1.2.2

Supporting Documents-

Department of Mathematical Sciences

Copy of Syllabus of All Programs Offered Indicating Credits/Electives Approved by Board

B.Sc. (Hons.) Mathematics

Course Structure and Syllabus

(Based on Choice Based Credit System)

Batch 2022 & onwards

DEPARTMENT OF MATHEMATICS

VISION

To be among the best mathematics departments in the region and to establish a national reputation as a centre for research and teaching in mathematics. Moreover, the department will contribute to the development of students as mathematical thinkers, and to function as productive citizens.

MISSION

- To discover, mentor, and nurture mathematically inclined students, and provide them a supportive environment that fosters intellectual growth.
- To prepare our undergraduate and graduate students to develop the attitude and ability to apply mathematical methods and ideas in a wide variety of careers.
- To perform widely recognized research in focused areas of mathematical and statistical theory, methodology, and education.
- To advocate for mathematical sciences and UTEP in schools and the local community.

B.Sc. (Honours Mathematics) Program

PROGRAM OBJECTIVES

Objective of the program is to catch young and talented students to motivate them to study Mathematics and to nurture them to develop their mathematical reasoning and logics. Other objectives of the program are to inspire students to pursue study in higher mathematics and grow as a skilful mathematician to cater the needs of knowledgeable society.

Duration: B.Sc. (Hons) Mathematics is a graduate level program offered by the Department of Mathematical Sciences. This is a 3-years program, consisting of six semesters with two semesters per year.

Program Code: BSHM (Bachelor of Science (Hons) in Mathematics)

Eligibility: 10+2 in any stream with Mathematics as one of the subjects with at least 50% marks in aggregate

PROGRAM EDUCATIONAL OBJECTIVES: At the end of the program, the student will be able to:

PEO1	Apply principles of basic science concepts in understanding, analysis and prediction of mathematical systems.
PEO2	Develop human resource with knowledge, abilities and insight in Mathematics and related fields required for career in academia and industry.
PEO3	Engage in lifelong learning and adapt to changing professional and societal needs.

PROGRAM SPECIFIC OUTCOMES

At the end of the program,

PSO1	Students will be able to understand the nature of Mathematics and shall be ready to study higher 'Abstract Mathematics'.
PSO2	Students will be able to visualize the importance of Mathematics and apply the knowledge of Mathematics in Physical, Chemical and Social Sciences.
PSO3	Students will be able to use latest mathematical tools and software.
PSO4	Students will be able to formulate computer codes to tackle the complex mathematical problems.
PSO5	Students will become more confident due to enhanced level of reasoning, logics, skills and shall be able to understand the needs of the society.

PROGRAM OUTCOMES: At the end of the program, the student will be able to:

PO1	Understand the concepts of different branches of Mathematics.
PO2	Demonstrate expertise to conduct wide range of scientific modelling.
PO3	Apply the concepts of mathematics in areas of mechanics, analysis, calculus, algebra, geometry, mathematical modelling etc., in industry, academia, and day-to-day life.

Scheme of the Program: B.Sc. (Hons.) Mathematics

SEMESTER FIRST **Contact Hrs. 24 Hrs.**

S.No.	Course Code	Course Type	Course Title	Load Allocation			Marks Distribution		Total Marks	Cr
				L	T	P	Internal	External		
1.	BSHM-101-22	Compulsory	Calculus-I	**4**	**-**	**-**	**40**	**60**	**100**	**4**
2.	BSHM-102-22		Algebra	**5**	**1**	**-**	**40**	**60**	**100**	**6**
3.	BSHM-103-22		Programming Lab-I	**-**	**-**	**4**	**30**	**20**	**50**	**2**
4.	BHHL-115-22		Communicative English	**2**	**-**	**-**	**20**	**30**	**50**	**2**
5.*	BSHP-111-21	Elective	Optics	**3**	**1**	**-**	**40**	**60**	**100**	**4**
	BSHP-113-21		Physics Lab-I	**-**	**-**	**4**	**30**	**20**	**50**	**2**
	UGCA-1902		Fundamentals of Computer and IT	**3**	**1**	**-**	**40**	**60**	**100**	**4**
	UGCA-1906		Fundamentals of Computer and IT (Laboratory)	**-**	**-**	**4**	**30**	**20**	**50**	**2**
				Total						**20**

L: Lectures T: Tutorial P: Practical Cr: Credits

Note*: Physics (BSHP-111-21 & BSHP-113-21) are compulsory for the Students with Non-Medical background. Students without Non-medical background should opt Fundamentals of Computer and IT (UGCA-1902 & UGCA-1906).

SEMESTER SECOND **Contact Hrs. 24 Hrs.**

S.No.	Course Code	Course Type	Course Title	Load Allocation			Marks Distribution		Total Marks	Cr
				L	T	P	Internal	External		
1.	BSHM-201-22	Compulsory	Real Analysis	**5**	**1**	-	**40**	**60**	**100**	**6**
2.	BSHM-202-22		Differential Equations	**4**	**-**	-	**40**	**60**	**100**	**4**
3.	BSHM-203-22		Programming Lab-II	-	-	**4**	**30**	**20**	**50**	**2**
4.*	BHHL-116A-22 **Or** BHHL-116B-22		Punjabi Compulsory **Or** Mudli Punjabi	**2**	**-**	**-**	**20**	**30**	**50**	**2**
5.**	BHIC-111-22	Elective	Chemistry-I	**3**	**1**	-	**40**	**60**	**100**	**4**
	BHIC-112-22		Chemistry Lab-I	-	-	**4**	**30**	**20**	**50**	**2**
	BBA-GE-201-18		Managerial Economics-II	**5**	**1**	**0**	**40**	**60**	**100**	**6**
				Total						**20**

L: Lectures T: Tutorial P: Practical Cr: Credits

Note 1*: Students with Punjabi as a passing subject in 10th class will study Punjabi Compulsory (BHHL-116A-22). Students without Punjabi as a subject in 10th class will study Mudli Punjabi (BHHL-116B-22).

Note 2: Chemistry (BHIC-111-22 & BHIC-112-22) is compulsory for the Students with Non-Medical background. Students without Non-medical background should opt Managerial Economics-II (BBA-GE-201-18).**

SEMESTER THIRD **Contact Hrs. 28 Hrs.**

S.No.	Course Code	Course Type	Course Title	Load Allocation			Marks Distribution		Total Marks	Cr
				L	T	P	Internal	External		
1.	BSHM-301-22	Compulsory	Theory of Real Functions	**5**	**1**	-	**40**	**60**	**100**	**6**
2.	BSHM-302-22		Group Theory I	**5**	**1**	-	**40**	**60**	**100**	**6**
3.	BSHM-303-22		Multivariable Calculus	**5**	1	-	**40**	**60**	**100**	**6**
4.	BSHM-304-22		Logic and Sets	**2**	**-**	**-**	**20**	**30**	**50**	**2**
5.*	BSHP-212-21	Elective	Elements of modern physics	**3**	**1**	**-**	**40**	**60**	**100**	**4**
	BSHP-213-21		Physics Lab-III	**-**	**-**	**4**	**30**	**20**	**50**	**2**
6.*	UGCA-1914		Programming in Python	**3**	**1**	**-**	**40**	**60**	**100**	**4**
	UGCA-1917		Programming in Python (Laboratory)	**-**	**-**	**4**	**30**	**20**	**50**	**2**
				Total						**26**

L: Lectures T: Tutorial P: Practical Cr: Credits

Note*: Physics (BSHP-212-21 & BSHP-213-21) are compulsory for the Students with Non-Medical background. Students without Non-medical background should opt Programming in Python (UGCA-1914 & UGCA-1917).

SEMESTER FOURTH **Contact Hrs. 30 Hrs.**

S.No.	Course Code	Course Type	Course Title	Load Allocation			Marks Distribution		Total Marks	Cr
				L	T	P	Internal	External		
1.	BSHM-401-22	Compulsory	Numerical Methods	**4**	**-**	-	**40**	**60**	**100**	**4**
2.	BSHM-402-22		Riemann Integration and Series of Functions	**5**	**1**	-	**40**	**60**	**100**	**6**
3.	BSHM-403-22		Ring Theory and Linear Algebra I	**5**	**1**	-	**40**	**60**	**100**	**6**
4.	BSHM-404-22		Programming Lab-III	-	-	**4**	**30**	**20**	**50**	**2**
5.	BSHM-405-22		Graph Theory	**2**	**-**	**-**	**20**	**30**	**50**	**2**
6.*	BHIC-211-22	Elective	Chemistry-II	**3**	**1**	**-**	**40**	**60**	**100**	**4**
	BHIC-212-22		Chemistry Lab-II	**-**	**-**	**4**	**30**	**20**	**50**	**2**
7.*	BBA-401-18		Business Research Methods	**5**	**1**	**-**	**40**	**60**	**100**	**6**
				Total						**26**

L: Lectures T: Tutorial P: Practical Cr: Credits

Note*: Chemistry (BHIC-211-22 & BHIC-212-22) is compulsory for the Students with Non-Medical background. Students without Non-medical background should opt Business Research Methods (BBA-401-18).

SEMESTER FIFTH **Contact Hrs. 30 Hrs.**

S. No.	Course Code	Course Type	Course Title	Load Allocation			Marks Distribution		Total Marks	Cr
				L	T	P	Internal	External		
1.	BSHM-501-22	Compulsory	Partial Differential Equations	**4**	**-**	-	**40**	**60**	**100**	**4**
2.	BSHM-502-22		Group Theory-II	**5**	**1**	-	**40**	**60**	**100**	**6**
3.	BSHM-503-22		Introduction to Number Theory	**5**	**1**	-	**40**	**60**	**100**	**6**
4.	BSHM-504-22		Mathematical Statistics	**5**	**1**	-	**40**	**60**	**100**	**6**
5.	BSHM-505-22		Programming Lab-IV	-	-	**4**	**30**	**20**	**50**	**2**
6.	EVS-101 A		Environmental Science	**2**	-	-	**20**	**30**	**50**	**2**
7.	BSHM-506-22	Value Added Course (Compulsory)	Computer Algebra System and Related Software	-	-	**2**	**Satisfactory/ Unsatisfactory**			**Non-Credit**
				Total						**26**

L: Lectures T: Tutorial P: Practical Cr: Credits

SEMESTER SIXTH **Contact Hrs. 28 Hrs.**

S.No.	Course Code	Course Type	Course Title	Load Allocation			Marks Distribution		Total Marks	Cr
				L	T	P	Internal	External		
1.	BSHM-601-22	Compulsory	Complex Analysis	5	1	-	40	60	100	6
2.	BSHM-602-22		Ring Theory and Linear Algebra-II	5	1	-	40	60	100	6
3.	BSHM-603-22		Theory of Equations	5	1	-	40	60	100	6
4.	BSHM-604-22		Mathematical Modeling	4	-	-	40	60	100	4
5.	BSHM-605-22		Programming Lab-V	-	-	4	30	20	50	2
6.	BSHM-606-22	Value Added Course (Compulsory)	Scientific Documentation Tool	-	-	2	Satisfactory/ Unsatisfactory			Non-Credit
				Total						24

L: Lectures T: Tutorial P: Practical Cr: Credits

Examination and Evaluation

Theory			
S. No.	**Evaluation criteria**	**Weightage in Marks**	**Remarks**
1	Mid term/sessional Tests	24	Internal evaluation (40 Marks) MSTs, Quizzes, assignments, attendance, etc., constitute internal evaluation. Average of two mid semester test will be considered for evaluation.
2	Attendance	6	
3	Assignments/Seminars/Presentations/Continuous Evaluation	10	
4	End semester examination	60	External evaluation
5	Total	100	Marks may be rounded off to nearest integer.
Practical			
1	Evaluation of practical record/ Viva Voice/Attendance/Seminar/ Presentation	30	Internal evaluation
2	Final Practical Performance + Viva-Voce	20	External evaluation
3	Total	50	Marks may be rounded off to nearest integer.

Instructions for Paper-Setter in B. Sc (Hons.) Mathematics

A. Scope

1. The question papers should be prepared strictly in accordance with syllabus and format as prescribed by the University.

2. The question paper should cover the entire syllabus with uniform distribution among each unit and weightage of marks for each question.

3. The language of questions should be simple, direct, and documented clearly and unequivocally so that the candidates may have no difficulty in appreciating the scope and purpose of the questions. The length of the expected answer should be specified as far as possible in the question itself.

4. The distribution of marks to each question/answer should be indicated in the question paper properly.

B. Type and difficulty level of question papers

1. Questions should be framed in such a way as to test the student's intelligence and understanding of the applied aspects of the subject. The weightage of the marks as per the difficulty level of the question paper shall be as follows:
   - i) Easy question 30%
   - ii) Average questions 50%
   - iii) Difficult questions 20%
2. The numerical content of the question paper should be up to 40%.

C. Format of question paper

1. Paper code and Paper-ID should be mentioned properly.
2. The question paper will consist of three sections: Sections-A, B and C.
3. Section-A is COMPULSORY consisting of TEN SHORT questions carrying two marks each (total 20 marks) covering the entire syllabus.
4. The Section-B consists of FOUR questions of eight marks each covering Unit I & II of syllabus (Taking two questions from each Unit I & II).
5. The Section-C consists of FOUR questions of eight marks each covering Unit III & IV of syllabus (Taking two questions from each Unit III & IV).
6. Sub-parts of the questions in Section B and C should be preferred for numerical/conceptual questions.
7. Attempt any five questions in all, selecting at least two questions from each of the two sections.

Question paper pattern for MST:

Roll No:	**No of pages:**
IK Gujral Punjab Technical University- Jalandhar	
Department of Mathematical Sciences	
Academic Session:	
Mid-Semester Test: I/II (Regular/reappear)	**Date:**
Programmse: B.Sc. (Hons.) Mathematics	**Semester:**
Course Code:	**Course:**
Maximum Marks: 24	**Time: 1 hour 30 minutes**

❖ Note: Section A is compulsory; Attempt any two questions from Section B and one question from Section C.

Section: A		**Marks**	**Cos**
1		2	
2		2	
3		2	
4		2	
Section: B			
5		4	
6		4	
7		4	
Section: C			
8		8	
9		8	

Details of Course Objectives

CO1	
CO2	
CO3	
CO4	
CO5	

SEMESTER-I

BSHM-101-22	**Calculus-I**	**L-4, T-0, P-0**	**4 Credits**

Pre-requisite: Elementary calculus of senior secondary level.

Course Objectives: The objectives of this course are to make the students understand the following:

1. The fundamental concepts of differential calculus.
2. The geometrical meaning of functions, limits, continuity, derivatives, mean value theorems.
3. Applications of derivatives.
4. The definition of Higher order derivatives and its basic applications.
5. The usability of Higher order derivatives to establish Taylor's theorem, Leibnitz theorem and Maclaurin theorem.

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

CO1	Understand the basic concepts of Differential and Integral Calculus.
CO2	Visualize all concepts geometrically.
CO3	Sketch curves of the functions intuitively with the help of Differential Calculus.
CO4	Apply the knowledge of Differential and Integral Calculus.
CO5	Understand the fundamental relation between differential and Integral Calculus.

Mapping of course outcomes with the program outcomes

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO1	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓

Course Title: Calculus-I
Course Code: BSHM-101-22

UNIT-I

Functions, their limits and continuity: Real line, intervals, order properties of real numbers, the least upper bound and the greatest lower bound properties, Archimedean property. Functions, Graphs of functions, Exponential functions, Inverse functions and Logarithmic functions, implicitly defined functions, some special functions, one-one functions, onto functions, composition of functions, limit of a function, calculating limits through limit laws, limits using L' Hospital's rule, The precise definition of limit and continuity (ε-δ definition), continuous functions and classification of discontinuities, uniform continuity.

UNIT-II

Differentiation: Derivative of a function, the derivative as a function, derivatives of polynomials and exponential functions, the product and quotient rules, rates of change in natural and social sciences, derivatives of trigonometric, inverse trigonometric, logarithmic, and hyperbolic functions, the chain rule, implicit differentiation, differentiation of determinants.

UNIT-III

Applications of derivative: maximum and minimum values, increasing and decreasing functions, Intermediate value theorems: Rolle's theorem, Lagrange's theorem, Cauchy's mean value theorem, how derivatives affect the shape of graph, concavity, convexity, the second derivative test, points of inflexion.

UNIT-IV

Higher order derivatives, calculation to the n^{th} derivative, determination of n^{th} derivative of rational functions. The n^{th} derivative of the products of power of sines and cosines, Leibnitz's theorem, the n^{th} derivative of the product of two functions, Maclaurin's theorem, Taylor's theorem.

TEXT BOOKS

1. Shanti Narayan and P. K. Mittal, Differential Calculus, S. Chand, 2015

RECOMMENDED BOOKS:

2. James Stewart, Calculus, 5th Edition, Brooks/Cole (Thomson), 2003.
3. Robert Wrede and Murray R. Spiegel, Advanced Calculus, 3rd Edition, Schaum's Outline Series (McGraw Hill), 2010.
4. Maurice D Weir, Frank R. Giordano and Joel Hass, Thomas' Calculus, 11th Edition, Pearson, 2008.
5. N. Piskunov, Differential and Integral Calculus, Mir Publishers, Moscow (CBS Publishers & Distributors, India), 1996.

BSHM-102-22	**Algebra**	**L-5, T-1, P-0**	**6 Credits**
Pre-requisite: - Complex numbers, Sets, Relation and Functions			
Course Objectives: This course is designed to introduce the basic notions of algebra. The major focus of the course will be on: De Moivre's theorem & its applications, matrices and their use in system of equations; theoretical foundation of theory of equations and their solutions.			
Course Outcomes: At the end of the course, the students will be able to			
CO1	Use the De Moivre's theorem for solving problems concerning powers of complex numbers and complex roots of polynomials etc.		
CO2	Use matrices in solving system of equations.		
CO3	Demonstrate linear independence and dependence of a set of vectors.		
CO4	Find inverse of a matrix using Gauss-Jordan method.		
CO5	Demonstrate the nature of solutions of polynomial equations and use Cardano's method, Ferrari method and Descarte's method for finding solutions of equations.		

Mapping of course outcomes with the program outcomes

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO1	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓

Course Title: Algebra

Course Code: BSHM-102-22

Unit I

Polynomials and Complex Numbers: Polynomials, The remainder and factor theorem, Synthetic division, Factored form of a polynomial, Fundamental theorem of algebra, Polar representation of complex numbers, De Moivre's theorem for integer and rational indices and their applications. The nth roots of unity.

Unit II

Roots of a Polynomial: Relations between the roots and the coefficients of polynomial equations, Theorems on imaginary, integral and rational roots Fundamental theorem of symmetric polynomials (without proof). Evaluation of symmetric functions of roots, Rational roots of polynomials with integral coefficients. Descartes rule of sign.

Unit III

Cubic and Biquadratic Equations: Strum's theorem (statement only), Solution of cubic equation using Cardano's method, and biquadratic equation by Descartes method and Ferrari's method.

Unit IV

System of Equations: Systems of linear equations (homogeneous and non-homogeneous), Row reduction and echelon forms, Row rank, column rank and their equivalence, Vector equations, The matrix equation Ax = b, Solution sets of linear systems, Gauss elimination method, Consistency of Linear System of equations, Augmented matrices, The inverse of a matrix, Gauss Jordon method.

RECOMMENDED BOOKS:

- Andreescu, Titu & Andrica Dorin, Complex Numbers from A to...Z. (2nd ed.). Birkhäuser (2014).
- Dickson, Leonard Eugene First Course in the Theory of Equations. The Project Gutenberg E-Book (http://www.gutenberg.org/ebooks/29785), (2009)
- Kolman, Bernard, & Hill, David R., Introductory Linear Algebra with Applications (7th ed.). Pearson Education, Delhi. First Indian Reprint 2003.

BSHM-103-22	**Programming Lab-I**	**L-0, T-0, P-4**	**2 Credits**

Pre-requisite: Knowledge of basic concepts in Mathematics, such as, graphs, functions, conics, matrices etc.

Course Objectives: This course is designed to introduce the basic knowledge of computer programming t simple algebraic operations on matrices and to visualize the geometry of curves and conics. two dimensions. The major focus of this course will be on geometric definition of two-dimensional shapes and a rigorous discussion on their properties and use.

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

CO1	Explain the basic concepts of programming.
CO2	Apply the knowledge of programming in different Matrix Operations.
CO3	Use programming in plotting and visualization of graphs of algebraic and transcendental functions.
CO4	Obtain Surface of revolution of curves.
CO5	Study further the tracing of conics.

Mapping of course outcomes with the program outcomes

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO1	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓

Course Title: Programming Lab-I

Course Code: BSHM-103-22

The following topics to be practiced using MATLAB:

i) Introduce the programming through MATLAB
ii) Perform Matrix Operations, such as, Addition, Multiplication, inverse, Transpose etc.
iii) Plot the graphs of algebraic and transcendental functions (For example, $e^{ax+b}, \log(ax+b), \frac{1}{ax+b,}$ with constants a, b, etc.)
iv) Obtain the surface of revolution of curves.
v) Trace of conics in Cartesian Coordinates /Polar Coordinates.
vi) Applications of derivative.

RECOMMENDED BOOKS:

1. Higham, D.J. and Higham, N.J., MATLAB Guide, 2nd Edition. Society for Industrial and Applied Mathematics (SIAM), 2005.
2. Gilat, A., MATLAB: An Introduction with Applications, 5th Edition. John Wiley & Sons, 2014.

BHHL-115-22	**Communicative English**	**L-2, T-0, P-0**	**2 Credits**

Pre-requisite: Basic proficiency in Communication Skills

Course objectives:

- To help the students become proficient in LSRW-Listening, Speaking, Reading & Writing skills
- To help the students become independent users of the English language
- To develop in them vital communication skills, integral to their personal, social, and professional interactions
- To teach them the appropriate language of professional communication
- To prepare them for the job market in their respective domains of specialization.

Course Outcomes: At the end of the course, the students will

CO1	acquire basic proficiency in reading &listening, writing and speaking skills
CO2	be able to understand spoken and written English language, particularly the language of their chosen technical field.
CO3	be able to converse fluently.
CO4	be able to produce their own clear and coherent texts.
CO5	become proficient in professional communication such as interviews, group discussions, office environments, important reading skills as well as writing skills and thereby will have better job prospects.

Mapping of Course Outcomes with the Program Specific Outcomes

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	-	-	-	-	✓
CO2	-	-	-	-	✓
CO3	-	-	-	-	✓
CO4	-	-	-	-	✓
CO5	-	-	-	-	✓

Course Title: Communicative English

Course Code: BHHL-115-22

UNIT I-(Literature)

(A) ***The Poetic Palette*** **(Orient Black Swan, Second Edition, 2016)**

The following poems from this anthology are prescribed:

1. Pippa's Song: Robert Browning
2. I Sit and Look Out: Walt Whitman
3. Women's Rights: Annie Louise Walker

(B) ***Prose Parables*** **(Orient Black Swan, 2013)**

The following stories from the above volume are prescribed:

1. Grief: Anton Chekov
2. The Doctor's Word: R.K. Narayan
3. The Doll's House: Katherine Mansfield

UNIT-II

Vocabulary: Synonyms, Antonyms; Standard Abbreviations; One-word substitution

Grammar: Subject-Verb Agreement; Noun- Pronoun Agreement; Use of phrases and clauses in sentences; Sentence Structures; Transformation of Sentences

UNIT-III

Reading and Understanding: Comprehension; Summarizing; Paraphrasing; Translation (from Hindi/Punjabi to English and vice-versa); Précis Writing

UNIT-IV

Mechanics of Writing & Speaking Skills: Business letters; Report writing; Career Documents- Job applications, Resume/CV writing, Conversations & Dialogues, Formal Presentations; Dynamics of Group Discussion.

Text & Reference Books:

1. John Eastwood, *Oxford Practice Grammar,* Oxford University Press, 2014.
2. Michael Swan, *Practical English Usage,* OUP, 1995
3. F.T. Wood, *Remedial English Grammar,* Macmillan, 2007.
4. William Zinsser, *On Writing Well,* Harper Resource Book, 2001.
5. Sanjay Kumar and Pushp Lata, *Communication Skills,* Oxford University Press, 2011.
6. Liz Hamp-Lyons and Ben Heasly, *Study Writing,* Cambridge University Press, 2006.

BSHP-111-21	**Optics**	**L-3, T-1, P-0**	**04 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: The objective of the course is to develop basic understanding of Interference, Diffraction and Polarization among students. They also learn about the LASER and its applications. Students will be equipped with knowledge to measure wavelength, refractive index, and other related parameters, which will act as a strong background if he/she chooses to pursue physics as a career.

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

CO1	Identify and illustrate physical concepts and terminology used in optics and other related wave phenomena
CO2	Analyze and understand coherence and phenomenon of interference and their applications
CO3	Acquainted with Fresnel's and Fraunhofer's diffraction and their applications.
CO4	Get thorough knowledge of the polarization of light, changes upon reflection and transmission and will learn to analyze the polarization in optical systems.
CO5	Describe the different types of lasers, its principle, properties and applications of laser beam.

Mapping of course outcomes with the program outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	-	✓	-	✓	✓
CO2	-	✓	-	✓	✓
CO3	-	✓	-	✓	✓
CO4	-	✓	-	✓	✓
CO5	-	✓	-	✓	✓

Course Title: Optics

Course Code: BSHP-111-21

PART-A

UNIT I

Interference: Definition and properties of wave front, Temporal and Spatial Coherence, Young's double slit experiment, Lloyd's single 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), Newton's Rings: Measurement of wavelength and refractive index, Interferometer: Michelson Interferometer-(1) idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, Fabry-Perot interferometer.

UNIT-II

Diffraction: Huygens Principle, Huygens-Fresnel Diffraction theory, Fraunhofer diffraction: Single slit. Circular aperture, Rayleigh criterion of resolution, Resolving Power of a telescope, Double slit, Multiple slits, Diffraction grating, Resolving power of grating. Fresnel Diffraction: Fresnel's Assumptions, Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light, Theory of a Zone Plate: Multiple Foci of a Zone Plate, Fresnel diffraction pattern of a straight edge and circular aperture.

PART-B

UNIT-III

Polarization: Plane polarized light, Representation of Unpolarized and Polarized light, Polarization by Reflection, Brewster's law, Malus Law, Polarization by Selective absorption by Crystals, Polarization by Scattering, Polarization by Double Refraction, Nicol Prism, Huygen's theory of Double Refraction, Polaroid, Elliptically and Circularly polarized lights, Quarter and Half wave plates.

UNIT-IV

Laser and Application: Lasers, Spontaneous emission, Stimulated absorption, Stimulated emission, Einstein coefficients, Einstein relations, Conditions for Laser actions, Population inversion, Different types of Laser Pumping mechanism: Optical Pumping, Electric Discharge and Electrical pumping, Resonators, Two, Three and Four level laser systems, Ruby laser, He-Ne gas Laser, Semiconductor laser, CO2 laser, applications of laser: Holography, Principle of Holography.

Text and Reference Books:

1. Optics: A.K. Ghatak (Tata-McGraw Hill), 1992.
2. Fundamentals of Optics: F.A. Jenkins and H.E. White (McGraw Hill), 1981.
3. A Textbook of Optics: Subrahmaniyam N. & et al., S. Chand Publishing, 2006.
4. O. Svelto: Principles of Lasers, Springer Science & Business Media, 2010.

BSHP-113-21	**Physics Lab-I**	**L-0, T-0, P-4**	**2 Credits**

Pre-requisite (If any): High-school education

Course Objectives: The aim and objective of the lab course is to introduce the students to the formal structure of electromagnetism and phenomenon of wave optics so that they can use these as per their requirement.

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

CO1	Able to verify the theoretical concepts/laws learnt in theory courses.
CO2	Trained in carrying out precise measurements and handling sensitive equipment.
CO3	Understand the methods used for estimating and dealing with experimental uncertainties and systematic "errors".
CO4	Learn to draw conclusions from data and develop skills in experimental design.
CO5	Document a technical report which communicates scientific information in a clear and concise manner.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	-	✓	-	✓	✓
CO2	-	✓	-	✓	✓
CO3	-	✓	-	✓	✓
CO4	-	✓	-	✓	✓
CO5	-	✓	-	✓	✓

Course Title: Physics Lab-I

Course Code: BSHP-113-21

Note: Students are expected to perform about 8-10 experiments from the following list, selecting minimum of 6-7 from the Physical Lab and 2-3 from the Virtual lab.

List of experiments:

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.
2. To study the laser beam characteristics like; wavelength, aperture, spot size, etc. using diffraction grating.
3. To study the diffraction using laser beam and thus to determine the grating element.
4. To study wavelength and laser interference using Michelson's Interferometer.
5. To find the refractive index of a material/glass using spectrometer.
6. To find the refractive index of a liquid using spectrometer.
7. To determine the angle of prism and resolving power of a prism.
8. To study the magnetic field of a circular coil carrying current using a Steward and Gees Tangent Galvanometer.
9. Determine the radius of circular coil using the Circular coil.
10. To study B-H curve using CRO.
11. To find out polarizability of a dielectric substance.
12. To find out the horizontal component of earth's magnetic field (B_h).

Text and Reference Books:

1. A Textbook of Practical Physics, I. Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal.
2. Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
3. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.
4. Practical Physics, C L Arora. S. Chand & Company Ltd.
5. http://www.vlab.co.in

UGCA-1902	Fundamentals of Computer and IT	L-3, T-1, P-0	4 Credits
Pre-requisite: NA			
Course Outcomes: At the end of the course, the student will be able to			
CO1	Understanding the concept of input and output devices of Computers		
CO2	Learn the functional units and classify types of computers, how they process information and how individual computers interact with other computing systems and devices.		
CO3	Understand an operating system and its working, and solve common problems related to operating systems		
CO4	Learn basic word processing, Spreadsheet and Presentation Graphics Software skills.		
CO5	Study to use the Internet safely, legally, and responsibly		

Course Title: Fundamentals of Computer and IT

Course Code: UGCA-1902

UNIT-I

Human Computer Interface: Concepts of Hardware and Software; Data and Information. **Functional Units of Computer System:** CPU, registers, system bus, main memory unit, cache memory, Inside a computer, SMPS, Motherboard, Ports and Interfaces, expansion cards, ribbon cables, memory chips, processors.

Devices: Input and output devices (with connections and practical demo), keyboard, mouse, joystick, scanner, OCR, OMR, bar code reader, web camera, monitor, printer, plotter. **Memory:** Primary, secondary, auxiliary memory, RAM, ROM, cache memory, hard disks, optical disks.

Data Representation: Bit, Byte, Binary, Decimal, Hexadecimal, and Octal Systems, Conversions and Binary Arithmetic (Addition/ Subtraction/ Multiplication) Applications of IT.

UNIT II

Concept of Computing, Types of Languages: Machine, assembly and High-level Language; Operating system as user interface, utility programs.

Word processing: Editing features, formatting features, saving, printing, table handling, page settings, spell-checking, macros, mail-merge, equation editors.

UNIT-III

Spreadsheet: Workbook, worksheets, data types, operators, cell formats, freeze panes, editing features, formatting features, creating formulas, using formulas, cell references, replication, sorting, filtering, functions, Charts & Graphs.

Presentation Graphics Software: Templates, views, formatting slide, slides with graphs, animation, using special features, presenting slide shows.

UNIT-IV

Electronic Payment System: Secure Electronic Transaction, Types of Payment System: Digital Cash, Electronic Cheque, Smart Card, Credit/Debit Card E-Money, Bit Coins and Crypto currency, Electronic Fund Transfer (EFT), Unified Payment Interface (UPI), Immediate Payment System (IMPS), Digital Signature and Certification Authority. Introduction to Bluetooth, Cloud Computing, Big Data, Data Mining, Mobile Computing and Embedded Systems and Internet of Things (IoT)

RECOMMENDED BOOKS:

1. Introduction to Information Technology, ITL Education Solutions limited, Pearson Education.
2. A. Goel, Computer Fundamentals, Pearson Education, 2010.
3. P. K. Sinha & P. Sinha, Fundamentals of Computers, BPB Publishers, 2007.
4. R.K. Jain, IT Tools, Khanna Publishing House.
5. Satish Jain, Ambrish Rai & Shashi Singh, Introduction to Information Technology, Paperback Edition, BPB Publications, 2014.
6. www.sakshat.ac.in
7. https://swayam.gov.in/course/4067-computer-fundamentals

UGCA-1906	**Fundamentals of Computer and IT Laboratory**	**L-0, T-0, P-4**	**2 Credits**
Pre-requisite (If any): NA			
CO1	Familiarizing with Open Office (Word processing, Spreadsheets and Presentation).		
CO2	To acquire knowledge on editor, spread sheet and presentation software.		
CO3	The students will be able to perform documentation and accounting operations.		
CO4	Students can learn how to perform presentation skills.		

Course Title: Fundamentals of Computer and IT (Laboratory)

Course Code: UGCA-1906

List of experiments:

- **Word Orientation:** The instructor needs to give an overview of word processor. Details of the four tasks and features that would be covered Using word – Accessing, overview of toolbars, saving files, Using help and resources, rulers, format painter.

    1) Using word to create Resume:
    Features to be covered: Formatting Fonts in word, Drop Cap in word, Applying Text effects, Using Character Spacing, Borders and Colors, Inserting Header and Footer, Using Date and Time option in Word.
    2) Creating an Assignment
    Features to be covered: Formatting Styles, inserting table, Bullets and Numbering, Changing Text Direction, Cell alignment, Footnote, Hyperlink, Symbols, Spell Check, Track Changes.
    3) Creating a Newsletter
    Features to be covered: Table of Content, Newspaper columns, Images from files and clipart, Drawing toolbar and Word Art, Formatting Images, Textboxes and Paragraphs
    4) Creating a Feedback form
    Features to be covered: Forms, Text Fields, Inserting objects, Mail Merge in Word.

- **Excel Orientation:** The instructor needs to tell the importance of Excel as a Spreadsheet tool, give the details of the four tasks and features that would be covered Excel - Accessing, overview of toolbars, saving excel files.

    1) Creating a Scheduler
    Features to be covered: Gridlines, Format Cells, Summation, auto fill, Formatting Text
    2) Creating an Assignment
    Features to be covered: Formatting Styles, inserting table, Bullets and Numbering, Changing Text Direction, Cell alignment, Footnote, Hyperlink, Symbols, Spell Check, Track Changes.
    3) Creating a Newsletter
    Features to be covered: Table of Content, Newspaper columns, Images from files and clipart, Drawing toolbar and Word Art, Formatting Images, Textboxes and Paragraphs

4) Creating a Feedback form
   Features to be covered: Forms, Text Fields, Inserting objects, Mail Merge in Word.

- **Presentation Orientation:**
  1) Students will be working on basic power point utilities and tools which help them create basic power point presentation.
     Topic covered includes: PPT Orientation, Slide Layouts, Inserting Text, Word Art, Formatting Text, Bullets and Numbering, Auto Shapes, Lines and Arrows
  2) This session helps students in making their presentations interactive.
     Topics covered include: Hyperlinks, Inserting–Images, ClipArt, Audio, Video, Objects, Tables and Charts
  3) Concentrating on the in and out of Microsoft power point. Helps them learn best practices in designing and preparing power point presentation.
     Topics covered includes: Master Layouts (slide, template, and notes), Types of views (basic, presentation, slide slotter, notes, etc), Inserting – Background, textures, Design Templates, Hidden slides, Auto content wizard, Slide Transition, Custom
  4) Animation, Auto Rehearsing
  5) Power point test would be conducted. Students will be given model power point presentation which needs to be replicated

- **Internet and its Applications:** The instructor needs to tell the how to configure Web Browser and to use search engines by defining search criteria using Search Engines
  1) To learn to setup an e-mail account and send and receive e-mails.
  2) Tolearntosubscribe/postonablogandtousetorrentsforacceleratedddownloads.
  3) Hands on experience in online banking and making an online payment for any domestic bill.

RECOMMENDED BOOKS:

1. R.K. Jain, IT Tools, Khanna Publishing House.
2. Introduction to Information Technology, ITL Education Solutions limited, Pearson Education.
3. Turban, Rainer and Potter, Introduction to information technology, John Wiley and Sons.
4. Joseph Brady & Ellen F Monk, Problem Solving Cases in Microsoft Excel, Thomson Learning.

SEMESTER-II

BSHM-201-22	**Real Analysis**	**L-5, T-1, P-0**	**6 Credits**

Pre-requisite: Elementary calculus

Course Objectives: The objectives of this course are to make the students understand the fundamental concepts of Real line and its property. Students will understand the bounded, unbounded and limit suprema and infima. They will use monotone convergence theorem for the calculation of square roots.They observe theconvergent and divergent sequences.They can apply various teststo check the convergence or divergence of sequences and series.

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

CO1	Understand the basic concepts of Real line and its property.
CO2	Understand the bounded, unbounded and limit suprema and infima.
CO3	Use of monotone convergence theorem for the calculation of square roots.
CO4	Check the convergence and divergence sequences and infinite series.
CO5	Apply the knowledge of various test to establish the convergence and divergence sequences and infinite series.

Mapping of course outcomes with the program outcomes

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO1	✓	✓	-	-	✓
CO2	✓	✓	-	-	✓
CO3	✓	✓	-	-	✓
CO4	✓	✓	-	-	✓
CO5	✓	✓	-	-	✓

Course Title: Real Analysis
Course Code: BSHM-201-22

UNIT-I

Real Numbers: Field and order structure of R, Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets, Supremum and Infimum.

UNIT-II

Completeness of $\mathbb{R}$: Completeness Property of R, The Archimedean Property, Density of Rational (and Irrational) numbers in R, Intervals. Limit points of a set, Isolated points, Closed sets, Countable and Uncountable sets.

UNIT-III

Sequences: Sequences, Limit points of a sequence, Limit Inferior and Superior, Convergent Sequences, Non convergent sequences (Definitions), Cauchy's sequence, Cauchy's General Principle of Convergence, Algebra of sequences, Some Important Theorem, [Ref. Text Book 1], Monotonic sequences.

UNIT-IV

Infinite Series: Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Tests for convergence: Comparison test, D'Alembert's Ratio Test, Rabb's. Gauss and Logrithmic test (Statement of these three tests only). Cauchy's Root test, Integral test, Alternating series, Leibniz test, Absolute and Conditional convergence.

TEXT BOOKS:

1. S. C. Malik and Savita Arora, Mathematical Analysis, New Age International (P) Ltd., New Delhi, 2017.

RECOMMENDED BOOKS:

1. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2. Gerald G. Bilodeau, Paul R. Thie, G.E. Keough, An Introduction to Analysis, 2nd Ed., Jones & Bartlett, 2010.
3. Brian S. Thomson, Andrew. M. Bruckner and Judith B. Bruckner, Elementary Real Analysis, Prentice Hall, 2001.
4. S.K. Berberian, A First Course in Real Analysis, Springer Verlag, New York, 1994.

BSHM-202-22	Differential Equations	L-4, T-0, P-0	4 Credits

Pre-requisite: - Functions, Differentiation, Integration.

Course Objectives: The Objective of this course is to introduce ordinary differential equations and basic theory ofexistence and uniqueness of solutions. This course further explains the analytic techniques incomputing the solutions of various ordinary differential equations appearing in various fields ofscience and technology.

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

CO1	Understand the basic definitions to know about ordinary differential equations, its various types and their solutions.
CO2	Visualize the geometrical meaning of first order differential equation.
CO3	Understand the fundamental concepts about existence and uniqueness of solution ofinitial value problem.
CO4	Understand the applications of differential equations in different type of Phenomenon.
CO5	Apply power series method to obtain series solutions of differential equations.

Mapping of course outcomes with the program outcomes

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	✓	✓	-	-	✓
CO2	✓	✓	-	-	✓
CO3	✓	✓	-	-	✓
CO4	✓	✓	-	-	✓
CO5	✓	✓	-	-	✓

Course Title: Differential Equations

Course Code: BSHM-202-22

Unit I

Differential equations: General, particular, explicit, implicit and singular solutions of a differential equation. Exact differential equations and integrating factors, separable equations and equations reducible to this form, Cauchy's linear equation and Bernoulli equations.

Unit II

Mathematical models (Linear Models): Introduction to compartmental model, exponential decay model, lake pollution model (case study of Lake Burley Griffin), drug assimilation into the blood (case of a single cold pill, case of a course of cold pills), exponential growth of population, limited growth of population, limited growth with harvesting.

Unit III

Higher Order Linear Differential Equations: General solution of homogeneous equation of second order, principle of super position for homogeneous equation, Wronskian: its properties and applications, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation, method of undetermined coefficients, method of variation of parameters.

Unit IV

Mathematical Models (Non-linear Models): Equilibrium points, Interpretation of the phase plane, predatory-prey model and its analysis, epidemic model of influenza and its analysis, battle model and its analysis.

TEXT BOOKS:

1. J. N. Kapur,, Mathematical Modelling, 1st Ed., New Age International (P) Ltd.,, New Delhi, 2021.
2. Shanti Narayan, Differential Equations and it's Applications,

RECOMMENDED BOOKS:

1. Belinda Barnes and Glenn R. Fulford, Mathematical Modeling with Case Studies, A Differential Equation Approach using Maple and MATLAB, 2nd Ed., Taylor and Francis group, London and New York, 2009.
2. C.H. Edwards and D.E. Penny, Differential Equations and Boundary Value problems Computing and Modeling, Pearson Education India, 2005.
3. S.L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, India, 2004.

BSHM-203-22	**Programming Lab-II**	**L-0, T-0, P-4**	**2 Credits**

Pre-requisite: Knowledge of basic concepts in Differential equations and Real analysis, such as, ODE, Order, Degree, Linear Differential Equations, sequence, series, limit point, convergence, divergence, etc.

Course Objectives: This course is designed to introduce the basic knowledge of computer programming to simple differential equations and to visualize the convergence and divergence of sequences and series. The major focus of this course will be on understanding the mathematical models behind a real-life situation.

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

CO1	Explain the basic concepts of MATLAB and Mathematica.
CO2	Apply the knowledge of programming in different Differential equations.
CO3	Use programming in plotting the solution and visualization of growth and decay mathematical models.
CO4	Plotting the recursive sequences and study the convergence of sequences through plotting.
CO5	Study the convergence/divergence of infinite series

Mapping of course outcomes with the program outcomes

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO1	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓

Course Title: Programming Lab-II

Course Code: BSHM-203-22

The following topics to be practiced using any software:

vii) Introduce the programming through MATLAB and MATHEMATICA
viii) Plotting of second order solution family of differential equation.
ix) Plotting of third order solution family of differential equation.
x) Growth model (exponential case only).
xi) Decay model (exponential case only).
xii) Plotting of recursive sequences.
xiii) Study the convergence of sequences through plotting.
xiv) Verify Bolzano-Weierstrass theorem through plotting of sequences and hence identify convergent subsequences from the plot.
xv) Study the convergence/divergence of infinite series by plotting their sequences of partial sum.
xvi) Cauchy's root test by plotting nth roots.
xvii) Ratio test by plotting the ratio of nth and (n+1)th term.

RECOMMENDED BOOKS:

1. Gilat, A., MATLAB: An Introduction with Applications, 5th Edition. John Wiley & Sons, 2014.
2. Martha L Abell, James P Braselton, Differential Equations with MATHEMATICA, 3rd Ed., Elsevier Academic Press, 2004.

ਪੰਜਾਬੀ ਲਾਜ਼ਮੀ

BHHL-116A-22

ਬੈਚੂਲਰ ਆਫ ਸਾਇੰਸ

(ਸਲੇਬਸ) ਸਮੈਸਟਰ -ਦੂਜਾ

Credit-2-0-0

ਯੂਨਿਟ-1

ਕਵਿਤਾ ਭਾਗ:

ਭਾਈ ਵੀਰ ਸਿੰਘ: ਚਸ਼ਮਾ

ਪ੍ਰੋ.ਪੂਰਨ ਸਿੰਘ : ਹੱਲ ਵਾਹੁਣ ਵਾਲੇ

ਪ੍ਰੋ.ਮੋਹਨ ਸਿੰਘ : ਕੋਈ ਆਇਆ ਸਾਡੇ ਵਿਹੜੇ

ਅੰਮ੍ਰਿਤਾ ਪ੍ਰੀਤਮ: ਅੰਨਦਾਤਾ

ਡਾ.ਹਰਿਭਜਨ ਸਿੰਘ: ਤੇਰੇ ਹਜ਼ੂਰ ਮੇਰੀ ਹਾਜ਼ਰੀ ਦੀ ਦਾਸਤਾਨ

ਸ਼ਿਵ ਕੁਮਾਰ ਬਟਾਲਵੀ: ਕੰਡਿਆਲੀ ਥੋਰ੍ਹ

ਪਾਸ਼: ਇਨਕਾਰ

ਸੁਰਜੀਤ ਪਾਤਰ: ਹੁਣ ਘਰਾਂ ਨੂੰ ਪਰਤਣਾ

ਕਹਾਣੀ ਭਾਗ:

ਸੁਜਾਨ ਸਿੰਘ :ਕੁਲਫੀ

ਕੁਲਵੰਤ ਸਿੰਘ ਵਿਰਕ : ਤੂੜੀ ਦੀ ਪੰਡ

ਗੁਰਦਿਆਲ ਸਿੰਘ : ਸਾਂਝ

ਸੰਤੋਖ ਸਿੰਘ ਧੀਰ: ਕੋਈ ਇਕ ਸਵਾਰ

ਮੋਹਨ ਭੰਡਾਰੀ :ਘੋਟਣਾ

ਵਰਿਆਮ ਸਿੰਘ ਸੰਧੂ : ਆਪਣਾ ਆਪਣਾ ਹਿੱਸਾ

ਯੂਨਿਟ-2 (ਭਾਸ਼ਾ ਤੇ ਲਿਪੀ)

ਭਾਸ਼ਾ ਦਾ ਟਕਸਾਲੀ ਰੂਪ, ਭਾਸ਼ਾ ਤੇ ਉਪ-ਭਾਸ਼ਾ ਵਿਚ ਅੰਤਰ, ਪੰਜਾਬੀ ਦੀਆਂ ਉਪ-ਭਾਸ਼ਾਵਾਂ

ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਉਪਰ ਪਏ ਪ੍ਰਭਾਵ

ਭਾਸ਼ਾ ਤੇ ਲਿਪੀ, ਗੁਰਮੁਖੀ ਲਿਪੀ ਦੀਆਂ ਵਿਸ਼ੇਸ਼ਤਾਵਾਂ

ਯੂਨਿਟ-3 (ਲੇਖਣੀ-ਕਲਾ)

ਪੈਰ੍ਹਾ ਰਚਨਾ

ਅਨੁਵਾਦ: ਅੰਗਰੇਜ਼ੀ ਤੋਂ ਪੰਜਾਬੀ, ਪੰਜਾਬੀ ਤੋਂ ਅੰਗਰੇਜ਼ੀ

ਦਫਤਰੀ ਚਿੱਠੀ ਪੱਤਰ

ਸਾਹਿਤ ਦੇ ਰੰਗ (ਸੰਪ.ਡਾ.ਮਹਿਲ ਸਿੰਘ),ਰਵੀ ਸਾਹਿਤ ਪ੍ਰਕਾਸ਼ਨ, ਅੰਮ੍ਰਿਤਸਰ,ਪਹਿਲੀ ਵਾਰ, 2016.

ਮੁਢਲੀ ਪੰਜਾਬੀ

BHHL-116B-22

ਬੈਚੂਲਰ ਆਫ ਸਾਇੰਸ

(ਸਲੇਬਸ) ਸਮੈਸਟਰ -ਦੂਜਾ

Credit-2-0-0

ਯੂਨਿਟ-1

ਪੈਂਤੀ ਅੱਖਰੀ (ਵਰਣਮਾਲਾ), ਅੱਖਰ ਕ੍ਰਮ

ਮਾਤਰਾਵਾਂ : ਮੁਢਲੀ ਜਾਣ-ਪਛਾਣ

ਲਗਾਖਰ :ਬਿੰਦੀ, ਟਿੱਪੀ, ਅੱਧਕ

ਪੰਜਾਬੀ ਸ਼ਬਦ ਬਣਤਰ: ਮੁਢਲੀ ਜਾਣ-ਪਛਾਣ

ਮੂਲ ਸ਼ਬਦ , ਅਗੇਤਰ, ਪਿਛੇਤਰ

ਸਮਾਨਾਰਥਕ ਸ਼ਬਦ, ਵਿਰੋਧਾਰਥਕ ਸ਼ਬਦ

ਸ਼ੁੱਧ- ਅਸ਼ੁੱਧ: ਦਿੱਤੇ ਪੈਰ੍ਹੇ ਵਿੱਚੋਂ ਅਸ਼ੁੱਧ ਸ਼ਬਦ ਨੂੰ ਸ਼ੁੱਧ ਕਰਨਾ

ਯੂਨਿਟ-2

ਹਫਤੇ ਦੇ ਸੱਤ ਦਿਨਾਂ ਦੇ ਨਾਂ

ਬਾਰ੍ਹਾਂ ਮਹੀਨਿਆਂ ਦੇ ਨਾਂ

ਰੁੱਤਾਂ ਦੇ ਨਾਂ

ਇਕ ਸੌ ਤੱਕ ਗਿਣਤੀ ਸ਼ਬਦਾਂ ਵਿਚ

ਰੋਜ਼ਾਨਾ ਵਰਤੋਂ ਦੀ ਪੰਜਾਬੀ ਸ਼ਬਦਾਵਲੀ:

ਬਾਜ਼ਾਰ, ਵਪਾਰ,ਰਿਸ਼ਤੇ-ਨਾਤੇ ਤੇ ਕਿੱਤਿਆਂ ਸਬੰਧੀ।

ਯੂਨਿਟ-3

ਸ਼ਬਦ ਸ਼੍ਰੇਣੀਆਂ : ਪਛਾਣ ਤੇ ਵਰਤੋਂ-

ਨਾਂਵ, ਪੜਨਾਂਵ, ਵਿਸ਼ੇਸ਼ਣ, ਕਿਰਿਆ, ਕਿਰਿਆ ਵਿਸ਼ੇਸ਼ਣ

ਪੰਜਾਬੀ ਵਾਕ ਬਣਤਰ :

ਸਧਾਰਣ ਵਾਕ

ਸੰਯੁਕਤ ਵਾਕ

ਮਿਸ਼ਰਤ ਵਾਕ

BHIC-111-22	**CHEMISTRY-I**	L-3, T-1, P-0	**Credits:4**

Prerequisite: Subject knowledge of senior secondary level

Objective(s):	1. To teach the fundamental concepts of Inorganic Chemistry and chemical bonding. 2. To teach the basic principles, chemical reaction and reaction mechanisms of organic compounds.

At the end of the course, the student will be able to

CO1. Understand the fundamental concepts and postulates of various theories regarding the structure of atom

CO2. Learn about the various theories pertaining to the different types of bonding

CO3. Understand the fundamental concepts of organic chemistry i.e structure, bonding and various effects in organic compounds

CO4. To study the various known reactive intermediate in organic synthesis

CO5. To learn the fundamental and advanced concepts of reaction mechanisms along with the study of reaction mechanisms in various types of substitution addition and elimination reactions

Mapping of course outcomes with the program outcomes

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	✓	-	-	✓	✓
CO2	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓
CO4	-	✓	✓	✓	✓
CO5	-	✓	✓	✓	✓

Course Title: Chemistry-I
Course Code: BHIC-111-22

Unit-I

Atomic Structure: Bohr's theory and its limitations and atomic spectrum of hydrogen atom. Wave mechanics: deBroglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and $\psi 2$. Quantum numbers and their significance. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of *s, p, d* and *f* orbitals. Contour boundary and probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations.

Chemical Bonding-I: 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.

Unit-II

Chemical Bonding-II: Covalent bond: Lewis structure, Valence Bond theory (Heitler London approach), Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization. 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.

Unit-III

Basics of Organic Chemistry Organic Compounds:
Classification, and Nomenclature, Hybridization, Influence of hybridization on bond properties. Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyper conjugation and their applications; Dipole moment; Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes.

Chemistry of Aliphatic Hydrocarbons-I:
Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

Unit-IV

Chemistry of Aliphatic Hydrocarbons-II:
Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations. Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroborationoxidation, ozonolysis, reduction (catalytic and chemical).

Aromatic Hydrocarbons 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.

Reference Books

1 Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
2 Cotton, F.A. & Wilkinson, G. Advanced Inorganic Chemistry, Wiley, VCH, 1999
3 Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry 3rd Ed., John Wiley Sons, N.Y. 1994
4 Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5 Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)

BHIC-112-22	**Chemistry Lab-I**	L-0, T-0, P-4	Credits: 02
Pre-requisite: Understanding of senior secondary level Chemistry			
Course Objectives: The objective of this course is to provide practical knowledge and illustrative experiments about various types of inorganic titrations and general organic techniques			
Course Outcomes: At the end of the course, the students will be able to			
CO1	Learn the quantitative analysis of various metal ions/cations and anions.		
CO2	Understand the various principles of different techniques involved in the quantitative analysis.		
CO3	Learn the basic qualitative techniques		
CO4	Learn chromatographic techniques for the identification and separation of compounds		
CO5	Learn about the applications of basic techniques		

Mapping of course outcomes with the program outcomes

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓

Course Title: Chemistry Lab-I
Course Code: BHIC-112-22

Part-I

(A) Acid-Base Titrations

(i) Estimation of carbonate and hydroxide present together in mixture.
(ii) Estimation of carbonate and bicarbonate present together in a mixture.
(iii) Estimation of free alkali present in different soaps/detergents

(B) **Oxidation-Reduction Titrations**

(i) Estimation of Fe(II) and oxalic acid using standardized $KMnO_4$ solution.
(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.
(iii) Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator.

Part-II

(i) Checking the calibration of the thermometer
(ii) Purification of organic compounds by crystallization using the following solvents: a) Water b) Alcohol, and c) Alcohol-Water.
(iii) Determination of the melting points of above compounds and unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus)
(iv) Effect of impurities on the melting point – mixed melting point of two unknown organic compounds
(v) Determination of boiling point of liquid compounds. (boiling point lower than and more than 100°C by distillation and capillary method)
(vi) Chromatography a) Separation of a mixture of two amino acids by ascending and horizontal paper chromatography b) Separation of a mixture of two sugars by ascending paper chromatography, c) Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC)

Reference Books:

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.
2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).
3. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012).

BBA-GE 201-18	**Managerial Economics II**	**L-5, T-1, P-0**	**6 Credits**

Pre-requisite: Understanding of basic knowledge of Managerial Economics

Course Objectives: This course aims to acquaint students with economy as a whole including measurement of national income, inflation and unemployment, which an objective to inculcate understanding of macroeconomic environment of an economy for better decision making.

Course Outcomes: After completion of the course, the students shall be able to:

CO1	Explain the concept of national income and its measurement using different approaches.
CO2	Describe the underlying theories of demand and supply of money in an economy.
CO3	Make use of employment and national income statistics students will be able to describe and analyze the economy in quantitative terms.
CO4	Interpret macroeconomic issues like money, inflation and unemployment.
CO5	Identify the phases of the business cycle and the problems caused by cyclical fluctuations in the market economy

Mapping of course outcomes with the program outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	-	✓	-	-	✓
CO2	-	✓	-	-	✓
CO3	-	✓	-	-	✓
CO4	-	✓	-	-	✓
CO5	-	✓	-	-	✓

Course Title: Managerial Economics II

Course Code: BBAGE 201-18

UNIT-I

National Income: Measuring National Income. Problems in the measurement of National Income. Theories of Money: Nature and functions of money – Types of money: Near money, inside money and outside money. Theories of demand for money – defining demand for money – Classical theories of demand for money – Friedman's re-statement of Quantity Theory of

Money; Liquidity preference theory and Keynesian Liquidity Trap. Theories of Supply of money; Defining supply of money; Measuring supply of money.

UNIT-II

Theories of Inflation and Unemployment: Meaning, Types and Theories of Inflation. - Cost of inflation and sacrifice ratio. - Measurement of Inflation in India - Policies to control inflation Meaning and types of unemployment. - Cost of unemployment and Oakun's Law Measurement of unemployment in India. - Concept of Stagflation - Concept of Philips Curve.

Unit-III

Business cycle: Meaning, types and phases. Monetary, Fiscal and Income policy – Meaning and instruments. Multiplier: Concept, Features and Leakages. Foreign trade multiplier.

Unit-IV

Macro-economic Framework in Indian Economy–Public Finance–Tax system in India– Financial Administration: Finance Commission.

RECOMMENDED BOOKS:

1. Ahuja, H.L.(2015) Macroeconomics-Theory and Policy. New Delhi: Sultan Chand.

2. Jhingan, M.L. (2016) Macro Economic Theory. Delhi: Vrinda Publications Pvt. Ltd

3. Dwivedi, D.N.(2017)Macroeconomics: Theory and Practice: Theory & Practice. New Delhi: McGraw Hill.

4. Jain, T.R., Khanna, O.P.(2014) Managerial Economics: V.K. Publications

5. Dewett, K.K., Navalur, M.H., (2006) Modern Economic Theory: New Delhi: Sultan Chand.

SEMESTER-III

BSHM-301-22	**Theory of Real Functions**	**L-5, T-1, P-0**	**6 Credits**

Pre-requisite: Sequences and Series

Course Objectives: The objectives of this course are to:

1. Introduce basic concepts of theory of real functions from theoretical point of view and also to explore important applications.
2. Develop analytical and computational skills of students.
3. Introduce sequential criterion for limits and continuity.
4. Discuss derivative and its applications.
5. Introduce Taylor's theorem with its different forms of remainder and also to explore its various applications.
6. Introduce Fourier series representation of certain functions.

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

CO1	Deal with the basic concepts of real analysis rigorously.
CO2	Use the concepts of limit, continuity and derivative in different fields of study.
CO3	Apply Taylor series in approximating functions, deal with certain inequalities and convex function.
CO4	Understand different forms of remainder term of Taylor series and also to utilize these remainder terms to assess the error in approximations.
CO5	Expand certain functions in terms of Fourier series.

Mapping of course outcomes with the program outcomes

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO1	✓	✓	-	-	✓
CO2	✓	✓	-	-	✓
CO3	✓	✓	-	-	✓
CO4	✓	✓	-	-	✓
CO5	✓	✓	-	-	✓

Course Title: Theory of Real Functions
Course Code: BSHM-301-22

UNIT-I

Limits of functions ($\epsilon - \delta$ approach), sequential criterion for limits, divergence criteria. Limit theorems, one sided limits. Infinite limits and limits at infinity. Continuous functions, sequential criterion for continuity, discontinuity criterion. Algebra of continuous functions. Continuous functions on an interval, intermediate value theorem, location of roots theorem, preservation of intervals theorem. (Scope: Section 4.1, 4.2, 4.3, 5.1,5.2, 5.3 of Textbook: Bartle et al. [1]).

UNIT-II

Uniform continuity, non-uniform continuity criteria, uniform continuity theorem, Lipschitz condition, continuous extension theorem, Weierstrass approximation theorem (without proof), Differentiability of a function at a point and in an interval, Caratheodory's theorem, Chain rule, Darboux's theorem. (Scope: Section 5.4.1-5.4.8, 6.1, 6.2.12 of Textbook: Bartle et al. [1]).

UNIT-III

Taylor polynomial, Taylor's theorem, estimate of error in approximating a function, convex function, application of Taylor theorem to inequalities and convex functions. (Scope: Section 6.4.1, 6.4.2,6.4.3, 6.4.5, 6.4.6 of Textbook: Bartle et al. [1]).

Inner product of functions, orthogonal functions, orthogonal set of functions, orthonormal set of functions, periodic functions, piecewise continuous function, even and odd functions. (Scope: Section 12.1 of Textbook: Zill [2]).

UNIT-IV

Trigonometric series, Fourier series, sufficient conditions for convergence of a Fourier series, sequence of partial sums of Fourier series, Fourier cosine series, Fourier sine series, Gibbs phenomenon, half range expansions. (Scope: Section 12.2,12.3 of Textbook: Zill [2]).

TEXT BOOKS

1. R. Bartle and D.R. Sherbert, Introduction to Real Analysis, John Wiley and Sons, 2003.
2. Dennis G. Zill, Advanced Engineering Mathematics, 6th Edition, Jones and Bartlett

   Publishers, 2016.
3. Shanti Narayan, M. D. Raisinghania, Elements of Real Analysis, 14th Revised Edition, S. Chand & Company LTD, New Delhi, 2013.

RECOMMENDED BOOKS:

1. K.A. Ross, Elementary Analysis: The Theory of Calculus, Springer, 2004.
2. A. Mattuck, Introduction to Analysis, Prentice Hall, 1999.
3. S.R. Ghorpade and B.V. Limaye, A Course in Calculus and Real Analysis, Springer, 2006.

BSHM-302-22	**Group Theory I**	**L-5, T-1, P-0**	**6 Credits**
Pre-requisite: Set Theory			
Course Objectives: The main aim of the course is to introduce the students to basic concepts from abstract algebra, especially the notion of a group. The course will help prepare you for further study in abstract algebra as well as familiarize you with tools essential in many other areas of mathematics. The other aim of this course is to provide the learner with the skills, knowledge and competencies to carry out their duties and responsibilities in a pure Mathematical environment.			
Course Outcomes: At the end of the course, the students will be able to			
CO1	learn the basic concepts like groups, subgroups, cyclic groups, normal subgroups, homomorphisms, etc.		
CO2	learn about binary operations on algebraic structures which are quite significant in modern mathematics.		
CO3	understand the theorems of group isomorphisms and isomorphisms.		
CO4	be acquainted with prerequisite knowledge required to learn advanced algebra.		
CO5	apply the learnt techniques in modern algebra.		

Mapping of course outcomes with the program outcomes

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO1	✓	✓	-	-	✓
CO2	✓	✓	-	-	✓
CO3	✓	✓	-	-	✓
CO4	✓	✓	-	-	✓
CO5	✓	✓	-	-	✓

Course Title: Group Theory I
Course Code: BSHM-302-22

UNIT-I

Groups: Symmetries of a square, Dihedral groups, definition and examples of groups including permutation groups and quaternion groups (illustration through matrices), elementary properties of groups.

UNIT-II

Subgroups: Subgroups and examples of subgroups, properties of subgroups, centralizer, center of a group, product of two subgroups, inverse of a subset of a group.

Cosets: Properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem, Euler's ϕ-function.

UNIT-III

Cyclic groups: Properties of cyclic groups, subgroups of cyclic groups, generators of cyclic group, important theorem on cyclic groups.

Normal Subgroups: Normal subgroups and their properties, examples of normal subgroups, product of two normal subgroups, normalizer of a subset of a group, quotient groups.

UNIT-IV

Group homomorphisms: Properties of homomorphisms, Cayley's theorem, properties of isomorphisms, First, Second and Third isomorphism theorems.

Text Book:

1. V. Khanna and S.K. Bhambari, Abstract Algebra, 5th Ed., Vikas Publishing House, New Delhi, 2016.

Books Recommended:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
3. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, New Delhi, 1999.
4. Joseph J. Rotman, An Introduction to the Theory of Groups, 4th Ed., Springer Verlag, 1995.
5. I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.

BSHM-303-22	**Multivariable Calculus**	**L-5, T-1, P-0**	**6 Credits**

Pre-requisite: Sets, Binary operations

Course Objectives: The main aim of the course is to introduce the students to the basic concepts of several variable functions, limit, continuity, differentiability, partial derivatives, gradient, divergence, curl, multiple integrals. They will be able to apply the acquired knowledge to find center of mass, volume of solids, areas of surfaces etc.

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

CO1	learn the basic concepts like several variable functions, limit continuity, differentiability, partial derivatives, etc.
CO2	learn about Lagrange multiplier method.
CO3	understand the concept of the directional derivatives, curl, divergence, gradient, etc.
CO4	be acquainted with the properties of multiple integrals, change of coordinates to polar coordinates.
CO5	apply the learnt techniques to find center of mass, volume of solids, areas of surfaces, etc

Mapping of course outcomes with the program outcomes

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO1	✓	✓	-	-	✓
CO2	✓	✓	-	-	✓
CO3	✓	✓	-	-	✓
CO4	✓	✓	-	-	✓
CO5	✓	✓	-	-	✓

Use of Scientific calculator is allowed.

Course Title: Multivariable Calculus
Course Code: BSHM-303-22

UNIT-I

Functions of several variables, limit and continuity of functions of two variables Partial differentiation, total differentiability and differentiability, sufficient condition for differentiability. Chain rule for one and two independent parameters, Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems.

UNIT-II

Double integration over rectangular region, double integration over non-rectangular region, double integrals in polar co-ordinates, Triple integrals, Triple integral over a parallelepiped and solid regions. Volume by triple integrals, cylindrical and spherical co-ordinates, change of variables in double integrals and triple integrals.

UNIT-III

Definition of vector field, divergence and curl, directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes, line integrals, applications of line integrals.

UNIT-IV

Green's theorem, Stoke's theorem, Divergence theorem, their applications.

Books Recommended

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus*, 3rd Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007.
3. E. Marsden, A.J. Tromba and A. Weinstein, *Basic Multivariable Calculus*, Springer (SIE), Indian reprint, 2005.
4. James Stewart, *Multivariable Calculus, Concepts and Contexts*, 2nd Ed., Brooks /Cole, Thomson Learning, USA, 2001.

BSHM-304-22	**Logic and Sets**	**L-2, T-0, P-0**	**2 Credits**

Pre-requisite: Sets, Binary operations

Course Objectives: The main aim of the course is to introduce the students to basic concepts from sets and logical operations. The course will help prepare the student to understand the relations between sets regarding membership, equality, subset, and proper subset, using proper notation. Perform the operations of union, intersection, complement, and difference on sets using proper notation.

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

CO1	learn the basic concepts like propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, etc.
CO2	learn about Propositional equivalence**,** Logical equivalences, Predicates and quantifiers**,** Binding variables and Negations.
CO3	understand the concept of sets, subsets, set operations and the laws of set theory and Venn diagrams.
CO4	be acquainted with the properties of product set, Composition of relations, Types of relations, Partitions, Equivalence Relations
CO5	apply the learnt techniques in computer algebra.

Mapping of course outcomes with the program outcomes

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO1	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓

Course Title: Logic and Sets
Course Code: BSHM-304-22

UNIT-I

Logic and Sets: Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators. Propositional equivalence**,** Logical equivalences.
Predicates and quantifiers: Introduction, Quantifiers, Binding variables and Negations.

UNIT-II

Sets, subsets, Set operations and the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Standard set operations. Classes of sets. Power set of a set. Difference and Symmetric difference of two sets. Set identities, Generalized union and intersections.
Relation: Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation, Partial ordering relations, n-ary relations.

Books Recommended:

1. R.P. Grimaldi, Discrete Mathematics and Combinatorial Mathematics, Pearson Education, 1998.
2. P.R. Halmos, Naive Set Theory, Springer, 1974. 3. E. Kamke, Theory of Sets, Dover Publishers, 1950.

PHYSICS-C-6	**BSHP-212-21**	**Elements of modern physics**	**L-3, T-1, P-0**	**4 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: The course content covers foundations of modern physics, experiments forming basis of quantum mechanics, Schrodinger equation and applications, uncertainty principle and applications. The topics covered in the course build a foundation of undergraduate physics students to study the advance branches: quantum physics, nuclear physics, particle physics and high energy physics.

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

CO1	Understand the implication of special theory of relativity.
CO2	Understand and explain the differences between classical and quantum mechanics.
CO3	Identify properties of the nucleus and other sub-atomic particles.
CO4	Assess whether a solution to a given problem is physically reasonable and solve Schrodinger equation for simple potentials.
CO5	Describe theories explaining the structure of atoms and the origin of the observed spectra.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PSO5
CO1	-	✓	-	-	✓
CO2	-	✓	-	-	✓
CO3	-	✓	-	-	✓
CO4	-	✓	-	-	✓
CO5	-	✓	-	-	✓

Detailed Syllabus:

PART-A

UNIT -I

Special Theory of Relativity: Michelson-Morley Experiment and its outcome, Postulates of Special Theory of Relativity, Lorentz Transformations. Simultaneity and order of events, Lorentz contraction, Time dilation. Relativistic transformation of velocity, frequency, and wave number. Relativistic addition of velocities. Variation of mass with velocity, Massless Particles, Mass-energy Equivalence. Relativistic Doppler effect, Relativistic Kinematics. Transformation of Energy and Momentum. Energy-Momentum Four Vector. **(10 Lectures)**

UNIT-II

Particle Properties of Waves: Electromagnetic waves, Blackbody Radiation, ultraviolet catastrophe, Rayleigh-Jeans formula, Planck radiation hypothesis, Photoelectric Effect, Compton Scattering, Quantum theory of light: wave and particle nature, X-Rays, X-Ray Diffraction, determination of wavelengths using Compton Effect, Pair-Production. **(10 Lectures)**

PART-B

UNIT-III

Dual Nature of Waves and Particles: Waves of probability, Description of a Waves in general, Group and Phase velocities and relation between them, De Broglie wavelength, wave-particle duality, Matter waves, Davisson-Germer experiment, Two-Slit experiment with electrons, gamma ray microscope thought experiment, Heisenberg uncertainty principle: Derivation and applications- impossibility of a particle following a trajectory, estimating minimum energy of a confined particle; Energy-time uncertainty principle-application to virtual particles and range of interaction.

(10 Lectures)

UNIT-IV

Introduction to Quantum mechanics: Need for Quantum mechanics, Wave description of particles by wave packets, Physical interpretation of a wave function: Born interpretation, probabilities, and normalization time-dependent and time-independent Schrodinger equation for wave function, Solution of stationary-state Schrodinger equation for one dimensional problem: particle in a box. **(10 Lectures)**

Text and Reference Books:

1. 1. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
2. Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
3. Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill.
4. Physics for Scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
5. Modern Physics, G.Kaur and G.R. Pickrell, 2014, McGraw Hill.
6. Quantum Mechanics: Theory & Applications, A.K.Ghatak & S.Lokanathan, 2004, Macmillan.
7. Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning.
8. Theory and Problems of Modern Physics, Schaum's outline, R. Gautreau and W. Savin, 2nd Edn, Tata McGraw-Hill Publishing Co. Ltd.
9. Quantum Physics, Berkeley Physics, Vol.4. E.H.Wichman, 1971, Tata McGraw-Hill Co.
10. Basic ideas and concepts in Nuclear Physics, K.Heyde, 3rd Edn., Institute of Physics Pub.
11. Six Ideas that Shaped Physics: Particle Behave like Waves, T.A.Moore, 2003, McGraw Hill.

PHYSICS-C	**BSHP-213-21**	**PHYSICS LAB-III**	**L-0, T-0, P-4**	**2 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: *The laboratory experiments forming basis of quantum mechanics, photoelectric effect, ionization potential, absorption and emission spectra, diffraction, and tunneling effect.*

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

CO1	Able to verify the theoretical concepts/laws learnt in theory courses.
CO2	Trained in carrying out precise measurements and handling sensitive equipment.
CO3	Understand the methods used for estimating and dealing with experimental uncertainties and systematic "errors".
CO4	Learn to draw conclusions from data and develop skills in experimental design.
CO5	Document a technical report which communicates scientific information in a clear and concise manner.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PSO5
CO1	-	✓	-	-	✓
CO2	-	✓	-	-	✓
CO3	-	✓	-	-	✓
CO4	-	✓	-	-	✓
CO5	-	✓	-	-	✓

Detailed Syllabus:

Note: Students are expected to perform 8-10 experiments from the list taking at least 2-3 from the virtual lab.

List of experiment:

1. Measurement of Planck's constant using black body radiation and photo-detector.
2. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photoelectrons versus frequency of light.
3. To determine work function of material of filament of directly heated vacuum diode.
4. To determine the Planck's constant using LEDs of at least 4 different colours.
5. To determine the wavelength of H-alpha emission line of Hydrogen atom.
6. To determine the ionization potential of mercury.
7. To determine the absorption lines in the rotational spectrum of Iodine vapour.
8. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
9. To setup the Millikan oil drop apparatus and determine the charge of an electron.
10. To show the tunneling effect in tunnel diode using I-V characteristics.
11. To determine (i) wavelength and (ii) angular spread of a laser using plane diffraction grating.
12. Dependence of scattering angle on kinetic energy and impact parameter in Rutherford scattering (mechanical analogue).
13. Measurement of the electrical and thermal conductivity of copper to determine its Lorentz number.
14. To determine energy band gap of a given semiconductor.

Reference Books:

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

UGCA-1914	**Programming in Python**	**L-3, T-1, P-0**	**4 Credits**

Pre-requisite: NA

Course Objectives: The main aim of the course is to introduce the students to basic concepts from Python.

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

CO1	Familiar with Python environment, data types, operators used in Python.
CO2	Compare and contrast Python with other programming languages.
CO3	Learn the use of control structures and numerous native data types with their methods.
CO4	Design user defined functions, modules, and packages and exception handling methods.
CO5	Create and handle files in Python and learn Object Oriented Programming Concepts.

Mapping of course outcomes with the program outcomes

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO1	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓

Course Title: Programming in Python
Course Code: UGCA-1914

UNIT-I

Introduction to Python Programming Language: Programming Language, History and Origin of Python Language, Features of Python, Limitations, Major Applications of Python, Getting, Installing Python, Setting up Path and Environment Variables, Running Python, First Python Program, Python Interactive Help Feature, Python differences from other languages. Python Data Types & Input/Output: Keywords, Identifiers, Python Statement, Indentation, Documentation, Variables, Multiple Assignment, Understanding Data Type, Data Type Conversion, Python Input and Output Functions, Import command. Operators and Expressions: Operators in Python, Expressions, Precedence, Associativity of Operators, Non Associative Operators. (12)

UNIT-II

Control Structures: Decision making statements, Python loops, Python control statements. Python Native Data Types: Numbers, Lists, Tuples, Sets, Dictionary, Functions & Methods of Dictionary, Strings (in detail with their methods and operations). (10)

UNIT-III

Python Functions: Functions, Advantages of Functions, Built-in Functions, User defined functions, Anonymous functions, Pass by value Vs. Pass by Reference, Recursion, Scope and Lifetime of Variables. Python Modules: Module definition, Need of modules, Creating a module, Importing module, Path Searching of a Module, Module Reloading, Standard Modules, Python Packages. (12)

UNIT-IV

Exception Handling: Exceptions, Built-in exceptions, Exception handling, User defined exceptions in Python. File Management in Python: Operations on files (opening, modes, attributes, encoding, closing), read() & write() methods, tell() & seek() methods, renaming & deleting files in Python, directories in Python. (10)

Classes and Objects: The concept of OOPS in Python, Designing classes, Creating objects, Accessing attributes, Editing class attributes, Built-in class attributes, Garbage collection, Destroying objects.

Text Books:

1. Pooja Sharma, Programming in Python, BPB Publications, 2017. 2. R. Nageswara Rao, Core Python Programming, 2nd Edition, Dreamtech.

Recommended Books:

1. Martin C. Brown, Python, The complete Reference, Mc Graw Hill Education.
2. A. Martelli, A. Ravenscroft and S. Holden, Python in a Nutshell, OREILLY.

Course Title: Programming in Python (Laboratory)

Course Code: UGCA-1917

List of Assignments:

1.	Compute sum, subtraction, multiplication, division and exponent of given variables input by the user.
2.	Compute area of following shapes: circle, rectangle, triangle, square, trapezoid and parallelogram.
3.	Compute volume of following 3D shapes: cube, cylinder, cone and sphere.
4.	Compute and print roots of quadratic equation $ax^2+bx+c=0$, where the values of a, b, and c are input by the user.
5.	Print numbers up to N which are not divisible by 3, 6, 9, e.g., 1, 2, 4, 5, 7,…
6.	Write a program to determine whether a triangle is isosceles or not?
7.	Print multiplication table of a number input by the user.
8.	Compute sum of natural numbers from one to n number.
9.	Print Fibonacci series up to n numbers e.g. 0 1 1 2 3 5 8 13…..n
10.	Compute factorial of a given number.
11.	Count occurrence of a digit 5 in a given integer number input by the user.
12.	Print Geometric and Harmonic means of a series input by the user.
13.	Evaluate the following expressions: a. $x-x^2/2!+x^3/3!-x^4/4!+\dots x^n/n!$ b. $x-x^3/3!+x^5/5!-x^7/7!+\dots x^n/n!$
14.	Print all possible combinations of 4, 5, and 6.
15.	Determine prime numbers within a specific range.
16.	Count number of persons of age above 60 and below 90.
17.	Compute transpose of a matrix.
18.	Perform following operations on two matrices. 1) Addition 2) Subtraction 3) Multiplication
19.	Count occurrence of vowels.
20.	Count total number of vowels in a word.

Text Books:

1. Programming in Python, Pooja Sharma, BPB Publications, 2017.
2. Core Python Programming, R. Nageswara Rao, 2nd Ediiton, Dreamtech.

Reference Books:

1. Python, The complete Reference, Martin C. Brown, Mc Graw Hill Education.
2. Python in a Nutshell, A. Martelli, A. Ravenscroft, S. Holden, OREILLY

SEMESTER-IV

BSHM-401-22	**Numerical Methods**	**L-4, T-0, P-0**	**4 Credits**

Pre-requisite: Differential and Integral Calculus

Course Objectives: The objectives of this course are to:

1. Introduce numerical methods for solving continuous problems which are difficult to deal with analytically.
2. Develop analytical and computational skills of students.
3. Introduce methods to deal with nonlinear equations, system of linear algebraic equations.
4. Introduce methods for constructing interpolating polynomials.
5. Introduce methods to deal with numerical differentiation, numerical integration and ordinary differential equations.
6. Develop understating of computational mathematics and also to demonstrate its importance in science and engineering.

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

CO1	Find approximate numerical solutions of nonlinear equations and system of linear algebraic equations.
CO2	Develop and use interpolating polynomials when explicit form of the function of interest is not known or complicated to deal with.
CO3	Deal with differentiation and definite integral problems approximately when it is difficult to get exact evaluation of these.
CO4	Apply the numerical methods for solving ordinary differential equations when it is difficult to deal with them analytically.
CO5	Apply the understanding of computational techniques in dealing with real world problems occurring in science and engineering.

Mapping of course outcomes with the program outcomes

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO1	✓	✓	-	-	✓
CO2	✓	✓	-	-	✓
CO3	✓	✓	-	-	✓
CO4	✓	✓	-	-	✓
CO5	✓	✓	-	-	✓

Course Title: Numerical Methods
Course Code: BSHM-401-22

UNIT-I

Computer representation of numbers, scientific notation, accuracy of numbers, errors and its different types, estimation of errors, propagation of errors, the concepts of stability and condition number. Algorithms and convergence.

Polynomial and transcendental equations: Bisection method, Newton-Raphson's method, Secant method, Regula-Falsi method, General iteration method, Rate of convergence.

UNIT-II

System of linear algebraic equations, Gaussian elimination method, Gauss-Jordan method. Iterative methods: Gauss Jacobi method, Gauss-Seidel method and their convergence analysis.

Interpolation, Lagrange interpolation, Newton's divided difference interpolation, Gregory-Newton's forward and Gregory-Newton's backward difference interpolation formulas, Error in interpolation.

UNIT-III

Numerical differentiation: methods based on finite differences. Numerical integration: Midpoint rule, Trapezoidal rule, Simpson's rule, Simpson's $\frac{3}{8}$-rule, Boole's rule, composite Trapezoidal rule, composite Simpson's rule.

UNIT-IV

Ordinary differential equations, Taylor series method, Euler's methods, Runge-Kutta methods, linear multi-step methods: Adams-Bashforth methods, Adams-Moulton methods and Milne-Simpson's method.

TEXT BOOKS

1. M. K. Jain. S. R.K. Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering Computation, 7th Ed., 2019.
2. Richard L. Burden and J. Douglas Faires, Numerical Analysis, 9th Edition, Cengage Learning, 2012.

RECOMMENDED BOOKS:

1. Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, 2007.
2. K. E. Atkinson, An Introduction to Numerical Analysis, 2nd Ed., Wiley, 1989.
3. C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 2008.
4. Uri M. Ascher and Chen Greif, A First Course in Numerical Methods, 7th Ed., PHI Learning Private Limited, 2013.
5. John H. Mathews and Kurtis D. Fink, Numerical Methods using Matlab, 4th Ed., PHI Learning Private Limited, 2012.

BSHM-402-22	**Riemann Integration and Series of Functions**	**L-5, T-1, P-0**	**6 Credits**

Pre-requisite: Functions, limit, continuity, differentiability, integrability, sequence and series

Course Objectives: The objectives of this course are to make the students understand the following:

1. Riemann integration and their basic properties, Fundamental theorems of Calculus.
2. Pointwise and uniform convergence of sequence of functions
3. Series and infinite series of functions.
4. Tests for uniform convergence of a series.

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

CO1	Define Riemann Stieltjes integral and illustrate the properties of integration and differentiation
CO2	Acquire the knowledge of sequence and series.
CO3	Have the knowledge of uniformly convergence of series by different Test.
CO4	Apply the differentiation to find out the maximum and minimum value of functions.
CO5	To understand the statement and prove of important theorems.

Mapping of course outcomes with the program outcomes

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO1	✓	✓	-	-	✓
CO2	✓	✓	-	-	✓
CO3	✓	✓	-	-	✓
CO4	✓	✓	-	-	✓
CO5	✓	✓	-	-	✓

Course Title: Riemann Integration and Series of Functions
Course Code: BSHM-402-22

UNIT-I

Riemann integration; inequalities of upper and lower sums; Riemann conditions of integrability. Riemann sum and definition of Riemann integral through Riemann sums; equivalence of two definitions;

UNIT-II

Riemann integrability of monotone and continuous functions, Properties of the Riemann integral; definition and integrability of piecewise continuous and monotone functions. Intermediate Value theorem for Integrals; Fundamental theorems of Calculus. Improper integrals; Convergence of Beta and Gamma functions.

UNIT-III

Pointwise and uniform convergence of sequence of functions; Cauchy's general principle of uniform convergence, A test for uniform convergence of sequence of functions, Countinuity of the uniform limit of a uniformly convergent sequence of continuous functions, Integrability of uniform limit of a uniformly convergent sequence of integrable functions. Derivability of the point-wise limit of a sequence of derivable functions if the derivatives are continuous and the sequence of derivatives is uniformly convergent

UNIT-IV

Infinite Series of functions, Test for uniform convergence of a series; Cauchy's general principle of convergence and Weierstrass M-Test for uniform convergence. Abel's test and Dirichlet's test. Weierstrass Approximation Theorem.

RECOMMENDED BOOKS

1. Shanti Narayan, Dr. M.D. Raisinghania, Elements of Real Analysis, S. Chand & Company, New Delhi.
2. K.A. Ross, Elementary Analysis, The Theory of Calculus, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
3. R.G. Bartle D.R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
4. Charles G. Denlinger, Elements of Real Analysis, Jones & Bartlett (Student Edition), 2011.

BSHM-403-22	**Ring Theory and Linear Algebra I**	**L-5, T-1, P-0**	**6 Credits**

Pre-requisite: Set Theory, Group Theory

Course Objectives: The main aim of the course is to introduce the students to basic concepts from abstract algebra, especially the notion of a ring and vector space. The course will help prepare you for further study in abstract algebra as well as familiarize you with tools essential in many other areas of mathematics. The other aim of this course is to provide the learner with the skills, knowledge and competencies to carry out their duties and responsibilities in a pure Mathematical environment.

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

CO1	learn the basic concepts like groups, subgroups, cyclic groups, normal subgroups, homomorphisms, etc.
CO2	learn about binary operations on algebraic structures which are quite significant in modern mathematics.
CO3	understand the theorems of group isomorphisms and isomorphisms.
CO4	be acquainted with prerequisite knowledge required to learn advanced algebra.
CO5	apply the learnt techniques in modern algebra.

Mapping of course outcomes with the program outcomes

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO1	✓	✓	-	-	✓
CO2	✓	✓	-	-	✓
CO3	✓	✓	-	-	✓
CO4	✓	✓	-	-	✓
CO5	✓	✓	-	-	✓

Course Title: Ring Theory and Linear Algebra I
Course Code: BSHM-403-22

UNIT-I

Ring Theory: Definition and examples of rings, properties of rings, integral domains and fields, characteristic of a ring,

Subrings and Ideals: subrings, ideals, ideal generated by a subset of a ring, operations on ideals, principal, prime and maximal ideals.

UNIT-II

Ring Homomorphism: Quotient rings, Ring homomorphisms, properties of ring homomorphisms, Isomorphism theorems I, II and III.

UNIT-III

Vector Spaces: Vector spaces, vector subspaces, algebra of subspaces, disjoint subspaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces, cosets of subspaces, quotient spaces, dimension of quotient spaces.

UNIT-IV

Linear transformations: Linear transformation, matrix representation of a linear transformation, properties of linear transformations, null space, range, rank and nullity of a linear transformation, algebra of linear transformations. Isomorphisms invertibility and isomorphisms, matrix of a linear transformation with respect to basis.

Text Book:

1. V. Khanna and S.K. Bhambari, Abstract Algebra, 5th Ed., Vikas Publishing House, New Delhi, 2016.

Books Recommended:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
3. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra, 4th Ed., Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
4. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, New Delhi, 1999.
5. S. Lang, Introduction to Linear Algebra, 2nd Ed., Springer, 2005.

6. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.
7. S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India,1999.
8. Kenneth Hoffman, Ray Alden Kunze, Linear Algebra, 2nd Ed., Prentice-Hall of India Pvt. Ltd., 1971.
9. D.A.R. Wallace, Groups, Rings and Fields, Springer Verlag London Ltd., 1998

Course Title: Programming Lab-III
Course Code: BSHM-404-22

List of Practicals (using any software)

1. Calculate the sum 1/1 + 1/2 + 1/3 + 1/4 + ----------+ 1/ N.
2. To find the absolute value of an integer.
3. Enter 100 integers into an array and sort them in ascending order.
4. Bisection Method.
5. Newton Raphson Method.
6. Secant Method.
7. Regulai Falsi Method.
8. LU decomposition Method.
9. Gauss-Jacobi Method.
10. SOR Method or Gauss-Siedel Method.
11. Lagrange Interpolation or Newton Interpolation.
12. Simpson's rule.

RECOMMENDED BOOKS:

1. John H. Mathews and Kurtis D. Fink, Numerical Methods using Matlab, 4th Ed., PHI Learning Private Limited, 2012.

BSHM-405-22	**Graph Theory**	**L-2, T-0, P-0**	**2 Credits**

Pre-requisite: Sets, Binary operations

Course Objectives: The main aim of the course is to introduce the students to the basic concepts of graphs, pseudo graphs, complete graphs, bi-partite graphs, isomorphism of graphs. They will be able to identify edges and vertices, find the degree of a vertex, express travelling salesman's problem.

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

CO1	learn the basic concepts like graphs, pseudo graphs, complete graphs, bi-partite graphs, isomorphism of graphs, etc.
CO2	learn about Eulerian circuits, Hamiltonian cycles.
CO3	understand the concept of the adjacency matrix, weighted graph, travelling salesman's problem.
CO4	be acquainted with the properties of shortest path, Dijkstra's algorithm, Floyd-Warshall algorithm.
CO5	apply the learnt techniques in computer algebra.

Mapping of course outcomes with the program outcomes

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO1	✓	✓	-	-	✓
CO2	✓	✓	-	-	✓
CO3	✓	✓	-	-	✓
CO4	✓	✓	-	-	✓
CO5	✓	✓	-	-	✓

Course Title: Graph Theory
Course Code: BSHM-405-22

UNIT-I

Graphs: Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bi-partite graphs, isomorphism of graphs.

UNIT-II

Paths and Circuits: Introduction with examples, Eulerian circuits, Hamiltonian cycles, the adjacency matrix, weighted graph, travelling salesman's problem, shortest path, Dijkstra's algorithm, Floyd-Warshall algorithm.

Books Recommended:

1. B.A. Davey and H.A. Priestley, Introduction to Lattices and Order, Cambridge University Press, Cambridge, 1990.
2. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 2nd Edition, Pearson Education (Singapore) P. Ltd., Indian Reprint 2003.
3. Rudolf Lidl and Gunter Pilz, Applied Abstract Algebra, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

BHIC-211-22	**Chemistry-II**	**L-3, T-1, P-0**	**Credits: 4**

Pre-requisite: Understanding of senior secondary level chemistry

Course Objectives: This course will equip students with the necessary knowledge concerning the fundamentals in the basic areas of physical chemistry viz. different states of matter, solutions, and ionic equilibrium. The problem-solving skills of students are expected to be enhanced through due weightage given to numerical problems in each unit.

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

CO1	Understand the basic principles and theories pertaining to different states of matter
CO2	Solve various problems related to pH
CO3	Define the various laws pertaining to gaseous state and solutions.
CO4	Familiarize with the different colligative properties of solutions and the concept of abnormal molecular mass
CO5	Understand the basic structure and symmetry elements in solids

Mapping of course outcomes with the program outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓

Course Title: Chemistry-II
Course Code: BHIC-211-22

UNIT-I

States of Matter: The kinetic molecular theory of gases, Postulates and derivation of kinetic gas equation and various gas laws, The ideal gas law: Applications, Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z and its variation with pressure for different gases. Causes of deviation from ideal behavior. Van der Waals equation of state, its derivation and application in explaining real gas behaviour. Critical state, relation between critical constants and vander Waal constants, Numericals based on above concepts.

UNIT-II

Liquid and Solid State: Physical properties of liquids; vapour pressure, surface tension and its effects, coefficient of viscosity and effect of temperature and pressure. Liquid Crystals: their types and applications. 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. Defects in Crystals.

UNIT-III

Ionic equilibria: Concept of Acids and Bases, degree of ionization, factors affectingdegree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di-and triprotic acids. Buffer solutions; buffer capacity, buffer range, buffer action. Salt Hydrolysis, Acid Base Titrations, Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

UNIT-IV

Solutions and Colligative Properties: Ways of expressing the concentration, Colligative properties: derivation of expression and determination of molecular masses (i) relative lowering of vapour pressure, Raoult's Law. (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure, effects of Osmosis and Semi permeability, Reverse Osmosis. Applications in calculating molar masses of normal, dissociated, and associated solutes in solution, Van't Hoff Factor, Numerical problems based on above concepts.

RECOMMENDED BOOKS:

1. P.W. Atkins & J. de Paula, Atkin's Physical Chemistry, Oxford University Press (2006).
2. S.H. Maron & C.F. Prutton, Principles of Physical Chemistry, 1st edition, Oxford and IBH (1958).
3. G.W. Castellan, Physical Chemistry, 4th edition, Narosa (2004)
4. I.N. Levine, Physical Chemistry 6th Ed., Tata Mc Graw Hill (2010)
5. T. Engel & P. Reid, Physical Chemistry 3rd Ed., Prentice-Hall (2012)

BHIC-212-22	**Chemistry Lab-II**	L-0, T-0, P-4	Credits: 02

Pre-requisite: Understanding of senior secondary level Chemistry

Course Objectives: To provide students practical knowledge and skills about various topics taught in theory class of physical chemistry, which in turn will enhance their problem solving and analytical skills.

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

CO1	Understand the basic procedures for carrying out a physical chemistry practical like preparation and standardization of solutions, handling the equipment and measuring with precision.
CO2	Correlate the theoretical and practical aspects and know about the limits of the experimental error.
CO3	Determine the various physical parameters for the various problems under consideration.
CO4	Verify various laws studied in the theory part.

Mapping of course outcomes with the program outcomes

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓

Course Title: Chemistry Lab-II
Course Code: BHIC-212-22

UNIT-I

Preparation and Standardization of Solutions.

UNIT-II

Surface tension measurements.
a) Determine the surface tension by (i) drop number (ii) drop weight method.
b) Study the variation of surface tension of detergent solutions with concentration.

UNIT-III

Viscosity measurement using Ostwald's viscometer.
a) Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature.
b) Study the variation of viscosity of sucrose solution with the concentration of solute.

UNIT-IV

pH metry
a) Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.
b) Preparation of buffer solutions of different pH;
(i) Sodium acetate-acetic acid
(ii) Ammonium chloride-ammonium hydroxide
c) pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.
d) Determination of dissociation constant of a weak acid.

Recommended Books:

1. J.B. Yadav, Practical Physical Chemistry, Krishna
2. Findlay, Practical Physical Chemistry, Longman, New York

Course Title: Business Research Methods
Course Code: BBA-401-18

Course Objective: The course aims at equipping students with an understanding of the research process, tools and techniques in order to facilitate managerial decision making.

Course Outcomes (COs): After completion of the course, the students shall be able to:

CO1: Explain the objectives and process of conducting research and its application in business.

CO2: Analyse the different types of research design and experimental errors.

CO3: Understand various techniques of sampling and methods of data collection.

CO4: Examine different types of scales and appraise about data preparation and analysis.

CO5: Identify and prepare various types of reports.

UNIT I

Research Methodology: definition, objectives, scope in management research, process of Research and limitations. Research Design: Formulating the Research Problem, Choice of Research Design, Types of Research Design, Sources of Experimental Errors

UNIT II

Sampling: Advantages and Limitation of Sampling, Sampling process, Types of Sampling: Non-probability sampling techniques, Probability sampling techniques, Sampling and non-sampling errors. Data collection: primary, secondary data collection, observation methods and survey methods.

UNIT III

Measurement Concept, Levels of measurement—Nominal, Ordinal, Interval and Ratio Attitude Measurement: Comparative scaling techniques, Non-comparative scaling techniques, Questionnaire Designing: Types, Guidelines for developing a good questionnaire

UNIT IV

Data Preparation And Analysis: Editing, Coding, Cross Tabulation and Practices through Excel (Basic Concepts) Report Writing: Types of Research Reports, Guidelines for Writing a Report, Report Format, Guidelines for evaluating a report.

Suggested Readings:

1. K.V. Rao: Research Methodology, Sterling Publishers
2. Srivastava and Rego: Business Research Methodology Tata McGraw Hill
3. Rajinder Nargundhkar : Marketing Research, Tata McGraw Hill
4. Cooper and Schindler, Business Research Methods, Tata McGraw Hill
5. C.R. Kothari : Research Methodology, New Age International Publishers

SEMESTER-V

BSHM-501-22	**Partial Differential Equations**	**L-4, T-0, P-0**	**4 Credits**

Pre-requisite: Calculus and ODE

Course Objectives: The objective of this course is to introduce partial differential equations (PDEs) and their methods of solutions. The major focus of the course will be on discussion of various solution methods and their implementations for solving a given PDE with associated conditions.

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

CO1	Evaluate PDE of both first and second order.
CO2	Analyze partial differential equations and transform into canonical form.
CO3	Apply partial derivative equation techniques to predict the behavior of certain phenomena.
CO4	Create information from partial derivative models and relate it with real problems.
CO5	Apply specific techniques to conduct research and produce innovative results.

Mapping of course outcomes with the program outcomes

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO1	✓	✓	-	-	✓
CO2	✓	✓	-	-	✓
CO3	✓	✓	-	-	✓
CO4	✓	✓	-	-	✓
CO5	✓	✓	-	-	✓

Course Title: Partial Differential Equations
Course Code: BSHM-501-22

L	T	P
4	0	0

UNIT-I

Partial Differential Equations – Basic concepts and Definitions, Mathematical Problems. First Order Equations: Classification, Construction and Geometrical Interpretation. Method of Characteristics for obtaining General Solution of Quasi Linear Equations. Canonical Forms of First-order Linear Equations.

UNIT-II

Non-linear partial differential equation of the first order, Cauchy's method of characteristics for solving Non-linear PDE, compatible systems of first order equations, Charpit's method, Jacobi's method.

UNIT-III

Method of Separation of Variables for solving first order partial differential equations. Derivation of Heat equation, Wave equation. Classification of second order linear equations as hyperbolic, parabolic or elliptic. Reduction of second order Linear Equations to canonical forms.

UNIT-IV

The Cauchy problem, the Cauchy-Kowalewskaya theorem, Cauchy problem of an infinite string. Initial Boundary Value Problems, Semi-Infinite String with a fixed end, Semi-Infinite String with a Free end, Equations with non-homogeneous boundary conditions.

RECOMMENDED BOOKS:

1. Tyn Myint-U and Lokenath Debnath, Linear Partial Differential Equations for Scientists and Engineers, 4th edition, Springer, Indian reprint, 2006.
2. S.L. Ross, Differential equations, 3rd Ed., John Wiley and Sons, India, 2004.
3. Martha L Abell, James P Braselton, Differential equations with MATHEMATICA, 3rd Ed., Elsevier Academic Press, 2004.

BSHM-502-22	**Group Theory- II**	**L-5, T-1, P-0**	**6 Credits**

Pre-requisite: Group Theory-I

Course Objectives: The main objective of the course is to introduce the students to learn basic concepts from abstract algebra, especially the notion of group automorphisms, Group actions. The course will help prepare the students to apply the concepts like Cayley's theorem, Sylow's theorems, etc. in abstract algebra as well as utilize them in many other areas of mathematics.

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

CO1	Understand the basic concepts like group automorphism, cyclic groups, commutator subgroup, etc.
CO2	Apply group actions on algebraic structures which are quite significant in modern mathematics.
CO3	Understand the theorems, namely, Cayley's theorem, Sylow's theorems, Cauchy theorem, etc.
CO4	Apply introductory knowledge to learn advanced algebra.
CO5	Apply the learnt techniques in modern algebra.

Mapping of course outcomes with the program outcomes

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO1	✓	✓	-	-	✓
CO2	✓	✓	-	-	✓
CO3	✓	✓	-	-	✓
CO4	✓	✓	-	-	✓
CO5	✓	✓	-	-	✓

Course Title: Group Theory-II
Course Code: BSHM-502-22

L	T	P
5	1	0

Unit-I

Automorphism: Inner automorphism, automorphism groups, automorphism groups of finite and infinite cyclic groups, applications of factor groups to automorphism groups.

Unit-II

Conjugate Classes: Conjugate element of a group, Theorems relating to relations of conjugacy, conjugate class of an element, Theorems relating to order of conjugacy classes, class equation of a groups.

Unit-III

Direct Product: Properties of external direct products, external direct product of cyclic groups, Internal direct products**.**

Finite Abelian Groups: Cauchy's theorem for finite abelian groups, Converse of Lagrange theorem for abelian groups.

Unit-IV

Sylow's Theorems: p −groups, Sylow's theorems and consequences, Finite abelian group as direct product of Sylow's p −subgroups, Fundamental Theorem of finite abelian groups.

Reference Books:

1. V.K. Khanna and S.K. Bhambri, A course in Abstract Algebra, 5th Ed., Vikas Publishing House Pvt. Ltd, Noida.

Recommended Books:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
3. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, 1999.
4. David S. Dummit and Richard M. Foote, Abstract Algebra, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2004.
5. J.R. Durbin, Modern Algebra, John Wiley & Sons, New York Inc., 2000.
6. D. A. R. Wallace, Groups, Rings and Fields, Springer Verlag London Ltd., 1998.

BSHM-503-22	**Introduction to Number Theory**	**L-5, T-1, P-0**	**6 Credits**

Pre-requisite: Elementary Algebra

Course Objectives: The main objective of the course is to introduce History of Numbers, their development, their properties, divisibility theorem, GCD, LCM and other basic concepts from Diophantine equations, etc. The course will help to prepare the students to apply the concepts like Chinese remainder theorem, divisibility tests in real life problems as well as utilize them in many other areas of mathematics.

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

CO1	Understand the basic concepts like Archimedean property, Euclid Algorithm, Sieve of Eratosthenes, etc.
CO2	Apply solvability of congruence equations, Diophantine equations, etc which is quite significant in modern mathematics.
CO3	Analyze the theorems, namely, Chinese Remainder Theorem, Fermat's theorem, Wilson's theorem, Euler theorem, etc.
CO4	Apply introductory knowledge to learn advanced number theory.
CO5	Create new techniques in mathematics.

Mapping of course outcomes with the program outcomes

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO1	✓	✓	-	-	✓
CO2	✓	✓	-	-	✓
CO3	✓	✓	-	-	✓
CO4	✓	✓	-	-	✓
CO5	✓	✓	-	-	✓

Course Title: Introduction to Number Theory
Course Code: BSHM-503-22

L	T	P
5	1	0

Unit-I

Properties of Numbers: Well ordering Principle, Archimedean Property, Principle of finite induction, Binomial theorem, Triangular number, Sum, difference, and product of triangular numbers.

Unit-II

Divisibility Theory: division Algorithm, Greatest common divisor (GCD) and its properties, Euclid's Algorithm, Least common multiplier and its properties, Relation between GCD and LCM, Linear Diophantine equations, Solvability theorems, solutions of Linear Diophantine Equations.

Unit-III

Primes and their Distribution: Fundamental theorem of arithmetic, irrational numbers, Sieve of Eratosthenes to check the primality, Golbach conjecture, Euclid's Infinite prime number theorem, Product of consecutive 'r' integers.

Unit-IV

Theory of Congruences: Basic properties of congruences, Special divisibility tests, Linear congruences and their incongruent solutions, Chinese remainder theorem, Fermat's Little theorem, Wilson's theorem, Euler's theorem.

Reference Books:

7. David M. Burton, Elementary Number Theory, 7th Ed., Tata McGraw-Hill, 2007, Print.

Recommended Books:

1. Neville Robinns, Beginning Number Theory, 2nd Ed., Narosa Publishing House Pvt. Ltd. 2007.

BSHM-504-22	**Mathematical Statistics**	**L-5, T-1, P-0**	**6 Credits**

Pre-requisite: Calculus and basic algebra

Course Objectives: This course is designed to introduce the fundaments of mathematical statistics to the students. The major focus of the course will be on theoretical foundation of these fundamentals and their applications.

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

CO1	Understand and demonstrate the notion of randomness.
CO2	Analyze a given data using measures of central tendency, dispersion, skewness and kurtosis.
CO3	Apply the concepts of probability in modeling processes and decision making
CO4	Apply the theory of probability distributions in real world situations.
CO5	Apply the principle of least squares to fit a curve from a given data
CO6	Analyze given data using the concepts of correlation and regression.

Mapping of course outcomes with the program outcomes

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO1	✓	✓			✓
CO2	✓	✓			✓
CO3	✓	✓			✓
CO4	✓	✓			✓
CO5	✓	✓			✓
CO6	✓	✓			✓

Course Title: Mathematical Statistics
Course Code: BSHM-504-22

L	T	P
5	1	0

UNIT-I

Frequency distributions and measures of central tendency: Mean, median, mode, partition values, Measures of dispersion, skewness and kurtosis.

Random experiment, sample space, event, algebra of events, probability axioms, probability definition, addition law of probability, multiplication law of probability, conditional probability and independence, Bayes' Theorem.

UNIT-II

Random variables, distribution function, properties of distribution function, discrete random variable, probability mass function, discrete distribution function, continuous random variable, probability density function. Continuous distribution function.

UNIT-III

Mathematical expectation, expectation of a random variable, Discrete probability distributions: binomial, Poisson, negative binomial distribution, uniform. Continuous probability distributions: uniform distribution, normal distribution, normal distribution as a limiting case of binomial distribution, exponential distribution.

UNIT-IV

Curve fitting and principle of least squares: Fitting of a straight-line, second-degree parabola and polynomial of $k-$th degree, fitting of exponential curve.

Correlation: Bivariate distribution, correlation, scatter diagram, Karl Pearson coefficient of correlation, limits for correlation coefficient, Rank correlation, limits for rank correlation coefficients.

Regression: lines of regression, regression curves, regression coefficients, properties of regression coefficients, angle between two lines of regression.

TEXT BOOKS

1. S.C. Gupta, V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, Delhi, 2014.

RECOMMENDED BOOKS:

6. S. Ross, A First Course in Probability, Pearson, 2008.

7. Robert V. Hogg, Joseph W. Mckean and Allen T. Craig, Introduction to Mathematical Statistics, 7th Ed., Pearson Education, Asia 2006.
8. V. K. Rohatgi, A. K. Md. Ehsanes Saleh, An Introduction to Probability and Statistics, John Wiley & Sons, 2015.

BSHM-505-22	**Programming Lab-IV**	**L-0, T-0, P-4**	**2 Credits**
Pre-requisite: Basic knowledge of any mathematical software (e.g. MATLAB, MATHEMATICA, MAPLE etc.)			
Course Objectives: This Lab is designed to deal with a given partial differential equation using a mathematical software. The major focus of the Lab is to get solutions of a given PDE and to plot them.			
Course Outcomes: At the end of the course, the students will be able to			
CO1	Apply a mathematical software to solve a given linear PDE analytically.		
CO2	Analyze solutions of a given PDE by plotting them.		
CO3	Understand and obtain characteristics of a first order PDE		
CO4	Apply a mathematical software for solving wave equation with different conditions.		
CO5	Apply a mathematical software for solving other types of PDEs		

Mapping of course outcomes with the program outcomes

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO1	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓

Course Title: Programming Lab-IV

Course Code: BSHM-505-22

L	T	P
0	0	4

List of Practical (Using any software)

(i) Solution of Cauchy problem for first order PDE.
(ii) Finding the characteristics for the first order PDE.
(iii) Plot integral surfaces of a given first order PDE with initial data.
(iv) Solution of wave equation with associated conditions.
(v) Solving some other types of PDEs, for example quasilinear PDEs.

RECOMMENDED BOOKS:

3. Higham, D.J. and Higham, N.J., MATLAB Guide, 2nd Edition. Society for Industrial and Applied Mathematics (SIAM), 2005.
4. Gilat, A., MATLAB: An Introduction with Applications, 5th Edition. John Wiley & Sons, 2014.
5. Stephen Wolfram, THE MATHEMATICA BOOK, 5th Edition, 2003, Wolfram Media.
6. M. L. Abell, J. P. Braselton, MATHEMATICA by Example, 4th Edition, Elsevier, 2009.

BSHM-EVS-101 A	**Environmental Science**	**L-2, T-0, P-0**	**2 Credits**

Pre-requisite: Basic knowledge of environment.

Course Objectives: This course will equip students with the necessary knowledge and make them aware about the environmental issues.

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

CO1	Understand environmental problems at local and national level through literature and general awareness.
CO2	Gain practical knowledge by visiting wildlife areas, environmental institutesand various personalities who have done practical work on various environmental Issues.
CO3	Apply interdisciplinary approach to understand key environmental issues and critically analyze them to explore the possibilities to mitigate these problems
CO4	Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world**.**
CO5	Become aware of the local, regional and global environmental problems**.**

Mapping of course outcomes with the program outcomes

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO1					✓
CO2					✓
CO3					✓
CO4					✓
CO5					✓

Course Title: Environmental Science

Course Code: EVS-101 A

L	T	P
2	0	0

Unit-I

Introduction to Environmental Studies

Multidisciplinary nature of Environmental Studies**:** Scope &Importance, Need for Public Awareness

Ecosystems

Concept of an Ecosystem: Structure & functions of an ecosystem (Producers, Consumers & Decomposers) Energy Flow in anecosystem: Food Chain, Food web and Ecological Pyramids, Characteristic features, structure & functions of following Ecosystems: Forest Ecosystem, Aquatic Ecosystem (Ponds, Lakes, River & Ocean)

Unit-II

Natural Resources

Renewable & Non-renewable resources, Forest Resources*:* Their uses, functions & values *(*Biodiversity conservation, role in climate change, medicines*)* & threats *(*Overexploitation, Deforestation, Timber extraction, Agriculture Pressure*)*, Forest Conservation Act

Water Resources*:* Their uses *(*Agriculture, Domestic & Industrial*)*, functions & values, Overexploitation and Pollution of Ground & Surface water resources *(*Case study of Punjab*)*, Water Conservation, Rainwater Harvesting

Land Resources*:* Land as a resource; Land degradation, soil erosion and desertification

Energy Resources*:* Renewable & non-renewable energy resources, useof alternate energy resources *(*Solar, Wind, Biomass, Thermal*)*, Urban problems related to Energy

Unit-III

Biodiversity & its conservation

Types of Biodiversity**:** Species, Genetic & Ecosystem

India as a mega biodiversity nation, Biodiversity hot spots andbiogeographic regions of India, Biodiversity Conservation and its types,

Examples of Endangered & Endemic species of India, Red data book

Unit-IV

Environmental Pollution & Social Issues

Types, Causes, Effects & Control of Air, Water, Soil & Noise Pollution, Nuclear hazards and accidents & Health risks, Global Climate Change**:** Global warming, Ozone depletion, Acid rain, Meltingof Glaciers & Ice caps, Rising sea levels**.**

Environmental disasters**:** Earthquakes, Floods, Cyclones, Landslides

Field Work

Visit to a National Park, Biosphere Reserve, Wildlife Sanctuary Documentation & preparation of a Biodiversity (flora & fauna) registerof campus/river/forest

Visit to a local polluted site: Urban/Rural/Industrial/Agricultural Identification & Photography of resident or migratory birds, insects(butterflies)
Public hearing on environmental issues in a village

RECOMMENDED BOOKS

1. Bharucha, E. Text Book for Environmental Studies. University Grants Commission,New Delhi.
2. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad– 380 013, India.
3. De A.K., Environmental Chemistry, Wiley Eastern Ltd.
4. Down to Earth, Centre for Science and Environment (R)
5. Gleick, H.P. 1993. Water in crisis, Pacific Institute for Studies in Dev., Environment& Security. Stockholm Env. Institute Oxford Univ. Press. 473p
6. Heywood, V.H & Waston, R.T. 1995. Global Biodiversity Assessment. CambridgeUniv. Press 1140p.
7. Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co. (TB)
8. Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co. USA, 574p
9. Survey of the Environment, The Hindu (M)

BSHM-506-22	**Computer Algebra System & Related Software**	**L-0, T-0, P-2**	**Non-Credit**

Pre-requisite: A basic knowledge of Computer.

Course Objectives: The objective of this course is to introduce computer algebra system: Mathematica and other software: Matlab and R open-source package. The major focus of the course will be on use of these software for solving mathematical and statistical problems.

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

CO1	Apply Mathematica for solving mathematical problems, for example, nonlinear equations, calculus problems and differential equations etc.
CO2	Apply Matlab for solving scientific problems.
CO3	Apply R open-source package for solving statistical problems.
CO4	Create their own Mathematica programs.
CO5	Apply Matlab for plotting of functions.

Mapping of course outcomes with the program outcomes

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO1		✓	✓	✓	✓
CO2		✓	✓	✓	✓
CO3		✓	✓	✓	✓
CO4		✓	✓	✓	✓
CO5		✓	✓	✓	✓

Course Title: Computer Algebra System and Related Software

Course Code: BSHM-506-22

L	T	P
0	0	2

UNIT-I

The structure of MATHEMATICA, notebook interfaces, constants, variables, algebraic calculations, four kinds of brackets, lists, tables, expressions, functions, built-in functions, functional operations, graphics, patterns, manipulating lists, transformation rules, evaluation of expressions, modularity, manipulating notebooks, relational and logical operators. Symbolic math commands: D; Integrate; Sum; Product; Solve: Eliminate; Reduce: Series: Limit; Minimize; Programming: conditionals; loops: Do; For and While.

UNIT-II

Use of MATLAB as calculator, in computing function values, in making graphs, for exploring linear algebra and to plot curve and surfaces.

Introduction to R- open-source package, R as a calculator, built-in functions, operators, creating a vector, vector functions, writing functions in R. Applications of R in measures of central tendency.

RECOMMENDED BOOKS

1. Wolfram, S., The MATHEMATICA Book, 5^{th} revised edition. Wolfram Media Inc, 2004.
2. Abell, M. and Braselton, J., Mathematica by Example, 5^{th} Edition. Academic Press, 2017.
3. Lent, C.S., Learning to Programming with MATLAB: Building GUI Tools, Wiley, 2013.
4. Amos Gilat. MATLAB, An Introduction with Applications, 2004.
5. Michael J. Crawley, Statistics: An Introduction using R, 2nd Edition, Wiley, 2015.
6. W. John Braun, Duncan J. Murdoch, A First Course in Statistical Programming with R, 3rd Edition, Cambridge University Press, 2021.

SEMESTER-VI

BSHM-601-22	**Complex Analysis**	**L-5, T-1, P-0**	**6 Credits**

Pre-requisite: Complex numbers system and Calculus of several variables.

Course Objectives: The objective of this course is to introduce function of a complex variable and concepts of calculus of complex variable function. The major of the course will be on a systematic mathematical treatment of these concepts and their applications.

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

CO1	Understand Complex functions, their continuity, differentiability and integration.
CO2	Understand the concept of analytic functions, decide when and where a given function is analytic and be able to find its series development.
CO3	Describe basic properties of complex integration and having the ability to compute such integrals.
CO4	Analyze the concept of singularity and poles.
CO5	Apply residue theorem to compute the several kinds of real integrals.

Mapping of course outcomes with the program outcomes

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO1	✓	✓	-	-	✓
CO2	✓	✓	-	-	✓
CO3	✓	✓	-	-	✓
CO4	✓	✓	-	-	✓
CO5	✓	✓	-	-	✓

Course Title: Complex Analysis

Course Code: BSHM-601-22

L	T	P
5	1	0

UNIT-I

Function of complex variables, limit, continuity and differentiability. Analytic functions, Harmonic functions, Cauchy-Riemann equations (Cartesian and Polar form), sufficient condition for differentiability, Construction of analytic functions.

UNIT-II

Curves, simply closed curves, Complex line integral, Path independence of a line integral, Cauchy's theorem, Cauchy's integral formula and applications. Liouville's theorem and its consequences.

UNIT-III

Taylor's theorem, Laurent's theorem and their examples. Zeros and singularities of an analytic function, Residue at a pole and at infinity, Cauchy's Residue theorem.

UNIT-IV

Evaluation of definite integrals, integration round the unit circle, Evaluation of the integral of the form $\int_{-\infty}^{\infty} f(x)dx$, Jordan's inequality, Jordan's lemma, Integral of the form $\int_{-\infty}^{\infty} \frac{P(x)}{Q(x)} \sin mx dx$ etc.

Recommended Books:

1. E. T. Copson, Theory of functions of complex variables. Oxford university press.
2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers.
3. J.B. Conway, Functions of one complex variable (Second Edition), Springer.
4. J. W. Brown and R. V. Churchill, Complex variables and applications, 8th Edition, McGraw Hill, Higher Education.
5. H.S. Kasana, Complex Variable, Theory and Applications, PHI.
6. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House.

BSHM-602-22	**Ring Theory and Linear Algebra-II**	**L-5, T-1, P-0**	**6 Credits**

Pre-requisite: Ring Theory and Linear Algebra-I

Course Objectives: The main objective of the course is to introduce the basic concepts from abstract algebra, especially the notion of group automorphisms, Group actions. The course will help the students to apply the concepts like field extensions, splitting fields etc. in abstract algebra as well as utilize in many other areas of mathematics.

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

CO1	Understand the basic concepts like polynomial rings, Division theorem, Factorization of polynomials, irreducibility, etc.
CO2	Apply Eisenstein criterion of irreducibility, Eigen Spaces, Diagonalization, Dual Spaces, Annihilators, etc. which are quite significant in modern mathematics.
CO3	Understand the theorems, namely, Gauss theorem, Cayley Hamilton theorem, etc.
CO4	Utilize introductory knowledge to learn advanced algebra.
CO5	Create and apply the new techniques in modern algebra.

Mapping of course outcomes with the program outcomes

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO1	✓	✓	-	-	✓
CO2	✓	✓	-	-	✓
CO3	✓	✓	-	-	✓
CO4	✓	✓	-	-	✓
CO5	✓	✓	-	-	✓

Course Title: Ring Theory and Linear Algebra-II
Course Code: BSHM-602-22

L	T	P
5	1	0

Unit-I

Field of quotients of Integral Domain, Polynomial rings over commutative rings, Division algorithm and consequences: Remainder Theorem, Factor Theorem, Prime element and irreducible element, Principal ideal domains, GCD and LCM of two polynomials.

Unit-II

Euclidean Domain, Unique Factorization Domain, relation between ED, PID and UFD, Primitive polynomials, Irreducible polynomials, Gauss Lemma, Gauss theorem on irreducible elements, Eisenstein criterion of irreducibility.

Unit-III

Polynomial of matrices and linear operators, Eigen Values and Eigen Vectors, Characteristic subspace of a matrix, Cayley-Hamilton theorem, Eigen Space, Annihilating polynomials, Minimal Polynomials, Diagonalization of a linear operator.

Unit-IV

Linear functional, Dual Spaces, Dual basis, Natural mapping and reflexivity, Annihilator, Transpose or adjoint of a linear transformation.

Reference Books:

2. V.K. Khanna and S.K. Bhambri, A course in Abstract Algebra, 5th Ed., Vikas Publishing House Pvt. Ltd, Noida.
3. KP Gupta, Linear Algebra, Pragati Prakashan, Meerut.

Recommended Books:

8. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
9. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
10. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, 1999.
11. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra, 4th Ed., Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
12. S. Lang, Introduction to Linear Algebra, 2nd Ed., Springer, 2005.
13. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.
14. S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India, 1999.
15. Kenneth Hoffman, Ray Alden Kunze, Linear Algebra, 2nd Ed., Prentice-Hall of India Pvt. Ltd., 1971.
16. S.H. Friedberg, A.L. Insel and L.E. Spence, Linear Algebra, Prentice Hall of India Pvt. Ltd., 2004.

BSHM-603-22	**Theory of Equations**	**L-5, T-1, P-0**	**6 Credits**

Prerequisite: Basic algebra

Course Objectives: The objectives of this course are to discuss properties of polynomials and their graphical representation, introduce Descarte's rule of sign, relation between roots and coefficients of an equation. Further, to deal with the concept of symmetric function and its applications, and Strum sequence and its applications.

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

CO1	Understand the different properties of polynomials.
CO2	Apply Descarte's rule of sign to find nature of the roots of an equation.
CO3	Apply the concept of symmetric function.
CO4	Evaluate cubic and biquadratic equations.
CO5	Apply Strum sequence in identifying the distinct real roots of a polynomial in an interval.

Mapping of course outcomes with the program outcomes

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO1	✓	✓	-	-	✓
CO2	✓	✓	-	-	✓
CO3	✓	✓	-	-	✓
CO4	✓	✓	-	-	✓
CO5	✓	✓	-	-	✓

Course Title: Theory of Equations

Course Code: BSHM-603-22

L	T	P
5	1	0

UNIT-I

General properties of polynomials, Graphical representation of a polynomial, maximum and minimum values of a polynomials, General properties of equations, Descarte's rule of signs positive and negative rule, Relation between the roots and the coefficients of equations.

UNIT-II

Symmetric functions, Applications of symmetric function of the roots, Transformation of equations. Solutions of reciprocal and binomial equations. Algebraic solutions of the cubic and biquadratic. Properties of the derived functions.

UNIT-III

Symmetric functions of the roots, Newton's theorem on the sums of powers of roots, homogeneous products, limits of the roots of equations.

UNIT-IV

Separation of the roots of equations, Strums theorem, Applications of Strum's theorem, Conditions for reality of the roots of an equation and biquadratic. Solution of numerical equations.

Recommended Books:

1. W.S. Burnside and A.W. Panton, The Theory of Equations, Dublin University Press, 1954.
2. C. C. MacDuffee, Theory of Equations, John Wiley & Sons Inc., 1954.

BSHM-604-22	Mathematical Modeling	L-4, T-0, P-0	4 Credits

Pre-requisite: Calculus and basic linear algebra

Course Objectives: This course is designed to introduce basics of Mathematical modeling in order to write physical phenomena in mathematical terms and also to discuss of linear ordinary differential equations. The major focus of the course will be on a systematic mathematical treatment of these concepts.

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

CO1	Understand system of ODEs and interpret their solutions.
CO2	Understand and deal with different mathematical models such as simulation and linear programming model.
CO3	Apply the concepts of mathematical modeling to formulate real world phenomena into mathematical terms.
CO4	Apply Monte Carlo simulation to find area under a curve and volume of a surface.
CO5	Apply Simplex method for solving linear programming problems.

Mapping of course outcomes with the program outcomes

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	✓	✓			✓
CO2	✓	✓			✓
CO3	✓	✓			✓
CO4	✓	✓			✓
CO5	✓	✓			✓

Course Title: Mathematical Modeling
Course Code: BSHM-604-22

L	T	P
4	0	0

UNIT-I

Systems of linear ordinary differential equations: differential operators, an operator method for linear systems with constant coefficients, Basic Theory of linear systems in normal form, homogeneous linear systems with constant coefficients: Two Equations in two unknown functions.

UNIT-II

Introduction to mathematical modeling, modeling approaches, classifications and some characteristics of mathematical modeling, limitations of mathematical modeling. Interacting population models: Influenza outbreak, predators and prey, competing species, model of a battle (with case studies).

UNIT-III

Simulation: introduction and limitations, Monte Carlo Simulation modeling: (deterministic) Area under a curve, volume under a surface, generating random numbers, middle square method, linear congruence.

UNIT-IV

Linear programming model: assumptions in linear programming models, formulation of simple linear programming models, limitations of linear programming models, graphical method of solution, Simplex method for solving problems containing two variables.

RECOMMENDED BOOKS

1. S.L. Ross, Differential equations, 3rd Ed., John Wiley and Sons, India, 2004.
2. B. Barnes and G. R. Fulford, Mathematical Modelling with Case Studies: Using Maple and Matlab,3rd Edition, 2015, CRC Press, Taylor & Francis Group.
3. Frank. R. Giordano, William. P. Fox, Steven B. Horton, A First Course in Mathematical Modeling, 5th Edition, 2014 Cengage Learning.
4. Dennis G. Zill, Advanced Engineering Mathematics, 6th Edition, 2018, Jones & Bartlett Learning.
5. P. K. Gupta, D. S. Hira, Operations Research, 7th Edition, S. Chand & Company, Pvt. Ltd, 2014.

BSHM-605-22	**Programming Lab-V**	**L-0, T-0, P-4**	**2 Credits**

Pre-requisite: Basic knowledge of any mathematical software (e.g. MATLAB, MATHEMATICA, MAPLE etc.)

Course Objectives: This Lab is designed to deal solution of differential equations, Monte Carlo simulation and Simplex method using application of any software. The major focus of the Lab will be on effective implementation of mathematical software to use built-in tools/ features for solving the above said problems.

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

CO1	Apply mathematical software to solve a system of ODEs
CO2	Analyze graphical behavior of solutions of different mathematical models.
CO3	Create random numbers and understand their applications.
CO4	Apply software for simulating area under a curve and volume under a surface.
CO5	Analyze optimal solution of a linear programming problem.

Mapping of course outcomes with the program outcomes

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO1		✓	✓	✓	✓
CO2		✓	✓	✓	✓
CO3		✓	✓	✓	✓
CO4		✓	✓	✓	✓
CO5		✓	✓	✓	✓

Course Title: Programming Lab-V

Course Code: BSHM-605-22

L	**T**	**P**
0	**0**	**4**

List of Practical (Using any software)

(i) Introduction to built-in features of a mathematical software.
(ii) Solving a system of linear ordinary differential equations.
(iii) Phase plane analysis of predator-prey model.
(iv) Phase plane analysis of model of a battle.
(v) Random number generation and then use it for one of the following
(a) Simulate area under a curve (b) Simulate volume under a surface.
(vi) Solving linear programming problems with two variables.

RECOMMENDED BOOKS:

1. Higham, D.J. and Higham, N.J., MATLAB Guide, 2nd Edition. Society for Industrial and Applied Mathematics (SIAM), 2005.
2. Gilat, A., MATLAB: An Introduction with Applications, 5th Edition. John Wiley & Sons, 2014.
3. Stephen Wolfram, THE MATHEMATICA BOOK, 5th Edition, 2003, Wolfram Media.
4. M. L. Abell, J. P. Braselton, MATHEMATICA by Example, 4th Edition, Elsevier, 2009.

BSHM-606-22	**Scientific Documentation Tool**	**L-0, T-0, P-2**	**Non-Credit**
Pre-requisite: A basic knowledge of Computer.			
Course Objectives: This course is designed to introduce a Scientific Documentation Tool namely Latex for effectively writing mathematical articles, project reports and general mathematics content. The major focus of the course will be on effective use of Latex features to make an appealing presentation of a scientific document.			
Course Outcomes: At the end of the course, the students will be able to			
CO1	Create tables using Latex features.		
CO2	Apply Latex for creating effective scientific documents.		
CO3	Understand different types documents that can be created using Latex.		
CO4	Understand and use different packages to various features of Latex.		
CO5	Apply Latex to create theorem and equation environments in a scientific document.		

Mapping of course outcomes with the program outcomes

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO1		✓	✓	✓	✓
CO2		✓	✓	✓	✓
CO3		✓	✓	✓	✓
CO4		✓	✓	✓	✓
CO5		✓	✓	✓	✓

Course Title: Scientific Documentation Tool

Course Code: BSHM-606-22

L	T	P
0	0	2

Latex: Sample documents, Type style, Resources

Environments: Lists, Centering, Tables, Verbatim, Theorem like environments, Equation environment

Type Setting: Fonts, Hats, Underlining, Braces, Arrays, Matrices, Math styles, Bold Math, Symbols for number sets, Binomial Coefficients

Documents: Document Class, Title, Section commands

Packages: Inserting files, inserting pictures, Making a bibliography

RECOMMENDED BOOKS

1. Lamport, L., LATEX: A Document Preparation System, User's Guide a Reference Manual, 2™ Edition, Addison-Wesley, 1994.
2. Erickson M.J. and Binder, D., A student's Guide to the Study, Practice and Tools of Modern Mathematics, CRC Press, 2011.

Study Scheme & Syllabus of

Bachelor of Science in Non-Medical

(B.Sc. Non-Medical)

Batch 2018 onwards

By

Department of Academics

IK Gujral Punjab Technical University

Semester 1st

Course Code	Course Title	Load Allocation			Marks Distribution		Total	Credits
		L	T	P	Internal	External		
BSNM101-18	Organic Chemistry	3	0	0	25	50	75	3
BSNM102-18	Inorganic Chemistry	3	0	0	25	50	75	3
BSNM103-18	Mathematical Physics	3	0	0	25	50	75	3
BSNM104-18	Mechanics-I	3	0	0	25	50	75	3
BSNM105-18	Differential Calculus	3	0	0	25	50	75	3
BSNM106-18	Solid Geometry	3	0	0	25	50	75	3
BSNM107-18	English	3	0	0	25	50	75	3
BSNM108-18 BSNM108A-18	Punjabi /**OR** Punjab History & Culture	3	0	0	25	50	75	3
BSNM109-18	Chemistry Lab-I	0	0	4	30	20	50	2
BSNM110-18	Physics Lab-I	0	0	4	30	20	50	2
	Total	**24**	**0**	**8**	**260**	**440**	**700**	**28**

IK Gujral Punjab Technical University Jalandhar
B.Sc. (Non-Medical) Batch 2018 onwards

Semester-I

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title:	**ORGANIC CHEMISTRY**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course

Unit	Content
I	**Structure and Bonding** Hybridization, bond lengths, bond angles, bond energy, localized and delocalized chemical bond, van der Waals interactions, inclusion compounds, clatherates, charge transfer complexes resonance, hyperconjugation, aromaticity, inductive and field effects, hydrogen bonding. **Mechanism of Organic Reactions** Curved arrow notation, drawing electron movements with arrows, half-headed and double-headed arrows, homolytic and heterolytic bond breaking. Types of reagents- electrophiles and nucleophiles. Types of organic reactions. Energy considerations. Reactive intermediates (carbocations, carbanions, free radicals, carbenes, arynes and nitrenes). Assigning formal charges on intermediates and other ionic species. Methods of determination of reaction mechanism (product analysis, intermediates, isotope effects, kinetic and stereochemical studies).
II	**Stereochemistry of Organic Compounds** Isomerism and its types, Optical isomerism - elements of symmetry, molecular chirality, enantiomers, stereogenic center, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogeric centers, diastereomers, threo and erythro, diastereomers, meso compounds, resolution of enantiomers, inversion, retention and racemization. Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature. Geometric isomerism - determination of configuration of geometric isomers. E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds. Conformational isomerism - conformational analysis of ethane and n-butane; conformational analysis of cyclohexane, axial and equatorial bonds, conformation of mono substituted cyclohexane derivative. Newman projection and Sawhorse formulae, Fischer and flying wedge formulae. Difference between configuration and conformation.
III	**Alkanes and Cycloalkanes** Introduction, IUPAC nomenclature, Isomerism and classification of carbon atoms of alkanes. Sources, methods of formation (with special reference to Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids). Physical properties and chemical reactions of alkanes. Mechanism of free radical halogenation of alkanes: orientation, reactivity and selectivity. Cycloalkanes - nomenclature, methods of formation, chemical reactions, Baeyer's strain theory and its limitations. Ring strain in small rings (cyclopropane and cyclobutane), theory of strainless rings. The case of cyclopropane ring; banana bonds.
IV	**Alkenes, Cycloalkenes, Dienes and Alkynes** *Alkenes* Nomenclature, methods of synthesis (mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides, regioselectivity in alcohol dehydration. Saytzeff rule, Hofmann elimination), physical properties and relative stabilities of alkenes. Chemical reactions of alkenes - mechanisms involved in hydrogenation, electrophilic and free radical additions, Markownikiff's rule, hydroboration-oxidation, oxymercuration-reduction. Epoxidation,

	ozonolysis, hydration, hydroxylation and oxidation with $KMnO_4$, Polymerization of alkenes. Substitution at the allylic and vinylic positions of alkenes. Industrial applications of ethylene and propene. *Cycloalkenes* Methods of formation, conformation and Chemical reactions of cycloalkenes. *Dienes* Nomenclature and classification of dienes: isolated, conjugated and cumulated dienes. Structure of allenes and butadiene, methods of formation, polymerization. Chemical reactions – 1, 2 and 1,4 addition, Diels-Alder reaction. *Alkynes* Nomenclature, structure and bonding in alkynes. Methods of formation. Chemical reactions of alkynes, acidity of alkynes. Mechanism of electrophilic and nucleophilic addition reactions, hydroboration oxidation, metal-ammonia reductions, oxidation and polymerization.
	Recommended Books: 1. Organic Chemsitry, Morrison and Boyd, Prentice- Hall. 2. Fundamentals of Organic Chemistry, Solomons, John Wiley. 3. Organic Chemistry. F.A. Carey, McGraw Hill, Inc. 4. Organic Chemistry, L.G. Wade Jr. Prentice Hall. 5. Organic ChemistryVol. I, II & III, S.M. Mukherji, S.P. Singh and R.P.Kapoor, Wiley Eastern Ltd (New Age International). 6. Introduction to organic chemistry, Stritwieser, Heathcock and Kosover, Macmilan.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title:	**INORGANIC CHEMISTRY**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course

Unit	Content
I	**Atomic Structure** de Broglie equation, Heisenberg's Uncertainty Principle and its significance. Schrödinger's wave equation and its derivation, significance of ψ and ψ^2. Quantum numbers. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions and 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.
II	**Chemical Periodicity** Effective nuclear charge, shielding or screening effect (Slater rules), variation of effective nuclear charge in periodic table. Atomic and ionic radii, Ionization enthalpy, Electron gain enthalpy and their trend in groups and periods. Electronegativity and various scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity.
III	**Chemical Bonding I** *Ionic bond:* General characteristics of ionic compounds, size effects, radius ratio rule and its limitations. Efficiency of packing, Hexagonal close packing, Cubic close packing. Structures of different crystal lattices, Sodium chloride, Cesium chloride, Wurtzite, Zinc blende, Fluorite, Rutile, Cristobalite, Nickel arsenide, Pervoskite, Rhenium oxide, Calcium carbide, The calcite and aragonite structures. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy.
IV	**Chemical Bonding II** *Covalent bond:* Lewis structure, Valence Bond theory, VSEPR theory (Prediction of structures and variation of bond angles on the basis of VSEPR theory, Shortcomings of VSEPR theory), Hybridization, Molecular orbital theory (LCAO method). Molecular orbital diagrams of diatomic and simple polyatomic molecules (Be_2, N_2, O_2, F_2, LiH, NO, CO, HCl, NO_2, BeH_2, NO_2^-), Formal charge, Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization. Ionic character in covalent compounds (Bond moment, dipole moment, Percentage ionic character) *Metallic Bond:* Valence bond and band theories. Semiconductors and insulators, defects in solids. *Weak Interactions:* van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interaction, Hydrogen bonding.
	Recommended Books: 1. D.F.C. Shriver, P.W. Atkins and C.H. Langford, Inorganic Chemistry, ELBS Oxford, 1991. 2. J.E. Huheey, E.A. Keiter, R.L. Keiter, Inorganic Chemistry, 4th Ed, Pearson Education, Singapore, 1999. 3. J.D. Lee, Concise Inorganic Chemistry, ELBS, Oxford 1994.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title	**MATHEMATICAL PHYSICS**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course:

Unit	Content
I	**First Order and Second Order Ordinary Differential equations:** First Order Differential Equations and Integrating Factor. Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problem. **Calculus of functions of more than one variable:** Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers.
II	**Vector Calculus**: Recapitulation of vectors: Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields.
III	**Vector Differentiation:** Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities. **Vector Integration:** Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications.
IV	**Orthogonal Curvilinear Coordinates:** Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems. **Dirac Delta function:** Dirac Delta function and its properties: Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function.
	Reference Books: 1. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier. 2. An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning. 3. Differential Equations, George F. Simmons, 2007, McGraw Hill. 4. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications. 5. Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book. 6. Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning. 7. Mathematical Physics, Goswami, 1st edition, Cengage Learning. 8. Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press. 9. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India. 10. Essential Mathematical Methods, K.F.Riley & M.P.Hobson, 2011, Cambridge Univ. Press.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title:	**Mechanics-I**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course:

Unit	Content
I	**Fundamentals of Dynamics:** Reference frames. Inertial frames; Review of Newton's Laws of Motion. Galilean transformations; Galilean invariance. Momentum of variable- mass system: motion of rocket. Motion of a projectile in Uniform gravitational field. Conservation of Energy, Conservative forces, Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse. Angular Momentum about the Centre of mass, Rotational invariance, Shape of Galaxy.
II	**Work and Energy:** Work and Kinetic Energy Theorem. Conservative and non- conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by non-conservative forces. Law of conservation of Energy. **Elastic and Inelastic Scattering:** Types of scattering and conservation laws, Laboratory and centre of mass systems, collision of particles which stick together, General elastic collision of particles of different mass, Cross-section of elastic scattering, Rutherford scattering.
III	**Rotational Dynamics**: Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation. Cylinder on an accelerated rough plane, Behavior of angular momentum vector, Principal axes and Euler's equations, Elementary Gyroscope, Symmetrical Top.
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 - q, η, and σ by Searles method
	Reference Books: 1. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill. 2. Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill. 3. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley. 4. Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning. 5. Feynman Lectures, Vol. I, R.P .Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education 6. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons. 7. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole. 8. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000 9. University Physics. F.W Sears, M.W Zemansky, H. D Young 13/e, 1986, Addison Wesley. 10. Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A. Serwa, 2010, Cengage Learning. 11. Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title:	**DIFFERENTIAL CALCULUS**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course:

Unit	Content
I	Definition of a sequence. limit of a sequence, theorems on limits of sequences, bounded, monotonic sequences. Least upper bound and greatest lower bound of a sequence. Limit superior, limit inferior. Nested Intervals. Cauchy's convergence criterion, infinite series.
II	Limits of Functions, $\varepsilon - \delta$ definition, right- and left-hand limits. Theorems on limits. Infinity. Special Limits. Continuity, $\varepsilon - \delta$ definition, right- and left-hand Continuity, continuity in an interval, theorems on continuity, piecewise continuity, uniform Continuity.
III	The concept and definition of a derivative, right- and left-hand derivatives, differentiability in an interval, piecewise differentiability, differentials, differentiation of composite functions, implicit differentiation, mean value theorems, Taylor theorem, applications.
IV	Functions of two or more variables, neighborhoods, regions, limits, iterated limits, continuity, uniform continuity, partial derivatives, higher-order partial derivatives, differentials, theorems on differentials, differentiation of composite functions, Euler's theorem on homogeneous functions. Implicit functions, Jacobians, partial derivatives using Jacobians, theorems on Jacobians, applications.
	Reference Books: 1. Robert Wrede and Murray R. Spiegel, Advanced Calculus, 3rd Edition, Schaum's Outline Series (McGraw Hill), 2010. 2. Maurice D Weir, Frank R. Giordano and Joel Hass, Thomas' Calculus, 11th Edition, Pearson, 2008. 3. James Stewart, Calculus, 5th Edition, Brooks/Cole(Thomson), 2003. 4. Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

IK Gujral Punjab Technical University Jalandhar
B.Sc. (Non-Medical) Batch 2018 onwards

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title:	**SOLID GEORMETRY**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course:

Unit	Content
I	The concept of co-ordinates, co-ordinate of a point in space, distance between two points. Plane: Definition of a plane, Normal form of the equation of a plane, Transformation from general form to normal form, Equation of plane in terms of its intercepts on the axis, Equations of the plane through the given points, Length of the perpendicular from a given point to a given plane, Bisectors of angles between two planes, Combined equation of two planes, Orthogonal projection on a plane.
II	Sphere: Definition and equation of the sphere; Equation of the sphere through four given points; Plane sections of a sphere; Intersection of two spheres; Equation of a circle; Sphere through a given circle; Intersection of a sphere and a line; Power of a point; Tangent plane; Plane of contact; Polar plane; Pole of a plane; Conjugate points; Conjugate planes; Angle of intersection of two spheres; Conditions for two spheres to be orthogonal; Radical plane; Coaxial system of spheres.
III	Cone**:** Definitions of a cone; vertex; guiding curve; generators; Equation of the cone with a given vertex and guiding curve; Enveloping cone of a sphere; Equations of cones with vertex at origin are homogenous; Condition that the general equation of the second degree should represent a cone; Condition that a cone may have three mutually perpendicular generators; Intersection of a line and a quadric cone; Tangent lines and tangent plane at a point; Condition that a plane may touch a cone; Reciprocal cones; Intersection of two cones with a common vertex; Right circular cone; Equation of the right circular cone with a given vertex; axis and semi-vertical angle.
IV	Cylinder: Definition of a cylinder, Equation to the cylinder whose generators intersect a given conic and are parallel to a given line; Enveloping cylinder of a sphere; The right circular cylinder; Equation of the right circular cylinder with a given axis and radius.
	Reference Books: 1. Shanti Narayan and P. K. Mittal, Analytical Solid Geometry, 17th Edition, S. Chand & Company, 2007. 2. P. K. Jain, A Textbook of Analytical Geometry of Three Dimensions, New Age International, 2005.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title:	**English**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Detail of Course

Unit	Content
I	**Literature** ***The Poetic Palette*** **(Orient BlackSwan, Second Edition, 2016)** The following poems from this anthology are prescribed: 1. Apparently With No Surprise: Emily Dickinson 2. Fool and Flea: Jeet Thayil 3. The Soul's Prayer: Sarojini Naidu 4. I Sit and Look Out: Walt Whitman 5. Women's Rights: Annie Louise Walker 6. Pippa's Song: Robert Browning **Vocabulary** Antonyms; Synonyms; One-word substitution; Homophones/Homonyms; Abbreviations
II	**Literature** **(b)** ***Prose Parables*** **(Orient Black Swan, 2013)** The following stories from the above volume are prescribed: a. The Eyes Are Not Here: Ruskin Bond b. Grief: Anton Chekov c. The Doctor's Word: R.K. Narayan d. The Doll's House: Katherine Mansfield e. Dusk: H.H. Munroe (Saki) f. The Kabuli wallah : Rabindranath Tagore **Grammar** Parts of Speech; Articles, Determiners; Modals; Modifiers; Prepositions; Voice; Transformation of sentences
III	Close Reading; Comprehension; Summarizing; Paraphrasing; Analysis and Interpretation; Translation (from Hindi/Punjabi to English and vice-versa)
IV	Essay Writing -Descriptive/Narrative/Argumentative; Business letters; Précis Writing
	Recommended Books: **1.** Oxford Practice Grammar by John Eastwood (Ed. 2014) **2.** Business English, Pearson, 2008. **3.** Language, Literature and Creativity, Orient Black swan, 2013. **4.** Language through Literature (forthcoming) ed. Dr. Gauri Mishra, Dr. Ranjana Kaul, Dr. Brati Biswas **5.** Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.

ਬੀ.ਐਸ.ਸੀ. ਨਾਨ-ਮੈਡੀਕਲ
ਸਮੈਸਟਰ-ਪਹਿਲਾ
ਸਲੇਬਸ-ਪੰਜਾਬੀ
ਪੰਜਾਬੀ-3L-3 ਕਰੈਡਿਟ

ਪਾਠ-ਕ੍ਰਮ:

ਯੂਨਿਟ-1 (ਸਾਹਿਤ)

(ੳ) ਕਵਿਤਾ ਭਾਗ :

1. ਰਉਂ ਰੁੱਖ- ਭਾਈ ਵੀਰ ਸਿੰਘ
2. ਰਾਧਾ ਸੰਦੇਸ਼-ਧਨੀ ਰਾਮ ਚਾਤ੍ਰਿਕ
3. ਪੁਰਾਣੇ ਪੰਜਾਬ ਨੂੰ ਆਵਾਜ਼ਾਂ-ਪ੍ਰੋ. ਪੂਰਨ ਸਿੰਘ
4. ਆਉ ਨੱਚੀਏ-ਪ੍ਰੋ.ਮੋਹਨ ਸਿੰਘ
5. ਤੇਰੇ ਹਜ਼ੂਰ ਮੇਰੀ ਹਾਜ਼ਰੀ ਦੀ ਦਾਸਤਾਨ-ਹਰਿਭਜਨ ਸਿੰਘ
6. ਚੌਂਕ ਸ਼ਹੀਦਾਂ ਵਿਚ ਉਸਦਾ ਆਖਰੀ ਭਾਸ਼ਣ- ਸੁਰਜੀਤ ਪਾਤਰ

(ਅ) ਕਹਾਣੀ ਭਾਗ :

1. ਭੂਆ-ਨਾਨਕ ਸਿੰਘ
2. ਪੇਮੀ ਦੇ ਨਿਆਣੇ-ਸੰਤ ਸਿੰਘ ਸੇਖੋਂ
3. ਧਰਤੀ ਹੇਠਲਾ ਬੌਲਦ- ਕੁਲਵੰਤ ਸਿੰਘ ਵਿਰਕ
4. ਦੂਜੀ ਵਾਰ ਜੇਬ ਕੱਟੀ ਗਈ-ਨਵਤੇਜ ਸਿੰਘ
5. ਬੁੱਤ ਸ਼ਿਕਨ-ਅਜੀਤ ਕੌਰ
6. ਬੱਸ ਕੰਡਕਟਰ-ਦਲੀਪ ਕੌਰ ਟਿਵਾਣਾ

ਯੂਨਿਟ-2 (ਭਾਸ਼ਾ ਤੇ ਲਿਪੀ)

ਭਾਸ਼ਾ ਦਾ ਟਕਸਾਲੀ ਰੂਪ, ਭਾਸ਼ਾ ਤੇ ਉਪ-ਭਾਸ਼ਾ ਵਿਚ ਅੰਤਰ, ਪੰਜਾਬੀ ਦੀਆਂ ਉਪ-ਭਾਸ਼ਾਵਾਂ,ਪੰਜਾਬੀ ਭਾਸ਼ਾ:ਨਿਕਾਸ ਤੇ ਵਿਕਾਸ।
ਭਾਸ਼ਾ ਤੇ ਲਿਪੀ, ਗੁਰਮੁਖੀ ਲਿਪੀ ਦੀਆਂ ਵਿਸ਼ੇਸ਼ਤਾਵਾਂ, ਗੁਰਮੁਖੀ ਲਿਪੀ: ਨਿਕਾਸ ਤੇ ਵਿਕਾਸ।

ਯੂਨਿਟ-3 (ਵਿਆਕਰਣ)

ਮੂਲ ਵਿਆਕਰਣਕ ਇਕਾਈਆਂ :
ਭਾਵੰਸ਼
ਸ਼ਬਦ
ਵਾਕੰਸ਼
ਉਪ-ਵਾਕ
ਵਾਕ

ਯੂਨਿਟ-4 (ਲੇਖਣੀ-ਕਲਾ)

ਸੰਖੇਪ ਰਚਨਾ (ਪ੍ਰੈਸੀ)
ਪੈਰ੍ਹਾ ਰਚਨਾ
ਸਰਲ ਅੰਗਰੇਜ਼ੀ ਪੈਰ੍ਹੇ ਦਾ ਪੰਜਾਬੀ ਅਨੁਵਾਦ

ਸਹਾਇਕ ਪੁਸਤਕਾਂ:

ਦੋ ਰੰਗ , ਗੁਰੂ ਨਾਨਕ ਦੇਵ ਯੂਨੀਵਰਸਿਟੀ,ਅੰਮ੍ਰਿਤਸਰ (ਸੰਪ. ਹਰਜਿੰਦਰ ਸਿੰਘ ਢਿੱਲੋਂ ਤੇ ਪ੍ਰੀਤਮ ਸਿੰਘ ਸਰਗੋਧੀਆ), ਦੂਜਾ ਐਡੀਸ਼ਨ, 2014.

ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਵਿਗਿਆਨ (ਸੁਖਵਿੰਦਰ ਸਿੰਘ ਸੰਘਾ), ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਅਕਾਦਮੀ, 2006.

IK Gujral Punjab Technical University Jalandhar
B.Sc. (Non-Medical) Batch 2018 onwards

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title:	**Punjab History & Culture**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Detail of Course

Unit	Content
I	1. Physical Features of the Punjab and impact on history. **2.** Sources of the ancient history of Punjab.
II	3. Harappan Civilization : Town planning ; Social, economic and religious life of the Indus valley people 4. The indo-Aryans: original home and settlement in Punjab.
III	5. Social, Religious and Economic life during later Rig Vedic age. 6. Social, Religious and Economic life during later Vedic Age.
IV	7. Teaching and impact of Buddhism 8. Jainism in the Punjab.
	Recommended Books: **1.** L. joshi (ed): History and Culture of the Punjab, Art-1, Patiala, 1989(3rd edition) **2.** L.M joshi and fauja singh (ed); History of Punjab, Vol.I, Patiala 1977. **3.** Budha Parkash: Glimpses of Ancient Punjab, Patiala, 1983. **4.** B.N Sharma: life in Northern India, Delhi. 1966.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title:	**CHEMISTRY LAB I**			
Contact Hours:	**L:0**	**T:0**	**P:4**	**Credits:2**

Inorganic Chemistry: Semi Micro analysis. Cation analysis, Separation and identification of ions from groups I, II, III, IV, V, and VI. Anionic analysis. Four ions with no interference.

Organic Chemistry Laboratory Techniques:

Determination of Melting Point

Naphthalene 80-82^{o}C

Cinnamic acid 132.5-133 ^{o}C

Benzoic acid 121.5-122 ^{o}C

Salicylic acid 157.5-158 ^{o}C

Urea 132.5-133 ^{o}C

Acetanilide 113.5-114 ^{o}C

Succinic Acid 184.5-185 ^{o}C

m-dinitro benzene 90 ^{o}C

p-dichlorobenzene 52 ^{o}C

Aspirin 135 ^{o}C

Determination of Boiling Point

Ethanol 78 ^{o}C

Cyclohexane 81.4 ^{o}C

Benzene 80 ^{o}C

Toluene 110°C

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title:	**Physics Lab-I**			
Contact Hours:	**L:0**	**T:0**	**P:4**	**Credits:2**

At least 06 experiments from the following:

1. Measurements of length (or diameter) using vernier caliper, screw gauge, and travelling microscope. Use of Plumb line and Spirit level.
2. Analysis of experimental data by:
   a) fitting the given data to a straight line b) to study probable error in observations.
3. To determine the height of an inaccessible object using a sextant.
4. To determine the horizontal distance of an object using a sextant.
5. To determine the vertical distance of an object using a sextant.
6. To verify the law of vibrating string by Melde's experiment.
7. To setup CRO for Sine and Square wave and to find their frequency and amplitude.
8. To study the Motion of Spring and calculate (a) Spring constant, (b) **g** and (c) Modulus of rigidity.
9. To establish a relation between angular acceleration α and torque τ, and hence to find out the moment of Inertia of flywheel.
10. Study the dependance of the moment of Inertia on distribution of mass (by noting the time periods of oscillations) using objects of various shape but of same mass.
11. To determine the Young's Modulus of a Wire by Optical Lever Method.
12. To determine the Young's Modulus of a Wire by Searle's method.
13. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.

REFERENCE BOOKS:

1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. Engineering Practical Physics, S.Panigrahi & B.Mallick,2015, Cengage Learning India Pvt. Ltd.
4. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.
5. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 201, Kitab Mahal
6. B Sc Practical Physics by C. L. Arora, S. Chand & Co.

Course Code	Course Title	Load Allocation			Marks Distribution		Total	Credits
		L	T	P	Internal	External		
BSNM201-18	Inorganic Chemistry-II	3	0	0	25	50	75	3
BSNM202-18	Physical Chemistry-I	3	0	0	25	50	75	3
BSNM203-18	Mechanics-II	3	0	0	25	50	75	3
BSNM204-18	Electricity and Magnetism	3	0	0	25	50	75	3
BSNM205-18	Integral Calculus	3	0	0	25	50	75	3
BSNM206-18	Theory of equations	3	0	0	25	50	75	3
BSNM207-18	English-II	3	0	0	25	50	75	3
BSNM208-18 Punjabi / **OR** BSNM208A-18 Punjab History & Culture		3	0	0	25	50	75	3
BSNM209-18	Chemistry Lab-II	0	0	4	30	20	50	2
BSNM210-18	Physics Lab-II	0	0	4	30	20	50	2
BSNM211-18	Computer Algebra system: MATLAB	0	0	2	30	20	50	1
	Total	**24**	**0**	**10**	**290**	**460**	**750**	**29**

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B.Sc. (Non-Medical) Batch 2018 onwards

Semester-II

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:	BSNM201-18			
Subject Title:	**INORGANIC CHEMISTRY-II**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course

Unit	Content
I	**Chemistry of s Block Elements** General characteristics (melting point, flame color, reducing nature, diagonal relationships and anomalous behavior of first member of each group). Reactions of alkali and alkaline earth metals with oxygen, hydrogen, nitrogen and water. Ease of formation, thermal stability and solubility of the following alkali and alkaline earth metal compounds: hydrides, oxides, peroxides, superoxides, carbonates, nitrates, sulphates. Complex formation tendency of s-block elements; crown ethers, cryptands and podands of Group I; basic beryllium acetate, beryllium nitrate, EDTA complexes of calcium and magnesium. Solutions of alkali metals in liquid ammonia and their properties.
II	**Chemistry of p Block Elements** Electronic configuration, atomic and ionic size, metallic/non-metallic character, melting point, ionization enthalpy, electron gain enthalpy, electronegativity, inert pair effect, diagonal relationship between B and Si and anomalous behaviour of first member of each group. ***Group III (Boron Group):*** Oxides, halides and hydrides of group III elements, boron sesquioxide and borates structure of borates, trihalides and lower halides of boron, preparation of boron hydrides reactions and structures of boranes. ***Group IV (Carbon Group):*** Structure and allotropy of the elements, types and structure of carbides, oxides of carbon and silicon, types and structures of silicates, Organo – silicon compounds and the silicones, halides of IV group elements. ***Group V (Nitrogen Group):*** Hydrides, properties and structure of ammonia, hydrazine, hydroxylamine, trihalides and Pentahalides of V groups elements, oxides of nitrogen, structure of N_2O, NO, N_2O_3, N_2O_4 and N_2O_5, oxo acids of nitrogen and phosphorous, phosphazenes and cyclophosphazenes. ***Group VI (Oxygen Group):*** Structure and allotropy of the elements. Oxides of sulfur (structure of SO_2 and SO_3) oxoacids of sulfur halides of sulfur, selenium and tellurium, compounds of Sulfur and nitrogen (S_4N_4). ***Group VII:*** Oxides of halogens (OF_2, O_2F_2, Cl_2C, ClO_2, Cl_2O_6, BrO_2, I_2O_5) (structures), Preparation, reaction and structure of interhalogen compounds. (ClF_3, BrF_3, I_2, Cl_5, IF_5, IF_7), Polyhalides, basic properties of halogens.
III	**Acids-bases** Various definitions of acids and bases, A generalized acid-base concept, Measurement of acid-base strength, Lewis interactions in non-polar solvents, Systematics of Lewis acid-base interactions, Bond energies, steric effects, solvation effects and acid-base anomalies, Classification of acids and bases as hard and soft. Pearson's HSAB concept, acid-base strength and hardness and softness. Symbiosis, theoretical basis of hardness and softness, electronegativity and hardness and softness.
IV	**Chemistry of Transition Elements** Characteristic properties of d–block elements. Properties of the elements of the first transition

	series, their simple compounds and complexes illustrating relative stability of their oxidation states, coordination number and geometry. General characteristics of elements of Second and Third Transition Series, comparative treatment with their 3d analogues in respect of ionic radii, oxidation states, magnetic behavior.
	Recommended Books: 1. J.D. Lee, Concise Inorganic Chemistry, 4th Ed. 2. J.E. Huheey, Inorganic Chemistry, Harper & Row. 3. F.A.Cotton and G. Wilinson, Advanced Inorganic Chemistry, Interscience Publishers. 4. N.N. Greenwood and A. Earnshaw, Chemistry of Elements, Pergamon Press.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:	BSNM202-18			
Subject Title:	**PHYSICAL CHEMISTRY-I**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course

Unit	Content
I	**Gaseous state** Kinetic molecular theory of gases, derivation of kinetic gas equation, deduction of gas laws from kinetic gas equation, imperfection in real gases, the compressibility of real gases, isotherms of real gases, equations of state, 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.
II	**Liquids state** 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.
III	**Colloidal State** Definition of colloids, classification of colloids. Solids in liquids (Sol): kinetic, optical and electrical, properties, stability of colloids, protective action, Hardy Schulze law, gold number. Liquids in liquids (emulsions): Types of emulsions, preparation. Emulsifiers. General applications of colloids.
IV	**Solutions, Dilute Solutions and Colligative Properties** Ideal and non–ideal solutions, methods of expressing concentrations of solutions, activity and activity coefficient. Dilute solution, colligative properties, Raoult's law, relative lowering of vapour pressure, molecular weight determination. Osmosis, Law of osmotic pressure and its measurement, determination of molecular weight from osmotic pressure. Elevation of boiling point and depression of freezing point, Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point. Experimental methods for determining various colligative properties. Abnormal molar mass degree of dissociation and association of solutes.
	Recommended Books: 1. Principles of physical chemistry, S.H. Maron & C.F. Prutton. 2. Physical Chemistry, K.J. Laidler. 3. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006). 4. Ball, D. W. Physical Chemistry Thomson Press, India (2007). 5. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004). 6. Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:	BSNM203-18			
Subject Title:	**Mechanics-II**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course:

Unit	Content	Contact Hours
I	**Gravitation:** Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere. Force between a Point Mass and Spherical shell. Force between a Point Mass and Solid Sphere, Gravitational and Electrostatic self-energy. Gravitational energy of the Galaxy and of uniform sphere.	**8**
II	**Central Force Motion:** Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Basic idea of global positioning system (GPS). Non-Inertial Systems: Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Components of velocity and acceleration in cylindrical and spherical Coordinate systems.	**10**
III	**Oscillations**: Simple Harmonic Oscillations (SHM). Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor.	**8**
IV	**Special Theory of Relativity:** Michelson-Morley Experiment. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Kinematics. Transformation of Energy and Momentum.	**8**
	Reference Books: 14. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill. 15. Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill. 16. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley. 17. Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.	

	18. Feynman Lectures, Vol. I, R.P .Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education 19. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons. 20. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole. 21. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000 22. University Physics. F.W Sears, M.W Zemansky, H. D Young 13/e, 1986, Addison Wesley. 23. Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A. Serwa, 2010, Cengage Learning 24. Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:	BSNM204-18			
Subject Title:	**ELECTRICITY AND MAGNETISM**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course:

Unit	Content	Contact Hours
I	**Electrostatics and Dielectrics:** Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric.	**12**
II	**Magnetism:** Magnetostatics: Biot-Savart's law & its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law. Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-,para- and ferro-magnetic materials.	**6**
III	**Electromagnetic Induction:** 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.	**6**
IV	**Maxwell's equations and Electromagnetic wave propagation:** 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, polarization.	**8**
	Reference Books: 12. Edward M. Purcell, Electricity and Magnetism, McGraw-Hill Education 1986. 13. J.H. Fewkes & J. Yarwood. Electricity and Magnetism, Oxford Univ. Press Vol. I, 1991. 14. D C Tayal, Electricity and Magnetism, Himalaya Publishing House 1988. 15. Ronald Lane Reese, University Physics, Thomson Brooks/Cole 2003. 16. D.J. Griffiths, Introduction to Electrodynamics, Benjamin Cummings 3rd Edn, 1998.	

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:	BSNM205-18			
Subject Title:	**INTEGRAL CALCULUS**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course:

Unit	Content
I	Integrals of functions of one variable, geometrical interpretation of integral as area, integration of standard functions, integration by substitution and parts, Integration by Partial fractions, integration of rational and irrational functions. Properties of definite integrals.
II	Reduction formulae for integrals of rational, trigonometric, exponential and logarithmic functions and of their combinations. Areas and lengths of curves in the plane, volumes and surfaces area of solids of revolution.
III	Integrals of functions of two variables, double integrals, Applications to evaluation of area, volumes and surfaces of solids of revolution, Change of order of Integration. Change of variables.
IV	Integrals of functions of three variables, Triple integral, Evaluation of volume, density etc., Change of order of Integration. Change of variables. Implicit and Explicit functions, Integration of hyperbolic and inverse hyperbolic functions.
	Reference Books: 3. H. S. Hall and S. R. Knight, Higher Algebra, H. M. Publications, 1994. 4. Chandrika Prasad, Text Book on Algebra and Theory of Equations, Pothishala Pvt. Ltd., 2017. 5. Richard L. Burden and J. Douglas Faires, Numerical Analysis, 9th Edition, Cengage Learning, 2012. 6. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering Computation, 6th Edition, New Age International Publishers, 2012.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:	BSNM206-18			
Subject Title:	**THEORY OF EQUATIONS**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course:

Unit	Content
I	Euclid's algorithm, synthetic division, roots and their multiplicity. Complex roots of real polynomials occur in conjugate pairs with same multiplicity. Relation between roots and coefficients. Transformation of equations. Descartes' Rule of Signs.
II	Solution of cubic and bi-quadratic equations, Cardano's method of solving a cubic, discriminant and nature of roots of real cubic, trigonometric solutions of a real cubic with real roots. Ferrari's method for a bi-quadratic equation.
III	Computer arithmetic and errors: Floating point representation of numbers, numbers and their accuracy, significant digits, source of errors, types of errors, errors in arithmetic operations. Numerical instability.
IV	Algorithms, convergence, solution of nonlinear equations: Bisection method, False position method, Fixed point iteration method, Newton-Raphson's method, Secant method.
	Reference Books: 1. H. S. Hall and S. R. Knight, Higher Algebra, H. M. Publications, 1994. 2. Chandrika Prasad, Text Book on Algebra and Theory of Equations, Pothishala Pvt. Ltd., 2017. 3. Richard L. Burden and J. Douglas Faires, Numerical Analysis, 9th Edition, Cengage Learning, 2012. 4. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering Computation, 6th Edition, New Age International Publisher, 2012.

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Course Name	**B.Sc. (Non-Medical)**			
Subject Code:	BSNM207-18			
Subject Title:	**ENGLISH-II**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course

Unit	Content
I	The following **short novel** to be read for enhancing vocabulary and learning sentence/speech construction: The Strange Case of Dr. Jekyll and Mr Hyde by Robert Louis Stevenson
II	**Grammar:** Parts of Speech, Adjectives and its degrees, Simple, compound and complex structures, Active and passive voices, Subject-verb agreement, Punctuation, Spelling rules and formation of words.
III	**Writing Skills:** Report writing, Letter writing: Business and official letters, notices and memorandums, Precis writing
IV	**Language Skills**: Comprehension, Public speaking/Oral communication, Translation (Punjabi into English), Technical words/vocabulary
	Recommended Books: Robert Louis Stevenson, *The Strange Case of Dr Jekyll and Mr Hyde*, Madhuban Publications, 2005 Wren and Martin, *High School English Grammar and Composition,* S Chand (Indian edition), 2008. A J Thomson and A V Martinet, *A Practical English Grammar*, Oxford India, 2007 R V Lesikar, M E Flatley, K Rentz and N Pande, *Business Comminication (Making Connections in Digital World)*, Tata McGraw Hill, 2010 M Frank, *Writig as Thinking: A Guided Process Approach, Englewood Cliffs*, Prentice Hall Regents.

ਬੀ.ਐਸ.ਸੀ. ਨਾਨ-ਮੈਡੀਕਲ
ਸਮੈਸਟਰ-ਦੂਜਾ
ਸਲੇਬਸ-ਪੰਜਾਬੀ
ਪੰਜਾਬੀ-3L-3 ਕਰੈਡਿਟ

ਪਾਠ-ਕ੍ਰਮ:

ਯੂਨਿਟ-1 (ਸਾਹਿਤ)

1. ਵਤਨ ਦਾ ਪਿਆਰ - ਪ੍ਰੋ. ਪੂਰਨ ਸਿੰਘ
2. ਸਾਕਾ ਸ੍ਰੀ ਨਨਕਾਣਾ ਸਾਹਿਬ- ਭਾਈ ਮੋਹਨ ਸਿੰਘ ਵੈਦ
3. ਘਰ ਦਾ ਪਿਆਰ - ਪ੍ਰਿੰ, ਤੇਜਾ ਸਿੰਘ
4. ਮੇਰੇ ਦਾਦੀ ਜੀ-ਗੁਰਬਖਸ਼ ਸਿੰਘ (ਪ੍ਰੀਤਲੜੀ)
5. ਮਨ ਦੀ ਮੌਜ - ਗਿ. ਲਾਲ ਸਿੰਘ ਕਮਲਾ ਅਕਾਲੀ
6. ਗੁਰ-ਸੰਗਤ ਬਾਣੀ - ਗਿ. ਹੀਰਾ ਸਿੰਘ ਦਰਦ
7. ਕਾਠ ਦੀ ਰੋਟੀ - ਪ੍ਰੋ. ਸਾਹਿਬ ਸਿੰਘ
8. ਗੁਰੂ ਅਰਜਨ ਦੇਵ ਜੀ ਦੀ ਸ਼ਹਾਦਤ - ਡਾ. ਗੰਡਾ ਸਿੰਘ
9. ਸ਼ਾਂਤੀ ਨਿਕੇਤਨ - ਸ.ਸ. ਅਮੋਲ
10. ਗਿੱਧਾ - ਦੇਵਿੰਦਰ ਸਤਿਆਰਥੀ
11. ਅੱਥਰੂ- ਬਲਰਾਜ ਸਾਹਨੀ
12. ਪੰਜਾਬ ਦਾ ਸਭਿਆਚਾਰ - ਸੂਬਾ ਸਿੰਘ
13. ਬੁਲ੍ਹੇ ਸ਼ਾਹ ਦੀ ਕਾਵਿ ਕਲਾ - ਪ੍ਰੋ. ਦੀਵਾਨ ਸਿੰਘ
14. ਸੜਕ ਪਾਰ ਕਰਦਾ ਬੁਢੇਪਾ -ਕੁਲਬੀਰ ਸਿੰਘ ਕਾਂਗ

ਯੂਨਿਟ-੨ (ਭਾਸ਼ਾ)

ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਦੀਆਂ ਵਿਸ਼ੇਸ਼ਤਾਵਾਂ
ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਉਪਰ ਪਏ ਪ੍ਰਭਾਵ

ਯੂਨਿਟ-੩ (ਵਿਆਕਰਣ)

ਪੰਜਾਬੀ ਸ਼ਬਦ ਸ਼੍ਰੇਣੀਆਂ : ਨਾਂਵ, ਪੜਨਾਂਵ, ਵਿਸ਼ੇਸ਼ਣ, ਕਿਰਿਆ, ਸਹਾਇਕ ਕਿਰਿਆ, ਕਿਰਿਆ ਵਿਸ਼ੇਸ਼ਣ, ਸਬੰਧਕ, ਯੋਜਕ, ਵਿਸਮਿਕ।

ਯੂਨਿਟ-੪ (ਲੇਖਣੀ-ਕਲਾ)

ਰਿਪੋਰਟਿੰਗ, ਸਮਾਚਾਰ ਲਿਖਣ ਦੀ ਵਿਧੀ ਤੇ ਤੱਤ
ਪੰਜਾਬੀ ਪੈਰ੍ਹੇ ਦਾ ਸਰਲ ਅੰਗਰੇਜ਼ੀ ਅਨੁਵਾਦ
ਦਫਤਰੀ ਚਿੱਠੀ ਪੱਤਰ

ਸਹਾਇਕ ਪੁਸਤਕਾਂ:

ਆਧੁਨਿਕ ਪੰਜਾਬੀ ਵਾਰਤਕ (ਸੰਪ. ਗੁਰਬਚਨ ਸਿੰਘ ਤਾਲਿਬ),ਪੰਜਾਬੀ ਸਾਹਿਤ ਪ੍ਰਕਾਸ਼ਨ ਅੰਮ੍ਰਿਤਸਰ।

ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਦਾ ਵਿਆਕਰਨ (ਭਾਗ-1) ਜੋਗਿੰਦਰ ਸਿੰਘ ਪੁਆਰ, ਬਲਦੇਵ ਸਿੰਘ ਚੀਮਾ, ਸੁਖਵਿੰਦਰ ਸਿੰਘ ਸੰਘਾ, ਵੇਦ ਅਗਨੀਹੋਤਰੀ), ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਅਕਾਦਮੀ, ਜਲੰਧਰ, ਐਡੀਸ਼ਨ 2009.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:	BSNM208A-18			
Subject Title:	**Punjab History & Culture**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course

Unit	Content
I	Foundation of Sikh Panth: Guru Nanak Dev and his Teachings: Early life, Conception of God, Importance of the Guru, Insistance on right conduct and earnest profession; Institution of community kitchen (Langer) and Congregational worship (sangat), Succession to Guruship.
II	Development of the Sikh Panth: Guru Angad Dev to Guru Arjan Dev: Increasing number of sangats: Sikh ceremonies; the Manji and Masand system, The founding of the sacred places, The Harimandir. Compilation of the Adi Granth.
III	Transformation of the Sikh Panth: Guru Hargobind to Guru Tegh Bahadur: Martyrdom of Guru Arjan Dev and Guru Hargobind's response; Armed conflict with the state; Circumstances leading to the accession and martyrdom of Guru Tegh Bahadur.
IV	Creation of Khalsa: Meaning; Circumstances leading to the creation of the Khalsa (1699); New Social order; Conflict with the Hill chiefs and Mughal administrators; Legacy.
	Recommended Book **1.** Grewal J.S., From Guru Nanak to Maharaja Ranjit Singh, G.N.D. University, Amritsar, 1982. 2. The New Cambridge History of India: The Sikhs of the Punjab, CUP, New Delhi, 1990. 3. Guru Nanak in History, Panjab University, Chandigarh, 1969. 4. Khushwant Singh, A History of the Sikhs, Vol. I (1469-1839), OUP, Delhi, 1977. 5. McLeod, W.H., Guru Nanak and the Sikh Religion, OUP, Delhi, 1968. 6. Teja Singh and Ganda Singh, A Short History of the Sikhs Vol. (1469-1765), Patiala 1983 7. Banerjee, I.B. Evolution of the Khalsa, 2 Vols., A. Mukherjee & Co., Calcutta, 1979. 8.Grewal, J.S. and S.S.Bal, Guru Gobind Singh, Panjab University, Chandigarh, 1987. 9. Indu Banga, The Khalsa Over 300 Years, Manohar, New Delhi, 1999. 10. Harbans Singh (ed), The Encyclopedia of Sikhism, 4 Vols., Punjabi University, Patiala 1992. 11. McLeod, W.H. Evolution of the Sikh Community, OUP, Delhi, 1970. 12. Historical Dictionary of Sikhism, OUP, New Delhi, 2002.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:	BSNM209-18			
Subject Title:	**CHEMISTRY LAB II**			
Contact Hours:	**L:0**	**T:0**	**P:4**	**Credits:2**

Crystallization:

Concept of indication of crystallization. Phthalic acid from hot water (using fluted filter paper & stem less funnel)

Acetanilide from boiling water.

Naphthalene from Ethanol

Benzoic acid from water

Physical Chemistry:

1. To determine the specific reaction rate of hydrolysis of ethyl acetate catalysed by Hydrogen ions at room temperature.

2. To study the effect of acid strength on hydrolysis of an ester.

Viscosity, Surface Tension (Pure Liquids)

3. To study the viscosity and surface tension of CCI glycerine solution in water.

4. To determine the solubility of benzoic acid at different temperatures and to determine ΔH of the dissolution process.

5. To determine the enthalpy of neutralisation of a weak acid/weak base versus strong base/strong acid and determine the enthalpy of ionisation of the weak acid/weak base.

6. To determine the enthalpy of dissolution of solid calcium chloride and calculate the lattice energy of calcium chloride from its enthalpy data using Born Haber cycle.

Recommended Books:

1. Practical Organic Chemistry by F.G. Mann and B.C. Saunders
2. Advanced Practical Physical Chemistry by J.B. Jadav.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:	BSNM210-18			
Subject Title:	**Physics Lab**			
Contact Hours:	**L:0**	**T:0**	**P:4**	**Credits:2**

At least 08 experiments from the following:

1. To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses.
2. To compare capacitances using De`Sauty's bridge.
3. Measurement of field strength B and its variation in a Solenoid (Determine dB/dx).
4. To study the Characteristics of a Series RC Circuit.
5. To study the series and parallel LCR circuit and determine its (a) Resonant Frequency, (b) Quality Factor Q.
6. To determine a Low Resistance by Carey Foster's Bridge.
7. To verify the Thevenin and Norton theorem.
8. To verify the Superposition, and Maximum Power Transfer Theorem
9. To determine unknown capacitance by flashing and quenching method.
10. To study B-H curve for a ferromagnetic material using CRO.
11. To find out the frequency of AC mains using electric-vibrator.
12. To find out polarizability of a dielectric substance.
13. To determine the value of self-inductance by Maxwell Inductance/Capacitance Bridge.
14. To determine the mutual inductance of two coils.
15. To find out the horizontal component of earth's magnetic field (Bh).
16. Ballistic Galvanometer: (i) Measurement of charge and current sensitivity (ii) Measurement of CDR (iii) Determine a high resistance by Leakage Method (iv) To determine Self Inductance of a Coil by Rayleigh's Method.

REFERENCE BOOKS:

11. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
12. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
13. Engineering Practical Physics, S.Panigrahi & B.Mallick,2015, Cengage Learning India Pvt. Ltd.
14. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.
15. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 201, Kitab Mahal.
16. B Sc. Practical Physics, C. L. Arora, S. Chand & Co.
17. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:	BSNM211-18			
Subject Title:	**Computer Algebra system: MATLAB**			
Contact Hours:	**L:0**	**T:0**	**P:2**	**Credits:1**

Course Objectives This course is designed to introduce a Computer Algebra System: MATLAB which is currently used in scientific computations. The main focus will be on introduction to basic concepts of MATLAB using simple examples.

UNIT-I

The MATLAB environment, scalars, variables, arrays, mathematical operations with arrays, built-in and user defined functions, graphics: two-dimensional and three-dimensional, m-files: script and function files, functions: input; disp and fprintf, relational and logical operators.

UNIT-II

Symbolic math: symbolic objects and expressions; collect; expand; factor; simplify; solve; diff and int commands, Programming: if-end structure; if-else-end structure; loops: for-end and while-end.

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

- Visualize functions in 2-D and 3-D.
- Use symbolic tools of MATLAB for solving problems arising in various fields of applications.
- Make their own computer programs for solving problems of their interest.

Reference Books.

1. D. J. Higham and N. J. Higham, MATLAB Guide, 2nd Edition, Society for Industrial and Applied Mathematics (SIAM), 2005.
2. Amos Gilat, MATLAB: An Introduction with Applications, 5th Edition, John Wiley & Sons, 2014.+

Third Semester

Course Code	Course Title	Load Allocation			Marks Distribution		Total	Credits
		L	T	P	Internal	External		
BSNM-301-18	Organic Chemistry-II	3	0	0	25	50	75	3
BSNM-302-18	Physical Chemistry-II	3	0	0	25	50	75	3
BSNM-303-18	Optics	3	0	0	25	50	75	3
BSNM-304-18	Thermal Physics	3	0	0	25	50	75	3
BSNM-305-18	Analysis-I	3	0	0	25	50	75	3
BSNM-306-18	Differential Equations	3	0	0	25	50	75	3
BSNM-307-18	English-III	3	0	0	25	50	75	3
BSNM-308-18(A) / BSNM-308-18(B)	Punjabi-III/Punjab History & Culture-III	3	0	0	25	50	75	3
BSNM-309-18	Environment Science	2	0	0	25	50	75	1
BSNM-310-18	Chemistry Lab-III	0	0	4	30	20	50	2
BSNM-311 -18	Physics Lab-III	0	0	4	30	20	50	2
Total		**26**	**0**	**8**	**285**	**490**	**775**	**29**

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:	**BSNM301-18**			
Subject Title:	**ORGANIC CHEMISTRY-II**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course

Unit	Content
I	**Alkyl and Aryl Halides** Nomenclature and classes of alkyl halides, Chemical reactions. Mechanisms of nucleophilic substitution reaction of alkyl halides, SN2 and SN1 reactions with energy profile diagrams. Nuclear and side chain reactions. The addition-elimination and the elimination-addition mechanisms of nucleophilic aromatic substitution reactions. Relative reactivities of alkyl halides vs allyl, vinyl and aryl halides.
II	**Arenes and Aromaticity** Nomenclature of benzene derivatives. The aryl group. Aromatic nucleus and side chain. Structure of benzene: Molecular formula and Kekule structure. Stability and carbon carbon bond lengths of benzene, resonance structure, MO picture. Aromaticity : the Huckel's rule, aromatic ions. Aromatic electrophilic substitution–general pattern of the mechanism, role of σ and π complexes. Mechanism of nitration, halogenation, sulphonation, mercuration and Friedel Crafts reaction. Energy profile diagrams. Activating and deactivating substituents, orientation and ortho/para ratio. Side chain reactions of benzene derivatives. Methods of formation and chemical reactions of alkylbenzenes.
III	**Alcohols** Classification and nomenclature. Monohydric alcohols-nomenclature. Acidic nature. Reactions of alcohols. Dihydric alcohols-nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [$Pb(OAC)_4$] and [HIO_4] and pinacol-pinacolone rearrangement. **Phenols** Nomenclature, structure and bonding, Preparation of phenols, physical properties and acidic character, Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols-electrophilic aromatic substitution, acylation and carboxylation. Mechanisms of Fries rearrangement, Claisen rearrangement, Gatterman synthesis, Reimer Tiemann reaction.
IV	**Aldehydes and Ketones** Nomenclature and structure of the carbonyl group. Synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, synthesis of aldehydes and ketones using 1,3-dithianes, synthesis of ketones from nitriles and from carboxylic acids. Physical properties. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations. Condensation with ammonia and its derivatives. Witting reaction. Mannich reaction. Use of acetals as protecting group. Oxidation of aldehydes, Baeyer-Villiger oxidation of Ketones, Cannizzaro reaction. MPV, Clemmensen, Wolff-Kishner, $LIAIH_4$ and $NaBH_4$ reductions. Halogenation of enolizable ketones. Halogenation of enoliable ketones.
	Recommended Books: 1. Organic Chemsitry, Morrison and Boyd, Prentice- Hall. 2. Fundamentals of Organic Chemistry, Solomons, John Wiley.

	3. Organic Chemistry. F.A. Carey, McGraw Hill, Inc. 4. Organic Chemistry, L.G. Wade Jr. Prentice Hall. 5. Organic Chemistry Vol. I, II & III, S.M. Mukherji, S.P. Singh and R.P. Kapoor, Wiley Eastern Ltd (New Age International). 6. Introduction to organic chemistry, Stritwieser, Heathcock and Kosover, Macmilan.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:	**BSNM302-18**			
Subject Title:	**PHYSICAL CHEMISTRY-II**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course

Unit	Content
I	**Thermodynamics-I** Definition of thermodynamic terms: System, surroundings etc. Types of systems, intensive and extensive properties. State and path functions and their differentials. Thermodynamic process. Concept of heat and work. First Law of Thermodynamics: Statement, definition of internal energy and enthalpy. Heat capacity, heat capacities at constant volume and pressure and their relationship. Joule's law-Joule-Thomson coefficient and inversion temperature, Calculation of w, q, dU & dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process.
II	**Thermodynamics-I** Thermochemistry: Standard state, standard enthalpy of formation-Hess's Law of heat summation and its applications. Heat of reaction at constant pressure and at constant volume. Enthalpy of neutralization. Bond dissociation energy and its calculation from thermo-chemical data, temperature dependence of enthalpy. Kirchhoff's equation. **Thermodynamics-II** Second Law of Thermodynamics: Need for the law, different statements of the law, Carnot cycle and its efficiency, Carnot theorem. Thermodynamic scale of temperature. Concept of Entropy : Entropy as a state function, entropy as a function of V & T, entropy as a function of P & T, entropy change in physical change, Clausius inequality, entropy as a criteria of spontaneity and equilibrium. Entropy change in ideal gases and mixing of gases.
III	**Thermodynamics-III** Third Law of Thermodynamics: Nernst heat theorem, statement and concept of residual entropy, evaluation of absolute entropy from heat capacity data. Gibbs and Helmholtz functions; Gibbs function (G) and Helmholtz function (A) as thermodynamic quantities, A & G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entrop y change, Variation of G and A with P, V and T. **Equilibrium** Chemical Equilibrium Equilibrium constant and free energy. Thermodynamic derivation of law of mass action. Determination of K_p, K_c, K_a and their relationship, Clausius-Clapeyron equation, applications.
IV	**Introduction to Phase Equilibrium** Statement and meaning of the terms-phase, component and degree of freedom, derivation of Gibbs phase rule, phase equilibria of one component system-water, CO_2 and S systems. Phase equilibria of two component systems-solid-liquid equilibria, simple eutectic-Bi-Cd, Pb-Ag systems, desilverisation of lead. Solid solutions-compound formation with congruent melting point (Mg-Zn) and incongruent melting point, ($NaCl-H_2O$), $FaCl_3-H_2O$) and $CuSO_4-H_2O$) system. Freezing mixtures, acetone-dry ice. Non-ideal system-azeotropes-$HCl-H_2O$ and ethanol water system. Partially miscible liquids Phenol-water, trines-thylamin-water, Nicotine-water System. Lower and upper consulate temperature, Effect of impurity on consolute temperature, immiscible liquids, steam distillation. Nernst distribution law-

	thermodynamic derivation and applications.
	Recommended Books: 1. Thermodynamics for Chemists, S. Glasstone. 2 Chemical thermodynamics, P.A. Rock. 3. Principles of Physical Chemistry, S.H. Maron & C.F. Prutton. 4. Physical Chemistry, P.W. Atkins. 5. Physical Chemistry, Vol.2, K.L. Kapoor. 6. Physical Chemistry, K.J. Laidler.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:	**BSNM303-18**			
Subject Title:	**OPTICS**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course

Unit	Content
I	**Interference:** Definition and properties of wave front, Temporal and Spatial Coherence, Young's double slit experiment, Lloyd's single mirror and Fresnel's Biprism. Phase change on reflection, Interference in Thin Films: parallel and wedge-shaped films, Newton's Rings: Measurement of wavelength and refractive index, Interferometer: Michelson Interferometer. (10 Lectures)
II	**Diffraction:** Huygens Principle, Fraunhofer diffraction: Single slit. Circular aperture, Rayleigh criterion of resolution, Resolving Power of a telescope, Double slit, Multiple slits, Diffraction grating, Resolving power of grating, Fresnel diffraction pattern of a straight edge and circular aperture. (10 Lectures)
III	**Polarization:** Plane polarized light, Representation of Unpolarized and Polarized light, Polarization by Reflection, Brewster's law, Malus Law, Polarization by Selective absorption by Crystals, Polarization by Scattering, Polarization by Double Refraction, Nicol Prism. (10 Lectures)
IV	**Laser and Application:** Lasers, Spontaneous emission, Stimulated absorption, Stimulated emission, Einstein coefficients, Einstein relations, Conditions for Laser actions, Population inversion, Different types of Laser Pumping mechanism: Optical Pumping, Electric Discharge and Electrical pumping, Resonators, Two, Three and Four level laser systems, Ruby laser, He-Ne gas Laser, CO2 laser, applications of laser: Holography. (10 Lectures)
	Recommended Books: 1. Optics: A.K. Ghatak (Tata-McGraw Hill), 1992. 2. Fundamentals of Optics: F.A. Jenkins and H.E. White (McGraw Hill), 1981. 3. Introduction to Modern Optics (2nd ed.), G.R. Fowles, Dover, ISBN 0-486-65957-7, 2012. 4. Fundamentals of Optics, F.A. Jenkins & H.E. White, McGraw-Hill, 2011. 5. Schaum's Outline of Theory and Problems of Optics, E. Hecht, McGraw-Hill,ISBN 0-07-027730-3,1998.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:	**BSNM304-18**			
Subject Title:	**THERMAL PHYSICS**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course

Unit	Content
I	**Thermodynamics:** Laws of Thermodynamics: The zeroth law; indicator diagrams, work done, first law, internal energy, Carnot cycle, Carnot's theorem, the second law. Entropy as a thermodynamic variable; reversible and irreversible processes. Principle of increase of entropy. Thermodynamic scale of temperature; its identity with perfect gas scale, impossibility of attaining absolute zero. (10 Lectures)
II	**Maxwell's equations**, application to Clausius-Clapeyron equation and Joule-Thomson effect. Thermodynamic potentials, relation to thermodynamic variables; equilibrium in thermo dynamic systems, simple applications, Thomson and adiabatic cooling, Joule-Thomson expansion; Constancy of U+PV, cooling, liquefaction of gases. Low temperatures: Production and measurement of very low temperatures, adiabatic demagnetization. (10 Lectures)
III	**Statistical Physics:** The statistical basis of thermodynamics: Probability and thermodynamic probability; principle of equal a priori probabilities, probability distribution, its narrowing with increasing n, average properties, fluctuations, micro and macrostates, accessible and inaccessible states. Phase space, division of phase space into cells.
IV	Thermal equilibrium between two systems, beta parameter and its identification with (kT)-1, probability and entropy, Boltzmann's entropy relation, statistical interpretation of second law of thermodynamics. Maxwell-Boltzmann statistics, application of M-B statistics to monoatomic gas, principle of equipartition of energy, Bose-Einstein statistics, deduction of Planck's radiation law, derivation of Wiens's displacement law and Stefan's law. Fermi-Dirac statistics, comparison of three types of statistics. (10 Lectures)
	Recommended Books: 1. Statistical Physics and Thermodynamics-V.S. Bhatia, Punjab University, Chandigarh, 1977 2. Thermodynamics and Statistical Physics-Khandelwal and Loknathan, Shivlal Agnawala, Agna, 1979 3. Heat and Thermodynamics-Zemansky and Dittman, Mc Graw HillScience/Engineering/Math-7th edition (Nov,1, 1996)

BSNM305-18 ANALYSIS-I

L	T	P
3	0	0

UNIT-I

Series of non-negative terms, P-test, comparison tests, Cauchy's integral test, Cauchy's root test, D'Alembert ratio test, Raabe's test, De Morgan and Bertrand's test, Gauss' test, logarithmic test, Alternating series, absolute and conditional convergence, rearrangement of absolutely convergent series.

UNIT-II

Riemann integral, integrability of continuous and monotonic functions, properties of integrable functions, the fundamental theorem of integral calculus, mean value theorems of integral calculus.

UNIT-III

Improper integral and their convergence, comparison tests, absolute and conditional convergence, Abel's and Dirichlet's test.

UNIT-IV

Beta and Gamma functions, properties of Gamma function, transformation of Gamma function, symmetrical property of Beta function, transformation of Beta function, relation between Beta and Gamma functions.

Reference Books.

- Shanti Narayan and M. D. Raisinghania, Elements of Real Analysis, S. Chand, 2018
7. Robert Wrede and Murray R. Spiegel, Advanced Calculus, 3rd Edition, Schaum's Outline Series (McGraw Hill), 2010.
8. S. Lang, Undergraduate Analysis, Springer-Verlag, New York, 1983.
9. S C Malik and Savita Arora, Mathematical Analysis, New Age International Publishers, 2017

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B.Sc. (Non-Medical) Batch 2018 onwards

BSNM306-18 DIFFERENTIAL EQUATIONS

L	T	P
3	0	0

UNIT-I

Exact differential equations, first order and higher degree equations solvable for x, y and p=dy/dx. Clairaut's form, singular solution as an envelope of general solutions. Geometric meaning of a differential equation. Orthogonal trajectories. Linear differential equations with constant coefficients.

UNIT-II

Linear differential equations with variable coefficients: Cauchy and Legendre equations. Linear differential equations of second order- transformation of the equation by changing the dependent variable/ the independent variable, methods of variation of parameters and reduction of order, Simultaneously differential equations.

UNIT-III

Partial differential equation: Formation of first and second order equations, linear equation of first order, integral surfaces passing through a given curve, surfaces orthogonal to a given system of surfaces.

UNIT-IV

Nonlinear first order partial differential equations: Charpit's method, Higher order linear partial differential equations with constant coefficients: complementary function, particular integral.

Reference Books.

1. W E Boyce and R C DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edition, Wiley, 2009.
2. R K Jain and S R K Iyengar, Advanced Engineering Mathematics, 4th Edition, Narosa Publishing House Pvt LtD, New Delhi, 2012
3. I N Sneddon, Elements of Partial Differential Equations, McGraw-Hill, 1957
4. S L Ross, Differential Equations, John Wiley & Sons, 2004
5. M D Raisinghania, Advanced Differential Equations, 19th Edition, S. Chand, 2018

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:	**BSNM307-18**			
Subject Title:	**ENGLISH-III**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the course:

Unit	Contents
I	**Textbook entitled 'Prism: Spoken and Written Communication, Prose & Poetry' published by Orient Longman** For enhancing vocabulary and learning sentence/speech construction: **Prose:** 1) The Bet – Anton Chekov 2) An Astrologer's Day – R. K. Narayan 3) The Gift of the Magi – O' Henry **Poetry:** 1) The Felling of the Banyan Tree – Dilip Chitre 2) Stay Calm – Grenville Kleiser
II	**Grammar and Vocabulary** Modal auxiliaries, Gerunds Infinitives; Participles; Usage of Conjunctions; Scientific & Technical Vocabulary;
III	**Reading & Writing Skills:** Note Making and Note Taking; Writing abstracts & summaries
IV	**Spoken Skills** 1) Meeting People, Exchanging Greetings and Taking Leave 2) Introducing Yourself 3) Introducing People to Others 4) Answering the Telephone and Asking for Someone 5) Dealing with a Wrong Number 6) Taking and Leaving Messages 7) Making Inquiries on the Phone 8) Calling for Help in an Emergency
	Recommended Books: William Zinsser. *On Writing Well*. Harper Resource Book. 2001 Robert Louis Stevenson, *The Strange Case of Dr Jekyll and Mr Hyde*, Madhuban Publications, 2005 Wren and Martin, *High School English Grammar and Composition,* S Chand (Indian edition), 2008. A J Thomson and A V Martinet, *A Practical English Grammar*, Oxford India, 2007

	R V Lesikar, M E Flatley, K Rentz and N Pande, *Business Comminication (Making Connections in Digital World)*, Tata McGraw Hill, 2010 M Frank, *Writing as Thinking: A Guided Process Approach, Englewood Cliffs*, Prentice Hall Regents.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:	**BSNM308-18 (A)**			
Subject Title:	**PUNJABI-III**			
Contact Hours:	**L:**	**T:**	**P:**	**Credits:**

Details of the Course

Unit	Contents	Contact Hours
I	**ਕਵਿਤਾ ਭਾਗ:** ਭਾਈ ਵੀਰ ਸਿੰਘ: ਸਮਾਂ, ਚਸ਼ਮਾ ਪ੍ਰੋ. ਪੂਰਨ ਸਿੰਘ : ਪੰਜਾਬ ਨੂੰ ਕੂਕਾਂ ਮੈਂ, ਹੱਲ ਵਾਹੁਣ ਵਾਲੇ ਪ੍ਰੋ.ਮੋਹਨ ਸਿੰਘ : ਮਾਂ, ਕੋਈ ਆਇਆ ਸਾਡੇ ਵਿਹੜੇ, ਪਿਆਰ ਪੰਧ ਅੰਮ੍ਰਿਤਾ ਪ੍ਰੀਤਮ: ਆਖਾਂ ਵਾਰਿਸ ਸ਼ਾਹ ਨੂੰ, ਅੰਨਦਾਤਾ	12
II	**ਕਹਾਣੀ ਭਾਗ:** ਸੰਤ ਸਿੰਘ ਸੇਖੋਂ : ਪੇਮੀ ਦੇ ਨਿਆਣੇ ਸੁਜਾਨ ਸਿੰਘ : ਕੁਲਫੀ ਕੁਲਵੰਤ ਸਿੰਘ ਵਿਰਕ : ਤੂੜੀ ਦੀ ਪੰਡ ਗੁਰਦਿਆਲ ਸਿੰਘ : ਸਾਂਝ	11
III	ਸਵਰ ਤੇ ਵਿਅੰਜਨ ਧੁਨੀਆਂ ਦਾ ਨਿਖੇੜਾ ਤੇ ਵਰਗੀਕਰਨ ਦੁੱਤ ਵਿਅੰਜਨ ਤੇ ਸੰਯੁਕਤ ਵਿਅੰਜਨ ਅਗੇਤਰ, ਪਿਛੇਤਰ	12

IV	ਪੰਜਾਬੀ ਦੀਆਂ ਧੁਨੀਆਂ ਦੇ ਪਰਿਵਰਤਨ ਦੀਆਂ ਦਿਸ਼ਾਵਾਂ : ਲੋਪ, ਆਗਮ, ਵਿਕਾਰ, ਵਿਸ਼ਮੀਕਰਨ, ਵਿਪਰਜ। ਪੰਜਾਬੀ ਵਾਕ ਬਣਤਰ ਦਾ ਵਿਸਤਾਰ ਪੂਰਵਕ ਅਧਿਐਨ	10

Reference Books

S.No.	Author(s)	Title of the Book	Publisher/Year
1	ਡਾ. ਮਹਿਲ ਸਿੰਘ (ਸੰਪ.)	ਸਾਹਿਤ ਦੇ ਰੰਗ	ਰਵੀ ਸਾਹਿਤ ਪ੍ਰਕਾਸ਼ਨ, ਅੰਮ੍ਰਿਤਸਰ।
2	ਡਾ. ਸੁਖਵਿੰਦਰ ਸਿੰਘ ਸੰਘਾ	ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਵਿਗਿਆਨ	ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਅਕਾਦਮੀ, ਜਲੰਧਰ

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:	**BSNM301-18 (B)**			
Subject Title:	**Punjab History & Culture-III**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course

Unit	Content
I	The Indo-Aryans: Original home and settlement in Punjab, Social, Religious and Economic life during the Rig Vedic Age, Social, Religious and Economic life during later Vedic Age
II	Alexandra's invasion and its impact. Punjab under Chandragupta Maurya and Ashoka.
III	The Kushans and their contribution to the Punjab. The Panjab under the Gupta Emperor. The Punjab under the Vardhana Emperors.
IV	The Punjab from 7th Century to 1000 A.D. (A Survey of Political and Socio-cultural History of Punjab. Development of Art and Architecture of Punjab.
	Recommended Books: 1. L.M. Joshi (ed): History and Culture of the Punjab, Art-I, Patiala, 1989 (3rd edition) 2. L.M. Joshi and Fauja Singh (ed); History of Punjab, Vol. I, Patiala, 1977. 3. Budha Prakash: Glimpses of Ancient Punjab, Patiala, 1983. 4. B.N. Sharma: Life in Northern India, Delhi, 1966.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:	**BSNM309-18**			
Subject Title:	**ENVIRONMENT SCIENCE**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course

Unit	Content
I	Introduction: Definition and scope and importance of multidisciplinary nature of environment. Need for public awareness. Ecosystems: Concept of Ecosystem, Structure, interrelationship, producers, consumers and decomposers, ecological pyramids-biodiversity and importance. Hot spots of biodiversity Natural Resources: Natural Resources and associated problems, use and over exploitation, case studies of forest resources and water resources.
II	Environmental Pollution: Definition, Causes, effects and control measures of air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards. Solid waste Management: Causes, effects and control measure of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies. Disaster Management: Floods, earthquake, cyclone and landslides.
III	Social Issues and the Environment From Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management. Resettlement and rehabilitation of people; its problems and concerns. Case studies. Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies. Wasteland reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of pollution) Act. Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation Public awareness (5)
IV	Human Population and the Environment, Population growth, variation among nations. Population explosion – Family Welfare Programme. Environment and human health, Human Rights, Value Education, HIV/AIDS. Women and child Welfare. Role of Information Technology in Environment and human health. Case studies (4) Field Work: Visit to a local area to document environmental assets river/forest/grassland/hill/mountain, Visit to a local polluted site-Urban/Rural/Industrial/Agricultural, Study of common plants, insects, birds, Study of simple ecosystems-pond, river, hill slopes, etc. (Field work Equal to 5 lectures)
	Recommended Books: 1. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner. 2. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India, Email:mapin@icenet.net (R) 3. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p 4. Clark R.S., Marine Pollution, Clanderson Press Oxford (TB) 5. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumabai, 1196p 6. De A.K., Environmental Chemistry, Wiley Eastern Ltd. 7. Down to Earth, Centre for Science and Environment (R) 8. Gleick, H.P. 1993. Water in crisis, Pacific Institute for Studies in Dev., Environment &

	Security. Stockholm Env. Institute Oxford Univ. Press. 473p 9. Hawkins R.E., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay (R) 10. Heywood, V.H & Waston, R.T. 1995. Global Biodiversity Assessment. Cambridge Univ. Press 1140p. 11. Jadhav, H & Bhosale, V.M. 1995. Environmental Protection and Laws. Himalaya Pub. House, Delhi 284 p. 12. Mckinney, M.L. & School, R.M. 1996. Environmental Science systems & Solutions, Web enhanced edition. 639p. 13. Mhaskar A.K., Matter Hazardous, Techno-Science Publication (TB) 14. Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co. (TB) 15. Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co. USA, 574p 16. Rao M N. & Datta, A.K. 1987. Waste Water treatment. Oxford & IBH Publ. Co. Pvt. Ltd. 345p. 17. Sharma B.K., 2001. Environmental Chemistry. Geol Publ. House, Meerut 18. Survey of the Environment, The Hindu (M) 19. Townsend C., Harper J, and Michael Begon, Essentials of Ecology, Blackwell Science (TB) 20. Trivedi R.K., Handbook of Environmental Laws, Rules Guidelines, Compliances and Stadards, Vol I and II, Enviro Media (R) 21. Trivedi R. K. and P.K. Goel, Introduction to air pollution, Techno-Science Publication (TB) 22. Wanger K.D., 1998 Environmental Management. W.B. Saunders Co. Philadelphia, USA 499p 23.Rao M. N. & Datta A.K. 1987. Waste Water Treatment. Oxford & IBH Publ. Co. Pvt. Ltd. 345 p. 24. Principle of Environment Science by Cunninghan, W.P. (TB) 25. Essentials of Environment Science by Joseph. (TB) 26. Environment Pollution Control Engineering by Rao, C.S. (TB) (M) Magazine (R) Reference (TB) Textbook

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:	**BSNM310-18**			
Subject Title:	**CHEMISTRY LAB III**			
Contact Hours:	**L:0**	**T:0**	**P:4**	**Credits:2**

Quantitative Analysis

Volumetric Analysis

1. Determination of acetic acid in commercial vinegar using NaOH.
2. Determination of alkali content-antacid tablet using HCI.
3. Estimation of calcium content in chalk as calcium oxalate by permanganometry.
4. Estimation of hardness of water by EDTA.
5. Estimation of ferrous and ferric by dichromate method.
6. Estimation of copper using sodiumthiosulphate.

Gravimetric Analysis

Analysis of Cu as CuSCN and Ni as Ni (dimethylgloxime)

Organic Chemistry Laboratory Techniques

Thin Layer Chromatography

Determination of R_f values and identification of organic compounds.

1. Separation of green leaf pigments (spinach leaves may be used).
2. Preparation and separation of 2, 4. dinitrophenylhydrazones of acetone, 2-butone, 2-Butanone, hexan-2 and 3-one using toluene and light petroleum (40 : 60).
3. Separation of a mixture of dyes using cyclohexane and ethyl acetate (8.5:1.5).

Recommended Books:

3. Practical Organic Chemistry by F.G. Mann and B.C. Saunders
4. Practical Inorganic Chemistry by J.R. Barrante G. Marr and B.W. Rockett
5. Vogel's Inorganic Quantitative Analysis

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:	**BSNM311-18**			
Subject Title:	**PHYSICS LAB-III**			
Contact Hours:	**L:0**	**T:0**	**P:4**	**Credits:2**

At least 08 experiments from the following:

1. To study the laser beam characteristics like; wave length using diffraction grating aperture & divergence.
2. Study of diffraction using laser beam and thus to determine the grating element.
3. To study laser interference using Michelson's Interferometer.
4. To study wavelength of sodium light using Newton Rings.
5. To determine the numerical aperture of a given optic fibre and hence to find its acceptance angle.
6. To find the refractive index of a material/glass using spectrometer.
7. To find the refractive index of a liquid using spectrometer
8. To find the velocity of ultrasound in liquid.
9. To determine the specific rotation of sugar using Laurent's half-shade polarimeter.
10. To determine the coefficient of thermal conductivity of a bad conductor using Lee's disc apparatus.
11. To compare heat transfer between different material surface and the black body surface by radiation.
12. To find the emissivity of different material surface.

REFERENCE BOOKS:

18. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
19. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
20. Engineering Practical Physics, S.Panigrahi & B. Mallick,2015, Cengage Learning India Pvt. Ltd.
21. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.
22. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 201, Kitab Mahal.
23. B Sc. Practical Physics, C. L. Arora, S. Chand & Co.
24. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

Fourth Semester

Course Code	Course Title	Load Allocation			Marks Distribution		Total	Credits
		L	T	P	Internal	External		
BSNM401-18	Inorganic Chemistry-III	3	0	0	25	50	75	3
BSNM402-18	Organic Chemistry-III	3	0	0	25	50	75	3
BSNM403-18	Wave Vibrations	3	0	0	25	50	75	3
BSNM404-18	Electronics	3	0	0	25	50	75	3
BSNM405-18	Analysis-II	3	0	0	25	50	75	3
BSNM406-18	Linear Algebra	3	0	0	25	50	75	3
BSNM407-18	English-IV	3	0	0	25	50	75	3
BSNM408-18 (A) / BSNM408-18 (B)	Punjabi-IV/Punjab History & Culture-IV	3	0	0	25	50	75	3
BSNM409-18	Chemistry Lab-IV	0	0	4	30	20	50	2
BSNM410-18	Physics Lab-IV	0	0	4	30	20	50	2
BSNM411-18	MATHEMATICA Software	0	0	2	30	20	50	1
Total		**24**	**0**	**10**	**290**	**460**	**750**	**29**

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:	BSNM401-18			
Subject Title:	**INORGANIC CHEMISTRY-III**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course

Unit	Content
I	**Coordination Compounds** Werner's coordination theory and its experimental verification, effective atomic number concept, chelates, nomenclature of coordination compounds, isomerism in coordination compounds, valence bond theory of transition metal complexes.
II	**Non-aqueous Solvents** Physical properties of a solvent, types of solvents and their general characteristics, reactions in non-aqueous solvents with reference to liquid NH_3 and liquid SO_2. **Oxidation and Reduction** Use of redox potential data-analysis of redox cycle, redox stability in water-Frost, Latimer and Pourbaix diagrams.
III	**Chemistry of Lanthanide Elements** Electronic structure, oxidation states and ionic radii and lanthanide contraction. Electronic absorption and magnetic properties of lanthanides. **Chemistry of Actinides** General features and chemistry of actinides, similarities between the later actinides and the later lanthanides. Electronic and magnetic properties of actinides and their general comparison with the lanthanide elements.
IV	**Bioinorganic Chemistry** Essential and trace elements in biological processes, metalloporphyrins and special reference to haemoglobin and myoglobin. Biological role of alkali and alkaline earth metal ions with special reference to Ca2+
	Recommended Books: 1. J.D. Lee, Concise Inorganic Chemistry, 4th Ed. 2. J.E. Huheey, Inorganic Chemistry, Harper & Row. 3. F.A.Cotton and G. Wilinson, Advanced Inorganic Chemistry, Interscience Publishers. 4. N.N. Greenwood and A. Earnshaw, Chemistry of Elements, Pergamon Press. 5. D.F.C. Shriver, P.W. Atkins and C.H. Langford, Inorganic Chemistry, ELBS Oxford, 1991s

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:	BSNM402-18			
Subject Title:	**ORGANIC CHEMISTRY-III**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course

Unit	Content
I	**Carboxylic Acids** Nomenclature, structure and bonding, physical properties, acidity of carboxylic acids, effects of substituents on acid strength. Reactions of carboxylic acids. Hell-Volhard-Zelinsky reaction. Synthesis of acid chlorides, esters and amides. Reduction of carboxylic acids. Mechanism of decarboxylation. **Carboxylic Acids Derivatives** Structure and nomenclature of acid chlorides, esters, amides and acid anhydrides, Relative stability & reactivity of acyl derivatives. Physical properties, interconversion of acid derivatives by nucleophilic acyl substitution. Preparation of carboxylic acid derivatives, chemical reactions. Mechanisms of esterification and hydrolysis (acidic and basic).
II	**Ethers and Epoxides** Nomenclature of ethers and methods of their formation, physical properties. Chemical reaction cleavage and autoxidation, Ziesel's method. Synthesis of epoxides. Acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organolithium reagents with epoxides. **Organometallic Compounds** Organomagnesium Compounds: The Grignard reagents-formation, structure and chemical reactions. Organolithium Compounds: Formation and chemical reactions. Organozinc and Organo copper Compounds: Nomenclature, structural features, Methods of formation and chemical reactions.
III	**Organic Compounds of Nitrogen** Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitroalkanes, Mechanisms of nucleophilc substitution in nitroarenes and their reduction in acidic, neutral and alkaline media. Reactivity, Structure and nomenclature of amines, Methods of preparation of amines by Reductive amination of aldehydic and ketonic compounds, Gabriel-phthalimide reaction and Hofmann bromamide reaction. Physical properties. Stereochemistry of amines. separation of a mixture of primary, secondary and tertiary amines. Structural features effecting basicity of amines. Amine salts as phase-transfer catalysts.
IV	**Heterocyclic Compounds** Introduction: Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine. Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution. Mechanism of nucleophilic substitution reactions in pyridine derivatives. Comparison of basicity of pyridine, piperidine and pyrrole.
	Recommended Books: 1. Organic Chemistry. F.A. Carey, McGraw Hill, Inc. 8th edition. 2. Organic Chemistry, Morrison and Boyd, Prentice Hall 3. Heterocyclic Chemistry, J.A. Joule, K. Mills and G.F. Smith, 3rd edition, Indian reprint, 2004. Chennai Microprint Pvt. Ltd. 4. Heterocyclic Chemistry, T.L. Gilchrist, Longman Scientific Technical 5. Organic ChemistryVol. I, II & III, S.M. Mukherji, S.P. Singh and R.P.Kapoor, Wiley Eastern Ltd (New Age International). 6. Introduction to organic chemistry, Stritwieser, Heathcock and Kosover, Macmilan.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:	BSNM403-18			
Subject Title:	**Waves Vibrations**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course

Unit	Content
I	**Simple and Damped Harmonic Motion:** Simple harmonic motion, energy of a SHO, Compound pendulum, Torsional pendulum, Electrical Oscillations, Lattice Vibrations, Transverse Vibrations of a mass on a string, Anharmonic Oscillations. Damped simple harmonic motion, Decay of free Vibrations due to damping, types of damping, Determination of damping coefficients – Logarithmic decrement, relaxation time and Q-factor. Electromagnetic damping. (10 Lectures)
II	**Forced Vibrations and Resonance**: Forced mechanical and electrical oscillator, Transient and Steady State Oscillations, Displacement and velocity variation with driving force frequency, Variation of phase with frequency resonance, Power supplied to forced oscillator by the driving force. Q-factor and band width of a forced oscillator, Electrical and nuclear magnetic resonances. (8 Lectures)
III	**Coupled Oscillations**: Stiffness coupled oscillators, Normal coordinates and modes of vibrations. Inductance coupling of electrical oscillators, Normal frequencies, Forced vibrations and resonance for coupled oscillators, Masses on string-coupled oscillators. (8 Lectures)
IV	**Waves in Physical Media**: Types of waves, wave equation (transverse) and its solution characteristics impedance of a string, Impedance matching, Reflection and Transmission of waves at boundary, Energy of vibrating string, wave and group velocity. (10 Lectures)
	Recommended Books: 1. Text Book of Vibrations and Waves: S.P. Puri (Macmillan India), 2004. 2. The Physics of Vibrations and Waves: H.J. Pain (Wiley and ELBS), 1976.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:	BSNM404-18			
Subject Title:	**ELECTRONICS**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course

Unit	Content
I	**P.N. Junction:** Intrinsic/Extrinsic semiconductor, Fermi level, Charge carries in semiconductors, PN junctions, depletion region, current components in pn junction, Characteristic of pn junction diode, pn junction as rectifier, characteristics and applications of Zener diode, Photodiode, LED and photocells. (10 Lectures)
II	**Electronic Devices**: Bipolar junction transistor, current components in transistors, CB, CE, CC configuration, h-parameters, transistor biasing, transistor as an amplifier, Emitter follower, characteristics and applications of FET, MOSFET. (10 Lectures)
III	**Transistor Circuits:** Feedback amplifiers; classification of amplifiers, feed-back concept, Sinusoidal oscillations; phase shift oscillators, Wien Bridge Oscillator, Crystal oscillator, Basic idea about AM modulation and demodulations, Oscilloscope. (10 Lectures)
IV	**Digital Principles:** Number system, Decimal, binary, Octal, hexadecimal, logic gates, AND, OR, NOT, NAND, NOR, XOR, XNOR, Karnaugh map techniques. (10 Lectures)
	Recommended Books: **1.** Integrated Electronics: J.Millman and C.C.Halkias (Tata McGraw Hill,2001). **2.** Electronic Devices & Circuits–J.Millman and C.C.Halkias (Tata McGraw Hill, 2009). **3.** Digital Principles & Applications–P.Malvine & Leach (Tata McGraw Hill,1993

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:	BSNM407-18			
Subject Title:	**ENGLISH-IV**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the course:

Unit	Contents
I	**Textbook entitled 'Prism: Spoken and Written Communication, Prose & Poetry' published by Orient Longman** **<u>For enhancing vocabulary and learning sentence/speech construction:</u>** **I. Prose:** 1) Socrates and the Schoolmaster – F. L. Brayne 2) With the Photographer – Stephen Leacock **II. Poetry:** 1) On Television – Roald Dahl 2) Say Not the Struggle Naught Availeth – Arthur Hugh Clough 3) Abou Ben Adhem – James Leigh Hunt
II	**Grammar and Vocabulary:** Transformation of sentences; Tenses; Active/Passive Voice; Narration
III	**Reading & Writing Skills:** Analytical reports; Drafting of career documents: Job Applications/ Resume/CV
IV	**Spoken Skills** 1. Getting People's Attention and Interrupting 2. Giving Instructions and Seeking Clarifications 3. Making Requests and Responding to Requests 4. Asking for Directions and Giving Directions 5. Thanking Someone and Responding to Thanks 6. Inviting and Accepting and Refusing an Invitation 7. Apologizing and Responding to an Apology 8. Asking for, Giving and Refusing Permission
	Recommended Books: William Zinsser. *On Writing Well*. Harper Resource Book. 2001 Robert Louis Stevenson, *The Strange Case of Dr Jekyll and Mr Hyde*, Madhuban Publications, 2005 Wren and Martin, *High School English Grammar and Composition,* S Chand (Indian edition),

	2008. A J Thomson and A V Martinet, *A Practical English Grammar*, Oxford India, 2007 R V Lesikar, M E Flatley, K Rentz and N Pande, *Business Comminication (Making Connections in Digital World)*, Tata McGraw Hill, 2010 M Frank, *Writig as Thinking: A Guided Process Approach, Englewood Cliffs*, Prentice Hall Regents.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:	BSNM408-18 (A)			
Subject Title:	**Punjabi-IV**			
Contact Hours:	**L:**	**T:**	**P:**	**Credits:**

Details of the Course

Unit	Contents	Contact Hours
I	ਡਾ.ਹਰਿਭਜਨ ਸਿੰਘ: ਅਪ੍ਰਮਾਣਿਕ, ਤੇਰੇ ਹਜ਼ੂਰ ਮੇਰੀ ਹਾਜ਼ਰੀ ਦੀ ਦਾਸਤਾਨ ਸ਼ਿਵ ਕੁਮਾਰ ਬਟਾਲਵੀ: ਕੰਡਿਆਲੀ ਥੋਰ੍ਹ, ਧਰਮੀ ਬਾਬਲ ਪਾਪ ਕਮਾਇਆ, ਰੁੱਖ ਪਾਸ਼: ਇਨਕਾਰ,ਸਭ ਤੋਂ ਖਤਰਨਾਕ,ਦਹਿਕਦੇ ਅੰਗਿਆਰਾਂ ‘ਤੇ ਸੁਰਜੀਤ ਪਾਤਰ: ਹੁਣ ਘਰਾਂ ਨੂੰ ਪਰਤਣਾ, ਕੁਝ ਕਿਹਾ ਤਾਂ..., ਪੁਲ	12
II	**ਕਹਾਣੀ ਭਾਗ:** ਸੰਤੋਖ ਸਿੰਘ ਧੀਰ: ਕੋਈ ਇਕ ਸਵਾਰ ਪ੍ਰੇਮ ਪ੍ਰਕਾਸ਼: ਲੱਛਮੀ ਮੋਹਨ ਭੰਡਾਰੀ : ਘੋਟਣਾ ਵਰਿਆਮ ਸਿੰਘ ਸੰਧੂ : ਆਪਣਾ ਆਪਣਾ ਹਿੱਸਾ	11
III	ਕੰਪਿਊਟਰ ਦੀ ਪਰਿਭਾਸ਼ਾ, ਡਾਟਾ ਸਟੋਰੇਜ਼ ਡਿਵਾਈਸਜ਼, ਟਾਈਪਿੰਗ ਦੀ ਮਹੱਤਤਾ, ਫਾਈਂਡ ਐਂਡ ਰੀਪਲੇਸ : ਫਾਈਂਡ ਐਂਡ ਚੇਜ਼ ਦ ਟੈਕਸਟ, ਸਪੈਲ ਚੈੱਕਰ	12

	ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਤੇ ਇੰਟਰਨੈੱਟ : ਈ.ਨਿਊਜਪੇਪਰ, ਵਿਕੀਪੀਡੀਆ	
IV	ਸਾਹਿਤ ਦੇ ਰੂਪ : ਕਵਿਤਾ, ਵਾਰਤਕ, ਕਹਾਣੀ, ਨਾਵਲ	10

Reference Books

S.No.	Author(s)	Title of the Book	Publisher/Year
1	ਡਾ. ਮਹਿਲ ਸਿੰਘ (ਸੰਪ.)	ਸਾਹਿਤ ਦੇ ਰੰਗ	ਰਵੀ ਸਾਹਿਤ ਪ੍ਰਕਾਸ਼ਨ, ਅੰਮ੍ਰਿਤਸਰ।
2	ਡਾ. ਸੁਖਵਿੰਦਰ ਸਿੰਘ ਸੰਘਾ	ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਵਿਗਿਆਨ	ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਅਕਾਦਮੀ, ਜਲੰਧਰ
3	ਰਤਨ ਸਿੰਘ ਜੱਗੀ	ਸਾਹਿਤ ਦੇ ਰੂਪ	ਪੰਜਾਬੀ ਯੂਨੀਵਰਸਿਟੀ, ਪਟਿਆਲਾ

Semester-IV

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:	BSNM408-18 (B)			
Subject Title:	**Punjab History & Culture IV**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course

Unit	Content
I	Guru Gobind Singh and the Khalsa Banda Singh Bahadur: Conquests and Execution
II	Sikh Struggle for Sovereignty Sikh Misls Ranjit Singh: Conquests, Administration and the Anglo-Sikh Relations Anglo-Sikh Wars and the Annexation
III	The Punjab under the British: New Administration, Education and Social Change
IV	Socio-Religious Reform Movements Role of Punjab in the Freedom Struggle
	Recommended Books: Kirpal Singh (ed.): History and Culture of the Punjab, Part-II, Punjabi University, Patiala, 1990. 2. Fauja Singh (ed.): History of Punjab, Vol. III, Punjabi University, Patiala, 1987. 3. J.S. Grewal: The Sikhs of the Punjab, CUP, Cambridge, 1991. 4. Sukhwant Singh. Agricultural Growth under Colonial Constraints: The Punjab 1849-1947, Manpreet Publication, Delhi, 2000. 5. Khushwant Singh, A History of the Sikhs, Vol. I, OUP, New Delhi, 1990. 6. Khushwant Singh, A History of the Sikhs, Vol. I, OUP, New Delhi, 1990.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:	BSNM409-18			
Subject Title:	**CHEMISTRY LAB IV**			
Contact Hours:	**L:0**	**T:0**	**P:4**	**Credits:2**

Qualitative Analysis

Detection of elements

1. Nitrogen,
2. Sulphur
3. Halogens

Detection of functional groups

1. Phenolic
2. carboxylic,
3. carbonyl,
4. esters,
5. carbohydrates,
6. amines, amides, nitro and anilide
   in simple organic compounds and preparing their derivatives

Recommended Books:

6. Practical Organic Chemistry by F.G. Mann and B.C. Saunders

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:	BSNM410-18			
Subject Title:	**Physics Lab-IV**			
Contact Hours:	**L:0**	**T:0**	**P:4**	**Credits:2**

At least 08 experiments from the following:

1. To determine the value of horizontal component of Earth's magnetic field Bh.
2. To determine unknown capacitance by flashing and quenching method.
3. To study the magnetic field of a circular coil carrying current.
4. To find out polarizability of a dielectric substance.
5. To determine the frequency of an electrically maintained tuning fork by i) Transverse mode of vibration ii) Longitudinal mode of vibration
6. To find out the frequency of AC mains using electric-vibrator/sonometer.
7. Experiment to study Doppler effect
8. To study V-I characteristic of a Ge-Si junction.
9. Analyze the suitability of a given Zener diode as a power regulator.
10. To study the band gap of a Ge semiconductor.
11. To study the the band gap of a Si semiconductor.

REFERENCE BOOKS:

25. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
26. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
27. Engineering Practical Physics, S.Panigrahi & B.Mallick,2015, Cengage Learning India Pvt. Ltd.
28. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.
29. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 201, Kitab Mahal.
30. B Sc. Practical Physics, C. L. Arora, S. Chand & Co.
31. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

IK Gujral Punjab Technical University Jalandhar
B.Sc. (Non-Medical) Batch 2018 onwards

Course Title: ANALYSIS-II

Course Code: BSNM405-18

UNIT-I

Sequence of functions: pointwise and uniform convergence, Cauchy's criterion for uniform convergence, Test (M_n-test) for uniform convergence, uniform convergence and continuity, uniform convergence and integration, uniform convergence and differentiation.

UNIT-II

Series of functions: pointwise and uniform convergence, Cauchy's criterion for uniform convergence, Weierstrass's M-test test, Abel's test, Dirichlet's test, uniform convergence and continuity, uniform convergence and integration, uniform convergence and differentiation. Weierstrass approximation theorem (Statement only).

UNIT-III

Vector differentiation, Gradient, Divergence and Curl with their properties and applications. Vector Integration: Line, Surface and Volume integration. Gauss divergence theorem, Stokes' theorem, Green's theorem.

UNIT-IV

Fourier series: Fourier expansion of piecewise monotonic functions, Fourier series for odd and even functions, half range series. Fourier series in the interval $[0, 2\pi]$, $[-1,1]$ and $[a, b]$.

Reference Books.

1. Tom Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 1985.
2. Shanti Narayan, M. D. Raisinghania, Elements of Real Analysis, S. Chand & Company, 2018.
3. S. C. Malik, Savita Arora, Mathematical Analysis, New Age International Publishers, 2017.
4. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons Inc, New York, 1999.

IK Gujral Punjab Technical University Jalandhar
B.Sc. (Non-Medical) Batch 2018 onwards

Course Title: LINEAR ALGEBRA

Course Code: BSNM406-18

UNIT-I

Linear independence of row and column vectors, row rank, column rank and rank of a matrix and their equivalence. Applications of matrices to a system of linear equations (both homogeneous and non-homogeneous). Theorems on consistency of a system of linear equations (both homogeneous and non-homogeneous).

UNIT-II

Eigenvalues, eigenvectors and characteristic equation of a matrix, Cayley-Hamilton theorem and its use in finding inverse of a matrix. Diagonalization.

UNIT-III

Vector Space: Definition and Examples of Vector Spaces, Subspaces, Algebra of subspaces, Linear span, Linear dependence and independence of vectors, Basis and dimension of a vector space, Basis and dimension of subspace, Direct sums and complements.

UNIT-IV

Linear transformations, Rank and Nullity of a linear transformation, Vector space of linear transformations. Linear transformations and matrices, Change of basis.

Reference Books.

1. P. B. Bhattacharya, S. K. Jain, S. R. Nagpaul, First Course in Linear Algebra, New Age International Publishers, 2015.
2. Bernard Kolman, David R. Hill, Elementary Linear Algebra with Applications, Pearson, 2007.
3. Vivek Sahai, Vikas Bist, Linear Algebra, Narosa, 2017.

IK Gujral Punjab Technical University Jalandhar
B.Sc. (Non-Medical) Batch 2018 onwards

Course Title: MATHEMATICA Software

Course Code: BSNM411-18

UNIT-I

The structure of MATHEMATICA, notebook interfaces, constants, variables, algebraic calculations, four kinds of brackets, lists, tables, expressions, functions, built-in functions, functional operations, graphics, patterns, manipulating lists, transformation rules, evaluation of expressions, modularity, manipulating notebooks, relational and logical operators.

UNIT-II

Symbolic math commands: D; Integrate; Sum; Product; Solve; Eliminate; Reduce; Series; Limit; Minimize; Programming: conditionals; loops: Do; For and While.

Reference Books.

1. Wolfram, S., The MATHEMATICA Book, 5th revised edition. Wolfram Media Inc, 2004.
2. Abell, M. and Braselton, J., Mathematica by Example, 5th Edition. Academic Press, 2017.

IK Gujral Punjab Technical University Jalandhar
B.Sc. Non-Medical Batch 2018 onwards

Bachelors of Science in Non-Medical (B.Sc. Non-Medical):

Courses & Examination Scheme:

Fifth Semester

Course Code	Course Title	Load Allocation			Marks Distribution		Total	Credits
		L	T	P	Internal	External		
BSNM501-18	Inorganic Chemistry-IV	3	0	0	25	50	75	3
BSNM502-18	Physical Chemistry-III	3	0	0	25	50	75	3
BSNM503-18	Elements of Modern Physics	3	0	0	25	50	75	3
BSNM504-18	Quantum Mechanics	3	0	0	25	50	75	3
BSNM505-18	Theory of probability	3	0	0	25	50	75	3
BSNM506-18	Numerical Analysis	3	0	0	25	50	75	3
BSNM507-18	English-V	3	0	0	25	50	75	3
BSNM508-18(A)/ BSNM508-18 (B)	Punjabi-V/Punjab History & Culture-V	3	0	0	25	50	75	3
BSNM509-18	Drug Abuse-I (Problem, and Management)	2	0	0	25	50	75	-
BSNM510-18	Chemistry Lab-V	0	0	4	30	20	50	2
BSNM511-18	Physics Lab-V	0	0	4	30	20	50	2
	Total							**28**

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title:	**INORGANIC CHEMISTRY-IV**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course

Unit	Content	Contact Hours
I	**Metal-ligand Bonding in Transition Metal Complexes** valence bond theory, Limitations of valence bond theory, an elementary idea of crystal-field theory, crystal field splitting in octahedral, tetrahedral and square planar complexes, factors affecting the crystal-field parameters.	10
II	**Magnetic Properties of Transition Metal Complexes** Types of magnetic behaviour, methods of determining magnetic susceptibility, spin-only formula. L-S coupling, correlation of μ_s and μ_{eff} values, orbital contribution to magnetic moments, application of magnetic moment data for characterization of 3d-metal complexes.	11
III	**Thermodynamic and Kinetic Aspects of Metal Complexes** A brief outline of thermodynamic stability of metal complexes and factors affecting the stability, substitution reactions of square planar complexes. **Electronic Spectra of Transition Metal Complexes** Term Symbols for p^2 & d^2 systems, spectroscopic ground states for d^1-d^{10} electronic configurations. Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, Orgel diagram for d^1-d^5.	12
IV	**Organometallic Compounds** Definition, nomenclature and classification of organometallic compounds. EAN rule, Preparation, properties, and applications of alkyls aryls of lithium and aluminium, Bonding in metal-ethylenic complexes, Mechanism of homogeneous hydrogenation reactions.	12

Reference Books:

1. B.N. Figgis, Introduction to Ligand Field, Wiley Eastern.
2. A.B.P. Lever, Inorganic Electronic Spectroscopy, Elsevier.
3. A. Earnshaw, Introduction to Magnetochemistry, Academic Press.
4. J.E. Huheey, Inorganic Chemistry Principles of Structure and Reactivity, Harper Inter-Science.
5. R.S. Drago, Physical Method in Chemistry, W.B. Saunders Company.
6. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, Wiley Inter-science.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title:	**PHYSICAL CHEMISTRY-III**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course

Unit	Content	Contact Hours
I	**Electrochemistry-I** Electrical transport-conduction in metals and in electrolyte solutions, specific conductance and equivalent conductance, measurement of equivalent conductance, variation of equivalent and specific conductance with dilution. Migration of ions and Kohlrausch law, Arrhenius theory of electrolyte dissociation and its limitations, weak and strong electrolytes, Ostwald's dilution law, its uses and limitations. Debye-Huckel-Onsager's equation for strong electrolytes (elementary treatment only). Transport number, definition and determination by Hittorf method and moving boundary method. Applications of conductivity measurements: determination of degree of dissociation, determination of Ka of acids, determination of solubility product of a sparingly soluble salt, conductometric titrations.	**11**
II	**Electrochemistry – II** Types of reversible electrodes-gas metal ion, metal ion, metal insolblue salt-anion and redox electrodes. Electrode reactions. Nernst equation, derivation of cell E.M.F. and Single electrode potential, standard hydrogen electrode, reference electrodes, standard electrode potential, sign conventions, electrochemical series and its significance. Electrolytic and Galvanic cells-reversible and irreverisible cells, conventional representation of electrochemi cells. EMF of a cell and its measurements. Computation of cell. EMF, Calculation of thermodynamic quantities of cell reactions (ΔG ΔH and K), polarization, over potential and hydrogen overvoltage. Concentration cells with and without transport, liquid junction potential, application of concentration cells, valency of ions, solubility product and activity coefficient, potentiometric titrations. Definition of pH and pKa, determination of pH using hydrogen, quinhydrone and glass electrodes, by potentiometric methods. Buffers-mechanism of buffer action, Henderson-Hazel equation, Hydrolysis of salts. Corrosion-types, theories and methods of combating it.	**12**
III	**Nuclear Chemistry** Introduction: Radioactivity, Nuclear Structure, Size of Nucleus, Mass Defects and Binding Energy, Nuclear Stability, Nuclear Forces, Nuclear Spin and Moments of Nuclei, Nuclear Models, Nuclear Decay Processes, The Laws of Radioactive Decay, Soddy-Fajans Group Displacement Law, Rate of Nuclear Decay and Half Life Time (Kinetics of Radioactive Decay), Induced Nuclear	**10**

	Reactions, Types of Nuclear Processes, High Energy Nuclear Reactions, Nuclear Reaction Cross-Section, Artificial radioactivity, Detection and Measurement of Radioactivity, Nuclear Fission, Nuclear Fusion, Applications of Radioactivity.	
IV	**Spectroscopy** Introduction: Electromagnetic radiation, regions of the spectrum, basic features of different spectrometers, statement of the Born-Oppenheimer approximation, degrees of freedom. **Rotational Spectrum** Diatomic molecules. Energy levels of a rigid rotor (semiclassical principles), selection rules, spectral intensity, distribution using population distribution (Maxwell-Boltzmann distribution) determination of bond length, qualitative description of non-rigid rotor, isotope effect. **Vibrational Spectrum** Infrared spectrum: Energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of anharmonic motion and isotope on the spectrum, idea of vibrational frequencies of different functional groups. Raman Spectrum: Concept of polarizability, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules. **Electronic Spectrum** Concept of potential energy curves for bonding and antibonding molecular orbitals, qualitative description of selection rules and Franck-Condon principle. Qualitative description of s, p, and n M.O., their energy levels and the respective transitions.	**12**

Reference Books:

1. Thermodynamics for Chemists, S. Glasstone.
2. R.S.Drago, “Physical Methods in Chemistry”.
3. Principles of Physical Chemistry, S.H. Maron & C.F. Prutton.
4. Physical Chemistry, P.W. Atkins.
5. G.M. Barrow “Introduction to Molecular Spectroscopy”.
6. C.N. Banwell “Fundamentals of Molecular Spectroscopy
7. Concise Inorganic Chemistry by J.D. Lee, Oxford; Fifth edition

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title:	**Elements of Modern Physics**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course

Unit	Content
I	**Dual Nature of Waves and Particles:** Black body ration, Planck's quantum, Planck's constant and light as a collection of photons; Photo Electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment, Problems with Rutherford model- instability of atoms and observation of discrete atomic spectra; Bohr's quantization rule and atomic stability; Wave-particle duality, Heisenberg uncertainty principle- impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle. Lecture (10)
II	**Quantum Mechanics:** Two slit interference experiment with photons, atoms & particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of wavefunction, probabilities and normalization; Probability and probability current densities in one dimension. One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as an example Lecture (10)
III	**Atomic structure:** The nuclear atom, Electron orbits, Atomic spectra, The Bohr Model, Energy level and spectra, Correspondence principle, Nuclear motion, Atomic excitation, Many electron atoms, Exclusion Principle, electron spin, spin orbit coupling, X-ray spectra. Zeeman effect, Stern-Garlach experiment. Lecture (10)
IV	**Special Theory of Relativity:** Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum. Energy-Momentum Four Vector. Lecture (10)

Recommended Books:

1. Concepts of Modern Physics, Arthur Beiser, 2009, McGraw-Hill
2. Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson,2009, PHI Learning
3. Six Ideas that Shaped Physics: Particle Behave like Waves, Thomas A. Moore, 2003, McGraw Hill
4. Quantum Physics, Berkeley Physics, Vol.4. E.H. Wichman, 2008, Tata McGraw-Hill Co.
5. Modern Physics, R.A. Serway, C.J. Moses, and C.A.Moyer, 2005, Cengage Learning

IK Gujral Punjab Technical University Jalandhar
B.Sc. Non-Medical Batch 2018 onwards

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title:	**Quantum Mechanics**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course

Unit	Content
I	**Time dependent and independent Schrodinger equation:** Time dependent Schrodinger equation, dynamical evolution of a quantum state; Interpretation of Wave Function, Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Position, momentum & Energy operators; Expectation value, Commutator of position and momentum operators; Wave Function of a Free Particle. Time independent Schrodinger equation, Hamiltonian, stationary states and energy eigenvalues; General solution of the time dependent Schrodinger equation, wave packets, Fourier transforms and momentum space wave function; Position-momentum uncertainty principle. (12 Lectures)
II	**Applications of Schrodinger Equation**: General discussion of bound states in an arbitrary potential- continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem- square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigenfunctions using Frobenius method. (12 Lectures)
III	**Quantum theory of hydrogen-like atoms**: time independent Schrodinger equation in spherical polar coordinates; separation of variables for the second order partial differential equation; angular momentum operator and quantu m numbers; Radial wavefunctions from Frobenius method; Orbital angular momentum quantum numbers l and m; s, p, d,.. shells (idea only) (12 Lectures)
IV	**Atoms in Electric and Magnetic Fields**:- Electron Angular Momentum. Space Quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment & Magnetic Energy, Gyromagnetic Ratio & Bohr Magneton. Atoms in External Magnetic Fields: Normal and Anomalous Zeeman Effect. (10 Lectures)

Recommended Books:

1. A Text book of Quantum Mechanics, P.M.Mathews & K.Venkatesan, 2nd Ed., 2010, McGraw Hill
2. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
3. Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
4. Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India.
5. Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
6. Quantum Mechanics for Scientists and Engineers, D.A.B. Miller, 2008, Cambridge University Press
7. Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
8. Introduction to Quantum Mechanics, David J. Griffith, 2nd Ed. 2005, Pearson Education
9. Quantum Mechanics, Walter Greiner, 2nd Edn., 2001, Springer

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title:	**THEORY OF PROBABILITY**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Course Objectives This course is designed to introduce theory of probability. The main focus of the course will be on the notions and uses of probability, random variables and probability distributions.

UNIT-I

Random experiment, sample space, event, algebra of events, Probability definition, addition law of probability, multiplication law of probability, conditional probability and independence, Bayes' Theorem

UNIT-II

Random variables, distribution function, properties of distribution function, discrete random variable, probability mass function, discrete distribution function, continuous random variable, probability density function. Continuous distribution function.

UNIT-III

Mathematical expectation, expectation of a random variable, Discrete probability distributions: binomial, Poisson, negative binomial distribution.

UNIT-IV

Continuous probability distributions: uniform distribution, normal distribution, normal distribution as a limiting case of binomial distribution, Gamma distribution, Beta distribution.

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

- Understand and demonstrate the notion of randomness.
- Apply the concepts of probability in modeling processes and decision making.

Reference Books

- S. Ross, A First Course in Probability, Pearson, 2008.
- S.C. Gupta, V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, Delhi, 2014.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title:	**NUMERICAL ANALYSIS**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Course Objectives This course is designed to introduce basic concepts of numerical analysis. The main objective of the course is to introduce the methods for solving problems numerically which are difficult to deal with analytically.

UNIT-I

Linear System of Equations**:** Gauss elimination method, Gauss Jordan method, LU decomposition method. Iterative Methods: Jacobi, Gauss-Seidel, Relaxation Methods; Eigenvalue Problem: Power Method.

UNIT-II

Interpolation**:** Interpolation with Unevenly Spaced Points: Lagrange Interpolation, Newton's Divided Difference Interpolation; Interpolation with Evenly Spaced Points: Newton's Forward Difference Interpolation Formula, Newton's Backward Difference Interpolation Formula, Spline interpolation.

UNIT-III

Numerical Differentiation and Integration: Numerical differentiation: Newton's Forward Difference Formula, Newton's Backward Difference Formula, Newton's Divided Difference Formula; Numerical Integration: Trapezoidal rule, Simpson's 1/3-rule and Simpson's 3/8 rule.

UNIT-IV

Numerical solution of ordinary differential equations (ODEs): Initial Value Problems of ODEs: Taylor series method, Euler's methods, Runge-Kutta methods and linear multi-step methods (Adams-Bashforth & Adams-Moulton).

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

- Analyze and solve different types of problems numerically arising in various fields of applications.
- Use different numerical methods for solving problems with the understating of their limitations.

Reference Books.

1. Richard L. Burden and J. Douglas Faires, Numerical Analysis, 9th Edition, Cengage Learning, 2012.
2. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering Computation, 6th Edition, New Age International Publisher, 2012.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title:	**ENGLISH-V**			
Contact Hours	**L: 3**	**T: 0**	**P: 0**	**Credits: 3**

Details of the Course:

Unit	Content
I	**(A) Literature** ***The Poetic Palette*** **(Orient Black Swan, Second Edition, 2016)** The following poems from this anthology are prescribed: a. The Charge of the Light Brigade: Alfred Tennyson b. He Wishes for the Cloths of Heaven: W. B. Yeats c. True ease in writing comes from art, not chance: Alexander Pope d. Goodbye party for Miss Pushpa T. S.: Nissim Ezekiel **(B) Vocabulary:** Various processes of Word formation; Standard Abbreviations & Acronyms; Internet Texting Abbreviations & Acronyms
II	**(A) Literature** ***Prose Parables*** **(Orient Black Swan, 2013)** The following stories from the above volume are prescribed: a. The Voice of God: Prem Chand b. The Face on the Wall: E.V. Lucas c. The Gold Frame: R. K. Laxman d. My Brother, My Brother: Norah Burke **(B) Grammar:** Use of Idioms/Phrases in sentences; Understanding Sentences Structures & practice on Transformation of sentences
III	**Reading & Writing Skills:** Close Reading; Comprehension; Translation (from Hindi/Punjabi to English and vice-versa) Business Correspondence- Business letters; Letter to the Editor; Business Emails; Drafting Notices & Memos
IV	**Interactive practice sessions on Oral Communication** • Self-Introduction, • Group Discussion and Role Play • Common Everyday Situations: Conversations and Dialogues

Recommended Books:

1. *Oxford Practice Grammar* by John Eastwood (Ed. 2014)
2. *Business English*, Pearson, 2008.
3. *Language, Literature and Creativity*, Orient Black swan, 2013.
4. *Remedial English Grammar*. F.T. Wood. Macmillan.2007.
5. *On Writing Well*. William Zinsser. Harper Resource Book. 2001
6. *Study Writing*. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
7. *Exercises in Spoken English*. Parts. I-III. CIEFL, Hyderabad. Oxford University Press.

IK Gujral Punjab Technical University Jalandhar
B.Sc. Non-Medical Batch 2018 onwards

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title:	**Punjabi-V**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

ਪਾਠ-ਕ੍ਰਮ:

ਯੂਨਿਟ-1 (ਸਾਹਿਤ)

1. ਡਾ. ਰੰਗਾ ਸਿੰਘ - ਪ੍ਰੋ. ਪ੍ਰੀਤਮ ਸਿੰਘ
2. ਨਾਨਕ ਸਿੰਘ - ਬਲਵੰਤ ਗਾਰਗੀ
3. ਬਾਬਾ, ਬੋਹੜ ਨਹੀਂ - ਭਗਵੰਤ ਸਿੰਘ
4. ਨਿੱਕੀ ਕਹਾਣੀ ਦਾ ਬਾਦਸ਼ਾਹ-ਅਜੀਤ ਕੌਰ
5. ਬਾਤਾਂ ਮੋਹਨ ਸਿੰਘ ਕੀਆਂ- ਕੁਲਬੀਰ ਸਿੰਘ ਕਾਂਗ
6. ਗੁਲਾਬੀ ਕਾਗਜ਼ ਉੱਤੇ ਲਿਖੀ ਕਵਿਤਾ:ਸੰਤੋਖ ਧੀਰ-ਗੁਰਬਚਨ ਸਿੰਘ ਭੁੱਲਰ
7. ਸੁਤਿੰਦਰ ਸਿੰਘ ਨੂਰ: ਸਾਹਿਤ ਦਾ ਜਥੇਦਾਰ-ਗੁਰਬਚਨ
8. ਮਿਲਖਾ ਸਿੰਘ-ਸਰਵਣ ਸਿੰਘ

ਯੂਨਿਟ-2 (ਭਾਸ਼ਾ)

ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਵਿਚ ਆਏ ਪਰਵਿਰਤਨ
ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਦੀ ਵਿਗਿਆਨ ਦੀ ਸਿਖਿਆ ਵਿਚ ਭੂਮਿਕਾ

ਯੂਨਿਟ-3 (ਵਿਆਕਰਣ)

ਪੰਜਾਬੀ ਵਿਆਕਰਣਕ ਇਕਾਈਆਂ: ਸਵਾਧੀਨ ਉਪਵਾਕ ਤੇ ਪਰਾਧੀਨ ਉਪਵਾਕ।

ਯੂਨਿਟ-4 (ਲੇਖਣੀ-ਕਲਾ)

ਸਨੇਹੀਆਂ ਨੂੰ ਚਿੱਠੀ-ਪੱਤਰ
ਪੋਸਟ ਕਾਰਡ ਲਿਖਣ ਦੀ ਵਿਧੀ ਤੇ ਨਮੂਨਾ

ਸਹਾਇਕ ਪੁਸਤਕਾਂ:

ਸਾਹਿਤ ਦੇ ਰੰਗ (ਸੰਪ. ਡਾ.ਮਹਿਲ ਸਿੰਘ),ਰਵੀ ਸਾਹਿਤ ਪ੍ਰਕਾਸ਼ਨ ਅੰਮ੍ਰਿਤਸਰ।

ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਦਾ ਵਿਆਕਰਨ ਜੋਗਿੰਦਰ ਸਿੰਘ ਪੁਆਰ, ਬਲਦੇਵ ਸਿੰਘ ਚੀਮਾ, ਸੁਖਵਿੰਦਰ ਸਿੰਘ ਸੰਘਾ, ਵੇਦ ਅਗਨੀਹੋਤਰੀ), ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਅਕਾਦਮੀ, ਜਲੰਧਰ, ਐਡੀਸ਼ਨ 2009.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title:	Punjab History & Culture-V			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

SECTION-A

Economy: Dev elopement of Resources: Transport and Communication,

Agriculture: Industry, Trade and Commerce, Education

SECTION-B

Society and Culture: Aristocracy, Middle classes, Artisans, Agricultural

Labourers: Social Religious Reformers.

SECTION-C

National Movement: Early Nationalist Activities, Agrarian Agitation
Of 1907, Ghadar Movement; Gandhian Movements

SECTION-D

Naujwan Bharat Sabha ;Hundustan Socialist Republican Association.
The Akali Movement (1920-25)

Suggested Readings:-

1. Badan-Powell,B.H., The Land System of British India, II, Oriental Publishers, 1974(reprint).
2. Bal, S.S., A Brief History of the Modern Punjab, Lyall Book Depot, Ludhiana, 1974.
3. Banga Indu, Five Punjabi Centuries: Essays for Dr J.S. Grewal, Manohar, New Delhi 1997.
4. Banerjee, Himadri, Agrarian Society of the Punjab, 1849-1901, Manohar Book Service, New Delhi 1982.
5. Barrier, N.G, The Sikhs and their Literature, Manohar Books Service, Delhi 1970.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title:	**Drug Abuse-I (Problem and Management)**			
Contact Hours:	**L:2**	**T:0**	**P:0**	

Details of the Course

Unit	Content
I	**Meaning of Drug Abuse**: Concept and Overview, Historical Perspective of Drug Abuse, Drug Dependence, Drug Addiction, Physical and Psychological Dependence: Drug Tolerance and withdrawal symptoms.
II	**Types of Abused Drugs and their Effects.** 1) Stimulants: Amphetamines – Benzedrine, Dexedrine, Cocaine. 2) Depressants: Alcohol Barbiturates: Nembutal, Seconal, Phenobarbital and Rohypnol. 3) Narcotics: Heroin, Morphine, Oxycodone. 4) Hallucinogens: Cannabis, Marijuana, Hashish, Hash Oil, MDMA, LSD. 5) Steroids.
III	**Nature and Extent of the Problem:** Magnitude or prevalence of the menace of Drug Abuse in India and Punjab, Vulnerable groups by age, gender and economic status, Signs and Symptoms of Drug Abuse: Physical, Academic, Behavioural and Psychological Indicators.
IV	**Management of Drug Abuse:** Medical Management: Medication for treatment and to reduce withdrawal effects. Psychiatric Management: Counselling, Behavioural and Cognitive therapy. Social Management: Family, Group therapy and Environmental Intervention.

References:

8. Ahuja, Ram (2003), Social Problems in India, Rawat Publication, Jaipur.
9. Extent, Pattern and Trend of Drug Use in India, Ministry of Social Justice and Empowerment, Government of India, 2004.
10. Inciardi, J.A. 1981. The Drug Crime Connection. Beverly Hills: Sage Publications.
11. Kapoor. T. (1985) Drug epidemic among Indian Youth, New Delhi: Mittal Pub. 15
12. Modi, Ishwar and Modi, Shalini (1997) Drugs: Addiction and Prevention, Jaipur: Rawat Publication.
13. National Household Survey of Alcohol and Drug abuse. (2003) New Delhi, Clinical Epidemiological Unit, All India Institute of Medical Sciences, 2004.
14. Sain, Bhim 1991, Drug Addiction Alcoholism, Smoking obscenity New Delhi: Mittal Publications.
15. Singh, Chandra Paul 2000. Alcohol and Dependence among Industrial Workers: Delhi: Shipra.
16. Sussman, S and Ames, S.L. (2008). Drug Abuse: Concepts, Prevention and Cessation, Cambridge University Press.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title:	**CHEMISTRY LAB V**			
Contact Hours:	**L:0**	**T:0**	**P:4**	**Credits:2**

(I) Synthesis and Analysis

(a) Preparation of Sodium trioxalatoferrate(III)
(b) Preparation of Ni-DMG Complex
(c) Preparation of Copper tetrammine complex
(d) Preparation of *cis*-bisoxalatodiaquachromate(III)ion

(II) Physical Chemistry

(a) Conductometric Titrations
(i) Determine the end point of the following titrations by the conductometric methods.
Strong acid-Strong base
Strong acid-Weak base
Weak acid-Strong base
Weak acid-Weak base
(ii) Determine the composition of a mixture of acetic acid and the hydrochloric acid by conductometric titration.

(b) (i) Molecular Weight Determination of acetanilide, napthalane, using camphor as solvent (Rast's methods).
(ii) To determine the molecular weight of a polymer by viscosity measurements.

(c) Adsorption: To study the adsorption of acetic acid oxalic/acid from aqueous solutions by charcoal.

(d) Phase Equilibria: To determine the distribution coefficient of iodine between CCI_4 and water.

(e) Refractometry: (i) Determination of refractive index of a liquid by Abbe refractometer, and hence the specific and molar refraction.
(ii) To determine the composition of unknown mixture of two liquids by refractive index measurements.

Reference books

1. Practical Inorganic Chemistry by J.R. Barrante G. Marr and B.W. Rockett
2. Vogel's Inorganic Quantitative Analysis
3. Advanced Practical Physical Chemistry by J.B. Jadav

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title:	**Physics Lab- V**			
Contact Hours:	**L:0**	**T:0**	**P:4**	**Credits:2**

List of Experiments:

1. Measurement of Planck's constant using black body radiation and photo-detector.
2. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light.
3. To determine work function of material of filament of directly heated vacuum diode.
4. To determine the Planck's constant using LEDs of at least 4 different colours.
5. To determine the wavelength of H-alpha emission line of Hydrogen atom.
6. To determine the ionization potential of mercury.
7. To determine the absorption lines in the rotational spectrum of Iodine vapour.
8. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
9. To setup the Millikan oil drop apparatus and determine the charge of an electron.
10. To show the tunneling effect in tunnel diode using I-V characteristics.
11. To determine the wavelength of laser source using diffraction of single slit.
12. To determine the wavelength of laser source using diffraction of double slits.
13. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating.
14. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency.
15. Study of Zeeman effect: with external magnetic field; Hyperfine splitting.
16. To study the quantum tunnelling effect with solid state device, e.g. tunnelling current in backward diode or tunnel diode.

Reference Books:

1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. Engineering Practical Physics, S.Panigrahi & B. Mallick,2015, Cengage Learning India Pvt. Ltd.
4. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.
5. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 201, Kitab Mahal.
6. B Sc. Practical Physics, C. L. Arora, S. Chand & Co.
7. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

Sixth Semester

Course Code	Course Title	Load Allocation			Marks Distribution		Total	Credits
		L	T	P	Internal	External		
BSNM601-18	Organic Chemistry-IV	3	0	0	25	50	75	3
BSNM602-18	Physical Chemistry-IV	3	0	0	25	50	75	3
BSNM603-18	Solid State Physics	3	0	0	25	50	75	3
BSNM604-18	Nuclear and Particle Physics	3	0	0	25	50	75	3
BSNM605-18	Modern algebra	3	0	0	25	50	75	3
BSNM606-18	Statics and dynamics	3	0	0	25	50	75	3
BSNM607-18	English-VI	3	0	0	25	50	75	3
BSNM608-18(A)/ BSNM608-18(B)	Punjabi- VI / Punjab History & Culture- VI	3	0	0	25	50	75	3
BSNM609-18	Drug Abuse-II (Management and Prevention)	2	0	0	25	50	75	-
BSNM610-18	Chemistry Lab- VI	0	0	4	30	20	50	2
BSNM611-18	Physics Lab- VI	0	0	4	30	20	50	2
	Total							**28**

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title:	**ORGANIC CHEMISTRY-IV**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course

Unit	Content	Contact Hours
I	**Spectroscopy** **Nuclear Magnetic Resonance (NMR) spectroscopy.** Proton Magnetic Resonance (1H NMR) spectroscopy, nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constants, areas of signals, interpretation of PMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,1,2-tribromoethane, ethyl acetate, toluene and acetophenone. **Electromagnetic Spectrum: Absorption Spectroscopy** Ultraviolet (U.V.) absorption spectroscopy introduction- (Beer-Lambert law), molar absorptivity, analysis of UVspectra, types of electronic transitions effect of conjugation. Concept of chromophores and auxochrome, Bathochrome, hypsochrome, hyperchrome, hypochromic shifts-UV spectra of conjugated compounds, Infrared (IR) Absorption spectroscopy-introduction, Hooke's law, Selection rules, intensity and IR bands, measurement of IR spectrum time characteristic absorption of various fundamental band interpretation of IR spectra of simple organic compounds.	**11**
II	**Problems based on spectroscopy** Problems pertaining to the structure elucidation of simple organic compounds using UV, IR and PMR spectroscopic techniques. **Synthetic Polymers** Addition or chain-growth polymerization. Free radical vinyl polymerization, ionic vinyl polymerization, Ziegler-Natta polymerization and vinyl polymers. Condensation or step growth polymerization. Polyesters, polyamides, phenol formaldehyde resins, urea formaldehyde resins, epoxy resins and polyurethanes. Natural and synthetic rubbers	**12**
III	**Organosulphur Compounds** Nomenclature, structural features, Methods of formation and chemical reactions of thiols, thioethers, sulphonic acids, sulphonamides and sulphaguanidine.	**10**

	Organic Synthesis via Enolates Acidity of α-hydrogens, alkylation of diethyl malonate and ethyl acetoacetate. Synthesis of ethyl acetoacetate: the Claisen condensation. Keto-enol tautomerism of ethyl acetoacetate. Alkylation of 1,3-dithianes. Alkylation and acylation of enamines.	
IV	**Carbohydrates** Classification and nomenclature. Monosaccharides, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Configuration of monosaccharides. Erythro and threo diastereomers. Conversion of glucose into mannose. Formation of glycosides, ethers and esters. Determination of ring size of monosaccharides. Cyclic structure of D(+)-glucose. Mechanism of mutarotation. ***Structures of ribose and deoxyribose*** An introduction to disaccharides (maltose, sucrose and lactose) and polysaccharides (starch and cellulose) without involving structure determination. **Amino Acids, Peptides, Proteins and Nucleic Acids** Classification, structure and stereochemistry of amino acids. Acid-base behaviour, isoelectric point and electrophoresis. Preparation and reactions of α-amino acids. Structure and nomenclature of peptides and proteins. Classification of proteins. Peptide structure determination, end group analysis, selective hydrolysis of peptides. Classical peptide synthesis, solid-phase peptide synthesis. Structures of peptides and proteins. Levels of protein structure. Protein denaturation/renaturation. Nucleic acids: Introduction. Constituents of nucleic acids. Ribonucleosides and ribonucleotides. The double helical structure of DNA.	**12**

Recommended Books:

1. Organic Chemistry. F.A. Carey, McGraw Hill, Inc. 8th edition.
2. Organic Chemistry, Morrison and Boyd, Prentice Hall
3. R.M. Silverstein, G.C. Bassler, T.C. Morrill, "Spectrometic Identification of Organic Compounds.
4. W. Kemp, "Organic Spectroscopy".
5. D.H. Williams, I. Fleming, "Spectroscopic Methods in Organic Chemistry".
6. J.R.Dyer, "Application of Absorption Spectroscopy of Organic Compounds".
7. D. H. Williams, I. Fleming, "Spectroscopic Problems in Organic Chemistry" 1967.
8. R.C. Banks, E.R. Matjeka, G. Mercer, "Introductory Problems in Spectroscopy" 1980.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title:	**PHYSICAL CHEMISTRY-IV**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course

Unit	Content	Contact Hours
I	**Quantum Mechanics-I** Black-body radiation, Planck's radiation law, Photoelectric effect, heat capacity of solids, Bohr's model of hydrogen atom (no derivation) and its defects, Compton effect. de Broglie hypothesis, Heisenberg's uncertainty principle, Sinusoidal wave equation, Hamiltonian operator, Schrodinger wave equation and its importance, physical interpretation of the wave function, postulates of quantum mechanics, particle in a one dimensional box, quantization of energy levels, extension to two and three dimensional boxes, degeneracy.	**12**
II	**Quantum Mechanics-II** Simple harmonic oscillator model of vibrational motion, setting up Schrodinger equation and discussion of solution and wave functions. Rigid rotator model of rotation of diatomic molecules transformation to spherical polar coordinates spherical harmonics and their discussion. Qualitative investigation H-atom, setting up Schrodinger equation, radial and angular part, radial distribution functions of 1s, 2s, 2p, 3s, 3p and 3d.	**12**
III	**Solid State** Definition of space lattice and unit cell, Law of crystallography- (i) Law of constancy of interfacial angles, (ii) Law of rationality of indices, (iii) Symmetry elements in crystals. X-ray diffraction by crystals. Derivation of Bragg's Law in Reciprocal space. Determination of crystal structure of NaCl, KCl by use of Powder method; Laue's method.	**10**
IV	**Photochemistry** Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of photochemistry: Grothus–Drapper law, Stark–Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of flourescence, phosphorescence, non–radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions–energy transfer processes (simple examples).	**11**

Recommended Books:

1. Physical Chemistry, A Molecular Approach by D.A. Mcguarrie and J.D. Simon.
2. Quantum Chemistry, Ira N. Levine.
3. Quantum Chemistry, H. Eyring J. Walter and G.E. Kimball.
4. Molecular Quantum Mechanics, P.W. Atkins.
5. R.S.Drago, "Physical Methods in Chemistry".

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title:	**Solid State Physics**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course

Unit	Content
I	**Crystal Structure:** Lattice translation, vectors and lattices, symmetry operations, basis and crystal structure, Miller indices, unit cell, two dimensional lattice, three dimensional lattices, hexagonal close packed structure. FCC and BCC structure, simple crystal structure, diffraction of x-rays according to law of Bragg and diffraction conditions. Reciprocal lattice, Brillouin zone, Reciprocal lattice to SC, BCC and FCC lattice, Atomic form factor, geometrical structure factor, experiment methods of x-rays diffraction. (10 Lectures)
II	**Crystal Binding and lattice Vibrations:** Various types of binding, crystals of inert gases, Vander-Waals-London interactions. Lenard-Jones potential, Ionic crystals, Madelung constant, Bulk Modulus, calculation of repulsive exponent. Born-Haber cycle, quantization of Lattice vibrations, phonon momentum, inelastic scattering by phonons. Wave motion on a lattice, one dimensional line of atoms, linear diatomic lattice, optical and acoustical branch. (10 Lectures)
III	**Free Electron Theory**: Drude-Lorentz theory, Sommerfeld model, the Fermi-Dirac distribution, Effect of temperature on f-d distribution, electronic specific heat, the electrical conductivity and Ohm's Law, the thermal conductivity of metals. Wiedemann -Frenz law, Hall effect. (12 Lectures)
IV	**Band Theory:** Nearly free electron model, origin and magnitude of energy gap, Density of states, K space, Bloch theorem, Kronig-Penney model of an infinite one dimensional crystal, classification of insulators, semiconductors and metals. The tight-binding approximation in evaluating the energy levels for an electron in a solid. The Weigner-Seitg approximation and the cohesive energy of metals. (12 Lectures)

Recommended Books:

1. Introduction to Solid State Physics, Charles Kittel, 8th Ed., 2004, Wiley India Pvt. Ltd.
2. Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India
3. Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill
4. Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning
5. Solid-state Physics, H. Ibach and H. Luth, 2009, Springer
6. Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
7. Solid State Physics, M.A. Wahab, 2011, Narosa Publications

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title:	**Nuclear and Particle Physics**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Details of the Course

Unit	Content
I	**Structure and Properties of the Nucleus**: Structure of the nucleus: Discovery of the nucleus, composition, basic properties; charge, mass, size, spin, magnetic moment, electric quadrupole moment, binding energy, binding energy per nucleon and its observed variation with mass number of the nucleus, coulomb energy, volume energy, surface energy, other corrections, explanation of the binding energy curve, liquid drop model of the nucleus, evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, nuclear force. (10 Lectures)
II	**Radioactive decays:** Alpha decay: basics of a-decay processes, theory of alpha emission, Gamow factor, Geiger Nuttall law, a-decay spectroscopy. (b) ß-decay: energy kinematics for ß-decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission & kinematics, internal conversion. **Reactions:** Types of Reactions, Conservation Laws, kinematics of reactions, Nuclear Q-value, reaction rate, reaction cross section, Concept of compound and direct reaction, resonance reaction, Coulomb scattering (Rutherford scattering). (10 Lectures)
III	**Interaction of Radiation with Matter**: Energy loss of particles in passage through matter, stopping power of matter for charged particles, energy range relationship and straggling. Interaction of gamma radiation with matter: photoelectric effect, Compton effect and pair production. Thomson scattering and Rayleigh scattering. Detectors and Accelerators: Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility), neutron detector, Need for accelerators. (10 Lectures)
IV	**Cosmic Rays and Elementary Particles:** Discovery of cosmic rays: hard and soft components, discovery of elementary particle, muon, pion, heavy mesons and hyperons, mass and life time determination for muon and pion. Primary Cosmic Rays: Particle interactions; basic features, types of particles and its families. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm, concept of quark model, color quantum number and gluons.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title:	**Modern algebra**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

Course Objectives This course is designed to introduce the basic concepts of modern algebra. The main focus of the course will be on the notions of algebraic structures, groups and rings.

UNIT-I

Groups, properties of group elements, subgroups, cyclic groups, cosets of a subgroup, Lagrange's theorem, normal subgroups and Quotient groups.

UNIT-II

Homomorphism, Isomorphism theorems, conjugate elements, class equation, permutation groups, alternating groups, simplicity of $A_n, n \geq 5$ (without proof).

UNIT-III

Rings, subring, characterization of a subring, integral domains, ideals, characteristic of a ring, Quotient rings.

UNIT-IV

Prime and maximal Ideals, homomorphism, Isomorphism theorems, Polynomial rings.

Course MODERN ALGEBRA Outcomes After completion of the course, the students will be able to

- Deal with algebraic structures and their use in proving theorems/results
- Demonstrate the abstract concepts of groups and rings.

Reference Books

- L. Gilbert, J. Gilbert, Elements of Modern Algebra, Cengage, 2015.
- M. Artin, Algebra, Pearson, 2010.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title:	**STATICS AND DYNAMICS**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

UNIT-I

Basic notions. Composition and resolution of concurrent forces-parallelogram law of forces, Components of a force in given directions, resolved parts of a force, resultant of any number of coplanar concurrent forces.

UNIT-II

Equilibrium conditions for coplanar concurrent forces, equilibrium of a body resting on a smooth inclined plane, equilibrium of three forces acting at a point, triangle law of forces, $\lambda - \mu$ theorem, Lami's theorem, parallel forces.

UNIT-III

Motion of a particle with constant acceleration, acceleration of falling bodies, motion under gravity, motion of a body projected vertically upwards: Newton's Laws of Motion, Motion of two particles connected by a string, motion along a smooth inclined plane, constrained motion along a smooth inclined plane. Variable acceleration: Simple harmonic motion, elastic string.

UNIT-IV

Curvilinear motion of a particle in a plane: Definition of velocity and acceleration, projectiles, motion in a circle. Work, power, conservative fields and the potential energy, work done against gravity, potential energy of a gravitational field.

Reference Books

- S. L. Loney, Statics, Macmillian and Company London.
- R. S. Verma, A Textbook on Statics, Pothishala Pvt. Ltd. Allahabad.
- S. L. Loney, An Elementary Treatise on the Dynamics of a Particle and of Rigid bodies, Cambridge University Press, 1956.
- M. Ray, A Textbook on Dynamics, S. Chand & Company, 1989.

IK Gujral Punjab Technical University Jalandhar
B.Sc. Non-Medical Batch 2018 onwards

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title:	**ENGLISH-VI**			
Contact Hours	**L: 3**	**T: 0**	**P: 0**	**Credits: 3**

Details of the Course:

Unit	Content
I	**Literature:** The study of the whole text of the play, *All My Sons* by Arthur Miller for vocabulary enrichment, learning sentence/speech construction and understanding dialogues/conversations.
II	**Grammar and Vocabulary:** Scientific/Technical Vocabulary; One word Substitution; Tenses; Active/Passive Voice; Narration; Common Errors
III	**Reading & Writing Skills:** Summary & Paraphrasing**,** Analysis and Interpretation; Formal Report writing; Formal Presentations-Practice on preparing Formal Presentations; Power Point Presentations
IV	**Interactive practice sessions on Oral Communication** • Communication at Workplace • Preparation for Interviews; Mock interviews • Delivering Formal Presentations/Power Point Presentations/Oral Presentations

Recommended Books:

1. *Oxford Practice Grammar* by John Eastwood (Ed. 2014)
2. *Business English*, Pearson, 2008.
3. *Language, Literature and Creativity*, Orient Black swan, 2013.
4. *Remedial English Grammar*. F.T. Wood. Macmillan. 2007.
5. *On Writing Well*. William Zinsser. Harper Resource Book. 2001
6. *Study Writing*. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006
7. *Exercises in Spoken English*. Parts. I-III. CIEFL, Hyderabad. Oxford University Press.

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B.Sc. Non-Medical Batch 2018 onwards

Course Name	B.Sc. (Non-Medical)			
Subject Code:				
Subject Title:	Punjabi-VI			
Contact Hours:	L:3	T:0	P:0	Credits:3

ਪਾਠ-ਕ੍ਰਮ:

ਯੂਨਿਟ-1 (ਸਾਹਿਤ)

1. ਕਿਰਤ - ਪ੍ਰੋ. ਪੂਰਨ ਸਿੰਘ
2. ਗੰਗਾ ਦੀਨ- ਪ੍ਰਿੰ.ਤੇਜਾ ਸਿੰਘ
3. ਮਾਂ-ਗੁਰਬਖਸ਼ ਸਿੰਘ ਪ੍ਰੀਤਲੜੀ
4. ਲਾਲ ਬਾਦਸ਼ਾਹ- ਹਰਿੰਦਰ ਸਿੰਘ ਰੂਪ
5. ਜਿਹੜੇ ਬੂਰੀਆਂ ਮੱਝੀਆਂ ਚੁੰਘਦੇ ਸੀ- ਸੂਬਾ ਸਿੰਘ
6. ਹਾਰ ਸ਼ਿੰਗਾਰ- ਗੁਲਜ਼ਾਰ ਸਿੰਘ ਸੰਧੂ
7. ਡੁੱਘੀਆਂ ਸਿਖਰਾਂ-ਨਰਿੰਦਰ ਸਿੰਘ ਕਪੂਰ
8. ਭਾਈ ਮਰਦਾਨਾ ਜੀ- ਹਰਪਾਲ ਸਿੰਘ ਪੰਨੂ

ਯੂਨਿਟ-2 (ਭਾਸ਼ਾ)

ਬਾਜ਼ਾਰ ਵਿਚ ਵਰਤੀ ਜਾਣ ਵਾਲੀ ਸ਼ਬਦਾਵਲੀ
ਵਪਾਰ ਵਿਚ ਵਰਤੀ ਜਾਣ ਵਾਲੀ ਸ਼ਬਦਾਵਲੀ

ਯੂਨਿਟ-3 (ਵਿਆਕਰਣ)

ਪੰਜਾਬੀ ਵਿਆਕਰਣਕ ਇਕਾਈਆਂ: ਨਾਂਵ ਵਾਕੰਸ਼ ਤੇ ਕਿਰਿਆ ਵਾਕੰਸ਼।

ਯੂਨਿਟ-4 (ਲੇਖਣੀ-ਕਲਾ)

ਅਖਬਾਰੀ ਲੇਖ
ਈ-ਮੇਲ ਲਿਖਣ ਦੀ ਵਿਧੀ

ਸਹਾਇਕ ਪੁਸਤਕਾਂ:

ਸਾਹਿਤ ਦੇ ਰੰਗ (ਸੰਪ. ਡਾ.ਮਹਿਲ ਸਿੰਘ),ਰਵੀ ਸਾਹਿਤ ਪ੍ਰਕਾਸ਼ਨ ਅੰਮ੍ਰਿਤਸਰ।

ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਦਾ ਵਿਆਕਰਨ ਜੋਗਿੰਦਰ ਸਿੰਘ ਪੁਆਰ, ਬਲਦੇਵ ਸਿੰਘ ਚੀਮਾ, ਸੁਖਵਿੰਦਰ ਸਿੰਘ ਸੰਘਾ, ਵੇਦ ਅਗਨੀਹੋਤਰੀ), ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਅਕਾਦਮੀ, ਜਲੰਧਰ, ਐਡੀਸ਼ਨ 2009.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title:	**Punjab History & Culture-VI**			
Contact Hours:	**L:3**	**T:0**	**P:0**	**Credits:3**

SECTION-A

1. Partition and Rehabilitation
2. Punjabi Suba and Territorial Reorganization
3. Green Revolution

SECTION-B

1. Agrarian Crisis
2. Punjab Politics
3. Demographic Changes and Urbanization

SECTION-C

1. Centre – State Relations and the Punjab Crisis
2. Militancy/Terrorism: Emergence and Impact

SECTION-D

1. Punjabi Diaspora
2. Future Perspectives of Punjab: Economy, Politics, Culture and society

Suggested Readings: -

1. Grewal, J.S., The Sikhs of the Punjab, CUP, Cambridge, 1990.
2. Grewal, J.S., and Indu Banga (eds.), Punjab in Prosperity and Violence: Administration, Politics and Social Change (1947-97), K.K. Publishers, Chandigarh 1998.
3. Banga, Indu (ed.), Five Punjabi Centuries: Polity, Economy, Society and Culture c. 1500-1990: Essays for J.S.Grewal, Manohar, New Delhi,1997.
4. Puri, Harish K. Paramjit Singh Judge and Jagroop Singh Sekhon, "Terrorism in Punjab : Understanding Reality at the Grassroots Level", Guru Nanak Journal of Sociology, Vol. XVIII No.I, G.N. D. University, Amritsar, 1997, pp. 37-99.
5. Khushwant Singh, A History of the Sikhs (1839-1988), Vol. II, OUP, Delhi, 1991.
6. Kirpal Singh, Partition of Punjab, Punjabi University, Patiala, 1972.
7. Pritam Singh & Shinder Singh Thandi (eds.), Punjabi Identity in Global Context, OUP, Oxford, 1999.
8. Pritam Singh, Punjab Economy: The Emerging Pattern, Enkay Publishers, New Delhi, 1995.

IK Gujral Punjab Technical University Jalandhar
B.Sc. Non-Medical Batch 2018 onwards

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title:	**Drug Abuse-II (Management and Prevention)**			
Contact Hours:	**L:2**	**T:0**	**P:0**	

Details of the Course

Unit	Content
I	**Prevention of Drug abuse I:** Role of family: Parent child relationship, Family support, Supervision, Shaping values, Active Scrutiny.
II	**Prevention of Drug abuse II:** School: Counselling, Teacher as role-model. Parent-teacher-Health Professional Coordination Random testing on students.
III	**Controlling Drug Abuse:** Media: Restraint on advertisements of drugs, advertisements on bad effects of drugs, Publicity and media, Campaigns against drug abuse, Educational and awareness program
IV	**Legislation:** NDPs act, Statutory warnings, Policing of Borders, Checking Supply/Smuggling of Drugs, Strict enforcement of laws, Time bound trials.

References:

9. Ahuja, Ram (2003), Social Problems in India, Rawat Publication, Jaipur.
10. Extent, Pattern and Trend of Drug Use in India, Ministry of Social Justice and Empowerment, Government of India, 2004.
11. Inciardi, J.A. 1981. The Drug Crime Connection. Beverly Hills: Sage Publications.
12. Kapoor. T. (1985) Drug epidemic among Indian Youth, New Delhi: Mittal Pub. 15
13. Modi, Ishwar and Modi, Shalini (1997) Drugs: Addiction and Prevention, Jaipur: Rawat Publication.
14. National Household Survey of Alcohol and Drug abuse. (2003) New Delhi, Clinical Epidemiological Unit, All India Institute of Medical Sciences, 2004.
15. Sain, Bhim 1991, Drug Addiction Alcoholism, Smoking obscenity New Delhi: Mittal Publications.
16. Singh, Chandra Paul 2000. Alcohol and Dependence among Industrial Workers: Delhi: Shipra.
17. Sussman, S and Ames, S.L. (2008). Drug Abuse: Concepts, Prevention and Cessation, Cambridge University Press.
18. Verma, P.S. 2017, "Punjab's Drug Problem: Contours and Characteristics", Economic and Political Weekly, Vol. LII, No. 3, P.P. 40-43.
19. World Drug Report 2016, United Nations office of Drug and Crime.
20. World Drug Report 2017, United Nations office of Drug and Crime.

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:				
Subject Title:	**CHEMISTRY LAB VI**			
Contact Hours:	**L:0**	**T:0**	**P:4**	**Credits:2**

(I) Organic Chemistry Laboratory Techniques

(a) Column Chromatography

Separation of *o* & *p*-nitrophenol
Separation of Leaf pigments from Spinnach leaves
Separation of *o* & *p*-nitro aniline
Separation of dyes

(b) Synthesis of Organic Compounds

Preparation of *p*-nitroacetanilide
Preparation of *p*-bromoacetanilide
Green Chemistry Experiment: Preparation of benzilic acid from Benzyl-using green approach.
Preparation of Methyl Orange, Methyl Red
Preparation of benzilic acid from benzyl-using green approach

Reference books

1. Experimental Organic Chemistry, Vol. I & II, P.R. Singh, D.S. Gupta and K.S. Bajpai, Tata McGraw Hill.
2. Laboratory Manual in Organic Chemistry, R.K. Bansal, Wiley Eastern.
3. Vogel's Textbook of Practical Organic Chemistry, B.S. Furniss, A.J. Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell, ELBS.
4. Practical Organic Chemistry by F.G. Mann and B.C. Saunders

Course Name	**B.Sc. (Non-Medical)**			
Subject Code:	**Physics Lab VI**			
Subject Title:				
Contact Hours:	**L:0**	**T:0**	**P:4**	**Credits:2**

Details of the Course

List of Experiments:

1. Characteristics of pn junction diode
2. Characteristics of Zener diode.
3. To determine the resistivity of semiconductors.
4. Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method)
5. To measure the Magnetic susceptibility of Solids.
6. To determine the Coupling Coefficient of a Piezoelectric crystal.
7. To measure the Dielectric Constant of a dielectric Materials with frequency.
8. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR).
9. To determine the refractive index of a dielectric layer using SPR.
10. To study the PE Hysteresis loop of a Ferroelectric Crystal.
11. To study the BH curve of iron using a Solenoid and determine the energy loss.
12. To measure the resistivity of a semiconductor (Ge) crystal with temperature by four-probe method (room temperature to 150*C and to determine its band gap.
13. To determine the Hall coefficient of a semiconductor sample.

REFERENCE BOOKS:

1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. Engineering Practical Physics, S.Panigrahi & B. Mallick,2015, Cengage Learning India Pvt. Ltd.
4. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.
5. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 201, Kitab Mahal.
6. B Sc. Practical Physics, C. L. Arora, S. Chand & Co.
7. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

M.Sc. Mathematics

Course Structure and Syllabus

(Based on Choice Based Credit System)

2022 onwards

DEPARTMENT OF MATHEMATICS

VISION

To be a knowledge nerve centre in Mathematics, Pure and Applied Research and industry requirements for creating sustainable infrastructure and enhancing quality of life.

MISSION

1. To offer globally relevant, industry-linked, research-focused, technology-enabled seamless education at the graduate, postgraduate and research levels in various areas of Mathematical sciences keeping in mind that the manpower so spawned is excellent in quality, is relevant to the global scientific and technological needs, is motivated to give its best and is committed to the growth of the Nation.
2. To develop and conduct continuing education programs for science graduates with a view to update their fundamental knowledge base and problem-solving capabilities in the various areas of core specialization of the University.
3. To develop comprehensive linkages with premier academic and research institutions within the country and abroad for mutual benefit.

M.Sc. (Mathematics) Program

The main objective of this program is to cultivate a mathematical aptitude and nurture the interests of the students towards problem solving aptitude. Further, it aims at motivating the young minds for research in mathematical sciences and to train computational scientists who can work on real life challenging problems.

Duration: M.Sc. Mathematics is a postgraduate level program offered by the Department of Mathematical Sciences. This is a 2-years program, consisting of four semesters with two semesters per year.

Program Code: MSM (Master of Science in Mathematics)

Eligibility: B.A./B.Sc. or equivalent from a recognized university with Mathematics as one of the major subjects with at least 50% marks in aggregate.

PROGRAM OBJECTIVES: The Program Objectives are the knowledge skills and attributes which the students have at the time of post-graduation. At the end of the program, the student will be able to:

1	To provide comprehensive curriculum to groom the students into qualitative scientific manpower
2	Enable students to enhance mathematical skills and understand the fundamental concepts of pure and applied mathematics.
3	To provide qualitative education through effective teaching learning processes by introducing projects, participative learning, and latest software tools.
4	To inculcate innovative skills, teamwork, ethical practices among students so as to meet societal expectations.
5	To encourage collaborative learning and application of mathematics to real life situations.
6	To inculcate the curiosity for mathematics in students and to prepare them for future research.

PROGRAM SPECIFIC OUTCOMES: At the end of the program, the student will be able to:

PSO1	Apply the knowledge of mathematical concepts in interdisciplinary fields.
PSO2	Understand the nature of abstract mathematics and explore the concepts in further details.
PSO3	Model the real-world problems into mathematical equations and draw the inferences by finding appropriate solutions.
PSO4	Identify challenging problems in mathematics and find appropriate solutions.
PSO5	Pursue research in challenging areas of pure/applied mathematics.
PSO6	Employ confidently the knowledge of mathematical software and tools for treating the complex mathematical problems and scientific investigations.
PSO7	Continue to acquire mathematical knowledge and skills appropriate to professional activities and demonstrate highest standards of ethical issues in mathematics.
PSO8	Comprehend and write effective reports and design documentation related to mathematical research and literature, make effective presentations.
PSO9	Qualify national level tests like NET/GATE etc.
PSO10	Effectively communicate and explore ideas of mathematics for propagation of knowledge and popularization of mathematics in society.

Scheme of the Program: First Semester **Contact Hours: 29 Hrs.**

Course Code	Course Type	Course Title	Load Allocation			Marks Distribution			Credits
			L	T	P	Internal	External	Total	
MSM-101-22	Compulsory	Algebra-I	4	1	0	40	60	100	4
MSM-102-22		Real Analysis-I	4	1	0	40	60	100	4
MSM-103-22		Complex Analysis	4	1	0	40	60	100	4
MSM-104-22		Ordinary Differential Equations and Special Functions	4	1	0	40	60	100	4
MSM-105-22		Mathematical Methods	4	1	0	40	60	100	4
MSM-106-22		Introduction to MATLAB (Lab)	0	0	4	30	20	50	2
Total			**20**	**05**	**04**	**230**	**320**	**550**	**22**

Scheme of the Program: Second Semester **Contact Hours: 29 Hrs.**

Course Code	Course Type	Course Title	Load Allocation			Marks Distribution			Credits
			L	T	P	Internal	External	Total	
MSM-201-22	Compulsory	Algebra-II	4	1	0	40	60	100	4
MSM-202-22		Real Analysis-II	4	1	0	40	60	100	4
MSM-203-22		Mechanics-I	4	1	0	40	60	100	4
MSM-204-22		Partial Differential Equations	4	1	0	40	60	100	4
MSM-205-22		Numerical Analysis	4	1	0	40	60	100	4
MSM-206-22		Numerical Analysis (Lab)	0	0	4	30	20	50	2
Total			**20**	**05**	**04**	**230**	**320**	**550**	**22**

Scheme of the Program: Third Semester **Contact Hours: 25 Hrs.**

Course Code	Course Type	Course Title	Load Allocation			Marks Distribution			Credits
			L	T	P	Internal	External	Total	
MSM-301-22	Compulsory	Topology	4	1	0	40	60	100	4
MSM-302-22		Number Theory and Cryptography	4	1	0	40	60	100	4
MSM-303-22		Mathematical Statistics	4	1	0	40	60	100	4
MSM-304-22		Functional Analysis	4	1	0	40	60	100	4
MSM-305-22		Tensor Calculus and Applications	4	1	0	40	60	100	4
Total			**20**	**05**	**00**	**200**	**300**	**500**	**20**

Scheme of the Program: Fourth Semester **Contact Hours: 25 Hrs.**

Course Code	Course Type	Course Title	Load Allocation			Marks Distribution			Credits
			L	T	P	Internal	External	Total	
MSM-401-22	Compulsory	Operations Research	4	1	0	40	60	100	4
MSM-WWW-22	Elective	Elective-I*	4	1	0	40	60	100	4
MSM-XXX-22		Elective-II*	4	1	0	40	60	100	4
MSM-YYY-22		Elective-III*	4	1	0	40	60	100	4
MSM-ZZZ-22		Elective-IV*	4	1	0	40	60	100	4
MSM-601-22		Dissertation	12	0	0	200	100	300	12
Total								**500**	**20**

Note:

1. Subject Operations Research (MSM-401-22) is compulsory.
2. Students may opt for Dissertation with 01 Elective course or without dissertation with 04 Elective courses from the list below.

LIST OF DEPARTMENTAL/INTERDISCIPLINARY ELECTIVES

***Electives- MSM-WWW-22, MSM-XXX-22, MSM-YYY-22, MSM-ZZZ-22**

MSM-501-22 Discrete Mathematics

MSM-502-22 Coding Theory

MSM-503-22 Differential Geometry

MSM-504-22 Advanced Number Theory

MSM-505-22 Advanced Complex Analysis

MSM-506-22 Advanced Operations Research

MSM-507-22 Advanced Fluid Mechanics

MSM-508-22 Advanced Solid Mechanics

MSM-509-22 Theory of Linear Operators

MSM-510-22 Advanced Numerical Methods

MSM-511-22 Topological Vector Spaces

MSM-512-22 Fractional Calculus

Examination and Evaluation

Theory			
S. No.	**Evaluation criteria**	**Weightage in Marks**	**Remarks**
1	Mid term/sessional Tests	24	Internal evaluation (40 Marks) MSTs, Quizzes, assignments, attendance, etc., constitute internal evaluation. Average of two mid semester test will be considered for evaluation.
2	Attendance	6	
3	Assignments	10	
4	End semester examination	60	External evaluation
5	Total	100	Marks may be rounded off to nearest integer.
Practical			
1	Evaluation of practical record/ Viva Voice/Attendance/Seminar/ Presentation	30	Internal evaluation
2	Final Practical Performance + Viva-Voce	20	External evaluation
3	Total	50	Marks may be rounded off to nearest integer.
Seminar			
1	Content	15	Internal evaluation
2	Queries	15	
3	Communication skills	10	
4	Visual effects	10	
5	Total	50	Marks may be rounded off to nearest integer.

<table>
<tr><td colspan="7">Dissertation</td></tr>
<tr><td></td><td colspan="4">Internal Assessment</td><td></td><td></td></tr>
<tr><td rowspan="2">Departmental Presentation</td><td colspan="2">Communication and presentation</td><td colspan="2">Response to queries</td><td>Maximum Marks</td><td>Evaluated by</td></tr>
<tr><td colspan="2">20</td><td colspan="2">30</td><td>50</td><td>Committee Member:
1.Head
2.Supervisor
3.One of Faculty Member</td></tr>
<tr><td rowspan="2">Dissertation</td><td>Plagiarism</td><td>Subject Matter</td><td>Usage of Language</td><td>Publication/Presentation in Conference</td><td rowspan="2">150</td><td rowspan="2"></td></tr>
<tr><td>25</td><td>70</td><td>25</td><td>30</td></tr>
<tr><td></td><td colspan="4">External Assessment</td><td></td><td></td></tr>
<tr><td rowspan="2">External Examiner</td><td colspan="4">Subject Matter</td><td rowspan="2">50</td><td rowspan="2">Committee Member:
1.Head
2.External Expert
3.Supervisor
4. Director (MC) nominee</td></tr>
<tr><td colspan="4">50</td></tr>
<tr><td rowspan="2">Viva Voce</td><td colspan="2">Communication and Presentation</td><td colspan="2">Response to queries</td><td rowspan="2">50</td><td rowspan="2"></td></tr>
<tr><td colspan="2">20</td><td colspan="2">30</td></tr>
<tr><td colspan="5">Total</td><td>300</td><td></td></tr>
</table>

Evaluation Process:

1. The subject matter evaluation can further be defined on the basis of Title, Review of literature/Motivation, Objectives, Methodology, Results and discussions, and Conclusion.
2. The usage of language and the subject matter shall be evaluated by the supervisor. Out of 300 marks, 95 marks are to be evaluated by the concerned supervisor.
3. Total 15% Plagiarism is admissible for submission of the dissertation. For (0-5)%of plagiarism, candidate should be awarded 25 marks. For >5%-10% candidate should be awarded 15 marks and for the range of > 10% to < 15%, candidate should be awarded 5 marks.
4. For publicationcandidate should be awarded full 30 marks and for presenting the work related to dissertation, candidate should be awarded 25 marks.

Instructions for Paper-Setter in M. Sc Mathematics

A. Scope

1. The question papers should be prepared strictly in accordance with the prescribed syllabus and pattern of question paper of the University.
2. The question paper should cover the entire syllabus with uniform distribution among each unit and Weightage of marks for each question.
3. The language of questions should be simple, direct, and documented clearly and unequivocally so that the candidates may have no difficulty in appreciating the scope and purpose of the questions. The length of the expected answer should be specified as far as possible in the question itself.
4. The distribution of marks to each question/answer should be indicated in the question paper properly.

B. Type and difficulty level of question papers

1. Questions should be framed in such a way as to test the students intelligent grasp of broad principles and understanding of the applied aspects of the subject. The Weightage of the marks as per the difficulty level of the question paper shall be as follows:
   - i) Easy question 30%
   - ii) Average questions 50%
   - iii) Difficult questions 20%
2. The numerical content of the question paper should be up to 40%.

C. Format of question paper

1. Paper code and Paper-ID should be mentioned properly.
2. The question paper will consist of three sections: Sections-A, B and C.
3. Section-A is COMPULSORY consisting of TEN SHORT questions carrying two marks each (total 20 marks) covering the entire syllabus.
4. The Section-B consists of FOUR questions of eight marks each covering Unit I & II of syllabus (Taking two questions from each unit I & II).
5. The Section-C consists of FOUR questions of eight marks each covering Unit III & IV of syllabus (Taking two questions from each unit III & IV).
6. Sub-parts of the questions in Section B and C should be preferred for numerical/conceptual questions.
7. Attempt any five questions from Section-B and Section-C, selecting at least two questions from each of the two sections.

Question paper pattern for MST:

Roll No:	**No of pages:**
IK Gujral Punjab Technical University- Jalandhar	
Department of Mathematical Sciences	
Academic Session:	
Mid-Semester Test: I/II/III (Regular/reappear)	**Date:**
Programme: M.Sc. Mathematics	**Semester:**
Course Code:	**Course:**
Maximum Marks: 24	**Time: 1 hour 30 minutes**

- Note: Section A is compulsory; Attempt any two questions from Section B and one question from Section C.

Section: A		**Marks**	**Cos**
1		2	
2		2	
3		2	
4		2	
Section: B			
5		4	
6		4	
7		4	
Section: C			
8		8	
9		8	

Details of Course Objectives

CO1	
CO2	
CO3	
CO4	
CO5	

SEMESTER-I

MSM-101-22	**Algebra-I**	**L-4, T-1, P-0**	**4 Credits**

Pre-requisite: Discrete Structures

Course Objectives: This course is designed to give students a foundation for all future mathematics courses. The fundamentals of algebraic problem-solving are explained. Students will explore foundations of Algebraic structures, Groups, Rings, Ideals, Fields, Homomorphisms, etc. The course also fulfills the objective to make students aware of the applicability of abstract mathematics in real world problems.

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

CO1	Apply the knowledge of Algebra to attain a good mathematical maturity and enables to build mathematical thinking and skill.
CO2	Utilize the class equation and Sylow theorems to solve different related problems.
CO3	Identify and analyze different types of algebraic structures such as Solvable groups, Simple groups, Alternate groups to understand and use the fundamental results in Algebra.
CO4	Design, analyze and implement the concepts of homomorphism and isomorphism between groups and rings for solving different types of problems, for example, Isomorphism theorems, quotient groups, conjugacy etc.
CO5	Create, select, and apply appropriate algebraic structures such as finitely generated abelian groups, Ideals, Fields to explore the existing results.
CO6	Identify the challenging problems in modern mathematics and find their appropriate solutions.

Mapping of course outcomes with the program outcomes

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO 10**
CO1	√	√	-	√	√	-	√	-	√	√
CO2	√	√	-	√	-	-	√	-	√	√
CO3	√	√	-	√	√	-	√	-	√	√
CO4	√	√	-	√	√	-	√	-	√	√
CO5	√	√	-	√	-	-	√	-	√	√
CO6	√	√	-	√	-	-	√	-	√	√

Course Title: Algebra-I
Course Code: MSM-101-22

UNIT-I

Groups, Subgroups & Homomorphisms: Groups, homomorphisms, Subgroups and Cosets, Cyclic groups, Permutation groups, Normal subgroups and quotient groups, Isomorphism theorems, Automorphisms, Symmetric groups, Conjugacy. [Ref 2: Unit 1]

UNIT-II

Solvability & Simplicity: Normal series, Derived Series, Composition Series, Solvable Groups, Simple groups and their examples, Alternating group A_n, Simplicity of A_n. [Ref 2: Unit 1]

UNIT-III

Finite Abelian Groups: Direct products, Finite Abelian Groups, Fundamental Theorem on Finitely generated Abelian Groups, Invariants of a finite abelian groups, Sylow's Theorems and their applications, Groups of order p^2, pq. [Ref 2: Unit 1]

UNIT-IV

Rings & Ideals: Ring, Subring, Ideals, Homomorphism and Algebra of Ideals, Maximal and prime ideals, Ideals in quotient rings, Nilpotent and nil ideals. [Ref 2: Unit 2]

RECOMMENDED BOOKS:

1. Bhattacharya, P. B., Jain, S.K. and Nagpaul, S.R., *Basic Abstract Algebra, 2nd Edition.* U.K.: Cambridge University Press, 2004.
2. Dummit, David. S., and Foote, Richard M., *Abstract Algebra, 3rd Edition*. New Delhi: Wiley, 2011.
3. Herstein, I.N., *Topics in Algebra, 2nd Edition*. New Delhi: Wiley, 2006.
4. Singh, Surjeet, and Zameeruddin, Q., *Modern Algebra, 7th Edition*. New Delhi: Vikas Publishing House, 1993.
5. Artin, M., *Algebra, 2nd Edition*. Pearson Publications, 2010.

MSM-102-22	**Real Analysis-I**	**L-4, T-1, P-0**	**4 Credits**

Pre-requisite: Basic Calculus

Course Objectives: This course is designed to provide a deeper and rigorous understanding of fundamental concepts viz. metric spaces, continuous functions, sequences, series: power series and the Riemann-Stieltjes integral etc. The focus of this course will be on theoretical foundation of the above said concepts and it will cultivate the rigorous mathematical logics and skills in the students.

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

CO1	Apply the knowledge of concepts of real analysis to study theoretical development of different mathematical techniques and their applications.
CO2	Understand the nature of abstract mathematics and explore the concepts in further details.
CO3	Identify challenging problems in real variable theory and find their appropriate solutions.
CO4	Deal with axiomatic structure of metric spaces and generalize the concepts of sequences and continuous functions in metric spaces.
CO5	Use theory of Riemann-Stieltjes integral which is a modification of Riemann theory of integration.
CO6	Extend their knowledge of real variable theory for further exploration of the subject at more advanced level.

Mapping of course outcomes with the program outcomes

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO 10**
CO1	√	-	-	-	-	-	√	-	√	√
CO2	-	√	-	-	-	-	√	-	√	√
CO3	-	-	-	√	-	-	√	-	√	√
CO4	-	√	-	-	-	-	√	-	√	√
CO5	√	-	-	-	-	-	√	-	√	√
CO6	-	-	-	-	√	-	√	-	√	√

Course Title: Real Analysis-I
Course Code: MSM-102-22

UNIT-I

Finite, Countable and Uncountable sets, Metric spaces, Open sets, closed sets, Compact sets, Perfect sets, Connected sets.

UNIT-II

Sequences, Convergent sequences, Subsequences, Cauchy sequences, Complete metric spaces. Cantor's intersection theorem, power series, absolute convergence.

UNIT-III

Continuity: Limits of functions, Continuous functions, Continuity and Compactness, Continuity and Connectedness, Discontinuities, Monotonic functions, Uniform continuity.

UNIT-IV

The Riemann-Stieltjes integral: Definition and existence of the Riemann-Stieltjes integral, Condition of integrability, The Riemann-Stieltjes integral as a limit of sum, Properties of the integral, Relation between Riemann integral and Riemann-Stieltjes integral, First and second mean value theorems of Riemann-Stieltjes integral.

RECOMMENDED BOOKS:

1. Rudin, W., *Principles of Mathematical Analysis, 3rd Edition*. New Delhi: McGraw-Hill Inc., 2013.
2. Royden, H.L. and Fitzpatrick, P.M., *Real Analysis, 4th Edition.* New Delhi: Pearson, 2010.
3. Carothers, N. L., *Real Analysis,* Cambridge University Press, 2000.
4. Apostol, T.M., *Mathematical Analysis –A modern approach to Advanced Calculus*. New Delhi: Narosa Publishing House, 1957.
5. Abbott, S., *Understanding Analysis, 2nd Edition.* Springer, 2016.
6. Malik S. C., Arora Savita, *Mathematical Analysis, 5th Edition,* New Age International Publishers, 2017.

MSM-103-22	**Complex Analysis**	**L-4, T-1, P-0**	**4 Credits**

Pre-requisite: Calculus of several variables and complex number system.

Course Objectives: The objective of this course is to introduce and develop a clear understanding of the fundamental concepts of Complex Analysis such as analytic functions, Cauchy-Riemann relations and harmonic functions and to make students equipped with the understanding of the fundamental concepts of complex variable theory. In particular, to enable students to acquire skill of contour integration to evaluate complicated real integrals via residue calculus.

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

CO1	Know the fundamental concepts of complex analysis.
CO2	Evaluate complex integrals and apply Cauchy integral theorem and formula.
CO3	Evaluate limits and checking the continuity of complex function & apply the concept of analyticity and the Cauchy-Riemann equations.
CO4	Solve the problems using complex analysis techniques applied to different situations in engineering and other mathematical contexts.
CO5	Establish the capacity for mathematical reasoning through analysing, proving and explaining concepts from complex analysis
CO6	Extend their knowledge to pursue research in this field.

Mapping of course outcomes with the program outcomes

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO 10**
CO1	√	√	-	-	√	-	√	-	√	√
CO2	√	√	-	√	√	-	√	-	√	√
CO3	√	√	-	√	√	-	√	-	√	√
CO4	√	√	√	√	√	-	√	-	√	√
CO5	√	√	√	√	√	-	√	-	√	√
CO6	√	√	√	√	√	-	√	-	√	√

Course Title: Complex Analysis

Course Code: MSM-103-22

UNIT-I

Function of complex variable, continuity and differentiability, Analytic functions, Cauchy Riemann equation (Cartesian and polar form). Harmonic functions, Harmonic conjugate, Construction of analytic functions. Stereographic projection and the spherical representation of the extended complex plane.

Unit-II

Complex line integral, Cauchy-Goursat theorem, independence of path; Cauchy's integral formulas and their consequences, Cauchy inequality, Liouville's theorem, Fundamental theorem of algebra, Morera's theorem.

Unit-III

Power series: Zeros and singularities of complex functions, classification of singularities: removable singularity, poles, essential singularities, Residue at a pole and at infinity, Circle of convergence, radius of convergence. Taylor's series and Taylor's theorem, Laurent'z series and Laurent theorem, Cauchy's Residue theorem and its applications in evaluation of real integrals: integration around unit circle, integration over semi-circular contours (with and without real poles), integration around rectangular contours.

Unit-IV

Conformal transformations, Bilinear transformations, Critical points, Fixed points, Problems on cross-ratio and bilinear transformation.

RECOMMENDED BOOKS:

1. Ahlfors, L.V., *Complex Analysis, 2nd Edition*. McGraw-Hill International Student Edition, 1990.
2. Kumar, R.R., Complex Analysis, Pearson Education, 2015.
3. Churchill, R. and Brown, J.W., *Complex Variables and Applications, 6th Edition*. New- York: McGraw-Hill, 1996.

MSM-104-22	**Ordinary Differential Equations and Special Functions**	**L-4, T-1, P-0**	**4 Credits**

Pre-requisite: Differential Calculus, Integral Calculus and some introduction to linear algebra.

Course Objectives: The Objective of this course is to introduce ordinary differential equations and fundamental theorems for existence and uniqueness. This course further explains the analytic techniques in computing the solutions of various ordinary differential equations appearing in various fields of science and technology.

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

CO1	Understand ordinary differential equations of various types, their solutions, and fundamental concepts about their existence.
CO2	Understand the concept and applications of eigen value problems.
CO3	Understand differential equations of Strum Liouville type.
CO4	Apply various power series methods to obtain series solutions of differential equations.
CO5	Discuss various kinds of special functions in detail, their properties, and relations.
CO6	Solve problems of ordinary differential equations arising in various fields.

Mapping of course outcomes with the program outcomes

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO 10**
CO1	√	-	√	√	√	-	√	-	√	√
CO2	√	-	√	√	√	-	√	-	√	√
CO3	√	-	√	√	√	-	√	-	√	√
CO4	√	-	√	√	√	-	√	-	√	√
CO5	√	-	√	√	√	-	√	-	√	√
CO6	√	-	√	√	√	-	√	-	√	√

Course Title: Ordinary Differential Equations and Special Functions

Course Code: MSM-104-22

UNIT-I

Review of linear differential equations with constant & variable coefficients, Fundamental existence and uniqueness theorem for system and higher order equations (Picard's and Piano theorems), System of linear differential equations, an operator method for linear system with constant coefficients, Phase plane method.

UNIT-II

Homogeneous linear system with constant coefficients, Eigenvalues and eigen functions, orthogonality of eigen functions, Complex eigenvalues, repeated eigenvalues, Ordinary differential equations of the Sturm-Liouville problems, Expansion theorem, Extrema properties of the eigen values of linear differential operators, Formulation of the eigen value problem of a differential operator as a problem of integral equation, Linear homogeneous boundary value problems

UNIT-III

Power series solution of differential equations: about an ordinary point, solution about regular singular points, the method of Frobenius, Bessel equation and Bessel functions, Recurrence relations and orthogonal properties., Series expansion of Bessel Coefficients, Integral expression, Integral involving Bessel functions, Modified Bessel function, Ber and Bei functions, Asymptotic expansion of Bessel Functions, Legendre's differential equations, Legendre Polynomials , Rodrigue's formula, Recurrence relations and orthogonal properties.

UNIT-IV

The Hermite polynomials, Chebyshev's polynomial, Laugrre's polynomial: Recurrence relations, generating functions and orthogonal properties.

RECOMMENDED BOOKS:

1. Ross, S.L., *Differential Equations, 3rd Edition.* John Wiley & Sons, 2004.
2. Boyce, W.E. and Diprima, R.C., *Elementary Differential Equations and Boundary Value problems, 4th Edition*. John Wiley and Sons, 1986.
3. Sneddon, I.N., *Special Functions of Mathematical Physics and Chemistry*. Edinburg: Oliver & Boyd, 1956.
4. Bell, W.W., *Special Functions for Scientists and Engineers.* Dover, 1986.

MSM-105-22	**Mathematical Methods**	**L-4, T-1, P-0**	**4 Credits**

Pre-requisite: Basic Calculus and Linear Algebra

Course Objectives: The objective of the course is to acquaint the students with the knowledge of mathematical techniques frequently applied in various branches of engineering and sciences. Also, one of the objectives of this course is to equip the students with the mathematical background required for the development of such techniques.

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

CO1	Understand the theory and applications of integral transforms.
CO2	Explain how integral transforms can be used to solve a variety of differential equations.
CO3	Solve integro-differential equations of Fredholm and Volterra type.
CO4	Understand the properties of various kinds of integral equations.
CO5	Develop their attitude towards problem solving.

Mapping of course outcomes with the program outcomes

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO 10**
CO1	√	-	√	√	√	-	-	-	√	√
CO2	√	-	√	√	√	-	-	-	√	√
CO3	√	-	√	√	√	-	-	-	√	√
CO4	√	√	-	√	√	-	-	-	√	√
CO5	√	-	√	√	√	-	-	-	√	√

Course Title: Mathematical Methods
Course Code: MSM-105-22

UNIT I

Laplace Transforms: Laplace Transform, Properties of Laplace Transform, Inverse Laplace Transform, Convolution theorem, Laplace transform of periodic functions, unit step function and impulsive function, Application of Laplace Transform in solving ordinary and partial differential equations and Simultaneous linear equations.

UNIT II

Fourier Transforms: Fourier transform, properties of Fourier transform, inversion formula, convolution, Parseval's equality, Fourier transform of generalized functions, application of Fourier transforms in solving heat, wave and Laplace equation. Fast Fourier transform.

UNIT III

Integral Equations: Relations between differential and integral equations, Integral equations of Fredholm and Volterra type, solution by successive substitution and successive approximation, integral equations with degenerate kernels.

UNIT IV

Integral equations of convolution type and their solutions by Laplace transform, Fredholm's theorems, integral equations with symmetric kernel, Solutions with separable kernels, Characteristic numbers, Resolvent kernel, Eigen values and Eigen functions of integral equations and their simple properties.

Text and Reference Books:

1. Sneddon, I.N., *The Use of Integral Transforms*. McGraw Hill, 1985.
2. Goldberg, R.R., *Fourier Transforms.* Cambridge University Press, 1970.
3. Smith, M.G., *Laplace Transform Theory*. Van Nostrand Inc., 2000.
4. Elsegolc, L., *Calculus of Variation*. Dover Publications, 2010.
5. Kenwal, R.P., *Linear Integral Equation; Theory and Techniques*. Academic Press, 1971.
6. Hildebrand, F.B., *Methods of Applied Mathematics* ***(Latest Reprint)***. Dover Publications.
7. Pal, S. and Bhunia, S.C., *Engineering Mathematics*. Oxford University Press, 2015.

MSM-106-22	**Introduction to MATLAB (Lab)**	**L-0, T-0, P-4**	**2 Credits**

Pre-requisite: Basic knowledge of computer

Course Objectives: This course is designed to introduce a powerful language MATLAB for technical computing. The main focus of the course will be on introduction to basic concepts of MATLAB and their applications using simple examples. This course will also develop programming skills for solving real world problems more efficiently and accurately

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

CO1	Apply the knowledge of mathematical software viz. MATLAB to solve real world problems efficiently.
CO2	Utilize the symbolic tools of MATLAB for handling different mathematical problems for example, solution of equations, differentiation, and integration etc.
CO3	Design and analyze their own computer codes of mathematical methods.
CO4	Understand and modify existing codes in scientific computing based on the use of different loops and conditional structures.
CO5	Use MATLAB software effectively for plotting in 2D and 3D.

Mapping of course outcomes with the program outcomes

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO 10**
CO1	√	-	-	-	-	√	-	-		√
CO2	√	-	-	-	-	√	-	-		√
CO3	√	-	-	-	-	√	-	-		√
CO4	-	-	-	-	-	√	-	-		√
CO5	√	-	-	-	-	√	-	-		√

Course Title: Introduction to MATLAB (Lab)
Course Code: MSM-106-22

UNIT-I

The MATLAB environment, scalars, variables, arrays, mathematical operations with arrays, built-in and user defined functions, script file, input to a script file, output commands: disp and fprintf, function files, comparison between script file and function file.

Plotting: Two-dimensional plots and three-dimensional plots.

UNIT-II

Programming: Relational and logical operators, Conditional statements: if-end structure; if-else-end structure; if-elseif-else-end structure, loops: for-end loop and while-end loop, Nested loops and nested conditional statements, the break and continue command.

Symbolic math: symbolic objects and symbolic expressions; commands: collect, expand, factor, simplify, simple, solve, diff and int.

Text and Reference Books:

1. Higham, D.J. and Higham, N.J., MATLAB Guide, 2nd Edition. Society for Industrial and Applied Mathematics (SIAM), 2005.
2. Gilat, A., MATLAB: An Introduction with Applications, 5th Edition. John Wiley & Sons, 2014.

SEMESTER-II

MSM-201-22	**Algebra-II**	**L-4, T-1, P-0**	**4 Credits**

Pre-requisite: Calculus of several variables and Real Analysis-I

Course Objectives: This course is designed to introduce the students to advanced ideas such as Polynomial rings, Field theory, Algebraic closures, splitting fields and Galois theory. It helps the students to learn about Eisenstein's irreducibility criterion which is quite helpful in the study of solvability of a polynomial. It makes the students to understand about the applications of Galois theory in other branches of mathematics.

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

CO1	Apply the knowledge of concepts of Polynomial rings, Euclidean Domain, UFD etc.
CO2	Understand the nature of abstract mathematics and explore the concepts in further details
CO3	Utilize the concepts of Einstein irreducibility criteria to check the factorization of polynomials, extension of fields etc.
CO4	Recognize the need of concept of fundamental theorem of algebra from a practical viewpoint.
CO5	Understand Galios extensions from theoretical point of view and apply its tools in different fields of applications.
CO6	Extend their knowledge of Homomorphisms, automorphisms and fixed fields by selecting and applying its tools for further research in this and other related areas.

Mapping of course outcomes with the program outcomes

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO 10**
CO1	√	-	-	√	√	-	-	-	√	√
CO2	-	√	-	√	√	-	-	-	√	√
CO3	√	-	-	√	√	-	-	-	√	√
CO4	-	√	-	√	√	-	-	-	√	√
CO5	-	√	-	√	√	-	-	-	√	√
CO6	-	-	-	√	√	-	-	-	√	√

Course Title: Algebra-II

Course Code: MSM-201-22

UNIT-I

Polynomial rings, factorization Domain and divisibility, Principal Ideal Domain (PID), Euclidean Domain (ED), factorization of polynomials in one variable over a field. Unique factorization domains, unique factorization in R[x], where R is a Unique Factorization Domain. Euclidean and Principal ideal domain. [Ref 2: Unit 2]

UNIT-II

Gauss Lemma, irreducible polynomials and Eisenstein's Irreducibility Criterion, Fields, Adjunction of roots, Algebraic extensions of field. [Ref 2: Unit 2,4]

UNIT-III

Algebraically closed fields, Splitting fields, normal extensions, finite fields, separable extensions. [Ref 2: Unit 4]

UNIT-IV

Automorphism of groups and fixed fields, Galois extensions. The fundamental theorem of Galois Theory, Fundamental theorem of algebra. [Ref 2: Unit 4]

RECOMMENDED BOOKS:

1. Bhattacharya, P.B., Jain, S.K. and Nagpaul, S.R., *Basic Abstract Algebra*, *2nd Edition.* U. K.: Cambridge University Press, 2004.
2. Dummit, David. S., and Foote, Richard M., *Abstract Algebra, 3rd Edition*. New Delhi: Wiley, 2011.
3. Herstein, I.N., *Topics in Algebra, 2nd Edition*. New Delhi: Wiley, 2006.
4. Singh, Surjeet, and Q. Zameeruddin. *Modern Algebra*, *7th Edition*. New Delhi: Vikas Publishing House, 1993.
5. Ash, R., *Abstract Algebra: The Basic Graduate Year*, Dover Publications Inc, 2006.

MSM-202-22	**Real Analysis-II**	**L-4, T-1, P-0**	**4 Credits**

Pre-requisite: Calculus of several variables and Real Analysis-I

Course Objectives: This course is designed to provide theoretical foundations of concepts of mathematical analysis, viz. sequence and series of functions, measure theory and integration that have many important applications in different branches of pure and applied mathematics. Further, this course will also develop rigorous understanding of the above said concepts.

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

CO1	Apply the knowledge of concepts of real analysis to study theoretical development of different mathematical concepts and their applications.
CO2	Understand the nature of abstract mathematics and explore the concepts in further details.
CO3	Apply the concepts of real analysis in solving and analyzing real world problems.
CO4	Recognize and elaborate the need of concept of measure from a practical viewpoint.
CO5	Understand measure theory and integration from theoretical point of view and apply its tools in different fields of applications.
CO6	Extend their knowledge of Lebesgue theory of integration by selecting and applying its tools for further research in this and other related areas

Mapping of course outcomes with the program outcomes

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO 10**
CO1	√	-	-	√	√	-	-	-	√	√
CO2	-	√	-	√	√	-	-	-	√	√
CO3	√	-	-	√	√	-	-	-	√	√
CO4	-	√	-	√	√	-	-	-	√	√
CO5	-	√	-	√	√	-	-	-	√	√
CO6	-	-	-	√	√	-	-	-	√	√

Course Title: Real Analysis-II

Course Code: MSM-202-22

UNIT-I

Sequences and series of functions, Uniform convergence, Uniform convergence and continuity, Uniform convergence and integration, Uniform convergence and differentiation, Equicontinuous families of functions, Weierstrass approximation theorem.

UNIT-II

Lebesgue Measure: Introduction, Lebesgue outer measure, Measurable sets and Lebesgue measure, non-measurable set, Measurable functions, Borel and Lebesgue measurability, Littlewood's three principles.

UNIT-III

Lebesgue Integral: The Lebesgue integral of a bounded function over a set of finite measure, the Comparison of Riemann and Lebesgue integral, the integral of a nonnegative function, The general Lebesgue integral, Convergence in measure.

UNIT-IV

Differentiation and Integration: The Four derivatives, Differentiation of monotone functions, differentiation of an integral. Absolute continuity.

RECOMMENDED BOOKS:

1. Royden, H.L. and Fitzpatrick, P.M., *Real Analysis, 4th Edition.* New Delhi: Pearson, 2010.
2. Barra, G. de., *Measure Theory and Integration*, New Delhi: Woodhead Publishing, 2011.
3. Rudin, W., *Principles of Mathematical Analysis, 3rd Edition*. New Delhi: McGraw-Hill Inc., 2013.
4. Carothers, N. L., *Real Analysis*, Cambridge University Press, 2000.
5. Apostol, T.M., *Mathematical Analysis –A modern approach to Advanced Calculus*. New Delhi: Narosa Publishing House, 1957.
6. Malik S. C., Arora Savita, *Mathematical Analysis, 5th Edition*, New Age International Publishers, 2017.

MSM-203-22	**Mechanics-I**	**L-4, T-1, P-0**	**4 Credits**

Pre-requisite: Basic Mechanics and Calculus of several variables

Course Objectives: To demonstrate knowledge of functional and extremum path and the application of the knowledge in solving some fundamental problems. To demonstrate the knowledge and understanding of the fundamental concepts in the dynamics of system of particles and Lagrangian and Hamiltonian formulation of mechanics. To represent the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulation of classical mechanics.

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

CO1	Understand the concept of functional and determine stationary paths of a functional to deduce the differential equation for stationary paths.
CO2	Use Euler-Lagrange equation to find stationary paths and its applications in some classical fundamental problems.
CO3	Define and understand basic mechanical concepts related to discrete and continuous mechanical systems.
CO4	describe and understand the motion of a mechanical system using Lagrange-Hamilton formalism.
CO5	Connect concepts and mathematical rigor to enhance understanding.

Mapping of course outcomes with the program outcomes

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO 10**
CO1	-	√	-	√	√	-	-	-	√	√
CO2	√	-	√	√	√	-	-	-	√	√
CO3	√	-	√	√	√	-	-	-	√	√
CO4	√	√	-	√	√	-	-	-	√	√
CO5	√	-	√	√	√	-	-	-	√	√

Course Title: Mechanics-I

Course Code: MSM-203-22

UNIT-I

Functional and its properties, Variation of a functional, Motivating problems: Brachistochrone, isoperimetric, Geodesics. Fundamental lemma of calculus of variation, Euler's equation for one dependent function of one and several variables. Generalization to *n* dependent functions and dependence on several derivatives. Invariance of Euler's equation, Moving end points problem, extremum under constraints.

UNIT-II

Constraints, Generalized coordinates, Generalized velocity, Generalized force, Generalized potential, D'Alembert principle, Lagrange's equation of first kind and second kind, uniqueness of solution, Energy equation for conservative field. Examples based on solving Lagrange's equation.

UNIT-III

Legendre transformation, Hamilton canonical equation, cyclic coordinates, Routhian procedure, Poisson bracket, Poisson's identity, Jacobi-Poisson theorem, Hamilton's principle, Principle of Least action.

UNIT-IV

Canonical transformations, Hamilton-Jacobi equation. Method of Separation of variables, Lagrange's bracket, Hamilton's equations in Poisson bracket, Canonical character of transformation through Poisson bracket. Invariance of Lagrange's bracket and Poisson's bracket.

RECOMMENDED BOOKS:

1. Elsegolc, L.D., *Calculus of Variation*, Dover Publication, 2007.
2. Gantmacher, F., *Lectures in Analytic Mechanics*, Moscow: Mir Publisher, 1975.
3. Goldstien, H., Poole, C. and Safco, J.L., *Classical Mechanics, 3rd Edition*. Addison Wesely, 2002.
4. Landau, L.D. and Lipshitz, E.M., *Mechanics*, Oxford: Pergamon Press, 1976.
5. Marsden, J.E., *Lectures on Mechanics*, Cambridge University Press, 1992.
6. Biswas, S. N., *Classical Mechanics*, Books and Applied (P) Ltd., 1999.

MSM-204-22	**Partial Differential Equations**	**L-4, T-1, P-0**	**4 Credits**

Pre-requisite: Calculus of several variables and ODE

Course Objectives: The Objective of this course is to introduce first and higher order partial differential equations and their classification. This course explains various analytic methods for computing the solutions of various partial differential equations. It also explains various applications of partial differential equations in real physical phenomenon like wave equation of string, diffusion equations and heat flow equations to students.

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

CO1	Understand partial differential equations of first order (linear and nonlinear), second and higher order.
CO2	Apply various analytic methods for computing solutions of various PDEs.
CO3	Determine integral surfaces passing through a curve, characteristic curves of second order PDE and compatible systems.
CO4	Understand the formation and solution of some significant PDEs like wave equation, heat equation and diffusion equation.
CO5	Apply the knowledge of PDEs and their solutions to understand physical phenomena.

Mapping of course outcomes with the program outcomes

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO 10**
CO1	√	-	√	√	√	-	-	-	√	√
CO2	√	-	√	√	√	-	-	-	√	√
CO3	√	-	√	√	√	-	-	-	√	√
CO4	√	-	√	√	√	-	-	-	√	√
CO5	√	-	√	√	√	-	-	-	√	√

Course Title: Partial Differential Equations

Course Code: MSM-204-22

UNIT-I

First Order PDE: Partial differential equations; its order and degree; origin of first order PDE; determination of integral surfaces of linear first order partial differential equations passing through a given curve; surfaces orthogonal to given system of surfaces; non-linear PDE of first order, Cauchy's method of characteristic; compatible system of first order PDE; Charpit's method of solution, solutions satisfying given conditions, Jacobi's method of solution.

UNIT-II

Second Order PDE: Origin of second order PDE; linear second order PDE with constant and variable coefficients; characteristic curves of the second order PDE; Monge's method of solution of non-linear PDE of second order.

UNIT-III

Separation of Variable Method and Derivation of Heat, wave and Laplace equations: Derivation of one-dimensional wave equation, Derivation of two-dimensional wave equation, Laplace's equation, Laplace's equation in plane polar coordinates, Laplace's equation in cylindrical coordinates, Laplace's equation in spherical coordinates, Derivation of one-dimensional heat equation.

UNIT-IV

Boundary value problems using separation of Variable Method: Boundary value problems in cartesian co-ordinates on Heat (or Diffusion) equation, wave equation and Laplace equation (1-D, 2-D and 3-D), Boundary value problems in polar co-ordinates, Boundary value problems in cylindrical co-ordinates, Boundary value problems in spherical co-ordinates.

RECOMMENDED BOOKS:

1. Sneddon, I.N., *Elements of Partial Differential Equation, 3rd Edition.* McGraw Hill Book Company, 1998.
2. Copson, E.T., *Partial Differential Equations, 2nd Edition.* Cambridge University Press, 1995.
3. Strauss, W.A., *Partial Differential Equations: An Introduction, 2nd Edition*. 2007.
4. Sharma, J.N. and Singh, K., *Partial differential equations for engineers and scientists, 2nd Edition.* New Delhi: Narosa Publication House, 2009.

MSM-205-18	**Numerical Analysis**	**L-4, T-1, P-0**	**4 Credits**

Pre-requisite: None

Course Objectives: The objective of the course on **Algebra-I** is to equip the M.Sc. students with the algebraic techniques that he/she needs for understanding theoretical treatment in different courses taught in this class and for developing a strong background if he/she chooses to pursue research in Mathematics as a career.

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

CO1	The study the basic numerical methods and their convergence properties for solving nonlinear, linear system of equations, initial value and boundary value problems.
CO2	The study of numerical methods for differentiation, integration, including Romberg integration.
CO3	The understanding of the elements of error analysis for numerical methods
CO4	Apply the numerical methods (such as Bisection, False position, Newton-Raphson, Secant, to solve equations.
CO5	Apply the numerical methods (such as Gauss Elimination, Gauss Jordan, LU factorization, Cholesky Factorization, Jacobi and Gauss Seidel) for linear system of equations./ apply the numerical methods (such as Newton forward and backward difference interpolation formula- Lagrange interpolation formula) for differentiation and integration.

Mapping of course outcomes with the program outcomes

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO 10**
CO1	√	-	-	-	-	-	-	-	√	√
CO2	-	√	-	-	-	-	-	-	√	√
CO3	√	√	-	-	-	-	-	-	√	√
CO4	√	-	-	-	-	-	-	-	√	√
CO5	√	√	-	-	-	-	-	-	√	√
CO6	-	-	-	√	-	-	-	-	√	√

Course Title: Numerical Analysis
Course Code: MSM-205-22

UNIT-I

Numerical computation and Error analysis: Numbers and their accuracy, Floating point arithmetic, Errors in numbers, Error estimation, General error formulae, Error propagation in computation. Inverse problem of error analysis and Numerical instability. Algebraic and transcendental equations: Bisection method, Iteration method, Regula-Falsi method, Secant method, Newton-Raphson's method. Convergence of these methods. Solution of system of nonlinear equations: Newton-Raphson's method.

UNIT-II

System of linear algebraic equations: Gauss elimination method without pivoting and with pivoting, Gauss-Jordon method, LU-factorization method, Jacobi and Gauss-Seidal methods, Convergence of iteration methods, Round-off errors and refinement, ill-conditioning, Inverse of matrices: Partition method. Eigen values and eigen vectors: Rayleigh Power method, Given's method.

UNIT-III

Interpolation: Finite differences, Newton's interpolation formulae, Gauss, Stirling's and Bessel's formulae, Lagrange's, Hermite's and Newton's divided difference formulae. Numerical differentiation and integration: differentiation at tabulated and non-tabulated points, Maximum and minimum values of tabulated function, Newton-Cotes Formulae-Trapezoidal, Simpson's, Boole's and Weddle' rules of integration with errors, Romberg integration. Double integration: Trapezoidal method and Simpson's method.

UNIT-IV

Ordinary differential equations: Taylor series and Picard's methods, Euler's and modified Euler methods, Runge-Kutta methods, Predictor-Corrector methods: Adams-Bashforth's and Milne's methods. Error analysis and accuracy of these methods. Solution of simultaneous and higher order equations, Boundary value problems of Ordinary differential equations: Finite difference methods.

RECOMMENDED BOOKS:

1. Sharma, J.N., *Numerical Methods for Engineers and Scientists, 2nd Edition*. Narosa Publ. House New Delhi/Alpha Science International Ltd., Oxford UK, 2007, Reprint 2010.
2. Jain, M.K., Iyengar, S.R.K. and Jain, R.K., *Numerical Methods for Scientific and Engineering Computation, 5th Edition. New Age International Publ.* New Delhi, 2010
3. Bradie, B., *A Friendly Introduction to Numerical Analysis*. Pearson Prentice Hall, 2006.
4. Atkinson, K.E., *Introduction to Numerical Analysis, 2nd Edition*. John Wiley, 1989.
5. Scarborough, J.B., *Numerical Mathematical Analysis.* Oxford & IBH Publishing Co., 2001.

MSM-206-22	**Numerical Analysis (Lab)**	**L-0, T-0, P-4**	**2 Credits**

Pre-requisite: Basic knowledge of Computer and MATLAB Programming

Course Objectives: This course is designed to provide understanding of implementation of basic numerical methods for solving different problems viz. nonlinear equations, system of linear equations, interpolation and extrapolation, numerical differentiation and integration, numerical initial and boundary value problems of ordinary differential equations etc. Further, this course will develop programming skills in the students in order to write and implement their own computer programs for solving problems arising in science, engineering and economics.

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

CO1	Apply their knowledge of computer programming to develop and implement their own computer codes of numerical methods for solving different types of complex problems viz. nonlinear equations, system of linear equations, interpolation and extrapolation, numerical differentiation and integration, numerical initial and boundary value problems of ordinary differential equations etc.
CO2	Understand different implementation modes of a numerical method in order to solve a given problem efficiently.
CO3	Analyze and modify computer codes available in the scientific literature.
CO4	Utilize the symbolic tools of MATLAB independently and in their computer codes for solving a given problem.
CO5	Develop, select and apply numerical methods as a computer code with the understanding of their limitations so that they can be implemented in order to get acceptable results.
CO6	Identify the challenging problems in continuous mathematics (which are difficult to deal with analytically) and find their appropriate solutions accurately and efficiently using computer codes.

Mapping of course outcomes with the program outcomes

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO 10**
CO1	√	-	-	-	-	-	-	-	√	√
CO2	-	√	-	-	-	-	-	-	√	√
CO3	√	√	-	-	-	-	-	-	√	√
CO4	√	-	-	-	-	-	-	-	√	√
CO5	√	√	-	-	-	-	-	-	√	√
CO6	-	-	-	√	-	-	-	-	√	√

Course Title: Numerical Analysis (LAB)

Course Code: MSM-206-22

The following programs of following methods are to be practiced:

1. To find a real root of an algebraic/ transcendental equation by using Bisection method.
2. To find a real root of an algebraic/ transcendental equation by using Regula-Falsi method.
3. To find a real root of an algebraic/ transcendental equation by using Newton-Raphson method.
4. To find a real root of an algebraic/ transcendental equation by using Iteration method.
5. Implementation of Gauss- Elimination method to solve a system of linear algebraic equations.
6. Implementation of Jacobi's method to solve a system of linear algebraic equations.
7. Implementation of Gauss-Seidel method to solve a system of linear algebraic equations.
8. To find differential coefficients of 1st and 2nd orders using interpolation formulae.
9. To evaluate definite integrals by using Newton - Cotes integral formulae.
10. To evaluate double integrals by using Trapezoidal and Simpson method.
11. To compute the solution of ordinary differential equations with Taylor's series method.
12. To compute the solution of ordinary differential equations by using Euler's method.
13. To compute the solution of ordinary differential equations by using Runge -Kutta methods.
14. To compute the solution of ordinary differential equations by using Milne-Simpson method.
15. To compute the solution of Boundary value problems of Ordinary Differential Equations by using Finite Difference method.

RECOMMENDED BOOKS:

1. Fausett, L.V., *Applied Numerical Analysis using MATLAB, 2nd Edition.* Pearson Prentice Hall, 2007.
2. Mathews, J.H. and Fink, K.D., *Numerical Methods using MATLAB, 4th Edition.* Pearson Prentice Hall, 2004.
3. Conte, S.D. and Boor, C.D., *Numerical Analysis*. New York: McGraw Hill, 1990.

Semester III

MSM-301-22	**Topology**	**L-4, T-1, P-0**	**4 Credits**

Pre-requisite: Real Analysis-I

Course Objectives: The objective of the course on **Topology** is to provide the knowledge of Topological Spaces and their importance. To acquaint students with the concept of Homeomorphism and the topological properties and important mathematical concepts which can be generalized in topological spaces, so that students may learn and appreciate the nature of abstract Mathematics.

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

CO1	Understand the concepts of topological spaces and the basic definitions of open sets, neighbourhood, interior, exterior, closure and their axioms for defining topological space.
CO2	Understand the concept of Bases and Subbases, create new topological spaces by using subspace.
CO3	Understand continuity, compactness, connectedness, homeomorphism and topological properties.
CO4	Understand how points of space are separated by open sets, Housdroff spaces and their importance.
CO5	Understand regular and normal spaces and some important theorems in these spaces.

Mapping of course outcomes with the program outcomes

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO 10**
CO1	√	√	-	√	√	-	-	-	√	√
CO2	√	√	√	√	√	-	-	-	√	√
CO3	√	√	-	√	√	-	-	-	√	√
CO4	√	√	-	√	√	-	-	-	√	√
CO5	√	√	-	√	√	-	-	-	√	√

Course Title: Topology

Course Code: MSM-301-22

L	T	P
4	1	0

UNIT-I

Introduction to topological spaces, open and closed sets, Neighbourhoods, interior, exterior, boundary, Accumulation points, and limit points. Derived sets, Interior and Closure of a set, Dense sets. Bases and subbases, Subspaces and relative Topology, Alternative methods of defining a Topology in terms of Kuratowski closure operator and neighbourhood systems.

UNIT-II

Open and closed mappings, Continuous mapping and homomorphism. Topological properties, Compactness, local Compactness. One-point compactification.

UNIT-III

Connected and arc-wise connected spaces and connected sets [Basic theorems of connected and disconnected sets; connectedness in terms of open and closed sets, connectedness uder continuous map; closure of connected set and connectedness in usual topological space.], Components and Locally connected spaces. Separation Axioms: T0, T1, T2 (or Hausdorff) spaces and sequences. Axioms of Countability and Seperability, Second Axiom and Lindeloff spaces.

UNIT-IV

Regular and completely regular, Normal and completely normal spaces. Metric spaces as T2, completely normal and first axiom spaces, Urysohn's Lemma, Tietze Extension Theorem.

BOOKS RECOMMENDED

1. Munkres, J. R., *Topology, a first course*, Prentice-Hall of India Ltd., New Delhi, 2000.
2. Joshi, K. D., *An introduction to general topology, 2nd edition*, Wiley Eastern Ltd., New Delhi, 2002.
3. Simmons, G.F., *Introduction to topology and Modern Analysis*, McGraw Hill Publications, 2017.
4. Kelley, J. L., *General Topology*, Springer Verlag, New York, 1990.
5. Armstrong, M.A., *Basic Topology*, Springer International Ed., 2005.

MSM-302-22	**Number Theory and Cryptography**	**L-4, T-1, P-0**	**4 Credits**

Pre-requisite: Congruences, Number System

Course Objectives: This course is designed to provide students an introduction to classical number theory and enable them to study higher courses in number theory, and to apply the learnt concepts of number theory using public-key cryptography.

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

CO1	Apply the knowledge of Number theory and Cryptography to attain a good mathematical maturity and enables to build mathematical thinking and skill.
CO2	Utilize the GCD, LCM, Fundamental Theorem of Arithmetic, Product of r consecutive integers, congruences, Chinese remainder theorem etc. to solve different related problems.
CO3	Apply different types of divisibility tests, Euler's theorem, Wilson theorem, Fermat's theorem, Mobius inversion formula to formulate and solve various related problems.
CO4	Design, analyze and implement the concepts of Diophantine equations for solving different types of problems. Understand and apply the concept of Power residue, order of $a(mod\ m)$, Primitive root, Reduced residue system, Euler's solvability criterion, Lagrange's theorem for the number of incongruent solutions of a polynomial.
CO5	Create, select and apply appropriate number theoretic techniques such as Mersene primes, Fermats primes, greatest integer functions, indices, residue classes, Legendre symbols, Gauss Lemma, quadratic reciprocity law to use in real life problems.
CO6	Identify the challenging problems in modern mathematics, such as, Cryptography and find their appropriate solutions.

Mapping of course outcomes with the program outcomes

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO 10**
CO1	√	√	-	√	√	-	-	-	√	√
CO2	√	√	-	√	√	-	-	-	√	√
CO3	√	√	√	√	√	-	-	-	√	√
CO4	√	√	-	√	√	-	-	-	√	√
CO5	√	√	-	√	√	-	-	-	√	√
CO6	√	-	√	√	-	-	-	-	√	√

Course Title: Number Theory and Cryptography
Course Code: MSM-302-22

L	T	P
4	1	0

UNIT-I

Divisibility, Greatest common divisor, Euclidean Algorithm, Least Common Multiplier, divisibility of product of r consecutive integers, The Fundamental Theorem of arithmetic, congruences and its properties, Special divisibility tests, Solvability of linear diophantine equations ($ax + by = c$) and congruence equations ($an \equiv b(mod\ c)$), Chinese remainder theorem.

UNIT-II

Arithmetic functions ϕ(n), d(n), σ(n), μ(n), Multiplicative functions, Mobius inversion Formula, Complete residue system, Fermat's little theorem, Wilson's theorem, Euler's theorem, Power residue, order of $a(mod\ m)$, Primitive root, Reduced residue system, Euler's solvability criterion, Lagrange's theorem for the number of incongruent solutions of a polynomial.

UNIT-III

Indices and its properties, The greatest integer function, Legendre's formula, Quadratic residues, Legendre symbol, Gauss's Lemma, Quadratic reciprocity law, perfect numbers, Mersenne primes and Fermat prime numbers. [Ref. 2]

UNIT-IV

Cryptography: some simple cryptosystems, need of the cryptosystems, the idea of public key cryptography, RSA cryptosystem. [Ref. 4]

RECOMMENDED BOOKS:

1. Burton, D.M., *Elementary Number Theory, 7th Edition*. McGraw-Hill Education, 2010.
2. Hardy, G.H. and Wright, E.M., *An introduction to the Theory of Numbers, 4th Edition*. Oxford University Press, 1975.
3. Niven, I., Zuckerman, H.S. and Montgomery, H.L., *Introduction to Theory of Numbers, 5th Edition*. John Wiley & Sons, 1991.
4. Koblitz N., *A Course in Number Theory and Cryptography, Graduate Texts in Mathematics, No.114*. New-York: Springer-Verlag, 1987.
5. Stallings, W., *Cryptography and Network Security, 5th Edition.* Pearson, 2010.

MSM-303-22	**Mathematical Statistics**	**L-4, T-1, P-0**	**4 Credits**

Pre-requisite: Basic Statistics and Calculus of several variables

Course Objectives: The aim of the course is to enable the students with understanding of various types of probability distributions and testing of hypothesis problems. It aims to equip the students with standard concepts of statistical techniques and their utilization.

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

CO1	Understand and utilize the concept of probability.
CO2	Explain the concept of random variable and its applications.
CO3	Explore the different types of discrete and continuous distributions and their utilization.
CO4	Deal with formulation of hypotheses as per situations and their testing.
CO5	Apply the knowledge of statistical techniques in various experimental and industrial requirements.

Mapping of course outcomes with the program outcomes

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO 10**
CO1	√	-	√	√	√	-	-	-	√	√
CO2	√	-	√	√	√	-	-	-	√	√
CO3	√	-	√	√	√	-	-	-	√	√
CO4	√	-	√	√	√	-	-	-	√	√
CO5	√	-	√	√	√	-	-	-	√	√

Course Title: Mathematical Statistics

Course Code: MSM-303-22

L	T	P
4	1	0

Unit I

Classical and axiomatic approaches to the theory of probability, Additive and multiplicative law of probability, Conditional probability, Independent events, Bayes theorem. Random variable, Distribution function and its properties, Discrete random variable, Probability mass function, Discrete distribution function, Continuous random variable, Probability density function, Continuous distribution function.

Unit II

Two dimensional random variables, joint, marginal and conditional distributions, Independence of random variables, Expectation of a random variable and its properties, Moments, Conditional expectation, Moment generating function and its properties, Cumulants, Characteristic function and its elementary properties.

Unit III

Study of various discrete and continuous distributions: Binomial, Poisson, Geometric, Hyper-geometric, Normal distributions, Rectangular (uniform), Exponential. Central limit theorem (Only particular cases: De-Moivre's Laplace theorem and Lindeberg-Levy theorem subsection 9.13.1 and 9.13.2 of [2]).

Unit IV

Concept of sampling distribution and its standard error, Testing of hypotheses and its fundamental notions, Tests based on Normal distribution (subsections 14.7.1, 14.7.2,14.8.3 and 14.8.4 of [2]), χ^2 -distribution (χ^2 -test for hypothetical value of population variance as in subsection 15.6 (i) and to test the `goodness of fit' as in subsection 15.6 (ii) of [2]), t -distribution (t -test for single mean and difference of means as in subsections 16.3.1 & 16.3.2 of [2]) and F-distribution (F-test for equality of two population variances as in subsection 16.6.1 of [2]).

BOOKS RECOMMENDED:

1. Hogg R. V., McKean J. W. and Craig A. T., *Introduction to Mathematical Statistics,* Pearson, 2005, Sixth Edition.
2. Gupta S. C. and Kapoor V. K., *Fundamentals of Mathematical Statistics, 11th Edition.* Sultan Chand & Sons, 2014.
3. Fisz M., *Probability Theory and Mathematical Statistics, 3rd Edition.* John Wiley & Sons, 1967.
4. Gun A.M., Gupta, M.K. and Dasgupta B., *Fundamentals of Statistics (Vol-I),* World Press, 2013.
5. Feller W., *An Introduction to Probability Theory and Its Applications (Vol-I), 3rd Edition.* John Wiley & Sons, 2003.

MSM-304-22	**Functional Analysis**	**L-4, T-1, P-0**	**4 Credits**

Pre-requisite: Real analysis and Linear Algebra

Course Objectives: This course will develop a deeper and rigorous understanding of fundamental concepts of functional analysis, their properties and related theorems.

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

CO1	Explain the fundamental concepts of functional analysis and their role in modern mathematics.
CO2	Utilize the concepts of functional analysis, for example continuous and bounded operators, normed spaces, Hilbert spaces and to study the behavior of different mathematical expressions arising in science and engineering.
CO3	Understand and apply fundamental theorems from the theory of normed and Banach spaces including the Hahn-Banach theorem, the open mapping theorem, the closed graph theorem and uniform boundedness theorem.
CO4	Understand the nature of abstract mathematics and explore the concepts in further details.
CO5	Explain the concept of projection on Hilbert and Banach spaces.

Mapping of course outcomes with the program outcomes

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO 6**	**PSO7**	**PSO8**	**PSO9**	**PSO 10**
CO1	√	√	-	√	√	-	-	-	√	√
CO2	√	√	√	√	√	-	-	-	√	√
CO3	√	√	√	√	√	-	-	-	√	√
CO4	√	√	-	√	√	-	-	-	√	√
CO5	√	√		√	√	-	-	-	√	√

Course Title: Functional Analysis

Course Code: MSM-304-22

L	T	P
4	1	0

UNIT-I

Normed linear spaces, Banach spaces, properties of normed spaces, finite dimensional normed spaces and subspaces, linear operators, bounded and continuous linear operators, linear functionals, normed spaces of operators

UNIT-II

Equivalent norms, conjugate spaces, Reflexivity. Hahn-Banach theorems for real/complex vector spaces and normed spaces, Applications to bounded linear functionals on C [a,b].

UNIT-III

Uniform boundedness theorem, open mapping theorem, closed graph theorem, Projections on Banach spaces.

UNIT-IV

Inner product spaces, Hilbert spaces, properties of inner product spaces, orthogonal complements, orthonormal sets, Hilbert – adjoint operator, self-ad joint, unitary and normal operators, projections on Hilbert spaces.

RECOMMENDED BOOKS:

1. Simmons, G.F., *Introduction to Topology and Modern Analysis*, 2008.
2. Rudin, W., *Functional Analysis, International Series in Pure and Applied Mathematics*, McGraw-Hill inc.,1991.
3. Kreyszig, E., *Introductory Functional Analysis with Applications*, John Wiley and Sons (Asia) Pvt. Ltd., 2006.
4. Bachman, G. and Narici, L., *Functional Analysis*, Dover, 2000.
5. Conway, J.B., *A Course in Functional Analysis, 2nd Edition*. Springer-Verlag, 2006.

MSM-305-22	**Tensor Calculus and Applications**	**L-4, T-1, P-0**	**4 Credits**

Pre-requisites: Linear Algebra, Vector Calculus and Basic Mechanics

Course Objectives: The objective of the course on Mechanics-II is to equip the students with the knowledge of Tensors and their applications. To make students understand the notion of continuum and the basic concepts of strain, stretch and rotation and the applications of tensors in understanding these concepts. One of the objectives is to make students understand the applications of Mathematical concepts in real world problems related to Mechanics.

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

CO1	Understand the concept of Tensor and their properties.
CO2	Understand the effect of co-ordinate transformations and visualize the tensor as a linear transformation.
CO3	Understand the conventions like summation convention and comma notations. Also, students shall learn the concepts of tensor calculus.
CO4	Understand continuum hypothesis, spatial and material co-ordinates and their applications.
CO5	Understand the concepts of strain, stretch, rotation and shall be able to apply the knowledge in solving real world problems related to continuum mechanics.

Mapping of course outcomes with the program outcomes

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO 10**
CO1	√	-	√	√	√	-	-	-	√	√
CO2	√	-	√	√	√	-	-	-	√	√
CO3	√	-	√	√	√	-	-	-	√	√
CO4	√	-	√	√	√	-	-	-	√	√
CO5	√	-	√	√	√	-	-	-	√	√

Course Title: Tensor Calculus and Applications

Course Code: MSM-305-22

L	T	P
4	1	0

Unit I

Tensors: Introduction, Range and Summation Conventions, Free and dummy suffixes, results in vector algebra and matrix, the symbol δ_{ij}&ε_{ijk} , Coordinate transformations, cartesian tensors, Properties of tensors, Isotropic tensors, Isotropic tensor of order four, Tensors as linear operators, Transpose of a tensor.

Unit II

Symmetric and skew tensors, Dual vector of a skew tensor, Invariants of a tensor, Deviatoric tensors, Eigenvalues and eigenvectors, Polar decomposition, Scalar, vector and tensor functions, Comma notation,

Unit III

Gradient of a scalar, divergence and curl of a vector, Gradient of a vector, divergence and curl of a tensor, Integral theorems for vectors and tensors.

Unit IV

Applications of Tensors in Continuum Mechanics: Notation of a continuum, Configuration of a continuum, Mass and density, Descriptions of motion, Deformation: Material and special coordinates, Deformation gradient tensor, Stretch and rotation, Strain tensors, Strain-displacement relations, Infinitesimal strain tensor, Infinitesimal stretch and rotation, Compatibility conditions., Principal strains, Strain-deviator.

BOOKS RECOMMENDED:

1. Jog, C.S.,*Foundations and Applications of Mechanics: Volume-I Continuum Mechanics.* Narosa Publishing House, New delhi.
2. Chandrasekharaiah, D.S. and Lokenath, D.,*Continuum Mechanics,* Academic Press, London (Prism Books Pvt. Ltd., Bangalore-India).

Semester IV

Course Title: Operations Research

Course Code: MSM-401-22

L	T	P
4	1	0

UNIT-I

Formulation of linear programming problem (LPP) -graphical method, Basic Feasible Solution, Extreme Points, Convex set, Convex linear combination, optimal solution of LPP using Simplex method, Big-M method and two-phase method, Exceptional cases in LPP i.e., Infeasible, unbounded, alternate and degenerate solutions.

UNIT-II

General Primal-Dual pair, Formulating a dual problem, Weak duality theorem, Fundamental theorem of Duality, Existence theorem, Complementary slackness theorem, Duality and Simplex method, Economic interpretation of Duality, Dual Simplex method.

UNIT-III

Initial basic Feasible solution of transportation problem, Balanced and unbalanced transportation problems, Optimal solutions of transportation problem using U-V /MODI methods, Assignment problems; Mathematical formulation of assignment problem, the traveling salesman problem, Test for optimality, degeneracy.

UNIT-IV

Concept of convexity and concavity, Maxima and minima of convex functions, Single and multivariate unconstrained problems, constrained programming problems, Kuhn-Tucker conditions for constrained programming problems, Quadratic programming, Wolfe's method.

BOOKS RECOMMENDED

1. Taha, H.A., *Operations Research-An Introduction,* PHI, 2007.
2. Kanti Swarup, Gupta, P.K. and Man Mohan, *Operations Research,* Sultan Chand & Sons, Ninth Edition, 2002.
3. Gupta P.K., Hira, D.S., *Operations Research,*7th Edition, S. Chand & Company Pvt. Ltd., New Delhi, 2016.
4. Hillier, F.S. and Lieberman, G.J., *Operations Research, Second Edition,* Holden-Day Inc, USA, 1974.
5. Bazaraa, M.S., Sherali, H.D., Shetty, C.M., *Nonlinear Programming: Theory and Algorithms,* John Wiley and Sons, 1993.
6. Chandra, S., Jayadeva, and Mehra, A., *Numerical Optimization with Applications,* Narosa Publishing House, 2009.

Elective Subjects

Course Title: Discrete Mathematics
Course Code: MSM-501-22

L	T	P
4	1	0

Unit-I

Mathematical Logic: Basic logical operations, conditional and bi-conditional statements, tautologies, contradiction, predicate calculus and its inference theory.

Recursion and Recurrence Relations: Polynomial expressions, telescopic form, recursion theorem, closed form expression, generating function, solution of recurrence relation using generating function, recursion.

Unit-II

Lattices and Boolean Algebra: Introduction to Binary relations, equivalence relations and partitions, Partial order relations, Hasse diagram. Lattices as partially ordered sets, properties, lattices as algebraic systems, sub lattices, direct products, Homomorphism, some special lattices. Boolean algebra as lattices, Boolean identities, sub-algebra, Boolean forms and their equivalence, sum of product, product of some canonical forms. Applications of Boolean algebra to circuit theory.

Unit-III

Graph Theory: Directed graphs, undirected graphs, paths, circuits, cycles, sub-graphs, induced Sub graphs, degree of vertex, connectivity, planner graph, complete, bi-partite complete graph, matrix representation of graph, adjacency and incidence matrix for graph, Eulerian paths and circuits, Trees and Coloring of the graph, Rooted tree, search tree, tree traversals, spanning trees, minimal spanning trees, Kruskal's algorithm. Chromatic number and polynomial, four-color problem (statement only).

Unit-IV

Algebraic Structures: Review of groups, codes and group codes, cyclic codes and coding methods based on entropy, Application of algebraic structure to error corrections and detection codes, discrete codes and first coding theorem.

BOOKS RECOMMENDED:

1. Tremblay, J.P. and Manohar, R.P., *Discrete Mathematics with Applications to Computer Science*, Tata McGraw Hill, 2008.
2. Ram, Babu, *Discrete Mathematics*, Pearson Education, 2007.
3. Harary, F., *Graph Theory*, Narosa, 1995
4. Doerr, Alan and Levsseur, K., *Applied Discrete Structures for Computer Science*, Galgotia Publication, 2005.
5. Liu, C.L, *Elements of Discrete Mathematics*, 3rd Edition, Tata McGraw Hill, 2008.
6. Grimaldi, R.P and Ramana, B.V., *Discrete and Combinatorial Mathematics-An Applied Introduction*, Pearson education, 5th Edition, 2004.
7. Lipschultz, S., *Theory and Practice of Data Structures*, McGraw-Hill, 1988.

Course Title: Coding Theory
Course Code: MSM-502-22

L	T	P
4	1	0

Unit-I

Introduction to Coding Theory: Code words, distance and weight function, Nearest-neighbour decoding principle, Error detection and correction, Matrix encoding techniques, Matrix codes, Group codes, decoding by coset leaders, Generator and parity check matrices, Syndrome decoding procedure, Dual codes.

Unit-II

Linear Codes: Linear codes, Matrix description of linear codes, Equivalence of linear codes, Minimum distance of linear codes, Dual code of a linear code, Weight distribution of the dual code of a binary linear code, Hamming codes.

Unit-III

BCH Codes: Polynomial codes, Finite fields, Minimal and primitive polynomials, Bose-Chaudhuri-Hocquenghem codes.

Unit-IV

Cyclic Codes: Cyclic codes, Algebraic description of cyclic codes, Check polynomial, BCH and Hamming codes as cyclic codes. Maximum distance separable codes, Necessary and sufficient conditions for MDS codes, Weight distribution of MDS codes, An existence problem, Reed-Solomon codes.

BOOKS RECOMMENDED

1. Vermani L R, *Elements of Algebraic Coding Theory*, Chapman and Hall, 1996.
2. Vera P.**,** *Introduction to the Theory of Error Correcting Codes*, John Wiley and Sons, 1998.
3. Roman Steven, *Coding and Information Theory*, Springer Verlag, 1992.
4. Garrett Paul, *The Mathematics of Coding Theory*, Pearson Education, 2004.

Course Title: Differential Geometry
Course Code: MSM-503-22

L	T	P
4	1	0

Unit I

Theory of Space Curves: Tangent, principal normal, bi-normal, curvature and torsion. Serretfrenet formulae, Contact between curves and surfaces. Locus of centre of curvature, spherical curvature, Helices.

Unit II

Spherical indicatrix, Bertrand curves, surfaces, envelopes, edge of regression, developable surfaces, two fundamental forms.

Unit III

Curves on a surface, Conjugate Direction, Principle Directions, Lines of Curvature, Principal Curvatures, Asymptotic Lines. Theorem of Beltrami and Enneper, Mainardi- Codazzi equations.

Unit IV

Geodesics, Differential Equation of Geodesic, torsion of Geodesic, Geodesic Curvature, Clairaut's theorem, Gauss- Bonnet theorem, Joachimsthal's theorem, Geodesic Mapping, Tissot's theorem.

Text and Reference Books:

1. Weatherburn, C.E., *Differential Geometry of Three Dimensions*, Cambridge University Press, 2016.
2. Willmore, T.J., *Introduction to Differential Geometry*, Dover Publications Inc., United States, 2012.
3. Bansi Lal, *Differential Geometry, 4th Edition.* Atma Ram & Sons, India, 1976.

Course Title: Advanced Number Theory
Course Code: MSM-504-22

L	T	P
4	1	0

UNIT-I

Partitions, Compositions, Ferrers graphs, Jacobi's triple product identity, Congruence properties of $p(n)$, Rogers-Ramanujan identities, Basic hypergeometric series, q-binomial theorem, Sylvester's theorem, Heine's transformation.

UNIT-II

Restricted partitions, q-Gauss theorem, Gaussian polynomials, Bailey's lemma (weak version), Rogers lemma, q-Saalschutz's theorem, Finite version of q-Saalschutz's theorem.

UNIT-III

Schur's theorem, Gollnitz-Gordon identities, Generalization and various analogues of Rogers-Ramanujan identities, Bailey's lemma (strong version), Watson's q-analogue of Whipple's theorem and its applications in deriving Rogers-Ramanujan identities and Gollnitz-Gordon identities.

UNIT-IV

Rank & Crank of a partition, n-colour partitions, Conjugate and self-conjugate n-colour partitions, Restricted n-colour partitions, Rogers-Ramanujan type identities for n-colour partitions.

RECOMMENDED BOOKS:

1. Agarwal, A.K., Padmavathamma and Subbarao, M.V., *Partition Theory*, Atma Ram & Sons, Chandigarh, 2005.
2. Andrews, G.E., *The Theory of Partitions, Encyclopedia of Mathematics and its Applications* (Addison-Wesley), 1976, Re-issued: Cambridge University Press, Cambridge, 1988.
3. Gasper, G. and Rahman, M., *Basic Hypergeometric Series, Encyclopedia of Mathematics and its Applications*, Vol. 35, Cambridge University Press, Cambridge, 1990.
4. Agarwal, R.P., *Resonance of Ramanujan Mathematics*, Vol. 1 (New Age International), 1996.
5. Gupta, H., *Selected Topics in Number Theory*, ABACUS Press, 1980.
6. N.J. Fine, *Basic Hypergeometric Series and Applications*, Mathematical Surveys and Monographs, No. 27, American Mathematical Society, 1988.

Course Title: Advanced Complex Analysis

Course Code: MSM-505-22

L	T	P
4	1	0

Unit-I

Analytic continuation, Analytic continuation by power series method, Natural boundary, Schwarz reflection principle, Analytic continuation along a path, Monodromy theorem, Runge's theorem, simple connectedness, Mittag-Leffler's theorem.

Unit-II

Maximum principle, Schwarz's Lemma, Hadamard's three circle theorem, Phragmen-Lindelof theorem, Weierstrass factorization theorem, Factorization of sine function, Gamma function. Entire functions, Jensen's formula, the genus and order of an entire function, Hadamard factorization theorem.

Unit-III

Harmonic functions, Basic properties, Harmonic functions on a disc, Subharmonic and Superharmonic functions, The Dirichlet problem, Green's function.

Unit-IV

Normal families of analytic functions, Montel's theorem, Hurwitz's theorem, Riemann mapping theorem, Univalent function, Distortion and Growth theorem for the class of normalized univalent functions, Covering theorem, starlike functions, convex functions, Subordination principle.

BOOKS RECOMMENDED

1. Nihari, Z., Conformal Mapping, Conformal Mapping, McGraw-Hill,1952.
2. Conway, J.B., Functions of One Complex Variable, Springer-Verlag,1973
3. Gamelin, T.W., Complex Analysis, Springer, 2004.
4. Tutschke, W. and Vasudeva, H.L., An Introduction to Complex Analysis- Classical and Modern Approaches, Chapman & Hall/CRC, 2005
5. Copson, E.T., An Introduction to Theory of Functions of a Complex Variable.

Course Title: Advanced Operations Research
Course Code: MSM-506-22

L	T	P
4	1	0

Unit I

Advanced Linear Programming: Revised simplex method, Sensitivity analysis, Parametric programming, Integer programming branch and bond algorithm, Goal programming, Standard form of LGPP, Partitioning algorithm.

Unit II

Game Theory: Two-person zero sum games pure strategies (minmax and maximum principles), Game with saddle point, Mixed strategies: Game without saddle point, Rule of Dominance, Solution methods for games without saddle point: Graphical method, Linear programming method.

Unit III

Dynamic Programming: Characteristics of dynamic programming, Recursive relations, continuous and discrete cases, forward recursion, linear programming versus dynamic programming, Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.

Unit IV

Inventory Models: Deterministic models: Classic EOQ (Economic order quantity) models, EOQ with price brakes, Multi item EOQ with storage limitation, Dynamic EOQ models(b) Probabilistic models: Probabilistic EOQ models, Single period models and multiperiod models.

Books Recommended

1. Taha, H.A., *Operations Research- An introduction*, 8th Edition, PHI, 2007.
2. Sharma, J.K, *Operation research: Theory & Applications*, 3rd Edition, Macmillan India, 2007.
3. Kasana, H.S and Kumar K.D, *Introductory Operations Research: Theory & Applications*, Springer, 2005.
4. Pant, J.C, Introduction to Optimization and Operations Research, Jain Brothers, 2004.

Course Title: Advanced Fluid Mechanics
Course Code: MSM-507-22

L	T	P
4	1	0

UNIT-I

Basic Concepts: Continuum Hypothesis, Viscosity, Most general motion of a fluid element, Rate of strain quadric, stress at a point, Tensor character of stress matrix, Symmetry of stress matrix, stress quadric, Stress in a fluid at rest, stress in a fluid in motion, Relation between stress and rate of strain components (Stoke's law of friction), Thermal conductivity, Generalized law of heat conduction, Fundamental equations of the flow of viscous fluids: Equation of state, equation of continuity -Conservation of mass, Equation of motion- Navier-Stoke's equations, Equation of energy- Conservation of energy, Symmetry of fundamental equations, Vorticity and circulation in a viscous incompressible fluid motion, (a) velocity transport equation, Circulation

UNIT-II

Dynamical similarity and Dynamical Analysis: Dynamical similarity, Reynold's law, Inspection analysis, Dimensional analysis, Buckingham π-theorem. Method of finding out the pi-products, Application of pi-theorem to viscous and compressible fluid. Physical importance of non-dimensional parameters. Reynolds number, Eckert Number, Froude Number, Mach Number, Pecklet Number, Grashoff Number, Prandtl Number, Brinkman Number, Nussel Number. Exact Solution of Navier-Stoke's equations of motion- Flow between parallel plates (Velocity and temperature distributions), (i) Plane Couette flows (ii) Plane Poiseulle Flow and (iii) Generalized Couette flow.

UNIT-III

Flow in a circular pipe (Hagen Poiseuille flow) -Velocity and temperature distribution, Flow through tubes of uniform cross section in the form of circle, annulus, ellipse and equilateral triangle under constant pressure gradient. Flow between two concentric rotating cylinders (Couette flow), Flow in convergent and divergent channels,

UNIT-IV

Steady incompressible flow with variable viscosity: Variable viscosity plane Couette flow and plane poiseulle flow. Unsteady incompressible flow with constant fluid properties: Flow due to a plane wall suddenly set in motion, flow due to an oscillating plane wall, starting flow in plane Couette motion, Starting flow in pipes, Plane coquette flow with transpiration cooling.

Books Recommended

1. Bansal, J L, *Viscous Fluid Dynamics*, OXFORD & IBH Publishing Company Pvt. Ltd., New Delhi, 1992.

2. Chorlton, F., *Textbook of Fluid Dynamics*, C.B.S. Publishers, Delhi, 1985.

3. Schlichting, H., *Boundary Layer Theory*, McGraw Hill Book Company, New York, 1979.

4. Young, A. D., *Boundary Layers*, AIAA Education Series, Washington DC, 1989.

5. Yuan, S.W., *Foundations of Fluid Mechanics*, Prentice Hall of India Private Limited, New Delhi, 1976.

Course Title: Advanced Solid Mechanics
Course Code: MSM-508-22

L	T	P
4	1	0

Unit-I

Basics and Extension of Beams: Hooke's law, generalized Hooke's law, Elastic moduli and their relationship, strain-energy density function and its connection with Hooke's law, Saint-Venant's principle. Extension of beams: extension of beams by longitudinal forces, beam stretched by its own weight and bending of beams by terminal couples.

Unit-II

Torsion and flexure of beams: Torsion of a circular shaft, cylindrical bars, and elliptic cylinder. Stress function, conformal mapping, solution of torsion problem by conformal mapping. Flexure of beams by terminal loads, bending of rectangular beams.

Unit-III

Two-and Three-dimensional Problems: Plane deformation, plane stress, plane elastostatic problems, Airy's stress function, solution of the bi-harmonic equation, stress and displacement formulae basic problems of circular region: uniform pressure, uniform radial displacement and concentrated loads. Spherical shell under external and internal pressures.

Unit-IV

Thermoelastic problems and Variational Methods: Thermal stresses in spherical bodies, two-dimensional thermoelastic problems. Variational methods: Theorems of potential energy, minimum complementary energy, work and reciprocity, Ritz method for one- and two-dimensional problems and Galerkin's method. Kantorovich and Trefftz methods. Application of Treffz method.

Books Recommended

1. Sokolnikoff, I.S., *Mathematical Theory of Elasticity*, TMH, New Delhi 1978.
2. Timoshenko.S. and Young D.H., *Elements of strength of materials Vol. I & Vol. II*, T. Van Nostrand Co-Inc Princeton, N.J., 1990.
3. Love, A.E.H, *A Treatise on the Mathematical theory of Elasticity*, Cambridge University Press, 1963.

Course Title: Theory of Linear Operators
Course Code: MSM-509-22

L	T	P
4	1	0

Unit I

Spectral theory in normed linear spaces, resolvent set and spectrum, spectral properties of bounded linear operators. Properties of resolvent and spectrum. Spectral mapping theorem for polynomials.

Unit II

Elementary theory banach algebra, Spectral radius of a bounded linear operator on a complex banach space.

Unit III

General properties of compact linear operators. Spectral properties of compact linear operators on normed spaces. Behaviors of compact linear operators with respect to solvability of operator equations. Fredholm type theorems. Fredholm alternative theorem. Fredholm alternative for integral equations.

Unit IV

Spectral properties of bounded self-adjoint linear operators on a complex Hilbert space. Positive operators. Monotone Sequences theorem for bounded self-adjoint operators on a complex Hilbert space, Square roots of a positive operator.

Books Recommended

1. Kreyszig E., *Introductory functional analysis with applications*, Johan-Wiley & Sons, New York, 1978.
2. Halmos P.R., *Introduction to Hilbert space and the theory of spectral multiplicity*, 2nd Edition. Chelsea Pub., Co., N.Y. 1957.
3. Dunford N. and Schwartz, J.T., *Linear operators-3 parts*, Inter-science Wiley, New York, 1958-71.

Bachman G. and Narici, L., *Functional analysis*, Academic Press, New York, 1998.

Course Title: Advanced Numerical Methods
Course Code: MSM-510-22

L	T	P
4	1	0

Unit-I

Iterative Methods for Linear Systems & Eigenvalue problem: The classical iterative methods: Jacobi, Gauss-Seidel and Successive Over Relaxation (SOR) methods. Conjugate gradient method. Eigenvalues & eigenvectors: Rayleigh power method & Givens method.

Unit-II

Finite Difference Methods: Explicit and implicit schemes, consistency, stability and convergence, Lax equivalence theorem, numerical solutions to elliptic, parabolic and hyperbolic partial differential equations.

Unit-III

Approximate Methods of Solution: Rayleigh-Ritz method, Galerkin method, Petrov-Galerkin method, Least square method, Collocation method and Extremal-Point collocation method for solving differential equations.

Unit-IV

Finite Element Method (FEM): FEM for second order differential equations (one and two-dimensional problems), variational methods, Finite elements: Line segment element, triangular element, rectangular element, curved-boundary element, Numerical integration over finite element: Ritz finite element method and Galerkin finite element method. (Scope: Section 8.1,8.2,8.3,8.3.1,8.4.1,8.4.2,8.4.3,8.4.7,8.5,8.6,8.7 of Ref [2])

RECOMMENDED BOOKS

1. Jain, M. K, Iyengar, S.R.K. and Jain, R.K., *Numerical Methods for Scientific and Engineering Computation*, 7th Edition, New Age International Publishers, 2019.
2. Jain M. K., *Numerical Solution of Differential Equations: Finite Difference and Finite Element Methods*, 3rd Edition, New Age International Limited Publishers, 2014.
3. Reddy J. N., *An Introduction to the Finite Element*, 3rd Edition, McGraw Hill Education, 2017.
4. Gupta Radhey S., *Elements of Numerical Analysis*, 2nd Edition, Cambridge University Press, 2015.
5. Seshu P., *Textbook of Finite Element Analysis*, 1st Edition, Prentice Hall India, 2003.

Course Title: Topological Vector Spaces
Course Code: MSM-511-22

L	T	P
4	1	0

Unit-I

Review of basic concepts of topological spaces and vector spaces. Prodect topological spaces, projection maps, compactness of prodect topological spaces-Tichonov's theorem.

Topological vector spaces (TVSs), examples of TVSs, Normed vector spaces as TVSs, Translation and multiplication maps, Neighborhood of 0, separated TVS, linear maps between TVSs, Bounded subsets of a topological vector space.

Unit-II

Locally convex topological spaces, normable and metrizable topological vector spaces, complete topological vector spaces

Unit-III

Frechet spaces, Uniform boundedness principle, open mapping and closed graph theorems for Frechet spaces.

Unit-IV

Banach-Alaoglu theorem, Variational inequalities, Lion-Stampacchia theory, Physical phenomenon represented by variational inequalities, points and external sets-Krein Miliman theorem.

BOOKS RECOMMENDED:

1. Munkres J. R., *Topology – A First Course*, Prentice-Hall of India, 1978.
2. Kelley, J.L., *Linear topological spaces*, Van Nostrand East West Press, New Delhi.
3. Wilansky A., *Modern Methods in Topological Vector Spaces*, McGraw Hill, 1978.
4. Simmons G. F., *Introduction to Topology and Modern Analysis*, McGraw-Hill, 1963.
5. Rudin W., *Functional Analysis*, 2nd Edition, McGraw Hill, 1973.

Course Title: Fractional Calculus
Course Code: MSM-512-22

L	T	P
4	1	0

Unit-I

Special Functions of the Fractional Calculus. Gamma Function. Mittag-Leffler function, Fractional Derivatives and Integrals. Grunwald-Letnikov Fractional Derivatives. Riemann Liouville Fractional Derivatives. Some Other Approaches.

Unit-II

Geometric and Physical Interpretation of Fractional Integration and Fractional Differentiation. Sequential Fractional Derivatives. Left and Right Fractional Derivatives. Properties of Fractional Derivatives. Laplace Transforms of Fractional Derivatives. Fourier Transforms of Fractional Derivatives. Mellin Transforms of Fractional Derivatives.

Unit-III

Linear Fractional Differential Equations. Fractional Differential Equation of a General Form. Existence and Uniqueness Theorem as a Method of Solution. Dependence of a Solution on Initial Conditions. The Laplace Transform Method. Standard Fractional Differential Equations. Sequential Fractional Differential Equations. Fractional Green's Function. Definition and Some Properties. One-Term Equation. Two Term Equation. Three-Term Equation. Four-Term Equation. General Case: n-term Equation.

Unit-IV

Other Methods for the Solution of Fractional-order Equations. The Mellin Transform Method. Power Series Method. Babenko's Symbolic Calculus Method. Method of Orthogonal Polynomials. Numerical Evaluation of Fractional Derivatives. Approximation of Fractional Derivatives. Order of Approximation. Computation of Coefficients. Higher-order Approximations.

Books Recommended

1. Podlubny, I., *Matrix approach to discrete fractional calculus vol. 3*, Fractional Calculus and Applied Analysis, 2000.
2. Carpinteri A, Mainardi F, editors. *Fractals and fractional calculus in continuum mechanics,* New York, Springer-Verlag Wien, 1997.
3. Mandelbrot B.B., *The fractal geometry of nature,* New York, W. H. Freeman, 2000.
4. Miller K.S., Ross B., *An introduction to the fractional calculus*. New York, John Wiley, 1993.
5. Oldham KB, Spanier J., *The fractional calculus,* New York, Academic Press; 1974.

Pre Ph.D. Course Work in Mathematics

(As per Ph.D. regulations-2022)

Structure of the Course Work

Sr. No.	Nature of Course	Name of Course	Credits	L	T	P
1.	Mandatory	Research Methodology	4	3	1	-
2.	Mandatory	Research Publication Ethics	2	2	-	-
3.	Core (discipline specified)	Subject Related Theory Paper	4	3	1	-
4.	Interdisciplinary	Seminar*	4	-	-	-
Total			**14**	**08**	**02**	**-**

* The evaluation of seminar will be based on the submission of project report on the topic of research or relevant area followed by the evaluation through presentation.

IKG Punjab Technical University
Department of Research

Total Marks 100 **L3:T1:P0**

Syllabi common to All branches/disciplines

PAPER I – RESEARCH METHODOLOGY

Unit-I **15**

Part A: OBJECTIVES AND TYPES OF RESEARCH: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process, Research methods *vs* Methodology. Types of research – Descriptive *vs*. Analytical, Applied *vs*. Fundamental, Quantitative *vs*. Qualitative, Conceptual *vs*. Empirical.

Part -B - RESEARCH FORMULATION – Defining and formulating the research problem - Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem, Literature review, Primary and secondary sources, reviews, treatise, monographs-patents, various tool for search, Critical literature review–Identifying gap areas from literature review - Development of working hypothesis.

Unit-II **10**

RESEARCH DESIGN AND METHODS – Research design- Basic Principles- Need of research design-Features of good design – Important concepts relating to research design – Observation and Facts, Laws and Theories, Prediction and explanation, Induction, Deduction, Development of Models. Developing a research plan-Exploration, Description, Diagnosis, Experimentation. Determining experimental and sample designs.

Unit-III **10**

STATISTICAL TECHNIQUES AND TOOLS

Introduction of statistics – Functions, Limitations, Measures of central tendency, Arithmetic mean , Median, Mode, Standard deviation, Co-efficient of variation, (Discrete serious and continuous serious), Correlation, Regression, Multiple Regression, Sampling distribution, Standard error, Concept of point and interval estimation, Level of significance, Degree of freedom, Analysis of variance, One way and two-way classified data- 'F'-test.

Unit-IV **10**

Part A: - REPORTING AND THESIS WRITING – Structure and components of scientific reports - Types of report – Technical reports and thesis – Significance – Different steps in the preparation – Layout, structure, and Language of typical reports – Illustrations and tables- Bibliography, referencing and footnotes - Oral presentation – Planning – Preparation –Practice – Making presentation – Use of visual aids - Importance of effective communication.

Part -B: - APPLICATION OF RESULTS AND ETHICS - Environmental impacts - Ethical issues -ethical committees - Commercialisation – Copy right – royalty - Intellectual property rights and patent law – Trade Related aspects of Intellectual Property Rights-Reproduction of

published material – Plagiarism - Citation and acknowledgement - Reproducibility and accountability.

Reference

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. *An introduction to Research Methodology*, RBSA Publishers.
2. Kothari, C.R., 1990. *Research Methodology: Methods and Techniques*. New Age International. 418p.
3. Sinha, S.C. and Dhiman, A.K., 2002. *Research Methodology*, Ess Ess Publications. 2 volumes.
4. Trochim, W.M.K., 2005. *Research Methods: the concise knowledge base*, Atomic Dog Publishing. 270p.
5. Wadehra, B.L. 2000. *Law relating to patents, trademarks, copyright designs and geographical indications*. Universal Law Publishing.

Additional reading

1. Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. *Research Methods: AProcess of Inquiry*, Allyn and Bacon.
2. Carlos, C.M., 2000. *Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options*. Zed Books, New York.
3. Coley, S.M. and Scheinberg, C. A., 1990, *"Proposal Writing",* Sage Publications.
4. Day, R.A*.,* 1992.*How to Write and Publish a Scientific Paper,* Cambridge University Press.
5. Fink, A., 2009. *Conducting Research Literature Reviews: From the Internet to Paper.* Sage Publications
6. Leedy, P.D. and Ormrod, J.E., 2004 *Practical Research: Planning and Design, Prentice* Hall.
7. Satarkar, S.V., 2000. *Intellectual property rights and Copyright*. Ess Ess Publications.

Research and Publication Ethics (RPE)
(2 Credits)

Course structure

- The course comprises of six modules listed in table below. Each module has 4-5 Units.

Modules	Unit title	Teaching hours
Theory		
RPE 01	Philosophy and Ethics	4
RPE 02	Scientific Conduct	4
RPE 03	Publication Ethics	7
Practice		
RPE 04	Open Access Publishing	4
RPE 05	Publication Misconduct	4
RPE 06	Database and Research Metrics	7
	Total	30

Syllabus in Details

THEORY

- **RPE 01: PHILOSOPHY AND ETHICS (3hrs.)**

1. Introduction to Philosophy: definition, nature and scope, concept, branches
2. Ethics: definition, moral Philosophy, nature of moral judgements and reactions

- **RPE 02: SCIENTIFIC CONDUCT (5 hrs.)**

1. Ethics with respect to science and research
2. Intellectual honesty and research integrity
3. Scientific misconducts: Falsification, Fabrication and Plagiarism (FFP)
4. Redundant publications: duplicate and overlapping publications, salami slicing.
5. Selective reporting and misrepresentation of data

- **RPE 03: PUBLICATION ETHICS (7hrs.)**

1. Publication Ethics: definition, introduction, and importance
2. Best practices/standards setting initiatives and guidelines: COPE, WAME, etc.
3. Conflicts of interest
4. Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice versa, types.
5. Violation of publication ethics, authorship, and contributorship
6. Identification of publication misconduct, complaints and appeals
7. Predatory publishers and journals

PRACTICE

- **RPE 04: OPEN ACCESS PUBLISHING (4 hrs.)**

1. Open access publications and initiatives
2. SHERPA/RoMEO online resource to check publisher copyright & self-archiving Policies.
3. Software tool to identify predatory publications developed by SPPU.
4. Journal finder/journal suggestion tool viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

- **RPE 05: PUBLICATION MISCONDUCT (4 hrs.)**

A. Group Discussion (2hrs.)

1. Subject specific ethical issues, FFP, authorship
2. Conflicts of interest
3. Complaints and appeals: examples and fraud from India and abroad

B. Software tools (2hrs.)

Use of plagiarism software like Turnitin, Urkund, and other open-source software tools.

- **RPE 06: DATABASES AND RESEARCH METRICS (7hrs.)**

  A. Databases (4hrs.)

  1. Indexing databases
  2. Citation databases: Web of Science, Scopus, etc.

  B. Research Metrics (3hrs.)

  1. Impact Factor of journal as per Citation Report, SNIP, SJR, IPP, Cite Score
  2. Metrics: h-index, g-index, i10 index, altmetrics

Core (Discipline Specified) Subjects

(Candidate can opt any one)

Subject Title: Methods in Applied Mathematics

Subject Code: PHDM-101

L	T	P	Credits
3	1	0	4

UNIT-I

Integral equations: Their origin and classification, Relation between differential and integral equations. IVP and BVP reducible to Integral equations, Integral equations with separable kernels, Method of successive approximations, Classical Fredholm theory.

UNIT-II

Fourier series and its Convergence, Gibbs phenomenon, Integration and Differentiation of Fourier series, the phase angle form of Fourier series, Complex Fourier series and frequency spectrum, Fourier integrals, Fourier Cosine and sine Integrals, Complex Fourier Integrals.

UNIT-III

Fourier Transforms, Properties of Fourier Transforms and its Applications, Convolution, Fourier Cosine and Sine Transforms, Discrete Fourier Transforms, Fast Fourier Transforms, Solution of equations, Hankel and Mellin transforms and their applications.

UNIT-IV

Wavelets, History of wavelets, The Haar wavelets, the Stromberg Wavelet, Wavelet expansion, Multiresolution analysis with Haar wavelets, Periodic wavelets, General Construction of wavelets, Wavelet transform versus Fourier transform. Simple applications of Wavelet theory.

Recommended Books:

1. Ram P. Kanwal: Linear Integral Equations, Academic Press,1971.

2. Abdul J. Jeeri: Introduction to Integral Equations with Applications. Monographs and Text

Books in Pure and Applied Mathematics. Marcel Dekker. INC,1985.

3. F.B. Hilderbrand: Methods of Applied Mathematics. Dover Publication,1965.

4. Lokenath Debnath and Dambaru Bhatta: Integral Transforms and Their Applications, 2nd Edition, Chapman and Hall/ CRC,2006.

5. Brian Davies: Integral Transforms and Their Applications, Text Books in Applied Mathematics, Vol 41, 3^{rd} Edition, Springer, 2002.

6. P. Wojtaszczyk: A Mathematical Introduction to wavelets, Cambridge University Press.

7. Veronique Delouille: An Introduction to Wavelet Analysis, Connexions, 2009.

8. Willard Miller, Introduction to the Mathematics of Wavelets, University of Minnesota, 2006.

9. Peter O' Neil: Advanced Engineering Mathematics, Cengage Learning, 2006.

Subject Title: Advanced Number Theory
Subject Code: PHDM-102

L	T	P	Credits
3	1	0	4

Unit-I

Partitions, Compositions, Ferrers graphs, Jacobi's triple product identity, Congruence properties of $p(n)$,Rogers-Ramanujan identities, Basic hypergeometric series, q-binomial theorem, Sylvester's theorem (Statement only), Heine's transformation (Statement only).

Unit-II

Restricted partitions, q-Gauss theorem, Gaussian polynomials, Bailey's lemma (weak version) (Statement only), Rogers lemma, q-Saalschutz's theorem (Statement only), Finite version of q-Saalschutz's theorem.

Unit-III

Schur's theorem, Gollnitz-Gordon identities, Generalization and various analogues of Rogers-Ramanujan identities, Bailey's lemma (strong version) (Statement only), Watson's q-analogue of Whipple's theorem (Statement only) and its applications in deriving Rogers-Ramanujan identities and Gollnitz-Gordon identities.

Unit-IV

Rank & Crank of a partition, n-colour partitions, Conjugate and self-conjugate n-colour partitions, Restricted n-colour partitions, Rogers-Ramanujan type identities for n-colour partitions.

Simple applications of number theory in ATM cash dispenser, conjugacy classes of symmetric groups.

Recommended Books:

1. Agarwal, A.K., Padmavathamma and Subbarao, M.V., Partition Theory, Atma Ram & Sons, Chandigarh, 2005.

2. Andrews, G.E., The Theory of Partitions, Encyclopedia of Mathematics and its Applications (Addison-Wesley), 1976, Re-issued: Cambridge University Press, Cambridge, 1988.

3. Gasper, G. and Rahman, M., Basic Hypergeometric Series, Encyclopedia of Mathematics and its Applications, Vol. 35, Cambridge University Press, Cambridge, 1990.

4. Agarwal, R.P., Resonance of Ramanujan Mathematics, Vol. 1 (New Age International), 1996.

5. Gupta, H., Selected Topics in Number Theory, ABACUS Press, 1980.

6. N.J. Fine, Basic Hypergeometric Series and Applications, Mathematical Surveys and Monographs, No. 27, American Mathematical Society, 1988.

Subject Title: Advanced Numerical Methods
Subject Code: PHDM-103

L	T	P	Credits
3	1	0	4

Unit-I

Iterative Methods for Linear Systems & Eigenvalue problem: The classical iterative methods: Jacobi, Gauss-Seidel and Successive Over Relaxation (SOR) methods. Conjugate gradient method. Eigenvalues & eigenvectors: Rayleigh power method & Givens method.

Unit-II

Finite Difference Methods: Explicit and implicit schemes, consistency, stability and convergence, Lax equivalence theorem, numerical solutions to elliptic, parabolic and hyperbolic partial differential equations.

Unit-III

Approximate Methods of Solution: Rayleigh-Ritz, collocation and Galerkin methods, properties of Galerkin approximations, Petrov-Galerkin method, Generalized Galerkin method.

Unit-IV

Finite Element Method (FEM): FEM for second order problems, One and two dimensional problems, The finite elements (elements with a triangular mesh and a rectangular mesh and three dimensional finite elements), Fourth-order problems, Hermite families of elements, iso-parametric elements, numerical integration. Simple applications of FEM to address heat transfer problems.

Recommended Books:

1. Jain, M.K, Iyengar, S.R.K. and Jain, R.K., Numerical Methods for Scientific and Engineering Computation, 5^{th} Edition, New Age international, 2008.
2. Hoffman Joe D., Numerical methods for Engineers and Scientists, McGraw-Hill, 1993.
3. Atkinson, K.E, An Introduction to Numerical Analysis, 2^{n} Edition, John Wiley, 2004.
4. Gupta R.S., Elements of Numerical Analysis, McMillan India, 2009.
5. Seshu P., Textbook of Finite Element Analysis, Prentice Hall India, 2003.

Subject Title: Continuum Mechanics
Subject Code: PHDM-104

L	T	P	Credits
3	1	0	4

Unit-I

Continuum Hypothesis: Notion of Continuum. Configuration of a Continuum, Mass and Density, Description of motion, Material and Spatial Coordinates

Analysis of Strain: Affine Transformation, infinitesimal Affine Deformation, Geometrical interpretation of the Components of Strain, Strain Quadric of Cauchy, Principal Strains, Invariants, General Infinitesimal Deformation, Examples of strain, Notation, Equations of Compatibility, Finite Deformation

Unit-II

Analysis of Stress: Body and Surface Forces, Stress Tensor, Note on Notation and Units, Equations of Equilibrium, Transformation of Coordinates, Stress Quadric of Cauchy, Maximal Normal and Shear Stresses, Examples of Stresses.

Unit-III

Stress Strain Relations: Hookes law, Generalized Hookes law, Homogeneous isotropic bodies, Elastioc moduli of isotropic bodies, Equilibrium Equations for an isotropic elastic solid, Dynamical equations of an isotropic elastic solid.
The strain energy function and its connection with Hooke's law, Uniqueness of solution of the Boundary-value problems of Elasticity, Saint-Venant's principle.

Unit-IV

Fundamental laws of continuum mechanics: Conservation of mass, Balance of linear momentum, Balance of angular momentum, General solutions of the Equation of Equilibrium, Balance of energy, Entropy inequality, Constitutive Equations

Recommended Books:

1. Sokolnikoff, I.S., Mathematical Theory of Elasticity, Krieger Publishing Company (1983)
2. Chandrasekharaiah and Debnath, Continuum Mechanics, Academic Press (1994).
3. Jog. C. S., Foundations and Applications of Mechanics: volume I: continuum Mechanics, Narosa Publications, (2006).

Subject Title: Advanced Analysis
Subject Code: PHDM-105

L	T	P	Credits
3	1	0	4

Unit-I

Distributions: Test functions & Distributions, Some Operations with Distributions, Supports and singular Supports of Distributions, Convolution of functions, Convolution of Distributions, Fundamental solutions,

Unit-II

The Fourier Transform, The Schwartz Space, The Fourier Inversion formula, Tempered Distributions.

Unit-III

Sobolev spaces: Definition and basic properties, Approximation by smooth functions, Extension theorems, lmbedding theorems, compactness theorem, Dual spaces, fractional order spaces, trace spaces, trace theory.

Unit-IV

Weak solutions of elliptic boundary value problems: Some abstract variational problems, examples of elliptic boundary value problems, Regularity of weak solutions, Examples of Galerkin method, Maximum Principles, eigenvalue problems, Introduction to Finite element methods.

Recommended Books:

1. S. Kesavan: Topics in Functional Analysis and Applications, New Age Publishers (P) Limited; 2003. Chap-1,2, and 3.