# Course Structure & Syllabus
# of
# 5 Year Integrated Master of Science (Int. M. Sc.)
# in
# Mathematics
# (Session 2019 – 2020 Onward)

**Department of Mathematics**
**Veer Surendra Sai University of Technology (VSSUT)**
**Siddhi Vihar, P.O.: Engineering College Burla,**
**Sambalpur–768018, Odisha, India**
**www.vssut.ac.in**

## VISION

The Department of Mathematics strives to be internationally recognized for its academic excellence through the depth of teaching and research, and making students technologically and mathematically competent with strong ethics contributing to the rapid advancement of the society.

## MISSION

M1. To transform young people to competent and motivated professionals.

M2. To produce PG students with strong foundation to join research or serve in academics.

M3. To cater to the development of the nation, particularly in Odisha for research and training.

## PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The program educational objectives of Int. M. Sc. in Mathematics are:

1. To provide an integrated graduate/post graduate course, suitable for students of high ability, combining and relating mathematics, science and technology.
2. To prepare students for further study and research, particularly in areas requiring the application of mathematics.
3. To enrich students with a knowledge of mathematics, its research potential and the interaction between them.

PEO-MISSION MATRIX

| | **M1** | **M2** | **M3** |
|---|---|---|---|
| **PEO1** | **3** | **2** | **1** |
| **PEO2** | **1** | **3** | **2** |
| **PEO3** | **2** | **2** | **3** |

## PROGRAMME OUTCOMES (POs)

The Program Outcomes of Int. M.Sc. in Mathematics are:

| | |
|---|---|
| PO1 | An ability to independently carry out research/investigation and development work to solve practical problems. |
| PO2 | An ability to write and present a substantial technical report/document |
| PO3 | An ability to demonstrate a degree of mastery over Mathematics which is at a level higher than the requirements in the undergraduate program in Mathematics. |
| PO4 | An ability to identify, analyze and formulate complex mathematical problems to reach logical conclusion. |
| PO5 | An ability to apply knowledge of Mathematics in different field of science and technology. |
| PO6 | An ability to recognize the need for and to ready for lifelong learning to keep updated on technological changes. |

## Program Specific Outcomes (PSOs)

| | |
|---|---|
| PSO1 | Design and analyze the mathematical models for the problem related to science, technology, and other socio-economic world. |
| PSO2 | Apply knowledge of Mathematics in different fields of science & technology, and to provide an opportunity to pursue careers in research and development, teaching and allied areas related to Mathematical Science. |

## Course Structure of 5 Year Integrated M. Sc. (Mathematics)

| Course Code | Name of the Course | L–T–P | Credit |
|---|---|---|---|
| | **FIRST SEMESTER** | | |
| IPH01001 | Physics–I | 3–1–0 | 04 |
| ICH01001 | Chemistry–I | 3–1–0 | 04 |
| IMA01001 | Mathematics–I | 3–1–0 | 04 |
| ICH01002 | Environmental Science | 2–0–0 | 02 |
| IPH01002 | Physics Lab.–I | 0–0–3 | 02 |
| ICH01003 | Chemistry Lab.–I | 0–0–3 | 02 |
| ICAC100-- | Audit I | | 00 |
| | | **Total Credits** | **18** |
| | **SECOND SEMESTER** | | |
| IPH02001 | Physics–II | 3–1–0 | 04 |
| ICH02001 | Chemistry–II | 3–1–0 | 04 |
| IMA02001 | Mathematics–II | 3–1–0 | 04 |
| IHU02001 | English for Communication | 2–0–0 | 02 |
| IPH02002 | Physics Lab.–II | 0–0–3 | 02 |
| ICH02002 | Chemistry Lab.–II | 0–0–3 | 02 |
| ICAC200-- | Audit II | | 00 |
| | | **Total Credits** | **18** |
| | **THIRD SEMESTER** | | |
| IPH03001 | Mathematical Physics – I | 3–1–0 | 04 |
| IMA03001 | Mathematics–III | 3–1–0 | 04 |
| IPH03002 | Mechanics | 3–1–0 | 04 |
| IIT03001 | Programming in C | 2–0–0 | 02 |
| IPH03003 | Mathematical Physics Lab | 0–0–3 | 02 |

| | | | |
|---|---|---|---|
| IIT03002 | Programming in C Lab | 0–0–3 | 02 |
| | | **Total Credits** | **18** |
| | **FOURTH SEMESTER** | | |
| IMA04001 | Mathematics-IV | 3–1–0 | 04 |
| IMA04002 | Elementary Algebra | 3–1–0 | 04 |
| IMA04003 | Solid Geometry | 3-1-0 | 04 |
| IPH04001 | Mathematical Physics–II | 3–1–0 | 04 |
| IHU04001 | Economics & Costing | 2–0–0 | 02 |
| ---- | Comprehensive viva | | 02 |
| | | **Total Credits** | **20** |
| | **FIFTH SEMESTER** | | |
| IMA05001 | Introduction to Probability & Statistics | 3–1–0 | 04 |
| IMA05001 | Introduction to Mathematical Methods | 3–1–0 | 04 |
| ---- | Elective-I | 3–1–0 | 04 |
| ---- | Elective-II | 3–1–0 | 04 |
| ---- | Seminar | | 02 |
| ---- | Comprehensive Viva | | 02 |
| | | **Total Credits** | **20** |
| | **SIXTH SEMESTER** | | |
| IMA05001 | Introduction to Complex Analysis | 3–1–0 | 04 |
| IMA05002 | Elementary Differential Geometry | 3–1–0 | 04 |
| ---- | Elective-III | 3–1–0 | 04 |
| ---- | Project | 0–0–4 | 02 |
| ---- | Seminar | | 02 |
| | | **Total Credits** | **16** |

| SEVENTH SEMESTER | | | |
|---|---|---|---|
| MMA01001 | Real Analysis | 3–1–0 | 04 |
| MMA01002 | Differential Equation | 3–1–0 | 04 |
| MMA01003 | Linear Algebra | 3–1–0 | 04 |
| MMA01004 | Data Structure using C | 3–1–0 | 04 |
| MMA01005 | Data Structure Lab | 0–0–3 | 02 |
| ---- | Comprehensive viva | | 02 |
| MCAC100-- | Audit III | | 00 |
| | | **Total Credits** | **20** |

| EIGHTH SEMESTER | | | |
|---|---|---|---|
| MMA02001 | Measure Theory and Integration | 3–1–0 | 04 |
| MMA02002 | Complex Analysis | 3–1–0 | 04 |
| MMA02003 | Topology | 3–1–0 | 04 |
| MMA02004 | Numerical Analysis | 3–1–0 | 04 |
| MMA02005 | Numerical methods using MATLAB | 0-0-3 | 02 |
| ---- | Seminar | | 02 |
| MCAC200-- | Audit IV | | 00 |
| | | **Total Credits** | **20** |

| NINTH SEMESTER | | | |
|---|---|---|---|
| MMA03001 | Functional Analysis | 3–1–0 | 04 |
| MMA03002 | Abstract Algebra | 3–1–0 | 04 |
| ---- | Elective IV | 3–1–0 | 04 |
| ---- | Open Elective | 3–1–0 | 04 |
| ---- | Seminar | | 02 |
| ---- | Dissertation–I | | 02 |
| | | **Total Credits** | **20** |

**TENTH SEMESTER**

| | | | |
|---|---|---|---|
| MMA04001 | Operations Research | 3–1–0 | 04 |
| ---- | Elective V | 3–1–0 | 04 |
| ----- | Elective VI | 3–1–0 | 04 |
| ----- | Industrial training/ Review/Internship training | | 02 |
| ----- | Dissertation–II | | 02 |
| | | **Total Credits** | **16** |

**Total Credit = 18+18+18+20+20+16+20+20+20+16 = 186**

## List of Elective Courses (Theory) or 5th Semesters

| | | | |
|---|---|---|---|
| IMAPE501 | Hydrodynamics | 3–1–0 | 04 |
| IMAPE502 | Elementary Graph theory | 3–1–0 | 04 |
| IMAPE503 | Elementary Combinatorics | 3–1–0 | 04 |

## List of Elective Courses (Theory) For 6th Semesters

| | | | |
|---|---|---|---|
| IMAPE601 | Elementary Number Theory | 3-1-0 | 04 |
| IMAPE602 | Fourier Series & Partial Differential Equations | 3-1-0 | 04 |
| IMAPE603 | Introduction to Linear Programming | 3-1-0 | 04 |

| | **List of Elective Courses (Theory) for 9th Semesters** | | |
|---|---|---|---|
| MMAPE301 | Statistical Method | 3–1–0 | 04 |
| MMAPE302 | Mathematical Modelling | 3–1–0 | 04 |
| MMAPE303 | Partial Differential Equation | 3–1–0 | 04 |
| MMAPE304 | Operator Theory | 3–1–0 | 04 |
| MMAPE305 | Analytic Number Theory | 3–1–0 | 04 |

## List of Open Elective Courses for 9th Semester

| | | | |
|---|---|---|---|
| MMAOE301 | Discrete Mathematical Structure | 3–1–0 | 04 |
| MMAOE302 | Matrix Algebra | 3–1–0 | 04 |
| MMAOE303 | Graph Theory | 3–1–0 | 04 |

## List of Elective Courses (Theory) For 10th Semesters

| | | | |
|---|---|---|---|
| | **Elective-V** | | |
| MMAPE401 | Cryptography | 3–1–0 | 04 |
| MMAPE402 | Vector Optimization | 3–1–0 | 04 |
| MMAPE403 | Applied Fluid dynamics | 3–1–0 | 04 |
| MMAPE404 | Advanced Abstract Algebra | 3–1–0 | 04 |
| | **Elective-VI** | | |
| MMAPE405 | Wavelet | 3–1–0 | 04 |
| MMAPE406 | Data Science | 3–1–0 | 04 |
| MMAPE407 | Advanced Complex analysis | 3–1–0 | 04 |
| MMAPE408 | Machine Learning | 3–1–0 | 04 |

Audit course 1 & 2

| Sl.No. | Course Code | Subject Name |
|---|---|---|
| 1. | MCAC--- | English for Research Paper Writing |
| 2. | MCAC--- | Disaster Management |
| 3. | MCAC--- | Sanskrit for Technical Knowledge |
| 4. | MCAC--- | Value Education |
| 5. | MCAC--- | Stress Management by Yoga |
| 6. | MCAC--- | Optimization Technique |
| 7. | MCAC--- | Constitution of India |
| 8. | MCAC--- | Pedagogy Studies |
| 9. | MCAC--- | Personality Development through Life Enlightenment Skills. |
| 10. | MCAC--- | Computational and Statistical Method |
| 11. | MCAC--- | Application of GIS |

## FIRST SEMESTER

**IMA01001 MATHEMATICS–I (ALGEBRA) 4 Credits [3-1-0]**

***Module–I***

Matrices: Matrix addition and multiplication, orthogonal matrix, normal matrix symmetric and skew symmetric matrix, complex matrices, block matrices, transpose of a matrix, elementary row operations, rank of matrix, inverse of a matrix using elementary row operation.

***Module–II***

Basic definitions and solution of system of linear equations, echelon form, canonical form, Gaussian elimination, homogeneous systems of linear equations, existence and uniqueness theorem of solutions, application to linear equations, eigenvalue and eigenvectors

***Module–III***

Vector space, subspace, span of a set, linear dependence and independence, dimension and basis, linear transformations, range and kernel, rank, nullity, inverse of linear transformation, rank nullity theorem, matrix representation of linear map, composition of linear maps.

***Module–IV***

Algebraic structure: Semigroup, group, homomorphism, subgroup, cosets, cyclic group, permutation group, normal subgroup.

***Module–V***

Ring: Definition, types of rings, ring homomorphism, ideals, quotient rings, integral domain, polynomial rings

***Reference Books:***


1. An Introduction to Linear Algebra, V Krishna Murty & V.P. Mainra, J.L. Arora (EWP), East West press Pvt. Ltd.
2. Linear Algebra, Seymour Lipschutz and Marc Lipson, Schaum‘s Outlines
3. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul: Basic Abstract Algebra, 2nd edition, Cambridge University Press.


**Course Outcomes:**

Upon completion of the course, the students will be able to:

| | |
|---|---|
| CO1 | Recognize the basic concept of Matrices and their uses |
| CO2 | Develop the solution system of linear equations with suitable applications |
| CO3 | Demonstrate the knowledge of Vector space and linear transformations |
| CO4 | Analyze basic group theory and applications |
| CO5 | Describe the basic concepts of ring theory |

**Course Articulation Matrix**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO2 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO3 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO4 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO5 | 3 | 1 | 3 | 3 | 2 | 1 |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| Course | 3 | 1 | 3 | 3 | 2 | 1 |

## SECOND SEMESTER

**IMA02001 MATHEMATICS-II (ANALYSIS-I) 4 Credits [3-1-0]**

***Module–I***

Algebra of real numbers, order, supremum and infimum of sets, completeness, density, decimal representation of real numbers, one to one correspondence of sets, countability, countability of *Q*, uncountability of *R*

***Module–II***

Open sets, closed sets, limit points of sets, interior, exterior and boundary of sets, Bolzano-Weierstrass theorem.

***Module–III***

Sequence and subsequence, Cauchy sequence, Weierstrass completeness principle, convergence of series, comparison test, Cauchy root test, D'Alembert test, limit, continuity of functions, properties of continuous functions, intermediate value theorem.

***Module–IV***

Differentiability of functions, mean value theorems, fixed point theorem, Taylor's theorem, maxima and minima.

***Module–V***

Riemann Integration: definition and existence of the integral, Darboux's theorem, fundamental theorem of calculus, mean value theorem for integration.

***Reference Books:***


1. Fundamental of Mathematical Analysis by G.Das & S.Pattnaik. TMH Publishing Co.
2. Mathematical Analysis by S.C. Mallik and S. Arora, New Age Science


**Course Outcomes:**

Upon completion of the course, the students will be able to:

| | |
|---|---|
| CO1 | Recognize the completeness property and countability of real numbers |
| CO2 | Demonstrate knowledge of topological properties of real numbers |
| CO3 | Implement the test of convergence of sequence and series |
| CO4 | Apply mean value theorems, fixed point theorem, Taylor's theorem |
| CO5 | Describe the concept of Riemann integration and apply fundamental theorem of calculus |

**Course Articulation Matrix**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO2 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO3 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO4 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO5 | 3 | 1 | 3 | 3 | 2 | 1 |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| Course | 3 | 1 | 3 | 3 | 2 | 1 |

## THIRD SEMESTER

**IMA03002 MATHEMATICS-III (ODE AND ANALYSIS II) 4 Credits [3-1-0]**

***Module–I***

Ordinary differential equation of first order and first degree, exact equations, integrating factors, equation reducible to linear form, first order equations of higher degree, homogeneous equations Clairaut's and Lagrange's equation.

***Module–II***

Second order linear equations: Constant and variable coefficients, Euler-Cauchy equations, method of undetermined coefficients, method of variation of parameters.

***Module–III***

Functions of several variables: Limit, continuity, partial derivatives, mean value theorem, differentiability, partial derivatives of higher order, Young's theorem (statement only), Schwartz theorem (statement only), derivatives of higher order, composite functions, change of variables, Taylor's theorem, Maclaurin's theorem, extremum values.

***Module–IV***

Implicit Functions, derivative of implicit functions, Jacobians, stationary values under subsidiary conditions, Lagrange's multipliers, improper integrals, Gamma and Beta functions,

***Module–V***

Integral theorems: Line integral, surface integral, differentiation under integral sign, surface and volume integrals, Gauss, Stokes and Green's theorem (without proof) with applications.

***Reference Books:***


1. A course on ordinary and partial differential Equation with Application- J. Sinha Roy & S. Padhy (Kalyani Publishers)
2. Mathematical Analysis by S.C. Mallik and S. Arora, New Age Science


**Course Outcomes:**

Upon completion of the course, the students will be able to:

| | |
|---|---|
| CO1 | Describe the solution of first order ordinary differential equations |
| CO2 | Demonstrate second order ordinary differential equations |
| CO3 | Recognize the concept of functions of several variables |
| CO4 | Apply derivatives of implicit functions to determine stationary values of functions of several variables |
| CO5 | Evaluate line integral, surface integral, volume integral and interrelate them |

**Course Articulation Matrix**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO2 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO3 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO4 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO5 | 3 | 1 | 3 | 3 | 2 | 1 |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| Course | 3 | 1 | 3 | 3 | 2 | 1 |

**IMA03004** **PROGRAMING IN C** **4 Credits [3-1-0]**

**Module 1:** **(08 Lectures)**

Introduction to computing- Block architecture of a computer, bit, bytes, memory, representation of numbers in memory. Introduction to problem solving- Basic concepts of an algorithm, program design methods, flowcharts. C Language Fundamentals- Character set, Identifiers, Keywords, Data Types, Constant and Variables, Statements. Input & Output - Input & Output Assignments, Formatted Outputs. Operators and Expressions-Operators, Precedence of operators.

**Module 2:** **(08 Lectures)**

Control structures, Decision making and Branching, Decision making & looping. Monolithic vs Modular programs, User defined vs standard functions, formal vs Actual arguments, Functions category, function prototypes, parameter passing, Recursion

**Module 3:** **(08 Lectures)**

Arrays- 1D Array, 2D Array & Multi-Dimensional Array. Strings- Declaration &Initialization, String Handling Functions, Pointers- Pointer variable and its importance, Pointer Arithmetic, Passing parameters, pointer to pointer, pointer to function. Dynamic Memory Allocation.

**Module 4:** **(08 Lectures)**

Structure- Nested Structure, Array of Structures, Pointer to Structure, Structure & Functions, Union- Array of Union Variables, Union inside Structure. Storage Classes: Auto, Extern, Global, Static

**Module 5:** **(08 Lectures)**

Development of Algorithms: Notations and Analysis, Storage structures for arrays, Stacks, Applications of Stack: Prefix, Postfix and infix expressions. Queues: Linear queue, Circular queue, Double ended queue.

**Text Books:**

1. E. Balaguruswamy "Programming in C", Tata McGraw Hill
2. Computer Fundamentals &Programming in C: ReemaThareja, Oxford University Press.

**Reference Books**:

1. Y.Kanetkar, "Let us C", BPB Publications.
2. Fundamentals of Data Structure, in c by Hariwitz and Sahni & Anderson Freed, University Press.
3. Data Structures by S.Lipschutz, Schaum's outline series in Computes

**Course Outcomes:**

Upon completion of the course, the students will be able to:

| | |
|---|---|
| CO1 | Develop basic knowledge on C Language Fundamentals |
| CO2 | Demonstrate Control structures, Decision making and Branching |
| CO3 | Apply the knowledge on array and pointers |
| CO4 | Demonstrate nested structure, array of structures, pointer to structure |
| CO5 | Demonstrate Stacks and Applications of Stack |

**Course Articulation Matrix**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO2 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO3 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO4 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO5 | 3 | 1 | 3 | 3 | 2 | 1 |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| Course | 3 | 1 | 3 | 3 | 2 | 1 |

**IMA03006** **PROGRAMING IN C LAB** **2 Credits [0-0-2]**

1. WAP to display student's data.
2. Input the roll no., name & marks in 4 subjects of a student. Calculate and print the total and average respectively.
3. WAP to Find LCM of two Numbers
4. WAP using do- while loop to display the square & cube of 1st n natural nos.
5. WAP to display prime numbers between Two Intervals
6. WAP to print Pascal's triangle
7. WAP of Simple Calculator using switch Statement
8. WAP to convert binary number to decimal
9. WAP to calculate the power using recursion
10. WAP to add two matrix using multi-dimensional arrays
11. WAP to Find the Frequency of Characters in a String
12. WAP to reverse an array using pointers
13. WAP to store information using structures with dynamically memory allocation

**Course Outcomes:**

Upon completion of the course, the students will be able to:

| | |
|---|---|
| CO1 | Demonstrate a working knowledge of writing basic C programming |
| CO2 | Demonstrate to use loop structure to write C program |
| CO3 | Demonstrate a basic mastery data handling |
| CO4 | Demonstrate to write programs using multi-dimensional arrays |
| CO5 | Demonstrate to store information using structures with dynamically memory allocation |

**Course Articulation Matrix**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 3 | 3 | 3 | 2 |
| CO2 | 3 | 2 | 3 | 3 | 3 | 2 |
| CO3 | 3 | 2 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 2 | 3 | 3 | 3 | 2 |
| CO5 | 3 | 2 | 3 | 3 | 3 | 2 |

**Program Articulation Matrix row for this Course**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| Course | 3 | 2 | 3 | 3 | 3 | 2 |

## FOURTH SEMESTER

**IMA04001 MATHEMATICS-IV (BASIC NUMERICAL ANALYSIS–I) 4 Credits [3-1-0]**

**Module 1:**
Definition and sources of errors, propagation of errors. bisection method, Newton's method, secant method, fixed point iteration method, solution of nonlinear equations.

**Module 2:**
Polynomial interpolation, Newton's divided differences, forward differences, backward differences, central differences, error in interpolation.

**Module 3:**
Numerical integration: Newton-Cotes integration formulas, trapezoidal rule, Simpson's 1/3rd rule, Gaussian quadrature, errors in numerical integration.

**Module 4:**
Existence and uniqueness of solution of ODE, Euler's method, midpoint method, improved Euler's method, Runge-Kutta Methods of order 4.

**Module 5:**
Numerical Solution of system of linear equations, Gauss elimination method, Gauss-Jordan elimination method

***Reference Books:***


1. An introduction to numerical analysis, Kendall E. Atkinson, John Wiley & Sons, Inc.
2. Numerical Analysis, B. P Acharya, Kalyani Publication.


**Course Outcomes:**

Upon completion of the course, the students will be able to:

| | |
|---|---|
| CO1 | Compile the roots of desired algebraic or transcendental equations |
| CO2 | Produce an interpolating polynomial for a given set of data with estimation of errors |
| CO3 | Apply numerical integration methods for computing definite integrals |
| CO4 | Describe the solution of ordinary differential equations by using numerical methods |
| CO5 | Demonstrate approximate solutions for system of linear equations |

**Course Articulation Matrix**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO2 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO3 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO4 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO5 | 3 | 1 | 3 | 3 | 2 | 1 |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| Course | 3 | 1 | 3 | 3 | 2 | 1 |

**IMA04002** **ELEMENTARY ALGEBRA** **4 Credits [3-1-0]**

**Module–I**

Review of sets and relations, ordering relations, the natural sequence, proofs by induction, cardinal numbers, cardinal arithmetic, order types, well-ordered sets and ordinal numbers.

**Module–II**

Axiom of choice, Well-ordering theorem, Zorn's lemma, Further properties of cardinal numbers, theorems equivalent to the axiom of choice, differences, integers, rational numbers, Cauchy sequences of rational numbers, real numbers.

**Module–III**

The Statement Calculus: Sentential connectives, truth tables, validity, consequences and applications.

The predicate calculus: Symbolizing everyday language, formulation, validity, consequences.

**Module–IV**

Informal Axiomatic Mathematics: Concept of axiomatic theory, informal theories, definitions of axiomatic theories by set-theoretical predicates.

Informal Axiomatic Set Theory: Axioms of extension and set formation, the axiom of pairing, the axioms of union and power set, the axiom of infinity, the axiom of choice, the axiom schemas of replacement and restriction.

**Module–V**

Boolean algebras: Definition, basic Properties, congruence relations, representations of Boolean Algebras, statement calculi as Boolean algebras, free Boolean algebras, applications of Boolean algebras.

***Reference Books:***


1. Robert R. Stoll: Set Theory and Logic, Dover Publications, Inc. New York.

**2.** Givant, Steven, Halmos, Paul: Introduction to Boolean Algebras, Springer, New York


**Course Outcomes:**

Upon completion of the course, the students will be able to:

| | |
|---|---|
| CO1 | Describe sets and relations and use method of induction to proof results |
| CO2 | Recognize axioms of choice and prove theorems equivalent to the axiom of choice |
| CO3 | Describe Statement Calculus and predicate calculus with their validation |
| CO4 | Demonstrate the concept of axiomatic theory |
| CO5 | Analyze Boolean algebra with applications |

**Course Articulation Matrix**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO2 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO3 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO4 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO5 | 3 | 1 | 3 | 3 | 2 | 1 |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| Course | 3 | 1 | 3 | 3 | 2 | 1 |

**IMA04003** **SOLID GEOMETRY** **4 Credits [3-1-0]**

***Module–I***

Introduction to coordinates, position vectors, unit vectors, direction cosines of a line, direction ratios, projection of a straight line, angle between two lines.

***Module–II***

Intercept form of a plane, normal form of a plane, angle between two planes, perpendicular distance of a point from a plane, plane through the intersection of two planes, planes through three given point.

***Module–III***

Equation of plane through a given point and parallel to given vectors, intersection of three planes, volume of the tetrahedron.

***Module–IV***

Curves, locus of the line intersecting two given lines and a given curve, surfaces, cylinder.

***Module–V***

Definitions of a sphere, sphere through four given points, plane section of a sphere, intersection of two spheres, intersection of a line and a sphere.

***Recommended Book:***

1. Coordinate Solid Geometry by B.D. Sharma, B.S. Tyagi, and Brahma Nand, Kedar Nath Ram Nath Publisher, Meerut, India.

**Course Outcomes:**

Upon completion of the course, the students will be able to:

| | |
|---|---|
| CO1 | Describe the concepts of three dimensional co-ordinate system and the geometry of lines in three dimensional space |
| CO2 | Recognize the elementary geometry of plane |
| CO3 | Apply knowledge of advance geometry of plane |
| CO4 | Define the locus of a line intersecting two given lines and a given curve in 3D |
| CO5 | Demonstrate working knowledge of geometry of sphere |

**Course Articulation Matrix**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO2 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO3 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO4 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO5 | 3 | 1 | 3 | 3 | 2 | 1 |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| Course | 3 | 1 | 3 | 3 | 2 | 1 |

## FIFTH SEMESTER

**IMA05001 INTRODUCTION TO PROBABILITY AND STATISTICS 4 Credits [3-1-0]**

***Module–I***

Sample space, events, definition of probability, Kolmogorov's axioms, proving axioms, inclusion-exclusion principle, sampling, conditioning and independence, mutual independence, properties of independence, the theorem of total probability, Bayes' theorem.

***Module–II***

Random variables, probability distributions, binomial, Poisson and hypergeometric distributions, normal distributions.

***Module–III***

Function of a random variables, joint distributions, transformation of random variables, central limit theorem.

***Module–IV***

Mean and variance of a distribution, moments, moment generating function, special discrete and continuous distributions.

***Module–V***

Estimation of Parameters, maximum likelihood method, confidence intervals, testing of hypotheses, (simple parameter only), Type-I and Type-II errors, power functions.

***Books recommended:***


1. Notes on probability, by Peter J. Cameron. (http://www.maths.qmul.ac.uk/~pjc/notes/prob.pdf)

2. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley India Pvt. Ltd, 9th edition


**Course Outcomes:**

Upon completion of the course, the students will be able to:

| | |
|---|---|
| CO1 | Describe mathematical model of chance in day to day life |
| CO2 | Incorporate chances of events through mathematical model of approximation |
| CO3 | Demonstrate a working knowledge of probability through the mathematical model of chance theory and strengthen the perception using parameters (Mean, Median, MGF). |
| CO4 | Express create dependence or independence of appreciation/depreciation of one commodity with other(s) |
| CO5 | Apply probability and statistical inferences to predication theory |

**Course Articulation Matrix**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO2 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO3 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO4 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO5 | 3 | 1 | 3 | 3 | 2 | 1 |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| Course | 3 | 1 | 3 | 3 | 2 | 1 |

**IMA05002 INTRODUCTION TO MATHEMATICAL METHODS 4 Credits [3-1-0]**

***Module–I***

***Fourier Series:*** Periodic functions, expansion of 2π and arbitrary periodic, Fourier series of even and odd functions, half rage expansions.

***Module–II***

***Laplace Transforms:*** Definition, existence theorem, inverse transform, shifting, transforms of derivatives and integrals, solution of differential and integral equations, convolution.

***Module–III***

***Integral Equations:*** Classification of integral equations, Neumann's iterative method for Fredholm's equation of second kind.

***Module–IV***

***Integral Equations:*** Volterra type integral equation, Integral equations of first kind and different properties.

***Module–V***

***Calculus of Variations*:** Functionals, variation of functionals, example of variation problems, Euler's equation, sufficient conditions for the extremum of a functional.

***Reference Books:***


1. E. Kreyszig, *Advanced Engineering Mathematics*, 9th Edition, John Wiley and Sons.
2. I. M. Gelfand and S. V. Fomin, *Calculus of Variations*, Dover Publications
3. I.N. Sneddon, *The Use of Integral Transforms,* Tata McGraw Hill


**Course Outcomes:**

Upon completion of the course, the students will be able to:

| | |
|---|---|
| CO1 | Write the Fourier series for periodic functions |
| CO2 | Describe Laplace transforms of functions and apply it to solve differential equations |
| CO3 | Recognize the classification of integral equations and solve Fredholm's equation of 2nd kind |
| CO4 | Analyze Volterra type integral equations of 1st kind with different properties |
| CO5 | Demonstrate the concept of functional and find the extremum of a functional |

**Course Articulation Matrix**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO2 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO3 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO4 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO5 | 3 | 1 | 3 | 3 | 2 | 1 |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| Course | 3 | 1 | 3 | 3 | 2 | 1 |

## SIXTH SEMESTER

**IMA06001 INTRODUCTION TO COMPLEX ANALYSIS 4 Credits [3-1-0]**

***Module–I***

Complex numbers: Definition and geometric interpretation, square roots, rational powers of complex numbers, topology of complex plane, limit, continuity and differentiability, analytic function.

***Module–II***

Cauchy Riemann equations, Laplace's equation, linear fractional transformations, complex integration, line integral in the complex plane, Cauchy's integral theorem, Cauchy's integral formula.

***Module–III***

Sequences and Series: Convergence tests (comparison test, geometric series test, ratio test, root test) power series, functions given by power series, radius of convergence.

***Module–IV***

Taylor's and Laurent's series, maximum modulus principle, Schwarz lemma

***Module–V***

Zeros and Singularities: Location and types of singularities, residue theorem, residue integration, evaluation of real integrals

***Reference Books:***


1. J. B. Conway, Functions of one complex variable, Springer, 1978.
2. Foundations of Complex Analysis (Second Edition), Narosa, S. Ponnusamy.
3. Complex Variable and applications, Brown and Churchill, Tata Mc Graw Hill


**Course Outcomes:**

Upon completion of the course, the students will be able to:

| | |
|---|---|
| CO1 | Analyze the difference between differentiability and analyticity and its interconnection with Laplace equation |
| CO2 | Demonstrate fundamental exhibition and explanation of complex integration |
| CO3 | Identify the existence of power series for functions under certain condition |
| CO4 | Analyze the technical twist existing in construction of Laurent series in presence of singular point |
| CO5 | Describe comprehension and cognition of the role of coefficient in Laurent series in evaluation of complex integral, identify location and types of singularities and evaluate the real integrals using residue theorem |

**Course Articulation Matrix**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO2 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO3 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO4 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO5 | 3 | 1 | 3 | 3 | 2 | 1 |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| Course | 3 | 1 | 3 | 3 | 2 | 1 |

**IMA06002 ELEMENTARY DIFFERENTIAL GEOMETRY 4 Credits [3-1-0]**

***Module–I***

Arc length, tangent, normal, binormal, tangent and osculating plane, principal normal and binormal, curvature and torsion, Serret-Frenet formulae.

***Module–II***

Curves on a surface, contact between curves and surfaces, osculating circle and osculating sphere, tangent surfaces, intrinsic equation of space curves.

***Module–III***

Fundamental existence theorems for space curves, surface representation, regular and singular points, tangent plane and normal, surfaces of revolution.

***Module–IV***

Metric on a surface, invariance of the metric, direction coefficients on a surface.

***Module–V***

Canonical geodesic equations, geodesics on a surface of revolution

***Reference Books:***


1. C. E .Weatherburn, Differential Geometry, Cambridge Univ. Press
2. D. Somasundaram, *Differential Geometry: A First Course*, Alpha Science International Ltd, 2004.


**Course Outcomes:**

Upon completion of the course, the students will be able to:

| | |
|---|---|
| CO1 | Apply Seret-Frenet formula |
| CO2 | Recognize geometry of surfaces |
| CO3 | Organize space curves |
| CO4 | Describe surface representation and metric on a surface |
| CO5 | Demonstrate geodesics on a surface of revolution |

**Course Articulation Matrix**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO2 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO3 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO4 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO5 | 3 | 1 | 3 | 3 | 2 | 1 |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| Course | 3 | 1 | 3 | 3 | 2 | 1 |

# List of elective for 5th Semester

**IMAPE501 HYDRODYNAMICS 4 Credits [3-1-0]**

***Module–I***

Definitions and Basic concepts of Kinematics, Lagrangian and Eulerian methods, Equation of continuity, Boundary surfaces, Stream Line, Path lines and streak lines, Velocity potential, Some problems and examples.

***Module–II***

Irrotational motions and rotational motions, Lagrange's equations of motion,Euler's equations of motion, Pressure equation, Equation for impulsive action,Some problems and examples.

***Module–III***

Bernoulli's theorem,Flow and circulation, Permanence of irrotational motion, Stream function, Irrotational motion in two-dimensions, Complex velocity potential, Sources and Sinks.

***Module–IV***

Two-dimensional irrotational motion produced by motion of circular and elliptic cylinders in a liquid, Kinetic energy of liquid.

***Module–V***

Blasius theorem for steady two dimensional flow, Stoke's stream function, Vortex motion, Vortex lines, Motion due to circular and rectilinear vortices.

***Reference Books:***


1. W.H. Besaint and A.S. Ramsey: A Treatise on Hydrodynamics, Part II, C.B.S. Publishers, Delhi, 1988.
2. M.D. Raisinghania, Fluid dynamics with complete hydrodynamics and Boundary layer Theory, S Chand Co Publisher, 2014
3. B.G. Verma: Hydrodynamics, PragatiPrakashan, Meerut, 1995.


**Course Outcomes:**

Upon completion of the course, the students will be able to:

| | |
|---|---|
| CO1 | Recognize the properties of fluids with examples |
| CO2 | Identify different equations of fluid motions |
| CO3 | Apply Bernoulli's theorem |
| CO4 | Demonstrate fluid motion in two-dimensions |
| CO5 | Describe stream function and motion due to circular and rectilinear vortices |

**Course Articulation Matrix**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO2 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO3 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO4 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO5 | 3 | 1 | 3 | 3 | 2 | 1 |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| Course | 3 | 1 | 3 | 3 | 2 | 1 |

**IMAPE502** **ELEMENTARY GRAPH THEORY** **4 Credits [3-1-0]**

***Module–I***

Graphs and Subgraphs: Definitions and examples, Degrees, Subgraphs, Graph Isomorphism, handshaking theorem, operations on graphs

***Module–II***

Digraph: Basic terminology, the Incidence and adjacency matrices, connectivity.

***Module–III***

Euler tours and Hamilton cycles: Euler tours, Hamilton cycles, The Chinese Postman problem, The Travelling Salesman problem

***Module–IV***

Trees: Trees and properties, simple theorems, rooted trees and properties.

***Module–V***

Plannar graphs, Kuratowski's graphs, Euler's formula and associated theorems.

***Reference Books:***


1. J.A. Bondy and U.S.R. Murty, Graph Theory with Applications, North Holland 1982. Chapters: 1,2,3,4.
2. Douglas B. West, Introduction to Graph theory, 2nd Edition, Prentice Hall.


**Course Outcomes:**

Upon completion of the course, the students will be able to:

| | |
|---|---|
| CO1 | Recognize basic knowledge of graphs |
| CO2 | Describe directed graphs with properties |
| CO3 | Demonstrate Euler tours and Hamilton cycles |
| CO4 | Define trees and spanning trees with different properties |
| CO5 | Demonstrate Planar graphs with applications |

**Course Articulation Matrix**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO2 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO3 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO4 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO5 | 3 | 1 | 3 | 3 | 2 | 1 |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| Course | 3 | 1 | 3 | 3 | 2 | 1 |

**IMAPE503 ELEMENTARY COMBINATORICS 4 Credits [3-1-0]**

Unit- I

Principle of counting-I: The rules of sum and product, permutations, combinations, binomial & multinomial theorems,

Unit- II

Principle of counting-II: Catalan numbers, Ramsay numbers, Stirling numbers and Bell numbers.

Unit- III

Principle of counting-III: The pigeonhole principle, the principle of inclusion and exclusion, derangements, Rook polynomials.

Unit- IV

Generating functions: ordinary generating functions, convolution of sequences, counting technique, exponential generating function.

Unit- V

Recurrence relations: First order relations, second & higher order linear homogeneous relations, linear non-homogeneous relations of second & higher orders, method of generating functions.

***Reference Books:***


1. V. K. Balakrishnan, *Theory and Problems of Combinatorics*, McGraw Hill, 1994
2. J. H. Van Lint and R.M. Wilson, *A Course in Combinatorics*, Cambridge University Press, 2001
3. C.L.Liu, Discrete Mathematics


**Course Outcomes:**

Upon completion of the course, the students will be able to:

| | |
|---|---|
| CO1 | Describe combinatorial proofs of various problems |
| CO2 | Recognize the properties of numbers of different kinds |
| CO3 | Apply use pigeonhole principle in different problems of interest |
| CO4 | Incorporate the solution of recurrence relations using generating functions |
| CO5 | Demonstrate a working knowledge of recurrence relations in different applied fields |

**Course Articulation Matrix**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO2 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO3 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO4 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO5 | 3 | 1 | 3 | 3 | 2 | 1 |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| Course | 3 | 1 | 3 | 3 | 2 | 1 |

## List of Elective Paper for 6th Semester

**IMAPE601 ELEMENTARY NUMBER THEORY 4 Credits [3-1-0]**

***Module–I***

***Divisibility:*** Division Algorithm, Prime and composite numbers, Fibonacci and Lucas Numbers, Fermat numbers, Greatest common divisors, Euclidean algorithm, Fundamental theorem of arithmetic, Least common multiple, Linear Diophantine equations

***Module–II***

***Congruences:*** Linear congruences, Pollard rho factoring methods, Divisibility test, Complete residue systems, System of linear congruences, The Chinese remainder theorem.

***Module–III***

Wilson's theorem, Fermat's little theorem, Euler's theorem, Multiplicative functions, Euler's phi function, Tau and sigma functions, Perfect numbers.

***Module–IV***

Mersenne primes, The Mobius function, Primitive roots and indices, Order of a positive integer, Primality test

***Module–V***

***Cryptology:*** Affine ciphers, Hill ciphers, Exponentiation ciphers, The RSA cryptosystem, The Knapsack ciphers.

***Recommended Book:***

1. T. Koshy, *Elementary Theory of numbers with Applications*, 2nd Edition, Academic Press, 2007.

**Course Outcomes:**

Upon completion of the course, the students will be able to:

| | |
|---|---|
| CO1 | Recognize elementary properties of numbers, use fundamental theorem of arithmetic and solve linear Diophantine equations |
| CO2 | Apply the theory of congruence to day to day life and solve system of linear congruences |
| CO3 | Apply the three important theorems in various number theoretic problems |
| CO4 | Define the primality of a number |
| CO5 | Demonstrate a working knowledge of various ciphers |

**Course Articulation Matrix**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO2 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO3 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO4 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO5 | 3 | 1 | 3 | 3 | 2 | 1 |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| Course | 3 | 1 | 3 | 3 | 2 | 1 |

**IMAPE602 FOURIER SERIES AND PDE 4 Credits [3-1-0]**

**Module I**
Fourier series, convergence of Fourier series, Fourier series of arbitrary period, Half range expansions, Approximation by Trigonometric polynomials.

**Module II**
Fourier integrals, Fourier transforms, Inverse Fourier transform, Convolution theorem, Discrete Fourier transforms.

**Module III**
Partial Differential Equations, first and second order partial differential equations, Solutions of wave equation.

**Module–IV**
Solution of Heat equation and Laplace's equation and their use in problems of vibrating string, one dimensional unsteady heat flow and two dimensional steady state heat flow.

**Module–V**
Modeling Membrane; Two dimensional wave equation: Rectangular membrane, solution of PDE by Laplace transformations.

***Reference Books:***


1. E. Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley and Sons.
2. K. Sankara Rao, Introduction to Partial Differential Equations, PHI Publications, Third Edition
3. N. Sneddon, Elements of Partial Differential Equations, Dover Publications, 2006.


**Course Outcomes:**
Upon completion of the course, the students will be able to:

| | |
|---|---|
| CO1 | Define periodic phenomenon and Fourier series expansion of periodic function |
| CO2 | Analyze the theory and applications of Fourier Transform |
| CO3 | Recognize first and second order PDE |
| CO4 | Describe the modeling in one dimension |
| CO5 | Demonstrate the modeling in two dimension |

**Course Articulation Matrix**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO2 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO3 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO4 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO5 | 3 | 1 | 3 | 3 | 2 | 1 |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| Course | 3 | 1 | 3 | 3 | 2 | 1 |

**IMAPE603 INTRODUCTION TO LINEAR PROGRAMMING 4 Credits [3-1-0]**

***Module–I***

Basic linear algebra, Lines and hyper planes, convex sets, convex hull, convex polyhedron, convex cone, simplex and convex function and their properties, fundamental theorem.

***Module–II***

Formulation of a linear programming problem, theorems dealing with vertices of feasible regions and optimality, graphical method, solution procedure, solution in some exceptional cases, standard form, matrix form.

***Module–III***

Introduction to simplex method, fundamental properties of solutions, computational procedure of simplex methods, infeasible and unbounded LPP's, alternate optima.

***Module–IV***

Duality: Primal and Dual Problem, Duality & Simplex method, Dual Simplex Method

***Module–V***

Transportation Problem, Properties of transportation matrix, N-W corner rule, Vogel's approximation method, and Transportation algorithm, Assignment Problem.

***Reference Books:***


1. H. A. Taha, *Operations Research: An Introduction*, Pearson Education Limited, 2011.
2. F. S. Hillier and G. J. Lieberman, *Introduction to Operation Research*, Tsinghua University Press, 2006.
3. K. Swarup, P. K. Gupta, Manmohan, *Operations Research*, Sultan Chand & Sons, 1990.


**Course Outcomes:**

Upon completion of the course, the students will be able to:

| | |
|---|---|
| CO1 | Describe the role of convexity in Linear programming problems (LPPs) |
| CO2 | Formulate and solve LPPs involving 2 decision variables |
| CO3 | Recognize the computational procedure of solutions of general LPPs |
| CO4 | Demonstrate dual forms of LPPs and related theorems |
| CO5 | Analyse transportation and assignment problems |

**Course Articulation Matrix**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO2 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO3 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO4 | 3 | 1 | 3 | 3 | 2 | 1 |
| CO5 | 3 | 1 | 3 | 3 | 2 | 1 |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| Course | 3 | 1 | 3 | 3 | 2 | 1 |

**N.B. The 5 year Integrated M.Sc. syllabus for 7$^{th}$, 8$^{th}$, 9$^{th}$ and 10$^{th}$ semesters is same as the syllabus of 2 year Applied M.Sc. 1$^{st}$, 2$^{nd}$, 3$^{rd}$ and 4$^{th}$ semesters respectively.**