduction, Floating-Point Form of Numbers, Roundoff, Loss of Significant Digits, Errors of Numeric Results, Error Propagation, Basic Error Principle, Algorithm Stability.

Solution of Equations by Iteration: Fixed-Point Iteration for Solving Equations $f(x) = 0$, Newton's Method for Solving Equations $f(x)=0$, Order of an Iteration Method Speed of Convergence, Convergence of Newton's Method, Secant Method for Solving $f(x) =0$.
Interpolation: Lagrange Interpolation, Newton's Divided Difference Interpolation, Equal Spacing: Newton's Forward Difference Formula, Equal Spacing: Newton's Back- ward Difference Formula, Spline Interpolation,
The topics to be discussed in this module can be found in chapter 19, sections 19.1, 19.2, 19.3, 19.4 of text [1] *below.*

Module II (36 hours)

Numerical Integration and Differentiation: Rectangular Rule. Trapezoidal Rule, Simpson's Rule of Integration, Adaptive Integration, Gauss Integration Formulas Maximum Degree of Precision, Numeric Differentiation.
Numerical Methods for Ordinary Differential Equations: Methods for First-Order ODEs, Picard's Iteration Method, Euler's method (Numeric Method), Improved Euler Method, Runge-Kutta Methods (RK Methods) off our the order.
Numerical Methods in Linear Algebra: Linear Systems: Gauss Elimination, Linear Systems: LU-Factorization, Matrix Inversion, Cholesky's Method, Gauss Jordan Elimination. Matrix Inversion. Linear Systems: Solution by Iteration, Gauss Seidel

Iteration Method, Jacobi Iteration

The topics to be discussed in this module can be found in chapter 19 section 1.2 and Problem set 1.7 CASPROJECT.6, Chapter 19 Sections19.5, Chapter20, Sections 20.1, 20.2, 20.3, Chapter 21 Sections 21.1, of text [1] *below.*

All the problems in this course should be computationally also solved using the software SageMath. The references provided below, especially text[2] and chapter 4 of text[3]can be used mainly for this.

Texts

Text 1– Erwin Kreyszig. *Advanced Engineering Mathematics*, 10th Edition, Wiley-India, 2011.

Text2– *Sage Reference Manual: Numerical Optimization, Release 7.6* by the Sage Development Team available online at http://doc.sagemath.org/pdf/en/reference/numerical/numerical.pdf

Text 3– Gregory V. Bard. *Sage for Undergraduates*, American Mathematical Society, available online at http://www.gregorybard.com/Sage.html

References

Ref. 1 – Richard L Burden, J Douglas Faires. *Numerical Analysis*, 9th Edition, Cengate Learning

Ref. 2 – E Isaacson, H B Keller. *Analysis of Numerical Methods*, Dover Publications, NewYork

Ref. 3 – W. Cheney, D Kincaid. *Numerical Mathematics and Computing*, 6th Edition, Thomson Brooks/Cole

FUZZY MATHEMATICS (ELECTIVE)

CODE: MMC 1633.4 **Instructional hours per week: 4**
No. of credits: 3

Course Outcomes: At the end of the Course, the Student will be able to-

CO-1. Able to construct Fuzzy sets.
CO-2. Analyze the properties of Crisp sets and fuzzy sets.
CO-3. Understand different Operations on Fuzzy sets
CO-4. Familiar with Fuzzy relations.
CO-5. Able to identify the similarities and difference between fuzzy set factors and crisp set factors.

Module-I (24 hours)

FROM CRISP SETS TO fuzzy SETS: A PARADIGM SHIFT. Introduction-crispsets: an overview-fuzzy sets: basic types and basic concepts of fuzzy sets, Fuzzy sets versus crisp sets, Additional properties of cuts, Representation of fuzzy sets.

Module-II (24 hours)

OPERATIONS ON fuzzy SETS AND Fuzzy ARITHMETIC: Operations on fuzzy sets-types of operations, fuzzy complements, fuzzy intersections, t-norms, fuzzy unions, t-conorms.
Fuzzy numbers, Linguistic variables, Arithmetic operations on intervals, Arithmetic operations on fuzzy numbers.

Module-III (24 hours)

Fuzzy RELATIONS: Crisp versus fuzzy relations, projections and cylindric extensions, Binary fuzzy relations, Binary relations on a single set, Fuzzy equivalence relations.
The topics to be discussed in this module can be found in
Chapter1: Sections 1.1 to1.4,
Chapter 2: Sections 2.1 and 2.2,
Chapter 3: Sections 3.1 to 3.4 (proof of theorems 3.7, 3.8, lemma 3.1, 3.2, theorems3.11, 3.12 3.13 need not be discussed)
Chapter 4: Sections 4.1 to 4.4
Chapter 5: Sections 5.1 to 5.5 of text [1] *below.*

Texts

Text1–George J Klir, Yuan. ***Fuzzy sets and fuzzy logic: Theory and applications*****, Prentice Hall of India Pvt. Ltd., NewDelhi, 2000**

References

Ref. 1 – Klir G J and T Folger. ***Fuzzy sets, Uncertainty and Information*****, PHI Pvt. Ltd., New Delhi, 1998**
Ref. 2 – H J Zimmerman. ***Fuzzy Set Theory and its Applications*****, Allied Publishers, 1996.**
Ref. 3 – Dubois D and Prade H. ***Fuzzy Sets and Systems: Theory and Applications*****, Ac.Press, NY, 1988.**

INTEGRAL TRANSFORMS

CODE: MMC 1633. 5 **Instructional hours per week: 4**
No. of credits: 3

Course Outcomes: At the end of the Course, the Student will be able to-

CO-1. Understand the basic concepts in Laplace transform.
CO-2. Analyze the relation between transforms and integrals.
CO-3. Apply transforms to Nonhomogeneous Linear Ordinary differential equations.
CO-4. Acquire knowledge on different forms of ODE's.
CO-5. Preliminary ideas about Fourier series and periodic functions.

After completing courses in ordinary differential equations and basic integral calculus, we see here some of its applications.

Module-I (38 Hours)

Laplace Transforms: Laplace Transform. Linearity. First Shifting Theorem (s-Shifting), $s-$ Shifting: Replacing s by $s - a$ in the Transform, Existence and Uniqueness of Laplace Transforms, Transforms of Derivatives and Integrals. ODEs, Laplace Transform of the Integral of a Function, Differential Equations, Initial Value Problems, Unit Step Function (Heaviside Function), Second Shifting Theorem ($t-$Shifting) Time Shifting ($t-$Shifting): Replacing t by $t - a$ in $f(t)$, Short Impulses. Diracs Delta Function. Partial Fractions Convolution , Application to Nonhomogeneous Linear ODEs, Differentiation and Integration of Transforms, ODEs with Variable Coefficients, Integration of Transforms, Special Linear ODEs with Variable Coefficients, Systems of ODEs

The topics to be discussed in this module can be found in sections 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7 of text [1] below.

Module-II (16 hours)

Fourier Series, Basic Examples, Derivation of the Euler Formulas, Convergence and Sum of a Fourier Series, Arbitrary Period. Even and Odd Functions. Half-Range Expansions From Period 2π to any Period $P = 2L$, Simplifications: Even and Odd Functions, Half- Range Expansions.

The topics to be discussed in this module can be found in Sections 11.1, 11.2, of text [1] below.

Texts

Text 1– Erwin Kreyszig. ***Advanced Engineering Mathematics,*** **10th Edition, Wiley-India, 2011.**

References

Ref. 1 – Peter V. O' Neil, ***Advanced Engineering Mathematics,*** **Thompson Publications, 2007**
Ref. 2 – M Greenberg, ***Advanced Engineering Mathematics,*** **2nd Edition, Prentice Hall**

DATA COMMUNICATION AND COMPUTER NETWORKS

CODE: MMC1641 **Instructional hours per week: 4**

No. of credits: 3

COURSE OUTCOMES: at the end of the Course, the Student will be able to -

CO1	Remember data communication fundamentals and types of connections
CO2	Understand pros and cons of different transmission media
CO3	Remember protocols and standards
CO4	Understand different LAN standards
CO5	Evaluate leaky bucket algorithm
CO6	Understand File Transfer Protocol

COURSE CONTENT

Module 1: Introduction to networks - Data Communication – Data flow simplex, Half duplex, Full duplex- Type of Connection – Point–to-Point, multi-drop. Bandwidth- bit rate, baud rate. Transmission media – Copper wires, fiber optics, Radio transmission, microwave, Satellite. switching-circuit, packet, message.

Module 2: Access control - pure- slotted ALOHA, CSMA, CSMA/CD. LAN Standards – Ethernet, Token bus, Token ring. Interfacing devices – bridge, hub, switch, router, gateway.

Module 3: Protocols – standards- Layering, packets, Layered PDUs, ISO-OSI model, TCP/IP model – Comparison. Framing- bit oriented, byte oriented, Error correction – detection – parity, hamming code, CRC. Flow control, error control- Piggybacking, pipelining, Protocols Noiseless and noisy channels – stop and wait, Stop and wait ARQ, Sliding window

Module 4: Internetworking- datagrams, fragmentation – routing-Distance vector routing, Link state routing. Concepts of congestion control-leaky bucket algorithm. Process to Process delivery- TCP, UDP, Application Layer-DNS, Remote login, File Transfer Protocol (FTP).

TEXT BOOK

1. Brijendra Singh, Data Communication and Computer Networks, 2/e, PHI 4.2

REFERENCES

1. Behrouz A Forouzan, Data Communication and Computer networks, 4th ed, McGraw Hill
2. Achyut S Godbole, Data communications and networks, McGrawHill, Second Edition

DATAMINING TECHNIQES

CODE: MMC1642 **Instructional hours per week: 3**

No. of credits: 3

COURSE OUTCOMES: at the end of the Course, the Student will be able to -

CO1	Remember types and application domains of datamining
CO2	Understand Data Pre-processing and Cleaning
CO3	Apply rule base in classification
CO4	Analyse Apriori algorithm
CO5	Understand characteristics and types of cluster analysis
CO6	Create decision trees for classification

COURSE CONTENT

Module 1: Overview: Data, Information, Knowledge; Knowledge Discovery; Types of data for Mining; Application Domains; Data Mining Functionalities; Data Processing – Understanding Data, Pre-processing Data –Forms of Data Pre-processing, Data Cleaning (Definition and Phases only), Need of Data Integration, Steps in Data Transformation, Need of Data Reduction;

Module 2: Data Warehouse: Database Systems & Data Warehouses – Difference; Data Warehouse – Definition & Features; Multidimensional Data Model – Data Cubes ; OLAP (Definition and Functions only); Market Basket Analysis; Association Rule – Overview; Criteria for classifying Frequent Pattern Mining ; Mining Single Dimensional Boolean Association Rule – Apriori Algorithm;

Module 3: Classification: Classification vs Prediction; Issues; Use of Decision Trees for Classification; Bayesian Classification – Bayes' Theorem, Naïve Bayesian Classifier; Lazy Learners - k–Nearest Neighbour Method; Rule-Based Classification – Using IF-THEN rules for classification.

Module 4: Cluster Analysis: Introduction & Requirements; Characteristics of Clustering Techniques; Types of Data in Cluster Analysis; Categories of Clustering- Partitioning Methods; Outlier Detection in Clustering.

TEXT BOOK

1. Sunitha Tiwari & Neha Chaudhary, Data Mining And Warehousing, Dhanpat Rai & Co

REFERENCES

1. Jiawei Han and Micheline Kamber, Data Mining Concepts and Techniques, Elsevier
2. Arun K Pujari, Data Mining Techniques, Universities Press
3. G.K Gupta, Introduction To Data Mining With Case Studies, PHI

PROJECT& VIVA-II (Computer Applications)

CODE: MMC1643 **Instructional hours per week: 5**
No. of credits: 4

1. AIM:

- To expose student to industry-standard project practices, through a real-life project work under time and deliverable constraints, applying the knowledge acquired through various courses.

2. OBJECTIVES:

- ✓ To provide an opportunity to apply the knowledge gained through various courses in solving a real life problem
- ✓ To provide an opportunity to practice different phases of software/system development life cycle
- ✓ To introduce the student to a professional environment and/or style typical of a global IT industry
- ✓ To provide an opportunity for structured team work and project management
- ✓ To provide an opportunity for effective, real-life, technical documentation
- ✓ To provide an opportunity to practice time, resource and person management.

3. PROJECT GUIDELINES

- Group Size – Maximum 3
- No. of records – No. of group members+ 1 (Department copy)
- Certificate should include the names of all members

The minimal phases for the project are: Project search, finalization and allocation, Investigation of system requirements, Data and Process Modelling, System Design, Program design, Program coding and unit testing, System integration, System implementation and acceptance testing.

3.1 Planning the Project: The Major Project is an involved Exercise which has to be planned well in advance. The topic should be chosen in Semester 5 itself. Related reading, training and discussions should start from semester 5 itself.

3.2 Selection of project work: A requirement for developing a computer based solution already exists and the different stages of system development life cycle is to be implemented successfully or select a project where a clear-cut requirement for developing a computer based solution may not be existing, but a possible utility for the same is conceived by the proposer.

3.3 Selection of Tools: No restrictions shall be placed on the students in the choice of platforms/tools/languages to be utilized for their project work, though open source is strongly recommended, wherever possible. No value shall be placed on the use of tools in the evaluation of the project.

3.4 Selection of Organisation & Guide: No restrictions shall be placed on the students in the choice of organization where project work may be done, in terms of locality, type (public/private) etc. It is the duty of the project coordinator to ensure that the Aim, Objectives and full project guidelines are communicated to the external organization.

Students may also choose to do project in the college/institute (or partially in the college/institute and partially in an external organization), especially product-based work, but in such cases the supervisors must ensure that (i) industry practices are followed (ii) the students undertake a planned visit to an IT industry with international operations to make up for the loss of experience and (iii) the services of an external guide with industry experience is obtained.

3.5 Project Management: Head of the department should publish a list of students, projects topics, internal guide and external organization (if any) and teams agreed, before the end of semester 5. Changes in this list may be permitted for valid reasons and shall be considered favorably by Head of the department any time before commencement of the project.

3.6 Documentation: The following are the major guidelines: The final outer dimensions of the report shall be 21 cm X 30 cm. The colour of the flap cover shall be uniform. Only hard binding should be done, with title of the thesis and the words "<BRIEF TITLE> COMPUTER APPLCIATION Project Report 200…" displayed on the spine in 20point, Bold, Times New Roman, as in example below. In case the title is too long, a shorter version of it may be used (Like "Image Pro" instead of "Image Pro – An Interactive Image Processing package"). It is highly recommended that Latex be used for documentation.

• The text of the report should be set in 12 pt, Times New Roman, Single Spaced.

• Headings should be set as follows: CHAPTER HEADINGS 20 pt, Times New Roman, Bold, All Caps, Centered.

WEB BASED BILLING SOFTWARE
COMPUTER APPLICATION PROJECT 2023

1. SECTION HEADINGS 12 pt, Times New Roman, Bold, All Caps, Left Adjusted.
1.1 Section Sub-headings 12 pt, Times New Roman, Bold, Left Adjusted.
Titles of Figures, Tables etc are done in 12 point, times New Roman, Italics, Centered.

<PROJECT TITLE>

<STUDENT'S NAME>

<COLLEGE NAME>

PROJECT REPORT
Submitted in partial fulfilment of the
Requirements for the award of
BSc (Mathematics and Computer Applications) [Double Main] degree of
University of Kerala
2023

Some general guidelines on documentation stylistics are:

• Double quotes and single quotes ("", ") should be used only when essential. In most cases words put in quotes are better highlighted by setting them in italics. Eg: This process is known as "morphing". This process is known as *morphing.*

• Page numbers shall be set at right hand top corner, paragraph indent shall be set as 3.

• Only single space need be left above a section or sub-section heading and no space may be left after them.

• Certificate should be in the format: "Certified that this report titled..... is abonafide record of the project work done by Sri/Kum..... under our supervision and guidance, towards partial fulfillment of the requirements for the award of the Degree of BSC (Mathematics and Computer Applications) [Double Main] of the University of Kerala" with dated signatures of Internal; Guide, external guide and also Head of Institute/College.

• If the project is done in an external organization, another certificates on the letterhead of the organization is required: "Certified that his report titled..... is a bonafide record of the project work done by Sri/Kum..... under any supervision and guidance, at the .....Department of..... (Organization) towards partial fulfilment of the requirements for the award of the Degree of BSC (Mathematics and Computer Applications)

[Double Main] of the University of Kerala".

Project report format

- Organizational overview (of the client organization, where applicable)
- Description of the present system
- Limitations of the present system
- The Proposed system- Its advantages and features
- Context diagram of the proposed system.
- Top level DFD of the proposed system with at least one additional level of Expansion
- Structure Chart of the System
- System flowchart
- Menu Tree
- Program List
- Files or tables (for DBMS projects) list. Class names to be entered for each file in OO systems.
- List of fields or attributes (for DBMS projects) in each file or table.
- Program – File table that shows the files/tables used by each program and the files are read, written to, updated, queried or reports were produced from them.
- Reports List with column headings and summary information for each report.
- System Coding and variable/file/table naming conventions
- System controls and standards
- Screen layouts for each data entry screen.
- Report formats for each report.

Program documentation is suggested on the following lines:

- Program id
- Program level run chart
- Program function Explanation
- Data entry screen (reproduced from system documentation).
- Report layout (reproduced from system documentations)
- Program level pseudocode or flowchart.
- Decision tables, decision trees, with English Explanation where necessary.
- Program listing
- Test data
- Test results.

3.7 Methodology: Wherever applicable, object oriented approach should be used for software development. The project report should generally contain details of the following steps *(though students should not attempt to fit every kind of project into this format):*

(a) Analysis

- Study of existing systems and its drawbacks (general)
- Understanding the functionalities of the system (detailed)
- Preparation of requirement
- Conduct of Feasibility study
- Identification of relevant Objects
- Abstraction of each object (attributed and methods)
- Relationship between objects

(b) Design

- Design of each subsystems
- Design of each classes
- Design of communications between objects
- Design of Algorithms for problem solving
- User interface Design
- Any other steps if necessary

(c) Coding and Impletion
(d) Testing
(e) Security, Backup and Recovery Mechanisms
(f) On line help and User Manuals
(g) Upgradability Possibilities

3.8 Project IPR & Utilization: The intellectual property rights in all project work done by the students shall vest with the University of Kerala, except in cases where some external organizations seek undertaking from students to concede IPR in all work done in their organization or under their guidance. Where possible, students should attempt to obtain at least a joint IPR for the University. In cases where project works are of public utility, students shall be asked to publish their work including source code and documentation, in so far as their rights are clear