Learning Outcomes based Curriculum Framework

(LOCF)

B.A./B.Sc. (Honours) Mathematics
Under
Choice Based Credit System

Semester Scheme with Multiple Entry and Exit Option for Under Graduate Course

2022 -23 onwards

SEMESTERS
(I, II, III, IV, V, VI, VII, VIII)

DEPARTMENT OF MATHEMATICS
ORIENTAL COLLEGE(AUTONOMOUS),
TAKYEL, IMPHAL

Department of Mathematics, Oriental College (Autonomous), Imphal

Syllabus for

Bachelor of Science/Arts in Mathematics

4 – Year UG Programme Course

Starting year of implementation: 2022 – 2023

1. Programme objectives:

The Objectives of the B.A/B.Sc. Mathematics (Honours) 4 Year UG Programme under the Choice Based Credit System (CBCS) are to develop the ability of

- Simplicity and lucidity of pre-presentation
- Critical analysis
- Logical and analytical thinking
- Convenient and powerful way of examining

The program covers the full range of mathematics. The course has a structured foundation of Algebra, Metric Space, Calculus, Geometry, Differential Equations, Discrete Mathematics, Vector Analysis, Sets and Logic, Tensor, Complex Analysis, Numerical Analysis, Probability Theory, Theory of Relativity, Computer Science and Programming, Graph Theory, Cryptography, Information Security, Higher Mechanics, Astronomy, Mathematical Modelling, Computational Mathematics Laboratory.

There are opportunities for the students who have passed B.A./B.Sc. Mathematics. They can pursue their higher studies in different areas. They can also look for jobs in different fields in private and public sector. There are wide scope of Mathematics in teaching and research fields.

2. Programme learning outcomes:

After completion of the programme, a student shall enable to understand

- Numerical, analytical and logical skills.
- Better problem solving skills.
- Real world applications.
- Understand the world better.
- Understand hypothesis, theories and proofs.

2.1. Disciplinary knowledge: Bachelor degree in Mathematics is the culmination of in-depth knowledge of Algebra, Calculus, geometry, Real analysis, Differential equations and several other branches of pure and applied mathematics, This also leads to study of relevant areas such as computer science and other disciplines.

2.2. **Communication Skills**: Ability to communicate the various mathematical concepts effectively using variety of examples mostly having real life applications and their geometric visualization. The skills and knowledge gained in this programme will lead to the proficiency in analytical reasoning which can be used to express thoughts and views in mathematically or logically correct statements.

2.3. Critical thinking and analytical reasoning: The students undergoing this program acquire the ability of critical thinking and logical reasoning and will apply in formulate or generalizing specific hypothesis conclusion. The learner will be able to recognize and distinguish the various aspects of real life problems.

2.4. **Problem solving**: The Mathematical knowledge gained by the student through this programme develops an ability to solve the problems, identify and define appropriate computing requirements for its solutions. This programme will enhance the overall development

2.5. **Research related skills**: After the completion of this programme, the student will develop the capability of inquiring about appropriate questions relating to the Mathematical concepts, arguments. He/she will be able to define problems, formulate hypothesis, proofs, write the results obtained clearly.

2.6. **Information/ digital literacy**: The completion of this programme will enable the learner to use appropriate softwares to solve the system of algebraic and differential equations.

2.7. **Self-directed learning**: The student after the completion of the programme will be to work independently, make an in-depth search of various areas of Mathematics and resources for self learning in order to enhance knowledge in Mathematics.

2.8. **Moral and ethical awareness / reasoning**: The student after the completion of the Course will develop an ability to identify unethical behavior such as fabrication falsification or misinterpretation of data and adopting objectives, unbiased and truthful actions in all aspects of life in general and Mathematical studies in particular.

2.9. **Lifelong learning**: This programme provides self directed learning and lifelong learning skills. With these skills, the learner will be able to think independently improve personal development.

3. **Programme Structure:**
The B.A. /B. Sc. Mathematics (Honours) program is a four year course divided into eight Semesters. A student is required to complete 182 credits for the completion of course and the award of degree in 4 years.

		Semester	Semester		Credits
Part I	First year	I	II	Bachelor'sCertificate in Mathematics (Level 5)	Minimum 46
Part II	Second year	III	IV	Bachelor's Diploma in Mathematics (Level 6)	Minimum 96
Part III	Third year	V	VII	Bachelor's Degree in Mathematics (Level 7)	Minimum 140
Part IV	Fourth year	VI	VIII	Bachelor's Degree with Honours in Mathematic (Level 8)	Minimum 182

The main components of this syllabus are as follows

1. **Discipline Specific Core Courses: (DSC).**
A course that should compulsorily be studied by a candidate as a core requirements is termed as a core course. All the courses have 6 credits with 4 credits of theory and 2 credits of practical or 5 credits of theory and 1 credit of tutorial.

2. **Discipline Specific Elective Courses(DSE):**
A course, which may be offered by the main discipline/subject of study, is referred to as Discipline Specific Elective. All the courses have 6 credits with 4 credits of theory and 2 credits of practical or 5 credits of theory and 1 credit of tutorial.

3. **Generic Elective Courses (GE):**
An elective course, chosen generally from an unrelated discipline/subject of study with intention to seek an exposure, is called a Generic Elective Course.
All the courses have 6 credits with 4 credits of theory and 2 credits of practical or 5 credits of theory and 1 credit of tutorial.

Ability Enhancement Course(AEC):
The Ability Enhancement Course may be of two kinds:

3.1. Ability Enhancement Compulsory Course (AECC):
All the courses have 4 credits including Theory/Practical/Projects.

3.2. Skill Enhancement Courses (SEC):
All the courses have 4 credits with 3 credits of theory and 1 credit of Practical/Tutorial/Projects and Field Work to be decided by the Department.

4. **Value Addition Courses**: Value Addition Course have 2 credits each.

5. **Dissertation/Project Work is** considered as a special course involving application of knowledge in solving/analyzing/exploring a real life situation/difficult problem. A Project/Dissertation work would be of 6 credits. A Project/ Dissertation work may be given in lieu of a discipline specific elective paper.

Assessment

Weightage for the Assessments (in percentage)

Type of Course	Formative Assessment(I.A)	Summative Assessment (S.A)
Theory	40%	60%
Practical	40%	60%
Projects	40%	60%
Experimental Learning (Internship etc.)		

Department of Mathematics, Oriental College (Autonomous), Imphal
4 – Year UG Programme Course Structure with honours in Mathematics

Sem.	**(A) Bachelor's Certificate in Mathematics (Level 5)** Year I (Level 5) total credits: 2 Semester×24=48 **Award of Certificate in Mathematics(after 1st Year: minimum 46(forty six) Credits**					
	Discipline specific Core Course (CC)	Discipline Specific Elective Course (HE)	Generic Elective Course (HG)	Skill Enhancement Course(SEC)	Ability Enhancement Compulsory Courses	Value Addition Courses (VAC)
	CC(18 courses x 6 credit each =108credits)	#DSEC(4 courses x 6 credit each=24credits)	HG (6 coursesx 6 credit each=36credits)	SEC(2 courses x 4 credit each=8)	AECC(2 coursesx4 credit each=8)	VAC (8 coursesx 2credit Each=16)
I	MAT - HC - 501			MAT-SE – 501/ MAT-SE – 501	GEN-AE 1 / MAN-AE - 1	VAC 1
	MAT - HC - 502					VAC 2
II	MAT – HC - 503			MAT-SE 502/ MAT-SE 502	EVS-AE - 2	VAC 3
	MAT – HC - 504					VAC 4
	(B) Bachelor's Diploma in Mathematics (Level 6) Year II (Level 6) total credits: 2 Sem. x 26=52 **Award of Diploma in Mathematics(after 2nd Year: minimum 96(ninety six) Credits**					
III	MAT-HC- 601		MAT-HG - 601			VAC 5
	MAT-HC- 602					
	MAT-HC- 603					
IV	MAT-HC- 604		MAT-HG- 602			VAC 6
	MAT-HC- 605					
	MAT-HC- 606					
	(C) Bachelor's Degree in Mathematics (Level 7) Year III (Level 7) total credits: 2 Sem. x 26=52 **Award of Degree in Mathematics(after3rd Year:minimum140(one hundred forty) Credits**					
V	MAT-HC - 701	MAT-HE-701/ MAT-HE-701/ MAT-HE-701	MAT-HG - 701			VAC 7
	MAT- HC - 702					
VI	MAT-HC - 703	MAT-HE 702 / MAT-HE 702/	MAT-HG - 702			VAC 8
	MAT-HC - 704					
	(D) Bachelor's (Hons) Degree in Mathematics (Level 8) Year IV (Level 8) total credits: 2 Sem. x 24=48 **Award of B A/B Sc Degree with honours in Mathematics on completion of course equal to minimum of 182(one hundred eighty-two)**credits					
VII	MAT-HC - 801	MAT-HE – 801/ MAT-HE- 801 / MAT-HE- 801	MAT-HG - 801			
	MAT-HC - 802					
VIII	MAT-HC- 803	MAT-HE – 802/ MAT-HE – 802/ MAT-HE – 802/ Research projects	MAT-HG - 802			
	MAT-HC- 804					

TOTAL:CC: 18 courses for 108 credits;DSEC: 4 courses for 24 credits; GEC; 6 courses for 36 credits;SEC: 2
courses for 8 credits; AECC: 2 courses for 8 credits; VAC: 8 courses for 16 credits
(altogether 40 courses/papers& 200 Credits)
DSEC option courses should represent the major branches of the Discipline/.MAT represents Mathematics

Core course= Hons. Discipline Specific Core Course (18 papers of 6 credit each) – **Course Code: HC**
AECC=Ability Enhancement Compulsory Course (2 papers of 4 credit each)- **Course Code: AE**
SEC= Skill Enhancement Course (2 papers of 4 credit each) - **Course Code: SE**
DSEC= Discipline Specific Elective Course (4 papers of 6 credit each) - **Course Code: HE**
GEC= Generic Elective Course (6 papers of 6 credit each) - **Course Code: HG**
VAC= Value Addition Courses (cf- Graduate Descriptors)

- Award of Bachelor's **Degree with Honours** in a Discipline on completion of courses equal to **minimum** 182 credits in 4 years
- Award of Bachelor's **Degree with pass certificate** in a Discipline on completion of courses equal to **minimum** 140 credits in 3 years
- Award of Bachelor's **with Diploma** in a Discipline on completion of courses equal to **minimum** 96credits in 2 years
- Award of Bachelor's **with Certificate** in a Discipline on completion of courses equal to **minimum** 46credits in 1 year

Department of Mathematics, Oriental College (Autonomous), Imphal

Course Structure

SEMESTER – WISE DISTRIBUTION OF COURSES

A. Discipline Specific Core Courses: (DSC).

Sl.No.	CC Paper Code	Semester	Course Name
1	MAT-HC-501	I	Calculus
2	MAT-HC-502	I	Algebra , Complex Trigonometry & Logic
3	MAT-HC-503	II	Real Analysis
4	MAT-HC-504	II	Differential Equations
5	MAT-HC-601	III	Theory of Real Functions
6	MAT-HC-602	III	Computer Science & Programming in C
7	MAT-HC-603	III	Multivariate Calculus
8	MAT-HC-604	IV	Partial Differential Equations
9	MAT-HC-605	IV	Riemann Integration
10	MAT-HC-606	IV	Numerical Analysis
11	MAT-HC-701	V	Metric Spaces
12	MAT-HC-702	V	Mechanics(Dynamics & Statics)
13	MAT-HC-703	VI	Complex Analysis
14	MAT-HC-704	VI	Group, Ring Theory and Linear Algebra
15	MAT-HC-801	VII	Laplace Transform & Vectors
16	MAT-HC-802	VII	Advanced Real Analysis
17	MAT-HC-803	VIII	Probability Theory
18	MAT-HC-804	VIII	Mathematical Modelling

B. Discipline Specific Elective Courses(DSE):

Sl. No.	DSE Paper Code	Semester	DSE Name
1.	MAT-HE-701	V	Information Security/Spherical Trigonometry & Astronomy/Advanced Computational Mathematics Laboratory
.2	MAT-HE-702	VI	Graph Theory /Linear Programming and its applications
3	MAT-HE – 801	VII	Geometry(two & Three Dimensions) /Special Theory of Relativity/ Cryptography
4	MAT – HE – 802	VIII	Rigid Dynamics & Tensor/Higher Mechanics/Fluid Mechanics/Research Projects.

C. Skill Enhancement Courses (SEC):

Sl No.	DSE Paper Code	Semester	SEC Name
1.	MAT- SE -501	I	La*TeX* /Computational Mathematics Laboratory
2	MAT -SE-502	II	Python Programming / Computer Algebra Systems and Related Software

- **Practical/Tutorials/Projects and FieldWork to be decided by the Department.**

D.Ability Enhancement Compulsory Courses:

Sl No.	AECC Paper Code	Semester	AECC Name
1.	GEN- AE 1	I	English/MIL
2.	EVS- AE -2	II	Environmental Science

E.Generic Elective Courses:

Sl.No.	GEC PaperCode	Semester	GEC Name
1.	MAT-HG-601	III	Quantitative Aptitude
2.	MAT-HG-602	IV	Basic Tools of Mathematics
3.	MAT-HG-701	V	Sets, Determinants and Logic
4.	MAT- HG-702	VI	Analytical Geometry of Two & Three Dimensions
5.	MAT- HG-801	VII	Elements of Probability
6.	MAT-HG-802	VIII	Mechanics

F. Value Addition Courses:

Sl.No	VAC Paper Code	Semester	VAC Name
1.	VAC-1	I	---
2.	VAC-2	I	---
3.	VAC-3	II	---
4.	VAC-4	II	---
5.	VAC-5	III	---
6.	VAC-6	IV	---
7.	VAC-7	V	---
8.	VAC-8	VI	---

Department of Mathematics, Oriental College (Autonomous), Imphal

Contents of Courses for B.A./B.Sc. degree with honours in Mathematics

Under Choice Based Credit System

Award of Bachelor of Arts (B. A.) / Science (B. Sc.) Mathematics (Honours)

Semester	Course	Course Code	Course Name	Credits	Remarks
I	Core (CC)	MAT-HC-501	Calculus (Theory)	4+2=6	Compulsory
		MAT-HC-501 (P)	Calculus (Practical)		
		MAT-HC-502	Algebra , Complex Trigonometry&Logic (Theory with tutorial)	5+1=6	
	Skill Enhancement (SEC)	MAT-SE-501	LaTeX / Computational Mathematics Laboratory (Theory)	3+1=4	Compulsory
		MAT-SE-501(P)	LaTeX /Computational Mathematics Laboratory (Practical)		
	Ability Enhancement (AECC)	GEN-AE-1	General English	3+1=4	Choose any one & Compulsory
		GMA- AE -1	General Manipuri (MIL)		
	Value Addition (VAC)	VAC - 1	-	2	Compulsory
		VAC - 2		2	
II	Core (CC)	MAT-HC-503	Real Analysis (Theory with tutorial)	5+1=6	Compulsory
		MAT-HC-504	Differential Equations (Theory)	4+2=6	
		MAT-HC-504(P)	Differential Equations (Practical)		
	Skill Enhancement (SEC)	MAT-SE-502	Python Programing / Computer Algebra Systems and Related Software (Theory)	3+1=4	Compulsory
		MAT-SE-502(p)	Python Programing / Computer Algebra Systems and Related Software (Practical)		
	Ability Enhancement	EVS – AE- 2	Environmental Science	3+1=4	

	(AECC		**(Theory with tutorial)**		**Compulsory**
	Value Addition (VAC)	**VAC - 3**	**-**	**2**	
		VAC - 4		**2**	
III	**Core (CC)**	**MAT-HC-601**	**Theory of Real Functions (Theory with tutorial)**	**5+1=6**	**Compulsory**
		MAT-HC-602	**Computer Science & Programing**	**4+2=6**	
		MAT-HC-603	**Multivariate Calculus (Theory with tutorial)**	**5+1=6**	
	Generic Elective (GEC)	**MAT-HG-601**	**Quantitative Aptitude (Theory with tutorial)**	**5+1=6**	**For the students of other discipline**
	Value Addition (VAC)	**VAC - 5**	**--**	**2**	**Compulsory**
IV	**Core (CC)**	**MAT-HC-604**	**Partial Differential Equations (Theory with tutorial)**	**5+1=6**	**Compulsory**
		MAT-HC-605	**Riemann Integration (Theory with tutorial)**	**5+1=6**	
		MAT-HC-606	**Numerical Analysis (Theory)**	**4+2=6**	
		MAT-HC-606(P)	**Numerical Analysis (Practical)**		
	Generic Elective (GEC)	**MAT-HG-602**	**Basic Tools of Mathematics**	**5+1=6**	For the students of other discipline
	Value Addition (VAC)	**VAC - 6**	**-**	**2**	
V	**Core (CC)**	**MAT-HC-701**	**Metric Spaces (Theory with tutorial)**	**5+1=6**	**Compulsory**
		MAT-HC-702	**Mechanics (Theory with tutorial)**	**5+1=6**	
	Discipline Specific Elective (DSEC)	**MAT-HE-701**	**Information Security/ Spherical Trigonometry and Astronomy/Advanced computational Mathematics Laboratory**	**5+1=6**	**Compulsory**
	Generic Elective (GEC)	**MAT-HG-701**	**Sets,Determinants & Logic (Theory with tutorial)**	**5+1=6**	For the students of

					other discipline
	Value Addition (VAC)	**VAC - 7**	**-**	**2**	**Compulsory**
VI	**Core (CC)**	**MAT-HC-703**	**Complex Analysis (Theory with tutorial)**	**5+1=6**	**Compulsory**
		MAT-HC-704	**Group, Ring Theory and Linear Algebra (Theory with tutorial)**	**5+1=6**	
	Discipline Specific Elective (DSEC)	**MAT-HE-702**	**Graph Theory/ Linear Programming and its applications**	**5+1=6**	**Compulsory**
	Generic Elective (GEC)	**MAT-HG-702**	**Analytical Geometry of Two & Three Dimensions (Theory with tutorial)**	**5+1=6**	For the students of other discipline
	Value Addition(VAC)	**VAC - 8**	**-**	**2**	**Compulsory**
VII	**Core (CC)**	**MAT-HC-801**	**Laplace Transform & Vector Analysis (Theory with tutorial)**	**5+1=6**	**Compulsory**
		MAT-HC-802	**Advanced Real Analysis (Theory with tutorial)**	**5+1=6**	
	Discipline Specific Elective (DSEC)	**MAT-HE-801**	**Geometry(Two & Three Dimensions)/Special Theory of Relativity/ Cryptography (Theory with tutorial)**	**5+1=6**	**Choose any one & Compulsory**
	Generic Elective (GEC)	**MAT-HG-801**	**Elements of Probability (Theory with tutorial)**	**5+1=6**	For the students of other discipline
	Core (CC)	**MAT-HC-803**	**Probability Theory (Theory with tutorial)**	**5+1=6**	**Compulsory**
		MAT-HC-804	**Mathematical Modelling**	**5+1=6**	

VIII			**(Theory with tutorial)**		
	Discipline Specific Elective **(DSEC)**	**MAT-HE-802**	**Rigid Dynamics & Tensor/HigherMechanics/Fluid Mechanics (Theory with tutorial**	**5+1=6**	**Choose any one & Compulsory**
			Research Project (Theory /Practical)	**6**	
	Generic Elective (GEC)	**MAT-HG-802**	**Mechanics (Theory with tutorial)**	**5+1=6**	**Compulsory**

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SEMESTER – I

Detailed Syllabus

Discipline Specific Core Courses (CC)

MAT – HC – 501
Calculus
Total Marks:100 (Theory-75, Practical-25)
Credits 6: (Theory - 04, Practical – 02)

Course Objectives: The course is designed to focus on basic concepts with tools of Calculus and Geometric properties of different Conic sections which are helpful in solving their applications to the real world problem. Also the Course will provide students essential skills involving computational mathematics.

Course Learning Outcomes: On successful completion of this Course, the student should be able

- to sketch curves in a plane in the different co – ordinate systems of reference.
- to understand the Calculus of Vector valued functions.
- to apply Calculus to develop basic principles of planetary motions.
- to develop basic mathematical problems in any software.

UNIT – I : Derivatives for Curve sketching (25 marks)

First and Second derivative tests for Extreme Values of Functions, Concavity and Curve sketching, Limits to infinity and infinite limits, Indeterminate Forms and L' Hospital's rule, Asymptotes, Higher order derivatives, Leibniz rule.

15 **Lectures**

UNIT – II : Curve tracing in Polar Co-ordinates (25 marks)

Parametric representation of curves, Polar Co-ordinates, Tracing of curves in Polar Co-ordinates, Graphing Polar Co-ordinates Equations, Areas and Lengths in Polar Co-ordinates, Classification of conics in Polar Co-ordinates.

15 Lectures

UNIT – III : Vector Calculus and its applications (25 marks)

Vector valued functions and their graphs, Limits and continuity of vector functions, Differentiations and integration of vector functions, Projectile motion, Unit tangent, Normal and binomial vectors, Curvature, Kepler's Second Law(Equal Area Law).

15 Lectures

MAT – HC – 501(P)

Practical (25 marks): Lab work to be performed on a computer using Mathematica / MATLAB /Maple / Scilab / Maxima or any software)

Instructions for Practical examination: (Two Programs only)
a) Program writing 10 marks b) Output – 10 marks
c) Viva Voce 3 marks d) Note book 2 marks
e) Duration: 2 hrs.

List of the practicals to be done

(i) Plotting the graphs of the following functions:
ax, $[x]$ (greatest integer function), $\sqrt{ax+b}$, $|ax+b|$, $c \pm |ax+b|$,
$x^{\pm n}$, $x^{\frac{1}{n}}$ $(n \in Z)$, $\frac{|x|}{x}$, $\sin(\frac{1}{x})$, $x\sin(\frac{1}{x})$ and $e^{\pm\frac{1}{x}}, for\ x \neq 0$
$e^{ax+b}, \log(ax+b), \frac{1}{(ax+b)}, \sin(ax+b), \cos(ax+b),$
$|\sin(ax+b)|, |\cos(ax+b)|$.

(Observe and discuss the effect of changes in the real constants a, b and c on the graphs.)

(ii) Plotting the graphs of polynomial of degree 4 and 5, their first and second derivatives, analysis of these graphs in context of the concepts covered in Unit 1.
(iii) Sketching parametric curves.
(iv) Tracing of conic in Cartesian co-ordinates.
(v) Graph of hyperbolic functions.
(vi) Computation of limit, Differentiation, Integration and sketching of vector – valued functions.
(vii) Complex numbers and their representations, Operations like addition, Multiplication, Division, Modulus, Graphical representation of Polar form.

Recommended books:

1. Thomas, Jr. George B., Weir, Maurice D., & Hass, Joel (2014). Thomas' *Calculus* (13th ed.) Person Education, Delhi. Indian Reprint 2017.
2. B.C. Das, B.N. Mukherjee. *Differential Calculus* (55th Edition), U.N. Dhur & Sons Private Ltd.

MAT – HC – 502
Algebra , Complex Trigonometry & Logic

Total Marks:100
Credits 6: (Theory - 05, Tutorial – 01)

Course Objectives: The objective of the course is to introduce the students to the existing world of theory of equations, complex numbers, number theory and matrices and their applications.

Course Learning Outcomes: On completion of this Course, the student should be able

- to learn various methods of obtaining roots of real and complex polynomials and will understand relations between the roots and coefficients of these polynomial equations.
- to employ De Moivre's theorem and its applications.
- to apply Euclid's algorithm and backwards substitution to find greatest common divisor.
- to recognize consistent and inconsistent systems of linear equations by using rank.

UNIT I : Theory of equations (20 Marks)

Polynomial functions, Division algorithm, Synthetic division, Remainder Theorem, Factor Theorem, Polynomial equations, Relation between roots and Co-efficient of a polynomial equation, Symmetric function of the roots of an equation, sum of powers of the roots, Solution of cubic and biquadratic equations. 15 **Lectures**

UNIT II: **Complex Trigonometry (15 Marks)**

Polar representation of complex numbers, The Cube roots of unity, De Moivre's theorem and its applications, Exponential functions of complex arguments, Gregory's series and Hyperbolic functions. **10 Lectures**

UNIT III : Relations, Functions and Basic Number Theory (35 marks)

Binary relations, Partial order relation, Equivalence relations, Functions, Inverse and composition, One to one correspondence and Cardinality of a set, Division Algorithm, Divisibility and the Euclidean Algorithm, Prime Numbers, Congruences and applications, Principles of Mathematical induction.

Sentences and Statements, Negation of a Statement, Truth values of Statements, Truth Tables, conjunction, disjunction, Implications, precedence of logical operators, Tautology, Importance of Tautology, Contradiction, Logically true statements, logically equivalent statements.

20 Lectures

UNIT IV : Matrices (30 marks)

The Rank of a matrix, and elementary operations, Row reduction and echelon forms, System of linear equations, Solution of the matrix equation $AX = B$, Solution sets of linear systems, linear independence, Eigenvectors and Eigen values, The Characteristic equation and Cayley – Hamilton Theorem.

20 **Lectures**

Recommended Books:

1. Chandrika Prasad, (1963), *Text Book on Algebra and Theory of equations*, Pothishala Pvt. Ltd..
2. B.C. Das & B.N Mukherjee, (2006), *Higher Trigonometry*, U.N Dhur & Sons Pvt. Ltd.
3. Burnside and Panton, *The Theory of Equations*, S. Chand & Co., New Delhi.
4. I.N. Herstein, Topics in Algebra, John Wiley & Sons, New Delhi
5. Shanti Narayan & P.K. Mittal, A Text Book of Matrices, S.Chand & & Co., New Delhi
6. Gupta & Malik , Set Theory and Number Systems, Rastogi Publications, Meerut
7. Samar Ballav Bhoi,(2018), A Text Book of Logic and Sets, Educreation Publishing, New Delhi.

References:

1. Goodaire, Edgar G & Parmentor, Michael M (2005); *Discrete Mathematics with Graph Theory* (3rd Ed.) Person Education Pvt. Ltd., Indian Reprint 2015.
2. MK Singal, Asha Rani Singal, (2020), *Algebra* (31st Ed.) R Chand ?& Co, New Delhi.
3. Kolman, Bernard, & Hill David R, (2001*), Introductory Linear Algebra with Applications* (7th Ed.) Pearson Education, Delhi, First Indian Reprint 2003.
4. Lay, David C., Lay, Steven R., & McDonald, Judi J, (2016), Linear Algebra and its Applications (5th ed.), Person Education.
5. Andrilli, Stephen, & Hecker David (2016), Elementary Linear Algebra (5th ed.) Academic Press, Elsevier Indian Private Limited.
6. Burton, David M, (2007) Elementary Number Theory (7th ed.), Tata Mc – Graw Hill Edition, Indian Reprint.

Skill Enhancement Course (SEC – 1)

MAT – SE – 501
LaTeX

Total Marks : 100 (Theory-75, Practical-25)
Credits 4 : (Theory - 03, Practical – 01)

Course Objectives: The purpose of this course is to acquaint students with the latest typesetting skills, which shall enable them to prepare high quality typesetting, beamer presentation and webpages.

Course Learning Outcomes: After studying this course the student will be able to:

- typeset mathematical formulas, use nested list, tabular & array environments.
- create or import graphics.
- use beamer to create presentation.

UNIT – I : Getting Started with LaTeX (20 marks,)

Introduction to **TeX and LaTeX ,** Typesetting a simple document, Adding basic information to a document, Environments, Footnotes, Sectioning and displayed material.

10 Lectures

UNIT – II : Mathematical Typesetting with LaTeX (30 marks)

Accents and symbols, Mathematical Typesetting (Elementary and Advanced): Subscript, Superscript, Fractions, Roots, Ellipsis, Mathematical Symbols, Arrays, Delimiters, Multiline formulas, Spacing and charging style in math mode.

10 Lectures

UNIT – III : Graphics and Beamer Presentation in LaTeX (25 marks)

Graphics in LaTeX, Simple pictures using PS Tricks, Plotting of functions, Beamer presentation.

10 Lectures

Recommended Books:

1. Binder, Donald & Erickson, Martin, (2011). *A Student's Guide to the Study, Practice, and Tools of Modern Mathematics*, CRC Press, Taylor & Francis Group, LLC.
2. Lamport, Leslie (1994), LaTeX: A Document Preparation System, User's Guide and Reference Manual(2^{nd} ed.), Pearson Education Indian Reprint.

MAT – SE – 501 (P)

Practical (25 marks): Lab work to be performed on a computer

Instructions for Practical (Two Programs only)

a) Program writing 10 marks b) Output – 10 marks

c) Viva Voce 3 marks d) Note book 2 marks. e) Duration: 2 hrs.

List of the practicals to be done

[1] Chapter 9 (Exercises 4 to 10), Chapter 10 (Exercises 1 to 4 and 6 to 9) Chapter 11 (Exercises 1, 3, 4 and 5) and Chapter 15 (Exercises 5, 6 and 8 to 11).

Skill Enhancement Course (SEC – 2)

MAT – SE – 501
Computational Mathematics Laboratory
Total Marks : 100 (Theory-75, Practical-25)
Credits 4 : (Theory - 03, Practical – 01)

Course Objective: This course is designed to introduce the student to the basics of power point presentations and working with spread sheets. Also the students of mathematics will have the chance to gain essential skills involving computational mathematics software called mathematica.

Course Learning Outcomes: On successful completion of the course, students will be able to

- Develop, manage power point presentations while preparing for presentations in seminars withadditional skills such as inserting pictures, objects, multimedia etc.
- Work out with excel files with skill of preparing charts to represent the information found in daily lifesituations.
- Use mathematica software to plot the graph of various functions.

UNIT-I : PowerPoint Presentation (15 marks)

Navigate the PowerPoint interface, creating new presentation from scratch – or by using beautiful templets, Add text, Pictures, Sound, Movies and Charts. Designing slides using themes, colours and special effects, Animate objects on slides, work with Master slides to make presentation easy. **5 Lectures**

UNIT – II : Spreadsheets (25 marks)

Examine spreadsheet concepts and explore the Microsoft Office Excel environment, Create, Open and View a workbook. Save and print workbooks. Enter and Edit data. Modify a worksheet and workbook.

Work with cell references. Learn to use functions and formulas. Create and edit charts and Graphics. Filter and sort table data. Work with pivot tables and charts. Import and Export data. **10 Lectures**

UNIT – III : Mathematica (35 marks)

Getting Acquainted with the notation and convention, the Kernel and the Front End, Built- functions. Basic operations, Assignment and Replacement. Logical Relations, Sum and Products, Loops.

Two Dimensional Graphics – plotting functions of a single variable, Additional Graphics Commands, Animations.

Three Dimensional Graphics – plotting functions of two variables, Special three dimensional plots.
Equation(s) solving commands, Matrix operations – vectors and matrices operations, eigenvalues andeigenvectors, trace, adjoint, inverse, diagonalization etc.

15 **Lectures**

Recommended books:

1. Binder, Donald & Erickson, Martin (2011). A student's guide to the Study, Practice, and Tools ofModern Mathematics. CRC Press, Taylor & Francis Group, LLC.
2. Hillier and Hillier (2003). Introduction to Management Science: A Modeling and Case StudiesApproach with Spreadsheet, Second Edition, McGraw-Hill.
3. Eugene Don, Ph. D., Schaum's Outlines Mathematica, Mc-Graw Hill (2009).

MAT – SE – 501(P)

Practical (25 marks): Lab work to be performed on a computer.

Instructions for Practical (Two Programs only)
a) Program writing 10 marks b) Output – 10 marks
c) Viva Voce 3 marks d) Note book 2 marks. e) Duration: 2 hrs.

List of the practicals to be done

(a) PowerPoint Presentation:

1. Change the fonts, colour of text on a slide
2. Add bullets or numbers to text
3. Format text as superscript or subscript
4. Insert a picture that is save on your local drive or an internal server
5. Insert a picture from the web
6. Insert shapes in your slide

(b) Spreadsheet:

1. Format, enhance, and insert formulas in spreadsheet.
2. Move data within and between workbooks.
3. Maintain a workbook and create a chart in a spreadsheet.
4. Create, modify and manage a database table and query.
5. Create relationships between tables in a database.
6. Import and export data among word processing software, a spreadsheet and a database.
7. Merge data in a database with a word processing document.

(c) Mathematica:

1. In an expression containing x, y, z replace all x, y, z by x^2, y^2 and z^2
2. Find the sum of $1 + \frac{1}{2} + \frac{1}{3} + \cdots + \frac{1}{100}$
3. Find the sum of $1 + \frac{1}{2^2} + \frac{1}{3^2} + \cdots to\ \infty$
4. Solve the equation: $x^3 - x + 1 = 0$
5. Solve the equation: $x - y = 1,\ x^2 - xy + y^2 = 10$
6. Plot the graph of sin x and cos x together, where $-\pi \leq x \leq \pi$

Department of Mathematics, Oriental College (Autonomous), Imphal

SEMESTER – II

Discipline Specific Core Courses (CC)

MAT – HC – 503
Real Analysis
Total Marks:100
Credits 6: (Theory - 05, Tutorial – 01)

Course Objectives:

The course will develop a deep and rigorous understanding of real line R and of defining terms to prove results about convergence and divergence of sequences and series of real numbers**.**

Course Outcomes:

Will understand many properties of the real line, recognize bounded convergent, divergent, Cauchy and monotonic sequences, applications of the ratio, root, alternating series and limit comparison test for convergence and absolute convergence of an infinite series of real numbers**.**

Unit-I (25 Marks)

Fundamental Properties of Real Numbers and Elements of Point Set Topology

Interval and its different kinds, Bounded and unbounded sets, Supremum and infimum, Field axioms, Order axioms, Order completeness in R, Archimedean property, Neighbourhood of a point, Interior points, Open sets and related properties/theorems, Limits points and derived set, Bolzano-Weierstrass Theorem, Adherent point and Closure of a set, Closed sets and related properties/theorems, Concept of compactness; Heine-Borel theorem.

20 Lectures

Unit-II (25 Marks)

Sequence of Real Numbers

Concept of sequence, Bounds of sequence, Limit points of a sequence, Bolzano Weierstrass theorem for sequence, Limit inferior and superior, Convergent and their properties, divergent and oscillate sequences, Cauchy sequences, Cauchy's general principle of convergence, Algebra of sequences, monotonic sequence and their properties, Subsequences, Nested interval theorem. **20 Lectures**

Unit-III (25 Marks)

Infinite Series

Introduction to series of real numbers, Sequence of partial sums and convergence of infinite series, Necessary condition for the convergence of an infinite series, Cauchy's general principle for convergence, Geometric series, some useful theorems on series of positive terms, Comparison test of convergence, convergence and divergence of p-series, Cauchy's root test, D'Alembert's ratio test, Raabe's test, Logarithmic test, D'Morgan & Bertrand test, Leibnitz's test for alternating series. Conditional and Absolute convergence.

20 Lectures

Unit-IV (25 Marks)
Limits and Continuity

Limit and Continuity (using $\varepsilon - \delta$ definition) of a function, Algebra of limits and continuous functions, Sequential criterion for limits and continuity, Types of discontinuities, Properties of continous functions on a closed interval, Uniform continuity. **10 Lectures**

RECOMMENDED BOOKS

1. **S.C. Malik and Savita Arora** - Mathematical Analysis, New Age International (P) Limited; Publishers, New Delhi.

2. **K.C. Maity & R.K. Ghosh** - An Introduction to Analysis, Differential Calculus Part I & II, Integral Calculus, Books and Allied (P) Ltd., Kolkata 700009.

3. **Shanti Narayan and P.K. Mittal** - A Course of Mathematical Analysis, S. Chand & Company Ltd. Ram Nagar, New Delhi - 110055.

REFERENCES:

1. **Shanti Narayan and Md. Raisinghania** - Elements of Real Analysis, S. Chand & Company Ltd., Ram Nagar, New Delhi - 110055.
2. **S.L. Gupta & N.R. Gupta** - Principles of Real Analysis, Pearson Education (Singapore) Pvt. Ltd., Indian Branch, 482 F.I.E. Patparaganj N.D. - 110092.
3. **S.K. Jain & S.K. Kaushik** - Introduction to Real Analysis, S. Chand & Company Ltd., Ram Nagar, N.D. - 110055.
4. **S.K. Sinha** - Real Analysis, P.C. Dwadash Shreni & Co (P) Ltd. Publisher & Book Seller's, Bara Bazar, Aligarh - 202001.
5. **V.K. krishnan** - Fundamentals of Real Analysis, Pearson Education (Singapore) Pte. Ltd., Indian Branch.
6. **K.K. Jha** - Honours Course in Real Analysis and Convergence, Navbharat Prakashan Patna - 4, Delhi - 6.
7. **D. Somasundarum & B. Choudhury** - A First Course in Mathematical Analysis, Narosa Publishing House, New Delhi.
8. **R.G. Bartle & D.R. Sharbert** - Introduction to Real Analysis, John Wiley and Sons (Asia)

MAT – HC – 504
Differential Equations

Total Marks:100 (Theory-75, Practical-25)
Credits 6: (Theory - 04, Practical – 02)

Course Objectives: The main objectives of this course are to introduce the students to the exciting world of Differential Equations, Mathematical Modeling and their applications.

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

- formulate Differential Equations for various Mathematical models.
- solve first order non-linear differential equation and linear differential equations of higher order using various techniques.
- apply these techniques to solve and analyze various mathematical models.

UNIT I : Differential Equations and Mathematical Modeling (30 marks)

Differential equations and mathematical models, Order and degree of a differential equations, Integrals as general and particular solutions, Exact differential equations and integrating factors of first order differential equations, Separable Equations, Homogeneous Equations, Reduction to homogeneous equations, Linear equations and Bernoulli Equation, Clairaut's Equation, Existence and Uniqueness of solution of initial and boundary value problems of first order ODE, singular solution of first order ODE. 15 **Lectures**

UNIT II : Second and higher order differential Equations (25 marks)

General solution of homogeneous equation of second order, Principle of superposition for a homogeneousequation, Wronskian, its properties and applications, Linear homogeneous and non- homogeneous equations of higher order with constant coefficients, Euler's equation, Method of undetermined coefficients, Method of variation of parameters, Applications of second order differential equations to mechanical vibration. **15 Lectures**

UNIT III : Analysis of Mathematical Models (20 marks) Application of first order differential equations to acceleration-velocity model, Growth and Decay model. Introduction to compartmental models, Lake pollution model (with case study of Lake Burley Griffin), Drug Assimilation models, population models (with limited growth, exponential growth) Epidemic models. 15 **Lectures**

MAT – HC – 504 (P)

Practical (25 marks): Lab work to be performed on a computer using Mathematica / MATLAB /Maple / Scilab / Maxima or any software)

Instructions for Practical examination: (Two Programs only)
a) Program writing 10 marks b) Output – 10 marks
c) Viva Voce 3 marks d) Note book 2 marks
e) Duration: 2 hrs.

List of the practicals to be done

Modelling of the following problems using Free and Open Source Software (FOSS) tools(Maxima/Python/Mathematica/MATLAB/Maple/Scilab or any software.)

1. Solving of Linear equations and Bernoulli Equation, Clairaut's Equations.
2. Plotting of second and third order respective solution for a family of differential equations
3. Growth and decay model(exponential cases only)
4. (a) Lake pollution model(with constant/seasonal flow and pollution concentration)
   (b) Limited growth of population
5. (a) Predatory-prey model
   (b)Epidemic model of influenza (basic epidemic model, contagious for life, disease with carriers)

Recommended books:

1. Barnes, Belinda &Fulford, Glenn R. (2015). *Mathematical Modelling with Case Studies, Using* Maple *and* MATLAB (3rd ed.). CRC Press, Taylor & Francis Group.

2. Edwards, C. Henry, Penney, David E., & Calvis, David T. (2015). *Differential Equation and BoundaryValue Problems*: *Computing and Modeling* (5th ed.). Pearson Education.

3. Ross, Shepley L. (2004). *Differential Equations* (3rd ed.). John Wiley & Sons. India.

Skill Enhancement Course (SEC – 1)

MAT – SE – 502
Python Programming

Total Marks : 100 (Theory-75, Practical-25)
Credits 4 : (Theory - 03, Practical – 01)

Course Objective: This course is designed to introduce the student to the basics of programming using Python. The course covers the topics essential for developing well documented modular programs using different instructions and built-in data structures available in Python.

Course Learning Outcomes: On successful completion of the course, students will be able to

- develop, document, and debug modular python programs to solve computational problems.
- select a suitable programming construct and data structure for a situation.
- use built-in strings, lists, sets, tuples and dictionary in applications.
- define classes and use them in applications.
- use files for I/O operations.
-

UNIT I : Introduction to Programming using Python (30 marks)

Structure of a Python Program, Functions, Interpreter shell, Indentation. Identifiers and keywords, Literals,Strings, Basic operators (Arithmetic operator, Relational operator, Logical or Boolean operator, Assignment Operator, Bit wise operator). Building blocks of Python: Standard libraries in Python, notion of class, object and method. **10 Lectures**

UNIT II : Creating Python Programs (20 marks)

Input and Output Statements, Control statements:-branching, looping, Exit function, break, continue and pass, mutable and immutable structures. Testing and debugging a program. **10 Lectures**

UNIT III: Visualization using 2D and 3D graphics and data structures (25 marks)

Visualization using graphical objects like Point, Line, Histogram, Sine and Cosine Curve, 3D objects, Built-in data structures: Strings, lists, Sets, Tuples and Dictionary and associated operations. Basic searching and sorting methods using iteration and recursion.

10 Lectures

Recommended books:

1. Downey, A.B., (2015),*Think Python–How to think like a Computer Scientist*, 3rd edition. O'ReillyMedia.
2. Taneja, S. &Kumar,N., (2017),*Python Programming-A Modular Approach*. Pearson Education.
3. Brown, M. C. (2001).The Complete Reference : Python, McGraw Hill Education.
4. Dromey, R. G. (2006), *How to Solve it by Computer*, Pearson Education.
5. Guttag, J.V.(2016),*Introduction to computation and programming using Python.* MIT Press.
6. Liang,Y.D. (2013),*Introduction to programming using Python*. Pearson Education.

MAT – SE – 502 (P)

Practical (25 marks): Lab work to be performed on a computer using Mathematica / MATLAB /Maple / Scilab / Maxima or any software)

Instructions for Practical examination: (Two Programs only)
a) Program writing 10 marks b) Output – 10 marks
c) Viva Voce 3 marks d) Note book 2 marks
e) Duration: 2 hrs.

List of the practicals to be done

1. Execution of expressions involving arithmetic, relational, logical, and bitwise operators in the shellwindow of Python IDLE.
2. Write a Python function to produce the outputs such as

(a)

```
*
* * *
* * * * *
* * *
*
```

(b)

```
1
232
34543
4567654
567898765
```

3. Write a Python program to illustrate the various functions of the "Math"module.

4. Write a function that takes the lengths of three sides:**side1**, **side2** and **side3** of the triangle as the input from the user using **input** function and return the area of the triangle as the output. Also, assert that sum of the length of any two sides is greater than the third side.

5. Consider a showroom of electronic products, where there are various salesmen. Each salesman is given a commission of 5%, depending on the sales made per month. In case the sale done is less than 50000, then the sales man is not given any commission. Write a function to calculate total sales of a salesman in a month, commission and remarks forthe salesman. Sales done by each salesman per week is to be provided as input. Assign remarks according to the following criteria**:**

Excellent: Sales >=80000
Good: Sales>=60000 and <80000
Average: Sales>=40000 and <60000
Work Hard: Sales<40000

6. Write a Python function that takes a number as an input from the user and computes its factorial.

7. Write a Python function to return nth terms of Fibonacci sequence

8. Write a function that takes a number with two or more digits as an input and finds its reverse andcomputes the sum of its digits.

9. Write a function that takes two numbers as input parameters and returns their least common multipleand highest common factor.

10. Write a function that takes a number as an input and determine whether it is prime or not.

11. Write a function that finds the sum of then terms of

the following series:a) 1 – x2 /2! +x4 /4! –x6 /6! +…

xn /n!

b) 1 +x2 /2! +x4 /4! +x6 /6! +… xn /n!

12. Write a Python function that takes two strings as an input from the user and counts the number ofmatching characters in the given pair of strings.

13. Write a Python function that takes a string as an input from the user and displays its reverse.

14.Write a Python function that takes a string as an input from the user and determines whether it ispalindrome or not

15.Write a Python function to calculate the sum and product of two compatible matrices

16.Write a function that takes a list of numbers as input from the user and produces the correspondingcumulative list where each element in the list present at index i is the sum of elements at index j <=i.

17.Write a function that takes **n** as an input and creates a list of n lists such that i^{th} list contains first fivemultiples of i.

18.Write a function that takes a sentence as input from the user and calculates the frequency of eachletter. Use a variable of dictionary type to maintain the count.

19.Write a Python function that takes a dictionary of *word***:***meaning* pairs as an input from the user andcreates an inverted dictionary of the form meaning:list-of-words.

20.Usage of Python debugger tool-pydband Python Tutor.

21.Implementation of Linear and binary search techniques

22.Implementation of selection sort, insertion sort, and bubble sort techniques

23.Write a menu-driven program to create mathematical 3D objects Curve, Sphere, Cone, Arrow, Ring,and Cylinder.

24.Write a program that makes use of a function to accept a list of n integers and displays a histogram.

25.Write a program that makes use of a function to display sine, cosine, polynomial and exponentialcurves.

26.Write a program that makes use of a function to plot a graph of people with pulse rate p vs. height h.The values of p and hare to be entered by the user.

27.Write a function that reads a file **file1** and displays the number of words and the number of vowels inthe file.

28.Write a Python function that copies the content of one file to another.

29.Write a function that reads a file **file1** and copies only alternative lines to another file **file2**.Alternative lines copied should be the odd numbered lines.

MAT – SE – 502
Computer Algebra Systems and Related Software

Total Marks : 100 (Theory-75, Practical-25)
Credits 4 : (Theory - 03, Practical – 01)

Course Objectives: This course aims at familiarizing students with the usage of computer algebra systems (Mathematica/MATLAB/Maxima/Maple) and the statistical software **R**. The basic emphasis is on plotting and working with matrices using CAS. Data entry and summary commands will be studied in R. Graphical representation of data shall also be explored

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

- Use CAS as a calculator, for plotting functions, animations and various applications of matrices.
- Understand the use of the software **R** for entry, summary calculation, pictorial representation of dataand exploring relationship between data.
- Analyze, test, and interpret technical arguments on the basis of geometry.

UNIT I : Introduction to CAS and Applications (20 marks)

Computer Algebra System (CAS), Use of a CAS as a calculator, Computing and plotting functions in 2D, Plotting functions of two variables using Plot3D and Contour Plot, Plotting parametric curves surfaces, Customizing plots, Animating plots, Producing tables of values, working with piecewise defined functions, Combining graphics. **10 Lectures**

UNIT II : Working with Matrices (20 marks)

Simple programming in a CAS, Working with matrices, Performing Gauss elimination, operations (transpose, determinant, inverse), Minors and cofactors, Working with large matrices, Solving system of linear equations, Rank and nullity of a matrix, Eigen value, eigenvector and diagonalization.

10 Lectures

UNIT III : R - The Statistical Programming Language (35 marks)

R as a calculator, Explore data and relationships in **R.** Reading and getting data into **R:** Combine and scan commands, Types and structure of data items with their properties. Manipulating vectors, Data frames, Matrices and lists. Viewing objects within objects. Constructing data objects and conversions, Summary commands**:** Summary statistics for vectors, Data frames, Matrices and lists, Summary tables. Stem and leaf plot, Histograms, Plotting in **R:** Box-whisker plots, Scatter plots, Pairs plots, Line charts, Pie charts, Cleveland dot charts and bar charts. Copy and save graphics to other applications. **10 Lectures**

Recommended books:

1. Bindner, Donald & Erickson, Martin. (2011). *A Student's Guide to the Study, Practice, and Tools ofModern Mathematics*.CRC Press, Taylor & Francis Group, LLC.

2. Torrence, Bruce F., &Torrence, Eve A. (2009). *The Student's Introduction to Mathematica®*: *AHandbook for Precalculus, Calculus, and Linear Algebra* (2nd ed.). Cambridge University Press.

3. Gardener, M. (2012). *Beginning R*: *The Statistical Programming Language*, Wiley.

Note: Theoretical and Practical demonstration should be carried out only in **one** of the CAS:Mathematica/MATLAB/Maxima/Scilab or any other.

MAT – SE – 502 (P):
Practical (25 marks): Lab work to be performed on a computer using
Mathematica / MATLAB /Maple / Scilab / Maxima or any software)

Instructions for Practical examination: (Two Programs only)
a) Program writing 10 marks b) Output – 10 marks
c) Viva Voce 3 marks d) Note book 2 marks
e) Duration: 2 hrs.

List of the practicals to be done

Chapter 12 (Exercises 1 to 4 and 8 to 12), Chapter 14 (Exercises 1 to 3)
[2] Chapter 3 [Exercises 3.2 (1 and 2), 3.3 (1, 2 and 4), 3.4 (1 and 2), 3.5 (1 to 4), 3.6 (2 and 3)].Chapter 6 (Exercises 6.2 and 6.3).
[2] Chapter 7 [Exercises 7.1 (1), 7.2, 7.3 (2), 7.4 (1) and 7.6].

Note: Relevant exercises of [3] Chapters 2 to 5 and 7 (The practical may be done on the database to bedownloaded from http://data.gov.in/.

SEMESTER – III

Discipline Specific Core Courses (CC)

MAT – HC – 601
Theory of Real Functions

Total Marks:100
Credits 6: (Theory - 05, Tutorial – 01)

Course Objectives: It is a basic course on the study of real valued functions that would develop an analytical ability to have a more matured perspective of the key concepts of calculus, namely, limits, continuity, differentiability and their applications.

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

- A rigorous approach of the concept of limit of a function.
- About continuity and uniform continuity of functions defined on intervals.
- The geometrical properties of continuous functions on closed and bounded intervals.
- The applications of mean value theorem and Taylor's theorem.

UNIT I : Limits of Functions (20 Marks)

Limits of functions (ε–δ approach), Sequential criterion for limits, Divergence criteria, Limit theorems, One-sided limits, Infinite limits and limits at infinity.

10 Lectures

UNIT II : Continuous Functions and their Properties (35 Marks)

Continuous functions, Sequential criterion for continuity and discontinuity, Algebra of continuous functions, Properties of continuous functions on closed and bounded intervals ; Uniform continuity, Non- uniform continuity criteria, Uniform continuity theorem.

20 Lectures

UNIT III : Derivability and its Applications (45 Marks)

Differentiability of a function, Algebra of differentiable functions, Carathéodory's theorem and chain rule; Relative extrema, Interior extremum theorem, Rolle's theorem, Mean- value theorem and its applications, Intermediate value property of derivatives - Darboux's theorem, Taylor polynomial, Taylor's theorem with Lagrange form of remainder, Application of Taylor's theorem in error estimation; Relative extrema, and to establish a criterion for convexity ; Taylor's series expansions of e^x , sin *x* and cos *x*.

30 Lectures

Recommended books:

1. Bartle, Robert G., &Sherbert, Donald R. (2015). *Introduction to Real Analysis* (4thed.).Wiley IndiaEdition. New Delhi.

2. Ghorpade, Sudhir R. &Limaye, B. V. (2006). *A Course in Calculus and Real Analysis*.UndergraduateTexts in Mathematics, Springer (SIE).First Indian reprint.

3. Mattuck, Arthur. (1999). *Introduction to Analysis*, Prentice Hall.

4. Ross, Kenneth A. (2013). *Elementary Analysis*: *The theory of calculus* (2nd ed.).Undergraduate Textsin Mathematics, Springer.Indian Reprint.

MAT- HC- 602
Computer Science & Programming
(in C or using any software)

Total Marks:100 (Theory-75, Practical-25)
Credits 6: (Theory - 04, Practical – 02)

Course Objectives:
- To familiarize students the concept of programming in C and exploring software like MATLAB, PYTHON etc.
- To provide a foundation in use of this software for real time applications and
- To prepare the students to use any software in their project works.

Course Outcomes: Students should be able to
- ability to write basic mathematical problems in C, MALAB, Python etc.
- find importance of mathematical soft ware for Lab Experiment

Unit –I: (25 Marks)

Basic model of a computer, Algorithm, Flow Chart, programming language, Compilers and operating system, character set, identifiers and keyword, Constant, variables and data type, operations and expressions, operator precedence and associativity, Basic input/output statements, introduction to simple C-programs. **15 Lectures**

Unit-II: (20 Marks)

Conditional statements and loops: Decision making with a program, logical and conditional operators, if statement, nested if else statement, loops, while loop, do-while loop, for loop, nested loops, break statement, switch statement, continue statement, goto statement, the comma operator. **15 Lectures**

Unit – III: (30 Marks)

Arrays: One dimensional arrays, declaration and initialization of one dimensional arrays, searching, insertion and delation of an element from an array, sorting an array. Two dimensional arrays.

Function: Defining a function, accessing a function, function declaration/prototype, function parameters, return values, passing arguments to a function, call by a reference, call by value, function calls, recursion, passing arrays to function. **15 Lectures**

MAT – HC – 602 (P):
Practical (25 marks): Lab work to be performed on a computer in C or any software

Instructions for Practical examination: (Two Programs only)
a) Program writing 10 marks b) Output – 10 marks
c) Viva Voce 3 marks d) Note book 2 marks
e) Duration: 2 hrs.

List of the practicals to be done

Practical :

1. To calculate the compound interest accepting the necessary data from the keyboard.
2. To find the value of $\frac{x}{1!} - \frac{x^3}{3!} + \frac{x^5}{5!} - \cdots\cdots\cdots\cdots$
3. To find the roots of a quadratic equation.
4. To find the factorial of a positive integer.
5. To reverse the order of some numbers.
6. That will read a positive number from the keyboard and check the number is prime or not.
7. To convert octal to decimal number.
8. To generate prime numbers up to n terms.
9. To find GCD of two given numbers.
10. To find GCD of two given numbers using recursion.
11. To arrange numbers in ascending order and decreasing order.
12.. To generate Fibonacci series of numbers up to n terms.
13. To write program to test a word is palindrome or not.
14. To implement selection sort.
15. To implement insertion sort.
16. To write program for union of two sets
17. To write program for intersection of two sets.

RECOMMENDED BOOKS.

1. **Byron Gottfried,** Programming with C, Tata McGraw Hill.
2. **E. Balaguruswami,** Programming with ANSIC, Tata McGraw Hill.
3. **RG Dromey,** How to solve it by computer, Prentice Hall of India.
4. **Venugopal & Prasad,** Programming with C, Tata McGraw Hill.

REFERENCES

1. **A. Kamtham -** Programming with ANSI & Turbo C, Pearson Education.
2. **B.W. Kernighan and D.M. Ritchie,** The Programming Language, Prentice Hall of India.
3. **V. Rajaraman,** Programming in C, Prentice Hall of India.
4. **Robert C Hutchison** and **Steven B. Just,** Programming using C language, Tata McGraw Hill.

MAT – HC – 603
Multivariate Calculus

Total Marks:100
Credits 6: (Theory - 05, Tutorial – 01)

Course Objectives: To understand the extension of the studies of single differential and integral calculus to functions of two or more independent variables. Also, the emphasis will be on the use of Computer Algebra Systems by which these concepts may be analyzed and visualized to have a better understanding.

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

- The conceptual variations when advancing in calculus from one variable to multivariable discussions.
- Inter-relationship amongst the line integral, double and triple integral formulations.
- Applications of multi variable calculus tools in physics, economics, optimization, and understandingthe architecture of curves and surfaces in plane and space etc.
-

UNIT I : Calculus of Functions of Several Variables and Properties of Vector Field (40 Marks)

Functions of several variables, Level curves and surfaces, Limits and continuity, Partial differentiation, Higher order partial derivative, Tangent planes, Total differential and differentiability, Chain rule, Directional derivatives, The gradient, Maximal and normal property of the gradient, Tangent planes and normal lines, Extrema of functions of two variables, Method of Lagrange multipliers, Constrained optimization problems; Definition of vector field, Divergence and curl. **20 Lectures**

UNIT II : Double and Triple Integrals (30 Marks)

Double integration over rectangular and nonrectangular regions, Double integrals in polar co-ordinates, Triple integral over a parallelepiped and solid regions, Volume by triple integrals, triple integration in cylindrical and spherical coordinates, Jacobians (Without Proof), Change of variables in double and triple integrals. **20 Lectures**

Unit III : Green's, Stokes' and Gauss Divergence Theorem (30 Marks)
Line integrals, Applications of line integrals: Mass and Work, Fundamental theorem for line integrals, Conservative vector fields, Green's theorem, Area as a line integral; Surface integrals, Stokes' theorem, The Gauss divergence theorem. **20 Lectures**

Recommended books:

1. Strauss, Monty J., Bradley, Gerald L., & Smith, Karl J. (2007). *Calculus* (3rd ed.). Dorling Kindersley(India) Pvt. Ltd. (Pearson Education). Delhi. Indian Reprint 2011.

2. Marsden, J. E., Tromba, A., & Weinstein, A. (2004). *Basic Multivariable Calculus*. Springer(SIE).First Indian Reprint.

Generic Elective Course (HG)

MAT – HG – 601
QUANTITATIVE APTITUDE

Total Marks:100
Credits 6: (Theory - 05, Tutorial – 01)

Course Objectives: The main aim of this course is to gain knowledge of elementary ideas about arithmetic abilities which one finds in daily life. It will help the students from any background to get acquainted with this knowledge and get prepared for any competitive examinations.

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

- gain sufficient ideas of mental and arithmetic abilities.
- handle mental/quantitative aptitude test questions with great ease.
- acquire the skill of solving problems of daily life quickly.

UNIT-I : Arithmetic Ability I (30 marks)

Chain Rule –Time and Work – Pipes and Cisterns

Time and Distance – Problems on Trains – Boats and Streams

20 Lectures

UNIT-II : **Arithmetic Ability II (30 marks)**

Simple Interest – Compound Interest – Stocks and Shares.

(Chapters 17, 18 & 19)Clocks – Area (Chapters 24, 25).

20 Lectures

UNIT-II : Arithmetic Ability III (40 marks)

Volume and Surface Area (Chapters 28), Permutations and Combinations (Chapters 30 & 31). **20 Lectures**

Recommended books:

1. Scope and treatment as in “Quantitative Aptitude”, S. Chand and Company Ltd. Ram Nagar, NewDelhi (2007).

Department of Mathematics, Oriental College (Autonomous), Imphal

SEMESTER – IV

Discipline Specific Core Courses (CC)

MAT – HC – 604
Partial Differential Equations
Total Marks:100
Credits 6: (Theory - 05, Tutorial – 01)

Course Objectives: The main objectives of this course are to teach students to form and solve partialdifferential equations and use them in solving some physical problems.

Course Learning Outcomes: The course will enable the students to

- formulate, classify and transform partial differential equations into canonical form
- Solve linear and non-linear partial differential equations using various methods: and applythese methods in solving some physical problems.
-

UNIT I : **First order PDE and Methods of Characteristics (30 Marks**)

Definitions & Basic concepts, Formation of PDE, classification and geometrical interpretation of first order partial differential equations (PDE), Method of characteristics and general solution of first order PDE, Lagrange and Charpit method, Cauchy's problems for first order PDE, Canonical form of first orderPDE, Method of separation of variables for first order PDE. **20 Lectures**

UNIT II : Classification of second order Linear PDE and Wave equations (35 Marks)

Classification of second order PDE, Reduction to canonical forms, Equations with constant coefficients, General solutions, Cauchy's Problem for second order PDE, Mathematical Modeling of vibrating string, vibrating membrane, Homogeneous wave equation, Initial boundary value problems, Non-homogenous boundary conditions, Finite string with fixed ends, Non- homogeneous wave equation. **20 Lectures**

Unit III : Methods of separation of Variables (35 Marks)

Methods of separation of Variables for second order PDE, vibrating string problems, Existence and uniqueness of solution of vibrating string problems, Heat conduction problem, Existence and uniqueness of solution of Heat conduction problems, General solution of higher order PDE with constant coefficient, Non- homogeneous Problems.

20 Lectures

Recommended books:

1. Myint-U, Tyn and Debnath, Lokenath. (2007). Linear Partial Differential Equation for Scientists andEngineers (4thed). Springer, Third Indian Reprint.

2. Sneddon, I. N. (2006). *Elements of Partial Differential Equations*, Dover Publications.Indian Reprint.

3. Stavroulakis, Ioannis P &Tersian, Stepan A. (2004). *Partial Differential Equations*: *An Introductionwith Mathematica and MAPLE* (2nd ed.). World cientific.

MAT – HC - 605
Riemann Integration

Total Marks:100
Credits 6: (Theory - 05, Tutorial – 01)

Course Objectives: To understand the integration of bounded functions on a closed and bounded interval and its extension to the cases where either the interval of integration is infinite, or the integrand has infinite limits at a finite number of points on the interval of integration. The sequence and series of real valued functions, and an important class of series of functions (i.e., power series).

Course Learning Outcomes: The course will enable the students to learn about:

- Some of the families and properties of Riemann integrable functions, and the applications of thefundamental theorems of integration.
- Beta and Gamma functions and their properties.
- The valid situations for the inter-changeability of differentiability and integrability within finite sum, and approximation of transcendental functions in terms of power series.

UNIT I : Riemann Integration (35 Marks)

Definition of Riemann integration,(Algebraic and order properties of Riemann Integrals) Boundedness theorem, Riemann integrability, Cauchy's criterion, Squeeze Theorem, Riemann integrability of step, continuous, and monotone functions, Additivity theorem, Fundamental theorems (First and Second forms), substitution theorem, Lebesgue's integrability criteria, composition theorem, product theorem, Integration by parts, Darboux sums, Darboux integrals, Darboux integrability criteria, equivalence of Riemann integral and Darboux integral. **20 Lectures**

UNIT II : Sequence and Series of Functions (35 Marks)

Point wise and uniform convergence of sequence of functions, Theorem on the continuity of the limit function of a sequence of functions, Theorems on the interchange of the limit and derivative, and the interchange of the limit and integrability of a sequence of functions. Point-wise and uniform convergence of series of functions, Theorems on the continuity, Derivability and integrability of the sum function of a series of functions, Cauchy criterion and the Weierstrass M-Test for uniform convergence. **20 Lectures**

UNIT III : Improper Integral and Power Series (30 Marks)

Improper integrals of Type-I, Type-II and mixed type, Convergence of Beta and Gamma functions, and their properties.
Definition of a power series, Radius of convergence, Absolute convergence (Cauchy-Hadamard theorem), Uniform convergence, Differentiation and integration of power series, Abel's Theorem.

20 Lectures

Recommended books:

1. Bartle, Robert G., &Sherbert, Donald R. (2015). *Introduction to Real Analysis* (4th ed.). Wiley IndiaEdition. Delhi.
2. Denlinger, Charles G. (2011). *Elements of Real Analysis*.Jones and Bartlett (Student Edition).FirstIndian Edition.Reprinted 2015.
3. Ghorpade, Sudhir R. &Limaye, B. V. (2006). *A Course in Calculus and Real Analysis*.UndergraduateTexts in Mathematics, Springer (SIE).First Indian reprint.
4. Ross, Kenneth A. (2013). *Elementary Analysis*: *The Theory of Calculus* (2nd ed.). Undergraduate Textsin Mathematics, Springer.

MAT – HC - 606
Numerical Analysis
Total Marks:100 (Theory-75, Practical-25)
Credits 6: (Theory - 04, Practical – 02)

Course Objectives: To comprehend various computational techniques to find approximate value for possible root(s) of non-algebraic equations, to find the approximate solutions of system of linear equations and ordinary differential equations. Also, the use of Computer Algebra System (CAS) by which the numerical problems can be solved both numerically and analytically, and to enhance the problem solving skills.

Course Learning Outcomes: The course will enable the students to learn the following:

- Some numerical methods to find the zeroes of nonlinear functions of a single variable and solution of asystem of linear equations, up to a certain given level of precision.
- Interpolation techniques to compute the values for a tabulated function at points not in the table.
- Applications of numerical differentiation and integration to convert differential equations into differenceequations for numerical solutions.

Unit I: (40 Marks)

Calculus of finite difference: The operators $\Delta, \nabla, E,$ factorial notation, their properties and interrelation between the operators, Fundamental theorem of difference calculus, ordinary and divided differences.

Interpolation: Newton's forward and Backward difference interpolation formulae, Newton's divided difference formulae and their properties.

Lagrange's and Hermite's interpolation (Osculating) formulae, Central difference interpolation, Gauss's forward, backward and central difference interpolation formula. Least square polynomial approximation. **20 Lectures**

Unit – II: (30 Marks)

Numerical differentiation: Derivative using forward, backward and central difference interpolation formulae.

Numerical integration: General quadrature formulae, Trapezoidal rule, Simpson's one- third rule and three-eighth rule, Weddle's rule, Newton-Cote's method.

Numerical solution of ODEs using Picard, Euler, and Euler's modified Runge-Kutta methods.

15 Lectures

Unit-III: (20 Marks)

Solution of algebraic and transcendential equations, Bisection method, Regula-Falsi method and Newton-Raphson method.
System of linear algebraic equation using Gauss elimination method.

10 Lectures

NB. Use of Scientific Calculator is allowed.

MAT- HC - 606 (P)
Practical (25 marks): Lab work to be performed on a computer in C or any Software

Instructions for Practical examination: (Two Programs only)
a) Program writing 10 marks b) Output – 10 marks
c) Viva Voce 3 marks d) Note book 2 marks
e) Duration: 2 hrs.

List of the practicals to be done

1.Calculate the Sum $\frac{1}{1}+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\cdots\cdots\cdots\cdots\cdots+\frac{1}{N}$
2.To find the Absolute value of an Integer.
3.Enter 100 Integers into an array and Sort them in an Ascending order.
4.Program for Newton's Forward difference interpolation formula.
5.Program for Newton's backward difference interpolation formula.
6.Program for Lagrange's interpolation formula
7.Program for Newton's divided difference interpolation formula.
8.To find the solution of non-linear equation by
(i) Bisection
(ii) Secant and
(iii) Newton- Raphson method.

9. To find the solution of linear equation by Gauss Elimination method.

10. Numerical Integration
(i) Trapezoidal rule
(ii) Simpson's 1/3 rule.

11. Ordinary differential equation
(i) Euler's method
(ii) Runge - Kutta method.

.

RECOMMENDED BOOKS:

1. **M.K. JAIN, S.R.K Iyenger, R.K. Jain -** Numerical methods for scientific and engineering computation, New Age international (P) Ltd.
2. **James B. Scarborough –** Numerical mathematical analysis, Oxford and IBH publishing Co. pvt. Ltd.
3. **H.C. Saxena** - Finite differences and numerical analysis, S Chand & Co. Ltd., New Delhi.

REFERENCES:

1. **K.E. Atkinson -** An introduction to numerical analysis, John Wiley and Sons.
2. **M.K. Jain, S.R.K. Iyenger, R.K. Jain -** Numerical method for problems and Solutions, New Age international (p) Ltd.
3. **R.Y. Robistein** - Simulation and Montecarlo method, John Wiley.
4. **C.E. Froberg** - Introduction to numerical analysis, Addison Wesley, 1979.

Generic Elective Course (HG)

MAT – HG – 602
BASIC TOOLS OF MATHEMATICS
Total Marks:100
Credits 6: (Theory - 05, Tutorial – 01)

Course Objectives: The objective of the course is to introduce the concept of vectors, algebraic ideas like various forms of mean, progression, polynomial will be taught to the students. The concept of differential calculus and probability will help the students in understanding their respective core courses with great comfort.

Course learning Outcomes: After studying this course, the student may understand

- The basic concepts of Vectors Analysis.
- Some topics of Algebra and Differential Calculus.
- Application of partial differentiation in daily life problems.
- Properties and methods of Integration, solving of definite and indefinite integrals.
- Basic ideas of probability such as probability distribution, expectations, Binomial Distribution,Poisson distribution, etc.

UNIT-I : Vectors: (30 marks)

Addition of two or more vectors, Negative of a vector, , Subtraction of two

vectors, Multiplication of a vector by a scalar, Vector equations, Collinear vectors,

Position vector of a point, Section formula of a point, Linear combination of a set

of vectors, Coordinates of two and three dimensional vectors.
Product of two or three vectors. 10 Lectures

UNIT-II : Algebra and Calculus (40 marks)

Algebra

Geometric Mean, Arithmetic Mean, Harmonic Mean and related Inequalities, Arithmetic and Geometric Progression, Polynomial, Equation, Linear Equation, Quadratic Equation, Roots and Coefficients, Fundamental Theorem of Algebra, Binomial Theorem, Permutation, and Combination, Mathematical Induction,

Differential Calculus

Mappings, Inverse Mapping and Composite Mappings.
Limit, Continuity, Differentiation, Maxima and Minima, Tangent and normal, Partial Differentiation.

Integral Calculus

Definition, Properties, Methods of Integration, Definite integrals, Infinite Integrals.

30 Lectures

UNIT-III : Probability (30 marks)
Probability

Definition, Random variable (discrete and continuous), Probability Distribution (mass function, density function, distribution function), Expectations, Some Standard Probability Distributions (Distributions : Binomial, Poisson, Negative Binomial, Geometric, Hypergeometric, Normal, Exponent, Uniform, Gamma, Beta, etc.)

20 Lectures

Recommended books:

1. B.S.Vatssa: Discrete Mathematics ch.1, 2e, Wishwa Prakashan (A Division of Wiley Eastern Ltd.)
2. Chandrika Prasad: Algebra and Theory of Equations, Pothisala Pvt. Ltd.
3. Das and Mukherjee: Differential Calculus, UN Dhur & Sons Pvt. Ltd.
4. Das and Mukherjee: Integral Calculus, UN Dhur & Sons Pvt. Ltd.
5. Ghosh & Maity: Vector Analysis, New Central Book Agency, Kolkata
6. S.C. Gupta and V.K. Kapoor: Fundamentals of Mathematical Statistics, Sultan Chand & Sons.
7. Chakraborty & Ghosh: Analytical Geometry and Vector Analysis, UN. Dhur & Sons, Kolkata.
8. Chakraborty & Ghosh: Advanced Analytical Geometry,UN. Dhur & Sons,Kolkata

Department of Mathematics, Oriental College (Autonomous), Imphal

SEMESTER – *V*

MAT – HC - 701
Metric Space
Total Marks:100
Credits 6: (Theory - 05, Tutorial – 01)

Course Objectives: This course will help the students to develop social competences since this branch of mathematics is a convenient and very powerful way of examining the behaviour of various mathematical models. In real life, Metric space methods have been employed for decades in various applications such as in internet search engines, image classification, or protein classification.

Course Outcomes: Students will understand the idea of distance between two elements in a set and to extend the concepts namely, open sets, closed sets, convergence of sequences, compact sets, continuity of functions etc. from real line to a metric space and extend several theorems and concepts about the real numbers and real valued functions, such as convergence and continuity, to the more general setting of these spaces.

Unit-I:
Metric Spaces (30 Marks)

Definition and example of a metric space, Diameter and boundedness of sets, Distance between two subsets of a Metric space, Fundamental inequalities (Holder and Minkowski).

Some function spaces, Subspace of a metric space. Open spheres/balls, Open sets and properties, closed sets, neighbourhood of a point, limit points, adherent Point, Interior, Exterior and Frontier points, closure of a set, Dense subsets.

20 Lectures

UNIT –II:
Complete Metric Spaces (35 Marks)
Sequences in metric space, Convergent sequences, Cauchy sequences, Convergence of a Cauchy Sequence,

Complete metric spaces, Examples of complete and in-complete metric spaces, Cantor's intersection theorem.

Continous functions: Characterization of continous functions, Uniform Continuity Homeomorphism.

20 Lectures

UNIT – III:
Compactness (35 Marks)

Compact metric spaces, Sequential Compactness, Bolzano Weirstrass property, Totally boundedness, Finite intersection property, equivalence among the kinds of compactness.

Continous functions and compact sets.

20 Lectures

RECOMMENDED BOOKS

1. **P.K. Jain and K. Ahmed**: metric spaces, Narosa Publishing House, New Delhi.

REFERENCES:

1. **G.F. Simmons**: Introduction to Topology and Modern analysis, Tata Mc Graw Hill Education Private Limited, New Delhi.
2. **S. Lipchutz**: General Topology, Schaum's Outline Series, Mc Graw Hill Company.
3. **S.C. Malik, Savita Arora**: Mathematical Analysis, New Age International (P) Ltd., (Chapter 19)
4. **E.T. Copson**: Metric Spaces, Universal Book Stall, 5 Ansari Road, New Delhi-11..
5. **R.K. Ghosh & K.C. Maity**: Differential Calculus(an introduction to analysis)Part-II(including Metric Spaces and Complex Analysis) New Central Books Agency (p) Ltd. Kolkata.

MAT – HC - 702
Mechanics (Dynamics & Statics)

Total Marks:100
Credits 6: (Theory - 05, Tutorial – 01)

Course Objectives: This course aims to provide knowledge how a physical system might develop or alter over time and study the causes of those changes.

Course Outcomes: Students should be able
- To analyse the problems involving tension in a string
- to illustrate laws of motion, kinemetics of motion and their interrelationship
- To explain the concepts of motion of particles

Unit-I (50 Marks)

DYNAMICS :

Components of velocities and accelerations along, radial and transverse, along tangential and normal (Art[1] 8,49, 87, 88) Simple Harmonic motions (Art[1] 22-25, Art[2]17.1-17.4. 17.6, 17.7)

Dynamics of a particle

Motion on smooth and rough plane curves (Art[1] 14.1, 14.2, 15.1, 15.2, 16.1, 16.2) Motion in resisting medium including projectile, Motion of varying mass (Art[1] 104-112) central orbit, Kepler's Law (Art[1] 53-55, 57, 60, 64-67, 69-70)
Acceleration in different Coordinates system (Art[1] 125-127)

30 Lectures

Unit-II (50 Marks)

STATICS:

Parallel forces: Resultant of two parallel forces (3-Art 4.2), unlike parallel forces (3-Art. 4.3), moment of a force, Definition (3-Art. 5.1), and couples: Definition of moment of couple (3-Art. 6.1), Theorem on moment of forces (3-Art. 6.2), Resultant of a couple and a force (3-Art. 6.8). Equilibrium of three coplanar forces (3-Art 8.1), any system of coplanar forces (3-Art 8.3). Centenary: Freely suspended thin, perfectly flexible string lines (3-Art 14.2). Geometrical properties of common Catenary (3-Art 14.3), Tension of the Catenary (3-Art 14.4), Finding the parameter of a Catenary for a uniform string (3-Art 14.5).

Forces in 3-dimension (5-Art 14.1), Conditions of equilibrium (5-Art 14.2), Pointsot's central axis (5-Art 14.3), Null points, lines and planes (5-Art. 14.6), Stable, Unstable and Neutral equilibrium (3-Art 11.4).

30 Lectures

RECOMMENDED BOOKS:

1. **S.L. LONEY:** An elementary treatise on dynamics of particle and of rigid bodies. Cambridge University press 1956, reprinted by S. Chand & Company (P) Ltd. 1988.
2. **DAS & MUKHERJEE**: Dynamics published by S. Chand & company (P) Ltd, 2010 ISBN-81-85624-96-8.
3. **DAS & MUKHERJEE:** Statics published by S. Chand & company (P) Ltd. 2010, ISBN-81-85624-18-6.
4. **S.L. LONEY:** An Elementary treatise on Statics published by A.I.T.B.S., New Delhi, 2004 ISBN-81-7473-123-7.
5. **A.S. RAMSEY**: Statics, CBS Publishers and Distribution, Shahdara, New Delhi-110032, India.

REFERENCES:

1. **M.RAY and G.C. SHARMA**: A Textbook of dynamics published by S. Chand & company (p) Ltd., 2008 (Chapter 1, 2, 6, 8, 9, 11, 12), ISBN-81-219-0342-4.
2. **R.S. VERNA**: A Text Book on Statics Pothishala Pvt Ltd., Allahabad.
3. **A.S. RAMSEY**: Dynamics Part-I, Cambridge University Press, 1973.

MAT – HE – 701
Information Security
Total Marks:100 (Theory – 75, Practical-25)
Credits 6: (Theory - 04, Practical – 02)

Course Objectives: This course is aims to introduce students the concept of Secrecy, Program threats, Authentication, Integrity, Access control, public key encryption.
Course Outcomes: This course will enable the students to keep confidential and protect the Messages exchanged over worldwide through computer networks.

Unit I (15 Marks)

Overview of Security:
Protection versus security; aspects of security–data integrity, data availability,; security problems,userauthentication, Orange Book. 7 Lectures

Unit II (15 Marks)

Security Threats:
Program threats, worms, viruses, Trojan horse, trap door, stack and buffer over flow; system threats- intruders; communication threats- tapping and piracy. 7lectures

Unit III (15 Marks)
Cryptography:
Substitution, transposition ciphers, symmetric-key algorithms- Data . Encryption Standard, advanced encryption standards, public key encryption - RSA; Diffie-Hellman key exchange, ECC cryptography, Message Authentication- MAC, hash functions.
17 lectures

Unit IV (15 Marks)
Digital signatures:
Symmetric key signatures, public key signatures, message digests, public key infrastructures.
7 Lectures

Unit V (15 Marks)
Security Mechanisms:
Intrusion detection, auditing and logging, tripwire, system-call monitoring
7 Lectures

Practical – 25 Marks

Instructions for Practical **[Two Programs Only a) Program writing 10 marks, b) Output - 10 marks c) Viva Voce 3 marks d) Note book 2 marks]**

RECOMMENDED BOOKS

1. W. Stallings, *Cryptography and Network Security Principles and Practices*, 4th Ed., Prentice-Hall of India, 2006
2. C. Pfleeger and S.L. Pfleeger, *Security in Computing* , 3rd Ed., Prentice-Hall of India, 2007.
3. D. Gollmann, *Computer Security*, John Wiley and Sons, NY, 2002.

4. J. Piwprzyk, T. Hardjono and J. Seberry, *Fundamentals of Computer Security,* Springer-Verlag Berlin , 2003.
5. J.M. Kizza, *Computer Network Security,* Springer, 2007.
6. M. Merkow and J. Breithaupt, *Information Security: Principles and Practices,* Pearson

MAT – HE - 701
Spherical Trigonometry and Astronomy

Total Marks :100
Credits 6: (Theory - 05, Tutorial – 01)

Course Objectives: The main objective of this course is

- to introduce Trigonometry to The Celestial bodies
- To study different systems of Celestial co-ordinates,
- To study effect of sunrise and sunset
- To study declination of a star

Course Outcomes: Students should be able to

- Determine declination of a star in the distance between two neighbouring stars
- Understand different kinds of time
- Understand planetary motion

Unit I (30 Marks)

Spherical Trigonometry

Spherical triangle, Polar triangle, properties of Polar and Spherical triangles. Sine formula, Cosine formula, four parts formula, Sine cosine formula, Cotangent formula, Napier's analogies, Delambre's analogies.

Right angled spherical triangle, Formulae relating to the right spherical triangles, Area of a spherical triangle. Area of a spherical polygon. 20 Lectures

Unit II (20 Marks)

Celestial sphere

Three systems of celestial coordinates. Rectangular coordinates. Sidereal time. Rising and setting of stars. Circumpolar stars. Rate of change of zenith distance and azimuth. Twilight. Motion of the Sun. Vernal and Autumnal Equinox. Summer and Winter Solstice. Different kinds of time. Seasons.

17 Lectures

Unit III (20 Marks)

Refraction, Precession and Nutation

Laws of Refraction. Cassini's hypothesis. Simpson's hypothesis. Bradely's formula. Effect of refraction on (1) sunrise and sunset (2) the right ascension and declination of a star (3) in the distance between two neighbouring stars (4) on the shape of the disc of the sun.

Precession on the right ascensions and declination of a star. Nutation in the right ascension and declination of a star. Precession and nutation both on the right ascension declination of a star. 16 Lectures

Unit IV: (30 Marks)

Aberration, Parallax

Annual and diurnal aberration. Annual aberration in (1) ecliptic longitude and latitude (2) right ascension and declination of a star. Diurnal aberration in (1) hour angle and declination (2) zenith distance and azimuth.

Geocentric parallax and Annual parallax. Geocentric parallax in (1) right ascension and declination (2) the distance between two planets (3) azimuth and zenith distance. Annual parallax in (1) latitude and longtitude (2) right ascension and declination.

16 Lectures

Planetary motion

Synodic and orbital Period. Kepler's laws. Deduction of Kepler's laws from Newton's laws of Gravitation. 5 Lectures

RECOMMENDED BOOKS:

1. **M. Ray:** *Spherical Trigonometry*
2. **M. Ray:** *Spherical Astronomy*
3. **K.K. De:** *Text Book of Astronomy, Books Syndicate Pvt. Ltd., Kolkata.*

REFERENCES:

1. **W.M. Smart:** *Text Book of Spherical Astronomy,* CUP-VIKAS Student's Edition
2. **W.M. Smart** *: Foundation of Astronomy,* CUP-VIKAS Student's Edition.
3. **Gorakh Prasad:** *Text Book on Spherical Astronomy,* Pothisala Pvt. Ltd., Allahabad
4. **Standy P. Wyatt:** *Principles of Astronomy:* Allyn and Bacon, Inc

MAT – HE - 701

Advanced Computational Mathematics Laboratory

Total Marks: 100 (Theory – 75, Practical- 25)

Credits 6: (Theory-04, Practical-02)

Course Objectives: The main aim of this course is

- to introduce common mathematical functions, 2 & 3 dimensional graphics
- To develop mathematical programmes for data analysis

Course Outcomes: The course will enable the students to

- Understand 2-D & 3- D graphics
- Understand colour map & colour functions
- Solve problems of different equations and numerical Integration.

UNIT –I (15 Marks)

Simple arithmetical operations, variables, round-off errors, formatting printing, common mathematical functions, script M-files, File Input-Output. Two-dimensional graphics, three-dimensional graphics. 10 Lectures

UNIT – II (20 Marks)

Generating matrices, colon operator, manipulating matrices, simple arithmetical operations, operator procedure, common mathematical functions, data manipulation commands, sparse matrices.

15 Lectures

UNIT - III (20 Marks)

Solving linear system of equations-square linear system, catastrophic round-off error, over determined and undetermined linear system, Initial-valued ordinary differential equations. 10 Lectures

UNIT – IV (20 Marks)

Programming in MATHLAB-Flow control and logic variables, matrix relational operators and logical operators, function M-files. 10 Lectures

PRACTICAL - 25 MARKS (List of practical topics based on MATLAB or any software)

1. Plotting of functions
2. Matrix operations, vector and matrix manipulation, matrix function
3. Data analysis and curve fitting
4. Use of FFT algorithm
5. Numerical Integration
6. Differential equations
7. 2-D graphics and 3-D graphics-general purpose graphic functions, colour maps and colour functions.
8. Sparse matrices-Iterative methods for sparse linear equations, eigenvalues of sparse matrices.

Instructions for Practical **[Two Programs Only a) Program writing 10 marks, b) Output - 10 marks c) Viva Voce 3 marks d) Note book 2 marks , Time – 2 hrs]**

RECOMMENDED BOOKS:

1. **MATHLAB-**High performance numeric computation and visualization software: User's guide
2. **A MATHLAB** Tutorial-Ed Doverman Dept. Of Math., Ohio State University.

MAT – HG - 701
Sets, Determinants and Logic
Total Marks :100
Credits 6: (Theory - 05, Tutorial – 01)

Course Objectives: The primary objective of this course is to understand Truth Tables, Logical equivalences, importance of Tautology.

Course Outcomes: On completion of this course, students should be able to construct truth tables of different statements. These are of great use in concluding some statements from some given statements.

Unit I : (25 Marks)

Sets, Subsets, Set Operations and the laws of set theory and Venn diagrams. Examples of finite and infinite sets.

Finite sets and counting principle. Empty set, properties of empty set. Standard set Operations. Classes of Sets. Power set of a set. 15 Lectures

Unit II : (25 Marks)

Difference and Symmetric difference of two sets. Set identities, Generalized union and intersections, Relation, Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation, Partial ordering relations , unary relations. 15 Lectures

Unit III : 20 Marks

Basic properties and different types of determinants, finding values with or without expansion including Laplace method, Vandermonde's determinant (no proof of related theorems). 15 Lectures

Unit IV: (**30 Marks**)

Sentences and statements, Negation of a statement, Truth values of Statements, Truth Tables, conjunction, disjunction, Implications, biconditional propositions, converse, contra positive and inverse propositions, precedence of logical operators, Propositional equivalence. Logical equivalences, Predicates and quantifiers Tautology, Importance of Tautology, Contradiction. Logically true statement, logically equivalent statement. 20 Lectures

RECOMMENDED BOOKS:

1. Gupta and Malik, Set theory and Number systems, Rastogi Publications, Meerut
2. E. Kamke, Theory of sets, Dover Publishers, 1950
3. Samar Ballav Bhoi, A text Book of Logic and Sets, Education Publishing.

Department of Mathematics, Oriental College (Autonomous), Imphal

SEMESTER – VI

Discipline Specific Core Courses (CC)

MAT – HC – 703
Complex Analysis

Total Marks:100
Credits 6: (Theory - 05, Tutorial – 01)

***Course Objectives*:** The aim of this course is to provide knowledge about the analytical aspects of complex functions in complex variables. The course also emphasizes on construction of regular functions, Cauchy's theorems, series expansions and transformations.

***Course Outcomes*:** Students should be able to understand the significance of differentiability and continuity of functions of complex variables leading to the understanding of Cauchy-Riemann equations, evaluation of the contour integral, to find critical and fixed points of different transformation.

Unit-I (30 Marks)

Complex numbers, Properties of Complex numbers, regions in the complex plane, functions of complex variables. Limits, Continuity and differentiability of functions of complex variable.

Analytic functions, examples of analytic functions, exponential functions, Logarithmic functions, Trigonometric functions. The necessary and sufficient condition for a function f(z) to be analytic.

20 Lectures

Unit-II (20 Marks)

Method of constructing a regular function, Cauchy-Riemann differential equations in Cartesian and polar forms, Complex equations of a straight line and circle.

10 Lectures

Unit-III (20 Marks)

Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals. Cauchy integral formula, Liouville's theorem and the fundamental theorem of Algebra.

10 Lectures

UNIT –IV (30 Marks)

Conformal Mappings

Definition, Transformation, Jacobian of transformation, Conformal transformation, Some general transformations, Necessary and sufficient condition for w = f (z) to represent conformal mapping, Bilinear transformation, critical points and fixed points. Cross ratio, preservance of cross ratio, Types of bilinear transformation, fixed points of bilinear transformation, Family of circles and straight lines under bilinear transformation.

25 Lectures

RECOMMENDED BOOKS

1. **R.V. Churchill & J.W. Brown**: Complex variables and Application (5th Edition) Mc Graw Hill International Editions.

REFERENCES

1. **H.S. Kasana**: Complex Variables (Theory and Applications), Prentice Hall of India, Private Ltd., New Delhi
2. **John B. Conway**: Functions of One Complex Variable, Narosa Publishing House.
3. **L.V. Ahlfors**: Complex Analysis, Mc Graw Hill Book Company.
4. **Murray R. Spiegel**: Complex Variables, Schaum's Outline Series, Mc Graw Hill Book Company.
5. **Shanti Narayan and P.K. Mittal**: Theory of Complex Variables: S Chand And Company Ltd., Ram Nagar, New Delhi.
6. **R.K. Ghosh & K.C. Maity**: Differential Calculus (an introduction to analysis) Part-II(including Metric Spaces and Complex Analysis) New Central Books Agency (p) Ltd. Kolkata.

MAT – HC – 704
Group, Ring Theory and Linear Algebra
Total Marks:100
Credits 6: (Theory - 05, Tutorial – 01)

Course Objectives: The course gives

- The definitions of the basic concepts of abstract algebra, analysis of the concept of permutation groups, definition of Isomorphism of groups, properties of ring.
- It will help to find solutions of linear equations.
- It gives knowledge of complex functions in complex variables
- It focus on real vector spaces, subspaces and aplications

Course Outcomes: The student should be able to

- Apply Lagrange's theorem, Fermat's & Wilson's theorem to some exercise.
- explore the groups of permutations and the alternating groups
- Prove Cayley's theorem & its generalization.
- Express vector spaces in different dimensions

Unit I (20 Marks)

Group Theory

Groupoid, Monoid, Semi group, Abelian group and their elementary properties; permutation group, cycle, Transposition, Even and Odd permutation, Alternating group, Subgroup, conditions for being a subgroup (finite cases), Examples of Abelian and Nonabelian groups.

Cosets, Lgrange's theorem, Fernat's and Wilson's theorem. Theorem: If H and K are subgroups, then HK is a subgroup if HK = KH Theorem on – Union and Intersection of subgroups, Order of finite group, index of a group.

Cyclic group and its examples, Isomorphism of groups. 15 Lectures

Unit II: 20 Marks

Ring theory:

Definitions and examples, some special classes of rings, ideals, quotient rings, ring homomorphism, Isomorphism theorems, Zero divisors, integral domain, finite fields, field of quotient of an integral domain, polynomial ring, division algorithm, remainder theorem, factorization of polynomials, irreducible and reducible polynomials, primitive polynomials, irreducibility tests, Eisenstein criterion. 15 Lectures

UNIT – III (30 Marks)

VECTOR SPACES:

Concept of Vector Space over a Field K, n-tuple space, Subspaces, Necessary and sufficient condition for being a Subspace, Subspace generated by a Subset, Sum as Direct sum of Subspace, Linear Span, Linear Dependence, Linear Independence and their basic properties, Basis, Dimensions, Finite Dimensional Vector Spaces, Existence Theorem for Basis, Complement of a Subspace and Existence of a Complement of a Subspace of a Finite Dimensional Vector Space, Dimension of sum of Subspaces, Quotient Space and its Dimension. 15 Lectures

UNIT – IV (30 Marks)

Linear Transformation

Kernel of a Linear Transformation, Isomorphism, Isomorphism Theorem, Representation of Linear Transformation as matrices, Algebra of Linear Transformations, Rank and Nullity of a Linear Transformation, Rank-Nullity Theorem. **15 Lectures**

INNER PRODUCT SPACES

Inner Product Spaces, Cauchy-Schwarz Inequality, Orthogonal Vectors, Orthogonal Complements, Orthonormal sets and Orthonormal Basis, Bessel's inequality for Finite Dimesnsional Vector Spaces, Gram-Schmidth Orthogonalization process.

10 Lectures

RECOMMENDED BOOKS

1. **I.N.Herstein**: Topics in Algebra, John Wiley & Sons, New Delhi.
2. **Kenneth Hoffman and Ray Kunze**: Linear Algebra, Pearson.
3. **V.K. Khanna & S.K. Bhambri**: A Course in Abstract Algebra, Vikas Publishing House Pvt. Ltd., New Delhi.

MAT – HE – 702

Graph Theory

Total Marks: 100

Credits 6: (Theory-05, Tutorial-01)

Course Objectives:

This course gives details about the different types of graph and its properties. It will help students to develop Mathematical modelling in terms of different Type of graph.

Course Outcomes: Students should be able

- to apply different types of Graph as a mathematical model for many real life Situation such as communication network, signal flow.
  to develop Euler's subordinate relationship
- solve Map-colouring problems

Unit I (15 Marks)

Definition, examples and basic properties of graphs, types of graphs, complete, directed graph, signed graph, weighted digraph, weighted signed digraphs.

10 lectures

Unit II (25 Marks)

Mathematical Models in terms of directed graphs. One way traffic problems, Genetic graphs, Senior-Subordinate Relationship, Food Webs, and Communication Networks. Tree, Basic properties, Spanning tree, Minimal Spanning tree, Kruskal's algorithm, Prime's Algorithm, Rooted tree, Binary tree.

15 lectures

Unit III (25 Marks)

Matrices associated with a Directed graph, Application of Directed graphs to Detection of Cliques, Mathematical models in terms of Signed graphs, Structure theorem and its Implications, Antibalance and Duobalance of a graph, the degree of Unbalanced of a graph.

15 lectures

Unit IV (35 Marks)

Mathematical modelling in terms of Weighted Digraphs, Weighted Digraphs and Markov chains, General communication networks, Signal Flow graphs, Weighted Bipartitic Digraphs and Difference Equations, Mathematical Modelling in terms of Unoriented Graphs, Map-Colouring problems, Planer graphs, Face-size equation , Euler's formula for a planar graph, To show the graphs K_5 and $K_{3,3}$ are non planar, Euler 'Subordinate relationship, Necessary and sufficient condition for a graph to be Euler graph. Konigsberg Bridge problem.
Food Webs, Communication Networks. Skill Enhancement

25 lectures

RECOMMENDED BOOKS

1. J.N, Kapur, Mathematical Modelling; Wiley Estern Limited
2. E. G. Goodaire & M.M Prementer, Discrete Mathematics (with graph); Prentice Hall

MAT – HE – 702
Linear Programming and its applications
Total Marks:100
Credits 6: (Theory - 05, Tutorial – 01)

Course Objectives: The course begins with the formulation of linear programming problem and then different methods to solve them will be discussed. Duality in LPP will be introduced; Introduction to Transportation problem and some solving methods will be covered. At the end Games and strategies will be discussed.
Course Outcomes: Students will understand the concept of LPP, TP and will be able to Solve real life problems using optimization techniques.

Unit-I (25 Marks)
Introduction to linear programming problems (LPP), Mathematical formulation of the LPP with illustrations, Graphical method, general Linear programming problems, canonical and standard form of LPP, Theory of Simplex method, optimality and unboundeness, the simplex algorithm, simplex method in tableau format, Introduction to artificial variables, two-phase method, big M method and their comparison. 20 Lectures

Unit- II (25 Marks)
Duality in LPP: Introduction, General Prime-Dual Pair, Formulation of the Dual Problem, Prime Dual
Relationship duality theorems, complementary slackness theorem, duality and simplex method, Economics.
Interpretation of the duality. 15 Lectures

Unit-III (25 Marks)
Transportation Problems (TP): LP formulation of TP, Existence of solution and duality in TP. Solution of transportation problems, North-West corner method, Least-cost method and Vogel approximation method for determination of strategy basic solution, algorithm of solving transportation problem, assignment problem and its mathematical formulation. Solution methods of assignment problem, special cases in assignment problems.
20 Lectures

Unit-IV (25 Marks)
Games and strategies: Introduction, Formulation of two person zero sum games, solving two person zero sum Games, maximum-minimax principle, Games without saddle points, games with mixed strategies, Graphical solution procedure to (2xn) and (mx2) games.
15 Lectures

Recommended Books:
1.Kantiswarup, P.K Gupta and Man Mohan – Operation Research, S. Chand and Co.

Reference Books:
1. G.Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002
2. R.Veerachamy and V. Ravi Kumar- Operation Research, I.K International Publishing House Pvt.
Ltd., New Delhi, Bangalore.

MAT – HG – 702
Analytical Geometry of Two & Three Dimensions
Total Marks:100
Credits 6: (Theory - 05, Tutorial – 01)

Course Objectives: The primary objective of the first part is to introduce the basic tools of plane geometry and geometric properties of different conic sections which are helpful in understanding their applications to the real world problems.
The second part of the course is to introduce the basic tools of space geometry.
Course Outcomes: The course will enable the student to

- Understand the basic knowledge about transformation of rectangular axes, pair of straight lines, elementary properties of conic sections in the Cartesian and polar co-ordinates systems.

Analytical Geometry of Two Dimensions

Unit I (30 Marks)

Transformations of Rectangular axes: translation, rotation and their combinations. General equation of second degree in x and y, Reduction to canonical forms. Classification of conics.

Pair of straight lines: condition that the general equation of second degree in x and y may represent two straight lines. Point of intersection of two intersecting straight lines. Angle between two lines given by $ax^2 + 2hxy + by^2 = 0$. Equation of bisectors. Equation of pair of straight lines joining the origin to the points in which a line meets a conic. 15 Lectures

Unit II (20 Marks)

Equations of pair of tangents from an external point, chord of contact, poles and polars in case of general conic, in particular for Circle, Parabola, Ellipse, Hyperbola. Polar equation of straight lines and circles. Polar equation of a conic referred to a focus as pole. Equation of chord joining two points. Equations of tangent and normal. 15 Lectures

Analytical Geometry of Three Dimensions:

Unit III (30 Marks)

Rectangular Cartesian co-ordinates. Distance between two points. Division of a line segment in a given ratio. Direction cosines and direction ratios of a straight line.

Equation of plane: General equation of a plane. Intercept and normal forms. Angle between two planes. Distance of a point from a plane and distance between two parallel planes. Bisectors of angles between two intersecting planes. 15 Lectures

Unit IV (20 Marks)

Equation of a straight line: General and symmetric form. Angle between two straight lines. Distance of a point from a line. Coplanarity of two straight lines. Shortest distance between two skew lines, Sphere and its tangent plane. 15 Lectures

RECOMENDED BOOKS

1. **B. Das**-Analytical Geometry with Vector Analysis, Orient Book Company, Kolkata.
2. **Shanti Narayan and P.K. Mittal**-Analytical Solid Geometry, S. Chand.

REFERENCES

1. **S.L. Loney**: Co-ordinate geometry of two dimensions, Macmillan and Sons Pvt. Ltd.
2. **R.J.T. Bell**: Co-ordinate geometry of three dimensions, Macmillan and Sons Pvt. Ltd.

Department of Mathematics, Oriental College (Autonomous), Imphal

SEMESTER – *V*II

Discipline Specific Core Courses (CC)

MAT – HC – 801
Laplace Transform & Vector Analysis
Total Marks:100
Credits 6: (Theory - 05, Tutorial – 01)

Course Objectives: This course aims to introduce students to the following concepts and cognitive skills. In this course the students

- Understand Laplace Transformation, their properties and applications
- Understand the concepts of Differential and Integration of vectors.

Course Outcomes: After studying this course the students will be able to

- State and prove Heaviside's shifting theorem
- Apply Laplace Transformation in solving PDE
- Solve the related problems of Gauss's, Green's and Stoke's theorems

Laplace Transformation

Unit – I (30 Marks)

Concept & definition of Laplace Transform,. Kernel of the Integral transformation [Ref. Ch - 6 (3)]. Existence of Laplace Transformation [Ref. Ch - 8.1 (4)]. Transformation of some elementary functions such as f (t) = e^{-at}, Cos at, Sin at, Cosh at, Sinh at, t^n etc. [Ref. Ch 6 (3)].

Properties of Laplace Transformation [Ref. Ch - 6 (3)]. First Translation or Shifting Theorem. Second Translation or Heaviside's shifting Theorem [Ref. Ch - 8.5 (4)].

15 Lectures

Unit – II (15 Marks)

Differentiation property [Ref. Ch - 6 (3)]. Change of scale property with examples [Ref. Ch - 8.5 (4)]. Laplace Transformation of Derivatives of order n with Theorems [Ref. Ch - 13.6 (5)]. 10 Lectures

Unit-III (25 Marks)

Inverse Laplace transformations. Theorems on multiplication by s and 1/s. First and Second Shifting properties with examples [Ref. Ch - 13.20 (5)]. Convolution Theorem. Properties of Convolution, examples of Convolution [Ref. Ch - 8.16 (4)].
Application of Laplace Transformation in solving PDE [Ref. Ch - 8.19 (4)]

15 Lectures

Unit-IV (30 Marks)

Vector Analysis

Scalar and vector product of three and four vectors, reciprocal vectors, Differetiation of vectors, Gradient, Divergence and Curl of a vector, vector integration, ordinary integrals of vectors, Line, Surface and Volume integrals, theorems of Gauss, Green, Stokes and related problems.

20 Lectures

RECOMMENDED BOOKS:

1. **B. Das**-Analytical Geometry with Vector Analysis, Orient Book Company, Kolkata.
2. **M.R. Spiegel-**Vector analysis and an introduction to tensor analysis-Schaum series.
3. Vector Analysis by Maity & Ghosh.
4. **Spiegel**: *Laplace Transform,* Schuam Outlines Series.

REFERENCES:

1. **L.N. Sneddon** : *The use of Integral Transform,* Mc-Graw Hill, New York 1972.
2. *An Introduction to Transform Theory,* Academic Press, New York by D.V. Widder.

MAT – HC – 802
Advanced Real Analysis
Total Marks:100
Credits 6: (Theory - 05, Tutorial – 01)

Course Objectives:

The study of real valued functions that would develop an analytical ability to have a more matured perspective of the key concept of Calculus.

Course Outcomes:

Students should be able to have

- a rigorous understanding of the families and properties of Rieman integral functions
- Concept of multiple integral, line and surface integrals and connection among all integrals (Green's and Stoke's theorem)

Unit-I (25 Marks)

Improper Integrals

Improper integrals, Different types of improper integrals, Evaluation, convergence of improper integrals, various forms of comparison tests, absolute and conditional convergence, Abel's test and Dirichlet's test, Beta function, Gamma function, Frullani's Integral.

15 Lectures

Unit-II (25 Marks)

Riemann Integration

Upper and lower Riemann Integrals (R.I.), Darboux's theorems, Integrability conditions, R.I. as a limit of a sum, properties, Inequalities for Integrals, Integral function, Mean value theorems 15 Lectures

Unit-III (25 Marks)

Functions of Several Variables

Differentiability and differential, Partial derivatives of higher order, Young's and Schwarz's theorems, Differentials of higher order, Functions of Functions, Differentials of higher order of a function of functions; Derivation of composite functions (the chain rules); Change of variables. 15 Lectures

Unit-IV (25 Marks)

Multiple Integrals

Concept of line integrals; Double and repeated integrals; Green's theorem in the plane, evaluation of area, Change of order of integration.

Surface areas; surface integrals; Stoke's Theorem; Volume integrals, Triple integrals; Gauss divergence Theorem and its application.

20 Lectures

RECOMMENDED BOOKS

1. **S.C. Malik and Savita Arora** - Mathematical Analysis, New Age International (P) Limited; Publishers, New Delhi.
2. **K.C. Maity & R.K. Ghosh** - An Introduction to Analysis, Differential Calculus Part I & II, Integral Calculus, Books and Allied (P) Ltd., Kolkata 700009.
3. **Shanti Narayan and P.K. Mittal** - A Course of Mathematical Analysis, S. Chand & Company Ltd. Ram Nagar, New Delhi - 110055.

REFERENCES

1. **S.L. Gupta & N.R. Gupta** - Principles of Real Analysis, Pearson Education (Singapore) Pvt. Ltd., Indian Branch, 482 F.I.E. Patparaganj N.D. - 110092.
2. **S.K. Jain & S.K. Kaushik** - Introduction to Real Analysis, S. Chand & Company Ltd., Ram Nagar, N.D. - 110055.
3. **S.K. Sinha** - Real Analysis, P.C. Dwadash Shreni & Co (P) Ltd. Publisher & Book Seller's, Bara Bazar, Aligarh - 202001.
4. **V.K. Krishnan** - Fundamentals of Real Analysis, Pearson Education (Singapore) Pte. Ltd., Indian Branch.

5. **K.K. Jha** - Honours Course in Real Analysis and Convergence, Navbharat Prakashan Patna - 4, Delhi - 6.
6. **D. Somasundarum & B. Choudhury** - A First Course in Mathematical Analysis, Narosa Publishing House, New Delhi.
7. **R.G. Bartle & D.R. Sharbert** - Introduction to Real Analysis, John Wiley and Sons (Asia)

Pte. Ltd., Singapore.

9. **R.R. Goldberg** - Method of Real Analysis, Oxford and INH Publishing Co.
10. **Murray R Spiegel** - Theory and Problems of Advanced Calculus, Schaum Out Line Series Mc Graw Hill Book Company.
11. **Frak Aryer Jr.** - Theory & Problem of Calculus, Schaum Out Line Series Mc Graw Hill Book Company.

MAT – HE – 801
Geometry (Two and Three Dimension)
Total Marks:100
Credits 6: (Theory - 05, Tutorial – 01)

Course Objectives: The primary aim of this course is to introduce the basic tools of plane geometry and geometric properties of different conic sections which are helpful in understanding their applications to the real world problems. The main aim is to introduce the basic tools of space geometry.

Course Outcomes: This course will enable the students to

- Understand basic knowledge about pair of straight lines, properties of conic sections in the Cartesian and polar co-ordinates, to trace parabola, ellipse, hyperbola in a plane using its mathematical properties.
- Understand about lines in 3D, projections, basic knowledge about different types of conicoids such as spheres, cone, cylinder, ellipsoid, hyperboloid and paraboloid.

Two dimensional Geometry

Unit – I (25 Marks)

Change of axes: Change of origin without changing the direction of axes. Change of direction of axes of co-ordinates without changing the origin.

Pair of Straight lines: Pair of straight lines, homogeneous equation of second degree, Angle between the pair of lines given by the homogeneous equation, Bisectors of the angles between the pair of lines, Condition for the general equation of second degree represents a

pair of straight lines, Point of intersection, Equation of the pair of lines joining the origin to the points of intersection of the line and a curve.

15 Lectures

Unit-II (25 Marks)

System of Conics: Every general equation of second degree in two variables always represents a conic section, The centre of a conic, Reduction of the general second degree equation into a central and non-central conics, Condition that a line is a tangent to a conic, Chord of contact, pole and polar, Diameter, conjugate diameters, feet of normals, Intersection of two conics, Pair of tangents.

Confocal Conics and their Properties

Polar equation of conics: Polar equation of a conic with respect to focus as pole, equation of a chord, tangent and normal. 15 Lectures

Three Dimensional Geometry

Unit-III (25 Marks)

Sphere: Equations of sphere, condition for the general equation of second degree to represent a sphere, plane section of sphere, intersection of a plane and a sphere, intersection of two spheres, power of a point, equation of a tangent plane, condition for a plane to be a tangent plane to a sphere, plane of contact, polar plane, pole of a plane.

Cone: Equation of a cone with a conic as guiding curve, enveloping cone of a sphere, quadratic cones with vertex at origin, condition for the general equation of second degree to represent a cone, reciprocal cone, right circular cone.

20 Lectures

Unit – IV (25 Marks)

Cylinder: Equation of cylinder, enveloping cylinder, right circular cylinder.

Central coincoids: Equations and properties of coincide, intersection of a line with a conicoid, Tangent line and plane, normal, number of normals from a given point, plane of contact. Polar plane of a point, enveloping cone and cylinder, chord, conjugate diameters.

Paraboloids: Equations and simple properties.

Confocal conicoids: Equations and simple properties. 20 Lectures

RECOMENDED BOOKS:

1. **B. Das**-Analytical Geometry with Vector Analysis, Orient Book Company, Kolkata.
2. **Shanti Narayan and P.K. Mittal-**Analytical Solid Geometry, S. Chand.

REFERENCES

1. **S.L. Loney**: Co-ordinate geometry of two dimensions, Macmillan and Sons Pvt. Ltd.
. **R.J.T. Bell**: Co-ordinate geometry of three dimensions, Macmillan and Sons Pvt. Ltd.

MAT – HE – 801
Special Theory of Relativity
Total Marks:100
Credits 6: (Theory - 05, Tutorial – 01)

Course Objectives: The objective of this course is

- To introduce the concept of space and time
- To grew out of a desire to understand consequences of Lorentz transformation, properties of mass energy and force

Course Objectives: The course will help students to expressed physical laws in mathematical terms. It will help to study related problems of Einstein's time distillation, the relativistic force of law and equivalence of mass and energy.

Unit – 1 (25 Marks)

Basic Aspects of STR

Inertial frames, Galilean tranformation, Michelson - Morley' experiment. The relavistic concept of space and time, Postulates of special theory of relativity. 10 Lectures

Unit – II (30 Marks)

Relativistic Kinematics

Lorentz transformation equations, the general Lorentz transformation equations, Consequences of Lorentz transformation equations like Relativity of simultaneity, Einstein's time distillation or apparent retardation of clocks, Relativity of space - Lorentz - Firzgerald contraction and related problems. 20 Lectures

Unit – III (30 Marks)

Relativistic Dynamics

Redefined momentum, the relativistic force Law and the Dynamics of a single particle, Equivalence of Mass and Energy, $E=mc^2$ and its consequences. 20 Lectures

Unit - IV

Realitivistic Mechanics **(15 Marks)**

Transformation properties of Momentum, Energy, Mass and Force. 10 Lectures

RECOMMENDED BOOKS

1. **M. Ray:** Special Theory of Relativity.
2. **A. Das:** The Special Theory of relativity.
3. **Banerjee and Banerjee**: The Special Theory of relativity, Prentice Hall of India, New Delhi.
4. **Resnick** : Special Theory of relativity, John Wiley.

REFERENCES

1. **Dirac:** General Theory of Relativity, Prentice Hall of India, New Delhi.
2. **S.K. Bose**: General Theory of Relativity, Wiley Eastern Ltd.

MAT – HE – 801
Cryptography
Total Marks:100 (Theory – 75, Practical – 25)
Credits 6: (Theory - 04, Practical – 02)

Course Objectives: Objective of studying cryptography is to provide students knowledge of symmetric encryption, substitution symmetric encryption (letters/block of letters are substituted by other letters/block letters), Transposition symmetric encryption application of permutation to the plaintext), public key Encryption, etc.

Course Outcomes: Students should be able to find importance of cryptography. They will have knowledge how to keep the information used by the common people secure, should be able to protect confidential messages exchanged over worldwide through computer network against manipulation.

Unit – I (15 Marks)

Prerequisites of Number theory

Prime numbers, format's theorem (without proof), Euler's theorem; Primality test- Methods of Native, Fermat, Miller- Rabin Leonard Adleman and Huang, probability, fast deterministic, number theoretic tests. Chinese Remainder Theorem, discrete logarithms.

8 Lectures

Unit – II (15 Marks)

Cryptography & Information Security

Information security, security attacks, services and mechanisms, conventional encryption techniques, substitution ciphers and transportation ciphers, cryptanalysis, sterography, stream and block ciphers. 8 Lectures

Unit – III (15 Marks)

Block Ciphers and DES

Block cipher principles, Data Encryption Standards (DES), strength of DES, differential and linear cryptanalysis of DES, block ciphers models of operation, triple DES, IDEA encryption and decryption, traffic confidentially, key distribution, random number generation.

10 Lectures

Unit –IV (15 Marks)

Public Key Cryptography

Principles of public key cryptography, prime and related prime numbers, modular arithmetic, key management, authentication, key length and encryption strength, RSA algorithm, security of RSA key management. 9 Lectures

Unit – V (15 Marks)

DSS & IP Security

Authentication functions, and message authentication codes, digital signatures, authentication protocols, digital signature standards (DSS) digital signature algorithm. IP security and its overview, intruders, viruses and related threads, firewell design principles.

10 Lectures

PRACTICAL – 25 Marks

Instructions for Practical **[Two Programs Only a) Program writing 10 marks, b) Output - 10 marks c) Viva Voce 3 marks d) Note book 2 marks]**

RECOMMENDED BOOKS

1. **William Stallings,** Cryptography and Network Security, Principles and Practice, Prentice Hall of India, New Delhi, 2007
2. **V.K Pachghare,** Cryptography and Information Security, PHI Learning (P) Ltd, New Delhi, 2009

REFERENCES:

1. **Johannes A. Buchman,** Introduction to cyptography, Spiringer Verlag
2. , **Bruce Schiener,** Applied Cryptography, Addition Wesley, 2001

MAT – HG – 801
Elements of Probability
Total Marks:100
Credits 6: (Theory - 05, Tutorial – 01)

Course Objectives: The course is designed to understand the notion of probability and applications.

Course Outcomes: The course will help to understand concept of probability like different types of distribution and applications, Bernoulli's number, Moment generating functions

Unit I (20 Marks)

Probability

Concepts: Classical and Axiomatic, Conditional Probability, Bayes's Theorem, Independent Events, Random Variable, discrete and continuous random variable, Distribution function, probability density function, Expectations, moments moment generating functions.

15 Lectures

Unit II (15 Marks)

Discrete Probability

Binomial, Poisson, Hypergeometrial distributions, their comparison, applications.

10 Lectures

Unit III (35 Marks)

Continuous Probability Distribution

Stirring's Approximation, Bernoulli Numbers, Uniform Distribution, Negative Binomial Exponential, Gamma and Betta Distributions, Normal Distributions. Limiting forms of Binomial and Poisson distributions, Chebyshev's Inequality.

20 Lectures

Unit IV (30 Marks)

Bernounoulli's theorem

Evaluation of Distribution function, Filling of Normal Curve of a frequency distribution. Applications of Normal Distribution, Moment Generating Function, Approximation for the Mean and Variance. 15 Lectures

RECOMMENDED BOOKS

1. J.N.Kapoor and M.N. Saxena – Mathematical Statistics, S.Chand & Co. New Delhi.
2. N.A.Rahman – A Course in Theoretical Statistics. Griffin, London.
3. K.L.Chung – Elementary Probability Theory with Stochastic Process, Narosa Publishing House, New Delhi, 1985.
4. Goon Gupta and Das Gupta Ground work of Statistics.

Department of Mathematics, Oriental College (Autonomous), Imphal

SEMESTER –VIII

Discipline Specific Core Courses (CC)

MAT – HC – 803
Probability Theory
Total Marks:100
Credits 6: (Theory - 05, Tutorial – 01)

Course Objectives: The main objective of this course is to introduce the students to the existing world of probability theory.

Course Outcomes: Students should be able

- To solve problems of probability generating functions, problems of weak and strong convergence of random variables, problems of probability under normal curve, problems of application of central limit theorem.

Unit – I (20 Marks)

Continous Probability distributions

Continous probability distributions - uniform, exponential, rectangular, beta gamma distributions, probability generating functions. 16 Lectures

Unit – II (20 Marks)

Generating functions & Convergence

Moment inequalities-Holder, Minkowsky, Schwarz: Weak and strong convergence of random variables, almost sure convergence, Convergence in r'th mean. 16 Lectures

Unit – III (20 Marks)

Convergence of distribution functions

Weak and complete convergence of distribution functions: probability inequalities: Chebychev, Markov and Jensen. 14 Lectures

Unit – IV (20 Marks)

Normal distribution

Normal distribution as limiting case of binomial distribution, properties of normal distribution, normal **probability** curve, area under normal curve, Characteristic functions and its properties. 15 Lectures

Unit - V (20 Marks)

Central Limit Theorem

Univariate distribution, Transformation, Bivariate normal distribution and its properties. De Moivre Laplace limit theorem, Liapunov theorem (without proof) and applications of central limit theorem. 14 Lectures

RECOMMENDE18 Lectures **D BOOKS**

1. **B.R. Bhatt,** Modern Probability Theory, Wiley Eastern Ltd., 1989
2. **P. Mukhopadhyay** Theory of Probability, New Central Book, Agency, Kolkata, 2002
3. **Kai Lai Chung,** A Course in Probability Theory, 3/e. Academic Press, 2001

REFERENCES

1. **M.H. Degroot, M.J. Schervish** : Probability and Statistics, Addison Wesley, 2001
2. **Sheldon Ross,** A First Course in Probability, Prentice Hall, New Jersey, 2002
3. . **William Feller,** An Introduction to Probability Theory and Its Applications, Volume 1, John Wiley and Sons, Inc., New York, 1971.
4 **A.N. Kolmogorov,** Foundations of the Theory of Probability, 2nd ed., AMS, 1997

MAT – HC – 804
Mathematical Modelling
Total Marks :100
Credits 6: (Theory - 05, Tutorial – 01)

Course Objectives: This course is designed to understand need, Techniques, classification of Mathematical modelling through different branches of mathematics.

Course Outcomes: On completion of this course, students should be able to design mathematical models for Traffic flow on a highway, model of planetary motion, population dynamics and genetics through difference equation, through linear, Non-linear programming, through calculus of variation.

Mathematical Modelling:

Unit I (20 Marks)

Need, Techniques, Classification. Mathematical Modelling through Geometry, Algebra, Trigonometry, Calculus. 15 Lectures

Unit II (30 Marks)

Mathematical Modelling in Dynamics through Ordinary Differential Equations of First Order. Mathematical Modelling in Population Dynamics, Mathematical Modelling of Epidemics through Systems of Ordinary Differential Equations of First Order.

20 Lectures

Unit III (20 Marks)

Mathematical Modelling of Planetary Motions, Circular Motion and Motion of Satellites, Mathematical Modelling through Difference Equations in Population Dynamics and Genetics. 15 Lectures

Unit IV (30 Marks)

Model for Traffic Flow on a Highway. Mathematical Modelling through Calculus of variations . Mathematical

Modelling through Linear Programming, Mathematical Modelling through non – linear Programming. 20 Lectures

Recommended Books

3. J.N. Kapur, Mathematical Modelling, Willy Extern Limited 1988
Giordano, Frank R., Fox, William P., & Horton, Steven B. (2014). A First Course in Mathematical Modelling (5th ed.). Brooks/Cole, Cengage Learing

MAT – HE – 801

Rigid Dynamics& Tensor

Total Marks: 100

Credits 6: ***(Theory-05, Tutorial-01)***

Course Objectives: The first part of the course is to
- develop an ability to grasp the concepts of equilibrium and tension.
- develop an understanding of the fundamentals and principles of motion of any rigid body

The second part aim
- at understanding the various relations which remain valid on change of systems.
- help the learners of relativity, differential geometry, and engineering mathematics.

Course Outcomes: Students should be able to
- analyse the problems of the motion of rigid bodies and simultaneously solve them
- get a hold of motion of compound pendulum
- study and learn the cause effect related to the relations between other papers of mathematics
- the applications in observing and relating real situations.

Unit I (50 Marks)

DYNAMICS OF RIGID BODIES:

Moments and products of inertia (Art[1] 144-149), Momental Ellipsoid (Art[1] 151) Equimomental systems, Principal Axis (Art[1] 154, 155)

D'Alembert's Principle, Equations of motion of rigid bodies, Motion of centre of inertia, Motion relative to centre of Inertia (Art[1] 162)

Motion about a fixed axis (Art[1] 168-171), Compound Pendulum (Art[1] 173-175), Motion in 2 dimension under finite and impulsive forces (Art[1] 187-190), Conservation of momentum and Energy. (Art[1] 235, 236, 238, 239, 242) 30 lectures

Unit II (50 Marks)

Tensors:

Space of N-dimension, Transformation of co-ordinates, contravariant and covariant vectors (Tensor of first order), Tensor of second order (or of rank two), Tensor of higher rank (or higher orders), Mixed tensors, Kronecker delta symbol, Invariant or scalar, Algebraic operations with tensors, Addition & subtraction of tensors, contraction, product of tensors, Inner Product, symmetric and Skew symmetric tensor. 30 lectures

RECOMMENDED BOOKS

1. **S.L. LONEY** : An elementary treatise on dynamics of particle and of rigid bodies. Cambridge university press 1956, reprinted by S. Chand & Company (P) Ltd. 1988.

MAT – HE – 801
Higher Mechanics
Total Marks:100
Credits 6: (Theory - 05, Tutorial – 01)

Course Objectives: This course aims to

- Provide knowledge about K.E. due to rotation, as quadratic functions of generalized velocities, Euler's geometrical equations.
- Understand applications to S.H.M., pendulum, projectile motion.

Course Outcomes: A student will understand the importance of advantages

- Of Hamiltonian approach over Lagrangian approach.
- Conditions for a transformation to be canonical.

UNIT – I (10 Marks)

System of Particles

Centre of mass, centre of gravity, momentum, conservation of Linear momentum, Angular momentum, kinetic Energy, conservation of Energy for a system of particles.

5 Lectures

UNIT – II (25 Marks)

***Motion of rigid** bodies*

Generalized coordinates for rigid body, translational and rotational motion Angular momentum, moments and products of Inertia, Kinetic Energy due to rotation, kinetic energy in terms of inertia tensor, principle axes, Principle moments of inertia, Euler's angle, Euler's geometrical equations, rate of change of vector, coriolis forces, and Euler's equation of motions.

20 Lectures

UNIT –III (25 Marks)

Lagrangian Mechanics

Generalized Coordinates, degrees of freedom, generalized force, generalized momenta, Holonomic, non-holonomic, Seleronomic and Rheonomic systems, virtual works, D' Alembert's principal, Kinetic Energy as quadratic functions of generalized velocities, Lagrangian of a force system, Lagrange's Equations of motion. Applications to S.H.M. Compound pendulum, projectile, central orbit, motion of a particle on the Earth's surface.

20 Lectures

UNIT – IV (25 Marks)

Hamiltonian Mechanics

Configuration space, system point, Hamiltonian of a force system, relation between Lagrangian and Hmiltonian of a system. Hamilton's Principle, Physical significiances of Hamiltonian, Derivation of Hamilton's Principle from Lagrange's Equations and Vice-Versa, Derivation from D' Alembert's Principle, Hamilton's Canonical Equation of motion, advantages of Hamiltonian approach over Lagrangian approach, meaning of Action in Hamiltonian sense, Least action Principle.

20 Lectures

UNIT – V (15 Marks)

Canonical Transformation

Meaning and conditions for a transformation to be canonical, Examples, Lagrange's bracket, Poisson's bracket and their properties, equations of motion in Poisson's bracket.

10 Lectures

RECOMMENDED BOOKS

1. **S.L. Loney** : An Elementary treatise on Dynamics of a particles and rigid bodies.
2. **G. Aruldhas** : Classical Mechanics, Prentice Hall of India, Private Limited, New-Delhi-2008.
3. **H. Goldstein** : Classical Mechanics Narosa Publishing House, New Delhi-1985.
4. C.R. Mondal : Classical Mechanics, Prentice hall of India New Delhi.

REFERENCES

1. **Murray R. Spiegel**: Theoretical Mechanics Mc Graw Hill Book Company, New Delhi.
2. **K. Shankara Rao** : Classical Mechanics Prentice Hall of India.
3. **R.G. Takwale and P.S. Puranik** : Introduction to Classical Mechanics, Tata Mc Graw Hill Publishing Company, New Delhi.

MAT – HE – 801
Fluid Mechanics
Total Marks:100
Credits 6: (Theory - 05, Tutorial – 01)

Course Objectives:

- To introduce description of different types of fluid motion
- To study equations of continuity indifferent forms
- To study geometric properties of different fluid rotation, flow fluids which are helpful in understanding their applications to the real problem.

Course Outcomes: Students will be able to

- Understand pressure equations and can solve Bernoulli's equations and its applications
- Learn about kinematic and dynamic similarities, potential functions, flows, flows fluids.

Unit I (25 Marks)

Kinetics

Eulerian and Lagrangian description of fluid motion. Concept of local and connective accelerations. Steady and Non-Steady flows. Stream lines and path lines. Equation of continuity in different forms. Irrational and Rotational flows. Controlled volume analysis for mass, momentum and energy. Velocity potential. 25 Lectures

Unit II (25 Marks)

Equation of Motion

Equations of motion-Eulerian and Lagragian. Pressure equation, Bernoulli's equation and its applications, Cauchy's integrals. Motion under the action of impulsive forces. Sources, Sinks, Doublets and their Images. 25 Lectures

Unit III (25 Marks)

Dimensional Analysis

Concept of Geometric, Kinematic and Dynamic Similarities, Concept of Fluid rotation, Velocity, Stream function and Potential function, Potential flows, Elementary flow fields and Principle of superposition. 15 Lectures

Unit IV (25 Marks)

Vortex Motion

General theorem (vortex motion and its properties), Rectilinear vortices, Motion under circular and rectilinear vortices. 10 Lectures

RECOMMEDED BOOKS

1. **G.K. Batchelor,** An introduction to Fluid Mechanics, Cambridge Univ. Press 1967.
2. **F. Chorlton**, Text Book of Fluid Dynamics, CBS Publication, Delhi 1985.

REFERENCES

1. **AJ Chorin & JF Mursden**, mathematical introduction to Fluid dynamics 1993.
2. **L.D. Landu and F.M. Lifshitz,** Fluid Mechanics, Pregmon Press 1985.
3. **O'Neil and F. Chorlton,** Ideal and incompressible Fluid Dynamics, Ellis Horwood,Ltd.1986

MAT – HE – 801
Research Project (Credits: 6)
Total Marks:100

MAT – HG – 801
Mechanics
Total Marks:100
Credits 6: (Theory - 05, Tutorial – 01)

Course Objectives: The course aim to
- understanding the components of velocity and acceleration
- develop an understanding of the fundamentals and principles of motion of particles
- develop an ability to grasp the concepts of equilibrium and tension.

Course Outcomes: Students should be able to
- illustrate laws of motion, kinematics of motion and to learn the cause-effect related to these
- explain the concepts of motion of particles; get a hold of S.H.M. of compounding two S.H.M. of simple pendulum.

UNIT I (50 Marks)

DYNAMICS

Kinematics in two dimensions: Tangential, normal, radial, transverse velocities and accelerations. Angular velocity and acceleration. Rectilinear motion and simple pendulum. S.H.M., compounding of two S.H.M. Repulsive motion. Motion under inverse square law.

Rectilinear Motion (Kinetics): Newton's law, Work, K.E., work energy principle, Impulse, Torque and angular momentum, conservation of energy, momentum and angular momentum, Hooke's law, extension of an elastic string: Horizontal & vertical case**.**

30 Lectures

UNIT II (50 Marks)

STATICS

Reduction of system of coplanar forces, equation of resultant, condition for equilibrium, astatic centre.
Laws, angles and cone of friction, equilibrium on a rough inclined plane, particle constrained to move on a rough curve under any given forces.

30 Lectures

RECOMMENDED BOOKS:

1. Statics – S. L. Loney
2. Dynamics – S. L. Loney
3. Mechanics – Singh & Sen, Bharti Bhawan Publication
4. Dynamics – Das & Mukherjee, published by S.Chand & Company (P) Ltd.2010 ISBN-81-85624-96-8
5. Statics - Das & Mukherjee, published by S.Chand & Company (P) Ltd.2010 ISBN-81-
   856224-18-