जे. सी. बोस विज्ञान एवं प्रौद्योगिकी विश्वविद्यालय, वाई एम सी ए, फरीदाबाद
J.C. BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA
SECTOR -6, FARIDABAD, HARYANA
(Established vide Haryana State Legislature Act No. 21 of 2009)
A+ GRADE NAAC Accredited

Ref. No. /Maths/1734 Dated: 18/09/2025

CERTIFICATE

This is to certify that the scheme & syllabi of B.Sc. Maths and comput. (course name & scheme) is duly approved by the competent body / authority and to the best of my knowledge the contents of the same, are correct in all respect.

This Scheme & Syllabus has been approved in 3rd (meeting no.) of BOS held on dated 10/09/2025 and

Applicable for the students admitted in the Session/Batch 2024-2025 w.e.f for the semester(s) 1st to VIth

Date: 18/09/2025

Neetu Gupta 18/09/25
Signature & Stamp of Chairperson

Name: Prof. Neetu Gupta

Deptt. Name Mathematics

CHAIRPERSON
Department of Mathematics
J.C. Bose University of Science and Technology, YMCA
Faridabad - 121006 (Haryana)

Stamp

Dean Academic

Academic Branch

B.Sc. MATHEMATICS AND COMPUTING / B.Sc. (Hons./ Hons. with Research) MATHEMATICS AND COMPUTING

Scheme and Syllabus

(upto 6th semester)

in accordance to NEP 2020

ACADEMIC SESSION

(w.e.f. 2024-2025)

DEPARTMENT OF MATHEMATICS

FACULTY OF SCIENCES

J.C. BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA, FARIDABAD, HARYANA-121006

J.C. BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA, FARIDABAD

VISION

J.C. Bose University of Science and Technology, YMCA aspires to be a nationally and internationally acclaimed leader in technical and higher education in all spheres which transforms the life of students through integration of teaching, research and character building.

MISSION

- To contribute to the development of science and technology by synthesizing teaching, research and creative activities.
- To provide an enviable research environment and state-of-the-art technological exposure to its scholars.
- To develop human potential to its fullest extent and make them emerge as world class leaders in their professions and enthuse them towards their social responsibilities.

DEPARTMENT OF MATHEMATICS

VISION

To emerge as a department of science, which will provide strong foundations in the areas of pure and applied mathematics in order to develop innovative minds for interdisciplinary research.

MISSION

- To develop strong communication skills among students.
- To develop strong moral values.
- To develop strong foundations in mathematics, to have a sound analytical and critical thinking ability for innovative solutions to practical problems.
- To continuously improve the basic infrastructure in pursuit of providing the necessary environment for academic excellence.
- To develop a nurturing environment for lifelong learning.

ABOUT THE PROGRAM:

B.Sc. Mathematics and Computing / B.Sc. (Hons./Hons. with Research) Mathematics and Computing

The B.Sc. in Mathematics and Computing is program that integrates the theoretical foundations of mathematics with computational techniques. This program is designed to equip students with a deep understanding of core mathematical principles and proficiency in modern computing tools, preparing them for a broad range of careers and advanced study opportunities. Graduates will have a strong foundation in core areas of mathematics, such as calculus, algebra, differential equations, and analysis, enabling them to approach and solve complex problems in both pure and applied mathematics. Students will develop expertise in computing technologies, algorithms, programming and data structures. They will be able to apply these skills to analyze and solve mathematical and computational problems. The well-structured programme empowers the students for careers in academia, industry, research, or advanced studies in mathematics, computer science or related disciplines.

Awarding UG Certificate, UG Diploma and UG Degrees

UG Certificate: Students who opt to exit after completion of the first year and have secured 52 credits will be awarded a UG certificate if, in addition, they complete one vocational Course/summer internship of 4 credits during the summer vacation of the first year. These students are allowed to re-enter the degree programme within three years and complete the degree programme within the stipulated maximum period of seven years.

UG Diploma: Students who opt to exit after completion of the 2nd year and have secured 106 credits will be awarded the UG diploma if, in addition, they complete one vocational Course/summer internship of 4 credits during the summer vacation of the second year. These students are allowed to re-enter within a period of three years and complete the degree programme within the maximum period of seven years.

3-year UG Degree: Students who wish to undergo a 3-year UG programme will be awarded UG Degree in the Major discipline after successful completion of three years, securing 160 credits and satisfying the minimum credit requirement.

4-year UG Degree (Honours): A four-year UG Honours degree in the major discipline will be awarded to those who complete a 4-year degree programme with 216 credits and have satisfied the credit requirements.

4-year UG Degree (Honours with Research): Students who secure 75% marks and above in the first six semesters and wish to undertake research at the undergraduate level can choose a research stream in the fourth year. They should do a research project or dissertation under the guidance of a faculty member of the University/College. The research project/dissertation will be in the major discipline. The students, who secure 216 credits including 12 credits from a research project/dissertation, are awarded UG Degree (Honours with Research).

PROGRAM OUTCOMES OF UG PROGRAM OF FACULTY OF SCIENCES

PO1	**Knowledge**	Capable of demonstrating comprehensive disciplinary knowledge gained during course of study
PO2	**Research Aptitude**	Capability to ask relevant/appropriate questions for identifying, formulating and analyzing the research problems and to draw conclusion from the analysis
PO3	**Communication**	Ability to communicate effectively on general and scientific topics with the scientific community and with society at large
PO4	**Problem Solving**	Capability of applying knowledge to solve scientific and other problems
PO5	**Individual and Team Work**	Capable to learn and work effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings
PO6	**Investigation of Problems**	Ability of critical thinking, analytical reasoning and research-based knowledge including design of experiments, analysis and interpretation of data to provide conclusions
PO7	**Modern Tool usage**	Ability to use and learn techniques, skills and modern tools for scientific practices
PO8	**Science and Society**	Ability to apply reasoning to assess the different issues related to society and the consequent responsibilities relevant to the professional scientific practices
PO9	**Life-Long Learning**	Aptitude to apply knowledge and skills that are necessary for participating in learning activities throughout life
PO10	**Ethics**	Capability to identify and apply ethical issues related to one's work, avoid unethical behavior such as fabrication of data, committing plagiarism and unbiased truthful actions in all aspects of work
PO11	**Project Management**	Ability to demonstrate knowledge and understanding of the scientific principles and apply these to manage projects

PROGRAM SPECIFIC OUTCOMES (PSOs)

The program specific outcomes (PSOs) are the statement of competencies/abilities that describes the knowledge and capabilities the undergraduate will have by the end of program studies.

After successful completion of B.Sc. Mathematics and Computing / B.Sc. (Hons./Hons. With Research) Mathematics and Computing, the students will be able to:

PSO1	Acquire an understanding and in-depth knowledge of core areas of mathematics like algebra, calculus, geometry and differential equations. This also leads to study of related areas like computer science and statistics. Thus, this program helps learners in building a solid foundation for higher studies in mathematics.
PSO2	Learn to logically question assertions, to recognize patterns and to distinguish between essential and irrelevant aspects of problems. They also share ideas and insights while seeking and benefitting from the knowledge and insight of others. This helps them to learn to behave responsibly in a rapidly changing interdependent society. They will be capable to present mathematics clearly and precisely, make vague ideas precise by formulating them in the language of mathematics, describe mathematical ideas from multiple perspectives and explain fundamental concepts of mathematics to non-mathematicians.
PSO3	Attain abilities of critical thinking, problem mapping and solving using fundamental principles of mathematics, systematic analysis and interpretation of results, and unambiguous oral and writing/presentation skills. This program has a strong foundation in basic and practical aspects of mathematics enabling the students to venture into research in front-line areas of mathematical sciences, to pursue higher studies in mathematics, and to enhance their employability for teaching jobs, government jobs, jobs in banking, insurance and investment sectors, data analyst jobs etc.

GRADING SCHEME

Marks (in %)	Grade	Grade	Category
90-100	O	10	Outstanding
80 ≤ Marks < 90	A+	9	Excellent
70 ≤ Marks < 80	A	8	Very Good
60 ≤ Marks < 70	B+	7	Good
50 ≤ Marks < 60	B	6	Above Average
45 ≤ Marks < 50	C	5	Average
40 ≤ Marks < 45	P	4	Pass
Marks <40	F	0	Fail
	Ab	0	Absent

Percentage calculation = CGPA*9.5

Course code and definition:

Course code	Definition
L	Lecture
T	Tutorial
P	Practical
DSC	Discipline Specific Course
MIC	Minor Course
MDC	Multidisciplinary Course
AEC	Ability Enhancement Course
SEC	Skill Enhancement Course
VAC	Value Added Course

Semester Wise Credits Distribution

Semester	Discipline Specific Course	Minor Course	Multidisciplinary Course	Ability Enhancement Course	Skill Enhancement Course	Value Added Course	Internship	Research Project/ Dissertation	Total Credits
I	13	4	3	2	3	2	-	-	27
II	13	4	3	2	3	2	-	-	27

*A Student exiting the program after securing 56 credits will be awarded **UG Certificate in Mathematics and Computing** provided that he/she secures 4 credits in work-based vocational courses offered during the summer term or an internship in Industry/University.

Exit Criteria 52+4=56 credits

Semester	Discipline Specific Course	Minor Course	Multidisciplinary Course	Ability Enhancement Course	Skill Enhancement Course	Value Added Course	Internship	Research Project/ Dissertation	Total Credits
III	13	4	3	2	3	2	-	-	27
IV	21	4	-	2	-	2	-	-	29

*A Student exiting the program after securing 110 credits will be awarded **UG Diploma in Mathematics and Computing** provided he/she secures additional 4 credits in a skill-based Summer Internship in Industry/ University during the first-year or second-year summer term.

Exit Criteria 106+4= 110 Credits

Semester	Discipline Specific Course	Minor Course	Multidisciplinary Course	Ability Enhancement Course	Skill Enhancement Course	Value Added Course	Internship	Research Project/ Dissertation	Total Credits
V	17	4	-	-	-	-	4	-	25
VI	17	4	-	-	2	-	-	-	23

*A Student who wants to undertake a 3-year UG program will be awarded **B.Sc. Mathematics and Computing** upon securing 160 credits.

One credit for compulsory tree plantation activity for UG students during their entire course.

Exit Criteria 161 Credits (160+1 for Tree plantation)

Students who secured 75 % and above marks till VI semester shall be eligible to opt for 'B.Sc. Mathematics and Computing Hons. with Research' Programme.

Semester	Discipline Specific Course	Minor Course	Multidisciplinary Course	Ability Enhancement Course	Skill Enhancement Course	Value Added Course	Internship	Research Project/ Dissertation	Total Credits
VII	24	4	-	-	-	-	-	-	28
VIII (4 Year UG Hons.)	24	4	-	-	-	-	-	-	28
VIII (4 Year UG Hons. with Research)	12	4	-	-	-	-	-	12	28
Total	**144/132**	**32**	**9**	**8**	**11**	**8**	**4**	**0/12**	**216**
A Student will be awarded UG Degree B.Sc. Mathematics and Computing (Hons.) / B.Sc. Mathematics and Computing (Hons. with Research) upon securing 216 credits.									

Semester – I									
Subject Code	**Title**	L	T	P	**Internal Assessment**	**End Semester Examination**	**Total**	**Credits**	**Category Code**
Discipline Specific Course (DSC)									
MTU-101-V	Calculus	4	0	0	25	75	100	4	DSC
MTU-103-V	Calculus (Lab)	0	0	2	15	35	50	1	DSC
MTU-105-V	Algebra	4	0	0	25	75	100	4	DSC
BCG-101-V	Fundamentals of Computers	4	0	0	25	75	100	4	DSC
Minor Course (MIC) To be chosen from the pool of Minor Courses provided by the University									
OSU-111-V	Inorganic Chemistry-I	4	0	0	25	75	100	4	MIC
PHU-109-V	Geometric Optics and Oscillations	3	1	0	25	75	100	4	MIC
Multidisciplinary Course (MDC)(Choose any one 3 Credit course)									
MTU-106-V	Electricity & Magnetism	2	0	0	25	75	100	2	MDC
OSU-103-V	Fundamentals of Programming	2	0	0	25	75	100	2	MDC
CHU-147-V	Chemistry-I	2	0	0	25	75	100	2	MDC
MTU-108-V	Electricity & Magnetism (Lab)	0	0	2	15	35	50	1	MDC
OSU-107-V	Fundamentals of Programing (Lab)	0	0	2	15	35	50	1	MDC
CHU-149-V	Chemistry I (Lab)	0	0	2	15	35	50	1	MDC
Ability Enhancement Course (AEC) To be chosen from the pool of Ability Enhancement Courses provided by the University									

AEC-101-V	Writing Skills and Art of Rhetoric	2	0	0	25	75	100	2	AEC
Skill Enhancement Course (SEC)									
MTU-107-V	Calculation Skills with Vedic Mathematics	3	0	0	25	75	100	3	SEC
Value Added Course (VAC)									
VAC-201-V	Environmental Studies-I	2	0	0	25	75	100	2	VAC
								Total Credit	**27**

SEMESTER-II

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
Discipline Specific Course (DSC)									
MTU-102-V	Real Analysis	4	0	0	25	75	100	4	DSC
MTU-104-V	Differential Equations	4	0	0	25	75	100	4	DSC
MTU-106-V	Differential Equations (Lab)	0	0	2	15	35	50	1	DSC
BCG-102-V	Introduction to Operating system	3	0	0	25	75	100	3	DSC
BCG-106-V	Operating system (Lab)	0	0	2	15	35	50	1	DSC
Minor Course (MIC) To be chosen from the pool of Minor Courses provided by the University									
CHU-103-V	Physical Chemistry-I	4	0	0	25	75	100	4	MIC
PHU-110-V	Basic Semiconductor Physics	3	1	0	25	75	100	4	MIC
Multidisciplinary Course (MDC) (Choose any one 3 Credit course)									
OSU-102-V	Database Management System	2	0	0	25	75	100	2	MDC
OSU-104-V	Database Management System (Lab)	0	0	2	15	35	50	1	MDC
CHU-150-V	Chemistry-II	2	0	0	25	75	100	2	MDC
CHU-152-V	Chemistry-II (Lab)	0	0	2	15	35	50	1	MDC
OSU-106-V	Mechanics	2	0	0	25	75	100	2	MDC
OSU-108-V	Mechanics (Lab)	0	0	2	15	35	50	1	MDC
Ability Enhancement Course (AEC) To be chosen from the pool of Ability Enhancement Courses provided by the University									
AEC-102-V	Communication, Mediation and Resolution	2	0	0	25	75	100	2	AEC
Skill Enhancement Course (SEC)									
OSU-110-V	Basic of Python	3	0	0	25	75	100	3	SEC
Value Added Course (VAC)									
AEC-117-V	Yoga and Meditation	2	0	0	25	75	100	2	VAC
							TOTAL CREDITS	27	

SEMESTER-III

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
Discipline Specific Course (DSC)									
MTU-201-V	Group Theory	4	0	0	25	75	100	4	DSC
MTU-203-V	Advanced Calculus	4	0	0	25	75	100	4	DSC
MTU-205-V	Advanced Calculus (LAB)	0	0	2	15	35	50	1	DSC
BCG-203-V	Object – oriented Programming using C++	3	0	0	25	75	100	3	DSC
BCG-209-V	Object –oriented Programming using C++ Lab	0	0	2	15	35	50	1	DSC
Minor Course (MIC) To be chosen from the pool of Minor Courses provided by the University									
CHU-241-V	Organic Chemistry-I	4	0	0	25	75	100	4	MIC
PHU-209-V	Nanomaterials and Nanostructures	3	1	0	25	75	100	4	MIC
Multidisciplinary Course (MDC)(Choose any one 3 Credit course)									
OSU-201-V	Computer Networks and Internet Technology	2	0	0	25	75	100	2	MDC
PHU-105-V	Fundamental of Waves & Optics	2	0	0	25	75	100	2	MDC
CHU-241-V	Organic Chemistry	2	0	0	25	75	100	2	MDC
OSU-207-V	Computer Networks & Internet Technology (Lab)	0	0	2	15	35	50	1	MDC
PHU-107-V	Wave & Optics (Lab)	0	0	2	15	35	50	1	MDC
CHU-243-V	Organic Chemistry (Lab)	0	0	2	15	35	50	1	MDC
Ability Enhancement Course (AEC) To be chosen from the pool of Ability Enhancement Courses provided by the University									
AEC-103-V	Effective Corporate Communication	2	0	0	25	75	100	2	AEC
Skill Enhancement Course (SEC)									
MTU-207-V	Latex	3	0	0	25	75	100	3	SEC
Value Added Course (VAC)									
VAC-202-V	Environmental Studies-II	2	0	0	25	75	100	2	VAC
							TOTAL CREDITS	27	

Semester – IV

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
Discipline Specific Course (DSC)									
MTU-202-V	Analytical Geometry	4	0	0	25	75	100	4	DSC
MTU-204-V	Theory of Real Functions	4	0	0	25	75	100	4	DSC
MTU-206-V	Ring Theory and Linear Algebra-I	4	0	0	25	75	100	4	DSC
MTU-208-V	Partial Differential Equations	4	0	0	25	75	100	4	DSC
MTU-210-V	Partial Differential Equations (Lab)	0	0	2	15	35	50	1	DSC
BCG-204-V	Design of UNIX Operating System	4	0	0	25	75	100	4	DSC
Minor Course (MIC) To be chosen from the pool of Minor Courses provided by the University									
CHU-104-V	Physical Chemistry-II	4	0	0	25	75	100	4	MIC
PHU-218-V	Basic Materials Science	3	1	0	25	75	100	4	MIC
Ability Enhancement Course (AEC) **To be chosen from the pool of Ability Enhancement Courses provided by the University**									
AEC-107-V	Communicative Hindi-I	2	0	0	25	75	100	2	AEC
AEC-104-V	Sanskrit-1	2	0	0	25	75	100	2	AEC
AEC-105-V	English-I	2	0	0	25	75	100	2	AEC
AEC-201-V	English-II	2	0	0	25	75	100	2	AEC
Value Added Course (VAC) To be chosen from the pool of Value Added Courses provided by the University									
VAC-104-V	Indian Knowledge System	2	0	0	25	75	100	2	VAC
VAC-105-V	Universal Human Values	2	0	0	25	75	100	2	VAC
VAC-106-V	Environment and Ecology	2	0	0	25	75	100	2	VAC
VAC-107-V	Natural Resources & Biodiversity Conservation	2	0	0	25	75	100	2	VAC
VAC-108-V	Health Psychology	2	0	0	25	75	100	2	VAC
VAC-102-V	Cultural Heritage & Nation Building	2	0	0	25	75	100	2	VAC
						TOTAL CREDITS		29	

Semester – V

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
Discipline Specific Course (DSC)									
MTU-301-V	Numerical Methods	4	0	0	25	75	100	4	DSC
MTU-303-V	Numerical Methods Lab	0	0	2	15	35	50	1	DSC
MTU-307-V	Sequence and Series of functions	4	0	0	25	75	100	4	DSC
MTU-309-V	Special Functions and Integral Transforms	4	0	0	25	75	100	4	DSC
BCG-321-V	Machine Learning-I	4	0	0	25	75	100	4	DSC
Minor Course (MIC) (Choose any one 4 Credit course from the following two courses)									
MTU-311-V	Mathematics for Machine Learning: A Practical Foundation	4	0	0	25	75	100	4	MIC
MTU-313-V	Probability and Statistics	4	0	0	25	75	100	4	MIC
MTU-315-V	Internship	-	-	-	-	-	-	4	SEC
							TOTAL CREDITS	25	

SEMESTER-VI

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
Discipline Specific Course (DSC)									
MTU-302-V	Complex Analysis	4	0	0	25	75	100	4	DSC
MTU-304-V	Complex Analysis Lab	0	0	2	15	35	50	1	DSC
MTU-308-V	Linear Programming Problems	4	0	0	25	75	100	4	DSC
MTU-310-V	Riemann Integral and Metric Space	4	0	0	25	75	100	4	DSC
BCG-320-V	Machine Learning-II	4	0	0	25	75	100	4	DSC
Minor Course (MIC) (Choose any one 4 Credit course)									
MTU-312-V	Number Theory	4	0	0	25	75	100	4	MIC
MTU-314-V	Graph Theory	4	0	0	25	75	100	4	MIC
Skill Enhancement Course (SEC)									
MTU-316-V	Tensor Tools for Mathematical Modeling	2	0	0	25	75	100	2	SEC
							TOTAL CREDITS	**23**	

SEMESTER-I

Semester-I				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
MTU-101-V	**Calculus**	**25 + 75 = 100**	**4**	**4**
		L – 4	**T - 0**	**P - 0**

Course Objectives:

Students will be able to:

- Examine the continuity and differentiability of a function at a point.
- Perform successive differentiation of functions.
- Understand various mean value theorems for differentiable functions.
- Sketch curves in Cartesian and polar coordinate systems.

Learning Outcomes:

- The objective of the course is to make the students understand the concepts of continuity, differentiability and mean value theorems.

Course Content:

Unit-I

Limit of a function, ε-δ definition of limit, Limit at infinity, Infinite limits, Continuity of a real valued function, Types of discontinuities, Properties of continuous functions, Geometrical interpretation of continuity, Indeterminate forms, L'Hôspital's rule.

Unit-II

Differentiability of a real valued function, Geometrical interpretation of differentiability, Relation between differentiability and continuity, Chain rule of differentiation, Successive differentiation, Calculation of n^{th} derivatives, Leibnitz's theorem .

Unit-III

Darboux's theorem, Rolle's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, Geometrical interpretation of mean value theorems, Taylor's theorem, Maclaurin's and Taylor's series expansions.

Unit-IV

Asymptotes, Asymptotes parallel to axes, Concavity, Points of inflection, First and second derivative test for relative extrema, Singular points, Tangents at origin, Tracing of curves, Parametric representation of curves, Tracing of parametric curves, Polar coordinates, Tracing of curves in polar coordinates.

Suggested Books/Reading:

1. Monty J. Strauss, Gerald L. Bradley and Karl J. Smith, *Calculus,* 3rd edition, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007.
2. Howard Anton, I. Bivens and Stephan Davis, *Calculus*, 10th edition, Wiley India, 2016.
3. George B. Thomas and R.L. Finney, *Calculus and Analytic Geometry*, 9th edition, Pearson Education, Delhi, 2010.
4. T. M. Apostol, J. Singh, S. Goyal, *Calculus*: *An Indian Adaptation*, Vol-1, 2nd edition, Wiley India, 2022.

Semester-I

Course	Name of Courses	Max Marks	Hrs. Per Week	Credit
MTU-103-V	Calculus (Lab)	15 + 35 = 50	2	1
		L – 0	T - 0	P - 2

Course Objectives:

Students will be able to

- Write a computer program for plotting the graph of different functions.
- Write a computer program for the limit and differentiation of various functions.
- Write a computer program for sketching parametric curves.
- Write a computer program for performing various matrix operations.

Learning Outcomes:

- Student will be able to get knowledge of MATLAB or MATHEMATICA for all functions of calculus.

Course Content:

Practical/Lab work to be performed on a computer:
Modeling of the following problems using MATLAB/MATHEMATICA etc.

(i) Basic matrix operations such as addition, multiplication, inverse, transpose, determinant, submatrix, compatibility, elementwise multiplication etc.
(ii) Plotting the graphs of functions cx, $[x]$, $|ax+b|$, $sin\,(ax+b)$, $cos\,(ax+b)$, $|sin\,(ax+b)|$, $|cos\,(ax+b)|$, e^{ax+b}, $log\,(ax+b)$ and to illustrate the effects of a and b on the graphs.
(iii) Plotting the graphs of polynomials of degree 4 and 5, their first and second derivatives and analysis of these graphs.
(iv) Computation of limit and differentiation of functions.
(v) Taylor series expansion of functions.
(vi) Sketching of curves along with their asymptotes.
(vii) Sketching of parametric curves.

Suggested Books/Reading:

1. Kevin M. O'Connor, Calculus Labs for MATLAB, Jonnes and Bartlett Publishers, 2005.
2. Howard Anton, I. Bivens and Stephan Davis, *Calculus*, 10th edition, Wiley India, 2016.

Semester-I				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
MTU-105-V	**Algebra**	**25 + 75 = 100**	**4**	**4**
		L – 4	**T - 0**	**P – 0**

Course Objectives:

Students will be able to:

- Explore different types of matrices.
- Have knowledge of system of Linear Equations, Echelon form.
- Know importance of rank of a Matrix, Eigen Values and Eigen Vectors.
- Find roots of cubic polynomials.

Learning Outcomes:

- The objective of the course is to make the students understand the concept of matrices, quadratic forms and solutions of polynomials.

Course Content:

Unit-I

Symmetric, Skew-symmetric, Hermitian and skew-Hermitian matrices. Elementary Operations on matrix. Rank of a matrix. Inverse of a matrix. Linear dependence and independence of rows and columns of a matrix. Row rank and column rank of a matrix. Eigen values, eigen vectors and the characteristic equation of a matrix. Minimal polynomial of a matrix.

Unit-II

Cayley-Hamilton theorem and its use in finding the inverse of a matrix, Applications of matrices to a system of linear (homogeneous and non–homogeneous) equations. Theorems on consistency of a system of linear equations. Unitary and Orthogonal Matrices. Diagonalisation of Matrices. Quadratic form.

Unit-III

Relations between the roots and coefficients of a general polynomial equation in one variable. Solutions of polynomial equations having conditions on roots. Common roots and multiple roots. Transformation of equations.

Unit-IV

Nature of the roots of an equation, Descartes' rule of signs, Solution of cubic and biquadratic equations.

Suggested Books/Reading:

1. Andreescu, Titu & Andrica Dorin. (2014). Complex Numbers from A to...Z.(2nd ed.) Birkhäuser.
2. David C. Lay, *Linear Algebra and its Applications*, 3rd Edition, Pearson Education Asia, Indian Reprint, 2007.

Semester-I

Course	Name of Courses	Max Marks	Hrs. Per Week	Credit
BCG-101-V	**Fundamentals of Computers**	**25 + 75 = 100**	**4**	**4**
		L – 4	**T - 0**	**P – 0**

Course Objectives:

This course will enable the students to :

- To understand the major components of computer system, the types and functions of memory.
- To learn about the difference between software and hardware in a computer system along with the fundamentals of Operating systems and its types.
- To understand the concept of programming languages and their corresponding Translators
- To learn about the basic types of Networks, Internet and computer viruses.

Course Content:

Unit-I

Computer Fundamentals
Generations of Computers, Definition, Block Diagram along with its components, characteristics & classification of computers, Limitations of Computers, Human-Being VS Computer, Applications of computers in various fields. Memory: Concept of primary & secondary memory, RAM, ROM, types of ROM, Cache Memory, flash memory, Secondary storage devices: Sequential & direct access devices viz. magnetic tape, magnetic disk, optical disks i.e. CD, DVD, virtual memory.

Unit-II

Computer Hardware & Software
I/O devices, definition of software, relationship between hardware and software, types of software. Overview of operating system: Definition, functions of operating system, concept of multiprogramming, multitasking, multithreading, multiprocessing, time-sharing, real time, single-user & multi-user operating system.

Unit-III

Computer Languages
Analogy with natural language, machine language, assembly language, high-level languages, fourth generation languages, compiler, interpreter, assembler, Linker, Loader, History and Characteristics of a good programming language, Planning the Computer Program: Concept of problem solving, Problem definition, Program design, Debugging, Types of errors in programming, Documentation, Structured programming concepts, Programming methodologies viz. top-down and bottom-up programming, Advantages and disadvantages of Structured programming.

Unit IV

Overview of Networking
An introduction to computer networking, Network types (LAN, WAN, MAN), Network topologies, Modes of data transmission, Forms of data transmission, Transmission channels(media),OSI model, Introduction to internet and its uses, Applications of internet, Hardware and Software requirements for internet, Intranet, Applications of intranet. Computer Virus: Definition, types of viruses, Characteristics of viruses, anti-virus software.

Suggested Books/Reading:

1. Gill Nasib Singh: Computing Fundamentals and Programming in C, Khanna Books Publishing

	Co., New Delhi.
2.	Balagurusamy E, Computing Fundamentals and C Programming, Tata McGraw Hill.
3.	Norton, Peter, Introduction to Computer, McGraw-Hill

Semester-I				
Course Code	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
OSU-111-V	**Inorganic Chemistry - I**	**25 + 75 = 100**	**4**	**4**
		L – 4	**T - 0**	**P - 0**

Course Objectives:

- Learn basic concept of atom and its structure in detail.
- Arrangement of electrons in atom.
- Concept of s, p, d and f orbitals and their shape using.
- Understand nature of chemical bonding and concept of molecular orbitals

Learning Outcomes:

- The objective of the course is to make the students understand the basic concept of atom and atomic structure, periodic properties of elements and chemical bonding.

Course Content:

Unit-I **Atomic Structure: (15 Hrs)**

Recapitulation of Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance; Schrödinger's wave equation, the significance of ψ and ψ^2. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f orbitals; Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, aufbau principle and its limitations.

Unit-II **Periodicity of Elements (15 Hrs)**

Brief discussion of the following properties of the elements, with reference to *s* & *p*-block and the trends shown. Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. Atomic and ionic radii. Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization enthalpy and trends in groups and periods. Electron gain entahlpy and trends in groups and periods. Electronegativity, Pauling's/ Allred Rochow's scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity.

Unit-III **Chemical Bonding-I (15 Hrs)**

Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy; Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions; HCl (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of the following simple molecules and ions containing lone pairs and bond pairs of electrons: H_2O, NH_3, PCl_3, PCl_5, SF_6, ClF_3, I_3^-, BrF_2^+, PCl_6^-, $ICl_2^-ICl_4^-$ and SO_4^{2-}, Multiple bonding and bond lengths.

Unit-IV **Chemical Bonding-I (15 Hrs)**

Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization. Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference. Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids. Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interaction. Hydrogen bonding (theories of hydrogen bonding, valence bond treatment). Effects of weak chemical forces, melting and boiling points, solubility, energetics of dissolution process.

Suggested Books/Reading:

1. Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010
2. Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K. Inorganic Chemistry, Principles of Structure and Reactivity, Pearson Education 2006.
3. Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970
4. Shriver, D.D. & P. Atkins, *Inorganic Chemistry 2nd Ed.,* Oxford University Press, 1994.
5. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.

Semester-I				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
PHU-109-V	**Geometric Optics and Oscillations**	**25 + 75 = 100**	**4**	**4**
		L - 3	**T - 1**	**P - 0**

Course Objectives:

Students will be able to:

- Revise the knowledge of calculus, vectors and vector calculus.
- Solve problems based on calculus, vectors and vector calculus.
- Use of fundamentals of calculus, vectors and vector calculus for various problems in physics.

Learning Outcomes:

- The objective of the course is to make the students understand the concept of mathematical physics and wide use of mathematics in physics.

Course Content:

Unit-I **The propagation of light and geometric optics** **(18 Hours)**

Fermat's principle of stationary time and its applications e.g. in explaining mirage effect, laws of reflection and refraction, Light as an electromagnetic wave and Fresnel equations, reflectance and transmittance, Brewster's angle, total internal reflection. Mirrors and lenses and optical instruments based on them, transfer formula and the matrix method.

Unit-II **Simple Harmonic Motion** **(10 Hours)**

Differential equation of simple harmonic oscillator, its solution and characteristics, energy in simple harmonic motion, linearity and superposition principle, motion of simple Bar pendulum and loaded spring.

Unit-III **Damped Oscillations** **(10 Hours)**

Equation of motion, dead beat motion, critically damped system, lightly damped system: relaxation time, logarithmic decrement, quality factor.

Unit-IV **Forced Oscillations** **(10 Hours)**

Equation of motion, complete solution, steady state solution, resonance, sharpness of resonance, power dissipation, quality factor.

Suggested Books/Reading:

1. Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 1507, Tata McGraw-Hill.
2. Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill.
3. Engineering Physics, H.K. Malik, A. K. Singh, Tata McGraw-Hill.
4. Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
5. Optics, Ajoy Ghatak, 1508, Tata McGraw Hill
6. The Physics of Vibrations and Waves, H. J. Pain, 1513, John Wiley and Sons.

Semester-I				
Course Code	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
MTU-106-V	**Electricity and Magnetism**	**25+75=100**	**2**	**2**
		L – 2	**T - 0**	**P - 0**

Course Objectives:

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

- Know the basic concepts of electric field and potential.
- Understand of dielectric behavior of matter.
- Learn the laws of magnetism and electromagnetic induction.
- Have an understanding of electromagnetic wave propagation.

Learning Outcomes:

- The objective of the course is to make the students understand the vector analysis, electrodynamics, magnetism and electrostatics.

Course Content:

Unit-I

Vector Analysis: Review of vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields (statements only), Gauss-divergence theorem and Stoke's theorem of vectors (statement only).

Unit-II

Electrostatics: Electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric.

Unit-III

Magnetism: Magnetostatics: Biot-Savart's law. Divergence and curl of magnetic field. Ampere's circuital law. Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para- and ferro- magnetic materials.

Unit-IV

Electrodynamics: Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field. Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves.

Suggested Books/Reading:

1. Edward M. Purcell, Electricity and Magnetism, 1986, McGraw-Hill Education
2. J.H. Fewkes & J. Yarwood, Electricity & Magnetism. Vol. I, 1991, Oxford Univ. Press
3. D C Tayal, Electricity and Magnetism, 1988, Himalaya Publishing House.
4. Ronald Lane Reese, University Physics, 2003, Thomson Brooks/Cole.
5. D. J. Griffiths, Introduction to Electrodynamics, 3rd Edn, 1998, Benjamin Cummings.

Semester-I				
Course Code	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
MTU-108-V	**Fundamentals of Programming**	**25+75=100**	**2**	**2**
		L – 2	**T - 0**	**P - 0**

Course Objectives:

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

- Differentiate between Procedure-Oriented programming and Object-Oriented programming.
- Have understanding the syntax of the language.
- Implement various object-oriented features like inheritance, data abstraction encapsulation and polymorphism to solve various computing problems using C++ language.
- Apply object-oriented concepts in real world programs.

Learning Outcomes:

- The objective of the course is to make the students understand the language C and C++.

Course Content:

Unit-I

Introduction to C and C++: History of C and C++, Overview of Procedural Programming and Object-Orientation Programming, using main() function, Compiling and Executing Simple Programs in C++. Data Types, Variables, Constants, Operators and Basic I/O: Declaring, Defining and Initializing Variables, Scope of Variables, Using Named Constants, Keywords, Data Types, Casting of Data Types, Operators (Arithmetic, Logical and Bitwise).

Unit-II

Expressions, Conditional Statements and Iterative Statements: Simple Expressions in C++ (including Unary Operator Expressions, Binary Operator Expressions), Understanding Operators Precedence in Expressions, Conditional Statements (if construct, switch-case construct), Understanding syntax and utility of Iterative Statements (while, do-while, and for loops), Use of break and continue in Loops, Using Nested Statements (Conditional as well as Iterative).

Unit-III

Functions and Arrays: Utility of functions, Call by Value, Call by Reference, Functions returning value, Void functions, Inline Functions, return data type of functions, Functions parameters, Differentiating between Declaration and Definition of Functions, Command Line Arguments/Parameters in Functions. Creating and Using One Dimensional Arrays (Declaring and Defining an Array, Initializing an Array, accessing individual elements in an Array, manipulating array elements using loops), Use various types of arrays (integer, float and character arrays / Strings) Two- dimensional Arrays (Declaring, Defining and Initializing Two-Dimensional Array, Working with Rows and Columns).

Unit-IV

Using Classes in C++: Principles of Object-Oriented Programming, Defining & Using Classes, Class Constructors, Constructor Overloading, Function overloading in classes, Class Variables &Functions, Specifying the Protected and Private Access, Copy Constructors,.Inheritance and Polymorphism: Introduction to Inheritance and Polymorphism.

Suggested Books/Reading:

1.	E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill.
2.	Sharma A. K., “Computer Fundamentals and Programming in C “, 2018
3.	Herbtz Schildt, "C++: The Complete Reference", Fourth Edition, McGraw Hill, 2017.
4.	E. Balaguruswamy, "Object Oriented Programming with C++", Tata McGraw-Hill Education, 2008.
5.	Paul Deitel, Harvey Deitel, "C++ How to Program", 8th Edition, Prentice Hall, 2011.

Semester-I				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
CHU-147-V	**Chemistry-I**	**25+ 75 = 100**	**2**	**2**
		L- 2	**T - 0**	**P - 0**

Course Objectives:

Students will be able to:

- Have understanding the basic concept of atomic structure.
- Explore the chemical bonding concept.
- Explain the role of inorganic Mathematics in biological systems.
- Basic concept of Bio-Inorganic Mathematics.

Learning Outcomes:

- The objective of the course is to make the students understand the concepts of atomic structures, role of mathematics in biological systems.

Course Content:

Unit-I

Postulates of Quantum mechanics, review of Bohr's theory and its limitations, Heisenberg Uncertainty principle. Dual behavior of matter and radiation, de-Broglie's relation. Hydrogen atom spectra. Significance of ψ and ψ2,

Unit-II

Schrödinger equation for hydrogen atom.
Ionic Bonding*:* General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds.

Unit-III

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR (H2O, NH3, PCl5, SF6, ClF3) and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for *s-s*, *s-p* and *p-p* combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods and heteronuclear diatomic molecules such as CO, NO.

Unit-IV

A brief introduction to bio-inorganic Mathematics. Role of metal ions present in biological systems with special reference to Na^+, K^+ and Mg^{+2} ions: Na/K pump; Role of Mg^{+2} ions in energy production and chlorophyll.

Suggested Books/Reading:

1. J. D. Lee: A new Concise Inorganic Mathematics, E L. B. S.17, 2008.
2. F. A. Cotton & G. Wilkinson: *Basic Inorganic Mathematics*, John Wiley, 3rd Ed., 1995.
3. Douglas, McDaniel and Alexader: *Concepts and Models in Inorganic Mathematics*, John Wiley, 3rd Ed. 1994.
4. James E. Huheey, Ellen Keiter and Richard Keiter: *Inorganic Mathematics:* Principles of

Semester-I

Course	Name of Courses	Max Marks	Hrs. Per Week	Credit
MTU-108-V	**Electricity and Magnetism (Lab)**	15 + 35 = 50	2	1
		L – 0	T - 0	P -2

Course Objectives:

Students will be able to

- Find a low resistance.
- Find inductance.
- Study circuits in series and parallel.

Learning Outcomes:

- Student will be able to get knowledge of inductance, resistance, circuits and capacitance.

Course Content:

At least five experiments from the following:

1. To compare capacitances using De' Sauty's bridge.
2. Measurement of field strength B and its variation in a Solenoid (Determine dB/dx)
3. To study the Characteristics of a Series RC Circuit.
4. To study a series LCR circuit LCR circuit and determine its

   (a) Resonant frequency, (b) Quality factor
5. To study a parallel LCR circuit and determine its

   (a) Anti-resonant frequency and (b) Quality factor Q
6. To determine a Low Resistance by Carey Foster's Bridge.
7. To find the inductance of a coil using Anderson's bridge.

Suggested Books/Reading:

1.	Advanced Practical Physics for students, B. L. Flint & H. T. Worsnop, 1971, Asia Publishing House.
2.	Engineering Practical Physics, S. Panigrahi and B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
3.	A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed.2011, KitabMahal

Semester-I

Course	Name of Courses	Max Marks	Hrs. Per Week	Credit
OSU-107-V	**Fundamentals of Programming (Lab)**	15 + 35 = 50	2	1
		L – 0	T - 0	P -2

Course Objectives:

Students will be able to

- Understand syntax of the language.
- Understand the Programming in C and C++.

Learning Outcomes:

- Student will be able to prepare different mathematical tools in programming language and will be able to learn the concepts of C and C++.

Course Content:

Introduction to Programming Lab

1. Write a program to print “HELLO”
2. Write a program to add two numbers.
3. Write a program to calculate simple interest.
4. Write a program to calculate absolute value of a number.
5. Write a program to swap the values of two numbers.
6. Write a program to find gross salary of a person.
7. Write a program to check if a number is even or odd.
8. Write a program to find greatest of three numbers.
9. Write a program to find grade of a student given his marks.
10. Write a program to find divisor or factorial of a given number.
11. Write a program to print the Fibonacci series.
12. Write a program to print first ten natural numbers.
13. Write a program to print the reverse of a number.
14. Write a program to print the multiplication table of a given number.
15. Write a program to find grade of a list of students given their marks.
16. Write a program using function power (a, b) to calculate the value of a raised to b.
17. Write a program to print a 1-D array of 10 numbers in reverse order.

Suggested Books/Reading:

1.	E. Balaguruswamy, "Object Oriented Programming with C++", Tata McGraw-Hill Education, 2008.
2.	E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill.

Semester-I

Course	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-149-V	Chemistry-I (Lab)	15 + 35 = 50	2	1
		L – 0	T - 0	P - 2

Course Objectives:

Students will be able to

- Understand preparations of different chemicals.
- Understand volumetric analysis.

Learning Outcomes:

- Student will be able to prepare different molar/normal solutions, understanding of estimation methods and their applicability for laboratory handling.

Course Content:

The students have to perform at least 4 experiments from the following:

1. Preparations: (Any two)

Preparation of Cuprous chloride, tetra ammine cupric sulphate, chrome alum, potassium trioxalatochromate (III), Nickel Dimethylglyoxime

2. Volumetric Analysis

- Preparation of reference solutions.
- Redox titrations: Determination of Fe^{2+}, $C_2O_4^{2-}$ (using $KMnO_4$, $K_2Cr_2O_7$)
- Complexometric titrations: Determination of Mg^{2+}, Zn^{2+} by EDTA.

Suggested Books/Reading:

1.	J. D. Lee: *A new Concise Inorganic Mathematics*, E L. B. S.17
2.	F. A. Cotton & G. Wilkinson: *Basic Inorganic Mathematics*, John Wiley.
3.	Douglas, McDaniel and Alexader: *Concepts and Models in Inorganic Mathematics*, John Wiley.

Semester-I				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
AEC-101-V	**Writing skills and Art of Rhetoric (WSAAR)**	**25 + 75 = 100**	**2**	**2**
		L –2	**T - 0**	**P - 0**

Course Objectives:

- Students will demonstrate great interpersonal communication skills.
- Students will adopt the habit of rational thinking and reflection.
- Students will adopt cognitive skills for better problem-solving.
- Students will practise communication for mediation and conflict-resolution.

Learning Outcomes:

- The objective of the course is to make the students understand the importance of communication and cognitive skills.

Course Content:

Unit-I	**Narration and Writing**

Define, Describe, Narrate and Argue; Articulating Questions and Innovative Thoughts; Narration: chronological order and achronological order; first-person, second-person and third person point of view in narration; key elements: plot, character, pov, setting and conflict; Storytelling, event news stories and Corporate Storytelling; problem-solution structures.
Exercise: *Ekphrasis*, Pictures: Describing scenes; Creating Stories out of words and pictures.

Unit-II	**Reasoning and Rhetoric**

Rhetoric, the art of persuasion; *ethos, logos* and *pathos*, Aristotle's triangle; Freytag's pyramid; reasoning; organizing; articulating; Synthesis; *Antanagoge; Hypophora.*
Recognize and evaluate the strength of an argument and its impact.
Exercise: Rhetorical and Oratorical Skills: Techniques for effective public speaking, both prepared and extemporaneous; Brainstorm ideas for your own short speech.

Unit-III	**Writing Features and Articles**

Op-Eds (Opinions and Editorials), Features; Articles; Topical Issues, Memes; Backgrounders; Memes; Idioms, Proverbs; Using Literary Devices and Figurative Language.
Exercises: Building Memes and Feature Writing.

Unit-IV	**Performance and Drills**

Reading Drills; Speaking Drills; Team-Performance Drills; Solo Performance Drills; Apply the elements of rhetoric you have learned so far in the final draft of your op-ed and discussion.

Suggested Books/Reading:

1.	Aspects of the Novel by E. M. Forster.
2.	The Rhetoric of Fiction by Wayne C Booth.
3.	The Art of Rhetoric by Aristotle.
4.	Writing Guide with Handbook by Michelle Bachelor Robinson, Spelman College Maria Jerskey.
5.	The Oxford Essential Guide to Writing by Thomas S. Kane.

Semester-I				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
MTU-107-V	**Calculation skills with Vedic Mathematics**	**25 + 75 = 100**	**3**	**32**
		L – 3	**T - 0**	**P - 0**

Course Objectives:

Students will be able to:

- Learn about the history of Vedic Mathematics, Sutras and Upsutras from Vedic Mathematics.
- Perform arithmetic calculations with speed and accuracy.
- Use Vedic sutras to find LCM and HCF of numbers.
- Calculate squares of numbers speedily with accuracy and explore different types of matrices.

Learning Outcomes:

- The objective of the course is to make the students understand the concept of Vedic Mathematics.

Course Content:

Unit-I

History of Vedic Mathematics, Introduction to Sutras and Upsutras, Addition in Vedic Mathematics without carrying, Dot method, Subtraction in Vedic Mathematics, Nikhilam Navatashcaramam Dashatah (All from 9 last from 10), Fraction-Addition and subtraction.

Unit-II

Multiplication of two numbers of two digits, Multiplication of two numbers of three digits Multiplication by Urdhva Tiryak sutra.

Unit-III

Division: two-digit divisor, Paravartya Yojayet method (three-digit divisor), Division by Urdhva Tiryak Sutra (Vinculum method), LCM, HCF.

Unit-IV

Square of two-digit numbers: Base method, squares of numbers ending in 5: Ekadhikena Purvena Sutra, Square roots: Dwandwa Yoga (duplex) Sutra.

Suggested Books/Reading:

1. Rajesh K. Thakur, The Essential of Vedic Mathematics, Rupa Publications, New Delhi, 2019.
2. S.B.K. Krishna Trithaji, *Vedic Mathematics,* Motilal Banarasi das, New Delhi, 1990.
3. Chaitanya A. Patil, Learn Vedic Speed Mathematics Systematically, 2018.

Semester-I

Course	Name of Courses	Max Marks	Hrs. Per Week	Credit
VAC-201-V	Environmental Studies-I	25 + 75 = 100	2	2
		L – 2	T - 0	P - 0

Course Objectives:

At the completion of this course, the learner will be able to:

- Understand human interaction with the environment and efforts taken at international level to protect and conserve environment.
- Understand concept of natural resources, their distribution, conservation, management and sustainable utilization.
- Develop critical thinking towards local, regional and global environmental issue.
- Describe the concept of ecosystem, biodiversity and their conservation.

Learning Outcomes:

- The objective of the course is to make the students understand the concept of natural resources, environmental issues, ecosystem and biodiversity.

Course Content:

Unit-I Humans and the Environment

The man-environment interaction: Humans as hunter-gatherers; Mastery of fire; Origin of agriculture; Emergence of city-states; Great ancient civilizations and the environment, Indic Knowledge and Culture of sustainability; Middle Ages and Renaissance; Industrial revolution and its impact on the environment; Population growth and natural resource exploitation; Global environmental change. *Environmental Ethics and emergence of environmentalism:* Anthropocentric and eco-centric perspectives (Major thinkers); The Club of Rome- Limits to Growth; UN Conference on Human Environment 1972; World Commission on Environment and Development and the concept of sustainable development; Rio Summit and subsequent international efforts.

Unit-II Natural Resources and Sustainable Development

Overview of natural resources: Definition of resource; Classification of natural resources- biotic and abiotic, renewable and non-renewable.
Biotic resources: Major type of biotic resources- forests, grasslands, wetlands, wildlife and aquatic (fresh water and marine); Microbes as a resource; Status and challenges.
Water resources: Types of water resources- fresh water and marine resources; Availability and use of water resources; Environmental impact of over-exploitation, issues and challenges; Water scarcity and stress; Conflicts over water.
Soil and mineral resources: Important minerals; Mineral exploitation; Environmental problems due to extraction of minerals and use; Soil as a resource and its degradation.
Energy resources: Sources of energy and their classification, renewable and non-renewable sources of energy; Conventional energy sources- coal, oil, natural gas, nuclear energy; non-conventional energy sources- solar, wind, tidal, hydro, wave, ocean thermal, geothermal, biomass, hydrogen and fuel cells; Implications of energy use on the environment.
Introduction to sustainable development: Sustainable Development Goals (SDGs)- targets and indicators, challenges and strategies for SDGs.

Unit-III Environmental Issues: Local, Regional and Global

Environmental issues and scales: Concepts of micro-, meso-, synoptic and planetary scales; Temporal and spatial extents of local, regional, and global phenomena.
Pollution: Impact of sectoral processes on Environment; Types of Pollution- air, noise, water, soil, thermal, radioactive; municipal solid waste, hazardous waste; transboundary air pollution; acid rain; smog.
Land use and Land cover change: land degradation, deforestation, desertification, urbanization.
Biodiversity loss: past and current trends, impact.
Global change: Ozone layer depletion; Climate change. Disasters – Natural and Man-made (Anthropogenic).

Unit-IV Conservation of Biodiversity and Ecosystems

Biodiversity and its distribution: Biodiversity as a natural resource; Levels and types of biodiversity; Biodiversity in India and the world; Biodiversity hotspots; Species and ecosystem threat categories. *Ecosystems and ecosystem services:* Major ecosystem types in India and their basic characteristics-forests, wetlands, grasslands, agriculture, coastal and marine; Ecosystem services-classification and their significance.
Threats to biodiversity and ecosystems: Land use and land cover change; Commercial exploitation of species; Invasive species; Fire, disasters and climate change. Major conservation policies: in-situ and ex-situ conservation approaches; Major protected areas; National and International Instruments for biodiversity conservation; the role of traditional knowledge, community-based conservation; Gender and conservation.

Field Work

The students are expected to be engaged in some of the following or similar identified activities:

a) Field visits to identify local/regional environmental issues, make observations including data collection and prepare a brief report.
b) Discussion on one national and one international case study related to the environment and sustainable development.
c) Participation in plantation drive and nature camps.
d) Documentation of campus flora and fauna.

Suggested Books/Reading:

1.	Chiras, D. D and Reganold, J. P. (2010). Natural Resource Conservation: Management for a Sustainable Future.10th edition, Upper Saddle River, N. J. Benjamin/Cummins/Pearson.
2.	Gilbert M. Masters and W. P. (2008). An Introduction to Environmental Engineering and Science, Ela Publisher (Pearson).
3.	Kaushik, A., &Kaushik, C. P. (2006). Perspectives in environmental studies. New Age International.
4.	Sharma, P. D., & Sharma, P. D. (2012). Ecology and environment. Rastogi Publications.
5.	William P. Cunningham and Mary A. (2015). Cunningham Environmental Science: A global concern, Publisher (Mc-Graw Hill, USA).

SEMESTER-II

Semester-II				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
MTU-102-V	**Real Analysis**	**25 + 75 = 100**	**4**	**4**
		L – 4	**T - 0**	**P - 0**

Course Objectives:

Students will be able to:

- Explore many properties of the real line R.
- Recognize bounded, convergent sequences and monotone sequences.
- Recognize divergent criterion, subsequences, Limit inferior and limit superior of sequences.
- Recognize infinite series, test for infinite series.

Learning Outcomes:

- The objective of the course is to make the students understand the concept of sequences and series of reals.

Course Content:

Unit-I

Well ordering property, Principle of Mathematical Induction, Finite and Infinite sets, Countable sets, Algebraic and Order Properties of R, Absolute value of a real number, ε-neighborhood of a point in R, bounded above and bounded below sets, Supremum and infimum of a non-empty subsets of R, The Completeness Property of R, Archimedean property, Density of a rational numbers in R.

Unit-II

Definition and types of intervals, Characterization of Intervals, Nested interval property, Uncountability of R.
Sequences of real numbers, Limit of a sequence, Tails of sequences, Bounded Sequences, Limit Theorems, Squeeze Theorem, Convergent sequences, Monotone sequences, Monotone convergence theorem.

Unit-III

Subsequences, Divergence Criteria, Monotone Subsequence Theorem, Bolzano Weierstrass Theorem for Sequences. Limit Superior and Limit inferior, Cauchy sequence, Cauchy Convergence Criterion, Properly Divergence Sequences.

Unit-IV

Introduction to Infinite series, Cauchy Criterion for series, P-Series test, Comparison test, Limit Comparison test, Absolute convergence, Root test, Ratio test, Raabe's test, Alternating series.

Suggested Books/Reading:

1. Robert G. Bartle and Donald R. Sherbert, Introduction to Real Analysis, 4th edition, John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2. Gerald G. Bilodeau+7, Paul R. Thie, Gerard E. Keough, An Introduction to Analysis, 2nd edition, Jones & Bartlett, 2010.
3. T.M. Apostol, Mathematical Analysis: A Modern Approach to Advanced Calculus, Pearson Education, 2008.
4. Sterling K. Berberian, A First Course in Real Analysis, Springer Verlag, NewYork,1994.

Semester-II				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
MTU-104-V	**Differential Equations**	**25 + 75 = 100**	**4**	**4**
		L – 4	**T - 0**	**P – 0**

Course Objectives:

The course will enable the students to

- Learn the basics of ordinary differential equations.
- Learn various techniques to solve first order differential equations.
- Solve linear differential equations of an arbitrary order using various techniques.
- Apply various techniques to solve and analyze various mathematical models.

Learning Outcomes:

- The objective of the course is to make the students understand the concept of differential equations and mathematical models.

Course Content:

Unit-I

Basic concepts of ordinary differential equations, Order and degree of a differential equation, General solution of first order ordinary differential equation, Separable equations, Homogeneous equations, Bernoulli's equation, Linear differential equations and equations reducible to linear form, Exact differential equations, Integrating factor, Initial value problems.

Unit-II

Clairaut's form and singular solution, Picard's method of successive approximations and the statement of Picard's theorem for the existence and uniqueness of the solutions of the first order differential equations, equations solvable for x, y and p.

Unit-III

Principle of superposition for a homogeneous linear differential equation, linearly dependent and linearly independent solutions on an interval, Wronskian and its properties, General solution of second order homogeneous differential equation with constant coefficients, Method of undetermined coefficients, Method of variation of parameters, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler-Cauchy equation.

Unit-IV

Orthogonal trajectories, Compartmental models, Exponential growth and decay models, Radioactive decay, Lake pollution model, Drug assimilation into the blood of a single cold pill, Limited growth of population, Limited growth with harvesting, Equilibrium points and stability.

Suggested Books/Reading:

1. Shepley L. Ross, *Differential Equations*, 3rd edition, Wiley India, 2014.
2. Belinda Barnes and Glenn R. Fulford, *Mathematical Modeling with Case Studies: A Differential Equation Approach Using Maple and MATLAB*, 3rd edition, CRC Press, Taylor & Francis, 2015.
3. C. Henry Edwards, David E. Penny and David T. Calvis, *Differential Equations and Boundary Value Problems: Computing and Modeling,* 5th edition, Pearson Education, 2015.
4. George F. Simmons, *Differential Equations with Applications and Historical Notes*, 3rd edition, CRC Press, Taylor & Francis, 2017.

Semester-II

Course	Name of Courses	Max Marks	Hrs. Per Week	Credit
MTU-106-V	**Differential Equations (Lab)**	15 + 35 = 50	2	1
		L – 0	T - 0	P – 2

Course Objectives:

Students will be able to

- Write a computer program for finding the solution of differential equations.
- Write a computer program for plotting a family of solutions of differential equations of various orders.
- Write a computer program for finding the particular solution of differential equations using the method of variation of parameters.
- Write a computer program for different types of mathematical models.

Learning Outcomes:

- Student will be able to prepare different mathematical models and plot differential outcomes.

Course Content:

List of practical (using any software):

1. Plotting solutions of first order differential equations.
2. Plotting solutions of second order differential equations.
3. Plotting solutions of third order differential equations.
4. Solution of differential equations using method of variation of parameters.
5. Exponential growth model.
6. Exponential decay model.
7. Lake pollution model.
8. Drug assimilation into the blood of a single cold pill.
9. Limited growth of population (with and without harvesting).

Suggested Books/Reading:

1.	Belinda Barnes and Glenn R. Fulford, *Mathematical Modeling with Case Studies: A Differential Equation Approach Using Maple and MATLAB*, 3rd edition, CRC Press, Taylor & Francis, 2015.
2.	C. Henry Edwards, David E. Penny and David T. Calvis, *Differential Equations and Boundary Value Problems: Computing and Modeling,* 5th edition, Pearson Education, 2015.

Semester-II

Course	Name of Courses	Max Marks	Hrs. Per Week	Credit
BCG-102-V	**Introduction to Operating System**	**25 + 75 = 100**	**3**	**3**
		L – 3	**T - 0**	**P – 0**

Course Objectives:

This course will enable the students to :

- To understand evolution and types of OS and to understand the structure, components and functions of OS.
- To learn about Processes, threads and various Scheduling policies.
- To understand the principle of Deadlocks and various memory management schemes.
- To understand virtual memory management, Disk management, I/O management and File system

Course Content:

Unit-I

Fundamentals of Operating System
Introduction to Operating System, its need and operating System services, Early systems, Structures - Simple Batch, Multi programmed, timeshared, Personal Computer, Parallel, Distributed Systems, Real-Time Systems, Process Management: Process concept and context, Process Control Block, Operation on processes,Threads, and Inter-process Communication.

Unit-II

CPU Scheduling Basic concepts, scheduling criteria, scheduling algorithms: FCFS, SJF, Premptive and non-premptive, Round Robin,& Queue Algorithms. Deadlocks: Deadlock characterization, Prevention and Avoidance, Deadlock Detection and Recovery Methods for handling deadlocks, Banker‘s Algorithm.

Unit-III

Memory Management
Logical versus Physical address space, Swapping, Contiguous allocation, Paging, Segmentation. Virtual Memory: Demand paging, Performance of demand paging, Page replacement, Page replacement algorithms, Thrashing.

Unit IV

Disk Scheduling and File Management Disk structure, Disk Scheduling Algorithms: FCFS, SSTF, SCAN, C-SCAN, LOOK, C-LOOK. Type of File systems, File Structure, File allocation methods: Contiguous allocation, Linked allocation, Indexed allocation, Free space management: Bit vector, Linked list, Grouping, Counting.

Suggested Books/Reading:

1.	Abraham Silberschatz, PeterB.Galvin, Operating System Concepts, Addison Wesley publishing. Co.,7th. Ed., 2004.
2.	Nutt Gary, "Operating Systems",Addison Wesley Publication,2000.
3.	Andrew S.Tannenbaum, "Modern Operating Systems", Pearson Education Asia, Second Edition, 2001.
4.	William Stallings, "Operating Systems, "Internals and Design Principles", 4th Edition,PH, 2001.

Semester-II				
Course Code	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
CHU-103-V	**Physical Chemistry - I**	**25 + 75 = 100**	**4**	**4**
		L – 4	**T - 0**	**P - 0**

Course Objectives:

The objective of the course is to make the students understand the different states of matter and various laws governing the properties of solid, liquid and gaseous state. Emphasis will also be on the basic concept of ionic equilibrium and its applications.

Learning Outcomes:

- Learn the states of matter in detail.
- Laws governing the solid, liquid and gaseous state.
- Have a deep-understanding methods to study the solid, liquid and gaseous state.
- Concept of ionic equilibria and its applications.

Course Content:

Unit-I **Gaseous state (18 Hrs)**

Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of ζ from η; variation of viscosity with temperature and pressure. Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities; Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z, and its variation with pressure and temperature for different gases. Causes of deviation from ideal behaviour. van der Waals equation of state, its derivation and application in explaining real gas behaviour, calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.

Unit-II **Liquid state (6 Hrs)**

Qualitative treatment of the structure of the liquid state; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases.

Unit-III **Solid state (16 Hrs)**

Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl.

Unit-IV **Ionic equilibria (20 Hrs)**

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono and diprotic acids. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid–base indicators; selection of indicators and their limitations.

Suggested Books/Reading:

1. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006).
2. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
3. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
4. Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).

Semester-II				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
PHU-110-V	**Basic Semiconductor Physics**	**25 + 75 = 100**	**4**	**4**
		L - 3	**T - 1**	**P - 0**

Course Objectives:

After the completion of this course, the learner will be able to:

- Learn the concepts of semiconductor physics.
- Analyze the problems of charge carriers in semiconductor materials.
- Learn the concepts of charge carrier generation, transport and recombination in semiconductor materials.
- Expertise the behaviour of intrinsic and extrinsic semiconductor materials.

Learning Outcomes:

- The objective of the course is to make the students understand the concept of basic semiconductor physics.

Course Content:

Unit-I

Electronic materials: Free electron theory, Density of states and energy band diagrams, Kronig-Penny model (to introduce origin of band gap), Energy bands in solids, E-k diagram, Direct and indirect bandgaps, Types of electronic materials: metals, semiconductors, and insulators, applications of semiconductors; Effective-mass of electron in conduction band and that of hole in valence-band, E-k diagrams of semiconductors (Si, Ge, GaAs, ZnS etc.).

Unit-II

Intrinsic Semiconductors: Fermi-level; Density-of-states near the edges of conduction and valence-band; Fermi-Dirac statistics approximated by Maxwell- Boltzmann; Intrinsic charge-carrier concentration, Law- of mass action.

Unit-III

Extrinsic Semiconductors: hydrogen-model for rough estimate of the donor and acceptor energy level, n- and p-type semiconductors; Fermi-level, Degenerate and nondegenerate semiconductors, Carrier concentration in n-and p- type semiconductors as function of temperature; Carrier mobility, Conductivity.

Unit-IV

Carrier generation and recombination, Carrier transport: diffusion and drift, p-n junction, Metal semiconductor junction (Ohmic and Schottky), Semiconductor materials of interest for optoelectronic devices.

Suggested Books/Reading:

1.	J. Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill Inc. (1995).
2.	B. E. A. Saleh and M. C. Teich, Fundamentals of Photonics, John Wiley & Sons, Inc., (2007).
3.	S. M. Sze, Semiconductor Devices: Physics and Technology, Wiley (2008).
4.	P. Bhattacharya, Semiconductor Optoelectronic Devices, Prentice Hall of India (1997).
5.	Online course: “Semiconductor Optoelectronics” by M R Shenoy on NPTEL.
6.	Online course: "Optoelectronic Materials and Devices" by Monica Katiyar and Deepak Gupta on NPTEL.

Semester-II				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
OSU-102-V	**Fundamentals of Database System**	**25 + 75 = 100**	**2**	**2**
		L – 2	**T - 0**	**P - 0**

Course Objectives:

The students will be able to

- Explore the basic concepts, applications and architecture of database systems.
- Master the basics of ER diagram.
- Know relational database algebra expressions and construct queries using SQL.
- Analyze sound design principles for logical design of databases, normalization.

Learning Outcomes:

- The objective of the course is to make the students understand the concept of database systems and modelling.

Course Content:

Unit-I

Database: Introduction to database, relational data model, DBMS architecture, data independence, DBA, database users, end users, front end tools.

Unit-II

Modeling: Entity types, entity set, attribute and key, relationships, relation types, E- R diagrams, database design using ER diagrams.

Unit-III

Relational Data Model: Relational model concepts, relational constraints, primary and foreign key, normalization: 1NF, 2NF, 3NF.

Suggested Books/Reading:

1.	Fundamentals of Database Systems by R. Elmasri and S.B. Navathe, 3rd edition, Addision- Wesley, Low Priced Edition,2000.
2.	An Introduction to Database Systems by C.J. Date, 7th edition, Addison-Wesley, Low Priced Edition, 2000.
3.	Database Management and Design by G.W. Hansen and J.V. Hansen, 2nd edition, Prentice- Hall of India, Eastern Economy Edition,1999.
4.	Database Management Systems by A.K. Majumdar and P. Bhattacharyya, 5th edition, Tata McGraw-Hill Publishing. , 1999.
5.	P. Rob, C. Coronel, Database System Concepts by, Cengage Learning India, 2008.
6.	R. Elmsasri, S. Navathe Fundamentals of Database Systems, Pearson Education, Fifth Edition, 2007. 9. MySQL: Reference Manual.

Semester-II				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
OSU-104-V	**Fundamentals of Database System (Lab)**	**15 + 35 = 50**	**2**	**1**
		L – 0	**T - 0**	**P - 2**

Course Objectives:

The students will be able to

- Create the database to store the details of people in any organization.
- Create the database to computerize any system.
- Create the database of details of any manufacturing unit.
- Explore the basic architecture of database systems.

Learning Outcomes:

- The objective of the course is to make the students prepare the databases for various fields.

Course Content:

Unit-I

Create a database having two tables with the specified fields, to computerize a library system of a Delhi University College. Library books Accession number, Title, Author, Department, Purchase Date, Price) Issued
Books (Accession number, Borrower)
a) Identify primary and foreign keys. Create the tables and insert at least 5 records in each table.
b) Delete the record of book titled “Database System Concepts”.
c) Change the Department of the book titled “Discrete Maths” to “CS”.
d) List all books that belong to “CS” department.
e) List all books that belong to “CS” department and are written by author “Navathe”.
f) List all computer (Department=”CS”) that have been issued.
g) List all books which have a price less than 500 or purchased between “01/01/1999” and “01/01/2004”.

Unit-II

Create a database having three tables to store the details of students of Computer Department in your college. Personal information about Student (College roll number, Name of student, Date of birth, Address, Marks (rounded off to whole number) in percentage at 10 + 2, Phone Number) Paper Details (Paper code, Name of the Paper) Student’s Academic and Attendance details (College roll number, Paper code, Attendance, Marks in home examination).
a) Identify primary and foreign keys. Create the tables and insert at least 5 records in each table.
b) Design a query that will return the records (from the second table) along with the name of student from the first table, related to students who have more than 75% attendance and more than 60% marks in paper
c) List all students who live in “Delhi” and have marks greater than 60 in paper1.
d) Find the total attendance and total marks obtained by each student.
e) List the name of student who has got the highest marks in paper2.

Unit-III

Create the following tables and answer the queries given below: Customer (Cust ID, email, Name, Phone, Referrer ID) Bicycle (Bicycle ID, Date Purchased, Color, Cust ID, Model No) Bicycle Model (Model No, Manufacturer, Style) Service (Start Date, Bicycle ID, End Date)
a) Identify primary and foreign keys. Create the tables and insert at least 5 records in each table.
b) List all the customers who have the bicycles manufactured by manufacturer “Honda”.
c) List the bicycles purchased by the customers who have been referred by customer “C1”.
d) List the manufacturer of red colored bicycles.
e) List the models of the bicycles given for service.

Unit-IV

Create the following tables, enter at least 5 records in each table and answer the queries given below. EMPLOYEE (Person Name, Street, City) WORKS (Person Name, Company Name, Salary) COMPANY (Company Name, City) MANAGES (Person Name, Manager Name)
a) Identify primary and foreign keys.
b) Alter table employee, add a column “email” of type varchar (20).
c) Find the name of all managers who work for both Samba Bank and NCB Bank.
d) Find the names, street address and cities of residence and salary of all employees who work for “Samba Bank” and earn more than $10,000.

e) Find the names of all employees who live in the same city as the company for which they work. f) Find the highest salary, lowest salary and average salary paid by each company. g) Find the sum of salary and number of employees in each company. h) Find the name of the company that pays highest salary.	
Suggested Books/Reading:	
1.	Fundamentals of Database Systems by R. Elmasri and S.B. Navathe, 3rd edition, Addision- Wesley, Low Priced Edition,2000.
2.	An Introduction to Database Systems by C.J. Date, 7th edition, Addison-Wesley, Low Priced Edition, 2000.
3.	Database Management and Design by G.W. Hansen and J.V. Hansen, 2nd edition, Prentice- Hall of India, Eastern Economy Edition,1999.
4.	Database Management Systems by A.K. Majumdar and P. Bhattacharyya, 5th edition, Tata McGraw-Hill Publishing.1999.
5.	P. Rob, C. Coronel, Database System Concepts by, Cengage Learning India, 2008.
6.	R. Elmsasri, S. Navathe Fundamentals of Database Systems, Pearson Education, Fifth Edition, 2007. 9. MySQL: Reference Manual.

Semester-II				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
CHU-150-V	**Chemistry-II**	**25 + 75 = 100**	**2**	**2**
		L – 2	**T - 0**	**P - 0**

Course Objectives:

After the successful completion of the course the learner would be able to

- Explore the basic concept chemical thermodynamics.
- Analyze chemical ionic equilibrium.
- Know phase equilibrium.
- Know about congruent and incongruent points.

Learning Outcomes:

- The objective of the course is to make the students understand the concept of laws of thermodynamics wholly.

Course Content:

Unit-I

Review of thermodynamics and the Laws of Thermodynamics, Important principles and definitions of thermoMathematics, Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution, Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, Variation of enthalpy of a reaction with temperature – Kirchhoff's equation, Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

Unit-II

Concept of EMF of a cell, Nernst equation and its importance, Types of electrodes, Standard electrode potential. Electrochemical series, Thermodynamics of a reversible cell, calculation of thermodynamic properties: G, H and S from EMF data.P

Unit-III

Free energy change in a chemical reaction, Thermodynamic derivation of the law of chemical equilibrium, Le Chatelier's principle and Relationships between Kp, Kc and Kx for reactions involving ideal gases. Phases, components and degrees of freedom of a system, criteria of phase equilibrium.

Unit-IV

Gibbs Phase Rule and its thermodynamic derivation, Derivation of Clausius–Clapeyron equation and its importance in phase equilibria, Phase diagrams of one-component systems (water and sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead- silver, $FeCl_3$-H_2O and Na-K only).

Suggested Books/Reading:

1. G. M. Barrow: Physical Mathematics Tata McGraw Hill, 2007.
2. G. W. Castellan: Physical Mathematics 4th Edn. Narosa, 2004.
3. J. C. Kotz, P. M. Treichel& J. R. Townsend: General Mathematics CengageLening India Pvt. Ltd., New Delhi, 2009.
4. B. H. Mahan: University Mathematics 3rd Ed. Narosa, 1998.
5. R. H. Petrucci: General Mathematics 5th Ed. Macmillan Publishing Co.: New York, 1985.

Semester-II

Course	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-152-V	Chemistry-II (Lab)	15 + 35 = 50	2	1
		L – 0	T - 0	P - 2

Course Objectives:

Students will be able to

- Determine the surface tension and viscosity.
- Determine the enthalpy of ionization of HCl with NaOH.
- Determine the EMF using Potentiometry.

Learning Outcomes:

- Student will be able to do experimental work and determine the enthalpy of different compounds, EMF, surface tension and viscosity.

Course Content:

The students have to perform at least 4 experiments from the following:

1. Determination of enthalpy of ionization of Ethanoic acid.

2. Study of solubility of benzoic acid in water and determination of enthalpy change.

3. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.

4. Determination of surface tension and viscosity.

5. Determination of EMF using Potentiometry.

6. Determination of cell constant and conductance of a solution.

Suggested Books/Reading:

1.	G. M. Barrow, Physical Mathematics Tata McGraw Hill, 2007.
2.	G. W. Castellan, Physical Mathematics 4th Edition Narosa, 2004.
3.	J. C. Kotz, P. M. Treichel and J. R. Townsend, General Mathematics CengageLening India Pvt. Ltd., New Delhi, 2009.
4.	B. H. Mahan, University Mathematics 3rd Edition Narosa, 1998.
5.	R. H. Petrucci, General Mathematics 5th Edition Macmillan Publishing Co., New York, 1985.

Semester-II				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
OSU-106-V	**Mechanics**	**25 + 75 = 100**	**2**	**2**
		L – 2	**T - 0**	**P - 0**

Course Objectives:

After the completion of the course, students will be able to

- Have knowledge of fundamentals of Mechanics.
- Have an understanding of rotational dynamics.
- Explore the laws of gravitation and central force motion.
- Know relative variation of length, mass and time with the velocity of an event.
- Analyze elasticity and various elastic parameters.

Learning Outcomes:

- The objective of the course is to make the students understand the concept of vectors, laws of motion, gravitation and elasticity.

Course Content:

Unit-I

Vectors: Vector algebra, Scalar and vector products. Derivatives of a vector with respect to a parameter, Ordinary Differential Equations: 1st order homogeneous differential equations, 2nd order homogeneous differential equations with constant coefficients, Momentum and Energy: Conservation of momentum, Work and energy, Conservation of energy, Motion of rockets.

Unit-II

Laws of Motion: Frames of reference, Newton's Laws of motion, Dynamics of a system of particles, Centre of Mass, Rotational Motion: Angular velocity and angular momentum, Torque, Conservation of angular momentum.

Unit-III

Gravitation: Newton's Law of Gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant), Kepler's Laws (statement only), Satellite in circular orbit and applications, Oscillations: Simple harmonic motion, Differential equation of SHM and its solutions, Kinetic and Potential Energy, Total Energy and their time averages, Damped oscillations.

Unit-IV

Elasticity: Hooke's law - Stress-strain diagram - Elastic moduli-Relation between elastic constants - Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants - Work done in stretching and work done in twisting a wire - Twisting couple on a cylinder - Determination of Rigidity modulus by static torsion - Torsional Pendulum-Determination of Rigidity modulus and moment of inertia - Y, η and K by Searles method. speed heory of Relativity: Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities.

Suggested Books/Reading:

1. University Physics. FW Sears, MWZ emansky & HD Young 13/e, Addison-Wesley,1986.
2. Mechanics Berkeley Physics course, v.1: Charles Kittel, et.al. 2007, Tata McGraw-Hill
3. Physics – Resnick, Halliday& Walker 9/e, Wiley, 2010.
4. Engineering Mechanics, Basudeb Bhattacharya, 2nd edn., Oxford University Press, 2015.
5. University Physics, Ronald Lane Reese, Thomson Brooks/Cole, 2003

Semester-II

Course	Name of Courses	Max Marks	Hrs. Per Week	Credit
OSU-108-V	Mechanics (Lab)	15 + 35 = 50	2	1
		L – 0	T - 0	P - 2

Course Objectives:

Students will be able to

- Determine the moment of inertia and Young's Modulus.
- Determine the height of a building, modulus of rigidity.
- Determine the acceleration of Bar and Ketar's Pendulum.
- Study the motion of a spring.

Learning Outcomes:

- Student will be able to do determine terms like height, length, moment of inertia, motion of spring etc. experimentally.

Course Content:

At least 5 experiments from the following:

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope
2. To determine the Height of a Building using a Sextant
3. To determine the Moment of Inertia of a Flywheel
4. To determine the Young's Modulus of a Wire by Optical Lever Method
5. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
6. To determine the Elastic Constants of a Wire by Searle's method
7. To determine g by Bar Pendulum
8. To determine g by Kater's Pendulum
9. To study the Motion of a Spring and calculate (a) Spring Constant, (b) g.

Suggested Books/Reading:

1.	B. L. Flint and H.T. Worsnop, Advanced Practical Physics for students, Asia Publishing House, 1971.
2.	Indu Prakash and Ramakrishna, A Text Book of Practical Physics, 11th Edition, Kitab Mahal, New Delhi, 2011.
3.	S. Panigrahi and B. Mallick, Engineering Practical Physics, Cengage Learning India Pvt. Ltd., 2015.

Semester-I				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
AEC-102-V	**Communication, Mediation and Resolution**	**25 + 75 = 100**	**2**	**2**
		L –2	**T - 0**	**P - 0**

Course Objectives:

- Students will revise grammar basics for correct and effective writing
- Students will learn organising techniques for formal writing.
- Students will learn the art of essay writing and drafting of proposals.
- Students will be able to draft proposals fine-tuned to corporate requirements.

Learning Outcomes:

- The objective of the course is to make the students understand the importance of communication and cognitive skills.

Course Content:

Unit-I

Communication and Barriers to Communication: 7C's of Communication, Win-Win Communication, Strategies for Effective Communication, Zero-Sum; Reasons for Conflict; Communication Barriers.

Unit-II

Critical Thinking and Cognitive Skills: reason; analysis, synthesis, divide and rule; root-cause analysis; logic and logical fallacies. Reasoning; Logic; Inductive and Deductive Reasoning; Logical fallacies: Ad hominem, straw man fallacy; bandwagon fallacy; hasty generalization; false dilemma; false dichotomy; Tu Quoque; circular reasoning and hasty generalization; Recognizing fallacies.

Unit-III

Mediation and Conflict-Resolution: Cognitive Skills and Critical thinking; Listening for key words, phrases and hints, Creative Communicating, Managing and celebrating Diversity, Adaptability and Negotiation; Dispute-resolution; arbitration; mediator's role; caucuses, third party, objectivity, impartiality, neutrality, offers, counter offers, questions, demands, and proposals, impasse, settlement, Brainstorming, Problem solving strategies, Stress management, Significance of Collaboration, Confronting challenges.

Unit-IV

Mediation in Practice: Exercises in role-playing and mediation and one case study assignment as directed by the teacher.

Suggested Books/Reading:

1. Kaul Asha, The Effective Presentation, Response Books, New Delhi.
2. Sanghi Seema, Towards Personal Excellence, Response Books, New Delhi.
3. Robbins Stephen and Sanghi Seema, Organizational Behaviour. Pearson. Latest Edition.
4. Bretag, Crossman and Bordia. Communication Skills. Tata Mc Graw-Hill.

Semester-II				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
OSU-110-V	**Basic of Python**	**25 + 75 = 100**	**2**	**2**
		L – 2	**T - 0**	**P - 0**

Course Objectives:

Students will be able to

- Understand the fundamentals of Python.
- Use loops and understand the conditional flow of control.
- Make use of functions in Python.
- Understand the basics of object oriented Programming & Exception Handling.

Learning Outcomes:

- The objective of the course is to make the students understand the concept of fundamentals of python and its various applications in different fields.

Course Content:

Unit-I	
Introduction To Python, Its applications, Data Types (primitive and non-primitive data types), Understanding Python variables, Python basic Operators, Understanding python blocks, Using string data type and string operations.	
Unit-II	
Understanding Program Flow Control, Conditional blocks using if, else and elif, simple for loops in python, for loop using ranges, string, Use of while loops in python, Nested Loops, Loop manipulation using pass, continue and break. Programming using Python conditional and loops block.	
Unit-III	
Understanding Python Functions, Types of Arguments, Lambda Function (need & use), Modules, organizing python projects into modules Importing own module as well as external modules, Basic understanding Packages.	
Unit-IV	
Python Object Oriented Programming, Concept of class, object and instances, Constructor, class attributes and destructors, Inheritance, overlapping and overloading operators, Basics of Exception Handling Mechanism.	

Suggested Books/Reading:

1.	Python Programming using Problem Solving Approach—Reema Thareja, Oxford University Press.
2.	Head First Python, A brain friendly guide – Paul Barry, O Reilly, 2nd Edition.
3.	A byte of Python- C.H. Swaroop.

Semester-II				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
AEC-117-V	**Yoga and Meditation**	**25 + 75 = 100**	**2**	**2**
		L – 2	**T - 0**	**P - 0**

Course Objectives:

- Students will be able to know about YOGA.
- Students will learn Meditation.
- Students will learn Pranayam.
- Students will be able to do Aasan.

Learning Outcomes:

- The objective of the course is to make the students understand the concept of Yoga and Meditation and benefits of these in daily life.

Course Content:

Unit-I

Introduction to yoga and its different levels, food habits, Sanskar of a yogi, Patanjali Yog sutra, its importance in life, benefits and history of yoga.

Unit-II

Meditation and its relation with yoga, mind relaxation, development of morality and ethics, prayer and its meaning, its importance in life, benefits and history of meditation. Mantra and their importance, introduction to some chanting mantras, practicing some of mantras, Gayatri Mantra, Namokar Jaap etc.

Unit-III

Pranayam and its introduction, types of pranayam, breathing exercises, preliminary preparation before pranayam, its importance and benefits in life. Practice of different types of Pranayam: Anulom-Vilom, Kapalbhati, NadiShodhan, Agni Sar, Bhastrika, Bharamari etc.

Unit-IV

Aasan and their types, benefits of different aasans, practicing of different aasans: Padamaasan, Surya-namaskar, tadaasan, navaasan, gomukhaasan, bhujangaasan etc.

Suggested Books/Reading:

1. Patanjali Yog sutra-Gita Press Gorakhpur.
2. Aasan Pranayam Mudra Bandh – Satyananda Saraswati.

SEMESTER-III

Semester-III				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
MTU-201-V	**Group Theory**	**25 + 75 = 100**	**4**	**4**
		L - 4	**T - 0**	**P - 0**

Course Objectives:

- Explore the basic concepts of groups and their elementary properties
- To know about subgroups, centralizer, normalizer and cyclic groups
- Analyze the idea of cosets and their properties, Cauchy's theorem, Lagrange's theorem
- Have understanding of Group homomorphisms and isomorphism theorems and to know about Commutator of subgroup and its applications, conjugate element

Learning Outcomes:

- The objective of the course is to make the students understand the concept of groups, subgroups and group homomorphisms.

Course Content:

Unit-I

Definition and examples of groups, Elementary properties of groups, composition table for finite groups, Order of a group and order of an element of a group, Subgroups and its examples, Subgroup Tests, Center of a group and centralizer of an element of a group.

Unit-II

Cyclic groups and its properties, Generators of a cyclic group; Group of symmetries; Permutation groups, Cyclic decomposition of permutations and its properties, Even and odd permutations and the alternating group,Cosets and Lagrange's theorem and their applications.

Unit-III

Normal Subgroups, simple groups, index theorem for simple groups, Commutator, commutator of subgroup and its applications, conjugate element, conjugate class, conjugate subgroup, class of subgroup, quotient group and their applications.

Unit-IV

Homomorphisms, Properties of homomorphisms, Cayley's theorem, Group Isomorphism, First, Second and Third isomorphism theorems for groups and their applications.

Suggested Books/Reading:

1.	Joseph A. Gallian, Contemporary Abstract Algebra Narosa Publishing House, New Delhi, 4th Edition, 1999. (IX Edition 2010).
2.	I.N. Herstein, Abstract Algebra ,3rd Edition, Wiley Publication,1996.
3.	Joseph J. Rotman, An Introduction to the Theory of Groups, Springer Verlag, 4th Edition, 1995.

Semester-III				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
MTU-203-V	**Advanced Calculus**	**25 + 75 = 100**	**4**	**4**
		L – 4	**T - 0**	**P - 0**

Course Objectives:

Students will be able to:

- Check continuity of functions of two variables.
- Evaluate partial derivatives, directional derivatives, extremum values of functions of two variables.
- Evaluate area and volume as double and triple integrals.
- Visualize vector fields and evaluate line integrals and to evaluate integrals using Green's theorem, Divergence theorem and Stokes theorem.

Learning Outcomes:

- The objective of the course is to make the students understand the functions of several variables and evaluation of mathematical terms for these functions.

Course Content:

Unit-I

Functions of several variables, domain and range, level curves and contour lines, limit and continuity of functions of two variables. Partial differentiation, total differentiability, chain rules, implicit differentiation.

Unit-II

Directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes and normal lines. Extremum points and saddle points, extremum values of functions of two variables, method of Lagrange multipliers.

Unit-III

Double integration over rectangular region, double integration over non-rectangular region, Area between two curves, change of order of integration, Triple integrals, Triple integral over a parallelepiped and solid regions. Volume by triple integrals, Change of variable in double integrals and triple integrals, Polar, cylindrical and spherical co-ordinates.

Unit-IV

Vector fields, divergence, curl and their physical interpretation, curves in space, velocity vector and tangent vector, Line integrals, Applications of line integrals: Mass and Work. Fundamental theorem for line integrals, conservative vector fields, independence of path, Statement and applications of Green's theorem, Divergence theorem, Stoke's theorem.

Suggested Books/Reading:

1. G. B. Thomas and R.L. Finney. *Calculus*. 9th Ed., Delhi: Pearson Education, 2005.
2. T. M. Apostol, J. Singh, S. Goyal, *Calculus*: *An Indian Adaptation*, Vol-1, 2nd edition, Wiley India, 2022.
3. T. M. Apostol, *Calculus*: *An Indian Adaptation*, Vol-2, 2nd edition, Wiley India, 2022.
4. M. J. Strauss, G.L. Bradley and K. J. Smith. *Calculus.* 3rd Ed., Delhi: Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 2007
5. Anton, H., I. Bivens, and S. Davis. *Calculus Multivariable*. 9th Ed., Singapore: John Wiley and Sons (Asia) P. Ltd., 2009.
6. Marsden, E., A.J. Tromba, and A. Weinstein. *Basic Multivariable Calculus*. Indian reprint: Springer (SIE), 2005.
7. Stewart, James. *Multivariable Calculus, Concepts and Contexts*. 2nd Ed., USA: Brooks Cole, Thomson Learning, 2001

Semester-III

Course	Name of Courses	Max Marks	Hrs. Per Week	Credit
MTU-205-V	**Advanced Calculus (Lab)**	15 + 35 = 50	2	1
		L – 0	T - 0	P - 2

Course Objectives:

Students will be able to:

- Know about MATLAB desktop.
- Understand the fundamental operations in MATLAB and write basic programs.
- Analyze plots and export this for use in their reports.
- Develop codes to visualize maxima/minima for surfaces.

Learning Outcomes:

- Student will be able to get knowledge of calculus using MATLAB.

Course Content:

- Revisiting plotting of graphs in 2D.
- Drawing Surfaces: Planes, Intersection of planes
- Visualizing Paraboloids: Intersection of a paraboloid and plane.
- Drawing different surfaces find level curves at the given heights.
- Drawing contour lines at different heights corresponding to different surfaces.
- Revising limits of single variables
- Finding limits for functions of two variables.
- Discuss the limit of different functions when n tends to infinity
- Discuss the limit of different functions when n tends to 0
- Visualizing saddle points on different surfaces
- Draw the tangent plane to different surfaces at the given point.
- Find critical points and identify relative maxima, relative minima or saddle points to given surfaces.

Suggested Books/Reading:

1.	R. Pratap, *Getting Started with MATLAB*, Oxford University Press, New Delhi, 2015.
2.	S.J. Chapman, *MATLAB Programming for Engineers*, 4th Edition, Cengage Learning, Boston, USA, 2015.

Semester-III				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
BCG-203-V	**Object Oriented Programming Using C++**	**25 + 75 = 100**	**3**	**3**
		L – 3	**T - 0**	**P – 0**

Course Objectives:

Students will be able to:

- To understand the difference between object-oriented programming and procedural programming.
- To learn basic concepts and syntax of C++.
- To implement C++ classes using encapsulation and design principles.
- To critically understand a program using more advanced C++ features such as the composition of objects, operator overloading, dynamic memory allocation, inheritance and polymorphism, file I/O, exception handling, templates etc.

Course Content:

Unit-I	**Object Oriented Programming Concepts**

Procedural Language and Object-Oriented approach, Characteristics of OOP, user-defined types, polymorphism, and encapsulation. Getting started with C++: syntax, data types, variables, string, function, namespace and exception, operators, flow control, recursion, array and pointer and structure.

Unit-II	**Abstracting Mechanism and Memory Management**

Classes, private and public, Constructor and Destructor, member function, static members, references;

Memory Management: new, delete, object copying, copy constructor, assignment operator, this input/output.

Unit-III	**Inheritance and Polymorphism**

Derived Class and Base Class, Different types of Inheritance, Overriding member function, Abstract Class, Public and Private Inheritance, Ambiguity in Multiple inheritances, Virtual function, Friend function, Static function, Operator Overloading. Template and Standard Template Library: Template classes, declaration, template functions, namespace, string, iterators, hashes, streams, and other types.

Unit-IV	**Exception and File Handling**

Exception and derived class, function exception declaration, unexpected exception, and exception when handling an exception, resource capture, and release. Streams and File handling: I/O streams, fos.open, fos.close, I/O stream libraries.

Suggested Books/Reading:

1.	Bjarne Stroustrup, The C++ programming language, Pearsons education
2.	Robert Lafore, Object oriented programming using C++,PHI
3.	Paul Deitel & Harvey Deitel, C++ How to program , Pearsons education
4.	Yashawant Kanetkar, Let Us C++, BFB

Semester-III				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
BCG-209-V	**Object-oriented Programming Using C++ (Lab)**	**15 + 35 = 50**	**2**	**1**
		L – 0	**T - 0**	**P – 2**

Course Content:

- Write a program to check a Number is prime or not.
- Write a program to find an element in list using binary search.
- Write a program to to implement Student grade using Classes.
- Write a program to compute total salary of employees using containership.
- Write a program to calculate grade of students using array of objects.
- Write a program to calculate area of different shapes using function overloading a) circle b) square c) cylinder d) triangle e) cone
- Write a program to find compound interest using default argument.
- Write a program to do swapping of two numbers using a) call by value b) call by reference c) call by address.
- Write a program to have 2 times addition using argument passing.
- Write a program to addition of two Matrix using argument passing
- Write a program to add two complex number using constructor function.
- Write a program to implement friend function to add two complex numbers.
- Write a program to add two complex number by using overloading binary + operator.
- Write a program to implement overloading unary - operator using point class
- Write a program to compare two length object by using == operator.
- Write a program to implement incremental operator on time class object using overloading function.
- Write a program to exchange the values of two variables using function templates.
- Write a program to implement an inheritance hierarchy of class quadrilateral, parallelogram, triangle and square use quadrilateral as super class for the hierarchy specify the instance variable and member function for each class, the private instance variable of quadrilateral should be xy coordinate pair for each of four numeric.
- Write a program that creates a object of class and output of each as area (except quadrilateral).
- Write a program to implement stack using class template that offers the following services for generic data type:- a) push an element on a stack b) pop an element from a stack .

Semester-III				
Course Code	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
CHU-241-V	**Organic Chemistry – I**	**25 + 75 = 100**	**4**	**4**
		L – 4	**T - 0**	**P – 0**

Course Objectives:

The objective of the course is to have an understanding the structure and bonding in organic chemistry, electronic displacements, stereochemistry and chemistry of aliphatic and aromatic hydrocarbons.

Learning Outcomes:

- Know the basic concepts of organic chemistry.
- Understand the basics of reaction mechanism.
- Stereochemistry and optical isomerism in organic compounds.
- Understand the chemistry of aliphatic and aromatic hydrocarbons

Course Content:

Unit-I **Recapitulation of basics of Organic Chemistry (9 Hrs)**

Hybridization, Shapes of molecules Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation Dipole moment; Hydrogen bonding (Applications to be discussed with relevant topics)
Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Types, shape and relative stability of Carbocations, Carbanions, Free radicals and Carbenes.
Introduction to types of organic reactions: Addition, Elimination and Substitution reactions.

Unit-II **Stereochemistry (15 Hrs)**

Fischer, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis–trans, syn-anti and E/Z notations with C.I.P rules.
Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture and their resolution. Relative and absolute configuration: D/L and R/S designations.

Unit-III **Chemistry of Aliphatic Hydrocarbons (18 Hrs)**

A. Carbon-Carbon sigma bonds
General methods of preparation, physical and chemical properties of alkanes: Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.
B. Carbon-Carbon pi-bonds:
General methods of preparation, physical and chemical properties of alkenes and alkynes, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations. Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration- oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation(oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene.
Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes

Unit-IV **Conformational Analysis and Aromatic Hydrocarbons (18 Hrs)**

Conformational analysis of alkanes: Relative stability and Energy diagrams. Types of cycloalkanes and their relative stability, Baeyer strain theory Chair, Boat and Twist boat forms of cyclohexane with energy diagrams; Relative stability of mono substituted cycloalkanes.
Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.

Suggested Books/Reading:

1.	Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2.	Eliel, E. L. &Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994
3.	Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4.	Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005

5.	Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

Semester-III				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
PHU-209-V	**Nanomaterials and Nanostructures**	**25 + 75 = 100**	**4**	**4**
		L - 3	**T - 1**	**P – 0**

Course Objectives:

After the completion of this course, the learner will be able to:

- Learn the basics of nanomaterials and nanostructures.
- Analyze the density of state variation with size of nanomaterials.
- Explore the synthesis routes of nanomaterials and nanostructures.
- Investigate the characterization techniques for study of nanomaterials.

Learning Outcomes:

- The objective of the course is to make the students understand the basics of nanostructures and nanomaterials and their synthesis routes.

Course Content:

Unit-I

Overview of Nanostructures and Nanomaterials: Classification based on Dimensionality. Hybrid nanomaterials. Density of states (1-D, 2-D, 3-D). Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods). Effect of size on material performance. Nanostructures: Carbon Nanotubes, Fullerenes, Nanowires, Graphene, Quantum Dots.

Unit-II

Applications of Schrodinger equation- Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences.

Unit-III

Synthesis Of Nanostructure Materials: Top down and bottom up approach, Ball milling. Physical vapor deposition (PVD): Thermal evaporation, Chemical vapor deposition (CVD). Sol-Gel. Hydrothermal method.

Unit-IV

Characterization: X-Ray Diffraction. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy.

Suggested Books/Reading:

1. C. P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.)
2. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company)
3. K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited).
4. Introduction to Nanoelectronics, V.V. Mitin, V.A. Kochelap and M.A. Stroscio, 2011, Cambridge University Press.
5. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).

Semester-III				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
OSU-201-V	**Computer Networks & Internet Technology**	**25 + 75 = 100**	**2**	**2**
		L – 2	**T - 0**	**P - 0**

Course Objectives:

Students will be:

- Acquainted with the concepts of Computer Networks, Its topologies and various communication models.
- Able to use internet terminologies like searching fundamentals and its types on internet, Telnet, Email, Chat Servers, FTP and Net Meeting etc. in order to solve problems.
- Able to develop a web page by using various tags and concepts of Hyper Text Markup Language.

Learning Outcomes:

- The objective of the course is to make the students understand the concept of computer networks, worldwide web and hypertext markup knowledge.

Course Content:

Unit-I

Computer Networks: Uses of Computer Network, Network Hardware, Network Software, Goals and Applications of Computer networks, Structure of Computer Network: Point-to-point structure, Broadcasting structure.

Unit-II

Types of Networks, Topologies. Reference Models: OSI Reference Model, TCP/IP reference Model, Comparison of OSI and TCP Reference Model. Data Communication: Transmission media, Wireless communication.

Unit-III

World Wide Web: Introduction, searching the www: Directories search engines and meta search engines, search fundamentals, search strategies, working of the search engines, Telnet and FTP, E Mail, Chat Servers, net meeting, video conferencing.

Unit-IV

Hypertext markup language: The anatomy of an HTML document: Marking up for structure and style: basic page markup, absolute and relative links, ordered and unordered lists, embedding images and controlling appearance, table creation and use, frames.

Suggested Books/Reading:

1.	Computer Networks (3rd edition), Tanenbaum Andrew S., International edition, 1996.
2.	Forouzan, Data Communications and Networking, TMH, 4th Edition, 2006.
3.	William Stallings, Data and Computer Communications, PHI, 7th Edition, 2003
4.	Fundamentals of the Internet and the World Wide Web, Raymond Greenlaw and Ellen Hepp 2001, TMH
5.	Internet & World-Wide Programming, Deitel, Deitel& Nieto, Pearson Education, 2000.
6.	Data Communications, Computer Networks and Open Systems (4th edition), Halsall Fred, Addison Wesley, Low Price Edition, 2000.

Semester-III				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
CHU-241-V	**Organic Chemistry-1**	**25 + 75 = 100**	**2**	**2**
		L – 2	**T - 0**	**P - 0**

Course Objectives:

Students will be able to:

- Check Analyse interference phenomena in various systems.
- Know the phenomenon of Diffraction of light in various systems
- Analyse and understand phenomena of polarization of light.

Learning Outcomes:

- The objective of the course is to make the students understand the fundamentals of organic chemistry, aliphatic hydrocarbons and stereochemistry.

Course Content:

Unit-I **Fundamentals of organic chemistry (7 Hrs.)**

Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and perconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Reaction intermediates: Carbocations, Carbanions and free radicals. Electrophiles and nucleophiles Aromaticity: Benzenoids and Hückel's rule.

Unit-II **Stereochemistry (8 Hrs.)**

Conformations with respect to ethane, butane and cyclohexane. Intercon version of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (up to two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; *cis- trans*nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

Unit-III **Aliphatic Hydrocarbons (Alkanes and Alkenes) (7 Hrs.)**

Functional group approach for the following reactions (preparations physical property & chemical reactions) to be studied with mechanism in context to their structure.
Alkanes: *Preparation:* Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.
Alkenes: *Preparation:* Elimination reactions: Dehydration of alcohols and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). *Reactions:* cis-addition (alk. KMnO4) andtrans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

Unit-IV **Alkynes and Aromatic Hydrocarbons (8 Hrs.)**

Alkynes: Preparation: Acetylene from CaC2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides.
Reactions: formation of metal acetylides and acidity of alkynes, addition of bromine and alkaline KMnO4, ozonolysis and oxidation with hot alk. KMnO4. Hydration to form carbonyl compounds.
Aromatic hydrocarbons: Preparation (benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.
Reactions: (benzene): Electrophilic substitution reactions: nitration, halogenation sulphonation. Friedel-Craft's reaction (alkylation and acylation) Side chain oxidation of alkyl benzenes.

Suggested Books/Reading:

1. T. W. Graham Solomons: *Organic Chemistry, John Wiley and Sons, 2015*.
2. Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry,* Orient Longman, 2003.
3. I.L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S, 2002.
4. R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Prentice Hall, 2016.
5. Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry,* S. Chand, 2016.

Semester-III				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
PHU-105-V	**Fundamentals of waves and Optics**	**25 + 75 = 100**	**2**	**2**
		L – 2	**T - 0**	**P - 0**

Course Objectives:

Students will be able to

- Acquainted with Analyze interference phenomena in various systems.
- Know the phenomenon of Diffraction of light in various systems
- Analyze and understand phenomena of polarization of light.

Learning Outcomes:

- The objective of the course is to make the students understand the concept of interference, polarization, diffraction and Newton's rings.

Course Content:

Unit-I

Interference: Division of amplitude and division of wave front. Young's Double Slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes).

Unit-II

Newton's Rings: measurement of wavelength and refractive index. Michelson's Interferometer: Construction and working. Idea of form of fringes (no theory needed), Determination of wavelength, Wavelength difference, Refractive index, and Visibility offringes.

Unit-III

Diffraction: Fraunhofer diffraction- Single slit; Double Slit. Multiple slits and Diffraction grating. Fresnel Diffraction: Half-period zones. Zone plate. Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis.

Unit-IV

Polarization: Polarization by reflection, refraction and scattering- Nicol prism, Quarter wave plate and half wave plate, Transverse nature of light waves. Plane polarized light – production and analysis. Circular and elliptical polarization. Specific Rotation, Polarimeter (Half shade and Biquartz).

Suggested Books/Reading:

1. Fundamentals of Optics, F.A Jenkins and H.E White, McGraw-Hill, 1976.
2. Principles of Optics, B.K. Mathur, Gopal Printing, 1995.
3. Fundamentals of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, R. Chand Publications, 2011.
4. University Physics. F.W. Sears, M.W. Zemansky and H.D. Young.13/e,1986.
5. Addison-Wesley Series.

Semester-III				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
OSU-207-V	**Computer Networks and Internet Technology (Lab)**	**15 + 35 = 50**	**2**	**1**
		L – 0	**T - 0**	**P - 2**

Course Objectives:

- Students will be able to
- Get acquainted with the concepts of Computer Networks, Its topologies and various communication.
- Use internet terminologies like searching fundamentals and its types on internet, Telnet, Email, Chat Servers, FTP and Net Meeting etc. in order to solve problems
- Develop a web page by using various tags and concepts of Hyper Text Markup Language.

Learning Outcomes:

Student will be able to get acquainted with HTML and Javascript.

Course Content:

Unit-I

1. Create HTML document with following formatting – Bold, Italics, Underline, Colors, Headings, Title, Font and Font Width, Background, Paragraph, Line Brakes, Horizontal Line, Blinking text as well as marquee text.
2. Create HTML document with Ordered and Unordered lists, Inserting Images, Internal and external linking
3. Create HTML document with Table: Create HTML document with following formatting – Bold, Italics, Underline, Colors, Headings, Title, Font and Font Width, Background, Paragraph, Line Brakes, Horizontal Line, Blinking text as well as marquee text.

<table>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3"></td><td rowspan="3">Some image here</td><td rowspan="3"></td></tr>
<tr><td colspan="3"></td></tr>
<tr><td colspan="3"></td></tr>
</table>

4. Create Form with Input Type, Select and Text Area in HTML.
5. Create an HTML containing Roll No., student's name and Grades in a tabular form.
6. Create an HTML document (having two frames) which will appear as follows:

<table>
<tr><td>About
Department 1
Department 2
Department 3</td><td>This frame would show the contents according to the link clicked by the user on the left frame</td></tr>
</table>

7. Create an HTML document containing horizontal frames as follows:

<table>
<tr><td>Department Names (could be along with Logos)</td></tr>
<tr><td>Contents according to the Link clicked</td></tr>
</table>

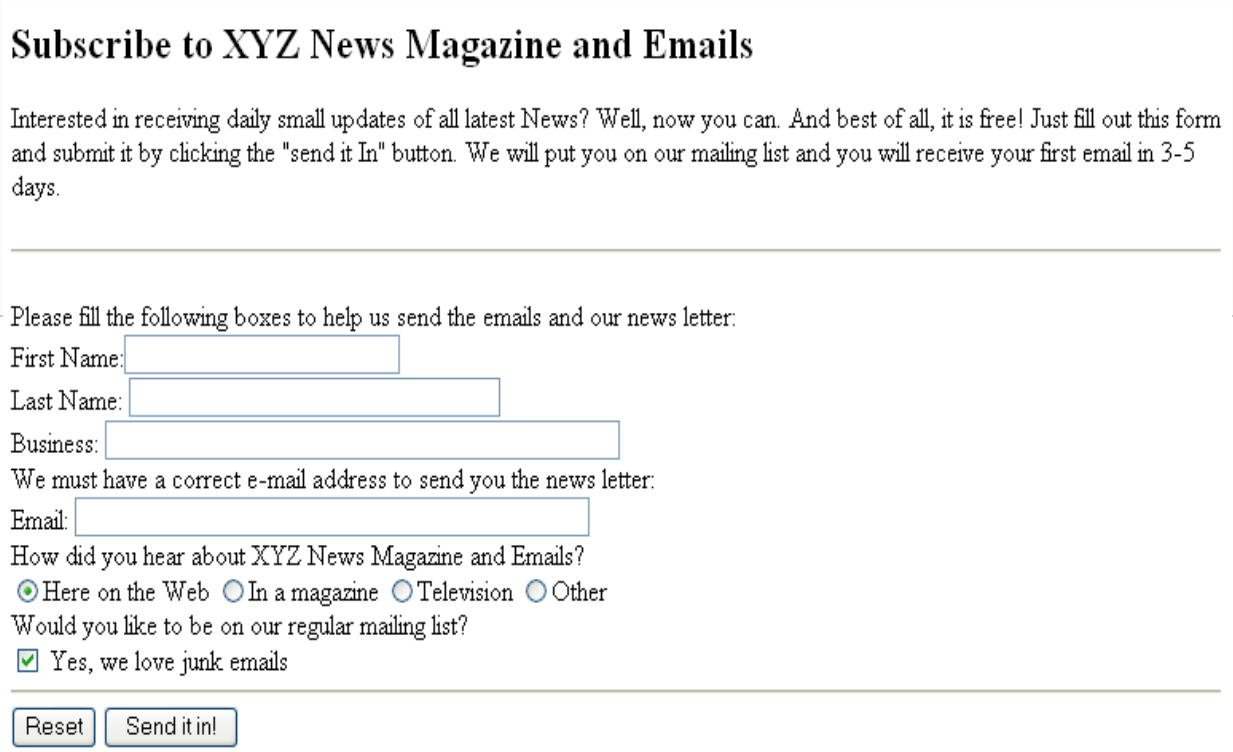
8. Create a website of 6 – 7 pages with different effects as mentioned in above problems.

9. Create HTML documents (having multiple frames) in the following formats

Frame 1
Frame 2

Frame 1	
Frame 2	**Frame 3**

10. Create a form using HTML which has the following types of controls:
    I. Text Box
    II. Option/radio buttons
    III. Check boxes
    IV. Reset and Submit buttons



List of Practicals using Javascript:

Create event driven program for following:

1. Print a table of numbers from 5 to 15 and their squares and cubes using alert.
2. Print the largest of three numbers.
3. Find the factorial of a number n.
4. Enter a list of positive numbers terminated by Zero. Find the sum and average of these numbers.
5. A person deposits Rs 1000 in a fixed account yielding 5% interest. Compute the amount in the account at the end of each year for n years.
6. Read n numbers. Count the number of negative numbers, positive numbers and zeros in the List.

Semester-III				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
CHU-241-V	**Organic Chemistry-1 (Lab)**	**15 + 35 = 50**	**2**	**1**
		L – 0	**T - 0**	**P - 2**

Course Objectives:

- The objective of the course is to have an understanding concept of fundamental lab practices of organic compounds, Organic Preparations and separations of organic compounds

Learning Outcomes:

- Student will be able to get acquainted with organic synthesis, crystallization of organic compounds and their identification

Course Content:

Unit-I **Basic Organic Lab Practices and Preparations (15 hrs)**

- Qualitative analysis of unknown organic compounds containing aryl halides.
- Qualitative analysis of unknown organic compounds containing aromatic hydrocarbons.
- Qualitative analysis of unknown organic compounds containing alcohols.
- Qualitative analysis of unknown organic compounds containing aldehydes.
- Qualitative analysis of unknown organic compounds containing ketones.
- Qualitative analysis of unknown organic compounds containing phenols.

Suggested Books/Reading:

1. T. W. Graham Solomons: *Organic Chemistry, John Wiley and Sons*.
2. Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry,* Orient Longman.
3. I.L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S.
4. R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Prentice Hall.
5. Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry,* S. Chand.

Semester-III				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
PHU-107-V	**Waves and optics (Lab)**	**15 + 35 = 50**	**2**	**1**
		L – 0	**T - 0**	**P - 2**

Course Objectives:

- The objective of the course is to have an understanding concept of fundamental lab practices of organic compounds, Organic Preparations and separations of organic compounds

Learning Outcomes:

- Student will be able to get acquainted with organic synthesis, crystallization of organic compounds and their identification

Course Content:

Unit-I **Basic Organic Lab Practices and Preparations (15 hrs)**

- Familiarization with Schuster`s focussing; determination of angle of prism.
- To determine the Refractive Index of the Material of a Prism using Sodium Light.
- To determine Dispersive Power of the Material of a Prism using Mercury Light
- To determine the value of Cauchy Constants.
- To determine the Resolving Power of a Prism.
- To determine wavelength of sodium light using Fresnel Biprism.
- To determine wavelength of sodium light using Newton's Rings.
- To determine the wavelength of Laser light using Diffraction of Single Slit.
- To determine wavelength of (1) Sodium and (2) Spectral lines of the Mercury light using plane diffraction Grating
- To determine the Resolving Power of a Plane Diffraction Grating.
- To determine the wavelength of laser light using diffraction grating.

Suggested Books/Reading:

1. B. L. Flint and H. T. Worsnop, Advanced Practical Physics for students, Asia Publishing House,1971.
2. Michael Nelson and Jon M. Ogborn, Advanced level Physics Practicals, 4th Edition, reprinted V Heinemann Educational Publishers, 1985.
3. Indu Prakash and Ramakrishna, A Text Book of Practical Physics, 11th Edition, Kitab Mahal, New Delhi, 2011.

Semester-III				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
AEC-103-V	**Effective Corporate Communication**	**25 + 75 = 100**	**2**	**2**
		L – 2	**T - 0**	**P - 0**

Course Objectives:

Students will be able:

- To acquaint students with the appropriate grammatical structures in written forms.
- To enable the students understand the significance of technical writing and formal communication.
- To equip students develop and demonstrate effective writing skills in varied forms.
- To inspire students to deliver persuasive presentations.

Learning Outcomes:

- The objective of the course is to make the students understand the basics of grammar, drafting proposals and technical writing.

Course Content:

Unit-I	**Writing Skills and Basics of Grammar**

Use of Idioms and Proverbs, Literary Tropes and Use of Figures of Speech. Subject-verb agreement; sentence correction; tense-verb usage; Composition of a Paragraph; Characteristics of a Good Paragraph.

Unit-II	**Technical Writing and Reports**

SPSE structure; IMRD structure; Report Writing: Types of Reports and Structure of a Long Report Hedging, Nominalization; Memos; Agenda and MoM; Case Study Method; Presentations; Business Letters-quotation and placing order.

Unit-III	**Drafting proposals**

From essays to proposals; Types of Essay Writing: Structure of an essay; Argumentative essays; Expository essays; Narrative essays; and Descriptive essays; Structure of an essay Reading, Writing and Comprehension. Drafting proposals; Synopsis Writing; Definitions; Comparisons and Contrasts; Hedging; Nominalization, proposal presentations.

Unit-IV	**Exercises in Proposal Presentations**

Drafting and Presenting Proposals.

Suggested Books/Reading:

1. Corporate Communication: A Strategic Approach by Cees B.M. van Riel and Charles Fombrun.
2. Strategic Communication for Business by Carolyn Barbour and Nancy Glen.
3. The Art of Writing Clearly by William Zinsser.
4. Everybody Writes: An Approach to Contemporary English Usage.

Semester-III				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
MTU-207-V	**Latex**	**25 + 75 = 100**	**3**	**3**
		L – 3	**T - 0**	**P – 0**

Course Objectives:

Students will be able to:

- Create and Typeset a LaTeX document.
- Typeset a mathematical document.
- Draw pictures in LaTeX.
- Create Beamer Presentations.

Learning Outcomes:

- The objective of the course is to make the students understand the concept of LATEX and its importance.

Course Content:

Unit-I

Getting Started with Latex: Introduction to TeX and LaTeX, Creating and typesetting a simple LaTeX document, adding basic information to documents, Environments, Footnotes, Sectioning, Displayed material.

Unit-II

Mathematical Type setting: Accents and symbols; Mathematical typesetting (elementary and advanced): Subscript/ Superscript, Fractions, Roots, Ellipsis, Mathematical symbols, Arrays, Delimiters, Multiline formulas, putting one thing above another, Spacing and changing style in math mode; Page Layout; Titles, Abstract Chapters, Sections, References, Equation references, citation. List making environments Table of contents, Figure handling, numbering, List of figures, List of tables, Generating index.

Unit-III

Graphics and PSTricks: Pictures and graphics in LaTeX, Simple pictures using PSTricks, Plotting of functions.

Unit-IV

Introduction Getting Started with Beamer: Beamer, Frames, setting up beamer document, Enhancing beamer presentation.

Suggested Books/Reading:

1. Dick Oliver, Teach Yourself HTML 4 in 24 Hours, Techmedia, 2002.
2. Craig Zacker: 10 Minutes Guide to HTML, Style sheets, PHI, 1997.
3. Martin J. Erickson and Donald Bindner, A Student's Guide to the Study, Practice, and Tools of
4. Modern Mathematics, CRC Press,2010.
5. Stefan Kottwitz, Latex Beginners Guide, Packt Publishing, 2011.

Semester-III

Course	Name of Courses	Max Marks	Hrs. Per Week	Credit
VAC-202-V	Environmental Studies-II	25 + 75 = 100	2	2
		L – 2	T - 0	P – 0

Course Objectives:

At the completion of this course, the learner will be able to:

CO1: Understand about different types of pollution, their sources and their adverse impacts.

CO2: Develop understanding on the climate change concept, climate change adaptation and mitigation.

CO3: Understand broad aspects of environmental management systems and various methods followed for assessment of environmental quality and associated risks.

CO4: Learn about the major environmental initiatives adopted at national and international level to protect ad conserve environment.

Course Content:

Unit-I **Environment Pollution and Health**

Understanding pollution: Production processes and generation of wastes; Assimilative capacity of the environment; Definition of pollution; Point sources and non-point sources of pollution. Air pollution: Sources of air pollution; Primary and secondary pollutants; Criteria pollutants- carbon monoxide, lead, nitrogen oxides, ground-level ozone, particulate matter, and sulphur dioxide; Other important air pollutants- Volatile Organic compounds (VOCs), Peroxyacetyl Nitrate (PAN), Polycyclic aromatic hydrocarbons (PAHs) and Persistent organic pollutants (POPs); Indoor air pollution; Adverse health impacts of air pollutants; National Ambient Air Quality Standards.
Water pollution: Sources of water pollution; River, lake, and marine pollution, groundwater pollution; water quality Water quality parameters and standards; adverse health impacts of water pollution on human and aquatic life.
Soil pollution and solid waste: Soil pollutants and their sources; Solid and hazardous waste; Impact on human health.
Noise pollution: Definition of noise; Unit of measurement of noise pollution; Sources of noise pollution; Noise standards; adverse impacts of noise on human health.
Thermal and Radioactive pollution: Sources and impact on human health and ecosystems.

Unit-II **Climate Change: Impacts, Adaptation and Mitigation**

Understanding climate change: Natural variations in climate; Structure of atmosphere; Anthropogenic climate change from greenhouse gas emissions– past, present and future; Projections of global climate change with special reference to temperature, rainfall, climate variability and extreme events; Importance of 1.5 °C and 2.0 °C limits to global warming; Climate change projections for the Indian sub-continent.
Impacts, vulnerability and adaptation to climate change: Observed impacts of climate change on ocean and land systems; Sea level rise, changes in marine and coastal ecosystems; Impacts on forests and natural ecosystems; Impacts on animal species, agriculture, health, urban infrastructure; the concept of vulnerability and its assessment; Adaptation vs. resilience; Climate-resilient development; Indigenous knowledge for adaptation to climate change. Mitigation of climate change: Synergies between adaptation and mitigation measures; Green House Gas (GHG) reduction vs. sink enhancement; Concept of carbon intensity, energy intensity, and carbon neutrality; National and international policy instruments for mitigation, decarbonizing pathways, and net zero targets for the future; Energy efficiency measures; Renewable energy sources; Carbon capture and storage, National climate action plan and Intended Nationally Determined Contributions (INDCs); Climate justice.

Unit-III **Environmental Management**

Introduction to environmental laws and regulation: Constitutional provisions- Article 48A, Article 51A (g) and other derived environmental rights; Introduction to environmental legislations on the forest, wildlife, and pollution control.
Environmental management system: ISO 14001 Concept of Circular Economy, Life cycle analysis; Cost-benefit analysis, Environmental audit and impact assessment; Environmental risk assessment Pollution control and management; Waste Management- Concept of 3R (Reduce, Recycle and Reuse) and sustainability; Ecolabeling /Eco

mark scheme.

Unit-IV	Environmental Treaties and Legislation

An overview of instruments of international cooperation; bilateral and multilateral agreements; conventions and protocols; adoption, signature, ratification and entry into force; binding and nonbinding measures; Conference of the Parties (COP) Major International Environmental Agreements: Convention on Biological Diversity (CBD); Cartagena Protocol on Biosafety; Nagoya Protocol on Access and Benefit-sharing; Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES); Ramsar Convention on Wetlands of International Importance; United Nations Convention to Combat Desertification (UNCCD); Vienna Convention for the Protection of the Ozone Layer; Montreal Protocol on Substances that Deplete the Ozone Layer and the Kigali Amendment; Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal; Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade; Stockholm Convention on Persistent Organic Pollutants; Minamata Convention on Mercury; United Nations Framework Convention on Climate Change (UNFCCC); Kyoto Protocol; Paris Agreement; India's status as a party to major conventions Major Indian Environmental Legislations: The Wild Life (Protection) Act, 1972; The Water (Prevention and Control of Pollution) Act, 1974; The Forest (Conservation) Act, 1980; The Air (Prevention and Control of Pollution) Act, 1981; The Environment (Protection) Act, 1986; The Biological Diversity Act, 2002; The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006; Noise Pollution (Regulation and Control) Rules, 2000; Industry-specific environmental standards; Waste management rules; Ramsar sites; Biosphere reserves; Protected Areas; Ecologically Sensitive Areas; Coastal Regulation Zone; Status phase-out of production and consumption of Ozone Depleting Substances by India; National Green Tribunal; Some landmark Supreme Court judgements Major International organisations and initiatives: United Nations Environment Programme (UNEP), International Union for Conservation of Nature (IUCN),World Commission on Environment and Development (WCED), United Nations Educational, Scientific and Cultural Organization (UNESCO), Intergovernmental Panel on Climate Change (IPCC), and Man and the Biosphere (MAB) programme.

Case studies/ Field Work

The students are expected to be engaged in some of the following or similar identified activities:

a) Field visits to identify local/regional environmental issues, make observations including data collection and prepare a brief report.
b) Discussion on one national and one international case study related to the environment and sustainable development.
c) Campus environmental management activities such as solid waste disposal, water management and sanitation and sewage treatment plant

Suggested Books/Reading:

1.	Ahluwalia, V. K. (2015). *Environmental Pollution, and Health*. The Energy and Resources Institute (TERI).
2.	India Code – Digital repository of all Central and State Acts: https://www.indiacode.nic.in/
3.	Kaushik, A., & Kaushik, C. P. (2006). Perspectives in environmental studies. New Age International.
4.	Masters, G. M., & Ela, W. P. (2008). *Introduction to environmental engineering and science* (No. 60457). Englewood Cliffs, NJ: Prentice Hall.
5.	Miller, G. T., & Spoolman, S. (2015) Environmental Science. Cengage Learning

SEMESTER-IV

Semester-IV				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
MTU-202-V	**Analytical Geometry**	**25 + 75 = 100**	**4**	**4**
		L - 4	**T - 0**	**P – 0**

Course Objectives:

Students will be able to

- Classify the general equations of second degree into different conics.
- Familiarize with polar equations of conic, chord, tangent.
- Recognize equations of sphere, cone, cylinder, enveloping cone, enveloping cylinder.
- Explain the properties of three-dimensional shapes and reduce general equation of second degree into canonical form.

Learning Outcomes:

- The objective of the course is to make the students understand the concept of conics and three-dimensional shapes.

Course Content:

Unit-I

Change of axes, System of conics, General equation of second degree. Reduction to canonical form, Tangent and normal to the conic, Chord of contact, Pole and polar with respect to a conic, Director circle of a conic.

Unit-II

Polar equation of a conic, Polar equation of chord of contact of a conic, Polar equation of tangent and normal to the conic, Sphere, Plane section of a sphere, Sphere through a given circle. Intersection of two spheres, Radical plane of two spheres.

Unit-III

Equation of a cone, right circular cone and reciprocal cone, Equation of a Cylinder, right circular cylinder, Enveloping cone, Enveloping cylinder.

Unit-IV

Central Conicoids, Equation of tangent plane, condition of tangency, Normal to the conicoids, Plane of contact and polar plane of a conicoid, Reduction of second degree equations

Suggested Books/Reading:

1. P. K. Jain and Khalil Ahmad, A Textbook of Analytical Geometry, New Age International Publishers, 2018.
2. J. G. Chakravorty and P. R. Ghosh, Advanced Analytical Geometry, U. N. Dhur& Sons Pvt. Ltd., 2018.
3. R. J. T. Bell, Elementary Treatise on Coordinary Geometry of Three Dimensions, MacMillan India Ltd., 1994.
4. D. Chatterjee, Analytical Geometry: Two and Three Dimensions, Narosa Publishing House, 2009.

Semester-IV				
Course Code	**Name of Course**	**Max Marks**	**Hrs. Per Week**	**Credit**
MTU-204-V	**Theory of Real Functions**	**25 + 75 = 100**	**4**	**4**
		L – 4	**T – 0**	**P – 0**

Course Objectives:

Students will be able to

- Explore many properties of the limits of functions.
- Know all the concepts of continuity and uniform continuity.
- Apply the mean value theorems on functions.
- Find the derivatives, maxima and minima of a function.

Learning Outcomes:

- The objective of the course is to make the students understand the basic concept of limit, continuity, differentiability and uniform continuity.

Course Content:

Unit-I

Limits of Functions: Cluster point, limit of a function, Uniqueness of limit, Sequential criterion for limits, Divergence criterion, Limit Theorems, Squeeze Theorem, One-Sided limits, Infinite limits, Limit at infinity

Unit-II

Continuous Functions: Continuity of a function at a point, Sequential criterion for continuity, Discontinuity criterion, Dirichlet's Function, Combinations of continuous functions, Composition of continuous functions, Continuous functions on Intervals, Boundedness Theorem, Maximum – Minimum Theorem, Location of Roots Theorem, Bolzano's Intermediate value theorem, Preservation of Intervals Theorem

Unit-III

Uniform continuity, non-uniform continuity criterion, Uniform continuity Theorem, Lipschitz function, Continuous Extension Theorem, Weierstrass Approximation theorem (only statement).
The derivative: Definition of differentiability of a function at a point in R, Composition of differentiable functions, Chain Rule

Unit-IV

Caratheodory's theorem, Inverse function, Relative minima and Relative maxima, Interior extremum theorem, Rolle's Theorem, Mean value theorem, first derivative test for extrema, Darboux's theorem, Cauchy mean value theorem, Taylor's Theorem, Applications of Taylor's Theorem, Convex functions

Suggested Books/Reading:

1.	Robert G. Bartle and Donald R. Sherbert, Introduction to Real Analysis, 4th edition, John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2.	Gerald G. Bilodeau, Paul R. Thie, Gerard E. Keough, An Introduction to Analysis, 2nd edition, Jones & Bartlett, 2010.
3.	Brian S. Thomson, Andrew M. Bruckner and Judith B. Bruckner, Elementary Real Analysis, Prentice Hall, 2001.
4.	Sterling K. Berberian, A First Course in Real Analysis, Springer Verlag, NewYork,1994.
5.	T.M. Apostol, Mathematical Analysis: A Modern Approach to Advanced Calculus, Pearson Education, 2008.

Semester-IV				
Course Code	**Name of Course**	**Max Marks**	**Hrs. Per Week**	**Credit**
MTU-206-V	**Ring Theory and Linear Algebra - I**	**25 + 75 = 100**	**4**	**4**
		L – 4	**T - 0**	**P – 0**

Course Objectives:

Students will have knowledge of

- Rings, Subrings, Ideals and Fields.
- Ring Homomorphism and Isomorphism Theorems.
- Vector Space, Subspace, Span and Quotient Space.
- Linearly independent and dependent vectors, Linear transformation and properties and isomorphism of linear transformations.

Learning Outcomes:

- The objective of the course is to make the students understand the basic concept of rings, ideals, vector spaces and linear transformations.

Course Content:

Unit-I

Definition and examples of rings, properties of rings, subrings, integral domains and fields, characteristic of a ring. Ideals, ideal generated by a subset of a ring, factor rings.

Unit-II

Operations on ideals, prime and maximal ideals, ring homomorphism, properties of ring homomorphism, Isomorphism theorems I, II and III.

Unit-III

Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear dependence and linear independence, basis and Standard basis, dimension of a vector space.

Unit-IV

Linear transformation, Properties of linear transformation, algebra of linear transformations, Matrix representation of a linear transformation, Isomorphism.

Suggested Books/Reading:

1. Joseph A. Gallian, Contemporary Abstract Algebra (10th Edition), Narosa Publishing House, New Delhi, 1999
2. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra (4th Edition), Prentice-Hall of India Pvt. Ltd., New Delhi, 2004
3. Kenneth Hoffman, Ray Alden Kunze, Linear Algebra 2nd Ed., Prentice-Hall of India Pvt. Limited, 1971

Semester-IV				
Course Code	**Name of Course**	**Max Marks**	**Hrs. Per Week**	**Credit**
MTU-208-V	**Partial Differential Equations**	**25 + 75 = 100**	**4**	**4**
		L – 4	**T - 0**	**P – 0**

Course Objectives:

Students will

- Gain knowledge of basic concepts of PDE and to learn methods and techniques for formulation and solutions of first order PDE's in broad multidisciplinary contexts.
- Have the procedural knowledge of solving homogeneous and non-homogeneous second and higher order linear PDE's.
- Attain deeper knowledge to classify second order linear PDE's and reduce them in Canonical (Normal) forms and find their solutions.
- Gain theoretical knowledge to model and solve the physical problems using PDE's such as Laplace, heat and wave equations.

Learning Outcomes:

- The objective of the course is to make the students understand the basic concept of Partial differential equations, its types and solutions.

Course Content:

Unit-I

Partial differential equations: Formation, order and degree, Linear and Non-Linear Partial differential equations of the first order: Complete solution, singular solution, General solution, Solution of Lagrange's linear equations, Charpit's general method of solution. Compatible systems of first order equations.

Unit-II

Linear partial differential equations of second and higher orders: Homogenous and Non-homogenous linear partial differential equations with constant coefficients, Partial differential equations with variable coefficients reducible to equations with constant coefficients, their complimentary functions and particular Integrals.

Unit-III

Classification of linear partial differential equations of second order: Hyperbolic, Parabolic and Elliptic, Reduction of second order linear partial differential equations to Canonical (Normal) forms and their solutions.

Unit-IV

Characteristic equations and characteristic curves of second order partial differential equation, Method of separation of variables: Solution of Laplace's equation, Wave equation (one and two dimensions), Diffusion (Heat) equation (one and two dimension) in Cartesian Co-ordinate system.

Suggested Books/Reading:

1. Ian N. Sneddon: Elements of Partial Differential Equations, Dover Publications, 2006.
2. M. D. Raisinghania, Ordinary and Partial Differential Equations, S. Chand Publications (20th Edition).
3. Tyn Myint-U & Lokenath Debnath: Linear Partial Differential Equation for Scientists and Engineers,4th edition, Birkhäuser 2007
4. D. A. Murray: Introductory Course on Differential Equations, Orient Longman, (India), 1967.
5. Erwin Kreyszig: Advanced Engineering Mathematics, John Wiley & Sons, New York, 2011.
6. Frank Ayres: Theory and Problems of Differential Equations, McGraw Hill Book Company, 1972.

Semester-IV				
Course Code	**Name of Course**	**Max Marks**	**Hrs. Per Week**	**Credit**
MTU-210-V	**Partial Differential Equations (Lab)**	**15 + 35 = 50**	**2**	**1**
		L – 0	**T - 0**	**P – 2**

Course Objectives:

Students will be able to

- Write computer program for plotting three dimensional graphs.
- Write computer program for solving Cauchy problem.
- Write computer program for the solution of different types of second order PDE.
- Write computer program for non-linear systems of PDE.

Learning Outcomes:

- The objective of the course is to make the students understand the basic concept of solving and plotting partial differential equations using MATLAB.

Course Content:

1.	Solution of Cauchy problem for first order PDE.
2.	Write a program to solve one dimensional parabolic equation.
3.	Write a program to solve one dimensional hyperbolic equation.
4.	Write a program to solve two-dimensional parabolic equation.
5.	Write a program to solve two-dimensional elliptic equation.
6.	Solution of non-linear systems of partial differential equations.
7.	Write a program to solve the heat equation.
8.	Write a program to solve the wave equation.

Suggested Books/Reading:

1.	Alexander Stanoyevitch, Introduction to numerical ordinary and Partial Differential Equations using MATLAB, Wiley, 2005.
2.	P. Howard, Partial Differential Equations in MATLAB, pdf, 2010.
3.	Jichun Li and Yi-Tung Chen, Computational partial differential equations using MATLAB, CRC Press, 2008.
4.	Stojanova A, Zlatanovska B, Kocaleva M, Gicev V., Obtaining functions from Fourier series with MATLAB, A journal for information Technology, Educational Development and Teaching Methods of Technical and Natural sciences, Vol 5, 2015.
5.	Mathew P. Coleman, An introduction to partial differential equations with MATLAB, 2013.
6.	Pratap, Rudra. Getting Started with MATLAB 5-A Quick Introduction for Scientists and Engineers. 1998.

Semester-IV				
Course Code	**Name of Course**	**Max Marks**	**Hrs. Per Week**	**Credit**
BCG-204-V	**Design of UNIX Operating System**	**25+75=100**	**4**	**4**
		L – 4	**T - 0**	**P - 0**

Note: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

Course Objectives:

- To understand the services provided and the design of an operating system.
- To evaluate the structure and organization of the file system.
- To familiar with what a process is and how processes are synchronized and scheduled.
- To compare and evaluate different approaches to memory management.

Learning Outcomes:

- Student will be able to:
- Develop an understanding of how an operating functions as a middle layer between the hardware of a computer.
- Appreciate the design issues and concepts of the Unix Operating Systems.
- Aware with the structure and organization of the file system.
- Familiar with the process management and memory management.

Course Content:

Unit-I	**Theoretical Concepts of UNIX Operating System**

Evolution of UNIX, Basic features of UNIX, Architecture of UNIX kernel, File subsystem and process control subsystem, UNIX vs. LINUX, Introduction to shell programming, System administrator privileges.

Unit-II	**File system of the UNIX OS**

Parent child relationship of files, Types of files, File system layout, Data structures of the file subsystem, Internal representation of files, inode, accessing and releasing inodes, the structure of regular files and directories, superblocks, inode and disk block assignment to a new file.

Unit-III	**Process Control System**

Concept of a process, state transitions, data structures, Context of a process, Layout of the system memory, process scheduler, scheduling parameters, round robin multiple feedback scheduling, Fair share scheduler.

Unit-IV	**Memory Management Policies**

Swapping, Data structures, implementation of swapping processes in and swapping out, Demand paging, Data structures, page stealer process, fault handler.

Suggested Books/Reading:

1.	The Design of the UNIX Operating System: Maurice J Bach, PHI.
2.	UNIX: Concepts and Applications Sumitabha Das: Tata McGraw Hill.
3.	UNIX Shell Programming: Yashwant Kanetkar: BPB publications.

Semester-IV				
Course Code	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
CHU-104-V	**Physical Chemistry - II**	**25 + 75 = 100**	**4**	**4**
		L – 4	**T - 0**	**P - 0**

Course Objectives:

The objective of the course is to have an understanding concept of thermodynamics in chemistry, system of variable composition, chemical equilibrium, solutions and colligative properties

Learning Outcomes:

- Understand the basic concept of chemical thermodynamics and the laws governing.
- Learn the basics of systems of variable compositions.
- Learn the concept of chemical equilibrium.
- Learn solution and colligative properties.

Course Content:

Unit-I **Chemical Thermodynamics (36 Hrs)**

Intensive and extensive variables; state and path functions; isolated, closed, and open systems.

First law: Concept of heat, Q, work, W, internal energy, U, and statement of first law; enthalpy, H, the relation between heat capacities, calculations of Q, W, ΔU, and ΔH for reversible, irreversible, and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions. Thermochemistry: Heats of reactions: standard states; enthalpy of formation and enthalpy of combustion and its applications; effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions.

Second Law: Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics. Calculation of entropy change for reversible and irreversible processes.

Third Law: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules. Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.

Unit-II **Systems of Variable Composition (8 Hrs)**

Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.

Unit-III **Chemical Equilibrium (8 Hrs)**

Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration (Le Chatelier Principle, Quantitatively). Free energy of mixing and spontaneity. equilibrium between ideal gases and a pure condensed phase.

Unit-IV **Solutions and Colligative Properties (8 Hrs)**

Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Thermodynamic derivation using chemical potential to derive relations between the four colligative properties [(i) relative lowering of vapour pressure, elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

Suggested Books/Reading:

1. Peter, A. & Paula, J. de. Physical Chemistry 9th Ed., Oxford University Press (2011).
2. Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
3. Rastogi, R.P and Mishra, R.R. An Introduction to Chemical Thermodynamics, 1995.
4. Kapoor, K.L., A text book of physical chemistry, vol 2, McGraw Hill education.

Semester-IV				
Course Code	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
PHU-218-V	**Basic Materials Science**	**25 + 75 = 100**	**4**	**4**
		L - 3	**T - 1**	**P - 0**

Course Objectives:

After the completion of this course, the learner will be able to:

- Gain knowledge of the structure and microstructure of the materials.
- Analyze the different types of defects in materials.
- Grasp the concepts of phase diagrams and phase transformations and correlate these with growth kinetics and microstructure evolution in materials.
- Analyze the diffusion process in materials.

Learning Outcomes:

- The objective of the course is to understand the basic concepts of materials science.

Course Content:

Unit-I

Structure of Materials: Structure at varying length scales: sub-atomic, atomic structure microstructure, macrostructure, Bravais Lattices, Crystallographic planes and directions- Miller indices, Bonding, packing fraction (SC, BCC, FCC, DC,HCP), coordination number.

Unit-II

Defects in Materials: Point defects, Schottky and Frenkel defects, Thermal Equilibrium of Point Defects, Line defects (Edge and screw), Burgers Vector, Surface defects – Surfaces, interfaces, Grain Boundary.

Unit-III

Solid Solutions and Intermediate Phases: phase rule, unitary & binary phase diagrams, Lever rule, Hume-Rothery rule; Free Energy and Equilibrium Phase Diagrams: Complete Solid Miscibility, Partial Solid Miscibility-Eutectic, Peritectic and Eutectoid reactions, Eutectoid mixture.

Unit-IV

Diffusion: Fick's first and second law, Kirkendall Effects, Phase Transformation: Nucleation, Growth and Overall Transformation Kinetics.

Suggested Books/Reading:

1.	J.C. Anderson, K.D. Leaver, P. Leevers and R.D. Rawlings, Materials Science for Engineers, CRC Press, London.
2.	V. Raghavan, Materials Science and Engineering: A First Course, PHI Learning, New Delhi.
3.	C. Kittel, Introduction to Solid State Physics, Wiley, India.
4.	A.J. Dekker, Solid State Physics, Macmillan Press, London.
5.	M. Tinkham, Introduction to Superconductivity, Dover Publication, New York.
6.	W.D. Callister, Materials Science and Engineering: An Introduction, John Wiley, New York.
7.	K.K. Chawla, Composite Materials: Science and Engineering, Springer, New York.
8.	M. Balasubramaniam, Composite Materials and Processing, CRC Press, New York.
9.	D. Hull and T.W. Clyne, Introduction to Composite Materials, Cambridge University Press, U.K.
10.	I.A. Parinov, S.H. Chang and V.Y. Topolov, Advanced Materials: Manufacturing, Physics, Mechanics and Applications, Springer, New York.

SEMESTER-V

Semester-V

Course	Name of Courses	Max Marks	Hrs. Per Week	Credit
MTU-301-V	Numerical Methods	25 + 75 = 100	4	4
		L – 4	T - 0	P - 0

Course Objectives:

At the end of this course, students will be able

- To understand about the solution of algebraic and transcendental equations.
- To understand about Newton‘s interpolation,Central difference interpolation formula, Gauss interpolation formulae, Langrage’s interpolation formula and Newton‘s divided difference formulae.
- To understand about the solution of simultaneous algebraic equations
- To understand about the solution of Trapezoidal rule, Simpson's 1/3rd and 3/8th rules.

Course Content:

Unit-I

Errors in Numerical calculations: Introduction, Numbers and their accuracy, Absolute, relative and percentage errors. Solution of Algebraic and Transcendental Equations: Bisection method, method of false position, secant method, iteration method, Newton's Raphson method. Order of convergence of the above methods.

Unit-II

Finite Differences And Interpolation: Various difference operators and relation between them, Newton‘s forward and backward interpolation formulae. Central difference interpolation formula. Gauss forward and backward interpolation formulae. Langrage’s interpolation formula and Newton‘s divided difference formulae.

Unit-III

Solutions of Simultaneous Algebraic Equations: Jacobi's method, Gauss-Seidal method, Gauss Elimination mehod ,Gauss-Jorden method , LUD Decomposition , Relaxation Method.

UNIT-IV:

Numerical Differentiation and Integration: Formula for derivatives, Newton’s forward interpolation formula, Newton’s backward difference formula, Newton cotes quadrature, Trapezoidal rule, Simpson's 1/3rd and 3/8th rules. Boole’s & Weddle rule, Gauss quadrature formula.

Suggested Books/Reading:

1. B.S. Grewal ,Numerical Methods in Engg. & Science, khanna Publications,11th edition, 2013.
2. M.K. Jain, S.R.K. Iyenger and R.K. Jain, Numerical Methods for Scientific and Engg. Computations,Wiley Eastern Ltd.
3. C.E.Froberg; Introduction to Numerical Analysis Addison Wesly publication company,1970.
4. S.S Shastri ,Introduction Methods of Numerical Analysis ,PHI learning pvt limited .

Semester-V

Course	Name of Courses	Max Marks	Hrs. Per Week	Credit
MTU-303-V	**Numerical Methods Lab**	**15 + 35 = 50**	**2**	**1**
		L – 0	**T - 0**	**P - 2**

Course Objectives:

At the end of this course, students will be able

- To implement numerical techniques for solving algebraic and transcendental equations using methods such as Bisection, False Position, Secant, Iteration, and Newton-Raphson.
- To write and execute programs for various interpolation methods, including Newton's forward and backward interpolation, Gauss interpolation, Lagrange's interpolation, and Newton's divided difference.
- To develop and test programs for solving systems of linear equations using iterative techniques like Jacobi's and Gauss-Seidel methods.
- To write programs for numerical integration using the Trapezoidal rule, Simpson's 1/3 rule, and Simpson's 3/8 rule.

Practicals:

Lab work to be performed on a computer using Matlab / Mathematica /Python

1. Write a program for Newton's forward interpolation formulae
2. Write a program for Newton's backward interpolation formulae
3. Write a program for Gauss forward interpolation formulae.
4. Write a program for Gauss backward interpolation formulae.
5. Write program for Langrage's interpolation formula
6. W.A.P for Newton's divided difference formulae
7. W.A.P to solve the equation using Bisection method
8. W.A.P to solve the equation using method of false position
9. W.A.P to solve the equation using secant method
10. W.A.P to solve the equation using iteration method
11. W.A.P to solve the equation using Newton's Raphson method
12. W.A.P to find the solutions of Simultaneous Algebric Equations using Jacobi's method,
13. W.A.P to find the solutions of Simultaneous Algebric Equations using Gauss-Seidal method.
14. W.A.P to evaluate the integral using Trapezoidal rule,
15. W.A.P to evaluate the integral Simpson's $1/3^{rd}$
16. W.A.P to evaluate the integral using Simpson's $3/8^{th}$ rules

Suggested Books/Reading:

1.	Steven C. Chapra, Raymond P. Canale, Numerical Methods for Engineers, McGraw-Hill Education, 8th Ed., 2020.
2.	Kendall E. Atkinson, An Introduction to Numerical Analysis, Wiley, 2nd ed., 1989.

Semester-V

Course	Name of Courses	Max Marks	Hrs. Per Week	Credit
MTU-307-V	**Sequence and Series of Functions**	**25 + 75 = 100**	**4**	**4**
		L – 4	**T - 0**	**P - 0**

Course Objectives:

At the end of this course, students will be able

- To know about Cauchy criterion for uniform convergence and Weierstrass *M*-test for uniform convergence of series of real-valued functions.
- To know about the constraints for the inter-changeability of differentiation, and integration with infinite sum of a series of functions.
- To handle the convergence of power series and properties of the limit function, including differentiation and integration of power series.
- To Appreciate utility of polynomials in the space of continuous functions.

Course Content:

Unit-I

Pointwise and uniform convergence of sequence of functions, The uniform norm, Cauchy criterion for uniform convergence, Continuity of the limit function of a sequence of functions, Interchange of the limit and derivative, and the interchange of the limit and integral of a sequence of functions.

Unit-II

Bounded convergence theorem. Pointwise and uniform convergence of series of functions, Theorems on the continuity, differentiability and integrability of the sum function of a series of functions.

Unit-III

Cauchy criterion and the Weierstrass *M*-test for uniform convergence. Dini's theorem. Definition of a power series, Radius of convergence and absolute convergence (Cauchy- Hadamard theorem).

Unit-IV

Differentiation and integration of power series, Abel's theorem, Weierstrass's approximation theorem; Approximation of continuous functions on closed intervals by polynomials.

Suggested Books/Reading:

1. Bartle, Robert G., & Sherbert, Donald R., Introduction to Real Analysis, 4th ed., Wiley India Edition, Indian Reprint, 2011.
2. Ross, Kenneth A., Elementary Analysis, The Theory of Calculus,2nd ed., Undergraduate Texts in Mathematics, Springer. Indian Reprint, 2013.

3.	Bilodeau, Gerald G., Thie, Paul R., & Keough, G. E., An Introduction to Analysis, 2nd ed., Jones and Bartlett India Pvt. Ltd. Student Edition, Reprinted 2015.
4.	Denlinger, Charles G. (2011), Elements of Real Analysis. Jones and Bartlett India Pvt. Ltd. Student Edition, Reprinted 2015.
5.	Rudin, W. , Principles of Mathematical Analysis, 3rd Edition, New York: McGraw-Hill, 1976.
6.	Goldberg, R. R., Methods of Real Analysis, 2nd Edition, New York: John Wiley &Sons, 1976.

Semester-V

Course	Name of Courses	Max Marks	Hrs. Per Week	Credit
MTU-309-V	**Special Functions and Integral Transforms**	**25 + 75 = 100**	**4**	**4**
		L – 4	**T - 0**	**P - 0**

Course Objectives:

At the end of this course, students will be able

- To know about Power Series method and Familiarize with Bessel differential equations and acquire deeper knowledge of Bessel functions.
- To learn to solve Legendre differential equation and understand the concepts of Legendre functions.
- To know about Laplace transforms, its properties. Also learn to solve ordinary differential equations using Laplace transforms.
- To familiarize with Fourier transforms of functions, explain Parseval's identity and learn to solve ordinary and Partial differential equations using Fourier transforms.

Course Content:

Unit-I

Series solution of differential equations: Power Series method, Bessel equation and its solution, Bessel functions and their properties, Recurrence relations and generating functions, Integral Representation of Bessel's function, Orthogonality of Bessel functions.

Unit-II

Legendre differential equation and its solution, Legendre Functions and their properties, Rodrigues' formula for Legendre polynomials, Recurrence relations and generating functions, Laplace integral representation of Legendre polynomial, Orthogonality of Legendre polynomials.

Unit-III

Laplace Transforms – Existence theorem for Laplace transforms, Linearity of the Laplace transforms, Shifting theorems, Change of scale Property, Laplace transforms of derivatives and integrals, Inverse Laplace transforms, convolution theorem, Applications of Laplace Transforms for solutions of ordinary differential equations and solutions of Simultaneous ordinary differential equations.

Unit-IV

Fourier transforms: Linearity property, Change of scale Property, Shifting, Modulation, Fourier Cosine and Sine Transforms, Fourier Transform of Derivatives, Relations between Fourier transform and Laplace transform, Convolution Theorem, Parseval's identity for Fourier transforms,Applications of Fourier Transforms to ordinary and partial differential equations.

Suggested Books/Reading:

1. I. N. Sneddon: Special Functions on Mathematical Physics&Chemistry,1966.
2. M. D. Rai Singhania: Ordinary and Partial differential equations, S.Chand and Company.

3.	L.C. Andrews: Special functions of Mathematics for Engineers, Oxford University Press and SPIE Press, 1992.
4.	George E. Andrews, Richard Askey, Ranjan Roy: Special Functions, Cambridge University Press, 1999.
5.	E.D. Ranville: Special Functions,Macmillan,1960
6.	W.W. Bell: Special Functions for Scientists & Engineers, 2004
7.	I.N. Sneddon: The use of integral transforms, McGraw Hill, 1972.
8.	S.K. Pundir: Integral transform methods in Science and Engineering, CBS Publishers and Distributors Pvt. Ltd., 2017.
9.	Lokenath ,Debnath and Dambaru Bhatta. Integral transforms and their applications, Taylor and Francis group, 2015.
10.	Murray R. Spiegel Laplace transform, Schaum's Series,1965

Semester-V				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
BCG-321-V	**Machine Learning-I**	**25 + 75 = 100**	**4**	**4**
		L – 4	**T - 0**	**P - 0**

Course Objectives:

At the end of this course, students will be able

- To understand the Domain of ML and basics techniques used in ML.
- To design and apply various machine learning algorithms for supervised learning.
- To design and apply various machine learning algorithms for unsupervised learning.
- To understand techniques and application of ML in real world scenario.

Course Content:

Unit-I

Introduction of Machine Learning(ML): Machine Learning basic concepts, Perspectives and Issues in Machine Learning, Types of Machine Learning, supervised – unsupervised – reinforcement, Data Representations: Numerical representation, Graph representation, Applications of Machine Learning.

Unit-II

Machine Learning-Supervised Learning (Regression/Classification): Linear models: Linear Regression, Logistic Regression, Nearest-Neighbours, Decision Trees, Support Vector Machines, Nonlinearity and Kernel Methods.

Unit-III

Unsupervised Learning: K-means/Kernel K-means, Dimensionality Reduction: PCA, Matrix Factorization and Matrix Completion, Separating hyperplanes: RPL Algortihm, Optimal separating hyperplane.

Unit-IV

Techniques and Applications: Scalable Machine Learning, Naïve Bayes, Introduction to Bayesian Learning and Inference, Recent trends in various learning techniques of machine learning and classification methods.

Suggested Books/Reading:

1. K. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012
2. T. Hastie, R. Tibshirani and J. Friedman, “The Elements of Statistical Learning”, Springer 2009 (freely available online)
3. E. Alpaydin, Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series), Third Edition, MIT Press, 2014
4. T. M. Mitchell, Machine Learning, First Edition, McGraw Hill Education.

Semester-V				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
MTU-311-V	**Probability and Statistics**	**25 + 75 = 100**	**4**	**4**
		L – 4	**T - 0**	**P - 0**

Course Objectives:

At the end of this course, students will be able

- To explore distributions in the study of the joint behavior of two random variables.
- To acquire mathematical and statistical knowledge of various distributions like Binomial, Poisson and Normal
- To acquire knowledge about the curve fitting
- To Learn basic Hypothesis testing

Course Content:

Unit-I

Probability Theory: Introduction, Fundamental concepts of probability, Laws of probability, Bayes theorem. Probability Distribution: Random variable, Discrete random variable, Cumulative distribution function, Expectation and variance of discrete random variable, Binomial and poisson distribution, Continuous random variable, Probability density function, Expectation and variance of continuous random variable, Normal distribution.

Unit-II

Bivariate Distribution: Joint probability, Joint probability mass function, Marginal and conditional probability function, Joint probability distribution function, Joint continuous density function, Marginal and conditional probability density function, Conditional cumulative distribution.

Unit-III

Correlation Analysis: Introduction, Correlation coefficient, Rank correlation.Regression Analysis: Introduction, Regression lines, method of least square, Curve Fitting: Introduction, Principle of least squares, Fitting of straight line, Fitting a second degree parabola.

Unit-IV

Hypothesis Testing: Introduction, Null hypothesis, Alternative hypothesis, Level of significance, Hypothesis testing for large samples (Test for single mean, Test for difference of means), Test for single proportion, Test for difference of proportions, T-test.

Suggested Books/Reading:

1. Irwin Miller & amp; Marylees Miller, John E. Freunds Mathematical Statistics with Applications (8th edition), Pearson, Dorling Kindersley Pvt. Ltd. India, 2014.

2.	Gupta S.C. and Kapoor V.K., Fundamentals of Mathematical Statistics, **S.** Chand Pub., New Delhi.,1970.
3.	Robert V. Hogg, Joseph W. McKean & Allen T. Craig ,Introduction to Mathematical Statistics ,7th edition, Pearson Education, 2013.
4.	Jim Pitman, Probability, Springer-Verlag, 1993.
5.	Sheldon M. Ross, Introduction to Probability Models ,11th edition, Elsevier, 1993.
6.	A. M. Yaglom and I. M. Yaglom, Probability and Information, D. Reidel Publishing Company. Distributed by Hindustan Publishing Corporation (India) Delhi, 1993.

Semester-V				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
MTU-313-V	**Mathematics for Machine Learning: A Practical Foundation**	**25+75-100**	**4**	**4**
		L – 4	**T - 0**	**P - 0**

Course Objectives:

At the end of this course, students will be able

- To understand core linear algebra and calculus concepts used in ML.
- To apply SVD and PCA for data reduction in Python.
- To use optimization techniques to train and evaluate ML models.
- To grasp basic probability and SVM principles in ML contexts.

Course Content:

Unit-I	
Vectors, Matrices,Vector Spaces, Basis, Dimension, Linear Transformations, Norms, Orthogonal Projections, Eigenvalues and Eigenvectors. Single Value Decomposition (SVD), Low-Rank Approximation, Python implementation of SVD.	
Unit-II	
Principal Component Analysis, (PCA) , Python implementation of PCA, Least Squares Method, , Linear Regression, Logistic Regression, Gradient, Jacobian, Chain rule,Change of Variables, Convex sets and convex functions, Introduction to Optimization. Numerical Optimization in Machine Learning, Gradient Descent and other optimization algorithms in machine learning.	
Unit-III	
Optimization using Python, Basic Probability, Bayes theorem and random variable, Expectation and variance. Introduction to support vector Machine (SVM), Optimization -based Formulation.	
Unit-IV	
Lagrangian Multiplier method, concepts of duality, hard and soft margin classifier, SVM in Python.	

Suggested Books/Reading:

1.	W. Cheney, Analysis for Applied Mathematics, New York: Springer Science+Business Media, 2001.
2.	S. Axler, Linear Algebra Done Right (Third Edition), Springer International Publishing, 2015.
3.	J. Nocedal and S. J. Wright, Numerical Optimization, New York: Springer Science+Business Media, 2006.
4.	J. S. Rosenthal, A First Look at Rigorous Probability Theory, 2nd ed., Singapore: World Scientific Publishing, 2006.

SEMESTER-VI

Semester-VI				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
MTU-302-V	**Complex Analysis**	**25 + 75 = 100**	**4**	**4**
		L – 4	**T - 0**	**P - 0**

Course Objectives:

At the end of this course, students will be able

- To explore complex numbers and their properties
- To know about the significance of analytic functions and Cauchy Riemann equations in Cartesian and polar coordinates
- To analyze the role of Cauchy integral formula and Liouville's theorem
- To find residues and apply residue theorem to evaluate integrals

Course Content:

Unit-I

Complex number system, Algebraic properties, Geometric interpretation, Properties of moduli, Regions in complex plane, Functions of complex variable, Topological aspects of the complex plane-ball, limit, continuity, derivatives, Cauchy sequence and convergence, Stereographic projection.

Unit-II

Analytic functions, Cauchy-Riemann equations, Sufficient conditions for differentiability, Polar conditions, Harmonic functions, Construction of analytic functions, Exponential function, Logarithmic function, Trigonometric function, Line integral.

Unit-III

Contours, Contour integral and its examples, Upper bounds for moduli of contour integrals, Cauchy-Goursat theorem, Cauchy integral formula, Derivatives of analytic function, Liouville"s theorem and the fundamental theorem of algebra.

Unit-IV

Taylor and Laurent series, Absolute and uniform convergence of power series, Zeros of analytic functions, Isolated singular points, Types of isolated singular points, Residues, Residue at poles, Residue theorem and its applications to evaluate real definite integral.

Suggested Books/Reading:

1. Joseph Bak and Donald J. Newman, *Undergraduate text in Mathematics*, *Complex Analysis*, 3rd edition, Springer, 2010
2. James W. Brown and Ruel V. Churchill, *Complex Variable and Applications*, 9th edition, McGraw Hill Education, New York, 2014.
3. John B. Conway, *Functions of one Complex variable*, Springer-Verlag, International student-Edition, Narosa Publishing House, 1980
4. H. A. Priestly, *Introduction to Complex Analysis*, 2nd edition, Oxford University Press, 2003.
5. Lars V. Ahlfors, *Complex Analysis*, 3rd edition, McGraw-Hill Education, 2017.

Semester-VI				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
MTU-304-V	**Complex Analysis Lab**	**15+35= 50**	**2**	**1**
		L – 0	**T - 0**	**P - 2**

Course Objectives:

At the end of this course, students will be able

- To evaluate addition, multiplication, conjugate and modulus of complex numbers.
- To perform the contour integrals.
- To expand some functions as their Taylor and Laurent series.
- To compute the poles and residues of functions.

Practicals:

Lab work to be performed on a computer using Matlab / Mathematica

1. Declare a complex number and represent it graphically.
2. Discuss the algebra of complex numbers.
3. Find the conjugate, modulus and phase angle of an array of complex numbers.
4. Compute the integral over a straight-line path between two specified end points.
5. Perform contour integration. For example
   (i) C is the Contour given by $x = y^2 + 1$,
   (ii) C is the contour given by $x = \cos t\,,\ y = \sin t$.
6. Plot complex functions and analyze their graph. For example
   (i) $f(z) = z$,
   (ii) $f(z) = z^4$.
7. Obtain the Taylor series expansion of a given function $f(z)$ around a given point z. Plot the magnitude of the function and the magnitude of its Taylor series expansion. For example
   (i) $f(z) = e^z$ around $z = 0$,
   (ii) $f(z) = e^{z^2}$ around $z = 1$.
8. Determine the number of terms in the Taylor series expansion of a function $f(z)$ around a given point z to achieve a specified percentage error. For example
   (i) $f(z) = e^z$ around $z = 0$. Determine the number of terms to get a percentage error of less than 5%.
9. Obtain the Laurent series expansion of a function f(z) around a given point z. For example
   (i) $f(z) = \frac{\sin z - 1}{z^4}$ around z = 0,
   (ii) $f(z) = \frac{\cot z}{z^4}$ around $z = 0$.
10. Compute the poles and corresponding residues of complex functions.

Suggested Books/Reading:

4.	Joseph Bak and Donald J. Newman, *Undergraduate text in Mathematics*, *Complex Analysis*, 3rd edition, Springer , 2010
5.	James W. Brown and Ruel V. Churchill, *Complex Variable and Applications*, 9th edition, McGraw Hill Education, New York, 2014.

Semester-VI				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
MTU-308-V	**Linear Programming Problems**	**25 + 75 = 100**	**4**	**4**
		L – 4	**T - 0**	**P - 0**

Course Objectives:

At the end of this course, students will be able

- To formulate and model real-life problems using linear programming techniques.
- To apply appropriate methods to solve LPPs, transportation, and assignment problems.
- To understand the concept of convexity and its significance in optimization.
- To use software tools like Excel Solver, LINGO, and Octave for solving LP problems.

Course Content:

Unit-I

LPP-Introduction, Formulation of linear programming problem, linear programming in matrix notation, graphical solution of linear programming problems, simplex method, Two phase method, Big-M method, Degeneracy, Alternate Optima, Unbounded and infeasible solution.

Unit-II

Definition of the dual of an LPP, significance of duality, weak duality and strong duality theorems (statements only), illustration of duality theorems through examples, resolution of degeneracy, duality in linear programming problems, primal-dual relationship, dual simplex method.
Assignment problem: Introduction and necessity of assignment problem, Assignment problem as linear programming problem, balanced and unbalanced assignment problem, Hungarian algorithm for the assignment problem.

Unit-III

Transportation Problem: Introduction and necessity of transportation problem, transportation model problem, Initial basic feasible solution (IBFS) by north west corner rule method, matrix minima method, Vogel's approximation method, optimal solution by modified distribution method, degeneracy in transportation problem.

Unit-IV

Game theory: Two person zero games, Minimax and maximum principle, Game with saddle point, Rule of dominance, Algebraic and graphical method. Decision theory: Types of decisions, Components of decision making.

Suggested Books/Reading:

1. N. S. Kambo, *Mathematical Programming Techniques*, Affilated East-West Press Pvt Ltd., 2008.
2. M. S. Bazaraa, H. D. Sherali, C. M. Shetty, *Nonlinear Programming: Theory and Algorithms*, 3rd ed., Wiley-Interscience, 2006.
3. F.S. Hillier, G. J. Lieberman, B. Nag and P. Basu, *Introduction to Operations Research*, 10th ed., Tata McGraw Hill, 2017.
4. P. R. Thie and G. E. Keough, *An introduction to Linear Programming and Game Theory*, 3rd ed., John Wiley & Sons, 2008.
5. H. A. Taha, *Operations Research: An Introduction*, 10th ed., Pearson, New Delhi, 2017.
6. S. D. Sharma, *Operation Research*, KedarNath Ram Nath Publications.
7. J. K. Sharma, *Mathematical Model in Operation Research*, Tata McGraw Hill

Semester-VI				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
MTU-310-V	**Riemann Integral and Metric Space**	**25 + 75 = 100**	**4**	**4**
		L – 4	**T - 0**	**P - 0**

Course Objectives:

At the end of this course, students will be able

- To know the basic concepts of Riemann Integral.
- To know about the Improper integral.
- To know the basic concepts of metric spaces.
- To analyze some concepts of metric space such as completeness and continuity.

Course Content:

Unit-I

Partition of a set, Refinement of a Partition, Inequalities for upper and lower Darboux sums, Upper and lower integral, Necessary and sufficient conditions for the integrability of a function using Darboux sums. Definition of Riemann integration by Riemann sum and equivalence of the two definitions (by Riemamm sum and Darboux sum), Properties of Riemann integrable functions, Integrability of monotone functions and continuous functions. Mean Value theorem, Primitive of a function, Fundamental theorems (I and II) of calculus.

Unit-II

Improper integrals: Type-I, Type-II and mixed type, Comparison Tests for improper integral of type-II and I. Convergence of Beta and Gamma functions.

Unit-III

Definition and examples of metric spaces, Open spheres and closed spheres, Neighbourhoods, Open sets, Interior, exterior and boundary points, closed sets, Limit points and isolated points, Interior and closure of a set, Bounded sets, Diameter of a set, Subspace of a metric space.

Unit-IV

Cauchy and Convergent sequences, Completeness of metric spaces, Continuous and uniformly continuous functions, Compact Spaces, Disconnected and connected sets.

Suggested Books/Reading:

1. D. Bansal, I.S. Gupta, Satbir Mehla and Indu Bala Bansal, *Real Analysis*, Jeevansons Publications, 2019.
2. Robert G. Bartle and Donald R. Sherbert, *Introduction to Real Analysis,* Wiley India,4th Edition, 2015.
3. S. Kumaresan, *Topology of metric spaces*. Alpha Science Int'l Ltd., 2005.
4. George F. Simmons, *Introduction to Topology and Modern Analysis*, McGraw-Hill Education, New Delhi, 2004.

Semester-VI				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
BCG-320-V	**Machine Learning-II**	**25 + 75 = 100**	**4**	**4**
		L – 4	**T - 0**	**P - 0**

Course Objectives:

At the end of this course, students will be able

- To learn the concept of how to learn patterns and concepts from data without being explicitly programmed in various IOT nodes.
- To design and analyze various machine learning algorithms and techniques with a modern outlook focusing on recent advances.
- To explore supervised and unsupervised learning paradigms of machine learning.
- To explore Reinforcement Learning and its techniques.

Course Content:

Unit-I

Combining Different Models: Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods: Boosting, Bagging, Random Forests.

Unit-II

Dimensionality Reduction: Dimensionality Reduction- Linear Discriminant Analysis, Review of Principal Component Analysis, Kernel PCA, Factor Analysis – Independent Component Analysis, Recommendation System.

Unit-III

Learning With Neural Networks: Artificial Neuron, Type of ANN architecture and activation functions, Perceptron, multilayer neural networks, Delta rule for learning neural network, Deep Learning - RNN, LSTM and CNN and Transfer Learning.

Unit-IV

Reinforcement Learning: Reinforcement Learning overview, Elements of Reinforcement Learning, Generalization in reinforcement learning, policy search, adaptive dynamic programming, Case study for robotics design.

Suggested Books/Reading:

1.	K. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012
2.	T. Hastie, R. Tibshirani and J. Friedman, “The Elements of Statistical Learning”, Springer 2009 (freely available online)
3.	C. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2007
4.	G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Education, New Delhi, 2004.

Semester-VI				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
MTU-312-V	**Number Theory**	**25 + 75 = 100**	**4**	**4**
		L – 4	**T - 0**	**P - 0**

Course Objectives:

At the end of this course, students will be able

- To understand division Algorithm, GCD and LCM, linear congruences and their properties, Chinese Remainder Theorem.
- To lean and apply Fermat's and Wilson's theorems, Mobius inversion formula and the greatest integer function
- To understand Euler's phi-function and its properties, Euler's theorem, Primitive roots
- To understand Quadratic residues, quadratic reciprocity and Fermat's Last theorem

Course Content:

Unit-I

Divisibility and properties, The division algorithm, G.C.D. (Greatest Common Divisors), L.C.M (Least Common Multiple), Prime Numbers, Euclidean Algorithm, Fundamental Theorem of Arithmetic, Congruences and Basic Properties, Linear Diophantine equation, Chinese remainder theorem.

Unit-II

Fermat's little theorem and applications, Wilson's theorem and applications, sum and number of divisors, perfect numbers, the Mobius Inversion formula and related results, the greatest integer function and its properties.

Unit-III

Euler's Phi-function and its properties, Euler's generalization of Fermat's theorem, reduced set of residues, Order of an integer modulo n, complete and reduced residue system, primitive roots for primes and composite numbers.

Unit-IV

Quadratic residues, Euler's criterion, the Legendre symbol and its properties, Gauss reciprocity law, quadratic congruences with composite moduli, the equation x^2+y^2=z^2, Fermat's last theorem (without proof).

Suggested Books/Reading:

1. D. M. Burton, *Elementary Number Theory*, 6th edition, Tata McGraw Hill, Indian reprint, 2007.
2. T. M. Apostol, *Introduction to Analytic Number Theory*, Narosa Publication House, New Delhi, 2013
3. N. Robbins, *Beginning Number Theory*, 2nd edition, Jones & Bartlett Learning, 2017.
4. G. A. Jones and J.M. Jones, *Elementary Number Theory*, Springer, 1998.

Semester-VI				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
MTU-314-V	**Graph Theory**	**25 + 75 = 100**	**4**	**4**
		L – 4	**T - 0**	**P - 0**

Course Objectives:

At the end of this course, students will be able

- To develop a strong understanding of the fundamental definitions, terminology, and concepts of graph theory.
- To apply core theorems and algorithms to solve problems, construct relevant examples, and explore extensions through natural questions.
- To attain proficiency in writing clear and rigorous proofs, particularly those involving standard graph-theoretic techniques.
- To understand and analyze the basic properties, types, and applications of trees within graph theory.

Course Content:

Unit-I

Graphs, isomorphism, subgraphs, matrix representations, degree, operations on graphs, degree sequences.

Unit-II

Walks, trails, paths, connected graphs, distance, cut-vertices, cut-edges, blocks, weighted graphs, connectivity, Dijkstra's shortest path algorithm, Floyd-Warshall shortest path algorithm.

Unit-III

Characterizations, number of trees, minimum spanning trees.

Unit-IV

Bipartite graphs, line graphs, chordal graphs, Eulerian graphs: Characterization, Fleury's algorithm, chinese- postman-problem.

Suggested Books/Reading:

1. F. Harary, *Graph Theory*, Narosa, 1988.
2. C. Berge, *Graphs and Hypergraphs*, North Holland/Elsevier, 1973.
3. Diestel, Reinhard, *Graph theory*, 4th ed., Heidelberg, Springer, 2010.
4. K.H. Rosen, *Discrete Mathematics and its application*, 5th edition, Tata McGraw.
5. C. L. Liu, *Elements of Discrete Mathematics*, 2nd edition, TMH 2000.

Semester-VI				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
MTU-316-V	**Tensor Tools for Mathematical Modeling**	**25 + 75 = 100**	**2**	**2**
		L – 2	**T - 0**	**P - 0**

Course Objectives:

At the end of this course, students will be able

- To understand and apply the fundamental concepts of vectors and tensors, including their basic operations, properties, and transformation rules in various coordinate systems.
- To model and analyze mechanical systems, particularly stress–strain behavior in elastic bodies, using appropriate vector and tensor notation.

Course Content:

Unit-I

Review of scalars and vectors, dot product and cross product, transformation laws for vectors. Introduction to tensors with basic definition and examples of scalars, vectors, and their orders; summation convention, free and dummy indices; transformation rules for tensors; Kronecker delta, and Levi-Civita symbol. Basic operations on tensors – scalar multiplication, addition, subtraction, and contraction; quotient rule; symmetric, skew-symmetric, and isotropic tensors; transpose and inverse of a tensor. Tensor properties and equality; deviatoric tensors; tensor invariants.

Unit-II

Gradient, divergence, curl, and Laplacian expressed in tensor form; comma notation for derivatives. Deformation of elastic bodies; properties of homogeneous strain and affine transformations; strain tensors and their relation to displacement; principal strains and strain invariants. Stress tensor – meaning and components; Generalized Hooke's Law describing the relation between stress and strain.

Suggested Books/Reading:

1.	D. S. Chandrasekharaiah and L. Debnath, L. Continuum Mechanics. Academic Press Inc., San Diego, CA, 1994.
2.	I. S. Sokolnikoff, Tensor Analysis: Theory and Applications to Geometry and Mechanics of Continua, Wiley, 2nd edition, 1964.
3.	S. Narayan, A text book of Cartesian Tensors (with an introduction to general tensors), 3rd edition. New Delhi: S. Chand Publications, 1968.
4.	E. C. Young, Vectors and Tensor Analysis, 2nd edition, 1993.
5.	H. Kolsky, Stress waves in Solids. Dover Publications, 1963.
6.	M. L. Boas, Mathematical Methods in the Physical Sciences, Wiley, 3rd edition, 2005.