

Supporting Documents-

Department of Mathematical Sciences

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





Supporting Documents- Mathematical Sciences

Copy of syllabus of all programs offered indicating credits/electives approved by board



I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY

Estd. Under Punjab Technical University Act, 1996 (Punjab Act No. 1 of 1997)

Ref. No. : IKGPTU/Reg/N/

Dated :

NOTIFICATION

Sub: Regarding Pre-Ph.D Course work.

This is for information of all concerned that Pre-Ph.D course work from 2016-17 will be conducted in the IKGPTU main campus Kapurthala in regular mode. The PhD course work will consists of minimum 15 credits. The structure of the course work is as under.

Sr. No.	Nature of course	Name of course	Credits	Remarks
1.	Core	1.Research Methodology	4	The syllabus of RM should be formulated faculty wise such as Engineering, Science, Management/ Humanities and Life sciences
		2.Subject related theory paper	4	Discipline specific related to advancements in theoretical methods for research
	Sec. 1. 18	3. Presentation	3	Discipline specific
2.	Interdisciplinary	4. Elective	4	From list of subjects from allied fields
	Total Minimum	credits	15	

Registrar

Endorsement No: IKGPTU/REG/N/ 4244-4251

Dated: 22.08.20/6

- 1. Secretary to Vice Chancellor: For kind information of Vice Chancellor
- 2. Dean (P&D)
- 3. Dean (RIC)
- 4. Dean (Academics)
- 5. Finance Officer
- 6. Controller of Examination
- 7. DR (Computers): For uploading on website
- File Copy

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I. K. Gujral Punjab Technical University, Jalandhar Jalandhar Kapurthala Highway, Near Pushpa Gujral Science City, Kapurthala - 144 603 Ph. No. 01822 - 662521. 662501 Fax No. : 01822-255506. 662526. Email : registrar@ptu.ac.in

I.K. Gujral Punjab Technical University Jalandhar, Main Campus-Kapurthala

(Department of Mathematical Sciences)

Scheme of Pre-Ph.D. course work in Mathematics

Sr. No.	Subject with code	L	Т	Р	Credits	Remarks
1.	Research Methodology (MPHM-101)	4	-	-	4	Compulsory
2.	(i) Methods in Applied Mathematics (MPHM-102) (ii) Continuum Mechanics (MPHM-103)	4	_	_	4	Any one
	(iii) Advanced Analysis (MPHM-104) (iv) Advanced Number Theory (UC-MSM-504-18) (v) Advanced Numerical Methods (UC-MSM-510-18)					
3.	Presentation (MPHM-105)	-	-	-	3	Discipline specific
4.	Interdisciplinary Subject	4	-	-	4	From list of subjects from allied fields
	T	otal	mini	mun	1 credits=1	5

Note. The subject 'Methods in Applied Mathematics (MPHM-102)' has been offered as an interdisciplinary for other Departments.

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RESEARCH METHODOLOGY

MPHM-101

- 1. Introduction to ResearchObjectives of research, motivation in research, types of research, significance of research, research methods vs methodology, research process in flow chart, criteria of good research, problems encountered by researchers in India.
- Difference between TEX and LATEX, basics of using latex, latex input files, input file structures, layout of the document, titles, chapter and sections, cross references, foot note, environments, typesetting, building blocks of a mathematical formula, matrices, tables, including encapsulated postscript graphics, bibliography, downloading and installing LATEX packages.
- 3. Introduction to MATHEMATICA and MATLAB
- Introduction to origin, basics of importing and exporting data, working with Microsoft excel, graphing, statistics in origin, hypothesis testing, power and sample size, basic linear regression and curve fitting.
- Error Analysis and Basic Statistics Measuring errors, uncertainties, parent and sample distributions, mean and standard deviation of distribution, types of probability distribution, instrumental and statistical uncertainties, propagation of errors, specific error formulas, method of least square fitting.
- 6. Multivariate analysis: Multiple regression, multiple discriminant analysis, multiple

analysis of variance, canonical correlation analysis, Factor analysis cluster analysis, path analysis. Computational techniques.

 Survey of literature: The students will be required to review literature in their respective disciplines and submit an assignment for evaluation.

REFERENCES:

1. Research methodology (http://www.newagepublishers.com/samplechapter/000896.pdf)

2. The not so short introduction to LATEX by TobianOetiker, Hubert Partl, HreneHyna

and Elisabeth Schlegl, Version 4.16, May 08, 2005 (http://tobi.oetiker.ch/lshort/lshort.pdf)

3. T.Veerarajan and T. Ramachandran "Numerical methods" Tata McGraw Hill, New Delhi, 2008

4. Data reduction and error analysis for physical sciences by Philip R. Bevington and D.

Keith Robinson

(http://www.physast.uga.edu/files/phys3330_fertig/BasicErrorAnalysis.pdf)

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UNIT-I

Integral Equations: Their origin and classification, Relation between differential and Integral equations, IVP AND BVP reducible to Integral equations, Integral equation with separable kernals, Method of successive approximations, Classical Fredolm 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 Transform and its Applications, Convolution, Fourier cosine and Sine transforms, Discrete Fourier Transforms, Fast Fourier Transform, 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.

Suggested Readings/ Books:

1. Ram P. Kanwal: Linear Integral Equations, Academic Press (1971)

- 2. Abdul J. Jerri: Introduction to Integral Equations with Applications, Monographs and Text Books in Pure and Applied Mathematics, Marcel Dekker, INC (1985)
- 3. F B Hildebrand: Methods of Applied Mathematics, Dover Publication (1965)
- 4. Lokenath Debnath and Dambaru Bhatta: Integral Transforms and Their Applications, Second Edition Chapman and Hall/ CRC (2006)
- 5. Brian Davies: Integral Transforms and Their Applications, Text Book in Applied Mathematics, Vol 41, 3rd Edition, Springer (2002)
- 6. P. Wojtaszczyk, A Mathematical Introduction to wavelets, London Mathematical Society Students Text, 73, (1999)
- 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 V. O'Neil, Advanced Engineering Mathematics, Thomson.

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Continuum Mechanics (MPHM-103)

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, Elastic 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).

Advanced Analysis (MPHM-104)

Unit-I

Distributions: Test functions & Distributions, Some Operations with Distributions, Supports and singular Supports of Distributions, Convolution of functions, Convolution of Distributions, Fundamental solutions, The Fourier Transform, The Schwartz Space, The Fourier Inversion formula, Tempered Distributions.

Unit-II

Sobolev spaces: Definition and basic properties, Approximation by smooth functions, Extension theorems, Imbedding theorems, compactness theorem, Dual spaces, fractional order spaces, trace spaces, trace theory.

Unit-III

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

S. Kesavan: Topics in Functional Analysis and Applications, New Age Publishers (P) Limited; 2003. Chap-1,2, and 3.

Advanced Number Theory (UC-MSM-504-18)

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-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.

Advanced Numerical Methods (UC-MSM-510-18)

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.

RECOMMENDED BOOKS

- 1. Jain, M.K, Iyengar, S.R.K. and Jain, R.K., *Numerical Methods for Scientific and Engineering Computation*, 5th 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, 2ⁿ 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.

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M. Sc. Mathematics is a post graduate level course of the Department of Mathematics which is a 2 years It is consisting of semester system (4 semesters) with two semesters per year.

Programme Code: MMS (Masters in Mathematical Sciences)

Eligibility: B.A/B.Sc. with Honours in Mathematics or B.A./B.Sc. (pass course) with Mathematics as one of thesubjects having at least 50% marks in aggregate and at least 55% marks in Mathematics subject.

First Semeste	r					Co	ntact Hou	irs: 2
Course	Course Title	Loa	d Allo	cation	Mar	ks Distributio	n	Cr
cour		L	T	Р	Internal	External	Total	
MMS-101	Algebra-I	4	1	0	50	100	150	
MMS-102	Real Analysis-I	4	1	0	50	100	150	
MMS-103	Complex Analysis	4	1	0	50	100	150	\square
MMS-104	Ordinary Differential Equations & Special functions	4	1	0	50	100	150	
MMS-105	Fundamentals of Computer and C Programming	4	0	0	50	100	150	
MMS-106	Fundamentals of Computer and C Programming Lab	0	0	2	50	-	50	
	Total	20	04	02	300	500	800	Nation of the

Second Sem	ester					Cont	act Hours	: 27]
Course	Course Title	Loa	d Alloo	ation	Mar	ks Distributio	on	Cr
Code		L	T	P	Internal	External	Total	1
MMS-201	Algebra-II	4	1	0	50	100	150	0
MMS-202	Real Analysis-II	4	1	0	50	100	150	
MMS-203	Mechanics	4	1	0	50	100	150	
MMS-204	Tensors and Differential Geometry	4	1	0	50	100	150	
MMS-205	Numerical Analysis	4	1	0	50	100	150	
MMs-206	Numerical Analysis Lab	0	0	2	50	-	50	1.1
	Total	20	05	02	300	600	800	

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M.Sc. Mathematics Batch 2012 onw

Course	Course Title	Loa	d Allo	cation	Mar	ks Distributio	n
cout		L	T	Р	Internal	External	Total
MMS-301	Topology	4	1	0	50	100	150
MMS-302	Operations Research	4	1	0	50	100	150
MMS-303	Mathematical Statistics	4	1	0	50	100	150
MMS-304	Functional Analysis	4	1	0	50	100	150
MMS-XXX	Elective –I	4	0	0	50	100	150
MMS-305	Seminar /	0	0	2	50	+	50
	Total	20	05	02	300	500	800

er					Conta	et Hours:	27 1
Course Title	Loa	d Allo	cation	Mar	ks Distributio	n	C
	L	T	Р	Internal	External	Total	-
Discrete Mathematics	4	1	0	50	100	150	
Mathematical Methods	4	1	0	50	100	150	
Partial differential equations	4	1	0	50	100	150	
Elective –II	4	• 1	0	50	100	150	
Elective –III	4	0	0	50	100	150	
Seminar	0	0	2	50	- 1	50	
Total	20	05	02	300	500	800	
	Course Title Discrete Mathematics Mathematical Methods Partial differential equations Elective –II Elective –III Seminar Total	Course Title Loa Image: Course Title Image: Course Title Image: Course Title Image: Course Title	Course Title Load Allow L T Discrete Mathematics 4 Mathematical Methods 4 Partial differential equations 4 Elective –II 4 Elective –III 4 Seminar 0 Total 20	erCourse TitleLoad AllocationLTPDiscrete Mathematics410Mathematical Methods410Partial differential equations410Elective –II410Elective –III400Seminar002Total200502	erCourse TitleLoad AllocationMarLTPInternalDiscrete Mathematics41050Mathematical Methods41050Partial differential equations41050Elective –II41050Elective –III40050Seminar00250Total200502300	ContaCourse TitleLoad AllocationMarks DistributionLTPInternalExternalDiscrete Mathematics41050100Mathematical Methods41050100Partial differential equations41050100Elective –II40050100Seminar00250-Total200502300500	Contact Hours: Course Title Load Allocation Marks Distribution L T P Internal External Total Discrete Mathematics 4 1 0 50 100 150 Mathematical Methods 4 1 0 50 100 150 Partial differential equations 4 1 0 50 100 150 Elective –III 4 0 0 50 100 150 Seminar 0 0 2 50 100 150 Total 20 05 02 300 500 800

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Elective -I MMS XXX (Any one subject to be opted)

MMS-501 Fluid Mechanics MMS-502 Solid Mechanics MMS-503 Coding Theory MMS-504 Advanced Complex Analysis

Note1: Student is to adopt one course from the list of Elective II and one course from list of Elective III

Elective - II Courses: MMS 505, MMS 506, MMS 510, MMS 512

Elective - III Courses: MMS 507, MMS 508, MMS 509, MMS 511

MMS-505 Advanced Operations Research MMS-506 Advanced Fluid Mechanics MMS-507 Advanced Solid Mechanics MMS-508 Number Theory and Cryptography MMS-509 Theory of Linear Operators MMS-510 Advanced Numerical Methods MMS-511 Topological Vector Spaces MMS-512 Fractional Calculus

Note 2:

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Instructions for paper setters and candidates:

(a) Eight questions are to be set preferably two questions from the each unit.

(b) The students are required to attempt any five questions. All questions carry equal marks.

(c) Duration of examination is three hours.

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Scheme and Syllabus of

M.Sc. Mathematics Batch 2017 onwards

M.Sc. Mathematics is a postgraduate level course of the Department of Mathematics which is a 2years course. It is consisting of semester system (4 semesters) with two semesters per year.

Program Code: MSM (Masters of Science in Mathematics)

Eligibility: B.A./B.Sc. with Honors in Mathematics or B.A./B.Sc. (pass course) with Mathematics as one of the subjects having at least 50% marks in aggregate.

First Semester

Contact Hours: 27 Hrs.

Course Code	Course Title	Load	l Alloo	cation	Marks	s Distribut	ion	Credits
		L	T	P	Internal	External	Total	
MSM-101	Algebra-I	4	1	0	20	80	100	5
MSM -102	Real Analysis-I	4	1	0	20	80	100	5
MSM -103	Complex Analysis	4	1	0	20	80	100	5
MSM -104	Ordinary Differential Equations and Special Functions	4	1	0	20	80	100	5
MSM -105	Mathematical Methods	4	1	0	20	80	100	5
MSM -106	Introduction to Computer Algebra System (Lab)	0	0	2	50	00	50	1
To	otal	20	05	02	150	400	550	26

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Contact Hours: 27 Hrs.



Course Code	Course Title	Load	Alloc	ation	Marks	ion	Credits	
		L	T	P	Internal	External	Total	
MSM -201	Algebra-II	4	1	0	20	80	100	5
MSM -202	Real Analysis-II	4.	1	0	20	80	100	5
MSM -203	Mechanics-I	4	1	0	20	80	100	5
MSM -204	Partial Differential Equations	4	1	0	20	80	100	5
MSM -205	Numerical Analysis	4	1	0	20	80	100	5
MSM -206	Numerical Analysis (Lab)	0	0	2	50	00	50	1
Т	°otal	20	05	02	150	400	550	26

Third Semester

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Contact Hours: 27 Hrs.

Course Code	Course Title	Load	Alloca	ation.	Marks	ion	Credits	
		L	T	P	Internal	External	Total	
MSM -301	Topology	4	1	0	20	80	100	5
MSM -302	Number Theory and Cryptography	4	1	0	20	80	100	5
MSM -303	Mathematical Statistics-I	4	1	0	20	80	100	5
MSM -304	Functional Analysis	4	1	0	20	80	100	5
MSM -XXX	Elective-I	4	1	0	20	80	100	5
MSM -305	Seminar	0	0	2	50	-	50	1
A	otal	20	05	02	150	400	550	26

Department of Mathematical Sciences I.K. Guiral Punjab Technical Charters

Contact Hours: 27 Hrs.

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Fourth Semester

Course Code	Course Title	Load	Alloc	ation	Marks	ion	Credits	
		L	T	P	Internal	External	Total	
MSM -401	Mechanics-II	4	1	0	20	80	100	5
MSM -402	Mathematical Statistics-II	4	1	0	20	80	100	5
MSM-403	Differential Geometry	4	1	0	20	80	100	5
MSM -YYY	Elective-II	4	1	0	20	80	100	5
MSM -ZZZ	Elective-III	4	1	0	20	80	100	5
MSM -404	Seminar	0	0	2	50	-	50	1
To	l otal	20	05	02	150	400	550	26

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Department of Mathematical Sciences I.K. Gujral Punjab Technical Sciences Kapurbals-144603 Pb. (Ind.)

Scheme and Syllabus of

M.Sc. Mathematics Batch 2017 onwards

Elective-I MSM XXX (Any one subject to be opted)

MSM -501 Coding Theory

MSM -502 Operations Research

Note1: Student is to adopt one course from the list of Elective-II and one course from list of Elective-III

Elective-II Courses: MSM-503, MSM-504, MSM-505, MSM-506

Elective-III Courses: MSM-507, MSM-508, MSM-509, MSM-510, MSM-511

MSM -503 Advanced Complex Analysis

MSM -504 Advanced Operations Research

MSM -505 Advanced Fluid Mechanics

MSM -506 Advanced Solid Mechanics

MSM -507 Theory of Linear Operators

MSM -508 Advanced Numerical Methods

MSM -509 Topological Vector Spaces

MSM -510 Fractional Calculus

MSM -511 Discrete Mathematics

Note 2:

Instructions for paper setters and candidates:

a) The entire question paper should be distributed into three sections viz. Section-A, Section-B, Section-C.

b) The Section-A should cover the entire syllabus, the Section-B should cover Unit-I & II and the Section-C should cover Unit-III & IV of the syllabus.

- c) Section-A should contain eight questions of two marks each. This section should cover the entire syllabus. All questions in this section should be compulsory.
- d) Section-B and Section-C should contain three questions each carrying 16 (sixteen) marks.
- e) Student should be asked to attempt at least two questions from Section-B and Section-C each.
- f) The awards for internal and external examination should be in 20:80 ratio.
- g) The Duration of examination is three hours.

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Scheme of the Program:

First Semester

Contact Hours: 28 Hrs.

Course Code	Course Title	L Alle	load	n	Marl	s Distribu	tion	
	The second	L	Т	P	Internal	External	Total	
JC-MSM-101- 18	Algebra-1	4	1	0	40	60	100	4
JC-MSM-102- 18	Real Analysis-I	4	1	0	40	60	100	4
JC-MSM-103- 18	Complex Analysis	4	1	0	40	60	100	4
UC-MSM-104- 18	Ordinary Differential Equations and Special Functions	4	1	0	40	60	100	4
UC-MSM-105- 18	Mathematical Methods	4	1	0	40	60	100	4
UC-MSM-106- 18	Introduction to Computer Algebra System (Lab)	0	0	3	50	25	75	3
	Total	20	05	03	250	325	575	23

Second Semester

Contact Hours: 28 Hrs.

Course Code	Course Title	Load Allocation			Mark	Credits		
		L	T	Р	Internal	External	Total	
UC-MSM- 201-18	Algebra-II	4	1	0	40	60	100	4
UC-MSM- 202-18	Real Analysis-II	4	1	0	40	60	100	4
UC-MSM- 203-18	Mechanics-I	4	1	0	40	60	100	4

Scheme & Syllabus (M.Sc. Mathematics) Batch 2018 & Onwards

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UC-MSM- 204-18	Partial Differential Equations	4	1	0	40	60	100	4
UC-MSM- 205-18	Numerical Analysis	4.	1	0	40	60	100	4
UC-MSM- 206-18	Numerical Analysis (Lab)	0	0	3	50	25	75	3
1	Fotal	20	05	03	250	325	575	23

Third Semester

Contact Hours: 25 Hrs.

Course Code	Course Title	1	1 4 11		1			.s. 25 ms.
	course Thie	Load A		ocation	Marks Distribution			Credits
		L	T	P	Internal	External	Total	
UC-MSM- 301-18	Topology	4	1	0	40	60	100	4
UC-MSM- 302-18	Number Theory and Cryptography	4	1	0	40	60	100	4
UC-MSM- 303-18	Mathematical Statistics	4	1	0	40	60	100	4
UC-MSM- 304-18	Functional Analysis	4	1	0	40	60	100	4
UC-MSM- 305-18	Mechanics-II	4	1	0	40	60	100	4
JC-MSM- 311-18	Seminar	0	0	2	50	0	50	2
T	otal	20	05	00	200	300	500	22

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Scheme & Syllabus (M.Sc. Mathematics) Batch 2018 & Onwarda

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Fourth Semester

Contact Hours: 27 Hrs

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S.No.	Course Code	Course Code Course Title			on	Marks Distribution			Credits
		areas and a	L	T	Р	Internal	External	Total	
1.	UC-MSM-401-18	Differential Geometry	4	1	0	40	60	100	4
2.	UC-MSM-WWW- 18	Elective	4	1	0	40	60	100	4
3.*	UC-MSM-XXX- 18 UC-MSM-YYY- 18	Elective	4	1	0	40	60	100	12
	UC-MSM-222-18	Dissertation	-	-	12	200	100	300	
4.	UC-MSM-412-18	Seminar	0	0	2	50	0	50	2
	Total						550	22	

TOTAL NUMBER OF CREDITS = 90

Note*: Students may opt either three Elective Theories or Dissertation.

Scheme & Syllabus (M.Sc. Mathematics) Batch 2018 & Onwards

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Department of Mathematical Sciences I.K. Gujral Purjab Technical University Kapurihala-144603 Pb. (https)



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LIST OF DEPARTMENTAL/INTERDISCIPLINARY ELECTIVES

Elective- UC-MSM-WWW-18, UC-MSM-XXX-18, UC-MSM-YYY-18, UC-MSM-ZZZ-18 (Any one subject to be opted)

MSM-501-18 Discrete Mathematics

MSM-502-18 Coding Theory

MSM-503-18 Operations Research

MSM-504-18 Advanced Number Theory

MSM-505-18 Advanced Complex Analysis

MSM-506-18 Advanced Operations Research

MSM-507-18 Advanced Fluid Mechanics

MSM-508-18 Advanced Solid Mechanics

MSM-509-18 Theory of Linear Operators

MSM-510-18 Advanced Numerical Methods

MSM-511-18 Topological Vector Spaces

MSM-512-18 Fractional Calculus

Examination and Evaluation

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S. No.	Evaluation criteria	Weightage in Marks	Remarks			
1	Mid term/sessional Tests	24	Internal evaluation (40 Marks)			
2	Attendance	6	MSTs, Quizzes, assignments, attendance, etc., constitute internal			
3	Assignments	10	evaluation. Average of two mid semester test will be considered fo evaluation.			
1 4	End semester examination	60	External evaluation			

Scheme & Syllabus (M.Sc. Mathematics) Batch 2018 & Onwards

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Ospartment of Mathem K. Guiral Punjab Tech 12-144813 -

MMS-101: ALGEBRA-I

L T P 4 1 0

Unit-I

Review of basic concept of groups, automorphisms and inner automorphisms of a group, Normalizer and Centralizer, Conjugate elements and conjugacy classes, class equation of a finite group and its applications, Cauchy's theorem, Sylow's theorems, Review of Permutation Groups, Alternating

Group A_n , simplicity of A_n , Direct Products, fundamental theorem of finitely generated abelian groups, Invariants of finite abelian groups.

Unit-II

Normal and sub normal series, Composition series, Zassenhaus's Lemma, Scherer's refinement theorem and Jordan-Holder theorem, Derived group, Solvable groups, Nilpotent groups, fundamental theorem of arithmetic.

Unit-III

Rings, Subrings, ideals, Sum and direct sum of ideals, Maximal, Prime, Nilpotent & Nil ideals, Statement of Zorn's Lemma, Rings of Fractions, Field of quotients of an integral domain.

Unit-IV

Factorization Theory in Integral Domains, Divisibility, Rings of Gaussian integers, Unique Factorization Domain (UFD), Principal Ideal Domain (PID), Euclidian Domain(ED) and their relationships, Polynomial rings over unique factorization domains.

BOOKS RECOMMENDED

- 1. Bhattacharya, P.B., Jain, S.K. & Nagpal, S.R.: Basic Abstract Algebra, Cambridge University Press, 1997.
- 2. Surjeet Singh, QuzaiZameeruddin: Modern Algebra, Vikas Publishing House, New Delhi,8th edition,2006.
- 3. I.N. Herstein: Topics in Algebra, 2nd edition, Wiley Eastern, 1975.

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MMS-102: REAL ANALYSIS-I

L T P 4 1 0

UNIT-I

Elementary set theory, finite, countable and uncountable sets. Metric spaces: definition and examples, open and closed sets, compact sets, elementary properties of compact sets, k- cells, compactness of k

cells, compact subsets of Euclidean space R^k . Perfect sets, Cantor set, separated sets, connected sets in a metric space, connected subsets of real line.

UNIT-II

Convergent sequences (in Metric spaces), Cauchy sequences, subsequences, complete metric space,

Cantor's intersection theorem, category of a set and Baire's category theorem.Examples of complete metric space, Banach contraction principle.

UNIT-III

Limits of functions (in Metric spaces), continuous functions, continuity and compactness, continuity and connectedness, discontinuities, monotonic functions, uniform continuity.

UNIT-IV

Riemann Stieltje'sIntegral : definition and existence of integral, properties of integral, integration and differentiation, Fundamental theorem of Calculus, 1st and 2nd mean value theorems for Riemann Stieltje's integral

BOOKS RECOMMENDED

- 1. Walter Rudin, Principles of Mathematical Analysis, 3rd edition, McGraw Hill, Kogakusha, 1976, International student edition
- 2. H. L. Royden, Real Analysis, 3rd edition, Macmillan, New York & London 1988.
- 3. Tom M. Apostol, Mathematical Analysis, Addition-Wesley.
- 4. G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Ltd (2008).

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MMS 103: COMPLEX ANALYSIS

L T P 4 1 0

Unit-I

Function of complex variable, continuity and differentiability, analytic functions, conjugate function, harmonic function. Cauchy Riemann equation (Cartesian and polar form).Construction of analytic functions.Stereographic projection and the spherical representation of the extended complex plane.

Unit-II

Complex line integral, cauchy's theorem, cauchy's integral formula and it's generalized form. cauchy's inequality, Poisson's integral formula, Morera's theorem, Liouville's theorem, power series, Taylor's theorem, Laurent's theorem. Fundamental theorem of algebra and Rouche's theorem, Maximum modulus principle, Schwarz lemma.

Unit-III

Zero's, Singularities, residue at a pole and at infinity. Cauchy's Residue theorem, Jordan's lemma, integration round unit circle, Evaluation of integrals.

Unit-IV

Conformal transformations, bilinear transformations, critical points, fixed points, Problems on cross-ratio and bilinear transformation.

BOOKS RECOMMENDED

- 1. Complex Analysis (2nd Edition) L. V. Ahlfors, McGraw-Hill International Student Edition, 1990.
- An Introduction to the Theory of functions of a complex Variable E. T. Copson, Oxford university press, 1995.
- 3. An Introduction To Complex Analysis A. R. Shastri, Macmillan India Ltd., 2003.
- 4. Complex Variables and Applications S. Ponnusamy, and H. Silverman, Birhkäuser, 2006.
- 5. Complex Variables and Applications- R Churchill R, Brown J.W: 6th edition, New york, McGraw-Hill 1996.

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Department of Mathematical Sciences ⁶ I.K. Gujral Punjab Technical University Kapurthala-144603 Pb. (India)

MMS 104: ORDINARY DIFFERENTIAL EQUATIONS AND SPECIAL FUNCTIONS

UNIT-I

Review of linear differential equations with constant & variable coefficients, Power series solution of differential equation about an ordinary point, Solution about regular singular points: The method of Frobenius, System of linear differential equations, An operator method for linear system with constant coefficients, Phase plane method.

UNIT-II

Homogeneous Linear systems with constant coefficients, Complex eigenvalues, repeated eigenvalues, Fundamental Existence and Uniqueness theorem, existence and Uniqueness theorem for system and Higher order equations, Linear homogeneous boundary value problems: Eigenvalues and eigen functions.

UNIT-III

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

BOOKS RECOMMENDED

- 1. S L Ross, Differential Equations, Third Edition, John Wiley & Sons (2004)
- W E Boyce, R C Diprima, elementary Differential Equations and Boundary Value problems, 4th Edition, John Wiely and Sons (1986)
- 3. IN Sneddon, Special Functions of Mathematical Physics and Chemistry, Edinburg, Oliver & Boyd (1956)
- 4. G Andrews, R Askey& R Roy, Special Functions, Cambridge (1999)
- 5. L Andrews, Special Functions for Engineers and Applied Scientists, Mcmillan (1985)
- 6. W W Bell, Special Functions for Scientists and Engineers, Dover, (1986)

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MMS 105: FUNDAMENTALS OF COMPUTER AND C PROGRAMMINGL T P 4 0 0

Unit 1

Computer's general concepts: historical overview, technological advantages in computers, shape of today's computer as a system, CPU, primary memory, secondary storage devices, input devices, output devices, significance of software system, categories of software system software, applications software, comiler, interpreter, utility program, binary arithmetic for integer and fractional numbers, operating system and its significance.

Unit 11

Character sets for c, constants and variables, arithmetic expressions input and output statements, comments, data types, statement labels, built in functions and libraries, logical if-else and nested if-else statement, switch, break, continue, go to statements, preprocessor in c

Unit III

While, for and do while loops in c, arrays, array variables, syntax rules, use of multiple subscripts in arrays, reading and writing multi-dimensional araays, storage classes structures and union

Unit IV

Function definition, function prototypes, Arguments, call by value, call by reference, passing array variable to a function, pointer variables, relationship of pointer and array, passing pointer variable to a function, strings handling, and file processing operations in c

BOOKS RECOMMENDED

- 1. Computer Programming in C V. Rajaraman, Prentice-Hall of India Pvt. Ltd., 2005.
- Computer Applications of Mathematics and Statistics A. K. Chattapadhyay and T. Chattapadhyay, Asian Books Pvt. Ltd., New Delhi, 2005.
- 3. The C Programming Language B. W. Kernighan and D. M. Ritchie, Prentice Hall, India, 1995.
- Primes and Programming An Introduction to Number Theory with Programming P. Goblin, Cambridge University Press, 1993.

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MMS 106: FUNDAMENTALS OF COMPUTER AND C PROGRAMMING LabL T P

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The following programs are to be practiced:

- 1. Determination of roots of quadratic equations, $Ax^2+Bx+C=0$,
- 2. Arranging given set of numbers in increasing/decreasing order, calculation of Mean, Mode, Median.
- 3. Evaluation of sum of power series eg. e^x , sin x, cos x, log (1 + x).
- 4. Calculation of GCD/LCM of two integers.
- 5. Evaluation of factorial of a positive integer and evaluation of binomial coefficients.
- 6. Generation of twin primes, random numbers.
- 7.Calculation of Coefficient of Correlation.8. Computation of scalar product of vectors.
- 9. Addition and multiplication of matrices.

10.Evaluation of Determinants.

11.Inversion of matrices.

12.Solution of System of linear equations.

13.Writing a given number in words using function.

14.Arranging a set of names in alphabetical order.

BOOKS RECOMMENDED

- 1. Computer Programming in C V. Rajaraman, Prentice-Hall of India Pvt. Ltd., 2005.
- Computer Applications of Mathematics and Statistics A. K. Chattapadhyay and T. Chattapadhyay, Asian Books Pvt. Ltd., New Delhi, 2005.
- 3. The C Programming Language B. W. Kernighan and D. M. Ritchie, Prentice Hall, India, 1995.
- Primes and Programming An Introduction to Number Theory with Programming P. Goblin, Cambridge University Press, 1993.

Candidates are required to perform at least 10-12 practicals

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> MMS-201: ALGEBRA-IIL T P 4 1 0

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Unit-I

Modules, sub modules, free modules, Quotient modules, Isomorhism theorem, Direct sums, Modules associated with a linear operator, Cyclic modules, Noetherian and Artinian modules and rings.

Unit-II

Field extension: Finite, Algebraic and Transcendental extensions, Simple, Separable and inseparable Extensions, Algebraically Closed fields, Splitting fields, Existence & uniqueness, Normal Extensions, Finite Fields.

Unit-III

Galois extensions, Galois group of an extension and Fundamental theorem of Galois Theory

Unit-IV

Review of vector spaces, Dual space, Dual basis, Reflexivity, Annihilators, inner product spaces, orthogonal and orthonormal basis, Gram schmidthorthogonalisation process.

BOOKS RECOMMENDED

1. Bhattacharya, P.B., Jain, S.K. & Nagpal, S.R.: Basic Abstract Algebra, Cambridge University Press, 1997.

2. Surjeet Singh, QuzaiZameeruddin: Modern Algebra, Vikas Publishing House, New Delhi,8th edition,2006.

3. I.N. Herstein: Topics in Algebra, 2nd edition, Wiley Eastern, 1975.

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Department of Mathematical Sciences I.K. Gujral Punjab Technical University Kapurthala-144603 Pb. (India)

MMS 202: REAL ANALYSIS-IIL T P 4 1 0

UNIT-I

Preliminaries, Lebesgue outer measure. Measurable sets. Regularity, Lebesgue measure, non-measurable sets. Measurable functions. Borel and Lebesgue measurability, Littlewood's three principles.

UNIT-II

The Lebesgue integral of a simple function and bounded function, comparison of Riemann and Lebesgue integral, Bounded convergence theorem, Integral of non -negative functions, Fatou's Lemma, Monotone convergence theorem, The general Lebesgue Integral, Lebesgue convergence theorem, Integration of series.

UNIT-III

Vitali,s Lemma, The Four derivates, continuous non differentiable functions. Functions of bounded variation.Lebesgue differentiation theorem.Differentiation and integration. The Lebesgue set

UNIT-IV

Convex functions, Jensen's inequality, TheL^p-spaces, Holder and Minkowski inequalities. Convergence in mean, Completeness of L^p, Approximation in L^p spaces.

BOOKS RECOMMENDED

- 1. H.L. Royden, Real Analysis, Macmillan, New York, 1988.
- 2. G.de Bara, Measure Theory and Integration, Ellis Horwood Limited, England, 2nd Edition 2003.
- 3. G.B. Folland, Real Analysis, second edition, John Wiley, New York, 1999.
- 4. E. Kreyszig Introductory Functional Analysis with Applications, John Wiley, 1989.

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MMS 203: MECHANICS

L T P 4 1 0

Unit-I

Generalized coordinates, Holonomic and non-holonomic systems scleronomic and rhenomic systems, Generalized potential, lagrange's equation of first kind and second kind uniqueness of solution, Energy equation for conservative field.

Unit-II

Hamilton variables, donkin's theorem ,Hamilton canonical equation, cyclic coordinates, Routh's equation , Poisson bracket , Poisson's identity , Jacobi -Poisson theorem, Hamilton's principle, principle of least action Poincare- Cartan integral invariant, whittaker's equations lee hwachung's theorem.

Unit-III

Small oscillations of conservative system Lagrange's equation for small oscillations, Nature of roots of frequency equation, Principle oscillations. Normal coordinates, Canonical transformations, free canonical transformations, Hamilton-Jacobi equation, and Jacobi theorem.

Unit-IV

Method of separation of variables, lagrange's bracket' condition of Canonical character of transformation in terms of Lagrange's bracket and Poisson's Bracket. Invariance of Lagrange's bracket and Poisson's bracket and canonical transformation, Lagrange's theorem on the stability of equilibrium position, Lyapunov theorem, Nadchetayev theorem, asymptotic stability of an equilibrium position.

BOOKS RECOMMENDED

- 1. F. Gantmacher. Lectures in analytic mechanics . Mir Publisher , Moscow, 1975.
- 2. H. goldstien, c.ppoole and j.l. sofco, classical mechanics, third edition, Addison Wesely, 2002.
- 3. Mechanics L. D. Landau and E. M. Lipshitz, Pergamon Press, Oxford, 1976.
- 4. Lectures on Mechanics J. E. Marsden, Cambridge University Press, 1992.

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MTS 204: TENSORS AND DIFFERENTIAL GEOMETRY

L T P 4 1 0

UNIT-I

Systems of Different orders - Summation Convention - Kronecker Symbols - Transformation of coordinates in Sn - Invariants - Covariant and Contravariant vectors - Tensors of Second Order - Mixed Tensors - Zero Tensor - Tensor Field - Algebra of Tensors - Equality of Tensors - Symmetric and Skew - symmetric tensors - Outer multiplication, Contraction and Inner Multiplication - Quotient Law of Tensors - Reciprocal Tensor of Tensor - Relative Tensor - Cross Product of Vectors.

UNIT-II

Riemannian Space - Christoffel Symbols and their properties ,Covariant Differentiation of Tensors - Riemann - Christoffel Curvature Tensor - Intrinsic Differentiation.

UNIT-III

Definition of a surface - curves on a surface - Surface of revolution - Helicoids - Metric - Direction coefficients - families of curves - Isometric correspondence - Intrinsic properties.

UNIT-IV

Geodesics - Canonical geodesic equations - Normal property of geodesics - Existence Theorems - Geodesic parallels - Geodesics curvature - Gauss - Bonnet Theorem - Gaussian curvature - surface of constant curvature.

BOOKS RECOMMENDED

- 1. Struik, D.T. Lectures on Classical Differential Geometry, Addison Wesley, Mass. 1950.
- 2. Kobayashi. S. and Nomizu. K. Foundations of Differential Geometry, Interscience Publishers, 1963.
- 3. Wilhelm Klingenberg: A course in Differential Geometry, Graduate Texts in Mathematics, Springer-Verlag 1978.
- 4. J.L.Synge and A.Schild, Tensor Calculus, Toronto, 1949.
- 5. A.S.Eddington. The Mathematical Theory of Relativity, Cambridge University Press, 1930.

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MTS 205: NUMERICAL ANALYSIS

L T P 4 1 0

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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. Algebraic and Transcendental Equations: Bisection method, iteration method, Regula- Falsi method, secant method, Newton-Raphson method. Convergence of these methods. Lin-Bairstow's method, Muller method ,Graeffe's root squaring method, solution of system of nonlinear equations, complex roots by Newton – Raphson method.

Unit-II

System of Linear Algebraic Equations: Guass elimination method, Gauss – Jordon method, LU factorization method, Jacobi and Gauss-Seidal methods, Convergence of iteration methods, Round-off errors and refinement, ill- conditioning, Partitioning method, Inverse of Matrices. Eigen values and eigen vector: Rayleigh Power method, Given's method and House –Holder method.

Unit-III

Interpolation: Finite differences, Newton interpolation formulae, Gauss, Stirling and Bessel'sformulae, Lagrange's, Hermits 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, Booles and Weddle rules of integration, Romberg integration, Gaussian integration, Double integration by Trapezoidal and Simpson rules.

Unit-IV

Ordinary Differential Equations: Taylor series and Picard's methods, Euler and modified Euler methods,

Runge –Kutta methods, Predictor- Corrector methods: Adam-Beshforth and Miline methods. Error analysis and accuracy of these methods. Solution of simultaneous and higher order equations, Boundary values problems: Finite difference and shooting methods

BOOKS RECOMMENDED

- 1. V. Rajaraman, Computer Oriented Numerical Analysis, Prentice-Hall of India Pvt. Ltd., 2002.
- J.N. Sharma, Numerical Methods for Engineers and Scientists(2nd edition), Narosa Publ. House New Delhi/Alpha Science international, Ltd, Oxford UK 2007.
- 3. E. Balagurusamy, Numerical Methods, Tata McGraw Hill, New Delhi, 1999.

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Head Department of Mathematical Sciences I.K. Gujral Punjab Technical University Kapurthala-144603 Pb. (India)

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- 4. B. Bradie: A friendly introduction to Numerical Analysis.Pearson Prentice Hall 2006
- 5. K. E. Atkinson, Introduction to Numerical Analysis (2nd edition), John Wiley, 1989.
- 6. S. D. Conte and C. De Boor, Elementary Numerical Analysis: An Algorithmic Approach (3rd edition), McGraw Hill, New York, 1980.
- 7. J. B. Scarborough, Numerical Mathematical Analysis, Oxford & IBH Publishing Co., 2001.

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MTS 206: NUMERICAL ANALYSIS LAB

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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 definite integrals by using Gaussian Quadrature.
- 11. To evaluate double integrals by using Trapezoidal and Simpson method.
- 12. To compute the solution of ordinary differential equations with Taylor's series method.
- 13. To compute the solution of ordinary differential equations by using Euler's method.
- 14. To compute the solution of ordinary differential equations by using Runge -Kutta methods.
- 15. To compute the solution of ordinary differential equations by using Milne-Simpson method.

BOOKS RECOMMENDED

- 1. E. Balagurusamy, Object Oriented Programming with C++, Tata McGraw Hill, New Delhi, 1999.
- 2. J N Sharma, Numerical Methods for engineers and Scientists (2nd Edn) Narosa Publishing House, New
- 3. Delhi/ Alpha Science International Ltd. Oxford UK, 2007.
- 4. Conte and de Boor, Numerical Analysis, McGraw Hill, New York, 1990
- 5. John H. Mathews, Numerical Methods for Mathematics, Science and Engineering (2nd Edn.), Prentice
- 6. Hall, New Delhi, 2000

Instructions for paper setters and candidates:

Candidates are required to atleast perform at least 10-12 Practical's are to be completed in asemester

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TOPOLOGY (MS-301)

L T P 4 1 0

Unit-I

Introduction topological spaces, closed sets, Closure, Dense subsets, neighborhoods, interior, exterior and boundary, Accumulation points and derived sets. Bases and subbases, Subspaces and relative Topology, Alternative methods of defining a Topology in terms of Kuratowski closure operator and neighborhood systems.

Unit-II

Open mappings and closed mappings, Continues functions and homomorphism's, Compactness and local Compactness. One -point compactification, connected and arc-wise connected spaces, Components and Locally connected spaces.

Unit-III

 T_0 and T_1 spaces, T_2 spaces and sequences. Hausdorffness of one point compactification, Axioms of Countability andSeperability, Equivalence of Separable, second Axiom and Lindelof properties in a metric spaces. Equivalence of compact and countably compact sets in metric spaces.

Regular and completely regular, Normal and completely normal spaces. Meric spaces as T₂, completely normal and first axiom spaces, Urysohn's Lemma, Tietze Extension Theorem.

UNIT-IV

BOOKS RECOMMENDED

1. Topology, a first course - J. R. Munkres, Prentice-Hall of India Ltd., New Delhi, 2000.

2. An introduction to general topology (2nd edition) – K. D. Joshi, Wiley Eastern Ltd. New Delhi, 2002.

3. G.F Simmons : Introduction to topology and Modern Analysis.

4. General Topology - J. L. Kelley, Springer Verlag, New York, 1990.

5. Basic Topology - M.A. Armstrong, Springer International Ed. 2005.

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OPERATIONS RESEARCH (MS-302)

L T P 4 1 0

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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, Big-M and two phase methods, Exceptional cases in LPP i.e., Infeasible, unbounded, alternate and degenerate solutions.

Unit-II

General Primal-Dual pair, Formulating a dual problem, Weak and strong duality theorems, Complementary slackness theorem, Dual simplex method, Economic interpretation of primal-Dual problems. Sensitivity analysis: change in right hand side of constraints, change in the objective function and coefficient matrix addition and deletion of constraint and variables.

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, typical assignment problem, the traveling salesman problem, Test for optimality, degeneracy, Project management with critical path method.

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. KantiSwarup, P.K. Gupta and Man Mohan, Operations Research ,Sultan Chand & Sons, Ninth Edition (2002).
- 3. Friderick S. Hillier and Gerald J. Lieberman, Operations Research ,Holden-Day Inc,USA,econd Edition (1974)
- Bazaraa, M.S., Sherali, H.D., Shetty, C.M., Nonlinear Programming: Theory and Algorithms, John Wiley and Sons, (1993).

5. Chandra, S., Jayadeva, Mehra, A., Numerical Optimization and Applications, Narosa Publishing House, (2013).

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MATHEMATICAL STATISTICS (MS-303)

L T P 4 1 0

91

Unit I

Classical and axiomatic approach to the theory of probability, additive and multiplicative law of probability, conditional probability and Bayes theorem.Random variable, function of random variable, and their distributions, probability mass function, probability density function, cumulative distribution function.

Unit II

Two dimensional random variables, joint, marginal and conditional distributions, independence of random variables, expectation, conditional expectation, moments, product moments, probability generating functions, moment generating function and its properties. Chebyshev's, Markov, Jenson, Techebyshey's, inequalities, stochastic convergence, central limit theorem.characteristic function and its elementary properties.

Unit III

Study of various discrete and continuous distributions, Binomial, Poisson, Geometric, Hyper geometric, Multinomial. Uniform, Exponential, Normal distributions, Gamma distribution, cauchy, exponential, Beta and gamma distributions, Bivariate normal distribution and distribution of order statistics and range.

Unit IV

Concept of sampling distribution and its standard error, Derivation of sampling distributions of Chisquare, t and F distribution of sample mean and sample variance Testing of hypotheses, fundamental notions important tests based on normal distributions, Tests of significance: tests based on normal distribution, Chi-square, t and F statistic. Analysis of variance: One way and two way classifications.

BOOKS RECOMMENDED

- 1. Hogg, R.V & Craige: Introduction to Mathematical Statistics. 7th edition(2005)
- 2. Mckean, J.W. and Craig, A.T., Mukhopadhyay, P: Mathematical Statistics.(2000)
- 3. S.C. Gupta and V.K. Kapoor, Fundamental of Mathematical Statistics 7th ed., (1990)
- Goon, Gupta and Das Gupta, Fundamentals of Statistics, Edition, 5. Publisher, World Press, 1975.
 5.Rohatgi V.K.: Introduction to probability theory & Mathematical Statistics 2009.

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FUNCTIONAL ANALYSIS (MS-304)

L T P 4 1 0

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Unit-I

Normed linear spaces, Banach spaces, properties of normed spaces, finite dimensional normed spaces and subspaces, linear operator, 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, application to bounded linear functional 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.

BOOKS RECOMMENDED

[1] G.F.Simmons: Introduction to topology and modern Analysis (2008)

[2] Walter Rudin, Functional Analysis, International Series in Pure and Applied Mathematics, McGraw-Hill,inc., 1991.

[3] Erwin Kreyszig, introductory Functional Analysis with Applications, John Wiley and Sons(Asia), Pvt.Ltd., 2006.

[4] George Bachman and Lawrence Narici, Functional Analysis, Dover, 2000.

[5] John B. Conway, A course in Functional Analysis, second edition, Springer-Verlag, 2006.

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DISCRETE MATHEMATICS (MS-401) 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 sum of canonical forms. Applications of Boolean algebra to circuit theory.

Unit-III

Graph Theory: Directedgraphs, undirected graphs, paths, circuits, cycles, sub-graphs, induced Sub graphs, degree of vertex, connectivity, planner graph, complete graph, complete bi-partitegraph, 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 Theorem(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. J.P. Tremblay and R.P. Manohar ,Discrete Mathematics with Applications to Computer Science, Tata McGraw Hill , 2008.

2. Ram, Babu, Discrete Mathematics, Pearson Education, (2007).

3. F. Harary, 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, Tata McGraw Hill , 2008 3rd Edition

6. Grimaldi, R.P and Ramana, B.V., Discrete and Combinatorial Mathematics-An Applied Introduction, Pearson education (2004) 5thed.

7. Seymour Lipschultz, "Theory and Practice of Data Structures", McGraw-Hill, 1988.

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MATHEMATICAL METHODS (MMS-402)L T P 4 1 0

UNIT I

Integral Transforms: Definitions and properties of Laplace transform, inversion formula convolution, Laplace transform of unit step function and impulsive function, application to ordinary and partial differential equations; Fourier transform, properties of Fourier transform, inversion formula, convolution, Parseval's equality; Fourier transform of generalized functions, application of transforms to heat wave and Laplace equation. Hankel Transforms and its applications in boundary value problems.

UNIT II

Integral Equations: Integral equations of Fredholm and Volterra type, solution by successive substitution and successive approximation, integral equations with degenerate kernels. Integral equations of convolution type and their solutions by Laplace transform, Fredholm's theorems, integral equations with symmetric kernel, Eigen values and Eigen functions of integral equations and their simple properties.

UNIT III

Calculus of Variations:The extreme of functionals and its properties, variation of functional, Euler equation in one and several independent variables, sufficient conditions for the extremum of a functional, moving end problems, variation problems with constraints- problem of geodesics and isoperimetric.

UNIT IV

Eigen Value Problems: Ordinary differential equations of the Sturm-Liouville Problem, eigen values and eigen functions, 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.

BOOKS RECOMMENDED:

- 1. The Use of Integral Transforms I. N. Sneddon, Tata McGraw Hill, 1985
- 2 Fourier Transforms R. R. Goldberg, Cambridge University Press, 1970.
- 3 Laplace Transform Theory M. G. Smith, Van Nostrand Inc., 2000.
- 4. Calculus of Variation- L. Elsegolc, Dover Publications, 2010
- 5. Kenwal, Ram P., Linear Integral Equation; Theory and techniques, Academic Press, 1971
- 6. Hildebrand, F.B., Methods of applied mathematics, Dover Publications, (Latest Reprint)

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Scheme and Syllabus of M.Sc. Mathematics Batch 2012 onwards PARTIAL DIFFERENTIAL EQUATIONS (MMS-403)L T P 4 1 0

UNIT I

First Order PDE: Definition of PDE, 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 coefficients, linear second order PDE with variable coefficients; characteristic curves of the second order PDE; Monge's method of solution of non-linear PDE of second order.

UNIT III

Method of Solution: Separation of variables in a PDE; Laplace, wave and diffusion equations, Elementary solutions of Laplace equations.

UNIT IV

Applications of PDE: Wave equation, the occurrence of wave equations, elementary solutions of one dimensional wave equation; vibrating membranes, three dimensional problems. Diffusion equation, resolution of boundary value problems for diffusion equation, elementary solutions of diffusion equation.

BOOKS RECOMMENDED:

1. Elements of Partial Differential Equation (3rd edition) – I. N. Sneddon, McGraw Hill Book Company, 1998.

2. Partial Differential Equations (2nd edition) - E. T. Copson, Cambridge University Press, 1995.

3. Partial Differential Equations: An Introduction [Hardcover]Walter A. Strauss ,(2ndedition) 2007. 4. J.N. Sharma and K. Singh, Partial differential equations for engineers and scientists, 2nd Edition, Narosa Publication House, New Delhi, 2009

5. Sankara Rao, Introduction to partial differential equations, PHI,2010.

4 Head

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FLUID MECHANICS (MMS-501)

L T P 4 1 0

Unit-I

Lagrangian and Eulerian methods, equation of continuity, stream lines. Path lines and streak lines, velocity potential and stream function, irrotational and rotational motions.

Unit-II

Euler's equation, Bernoulli's equation, equations referred to moving axes, impulsive actions, vortex motion and its elementary properties, motions due to circular and rectilinear vortices, Kelvin's proof of permanence.

Unit-III

Unit-IV

Irrotational motion in two-dimensions, complex-velocity potential sources, sinks, doublets and their images, conformal mapping.

Stress components in a real fluid. Navier- Stokes equations of motion. Plane Poiseiuille and Couette flows between two parallel plates. Flow through a pipe of uniform cross section in theform of circle, annulus, Theory of lubrication.

BOOKSRECOMMENDED

1. Yuan S.W., Foundations of Fluid Mechanics, Prentice Hall of India Private Limited (1976).

2. Chorlton F., Textbook of Fluid Dynamics, C. B. S. Publishers (2005).

3. Besant W.H. and Ramsay A.S., Treatise of Hydro Mechanics, Part II, CBS Publishers (2004).

4. Rathy R.K., An Introduction to fluid Dynamics, Oxford and IBH Publishing Company (1976).

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SOLID MECHANICS (MMS 502) 4 1 0

Unit-I

Analysis of Strain: Affine transformations. Infinitesimal affine deformation.Geometrical interpretation of the components of strain.Strain quadric of Cauchy. Principal strains and invariants. General infinitesimal deformation.Equations of compatibility, Finite deformations.Examples of uniform dilatation, simple extension and shearing strain.

Unit-II

Analysis of Stress: Body and surface forces, stress tensor, equations of equilibrium, transformation of coordinates, stress quadric of Cauchy. Principal stress and invariants.Maximum normal and shear stresses, examples of stresses.

Unit-III

Equations of Elasticity: Generalized Hooke's law, homogeneous isotropic bodies, Elastic moduli for isotropic bodies. Equilibrium and dynamic equations for an isotropic elastic solid.Beltrami-Michell compatibility equations.

Unit-IV

Boundary value problems of elasticity: Strain Energy, Strain energy function, Uniqueness of solution of the boundary-value problems of elasticity, Saint-Venant's Principle, Bounds on the elastic constants, Related Integral theorems, Principle of virtual work, Principles of minimum potential and complementary energy.

BOOKS RECOMMENDED:

 I.S. Sokolnikoff, *Mathematical Theory of Elasticity*, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1977.
 Martin, H. Sadd, *Elasticity, Theory Applications and Numerics*, Elsevier Academic Press, UK, 2006.

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CODING THEORY (MMS-503)

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, Syndrom 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).

1 Head Department of Mathematical Sciences I.K. Gujral Punjab Technical University Kapurthala-144603 Pb. (India)

ADVANCED COMPLEX ANALYSIS (MMS-504)

L T P 4 1 0

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

Unit-I

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.

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.

Unit-IV

BOOKS RECOMMENDED

1. Z.Nihari, Conformal Mapping, Conformal Mapping, McGraw-Hill, 1952.

2. J. B. Conway, Functions of One Complex Variable, Springer-Verlag, 1973

3. T. W. Gamelin, Complex Analysis, Springer, 2004.

4. W.Tutschke and H.L.Vasudeva, An Introduction to Complex Analysis- Classical

and Modern Approaches, Chapman & Hall/CRC, 2005

5. E.T. Copson, An Introduction to Theory of Functions of a Complex Variable.

1 Head Department of Mathematical Sciences I.K. Gujral Punjab Technical University Kapurthala-144603 Pb. (India)

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Advanced Operations Research (MMS-505)

Unit 1

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 2

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 3

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 4

Inventory Models: (a) 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, PHI, 2007, Eighth ed.

2. Sharma, J.K, Operation research: Theory & Applications , Macmillan India, 2007, Third ed

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

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ADVANCED FLUID MECHANICS (MMS-506)

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, (b) 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.

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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.

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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

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Advanced Solid Mechanics(MMS-507)

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 VariationalMethods: 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

Sokolnikoff, I S Mathematical Theory of Elasticity, (Ch3: 20,21,23,26,28;Ch4: 31-36,43-44,52,57;Ch:5: 66-71, 77(a,b,c);Ch6: 94,96,99-101; Ch 7: 107-109, 112-113, 115, 117-119) TMH New Delhi 1978.
 Timoshenko.S. and Young D.H. – "Elements of strength of materials Vol. I and 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 (4thEdition, Jan 2013).

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Number Theory and Cryptography(MMS-508)

Unit-I

Some Topics in Elementary Number Theory: Time estimates for doing arithmetic, Divisibility and the Euclidean algorithm, Congruence's, some applications to factoring.

Unit-II

Finite Fields and Quadratic Residues: Finite fields, Quadratic residues and reciprocity.

Unit-III

Cryptography: some simple cryptosystems, enciphering matrices.

Unit-IV

Public Key: The idea of public key cryptography, RSA, Discrete log. Elliptic Curves: Basic facts, Elliptic curve cryptosystems.

BOOKS RECOMMENDED:

- 1. Koblitz N., A Course in Number Theory and Cryptography, Graduate Texts in Mathematics, No.114, Springer-Verlag, New York/Berlin/Heidelberg, 1987.
- Baker A., A Concise Introduction to the Theory of Numbers, Cambridge University Press, New York/Port Chester/Melbourne/ Sydney, 1990.
- Parshin A.N. and Shafarevich I.R. (Eds.), Number Theory, Encyclopaedia of Mathe-matics Sciences, Vol. 49, Springer-Verlag, New York/Berlin/Heidelberg, 1995.
- Stillwell J., Elements of Number Theory, Undergraduate Texts in Mathematics, Springer-Verlag, NewYork/Berlin/Heidelberg, 2003.
- Tilborg H.C.A. van, An Introduction to Cryptography, Kluwer Academic Publishers, Boston/ Dordrecht/Lancaster, 1988.

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Theory of Linear Operators (MMS-509)

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. Behaviours 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 Hibert 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 Edn. Chelsea Pub., Co., N.Y. 1957.

3. Dunford N. and Schwartz, J.T. Linear operators-3 parts, Inter-science Wiley, New York, 1958-71.

4. Bachman G. and Narici, L., Functional analysis, Academic Press, New York, 1998.

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Advanced Numerical Methods(MMS-510)

Unit-I

Iterative Methods for Linear Systems: The classical iterative methods (Jacobi, Gauss-Seidel andSuccessive Over Relaxation (SOR) methods),Krylov subspace methods; Conjugategradient, Bi-conjugate-gradient (BiCG), BiCG stability methods, Preconditioning techniques, parallelimplementations.

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 threedimensional finite elements), Fourth-order problems, Hermite families of elements, iso-parametric elements, numerical integration.

BOOKS RECOMMENDED:

1. Jain, M.K, Iyengar, S.R.K. and Jain, R.K., Numerical Methods for Scientific and Engineering Computation, New Age international, 2008, 5th Edition.

2. Hoffman Joe D., Numerical methods for Engineers and Scientists, McGrow-Hill, 1993.

3. Atkinson, K.E, An Introduction to Numerical Analysis, John Wiley, 2004, 2nd Edition.

4. Gupta R.S., Elements of Numerical Analysis, McMillan India, 2009

5. Seshu P., Textbook of Finite Element Analysis, Prentice Hall India, 2003.

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Topological Vector Spaces (MMS-511)

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, Neighbourhood 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-KreinMiliman 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, McGraw Hill, 2nd edition, 1973.

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Fractional Calculus (MMS-512)

Unit-I

Special Functions of the Fractional Calculus. Gamma Function. Mittag-Leffler function, Fractional Derivatives and Integrals. Grunwald-Letnikov Fractional Derivatives. RiemannLiouville Fractional Derivatives. Some Other Approaches.

Unit-II

Geometric and PhysicalInterpretation of Fractional Integration and Fractional Differentiation. SequentialFractional Derivatives. Left and Right Fractional Derivatives. Properties of FractionalDerivatives. Laplace Transforms of Fractional Derivatives. Fourier Transforms ofFractional Derivatives. Mellin Transforms of Fractional Derivatives.

Unit-III

Linear Fractional Differential Equations. Fractional Differential Equation of a GeneralForm. Existence and Uniqueness Theorem as a Method of Solution. Dependence of aSolution on Initial Conditions. The Laplace Transform Method . Standard FractionalDifferential Equations. Sequential Fractional Differential Equations. Fractional Green's Function. Definition and Some Properties. One-Term Equation. TwoTerm Equation. Three-Term Equation. Four-Term Equation. General Case: n-termEquation.

Unit-IV

Other Methods for the Solution of Fractional-order Equations. The Mellin TransformMethod. Power Series Method. Babenko's Symbolic Calculus Method. Method ofOrthogonal 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. Fractional Calculus and Applied Analysis, vol. 3, no. 4, 2000.

2. Carpinteri A, Mainardi F, editors. Fractals and fractional calculus in continuummechanics. New York: Springer-VerlagWien; 1997.

3. Mandelbrot BB. The fractal geometry of nature. New York: W. H. Freeman; 2000.

4. Miller KS, 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.

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Scheme and Syllabus of

M.Sc. Mathematics Batch 2017 onwards

M.Sc. Mathematics is a postgraduate level course of the Department of Mathematics which is a 2years course. It is consisting of semester system (4 semesters) with two semesters per year.

Program Code: MSM (Masters of Science in Mathematics)

Eligibility: B.A./B.Sc. with Honors in Mathematics or B.A./B.Sc. (pass course) with Mathematics as one of the subjects having at least 50% marks in aggregate.

First Semester

Contact Hours: 27 Hrs.

Course Code	Course Title	Load	Alloc	ation	Marks	s Distribut	ion	Credits
		L	T	P	Internal	External	Total	•
MSM-101	Algebra-I	4	1	0	20	80	100	5
MSM -102	Real Analysis-I	4	1	0	20	80	100	5
MSM -103	Complex Analysis	4	1	0	20	80	100	5
MSM -104	Ordinary Differential Equations and Special Functions	4	1	0	20	80	100	5
MSM -105	Mathematical Methods	4	1	0	20	80	100	5
MSM -106	Introduction to Computer Algebra System (Lab)	0	0	2	50	00	50	1
1	Total	20	05	02	150	400	550	26

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Contact Hours: 27 Hrs.

Second Semester

Course Code	Course Title	Load	Alloca	tion	Marks	s Distributi	ion	Credits
		L	Т	Р	Internal	External	Total	
MSM -201	Algebra-II	4	1	0	20	80	100	5
MSM -202	Real Analysis-II	4	1	0	20	80	100	5
MSM -203	Mechanics-I	4	1	0	20	80	100	5
MSM -204	Partial Differential Equations	4	1	0	20	80	100	.5
MSM -205	Numerical Analysis	4	1	0	20	80	100	5
MSM -206	Numerical Analysis (Lab)	0	0	2	50	00	50	1
	Total	20	05	02	150	400	550	26

Third Semester

Contact Hours: 27 Hrs.

Course Code	Course Title	Load	Alloca	ation	Marks	s Distribut	ion	Credits
		L	Т	Р	Internal	External	Total	
MSM -301	Topology	4	1	0	20	80	100	5
MSM -302	Number Theory and Cryptography	4	1	0	20	80	100	5
MSM -303	Mathematical Statistics-I	4	1	0	20	80	100	5
MSM -304	Functional Analysis	4	1	0	20	80	100	5
MSM -XXX	Elective-I	4	1	0	20	80	100	.5
MSM -305	Seminar	0	0	2	50	-	50	1
1	Fotal	20	05	02	150	400	550	26

Contact Hours: 27 Hrs.

Fourth Semester

Course Code	Course Title	Load	Alloca	tion	Marks	Distribut	ion	Credits
		L	Т	Р	Internal	External	Total	
MSM -401	Mechanics-II	4	1	0	20	80	100	5
MSM -402	Mathematical Statistics-II	4	1	0	20	80	100	5
MSM-403	Differential Geometry	4	1	0	20	80	100	5
MSM -YYY	Elective-II	4	1	0	20	80	100	5
MSM -ZZZ	Elective-III	4	1	0	20	80	100	5
MSM -404	Seminar	0	0	2	50	-	50	1
Т	otal	20	05	02	150	400	550	. 26

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Scheme and Syllabus of

M.Sc. Mathematics Batch 2017 onwards

Elective-I MSM XXX (Any one subject to be opted)

MSM -501 Coding Theory

MSM -502 Operations Research

Note1: Student is to adopt one course from the list of Elective-II and one course from list of Elective-III

Elective-II Courses: MSM-503, MSM-504, MSM-505, MSM-506

Elective-III Courses: MSM-507, MSM-508, MSM-509, MSM-510, MSM-511

MSM -503 Advanced Complex Analysis

MSM -504 Advanced Operations Research

MSM -505 Advanced Fluid Mechanics

MSM -506 Advanced Solid Mechanics

MSM -507 Theory of Linear Operators

MSM -508 Advanced Numerical Methods

MSM -509 Topological Vector Spaces

MSM -510 Fractional Calculus

MSM -511 Discrete Mathematics

Note 2:

Instructions for paper setters and candidates:

a) The entire question paper should be distributed into three sections viz. Section-A, Section-B, Section-C.

b) The Section-A should cover the entire syllabus, the Section-B should cover Unit-I & II and the Section-C should cover Unit-III & IV of the syllabus.

c) Section-A should contain eight questions of two marks each. This section should cover the entire syllabus. All questions in this section should be compulsory.

- d) Section-B and Section-C should contain three questions each carrying 16 (sixteen) marks.
- d) Section-B and Section-C should contain three questions each each should be asked to attempt at least two questions from Section-B and Section-C each.
 e) Student should be asked to attempt at least two questions from Section-B and Section-C each.
- e) Student should be asked to attempt at least two questions
 f) The awards for internal and external examination should be in 20:80 ratio.
- f) The awards for internal and external examination
 g) The Duration of examination is three hours.

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Course Title: Algebra-I Course Code: MSM-101

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Course Objectives: The main aim of the course:

- is to introduce basic topics of algebra like groups, sylow groups, rings, ideals, etc.
- to make the students learn about operations on algebraic structures which are quite significant .
- in modern mathematics. to make the students understand the theorems of group isomorphisms and ring isomorphisms.
- .

UNIT-I

Groups: Groups, homomorphisms, Subgroups and Cosets, Cyclic groups, Permutation groups, Normal subgroups and quotient groups, Isomorphism theorems, Automorphisms, Dihedral groups, Symmetric groups, Conjugacy. [Ref 2: Unit 1]

UNIT-II

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

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: 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.
- 6. Fraleigh, J. B., A First Course in Abstract Algebra, 7th Edition. Pearson Publications, 2002.

Course Outcomes:

The students will be able to learn the basic concepts like groups, rings, etc.

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- They will be acquainted with prerequisite knowledge required to learn advanced algebra.
- They will be able to apply the learnt techniques in modern algebra .

Course Title: Real Analysis-I Course Code: MSM-102

L	Т	P
4	1	0

Course Objectives: This course will develop

- a deeper and rigorous understanding of fundamental concepts viz. metric spaces, some important sets, continuous functions, sequences and series of numbers as well as functions, and the Riemann-Stieltjes integral in analysis.
- to introduce theoretical foundations of the above said concepts to students
- . to develop their rigorous mathematical thinking and writing.

UNIT-I

Finite, Countable and Uncountable sets, Metric spaces, Compact sets, Perfect sets, Connected sets, Convergent sequences, Sub sequences, Cauchy sequences, Power series, Absolute convergence, Algebra of series, Rearrangements of elements in a series.

UNIT-II

Limits of functions, Continuous functions, Compactness, Connectedness, Monotonic functions, Infinite limits and Limits at infinity.

UNIT-III

The Riemann-Stieltjes integral: Definition and existence of the Riemann-Stieltjes integral, Properties of the integral, Integration and differentiation, Integration of vector-valued functions, Rectifiable curves.

UNIT-IV

Sequences and series of functions: Interchanging order of limits for sequences of functions, Uniform convergence, Uniform convergence and continuity, Uniform convergence and integration, Uniform convergence and differentiation, Equicontinuous families of functions, Stone Weierstrass Theorem.

RECOMMENDED BOOKS:

- 1. Rudin, W., Principles of Mathematical Analysis, 3rd Edition. New Delhi: McGraw-Hill Inc.,
- 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.

Course Outcomes: After completion of the course, the student will be able to Understand hypotheses and writing mathematical proofs. ٠

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- Understand the theoretical structures of basic concepts in analysis. .
- Understand axiomatic structure of metric spaces and consideration of sequences and series, . continuous functions in metric spaces.
- Understand the theoretical foundation and properties of the Riemann-Stieltjes integral.

Course Title: Complex Analysis Course Code: MSM-103

L	Т	P
4	1	0

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Course Objectives: The objective of this course is

- to introduce and developing a clear understanding of the fundamental concepts of Complex Analysis such as analytic functions, Cauchy-Riemann relations and harmonic functions etc.
- to make students equipped with the understanding of the fundamental concepts of complex variable .
- in particular, to enable students to acquire skill of contour integration to evaluate complicated real . integrals via residue calculus.

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. Exponential function, Trigonometric and inverse trigonometric functions, Logarithmic function, Complex powers, Branches of multivalued functions with reference to arg(z), log(z), z^c. 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, Maximum modulus principle, Schwarz lemma, Poisson's integral formula.

Unit-III

Power series: circle of convergence, radius of convergence. Taylor's series and Taylor's theorem, Laurent'z series and Laurent theorem, Zeros and singularities of complex functions, classification of singularities: removable singularity, poles, essential singularities, Residue at a pole and at infinity, 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, Argument principle, Rouche's theorem

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. Copson, E.T., An Introduction to the Theory of functions of a complex Variable. Oxford university press, 1995.
- 3. Shastri, A.R., An Introduction to Complex Analysis. Macmillan India Ltd., 2003.
- 4. Ponnusamy, S. and Silverman, H., Complex Variables and Applications. Birhkäuser, 2006.

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5. Churchill, R. and Brown, J.W., Complex Variables and Applications, 6th Edition. New-York: McGraw-Hill, 1996.

Course Outcomes: After the completion of this course the student will be able to

represent complex numbers algebraically and geometrically.

- Evaluate Complex integrals and applying Cauchy integral.
- evaluate limits and checking the continuity of complex function & apply the concept and .
- consequences of analyticity and the Cauchy-Riemann equations and of results on harmonic and entire functions including the fundamental theorem of algebra.

Course Title: Ordinary Differential Equations and Special Functions Course Code: MSM-104

L	Т	Р
4	1	0

Course Objectives: The objective of this course is

to introduce ordinary differential equations and fundamental theorems for existence and uniqueness.

- to learn analytic techniques for computing solutions of various ordinary differential equations with . and without initial and boundary conditions.
- to explore the use of series methods about ordinary and regular-singular points.

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.

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- 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.

Course Objectives: Students will be able to:

- classify ordinary differential equations according to their order and linearity, as well as distinguish between initial value problems and boundary value problems.
- determine regions of the plane in which a given first-order differential equation will have a
- obtain solutions for system of ordinary differential equations and eigen value problems by using . various tools of linear algebra.

Course Title: Mathematical Methods Course Code: MSM-105

L	Т	P
4	1	0
4	1	-

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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, Green's function, Linear equations in cause and effect, 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.

RECOMMENDED 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.

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7. Pal, S. and Bhunia, S.C., Engineering Mathematics. Oxford University Press, 2015.

Course Title: Introduction to Computer Algebra System Course Code: MSM-106

L	Т	Р
0	0	2

Course Objectives: This course

- introduces computer algebra systems (CAS) viz. MATLAB and MATHEMATICA that are widely used in scientific computing.
- enables the students to be familiar with the CAS so that they can apply these systems to solve . real world problems more efficiently and accurately.

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

UNIT-II

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; basic numerical mathematics, Programming: conditionals; loops: Do; For and While.

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

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

- use symbolic tools of MATLAB and MATHEMATICA for doing mathematics more efficiently and rapidly.
- understand basic loops and conditional structures that can be used to develop their own computer programs.
- visualize functions in 2-D and 3-D.
- use these CAS for solving applied problems in science and engineering. .

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Course Title: Algebra-II Course Code: MSM-201

L	Т	P
4	1	0

Course Objectives: The main aim of this course

- is to introduce the students to advanced ideas such as Polynomial rings, Field theory, Algebraic closures, splitting fields and Galois theory.
- To make the students learn about Eisenstein's irreducibility criterion which is quite helpful in the study of solvability of a polynomial.
- To make the students understand about the applications of Galois theory in other branches of mathematics.

UNIT-I

Polynomial rings, 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.

Course Outcomes:

• The students will be able to learn the advanced concepts of algebra which will develop their interest to pursuit study in advanced algebra.

 They will acquire abstract and rational thinking by understanding the concepts such as Eisenstein's irreducibility criterion.

• They will be encouraged to do further research in advanced algebra.

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Course Title: Real Analysis-II Course Code: MSM-202

L	Т	P
4	1	0

Course Objectives: This course aims

- to lay theoretical foundations of important aspects of mathematical analysis viz. derivative, mean value theorems (MVTs), functions of several variables, measure theory and integration that have many important applications in different branches of pure and applied mathematics.
- to make students familiar with these concepts, their properties and also some of their fruitful . applications.

UNIT-I

Differentiation of Real functions, Mean value theorems, Taylor's theorem, Differentiation of vector-valued functions, Functions of several variables: Linear transformations, Differentiation, Contraction principle, The Inverse function theorem, The implicit function theorem. [Ref. 3]

UNIT-II

Lebesgue Measure: Introduction, Lebesgue outer measure, Measurable sets and Lebesgue measure, nonmeasurable set, Measurable functions, Borel and Lebesgue measurability, Littlewood's three principles.

UNIT-III

Lebesgue Integral: The Riemann integral, The Lebesgue integral of a bounded function over a set of finite measure, the integral of a nonnegative function, The general Lebesgue integral, Convergence in measure.

UNIT-IV

Differentiation and Integration: Differentiation of monotone functions, The Four derivatives, Functions of bounded variation, differentiation of an integral, Lebesgue Differentiation Theorem. Absolute continuity. Convex Functions.

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.

Course Outcomes After completing the course, the student will

- understand derivative, MVTs and functions of several variables that would be the basis for rigorous understanding of advanced analysis and its applications.
- understand how Lebesgue measure is defined and its properties.
- . understand how the measures may be used in the development of integrals.
- become familiar with deep understanding and application of Lebesgue theory of integration. .
- .

Course Title: Mechanics-I Course Code: MSM-203

L	Т	P
4	1	0

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, Small oscillations of conservative system, Lagrange's equation for small oscillations, Nature of roots of frequency equation, Principle oscillations. Normal coordinates.

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. Action-Angle Variables.

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.

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Course Title: Partial Differential Equations Course Code: MSM-204

L	Т	P
4	1	0

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Course Objectives: the objective of this course is

- to introduce first and higher order partial differential equations and their classification
- to study analytic methods for computing solutions of various partial differential equations.
- to study applications of partial differential equations which appear in real life and physical phenomena like as wave equation of string, diffusion equation and heat flow equation etc.

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 and Higher Order PDE: Origin of second order PDE; linear second and higher 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: Separation of variables for PDE; wave, diffusion and Laplace equations and their solutions by Separation of variables method; Elementary solutions of Laplace equations.

UNIT-IV

Applications of PDE: Vibrations governed by one and two-dimensional wave equations; vibrations of string and membranes; three dimensional problems; diffusion equation; resolution of boundary value problems for diffusion equations and elementary solutions of diffusion equations.

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.

Course Outcomes: Students will be able to:

- understand the mathematical derivation of the methods and partial differential equations. .
- learn analytic techniques for computing solutions of various partial differential equations. .
- learn the behavior of partial differential equations as parabolic, elliptic and hyperbolic and the .
 - applications of partial differential equations. & Head

Course Title: Numerical Analysis Course Code: MSM-205

L	Т	P
4	1	0

122

Course Objectives: The objective of this course includes

- the study the basic numerical methods and their convergence properties for solving nonlinear equations, linear system of equations, initial value problems and boundary value problems.
- the study of numerical methods for differentiation, integration, including Romberg integration.
- the course will also develop an understanding of the elements of error analysis for numerical methods. .

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. Lin-Bairstow's method, Muller's method, Graeffe's root squaring method, Solution of system of nonlinear equations, Complex roots by 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, Partitioning method, Inverse of matrices. Eigen values and eigen vectors: Rayleigh Power method, Given's method and Householder'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, Gaussian integration, Double integration by Trapezoidal and Simpson's rules.

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: Finite difference and Shooting 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.

Course Outcomes: Upon successful completion of this course, the student will be able to:

- apply the numerical methods (such as Bisection, False position, Newton-Raphson, Secant, to solve equations.
- 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.

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Course Title: Numerical Analysis (LAB) Course Code: MSM-206

L	Т	P
0	0	2

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Course Objectives: This course

- provides understanding of implementations of basic numerical methods for solving problems viz. nonlinear equations, system of equations, interpolation, extrapolation, differentiation, integration and ordinary differential equations.
- to enable students to develop their own computer programs of the numerical methods for . solving different problems.

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 definite integrals by using Gaussian Quadrature.
- 11. To evaluate double integrals by using Trapezoidal and Simpson method.
- 12. To compute the solution of ordinary differential equations with Taylor's series method.
- 13. To compute the solution of ordinary differential equations by using Euler's method.
- 14. To compute the solution of ordinary differential equations by using Runge -Kutta methods.
- 15. To compute the solution of ordinary differential equations by using Milne-Simpson method.
- 16. To compute the solution of Boundary value problems of Ordinary Differential Equations by
- using Finite Difference method.
- 17. To compute the solution of Boundary value problems of Ordinary Differential Equations by using Shooting method.

RECOMMENDED BOOKS:

- 1. Fausett, L.V., Applied Numerical Analysis using MATLAB, 2nd Edition. Pearson Prentice Hall,
- 2. Mathews, J.H. and Fink, K.D., Numerical Methods using MATLAB, 4th Edition. Pearson Prentice
- 3. Balagurusamy, E., Object Oriented Programming with C++. New Delhi: Tata McGraw Hill, 1999.
- 4. Conte, S.D. and Boor, C.D., Numerical Analysis. New York: McGraw Hill, 1990.

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

- Understand different implementation modes of numerical methods.
- Develop and implement their own computer programs.
- Solve problems more accurately and efficiently.
- Instructions for paper setters and candidates: Candidates are required to perform at least 10-12 Practical in a semester.

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Course Title: Topology Course Code: MSM-301

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UNIT-I

Introduction topological spaces, closed sets, Closure, Dense subsets, neighborhoods, interior, exterior and boundary, Accumulation points and derived sets. Bases and subbases, Subspaces and relative Topology, Alternative methods of defining a Topology in

terms of Kuratowski closure operator and neighborhood systems.

UNIT-II

Open mappings and closed mappings, Continues functions and homomorphism's, Compactness and local Compactness. One-point compactification, connected and arc-wise connected spaces, Components and Locally connected spaces.

UNIT-III

T0 and T1 spaces, T2 spaces and sequences. Hausdorffness of one-point compactification, Axioms of Countability and Seperability, Equivalence of Separable, second Axiom and Lindel of properties in a metricspaces. Equivalence of compact and countably compact sets in metric 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,
- 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.

Course Title: Number Theory and Cryptography Course Code: MSM-302

L	T	Р
4	1	0

Course Objectives: The main objectives of this course:

- is to teach the basic foundations of Number Theory, namely, Prime Numbers, Division algorithm, Arithmetic functions, Diophantine equations and Cryptography.
- To make the students learn about the interrelation of various concepts of number theory such as Fermat's Last theorem, Reciprocity law, etc. with other branches of . mathematics.

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- To make students understand the various techniques such as Division tests, Chinese remainder theorem, etc.
- To make the students learn about coding and decoding processes using Discrete log, . public key cryptography and RSA cryptography.

UNIT-I

Divisibility, Greatest common divisor, Euclidean Algorithm, The Fundamental Theorem of arithmetic, congruences, Special divisibility tests, Chinese remainder theorem, residue classes and reduced residue classes, Fermat's little theorem, Wilson's theorem, Euler's theorem.

UNIT-II

Arithmetic functions $\phi(n)$, d(n), $\sigma(n)$, $\mu(n)$, Mobius inversion Formula, the greatest integer function, perfect numbers, Mersenne primes and Fermat numbers,

UNIT-III

Primitive roots and indices, Quadratic residues, Legendre symbol, Gauss's Lemma, Quadratic reciprocity law, Jacobi symbol, Diophantine equations: ax + by = c, $x^2 + y^2 = z^2$, $x^4 + y^4 = z^2$, sums of two and four squares, [Ref. 2]

UNIT-IV

Cryptography: some simple cryptosystems, need of the cryptosystems, Discrete log, 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.

Course Outcomes:

- The students will learn fundamental theorems and results in number theory.
- They will be able to apply the learnt techniques in different fields of mathematics.
- They will be acquainted with prerequisite knowledge required to learn advanced .
- course in Number Theory.
- They will be able to construct codes and decode the encrypted code using the learnt techniques.

Course Title: Mathematical Statistics-I Course Code: MSM-303

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L	T	P
4	1	0
Course Objectives: The main objectives of this course is:

To cover the basic concepts of mathematical statistics, random experiments and their applications.

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- To make the students to learn the theory of probability, one dimensional and twodimensional random variables, expectation etc. to study the random experiments. .
- To enhance the statistical thinking of the students.

UNIT-I

Classical, empirical and axiomatic approaches to the theory of probability, the probability set function, algebra of events, conditional probability, addition and multiplicative theorems of probability and their generalizations to n events. Total probability theorem and Bayes' theorem and their applications.

UNIT-II

Random variables (discrete and continuous) and their density functions. Cumulative distribution function and its properties. Different methods to derive the distribution of the function of a random variable. Non-central and central moments of a random variable, expected value of functions of random variable.

UNIT-III

Two dimensional random variables, joint, marginal and conditional density functions, distribution function, independence of random variables. Distribution of the functions of two-dimensional random variables. Joint moments of a two-dimensional random variable.

Unit -IV

Cauchy-Schwartz inequality, Jenson's inequality, product moment correlation coefficient, conditional expectation and variance, probability generating function, moment generating function and its properties. Characteristic function and its elementary properties. Chebychev's inequality, Convergence in probability, weak law of large numbers.

- BOOKS RECOMMENDED:
 - 1. Hogg R. V., McKean J. W. and Craig A. T., Introduction to Mathematical Statistics, Pearson,
 - 2. Gupta S. C. and Kapoor V. K., Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 2014, Eleventh Edition.
 - 3. Fisz M., Probability Theory and Mathematical Statistics, John Wiley & Sons, 1967, Third
 - 4. Gun A. M., Gupta M. K. and Dasgupta B., Fundamentals of Statistics (Vol-I), World Press,
 - 5. Feller W., An Introduction to Probability Theory and Its Applications (Vol-I), John Wiley & Sons, 2003, Third Edition.
 - 6.

After completion of this course, the students will **Course Outcomes**

- Learn the basic concepts of mathematical statistics.
- Be able to apply statistical methods in solving real life problems. .
- Be able to analyze the different possible inferences for a given physical situation.

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Course Title: Functional Analysis Course Code: MSM-304

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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.

Course Title: Mechanics-II Course Code: MSM-401

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Unit I

Tensors: Introduction, Range and Summation Conventions, Free and dummy suffixes, results in vector algebra and matrix, the symbol $\delta_{ij} \& \varepsilon_{ijk}$, Coordinate transformations, cartesian tensors, Properties of tensors, Isotropic tensors, Isotropic tensor of order four, Tensors as linear operators, Transpose of a

tensor.

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Unit II

Tensor Continued: 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, 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 III

Continuum Hypothesis: 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.

Unit IV

Motion and Stress: Material and local time-derivatives, Stretching and vorticity, path lines, stream lines, and vortex lines, Transport formulas, Circulation and vorticity, Body forces and surfaces forces, Stress components, Stress tensor, Normal and shear stresses, stress-deviator, Boundary conditions for stress tensor, Piola-Kirchhoff stress tensors.

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).

Course Title: Mathematical Statistics-II Course Code: MSM-402

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Course Objectives: The main objectives of this course are:

- To introduce various types of distributions, descriptive statistics, theory of estimation and testing of hypothesis etc.
- To make the students learn estimation and testing of hypotheses of parameters of distributions and their applications in real life situations.

Unit-I

Study of various discrete and continuous distributions: Binomial, Poisson, Geometric, Hyper geometric, Multinomial; Uniform, Exponential, Normal, Cauchy, exponential, Beta and gamma distributions, Bivariate normal distribution. Convergence in distribution (law), Central limit theorems (Laplace-Demoiver and Lindeber-Levy).

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Unit-II

Introduction to statistical methods, frequency distributions, measures of central tendency and dispersion, moments and measures of Skewness and Kurtosis. Fitting of Binomial, Poisson and Normal distributions. Theory of attributes independence and association, bivariate correlation and regression.

Unit-III

General concept of Point estimation, unbiasedness, consistency, efficiency, sufficient statistics, Factorization Theorem (without proof), Cramer Rao Inequality (without proof) and their applications. Maximum Likelihood method of estimation and method of moments.

Unit-IV

Concept of sampling distribution and its standard error. Derivation of sampling distributions of Chisquare, t and F. Distribution of sample mean and sample variance from normal distribution. Test of significance, Type I and Type II errors, level of significance. Tests of significance using Chi-square, t and F distributions. Analysis of variance: One way and two-way classifications (one and multiple but equal observations per cell).

BOOKS RECOMMENDED:

- 1. Hogg R. V., McKean J. W. and Craig A. T., Introduction to Mathematical Statistics, Pearson, 2005, Sixth Edition.
- Gupta S. C. and Kapoor V. K., Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 2014, Eleventh Edition.
- 3. Fisz M., Probability Theory and Mathematical Statistics, John Wiley & Sons, 1967, Third
- 4. Gun A. M., Gupta M. K. and Dasgupta B., Fundamentals of Statistics (Vol-I), World Press,
- Feller W., An Introduction to Probability Theory and Its Applications (Vol-I), John Wiley & Sons, 2003, Third Edition.

Course Outcomes After completion of this course, the students will

- Learn the different distributions, estimation theory and testing of hypothesis.
- Be able to use efficiently statistical tools in solving real life problems.
- Be able to analyze the hypothesis/hypotheses using different tests of significance.

Course Title: Differential Geometry Course Code: MSM-403

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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.

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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.

BOOKS RECOMMENDED:

- 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.

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Elective Subjects

Course Title: Coding Theory Course Code: MSM-501

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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: Operations Research Course Code: MSM-502

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Formulation of linear programming problem (LPP) -graphical method, Basic Feasible Solution, Extreme Points, Convex set, Convex linear combination, optimal solution of LPP using Simplex, Big-M and two-phase methods, Exceptional cases in LPP i.e., Infeasible, unbounded, alternate and degenerate solutions.

UNIT-II

General Primal-Dual pair, Formulating a dual problem, Weak and strong duality theorems, Complementary slackness theorem, Dual simplex method, Economic interpretation of primal-Dual problems. Sensitivity analysis: change in right hand side of constraints, change in the objective function and coefficient matrix addition and deletion of constraint and variables.

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, typical assignment problem, the traveling salesman problem, Test for optimality, degeneracy, Project management with critical path method.

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
- 3. Hillier, F.S. and Lieberman, G.J., Operations Research, Second Edition, Holden-Day Inc, USA,
- 4. Bazaraa, M.S., Sherali, H.D., Shetty, C.M., Nonlinear Programming: Theory and Algorithms, John Wiley and Sons, 1993.
- 5. Chandra, S., Jayadeva, and Mehra, A., Numerical Optimization and Applications, Narosa Publishing House, 2013.

Course Title: Advanced Complex Analysis Course Code: MSM-503

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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.

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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-504

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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.

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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-505

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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, (b) 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-506

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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, twodimensional thermoelastic problems. Variational methods: Theorems of potential energy, minimum

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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-507

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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.

4. Bachman G. and Narici, L., Functional analysis, Academic Press, New York, 1998.

Course Title: Advanced Numerical Methods Course Code: MSM-508

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Unit-I

Iterative Methods for Linear Systems: The classical iterative methods (Jacobi, Gauss-Seidel and Successive Over Relaxation (SOR) methods), Krylov subspace methods; Conjugate gradient, Biconjugate-gradient (BiCG), BiCG stability methods, Preconditioning techniques, parallel implementations.

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.

BOOKS RECOMMENDED:

1. Jain, M.K, Iyengar, S.R.K. and Jain, R.K., Numerical Methods for Scientific and Engineering Computation, 5th Edition, New Age international, 2008.

2. Hoffman Joe D., Numerical methods for Engineers and Scientists, McGrow-Hill, 1993.

3. Atkinson, K.E, An Introduction to Numerical Analysis, 2nd 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.

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Course Title: Topological Vector Spaces Course Code: MSM-509

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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-510

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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.

Course Title: Discrete Mathematics Course Code: MSM-511

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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.

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M.Sc. Mathematics

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Course Structure and Syllabus University Campus (Based on Choice Based Credit System) 2018 onwards

PHead 1

DEPARTMENT OF MATHEMATICAL SCIENCES

VISION

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

MISSION

- 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;
- 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.

Scheme & Syllabus (M.Sc. Mathematics) Batch 2018 & Onwards

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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 (Masters 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.

Scheme & Syllabus (M.Sc. Mathematics) Batch 2018 & Onwards

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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, team work, 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.

Scheme & Syllabus (M.Sc. Mathematics) Batch 2018 & Onwards

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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 in to 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.

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

Scheme & Syllabus (M.Sc. Mathematics) Batch 2018 & Onwards

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Pleful Department of Mathematical Sciences I.X. Guiral Punjab Technical University Kapurthale-144503 Pb. (India)

Scheme of the Program:

First Semester

Contact Hours: 28 Hrs.

Course Code	Course Title	Load Allocation			Marks Distribution			Credits
		L	Т	P	Internal	External	Total	
JC-MSM-101- 18	Algebra-I	4	1	0	40	60	100	4
JC-MSM-102- 18	Real Analysis-I	4	1	0	40	60	100	4
JC-MSM-103- 18	Complex Analysis	4	1	0	40	60	100	4
UC-MSM-104- 18	Ordinary Differential Equations and Special Functions	4	1	0	40	60	100	4
UC-MSM-105- 18	Mathematical Methods	4	1	0	40	60	100	4
UC-MSM-106- 18	Introduction to Computer Algebra System (Lab)	0	0	3	50	25	75	3
	Total	20	05	03	250	325	575	23

Second Semester

Contact Hours: 28 Hrs.

Course Code	Course Title	Load Allocation		Marks Distribution			Credits	
		L	T	P	Internal	External	Total	
UC-MSM- 201-18	Algebra-II	4	1	0	40	60	100	4
UC-MSM- 202-18	Real Analysis-II	4	1	0	40	60	100	4
UC-MSM- 203-18	Mechanics-I	4	1	0	40	60	100	4

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1 Had Department of Mathematical Sciences IX Gujral Punjab Technical University Scientifiala-144503 (b) (Incl.)

UC-MSM- 204-18	Partial Differential Equations	4	1	0	40	60	100	4
UC-MSM- 205-18	Numerical Analysis	4	1	0	40	60	100	4
UC-MSM- 206-18	Numerical Analysis (Lab)	0	0	3	50	25	75	3
Total		20	05	03	250	325	575	23

Third Semester

Contact Hours: 25 Hrs.

Course Code	Course Title	Load	Alloc	ation	Marks Distribution			Credits
		L	Т	P	Internal	External	Total	
UC-MSM- 301-18	Topology	4	1	0	40	60	100	4
UC-MSM- 302-18	Number Theory and Cryptography	4	1	0	40	60	100	4
UC-MSM- 303-18	Mathematical Statistics	4	1	0	40	60	100	4
UC-MSM- 304-18	Functional Analysis	4	1	0	40	60	100	4
UC-MSM- 305-18	Mechanics-II	4	1	0	40	60	100	· 4
UC-MSM- 311-18	Seminar	0	0	2	50	0	50	2
	Total	20	05	00	200	300	500	22

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Fourth Semester

Contact Hours: 27 Hrs.

No.	Course Code	Course Code Course Title		Load ocatio	on	Marks Distribution			Credits
			L.	T	P	Internal	External	Total	
1.	UC-MSM-401-18	Differential Geometry	4	1	0	40	60	100	4
2.	UC-MSM-WWW- 18	Elective	4	1	0	40	60	100	4
3.*	UC-MSM-XXX- 18 UC-MSM-YYY- 18 UC-MSM-ZZZ-18	Elective	4	1	0	40	60	100	12
	UC-MSM-411-18	Dissertation	-	-	12	200	100	300	•
4.	UC-MSM-412-18	Seminar	0	0	2	50	0	50	2
		То	tal		_			550	22

TOTAL NUMBER OF CREDITS = 90

Note*: Students may opt either three Elective Theories or Dissertation.

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LIST OF DEPARTMENTAL/INTERDISCIPLINARY ELECTIVES

Elective- UC-MSM-WWW-18, UC-MSM-XXX-18, UC-MSM-YYY-18, UC-MSM-ZZZ-18 (Any one subject to be opted)

MSM-501-18 Discrete Mathematics

MSM-502-18 Coding Theory

MSM-503-18 Operations Research

MSM-504-18 Advanced Number Theory

MSM-505-18 Advanced Complex Analysis

MSM-506-18 Advanced Operations Research

MSM-507-18 Advanced Fluid Mechanics

MSM-508-18 Advanced Solid Mechanics

MSM-509-18 Theory of Linear Operators

MSM-510-18 Advanced Numerical Methods

MSM-511-18 Topological Vector Spaces

MSM-512-18 Fractional Calculus

Examination and Evaluation

5. 110.	Evaluation criteria	Weightage in Marks	Remarks
1	Mid term/sessional Tests	24	Internal evaluation (40 Marks)
2	Attendance	6	MSTs, Quizzes, assignments,
3	Assignments	10	evaluation. Average of two mid semester test will be considered for evaluation.
4	End semester examination	60	External evaluation

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5	Total	100	Marks may be rounded off to nearest integer.
ractio	cal		
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.
Semi	nar		
1	Content	15	
2	Queries	15	Internal evaluation
3	Communication skills	10	
4	Visual effects	10	
5	Total	50	Marks may be rounded off to neares integer.

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			Disse	rtation		
		In	ternal Asses	sment		
	Communicat presentat	ion and ion	Maximum Marks	Evaluated by		
Departmental Presentation	20			30	50	Committee Member: 1.Head 2.Supervisor 3.One of Faculty Member
	Plagiarism Subject Usage of Publication/Presentation Matter Language in Conference		150			
Dissertation	25	70	25	30		
		E				
				Committee Member: 1.Head		
External Examiner			50	2.ExternalExpert3.Superviso4. Director(MC)nominee		
Viva Voce	Commu and Pres	nication	F	Response to queries	50	
	2	20		30		
			Total		300	

Evaluation Process:

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- 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.
- 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.
- 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.
- For publication candidate 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 (Hons.) 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 units 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.
- The distribution of marks to each question/answer should be indicated in the question paper properly.
- B. Type and difficulty level of question papers

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- 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.
- 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).
- 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.
- Attempt any five questions from Section-B and Section-C, selecting at least two questions from each of the two sections.

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Question paper pattern for MST:

	No of pages:		
Roll No:			
IK Gujral Punjab Technical Un	iversity- Jalandhar		
Department of Mathemat	ical Sciences		
Academic Sessi	on:		
Mil Semester Test: 1/11/111 (Regular/reappear)	Date:		
Mid-Semester Test. Within (regeneration	Semester:		
Programme: B.Sc. (Hons.) Mathematics			
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.

Marks	Cos
2	
2	
2	
2	
2	
4	
4	
4	
	10000
8	
0	-
8	1
and a second sec	Marks 2 2 2 2 2 2 2 2 2 4 4 4 8 8 8

Details of Course Objectives

COI	
CO2	
CO3	· · ·
CO4	
CO5	

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SEMESTER-I

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NO MOM		-	Algeh	ra-I		L-4	, T-1, P-0		4 Credit	8
101-18	-		Triges					_		
re-requisite	: Discret	e Structu	res							
Course Objectourses. The foundations course also the real work	ectives: T e fundar of Alge fulfills th d probler	This cours nentals o braic strue e objectiv ns.	e is desig f algebra uctures, ve to mak	ned to giv aic proble Groups, 1 e students	ve studen em-solvir Rings, Io s aware o	nts a found ng are ex deals, Fie f the appl	dation for plained. S elds, Hom icability c	all future Students nomorph of abstrac	e mathen will exp isms etc ct mather	natics plore: . The natics
Course Out	comes: A	t the end	of the co	ourse, the	students	will be a	ble to			
C01	Apply to build	the know d mathem	ledge of natical thi	Algebra t	o attain a d skill.	a good ma	athematic	al maturi	ity and en	nables
CO2	Utilize	the class	equation	n and Sylo	ow theore	ems to so	lve differe	ent relate	d proble	ms.
CO3	Identif Simple Algeb	y and ana groups, ra.	alyze diff Alternat	ferent typ te groups	es of alg to unde	ebraic str rstand and	uctures su d use the	ich as So fundam	ental res	ults in
CO4	Design betwee Isomo	n, analyz en group orphism th	e and im s and rin neorems,	plement ngs for s quotient	the conc olving d groups, c	epts of h lifferent t conjugacy	omomorp types of j etc.	problems	s, for ex	ample,
CO5	Create	e, select a in groups,	and apply, Ideals, H	y appropr Fields to e	iate alge explore the	braic stru ne existin	g results.			
CO6	Identi soluti	fy the ch ons.	allenging	g problem	s in mod	lern math	ematics a	nd find t	neir appi	opria
		Mappin	ng of cou	rse outcoi	mes with	the progr	ram outco	mes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1
COL	1	1	-	1	1	-	V	-	V	V
C02	V	1	-	1	-	-	V	-	V	V
CO3	1	1	-	1	V	-	V	-	V	V
CO4	V	1	-	1	V	-	~	-	V	V
CO5	1	1	-	1	-	-	V	-	V	V
				1					1. 1	

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Head Department of Mathematical Sciences I.K. Gujral Punjab Technical University Kapurthala-144603 Pb. (India)

Course Title: Algebra-I Course Code: UC-MSM-101-18

UNIT-I

Groups: 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

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

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 p², pq. [Ref 2: Unit 1]

UNIT-IV

Rings: 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,
- 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.

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UC-MSM 102-18	-]	Real Ana	alysis-I		L-4	, T-1, P-0		4 Credits	5
Pre-requisit	te: Basic	Calculus	5						1 4 4	ng of
Course Obj fundamental as well as fu on theoretic logics and s	ectives: concept inctions, al founda kills in th	This cou ts viz. me and the F ation of the he student	rse is de etric spac Riemann- ne above s ts.	signed to es, contir Stieltjes said conc	provide nuous fur integral e epts and	a deeper actions, so etc. The n it will cul	and rigo equences nain focu tivate the	and series of this rigorous	erstandi es of nur course w mathem	ng of nbers vill be atical
Course Ou	tcomes:	At the en	d of the o	course, th	e student	s will be	able to			d'and.
C01	Apply develo	the know pment of	wledge o different	of concept mathema	ots of rea atical tech	al analysinniques a	nd their a	er to stupplicatio	idy theo ins.	further
CO2	Unders	stand the	nature o	f abstract	t mathem	atics and	explore	find th	eir appro	opriate
CO3	Identif solutio	fy challer ons.	nging pro	oblems in	n real va	triable un	and genu	aralize t	he conce	epts of
CO4	Deal sequer	with axion nces and s	omatic st series, an	d continu	of metric	tions in n	netric spa	ces.	orals aris	sing in
CO5	Use t differ	heory of ent fields	Rieman of scienc	n-Stieltje e and en	s integra	ii in solv	further a	veloratio	on of the	subject
CO6	Exten for go	d their ki	nowledge research.	e of real v	ariable t	heory for		xpioratic		
		Mapping	g of cour	se outcor	nes with	the prog	ram out	comes	•	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	101	-	-	-	-	-	V	-	V	V
CO2	-	1	-	-	-	-	V	-	N	N
CO3	-	-	-	V	-	1	1	-	V	N
CO4	-	1	-	-	-	-	V	-	1	V
CO5	1	-	-	-	-	-	V	-	V	V
CO6	-	-	-	-	V	-	~	-	V	V

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Head Department of Mathematical Sciences I.K. Gujral Punjab Tachnical University Kapurthala-144803 Pb. (India)

Course Title: Real Analysis-I Course Code: UC-MSM-102-18

UNIT-I

Finite, Countable and Uncountable sets, Metric spaces, Compact sets, Perfect sets, Connected sets, Convergent sequences, Sub sequences, Cauchy sequences, Power series, Absolute convergence, Algebra of series, Rearrangements of elements in a series.

UNIT-II

Limits of functions, Continuous functions, Compactness, Connectedness, Monotonic functions, Infinite limits and Limits at infinity.

UNIT-III

The Riemann-Stieltjes integral: Definition and existence of the Riemann-Stieltjes integral, Properties of the integral, Integration and differentiation, Integration of vector-valued functions, Rectifiable curves.

UNIT-IV

Sequences and series of functions: Interchanging order of limits for sequences of functions, Uniform convergence, Uniform convergence and continuity, Uniform convergence and integration, Uniform convergence and differentiation, Equicontinuous families of functions, Stone Weierstrass Theorem.

RECOMMENDED BOOKS:

- 1. Rudin, W., Principles of Mathematical Analysis, 3rd Edition. New Delhi: McGraw-Hill Inc.,
- 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.

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CHEAD

UC-MSM	-	(Complex	Analysis		L-4	, T-1, P-0)	4 Credit	S
103-18		l	uaral vari	ables and	l complex	k number	system.			
're-requisi	te: Calcu	ilus of se	verai van	aores are				1	undarata	nding
Course Obj of the funda relations an fundamenta of contour i	jectives: amental d harmo l concep ntegratic	The obje concepts nic funct ts of com on to eval	ctive of t of Comp ions and plex vari uate com	his course blex Anal to make able theo plicated r	e is to int ysis such students ry. In par real integ	roduce an as analy equippe rticular, to rals via re	the function d with the o enable s	ions, Ca e unders tudents culus.	uchy-Rie tanding to acquir	emann of the e skill
Course Ou	tcomes:	At the er	nd of the	course, th	e studen	ts will be	able to			
CO1	Know	the funda	amental c	oncepts o	of comple	x analysi	S.	m and fo	rmula.	
CO2	Evalua	ate compl	ex integr	als and aj	oply Cau	cny integ	rai theorem	in and it		
CO3	Evalua of ana	ate limits lyticity a	and chec nd the Ca	king the ouchy-Rie	continuit emann eq	y of computions.	blex funct	ion & ap	ferent sit	uation
CO4	Solve in eng	the probl	ems usin and other	g comple	atical con	ntexts.	through	analysit	ng. provi	ing and
CO5	Establ explai	lish the c ining con	cepts from	for mathe m comple	ematical ex analys	is	iald.	anarysn	15, pro-	0
CO6	Exten	d their ki	nowledge	to pursu	e research	n in this i	ieia.			
		Mapping	g of cour	se outcor	nes with	the prog	ram outc	comes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1
C01	1	1	-	-	\checkmark	-	V	-	V	V
CO2	1	1	-	1	V	-	V	-	. 1	V
CO3		1	-	1	1	-	V	-	V	V
		1	1	1	1	-	V	-	V	V
C04			1	1	~	-	1	-	V	V
05						-	V	-	1	V
C06	N	N	N	V	V					1

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Course Title: Complex Analysis Course Code: UC-MSM-103-18

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. Exponential function, Trigonometric and inverse trigonometric functions, Logarithmic function, Complex powers, Branches of multivalued functions with reference to arg(z), log(z), z^c. 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, Maximum modulus principle, Schwarz lemma, Poisson's integral formula.

Unit-III

Power series: circle of convergence, radius of convergence. Taylor's series and Taylor's theorem, Laurent'z series and Laurent theorem, Zeros and singularities of complex functions, classification of singularities: removable singularity, poles, essential singularities, Residue at a pole and at infinity, 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, Argument principle, Rouche's theorem

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.

		TATIDO	4 Credits
UC-MSM-	Ordinary Differential Equations and	L-4, 1-1, F-0	4 Creans
104-18	Special Functions		

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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	Under: fundar	stand orc mental co	linary di ncepts ab	fferential oout their	equation	ns of vai e.	nous typ	es, tien	Solution	.,
CO2	Under	stand the	concept	and appli	cations o	of eigen v	alue prob	olems.		
CO3	Under	stand dif	ferential	equations	s of Strun	n Liouvill	e type.	Litiana	of diff	erential
CO4	Apply equati	various ons.	power	series m	ethods t	o obtain	series	solutions	nd relati	one
CO5	Discu	ss variou	s kinds o	f special	functions	in detail	, their pro	operties a	ields	5113.
CO6	Solve	problem	s of ordin	nary diffe	rential ec	quations a	rising in	various i	Terus.	
S		Mapping	g of cour	se outco	mes with	the prog	gram out	comes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C01	V	-	1	1	V	-	V	-	V	V
CO2	1	-	1	V	V	-	V	-	V	V
CO3		-	1	1	V	-	V	-	V	V
600			1	1	~	-	1	-	V	1
CO4	N N					-		-	1	V
C05	N	-	N	V	v				1	1
006		-	N	V	N	-	N	-		1

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Course Title: Ordinary Differential Equations and Special Functions Course Code: UC-MSM-104-18

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.

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UC-MSI	M-	Ma	themati	cal Meth	ods	L	4, T-1, P	-0	4 Cred	its
Pre-requis	site: Basi	c Calculu	is and Lii	near Alge	ebra					
Course Ol mathemati one of the required for	bjectives cal techn objectiv or the dev	The obj iques frec es of this relopmen	ective of quently ap s course t of such	the course pplied in is to equi technique	se is to ac various b ip the stu es. he studen	equaint the ranches of ranches with the ranches with the second s	e students of enginee ith the manual e able to	s with th ering and athemati	e knowle sciences cal back	edge of a. Also, ground
Course O	utcomes	At the e	nu or uic	course, c			-		•	1
CO1	Under	stand the	theory a	nd applic	ations of	integral	transform	s.		
CO2	Expla equati	in how i	integral 1	transform	ns can be	e used to	o solve a	a variety	of diff	erential
CO3	Solve	integro-o	lifferenti	al equation	ons of Fre	dholm a	nd Volter	ra type.		
CO4	Unde	rstand the	e properti	es of var	ious kind	s of integ	ral equati	ons.		
CO5	Deve	lop their a	attitude to	owards p	roblem sc	olving.				
		Mapping	g of cour	se outco	mes with	the prog	gram out	comes		-
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	-	1	1	V	-	-	-	V	V
C02		-	1	V	1	-	-	-	· · 1	V
					1		-	-	V	V
CO3	N	-	N	V	V					
CO4	V	V	-	\checkmark	V	-	-	-	N	N
CO5	1	-	1	V	V	-	-	-	V	V

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Head Department of Mathematical Sciences I.K. Gujral Punjab Technical University Kapurthala-144303 Fp. (India)

Course Title: Mathematical Methods Course Code: UC-MSM-105-18

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, Green's function, Linear equations in cause and effect, 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.

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UC-MSM 106-18	I- I S	Introduction to Computer Algebra L-0, 1-0, P-3 5 Creates System Introduction to Computer Algebra Introduction to Computer Algebra										
Pre-requisi	ite: Ba	sic knowled	dge of co	mputer								
Course Ob MATLAB a of this cour programmi	jective and M/ rse is t ng skil	s: This cou ATHEMAT o enable st ls for solvin	TCA that udents to ng proble	des an int are wide make us ems of rea	troduction ly used in se of sym I world n	n to Comp scientific bol tools nore effic	outer Alg computi of these iently an	ebra Syst ng. The r CAS an d accurat	tem (CAS najor obj d also de ely	S) viz. ective evelop		
Course Ou	itcome	s: At the en	nd of the	course, th	ne student	ts will be	able to		•			
C01	App MA	ly the I THEMATI	cnowledg CA to so	ge of lve real w	mathema vorld prot	tical so blems eff	oftware iciently.	viz. M	IATLAB	and		
CO2	Util for e	ize the sym example, so	bolic too	ls of these equation	e CAS for s, differen	handling ntiation, i	different ntegratio	n etc.	atical pro	oblems		
CO3	Des	ign and ana	lyze thei	r own con	mputer co	des of m	athematic	cal metho	ods.			
CO4	Unc diff	lerstand and erent loops	d modify and conc	existing ditional st	codes in s ructures.	scientific	computir	ng based	on the us			
C05	Use	these CAS	with the	understa	inding of	limitation	ns of the	systems.				
CO6	Ider solu	ntify the ch ations accu	allenging rately and	g problem d efficien	s in math tly using	ematics a Compute	nd find t r Algebra	heir appr System	opriate			
		Mapping	g of cour	se outcoi	mes with	the prog	ram out	comes	•			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10		
CO1	1	-	-	-	-	V	-	-	V	\checkmark		
CO2	1	-	-	-	-	1	-	-	V	V		
C03			-	-	-	1	-	-	V	V		
						1	-	-	V	V		
CO4	-	-	-				1000					
CO5	V	-	-	-		N			, , , , , , , , , , , , , , , , , , ,			
CO6	-	-	-	V	-	-	-	-	N	N		

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ford Department of Mathematical Sciences K. Gujtal Punjab Technical University

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Course Title: Introduction to Computer Algebra System Course Code: UC-MSM-106-18

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

UNIT-II

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; basic numerical mathematics, Programming: conditionals; loops: Do; For and While.

Text and Reference Books:

- 1. Higham, D.J. and Higham, N.J., MATLAB Guide, 2nd Edition. Society for Industrial and Applied Mathematics (SIAM), 2005.
- Gilat, A., MATLAB: An Introduction with Applications, 5th Edition. John Wiley & Sons, 2014.
- 3. Wolfram, S., The MATHEMATICA Book, 5th revised edition. Wolfram Media Inc, 2004.
- 4. Abell, M. and Braselton, J., Mathematica by Example, 5th Edition. Academic Press, 2017.

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SEMESTER-II

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UC-MSM	-]	Real Ana	lysis-II		L-4	, T-1, P-0		4 Credit	s
202-18					10 14	alucia I				
re-requisi	te: Calc	ulus of se	veral var	iables and	d Real A	nalysis-1				
Course Ob nathematics ntegration nathematic	jectives: al analys that hav s. Furthe	This cou is, viz. de e many r, the obje	urse is de erivative, importan ective is e	esigned to MVTs, f t applica enable stu	o conside functions tions in dents fan	of severa different niliar with	ical founda al variables branches n these cond	ations of of purcepts an	of concept the theor and applied and applied their first	pts of y and pplied ruitful
Course Ou	tcomes:	At the en	d of the c	course, th	e student	s will be	able to			
CO1	Apply in orde applica	the know er to study ations.	ledge of c theoretic	concepts of cal develo	of function opment of	ons of sev f differen	eral variabl t mathemat	es and ical con	measure neepts an	theory d their
CO2	Under details	stand the	nature o	f abstrac	t mathen	natics and	explore t	he con	in appli	cation
CO3	Utilize differe	e the conc ent fields	epts of d for exam	erivative. ple mana	, MVTS gement,	for vector industry a	and econon	nics etc		
CO4	Recog	gnize the	need of c	oncept of	measure	from a p	oractical vie	w pon	uiony on	d annl
C05	Under its too	rstand me ols in diffe	easure the erent field	ory and i ds of app	ntegratio lications.	n from th	neoretical p		view and	
CO6	Exten its too	d their kr ols for fur	nowledge ther resea	of Lebes arch in th	sgue theo is and ot	bry of inter her relate	d areas	selecti	ng and a	ppiym
10.00		Mapping	g of cours	se outcor	nes with	the prog	gram outco	omes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1
C01	1	-	-	1	\checkmark	-	-	-	V	V
CO2	-		-	1	V	-	-	-	V	V
CO2	1	-	-	1	1	-	-	-	·. V	V
CO4	-	1	-	V	V	-	-	-	V	N
CO5	-	V	-	V	V	-	-	-	V	N
CO6	-	-	-	V	V	-	-	-	V	1

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Course Title: Real Analysis-II Course Code: UC-MSM-202-18

UNIT-I

Differentiation of Real functions, Mean value theorems, Taylor's theorem, Differentiation of vectorvalued functions, Functions of several variables: Linear transformations, Differentiation, Contraction principle, The Inverse function theorem, The implicit function theorem. [Ref. 3]

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 Riemann integral, The Lebesgue integral of a bounded function over a set of finite measure, the integral of a nonnegative function, The general Lebesgue integral, Convergence in measure.

UNIT-IV

Differentiation and Integration: Differentiation of monotone functions, The Four derivatives, Functions of bounded variation, differentiation of an integral, Lebesgue Differentiation Theorem. Absolute continuity. Convex Functions.

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.

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UC-MSN 203-18	A-		Mecha	anics-I		L-	4, T-1, P-	•0	4 Credi	ts
Pre-requis	ite: Basi	c Mechar	nics and C	Calculus	of several	variable	S			
		100000	2.5							d the
Course O	bjectives	s: To de	monstrat	e knowl	edge of	function	al and ex	tremum	path ar	to the
application	of the	knowled	lge in so	olving so	ome fund	lamental	problem	s. 10 d	emonstra	ite the
knowledge	and und	erstandin	g of the f	fundamer	ntal conce	epts in the	e dynamic	es of syst	em of pa	notion
and Lagrar	ngian and	I Hamilto	nian forn	nulation	of mecha	nics. To	represent	the equa	cions of f	notion
for compl	icated m	echanical	systems	s using	the Lag	rangian a	and Ham	iltonian	formulat	ion of
classical m	echanics						11-1-	-	-	-
Course Or	utcomes	At the en	nd of the	course, t	he studen	its will be	e able to			
CO1	Under	etand the	concent	of functi	onal and	determin	e stationa	ry paths	of a fun	ctional
COI	to ded	luce the d	ifferentia	l equatio	n for stat	ionary pa	ths.			
	to dec	luce the a			C 1 44		atha and	ite applie	ations in	1 some
CO2	Use E	Euler-Lag	range eq	uation to	find stat	lionary p	atris and	us appin	actions in	1 Jointe
	classi	cal funda	mental pi	roblems.			1.00			•
CO3	Defin	e and und	derstand l	basic me	chanical o	concepts	related to	discrete	and con	tinuous
	mech	anical sys	stems.						1.5	
CO4	descr	ibe and	understar	nd the n	notion of	f a mecl	nanical sy	stem us	sing La	grange-
	Hami	lton form	alism.							
COS	Conn	ect conce	ents and n	nathemat	ical rigor	in order	to enhanc	e unders	tanding.	
05	Com	cer conce	pts and n					00000		
		Mapping	g of cour	se outco	mes with	the prog	gram out	comes		
-	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
	101						-	-	1	V
CO1	-	N		V	v					
CO2	V	-	N	V	V	-		-	N	V
								-	V	V
CO3	N	-	N	N	V	-		-		
C04		1	-	V	V	-	-	-	V	V
04		1								
COF			1	V	V	-	-	-	· v	N

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Department of Mathematical Sciences I.K. Gujral Punjab Technical University Kapurthala-144603 Pb. (India)

Course Title: Mechanics-I Course Code: UC-MSM-203-18

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, Small oscillations of conservative system, Lagrange's equation for small oscillations, Nature of roots of frequency equation, Principle oscillations. Normal coordinates.

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. Action-Angle Variables.

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.

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-	Partial	Differen	itial Equ	ations	L-4	, T-1, P-0		4 Credit	S
te: Calcu	ilus of se	veral vari	ables and	ODE					
jectives: equation the solu- s of parti- sion equ	The Ol s and the utions of al different ations an	bjective c eir classif various ential equ d heat flo	of this co fication. partial nations in ow equati	ourse is to This cound different real phy on to stud	o introdu- se explai ial equat vsical phe dents.	ce first an ns various ions. It nomenon	ad highe s analyti also ex like wa	r order f ic metho plains v ve equat	ds for arious ion of
tcomes:	At the er	nd of the	course, th	ne studen	ts will be	able to			
Under and hi	stand par gher orde	tial differ er.	ential eq	uations o	f first ord	ler (linear	and nor	DEs	second
Apply	various a	analytic n	nethods f	or compu	iting solu	tions of va	arious r		
Detern order	nine inte PDE and	gral surfa compatit	ices passi ble syster	ing throu ns.	gh a curv	e, charact	eristic c	urves of	second
Under heat e	rstand the quation a	formation formation	on and so sion equa	lution of tion.	some sign	nificant PI	DEs like	wave eq	hysica
Apply	the kno mena.	wledge o	of PDEs	and their	• solution	s in order	to unde		nysica
	Mapping	g of cour	se outcom	mes with	the prog	ram outc	omes		
PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1
		V	V	V	-	-	-	V	V
1		1		1	-		-	~	V
×					-	-	-	V	V
N	-	N	V	v					
V	-	V	V	V	-	-	-	N	,
				V	-	-	-	V	V
	ie: Calcu jectives: equation the solu s of parti- asion equ tcomes: Under- and hi Apply Detern order Under- heat e Apply pheno PO1 √ √ √	Partialte: Calculus of sejectives: The Oleequations and thethe solutions ofs of partial differenceasion equations andtcomes: At the endUnderstand partial differenceand higher orderApply various andDetermine inteorder PDE andUnderstand theheat equation andApply the knownphenomena.MappingPO1PO2 $$	Partial Different te: Calculus of several varial jectives: The Objective of equations and their classifies the solutions of various s of partial differential equations and heat floc tcomes: At the end of the Understand partial differential equations analytic m Determine integral surfa order PDE and compatible Understand the formation Determine integral surfa order PDE and compatible Understand the formation heat equation and diffuse Apply the knowledge of phenomena. Mapping of court PO1 PO2 PO3 $\sqrt{-}$ $\sqrt{-}$ $\sqrt{-}$ $\sqrt{-}$ $\sqrt{-}$ $\sqrt{-}$ $\sqrt{-}$ $\sqrt{-}$ $\sqrt{-}$	Partial Differential Equates: te: Calculus of several variables and gettives: iectives: The Objective of this concellations and their classification. the solutions of various partial is of partial differential equations in asion equations and heat flow equations in the solutions and heat flow equations and heat flow equations. Understand partial differential equations in the solutions of various partial is of partial differential equations and heat flow equations. Understand partial differential equations in the solutions and heat flow equation and higher order. Apply various analytic methods for Determine integral surfaces pass order PDE and compatible system Understand the formation and so heat equation and diffusion equation equation and diffusion equation e	- Partial Differential Equations te: Calculus of several variables and ODE jectives: The Objective of this course is to equations and their classification. This court the solutions of various partial differential s of partial differential equations in real physicion equations and heat flow equation to studies tcomes: At the end of the course, the studen Understand partial differential equations of and higher order. Apply various analytic methods for computor Determine integral surfaces passing throu order PDE and compatible systems. Understand the formation and solution of heat equation and diffusion equation. Apply the knowledge of PDEs and their phenomena. Mapping of course outcomes with PO1 PO2 PO3 PO4 PO5 $$ $ $ $$ $$ $$ $ $ $$	Partial Differential Equations L-4 te: Calculus of several variables and ODE jectives: The Objective of this course is to introduce equations and their classification. This course explaits the solutions of various partial differential equations in real physical phenomena. te: Ourderstand the end of the course, the students will be Understand partial differential equations of first ord and higher order. Apply various analytic methods for computing solu Determine integral surfaces passing through a curv order PDE and compatible systems. Understand the formation and solution of some sign heat equation and diffusion equation. Apply the knowledge of PDEs and their solution phenomena. Mapping of course outcomes with the prog PO6 V - V - V - V - V - V -	Partial Differential Equations L-4, T-1, P-0 te: Calculus of several variables and ODE jectives: The Objective of this course is to introduce first are equations and their classification. This course explains various the solutions of various partial differential equations. It is of partial differential equations in real physical phenomenon ision equations and heat flow equation to students. tcomes: At the end of the course, the students will be able to Understand partial differential equations of first order (linear and higher order. Apply various analytic methods for computing solutions of various order PDE and compatible systems. Understand the formation and solution of some significant PI heat equation and diffusion equation. Apply the knowledge of PDEs and their solutions in order phenomena. Mapping of course outcomes with the program outcomes and with the program outcomes. PO1 PO2 PO3 PO4 PO5 PO6 PO7 V - V - <t< td=""><td>Partial Differential Equations L-4, T-1, P-0 te: Calculus of several variables and ODE </td><td>Partial Differential Equations L-4, T-1, P-0 4 Credit te: Calculus of several variables and ODE introduce first and higher order prequations and their classification. This course explains various analytic methods the solutions of various partial differential equations. It also explains various analytic methods of partial differential equations in real physical phenomenon like wave equations and heat flow equation to students. tcomes: At the end of the course, the students will be able to Understand partial differential equations of first order (linear and nonlinear), s and higher order. Apply various analytic methods for computing solutions of various PDEs. Determine integral surfaces passing through a curve, characteristic curves of order PDE and compatible systems. Understand the formation and solution of some significant PDEs like wave equation. Apply the knowledge of PDEs and their solutions in order to understand phenomena. Mapping of course outcomes with the program outcomes PO1 PO2 PO3 PO4 PO5 PO6 PO7 PO8 PO9 V - V - - V - V</td></t<>	Partial Differential Equations L-4, T-1, P-0 te: Calculus of several variables and ODE	Partial Differential Equations L-4, T-1, P-0 4 Credit te: Calculus of several variables and ODE introduce first and higher order prequations and their classification. This course explains various analytic methods the solutions of various partial differential equations. It also explains various analytic methods of partial differential equations in real physical phenomenon like wave equations and heat flow equation to students. tcomes: At the end of the course, the students will be able to Understand partial differential equations of first order (linear and nonlinear), s and higher order. Apply various analytic methods for computing solutions of various PDEs. Determine integral surfaces passing through a curve, characteristic curves of order PDE and compatible systems. Understand the formation and solution of some significant PDEs like wave equation. Apply the knowledge of PDEs and their solutions in order to understand phenomena. Mapping of course outcomes with the program outcomes PO1 PO2 PO3 PO4 PO5 PO6 PO7 PO8 PO9 V - V - - V - V

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Course Title: Partial Differential Equations Course Code: UC-MSM-204-18

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 and Higher Order PDE: Origin of second order PDE; linear second and higher 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: Separation of variables for PDE; wave, diffusion and Laplace equations and their solutions by Separation of variables method; Elementary solutions of Laplace equations.

UNIT-IV

Applications of PDE: Vibrations governed by one and two-dimensional wave equations; vibrations of string and membranes; three dimensional problems; diffusion equation; resolution of boundary value problems for diffusion equations and elementary solutions of diffusion equations.

RECOMMENDED BOOKS:

- 1. Sneddon, I.N., Elements of Partial Differential Equation, 3rd Edition. McGraw Hill Book
- 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.

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				Analysis		L-4	. T-1, P-0		4 Credit	S
UC-MSM- 205-18		N	imerical	Analysis			, - ,			
	Pasie	Calculus	analysi	s and line	ear algeb	ra				
Course Ob Mathematics science, eng with analyti numerical m initial and b	jectives: s in order ineering ically. T nethods t oundary	This co r to solve and econ this court o solve the value pro-	the prob omics etc se addre proble blems of	designed lems arisi c. that do sses dev ms, viz. f ordinary	to intro ing in va not posse elopmen system o differen	oduce the rious field ess analyt t, analys f linear & tial equat	basic con ds of applic ical solutions and app c nonlinear ions etc.	ation, f ons or d olication equation	for examplificult to n of difores, num	ple in o deal ferent erical
Course Ou	tcomes:	At the en	d of the	course, th	e student	ts will be	able to	merica	Lcomput	ing.
CO1	Identity	y and ana	lyze diffe	erent type	s of erro	rs encoun	tered in nu	merica	- instan	rising
CO2	Apply in scie	the know nce, engir	ledge of neering a	Numerica nd econo	l Mather mics etc.	natics to s	solve proble		the real	world
CO3	Utilize proble	the tools ms from t	s of the N the view	Numerical point of r	I Mathen	natics in o	atics.	mulate	fferent ty	vnes of
CO4	Design proble etc.	n, analyze ms, viz. i	e and imp nitial and	plement o d boundar	of numer ry value j	problems	of ordinary	/ differ	ential equ	uations
C05	Create their l out in	e, select a imitations further re	nd apply s so that a esearch.	appropri any possil	ate nume ble modif	fication in	these tech	n the u niques	could be	carried
CO6	Identi deal v	fy the characteristic for the second	allenging tically) a	g problem and find t	is in cont heir appr	tinuous m opriate so	athematics olutions acc	curately	and effi	ciently
		Mapping	g of cour	se outcor	nes with	the prog	ram outco	mes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
COL	-	-	-	1	-	-	-	-	V	V
CO2	1	-	-	-	-	-	-	-	V	V
CO3	V	-	-	-	-	-	-	-	V	V
CO4	V	-	-	-	-	-	-	-	V	N
CO5	V	1	-	-	-	7	-	-	·. N	N
CO6		-	-	V	-	-	-	-	N	N

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CHeader 5 Department of Mathematical Sciences

Lepartment of Mathematical Sciences I.K. Gujral Punjab Technical University Kapurthub-144603 Pb. (India)

Course Title: Numerical Analysis Course Code: UC-MSM-205-18

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. Lin-Bairstow's method, Muller's method, Graeffe's root squaring method, Solution of system of nonlinear equations, Complex roots by 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, Partitioning method, Inverse of matrices. Eigen values and eigen vectors: Rayleigh Power method, Given's method and Householder'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, Gaussian integration, Double integration by Trapezoidal and Simpson's rules.

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: Finite difference and Shooting 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.

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Department of Mathematical Sciences I.K. Guiral Puniab Technical University Kaourthala-144603 Ph. (India)

00-1412141		Num	erical An	alysis (L	ab)	L-0	, T-0, P-3	18.8	3 Creatts	
206-18		Titunit								
Pre-requisit	e: Basi	ic knowl	edge of	Compute	r progra	mming a	nd Compu	uter Al	gebra Sy	stem
Course Obj numerical m equations, in initial and be develop pro- programs fo	ectives: nethods nterpolat oundary grammin r solving	This count for solvinion and ovalue pro og skills i problem	rse is desing differ extrapola blems of n the stu- s arising	igned to pent prob tion, num ordinary dents in o in science	provide u lems viz nerical d different order to e, engine	inderstand inderstand ifferentia ial equati write and eering and	ding of imj ear equation tion and in ons etc. Fu implement economic	plemen ons, sys ntegration urther, t t their s.	tation of stem of l ion, num his cours own com	basic linear erical e will puter
Course Out	comes:	At the en	d of the c	ourse, the	e student	s will be	able to			
CO1	Apply own co probler extrapo bounda	their kno omputer of ns viz. r olation, r ary value	wledge of codes of nonlinear numerica problems erent imp	numerica equation differents of ordin	ary differ	annining Is for sol m of line and inte rential equess of a nu	ving differ ear equation egration, r uations etco	ent typons, into numeric ethod in	n order to	mplex n and l and
	a giver	n problem	n efficient	tly.				1		-
						11	a colontitic	liferal	ure	
CO3	Analyz	ze and mo	odify con	nputer co	des avail	able in the	e scientific	(CAS	ure.	ample
CO3 CO4	Analyz Utilize MATI codes	the syn AB, MA	mbolic t THEMA	ools of ATICA as problem	des avail Compute nd MAP n.	able in the er Algebr LE inder	e scientific ra System pendently	(CAS and in	(i) for ex their con	cample mputer
CO3 CO4 CO5	Analyz Utilize MATI codes Devel- unders accept	the synchronic terms of terms	odify com mbolic t ATHEMA ng a given et and a of their l ilts.	ools of ATICA and problem pply num imitation	des avail Compute nd MAP n. merical s so that	able in the er Algebruck LE inder methods they car	as a con be imple	(CAS and in nputer mented	their con code will in order	tample mputer ith the to get
CO3 CO4 CO5 CO6	Analyz Utilize MATI codes Devel- unders accept Identi deal v using	the syn AB, MA for solvin op, select standing table resu fy the ch vith analy compute	bdify com mbolic t ATHEMA ng a given et and a of their l ilts. allenging /tically) a r codes.	ools of ATICA and problem imitation problem and find t	des avail Compute nd MAP n. merical as so that is in cont heir appr	able in the er Algebra LE indep methods they car inuous m copriate so	e scientific ra System bendently as a con be imple athematics olutions ac	(CAS and in nputer mented s (whic curatel	their con code wi in order h are diff	tample mputer ith the to get icult to iciently
CO3 CO4 CO5 CO6	Analyz Utilize MATI codes Devel- unders accept Identi deal v using	the synches and more the synches and more the synches and the	bdify com mbolic t ATHEMA ng a given of and a of their l allenging vtically) a r codes. g of cours	ools of ATICA and problem imitation poly num imitation problem and find t	des avail Compute nd MAP n. merical as so that as in cont heir appr mes with	able in the er Algebr LE indep methods they car inuous m copriate so the prog	as a com abe imple	(CAS and in nputer mented s (whic curatel	their con code wi in order h are diff y and eff	ample mputer ith the to get icult to iciently
CO3 CO4 CO5 CO6	Analyz Utilize MATI codes Devel- unders accept Identi deal v using	the synches and more the synches and more the synches and the	odify com mbolic tr ATHEMA ng a given et and a of their l ults. allenging /tically) a r codes. g of cours	aputer coo ools of ATICA and problem imitation pply num imitation problem and find t se outcor	des avail Compute nd MAP n. merical as so that is in cont heir appr nes with PO5	able in the er Algebric LE indep methods they car inuous me opriate so the prog	e scientific ra System bendently as a com be imple tathematics plutions ac gram outco	(CAS and in nputer mented s (whic curatel omes PO8	b) for ex their con code wi in order h are diff y and eff	ith the ith the icult to iciently
CO3 CO4 CO5 CO6	Analyz Utilize MATI codes Devel- unders accept Identi deal v using	ze and mo e the syn _AB, M/ for solvin op, select standing table resu fy the ch vith analy compute Mapping PO2	odify com mbolic to ATHEMA ng a given et and a of their l allenging vtically) a r codes. g of cours PO3	PO4	des avail Compute nd MAP n. merical is so that is in cont heir appr mes with PO5	able in the er Algebra LE indep methods they can copriate so the prog	e scientific ra System bendently as a com a be imple bathematics plutions ac gram outco PO7	(CAS and in nputer mented s (whic curatel omes PO8	b) for ex- their con- code with in order h are diff y and eff	ith the to get
CO3 CO4 CO5 CO6 CO1 CO2	Analyz Utilize MATI codes Devel- unders accept Identi deal v using	ze and mo e the syn _AB, M/ for solvin op, select standing table resu fy the ch vith analy compute Mapping PO2	odify com mbolic to ATHEMA ng a given et and a of their l allenging /tically) a r codes. g of cours PO3 -	ools of ATICA and problem pply num imitation problem and find t se outcor PO4 - -	des avail Compute nd MAP n. merical as so that is in cont heir appr mes with PO5 - -	able in the er Algebric LE indep methods they can inuous m ropriate so the prog PO6 - -	e scientific ra System bendently as a com be imple athematics plutions ac gram outco PO7	(CAS and in nputer mented s (whic curatel omes PO8 - -	b) for ex- their con- code will in order h are diff y and eff \bigvee	$\frac{\text{ample}}{\text{mputer}}$

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						1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-			1	V
CO4	V	-	-	-	-	-	-	-		
CO5	1	1	-	-	-	-	-	-	V	V
							-	-	·. 1	V
CO6		-		V						

Course Title: Numerical Analysis (LAB)

Course Code: UC-MSM-206-18

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 definite integrals by using Gaussian Quadrature.
- 11. To evaluate double integrals by using Trapezoidal and Simpson method.
- 12. To compute the solution of ordinary differential equations with Taylor's series method.
- 13. To compute the solution of ordinary differential equations by using Euler's method.
- 14. To compute the solution of ordinary differential equations by using Runge -Kutta methods.
- 15. To compute the solution of ordinary differential equations by using Milne-Simpson method.
- 16. To compute the solution of Boundary value problems of Ordinary Differential Equations by
- using Finite Difference method.
- 17. To compute the solution of Boundary value problems of Ordinary Differential Equations by using Shooting method.

RECOMMENDED BOOKS:

- 1. Fausett, L.V., Applied Numerical Analysis using MATLAB, 2nd Edition. Pearson Prentice Hall,
- 2. Mathews, J.H. and Fink, K.D., Numerical Methods using MATLAB, 4th Edition. Pearson Prentice Hall, 2004.
- 3. Balagurusamy, E., Object Oriented Programming with C++. New Delhi: Tata McGraw Hill, 1999.
- 4. Conte, S.D. and Boor, C.D., Numerical Analysis. New York: McGraw Hill, 1990.

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SEMESTER-III

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UC-MSM	I-		Торо	logy		L-4	4, T-1, P-0		4 Credit	S
301-18 Pre-requisi	te: Real	Analysis	-I							
Course Ob Topological Homeomor be generaliz Mathematic	jectives: Spaces phism an zed in top	The obj s and t ad the top pological	ective of heir imp pological spaces, so	the cou portance. propertie	rse on T To ac es and im dents may	opology quaint s portant n learn and	is to prov tudents w nathematic d appreciat	ide the vith the al conce the na	knowled e conce epts whic ture of al	lge of pt of ch can ostract
Course Ou	tcomes:	At the er	nd of the	course, th	ne studen	ts will be	able to			
CO1	Unders neighb space.	stand the oourhood,	concepts, interior,	of topolo exterior	ogical spa , closure	aces and their	the basic d	efinition or defin	ns of ope ing topo	n sets, logical
CO2	Under	stand the subspace	concept	of Base	s and Su	iddases, c	leate new	homoor	norphisn	an an
CO3	Under topolo	stand cogical pro	ontinuity	, comp	bactness,	connec	tedness,	House	roff space	res an
CO4	Under their i	rstand ho importanc	w points ce.	of space	e are sepa	arated by	open sets	, House	itori spav	
C05	Unde	rstand reg	gular and	normal s	spaces an	d some in	nportant th	eorems	in these	spaces
	-	Mapping	g of cour	se outco	mes with	the prog	gram outco	omes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1
COL	V	1	-	1	V	-	-	-	V	V
CO1 CO2	1	1	1	1	1	-	-	-	V	V
C03	1	1	-	1	1	-	-	-	1	V
CO4	V	1	-	1	1	-	-	-	. 1	V
				1	1				1	

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fran Department of Mathematical Sciences I.K. Gujral Punjab Tachnical University Kapurthala-144603 Fb. (India)

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Course Title: Topology Course Code: UC-MSM-301-18

UNIT-I

Introduction topological spaces, closed sets, Closure, Dense subsets, neighborhoods, interior, exterior and boundary, Accumulation points and derived sets.

Bases and subbases, Subspaces and relative Topology, Alternative methods of defining a Topology in terms of Kuratowski closure operator and neighborhood systems.

UNIT-II

Open mappings and closed mappings, Continues functions and homomorphism's, Compactness and local Compactness. One-point compactification, connected and arc-wise connected spaces, Components and Locally connected spaces.

UNIT-III

T0 and T1 spaces, T2 spaces and sequences. Hausdorffness of one-point compactification, Axioms of Countability and Seperability, Equivalence of Separable, second Axiom and Lindel of properties in a metricspaces. Equivalence of compact and countably compact sets in metric 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,
- 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.

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1 port Department of Mathematical Sciences I.K. Guiral Puniab Toolinical University Kapurthala-144503.05 (Indian

UC MSM	- N	umber T	heory a	nd Crypt	ography	L-4	, T-1, P-0)	4 Credit	s
302-18										
Pre-requisi	te: Cong	ruences, 1	Number S	System			•	ion to cla	esical n	mber
Course Obj theory and e of number t	ectives: enable the heory usi	This cour em to stud ng public	se is desi dy higher c-key cry	gned to p · courses ptography	rovide sti in numbe y.	er theory,	and to ap	ply the l	earnt cor	acepts
Course Ou	tcomes:	At the en	d of the d	course, th	e student	s will be	able to			
C01	Apply mather	the kno natical m	wledge aturity ar	of Numb	per theores to build	ry and C I mathem	Cryptogra atical thir	phy to king and	attain a I skill.	good
CO2	Utilize	the condre symbol	ngruences ols to sol	s, Chines ve differe	se remai	nder the	orem, in ns.	dices, re	eorem	Wilson
CO3	Identif theore	ỳ and an m, Mobiu	alyze di 1s inversi	fferent ty on formu	pes of d la to forr	nulate an	d solve va	arious re	lated pro	blems.
CO4	Design	n, analyze ent types	e and im of proble	plement ms, for ex	the conce xample, s	sum of tw	o and fou	ir square	S.	primes
CO5	Create	e, select a st integer	and apply function	y approp is in Cryp	riate nun otography	to use in	real life	problem	s. beir app	ropriate
CO6	Identi soluti	fy the ch ons.	allenging	problem	s in mod	ern math	ematics a			oprim
1.1.1.1		Mapping	g of cour	se outcor	nes with	the prog	ram out	comes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1
CO1	1	1	-	V	V	-	-	-	V	V
CO2	V	V	-	V	V	-	-	-	\checkmark	V
C03	1	V	V	V	1	-	-	-	1.	V
CO4	1	1	-	1	V	-	-	-	1	V
CO5	V	V	-	1	1	-	-	-	V	V
C06		-	1	~	-	-	-	-	1	1

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He 2 Department of Mathematical Sciences

I.K. Gujral Punjab Technical University

Kapurthala-144603 Pb. (India)

Course Title: Number Theory and Cryptography Course Code: UC-MSM-302-18

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 $(an \equiv b \pmod{c})$, Chinese remainder theorem.

UNIT-II

Arithmetic functions $\phi(n)$, d(n), $\sigma(n)$, $\mu(n)$, 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.
- Bardy, G.H. and Wright, E.M., An introduction to the Theory of Numbers, 4th Edition. Oxford University Press, 1975.
- Niven, I., Zuckerman, H.S. and Montgomery, H.L., Introduction to Theory of Numbers, 5th Edition. John Wiley & Sons, 1991.
- 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.

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CHelon L Department of Mathematical Sciences J.K. Guiral Punjab Technical University

Kapurthala 144603 Pb. (India)

UC-MS	M-	М	athemat	ical Stati	istics	I	₋-4, T-1, Ì	P-0	4 Cred	lits		
Pre-requi	site: Bas	ic Statisti	ics and C	alculus o	f several	variables	5					
Course O types of pr with stand	bjectives robability ard conc	s: The air y distribu epts of st	n of the o tions and atistical t	course is t testing c echnique	to enable of hypoth is and the	the stude esis prob	ents with lems. It a tion.	understa ims to ec	nding of quip the s	various tudents		
Course O	utcomes	: At the e	end of the	e course, t	the stude	nts will b	be able to					
CO1	Unde	rstand an	d utilize	the conce	pt of pro	bability.						
CO2	Expla	Explain the concept of random variable and its applications.										
CO3	Explo	Explore the different types of discrete and continuous distributions and their utilization.										
CO4	Deal	with forn	nulation	of hypoth	eses as p	er situati	ons and tl	neir testir	ng.			
C05	Apply	y the kno rements.	wledge o	of statistic	cal techni	ques in v	arious ex	periment	tal and in	dustrial		
		Mapping	g of cour	se outco	mes with	the pro	gram out	comes				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10		
C01	V	-	V	V	\checkmark	-	-	-	.1	V		
CO2	\checkmark	-	\checkmark	V	V	-	-	-	V	V		
CO3		-	\checkmark	1	\checkmark	-	-	-	V	V		
CO4	1	-	V	V	V	-	-	-	V	V		
CO5	V	-	1	1		-	-	-	V	V		

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Department of Mathematical Sciences I.K. Gujral Punjab Technical University Konusthala-144603 Pb. (India)

Course Title: Mathematical Statistics

Course Code: UC-MSM-303-18

Unit I

Classical and axiomatic approach to the theory of probability, additive and multiplicative law of probability, conditional probability and Bayes theorem.Random variable, function of random variable, and their distributions, probability mass function, probability density function, cumulative distribution function.

Unit II

Two dimensional random variables, joint, marginal and conditional distributions, independence of random variables, expectation, conditional expectation, moments, product moments, probability generating functions, moment generating function and its properties. Chebyshev's, Markov, Jenson, Techebyshey's, inequalities, stochastic convergence, central limit theorem. characteristic function and its elementary properties.

Unit III

Study of various discrete and continuous distributions, Binomial, Poisson, Geometric, Hyper geometric, Multinomial. Uniform, Exponential, Normal distributions, Gamma distribution, Cauchy, exponential, Beta and gamma distributions, Bivariate normal distribution and distribution of order statistics and range.

Unit IV

Concept of sampling distribution and its standard error, Derivation of sampling distributions of χ^2 , t and F distribution of sample mean and sample variance Testing of hypotheses, fundamental notions important tests based on normal distributions, Tests of significance: tests based on normal distribution, χ^2 , t and F statistic. Analysis of variance: One way and two-way classifications.

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.
- Feller W., An Introduction to Probability Theory and Its Applications (Vol-I), 3rd Edition. John Wiley & Sons, 2003.

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1 Head 2 Department of Mathematical Sciences I.K. Gujral Punjab Technical University aourthala-144603 Pb. (India)

UC-M 304-	ISM- 18		Functio	nal Anal	ysis		L-4, T-1,	P-0	4 Cre	dits			
Pre-req	uisite: Re	al analys	is and Li	near Alge	bra								
Course Concepts	Objective of functi	es: This c onal anal	ourse wil ysis, thei	l develop r properti	a deeper es and re	and rigo	orous unde eorems.	rstandin	ng of func	lamenta			
Course	Outcome	s: At the	end of th	e course,	the stud	ents will	be able to)					
CO1	Expl math	Explain the fundamental concepts of functional analysis and their role in modern mathematics.											
CO2	Utiliz opera math	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	Unde space graph	erstand ar es includi n theorem	nd apply f ng the H n and unif	`undamen ahn-Bana form bour	tal theor theor ndedness	ems fror em, the theorem	n the theor open map n.	ry of nor ping the	rmed and orem, th	Banach e closec			
CO4	Unde detai	erstand th ls.	e nature	of abstrac	ct mathe	matics a	nd explor	e the co	ncepts ir	n further			
CO5	Expla	ain the co	oncept of	projection	n on Hill	pert and	Banach sp	baces.	•	100			
	1	Mapping	of cours	se outcon	nes with	the pro	gram out	comes					
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10			
CO1	1	1	-	V		-	-	-	V				
CO2	V	\checkmark	V	\checkmark	\checkmark	-	-	-	V	V			
CO3	1	V	V	1	V	-	-	•	\checkmark				
CO4	1	V	-	V	\checkmark	-	-	-	1	\checkmark			
C05	\checkmark	V			V	-	-	-	V	1			

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Head Department of Mathematical Sciences I.K. Gujral Punjab Technical University Teourthala-14460 (Pb. (India)

Course Title: Functional Analysis Course Code: UC-MSM-304-18

UNIT-I

Normed Spaces with examples l^p , l^∞ , C[a, b] etc, Banach Spaces, Incomplete normed spaces, Finite Dimensional Normed Spaces and Subspaces, Equivalent norms, Compactness of Metric/ Normed spaces, Riesz's Lemma for two subspaces of a Normed space.

UNIT-II

Linear Operators- definition and examples, Range and Null space, Inverse Operator, Bounded and Continuous linear operators in a Normed Space, Bounded Linear Functionals in a Normed space with examples, Concept of Reflexive space, Dual basis, Dual spaces with examples.

UNIT-III

Inner Product and Hilbert space, Further properties of Inner product spaces, Projection Theorem, Orthonormal Sets, Representation of functionals on a Hilbert Spaces (Riesz's Lemma and Representation), Hilbert Adjoint Operator, Self-adjoint, Unitary & Normal Operators.

UNIT-IV

Fundamental Theorems for Normed & Banach Spaces: Partially Ordered Set and Zorn's Lemma, Hahn Banach Theorem for Real Vector Spaces, Hahn Banach Theorem for Complex Vector Spaces and Normed Spaces, Uniform Boundedness Theorems (Banach-Steinhaus Theorem), Open Mapping Theorem, Closed Graph Theorem.

RECOMMENDED BOOKS:

- 1. Kreyzig, E., Introductory Functional Analysis with Applications. New York: John Willey and Sons, 1989.
- 2. Limaye, B. V., Functional Analysis. New Delhi: New Age International (P) Ltd, 1996.
- 3. Simmons, G. F., *Introduction to topology and modern analysis*. New Delhi: Tata McGraw-Hill Education Private Limited, 2012.
- 4. Nair, M. T., *Functional Analysis-A First Course*. New Delhi: Prentice- Hall of India Private Limited, 2008.
- 5. Rudin, W., Functional Analysis, Tata-McGraw Hill Pub. Co.

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UC-MSM- 305-18			Mec	hanics-I	I		L-4, T-1,]	P-0	4 Cre	dits		
Pre-requ	isites: L	inear Alg	ebra, Ve	ctor Calc	ulus and	Basic Me	chanics					
Course (knowledge and the b	Objective ge of Ten asic conc	es: The ol sors and t epts of str	ojective o heir appl rain, stret	of the cou ications. ch and ro	irse on M To make tation and	lechanics students	-II is to eq understanc ications of	uip the the not tensors	students tion of co	with the ntinuum standing		
these co	ncepts. (One of t	he objec	tives is	to make	e student	s understa	and the	applica	tions of		
Mathema	atical con	cepts in re	eal world	problem	s related	to Mecha	anics.					
Course (Outcome	s: At the	end of th	e course,	the stude	ents will b	be able to	100	•			
CO1	Unde	erstand th	e concen	tofTens	or and th	air propa	tion	-		-		
CO2	Unde	Understand the effect of co-ordinate transformations and visualize the tensor as a linear transformation.										
CO3	Unde	erstand the ents shall	e conven learn the	tions like concepts	e summat of tenso	ion convo r calculus	ention and	comma	a notatior	ns. Also,		
CO4	Unde appli	erstand c cations.	ontinuun	n hypoth	nesis, sp	atial an	material	co-ordi	inates ar	nd their		
CO5	Unde know	rstand th ledge in :	e concep solving r	ots of stra eal world	ain, stret problem	ch, rotati s related	on and sh to continu	all be a um mec	ble to ap chanics.	oply the		
		Mapping	g of cour	se outco	mes with	the prog	gram outo	comes				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10		
C01	V	-	V	V	V		-	-	V	V		
CO2	V	-	\checkmark	V	V	-	-	-	V	1		
CO3	V	- /	\checkmark	V	\checkmark	-	-	-	V	V		
CO4	V	-	1	V	V	-	-	-	V	V		
C05	V	-	\checkmark		V	-	-		V	\checkmark		

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Course Title: Mechanics-II Course Code: UC-MSM-305-18

Unit I

Tensors: Introduction, Range and Summation Conventions, Free and dummy suffixes, results in vector algebra and matrix, the symbol $\delta_{ij} \& \varepsilon_{ijk}$, Coordinate transformations, cartesian tensors, Properties of tensors, Isotropic tensors, Isotropic tensor of order four, Tensors as linear operators, Transpose of a tensor.

Unit II

Tensor Continued: Symmetric and skew tensors, Dual vector of a skew tensor, Invariants of a tensor, Deviatoric tensors, Eigenvalues and eigenvectors, Polar decomposition

Unit III

Scalar, vector and tensor functions, Comma notation, 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

Continuum Hypothesis: 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).

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SEMESTER-IV

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SM- 18]	Differential Geometry				L-4, T-1,	P-0	4 Cre	dits		
isite: Ba	sic calcul	lus and v	ector calc	culus							
Dbjective ntial gec al calculu	es: The o ometry so us.	bjective as to de	of this co cal with g	ourse is to geometry	make str of curves	udents far s and spa	niliar wi ces usinį	th basic of the me	concepts thods o		
Jutcome	s: At the	end of th	e course,	the stude	entts will	be able to)		199		
Unde and s	Understand the basic concepts and results related to space curves, tangents, normals and surfaces.										
Expla	ain the ge	cometry o	of differen	nt types o	f curves	and space	s.		1997.11		
Expla	ain the ph	ysical pr	operties of	of differe	nt curves	and spac	es.				
Unde impo	Understand principal directions and curvatures, asymptotic lines and then apply their important theorems and results to study various properties of curves and surfaces.										
Utiliz	e Geode	sics, it's a	all related	l terms, p	roperties	and theory	rems.				
	Mappin	g of cour	se outco	mes with	the prog	gram out	comes	•			
PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10		
V	V	-	\checkmark	\checkmark	-	-	-	V			
	V	V	V	-	-	-	-	\checkmark	V		
V	-	V	V	V	-	\checkmark		V	V		
V	\checkmark		\checkmark	V	-	\checkmark	-	V	\checkmark		
1	1	V	V	\checkmark	-		-	V	V		
	SM- 8 isite: Ba Dbjective ntial geo al calculu Dutcome: Unde and s Expla Unde impo Utiliz PO1 √ √ √ √ √	SM- Image: Smale state isite: Basic calculation isite: Basic calculation is the state of	SM- Different isite: Basic calculus and v Dbjectives: The objective ntial geometry so as to de al calculus. Dutcomes: At the end of the land surfaces. Dutcomes: At the geometry of Explain the geometry of Explain the physical principal d important theorems and utilize Geodesics, it's and surfaces. Dutlize Geodesics, it's and surfaces. Dutlize Geodesics, it's and surfaces. Dutilize Geodesics, it's and surfaces. Understand principal d important theorems and surfaces. Utilize Geodesics, it's and surfaces. Dutilize Geodesics, it's and surfaces. Utilize Geodesics, it's and surfaces. Utilize Geodesics, it's and surfaces. V V V V V V V V	SM- 8Differential Geometry isite: Basic calculus and vector calculationDbjectives: The objective of this contrial geometry so as to deal with gal calculus.Dutcomes: At the end of the course, Understand the basic concepts a and surfaces.Explain the geometry of different Explain the physical properties of Understand principal directions important theorems and results the Utilize Geodesics, it's all relatedPO1PO2PO3PO4 $$	SM- 18Differential Geometryisite:Basic calculus and vector calculusObjectives:The objective of this course is to ntial geometry so as to deal with geometry al calculus.Outcomes:At the end of the course, the studeUnderstand the basic concepts and result and surfaces.Explain the geometry of different types of Explain the physical properties of differe Understand principal directions and curva important theorems and results to study vUtilize Geodesics, it's all related terms, pMapping of course outcomes withPO1PO2PO3PO4PO5 $$ </td <td>SM-18 Differential Geometry isite: Basic calculus and vector calculus Objectives: The objective of this course is to make structures Ital geometry so as to deal with geometry of curves al calculus. Outcomes: At the end of the course, the studentts will Understand the basic concepts and results related and surfaces. Explain the geometry of different types of curves Understand principal directions and curvatures, as important theorems and results to study various pr Utilize Geodesics, it's all related terms, properties Mapping of course outcomes with the prog PO1 PO2 PO3 PO4 PO5 PO6 $\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{$</td> <td>SM- 18Differential GeometryL-4, T-1,isite: Basic calculus and vector calculusObjectives: The objective of this course is to make students far ntial geometry so as to deal with geometry of curves and spa al calculus.Outcomes: At the end of the course, the studentts will be able to Understand the basic concepts and results related to space and surfaces.Explain the geometry of different types of curves and spaceExplain the physical properties of different curves and space important theorems and results to study various properties of Utilize Geodesics, it's all related terms, properties and theoryPO1PO2PO3PO4PO5PO6PO7$$</td> <td>SM- 18Differential GeometryL-4, T-1, P-018isite: Basic calculus and vector calculus20Dejectives: The objective of this course is to make students familiar with ntial geometry so as to deal with geometry of curves and spaces using al calculus.20Dutcomes: At the end of the course, the studentts will be able to20Understand the basic concepts and results related to space curves, ta and surfaces.21Explain the geometry of different types of curves and spaces.22Explain the physical properties of different curves and spaces.23Understand principal directions and curvatures, asymptotic lines and important theorems and results to study various properties of curves24V-20PO3PO420PO5PO620PO3PO420V-21VV22VV23VV24V-25VV26VV27VV28V-29VV20VV21VV22VV23VV24V-25VV26VV27VV28V-29VV20VV20VV21VV22VV<td>SM- 8 Differential Geometry L-4, T-1, P-0 4 Cree 8 isite: Basic calculus and vector calculus 9 Dijectives: The objective of this course is to make students familiar with basic on the algeometry so as to deal with geometry of curves and spaces using the meal calculus. 9 Dutcomes: At the end of the course, the studentts will be able to 1 1 Understand the basic concepts and results related to space curves, tangents, and surfaces. 1 2 Explain the geometry of different types of curves and spaces. 1 2 Understand principal directions and curvatures, asymptotic lines and then apping of course outcomes with the program outcomes 1 Utilize Geodesics, it's all related terms, properties and theorems. 1 1 PO1 PO2 PO3 PO4 PO5 PO6 PO7 PO8 PO9 $\sqrt{1}$ $\sqrt{1}$</td></td>	SM-18 Differential Geometry isite: Basic calculus and vector calculus Objectives: The objective of this course is to make structures Ital geometry so as to deal with geometry of curves al calculus. Outcomes: At the end of the course, the studentts will Understand the basic concepts and results related and surfaces. Explain the geometry of different types of curves Understand principal directions and curvatures, as important theorems and results to study various pr Utilize Geodesics, it's all related terms, properties Mapping of course outcomes with the prog PO1 PO2 PO3 PO4 PO5 PO6 $\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{$	SM- 18Differential GeometryL-4, T-1,isite: Basic calculus and vector calculusObjectives: The objective of this course is to make students far ntial geometry so as to deal with geometry of curves and spa al calculus.Outcomes: At the end of the course, the studentts will be able to Understand the basic concepts and results related to space and surfaces.Explain the geometry of different types of curves and spaceExplain the physical properties of different curves and space important theorems and results to study various properties of Utilize Geodesics, it's all related terms, properties and theoryPO1PO2PO3PO4PO5PO6PO7 $$	SM- 18Differential GeometryL-4, T-1, P-018isite: Basic calculus and vector calculus20Dejectives: The objective of this course is to make students familiar with ntial geometry so as to deal with geometry of curves and spaces using al calculus.20Dutcomes: At the end of the course, the studentts will be able to20Understand the basic concepts and results related to space curves, ta and surfaces.21Explain the geometry of different types of curves and spaces.22Explain the physical properties of different curves and spaces.23Understand principal directions and curvatures, asymptotic lines and important theorems and results to study various properties of curves24V-20PO3PO420PO5PO620PO3PO420V-21VV22VV23VV24V-25VV26VV27VV28V-29VV20VV21VV22VV23VV24V-25VV26VV27VV28V-29VV20VV20VV21VV22VV <td>SM- 8 Differential Geometry L-4, T-1, P-0 4 Cree 8 isite: Basic calculus and vector calculus 9 Dijectives: The objective of this course is to make students familiar with basic on the algeometry so as to deal with geometry of curves and spaces using the meal calculus. 9 Dutcomes: At the end of the course, the studentts will be able to 1 1 Understand the basic concepts and results related to space curves, tangents, and surfaces. 1 2 Explain the geometry of different types of curves and spaces. 1 2 Understand principal directions and curvatures, asymptotic lines and then apping of course outcomes with the program outcomes 1 Utilize Geodesics, it's all related terms, properties and theorems. 1 1 PO1 PO2 PO3 PO4 PO5 PO6 PO7 PO8 PO9 $\sqrt{1}$ $\sqrt{1}$</td>	SM- 8 Differential Geometry L-4, T-1, P-0 4 Cree 8 isite: Basic calculus and vector calculus 9 Dijectives: The objective of this course is to make students familiar with basic on the algeometry so as to deal with geometry of curves and spaces using the meal calculus. 9 Dutcomes: At the end of the course, the studentts will be able to 1 1 Understand the basic concepts and results related to space curves, tangents, and surfaces. 1 2 Explain the geometry of different types of curves and spaces. 1 2 Understand principal directions and curvatures, asymptotic lines and then apping of course outcomes with the program outcomes 1 Utilize Geodesics, it's all related terms, properties and theorems. 1 1 PO1 PO2 PO3 PO4 PO5 PO6 PO7 PO8 PO9 $\sqrt{1}$		

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Course Title: Differential Geometry

Course Code: UC-MSM-401-18

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.

BOOKS RECOMMENDED:

- 1. Weatherburn, C.E., *Differential Geometry of Three Dimensions*, Cambridge University Press, 2016.
- 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.

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ELECTIVE SUBJECTS

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UC-M	ISM-501- 18	Discret	e Mathen	natics		I	4, T-1, P-0	•	4 Crea	lits
Pre-re	equisite: Se	et Theory	, Relations	s, functior	ıs.					
Cours mathe motiv conce colou	se Objecti ematical ar rate student epts of Gr rings, Plan	ves: Prep guments is how to aph theo arity, are	pare stude require ir solve prac ry such a introduce	nts to dev n learning tical probl as Trees, d.	velop math many ma lems using Eulerian	nematical athematics g discrete r Graphs,	foundations s and compunathematics. Matching, N	to unde ter scie Also, i /ertex	erstand ar ences cou n this cou colouring	nd create irses. To rse basic gs, Edge
CO1	construct	mathem	atical argu	mente usi	ng logical	connecti	ves and quant	ifiers		
COI	construct	mathema	atical argu	intents usi	ng logical	connectiv	les and quant	mers.		
CO2	understar study of	nd how la networks	attices and	Boolean	algebra a	re used as	tools and ma	athema	tical mod	els in the
CO3	validate t	the correc	tness of a	n argumei	nt using st	atement a	nd predicate	calculu	IS.	
CO4	learn how graphs ar	v to work nd recurre	with som	ne of the o on.	discrete st	ructures w	hich include	sets, r	elations, f	functions,
CO5	understar	nd the cor	ncepts Plai	narity incl	luding Eul	er identity	/.			14.15
CO6	discuss a	nd unders	stand the i	mportance	e of the co	oncepts Ma	atching's and	Colou	rings'.	
	1	Мар	ping of co	ourse out	comes wit	th the pro	gram outcoi	nes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	~	1	~	1	-	-	-	~	1
CO2	~	1	1	~	~	-	-		~	~
CO3	~	~	~	~	~	-			~	~
CO4	~	1	1	~	~	-	-	-	~	~
CO5	~	~	1	1	1	-	-	-	~	~
CO6	1	1	~	~	~	-	-	-	~	~

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Course Title: Discrete Mathematics Course Code: UC-MSM-501-18

Unit-I

Mathematical Logic: Basic logical operations, conditional and bi-conditional statements, tautologies, contradiction, predicate calculus.

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. Boolean algebra as lattices, Boolean identities, sub-algebra, Boolean forms and their equivalence, 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, Eulerian paths and circuits, Trees and Coloring of the graph, Rooted tree, spanning trees, minimal spanning trees, Kruskal's algorithm. Chromatic number, four-color problem (statement only).

Unit-IV

Algebraic Structures: Review of groups, codes and group codes, encoders and decoders, hamming matrices, parity checks, decoding and error correction.

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. Anami, B.S and Madalli, V.S., Discrete Mathematics, University Press, 2016.
- 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..

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UC-M	MSM-502- Codin 18				у	L	-4, T-1, P-	0	4 Cred	its
Pre-re	quisite: Li	inear Alge	bra, Proba	ability the	ory			•		
Cours we int Cyclic codes	se Objecti troduce th c codes, T	ves: Codin e basic co he Group	ng Theory oncepts of of a code	helps to d Coding 7 e, Quadra	letects erro Theory su atic residu	ors in Tran ch as, Do ne codes a	uble Error- and Bose-C	of messag -Correcti Chaudhur	ges. In thi ng B.C.I 'i- Hocqu	s course H. code, enghem
Course	e Outcom	es: At the	end of the	e course, t	he student	s will be a	able to			
CO1	understa	nd the con	cept of M	aximum-	Likelihood	d Decodin	g and Synd	rome De	coding.	
CO2	analyze	Double Er	ror-Correc	cting B.C.	.H. code a	nd Finite	Fields Poly	nomials.		
CO3	understa	nd Cyclic	Codes.							
CO4	study the	e concept o	of Bose-C	haudhuri-	Hocqueng	ghem (B.C	C.H.) Codes	and Wei	ght Distri	butions.
CO5	learn ab encoding	out basic g, and deco	technique	es of alg coset leade	ebraic coo ers etc.	ding theo	ry like ma	atrix enco	oding, po	lynomial
CO6	learn ho	w algebrai	c coding t	heory is a	pplicable	in real wo	orld problem	ns.		
		Мар	ping of co	ourse out	comes wit	h the pro	gram outc	omes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C01	1	1	~	~	~	-	-	-	1	1
CO2	~	~	~	~	~	-	-	-	1	~
CO3	1	1	1	1	1	-		- 62	1	1
CO4	1	~	1	~	1	-	-	-	1	1
C05	~	~	~	~	~	-	-	-	1	1
CO6	~	~	1	~	~		-	-	~	1

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Course Title: Coding Theory Course Code: UC-MSM-502-18

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.

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UC-MSM	-	0	peration	s Resear	ch	L-	4, T-1, P-0		4 Credi	ts			
505-18				is and lie	poor algeb)ra	-	_	1000				
Pre-requisit Course Obj get best response programmin constrained its physical problems	ectives: sults fro g probl problem consid	This cou om a se lems, tra ns etc. The erations	urse is de t of sev nsportati e major and imp	signed to eral poss on proble focus will lementati	introduce sible solu- em, assign l be on for ion of op	e basic op ations of gnment p ormulatio	timization different problem an n of real w on algorith	technic proble d unc orld pl ms for	ques in or ms viz. onstraine nenoment solving	rder to linear d and a from these			
Course Out	tcomes:	At the en	nd of the	course, th	he studen	ts will be	able to						
CO1	Apply results progra uncon	the know from a mming strained a	wledge of set of s problem and const	f basic op several po ns, trans trained pr	otimizatio ossible s sportation oblems e	on technic olution c proble tc.	ques in ord of different m, assign	er to g problement	et best p ems viz. problen	ossible linear n and			
CO2	Formu	Formulate an optimization problem from its physical consideration.											
CO3	Select limita	Select and implement an appropriate optimization technique keeping in mind its limitations in order to solve a particular optimization problem.											
CO4	Under	rstand the	eoretical ilable in	foundation the scient	on and in tific litera	nplementa iture.	ation of sin	nilar ty	pe optim	izatior			
C05	Conti appro	nue to a priate to	acquire k professio	cnowledg	e and sl ities	cills of o	optimizatio	n tech	niques t	hat are			
CO6	Exten	d their k on these	nowledge types of	e of basic optimizat	c optimiz	ation techniques.	hniques to	do inte	eresting r	esearcl			
		Mapping	g of cour	se outcoi	mes with	the prog	gram outco	omes					
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10			
CO1	~	-	-	-	-	-	-	-	1	~			
CO2	-	-	~	-	-		-	-	. 1	~			
CO3	~	~	-	-	-	-	-	-	1	1			
CO4	-	~	-	-		-	-		1	1			
CO5	-	-	-	-	-	-	~	-	~	1			
				1	1				1 /	1 1			

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Course Title: Operations Research Course Code: UC-MSM-503-18

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, Big-M and two-phase methods, Exceptional cases in LPP i.e., Infeasible, unbounded, alternate and degenerate solutions.

UNIT-II

General Primal-Dual pair, Formulating a dual problem, Weak and strong duality theorems, Complementary slackness theorem, Dual simplex method, Economic interpretation of primal-Dual problems. Sensitivity analysis: change in right hand side of constraints, change in the objective function and coefficient matrix addition and deletion of constraint and variables.

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, typical assignment problem, the traveling salesman problem, Test for optimality, degeneracy, Project management with critical path method.

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. Hillier, F.S. and Lieberman, G.J., Operations Research, Second Edition, Holden-Day Inc, USA, 1974.
- 4. Bazaraa, M.S., Sherali, H.D., Shetty, C.M., *Nonlinear Programming: Theory and Algorithms*, John Wiley and Sons, 1993.
- 5. Chandra, S., Jayadeva, and Mehra, A., *Numerical Optimization and Applications*, Narosa Publishing House, 2013.

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Kapurthala-144603 Pb. (India)

UC-M	ISM-504- 18	A	Advanced	Number	Theory	1	L-4, T-1, P	-0	4 Cred	lits
Pre-re	quisite: El	ementary	Number 7	Theory						
Course Compo identity applica	e Objectivositions. In y, Gollnitz- tions. Also e Outcome	ves: This this cours Gordon i o, the weal es: At the	Course se we introdentities, k and stronend of the	helps the oduce the Rogers-Rang version course, th	students concepts amanujan as of vario ne student	to under of variou type iden us import will be at	rstand the s identities atities for n ant theorer ole to	concept like Jaco -colour p ns.	of Partit obi's triple partitions,	ions and e product and their
CO1	understar	nd the diff	erent type	s of partit	ions & co	mposition	IS.			
CO2	students	will have	a working	knowledg	ge of the v	arious typ	pes of iden	tities		
CO3	work with variables	h congrue	nce's, solv	e congrue/	ence equat	ions and s	systems of o	equations	with one	and more
CO4	be literate	e in the la	nguage ar	nd notation	n of numb	er theory.				
C05	understar	nd the con	cept of fo	r n-colour	partitions		120			
		Мар	ping of co	ourse outo	comes wit	h the pro	gram outo	omes .		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C01	~	× .	~	~	~	-	-	-	~	~
CO2	~	1	1	~	~	-	-	-	~	1
CO3	~	1	1	~	~	-	-		~	~
CO4	~	1	~	1	~	-	-	<u>-</u>	1	~
C05	~	~	~	1	~	-	-	-	1	1

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C Head

Course Title: Advanced Number Theory Course Code: UC-MSM-504-18

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.

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.

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freehert Department of Mathematical Sciences I.K. Gujral Punjab Technical University Kapurthala-144603 Pb. (India)

UC-N 505	4SM- 5-18	Ad	vanced C	omplex A	nalysis	L-	4, T-1, P-0	•	4 Cred	its
Pre-req	uisite: Co	omplex Ai	nalysis, Ro	eal Analys	sis					
Course Comple Mathem	Objectiv ex Analys natics.	es: This c	ourse is d ill provic	esigned to le basic t	o enable the topics nee	ne readers eded for	to understa students to	nd furth pursue	er deeper research	topics of in pure
Course	Outcome	es: At the	end of the	course, th	ne student:	s will be a	ble to			
C01	equip v analyse	with neces is and prob	sary know plem solvi	wledge an ng involvi	d skills to ing compl	enable t ex numbe	hem handle rs.	e mather	natical of	perations,
CO2	underst	anding of	topologic	al and geo	metric pro	operties of	f the comple	ex plane		
CO3	analyze	how com	plex num	bers provi	de a satisf	ying exter	nsion of the	real nur	nbers	
CO4	learn te and sca	chniques o ling as an	of complex example of	x analysis of comple:	that make x multiplie	e practical cation);	problems e	asy (e.g	. graphica	l rotation
CO5	continu	e to devel	op proof	technique	s.					
		Map	ping of co	ourse outo	comes wit	h the pro	gram outco	omes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C01	~	1	~	~	~	-	-	-	~	~
CO2	~	1	1	1	~	-	-	-	1	1
CO3	1	1	1	1	1	-	-	-	~	1
CO4	1	1	1	1	~	-	-	-	~	1
CO5	1	~	~	~	~	-	-	-	~	~

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Heats

Department of Mathematical Sciences I.K. Gujral Punjab Technical University Kapurthala-144603 Pb. (India) Page 62 of 77

Course Title: Advanced Complex Analysis

Course Code: UC-MSM-505-18

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.

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Kapurthala-144603 Pb. (India)

UC-MS 506-1	SM- 18	Adva	nced Op	erations	Research	h	L-4, T-1,	P-0	4 Cre	dits
Pre-requ	isite: Ba	isic Calcu	ulus, anal	ysis, line	ar algebra	a and op	erations re	esearch.	•	
Course implement several por programme focus of t and imple Course C	Objective ntation of ossible so ning prol his course ementation	res: This f advance olutions of blem, gas e will be of on of opti s: At the	s course ed optim of differe me theor on formu mization end of th	is desi ization te nt proble y, dynam lation of r techniqu e course,	gned to echniques ms viz. a nic progra- real-world es for sol the stude	provide in orde dvanced amming d phenor ving the ent will b	e a theo er to get b linear pro and inver mena from se problem be able to	retical in best resul ogrammin ntory mo its physi ns.	ntroducti ts from ng proble dels. Th cal consi	on and a set of m, goal e major deration
C01	Appl possi	y the kn ble result	lowledge ts from a	of adva set of sev	nced opt /eral poss	imizatio sible solu	n techniq utions of a	ues in o given pr	rder to poblem.	get best
CO2	Form	ulate an	optimizat	tion prob	lem from	its phys	ical consid	derations		100
CO3	Selec	t and in ations in	order to s	an approsolve a pa	opriate o rticular c	ptimizat ptimizat	ion techni tion proble	que keep em.	oing in r	nind its
CO4	Unde the se	erstand ar cientific l	nd analyz iterature.	ze similar	types of	other o	ptimizatio	n technic	jues avai	lable in
CO5	Cont appro	inue to opriate to	acquire professio	knowledg onal activ	ge and s ities.	kills of	optimiza	tion tech	iniques 1	that are
CO6	Exter resea	nd their k rch work	nowledge on these	e of advar and simi	iced optir lar types	nization of optim	technique	s in order chniques.	to do int	eresting
New York		Mappin	g of cour	se outco	mes with	the pro	gram out	comes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C01	~	-	-	-	-	-	-	-	1	1
CO2	-	-	1	-	-	-	-	-	1	~
CO3	~	1	-		-	-	-	-	~	~
CO4	-	~	-	-	-	-	-	-	~	1
CO5	-	-	-	-	-	-	~	-	~	1
CO6	-	-	-	-	~	-	-	-	~	~

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Heaters

Course Title: Advanced Operations Research

Course Code: UC-MSM-506-18

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.
- 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.

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UC-N 507	ASM- 7-18	Ad	lvanced F	Fluid Mec	hanics	L-	4, T-1, P-0		4 Credi	its
Pre-req	uisite: Fl	uid Mecha	anics and	Continuur	n Mechan	ics				
Course where the in resea an appro- Course	Objectiv he studen rch proble eciation o Outcome	es: This co ts will be a ems. The c f their app es: At the c	ourse is in able to appobjective i lication to end of the	tended to ply the teo is to provi o real worl	provide a chniques u de the stud d problem ne students	treatment used in der dent with us. s will be a	of advance riving arrar knowledge ble to	ed topics nge of im of the fl	in fluid n portant re uid mech	nechanics esults and anics and
C01	Unders sink, so	tand the co ource, vorte	oncept of ex etc.	rotational	and irrota	tional flow	w, stream fi	unctions,	velocity	potential,
CO2	analyze Navier-	simple fl Stoke's eq	uid flow p Juation of	problems (motion.	flow betw	een paral	lel plates, f	low thro	ugh pipe	etc.) with
CO3	underst	and the ph	enomeno	n of flow :	separation	and boun	dary layer	theory		1380
CO4	understa	and the cor	ncept of the	ermal conc	luctivity.					
CO5	learn ab	out the fun	damental	equations	of the flow	w and ene	rgy	•		
		Map	ping of co	ourse outo	comes wit	h the pro	gram oute	omes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C01	~	-	~	~	· ✓	-	-	-	~	~
CO2	~	-	~	~	~	-	-	-	~	~
CO3	1	-	1	~	~	-	-	-	1	~
CO4	~	-	1	~	~	-	-	-	~	1
C05	1		1	1	1				1	1

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208

Course Title: Advanced Fluid Mechanics

Course Code: UC-MSM-507-18

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 nondimensional 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

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Head Department of Mathematical Sciences

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UC-M 508-	SM-	Adv	vanced So	olid Mech	anics	L-4	, T-1, P-0		4 Credit	S
Pre-requ	uisite: Me	chanics-I	and Conti	nuum Me	chanics					
Course classical involves determin	Objective methods (a) station me stresses	es: The pri and equip analysis , strains a	the stude of a cor nd deform	rse object ents with nponent t ation due	ive is to s the tools to find the to interna	olve adva necessary e internal l actions.	nced solid to solve r actions (mechanics nechanics forces [*] an	es problen s problem d momer	ns using s, which nts), and
Course	Outcome	s: At the e	end of the	course, th	e students	will be at	Sie to			12.2.2
CO1	understa	and the the	ory of ela	sticity inc	luding stra	ain/displac	cement and	I Hooke's	a law relat	ionships.
CO2	analyze	solid mec	hanics pro	oblems usi	ing classic	al method	ls and ener	gy metho	ods.	
CO3	solve fo	r stresses	and deflect	ctions of b	eams und	er unsymr	metrical loa	ading.		
CO4	obtain s	tresses and	d deflectio	ons of bea	ms on elas	stic found	ations.			
CO5	solve to	rsion prob	lems in b	ars and thi	in walled i	nembers.				
		Map	ping of co	ourse outc	comes wit	h the pro	gram outo	omes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C01	~	-	~	~	~	-	-	-	-	1
CO2	~		~	~	~	-	-	-	-	1
CO3	~	-	~	~	~	-	-	-	-	1
CO4	~		~	~	~	-	-	-	-	1
										1

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Head

Course Title: Advanced Solid Mechanics

Course Code: UC-MSM-508-18

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, twodimensional 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.

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UC-M 509-	ISM-	The	ory of Li	near Oper	ators	L-4	, T-1, P-0		4 Credit	S
Pre-req	uisite: Re	al Analysi	s, Topolo	gy, Integra	l Equatio	ns				
Course are nece equation	Objective ssary for is, mathem	es: To teac a deeper u natical phy	h the fund nderstand sics, harn	lamentals ing of man nonic anal	of Banach ny adjace ysis, oper	n Algebras nt mathen ator theor	s and Spect natical field y etc.)	tral Opera ds (integr	ator Theor al and dif	ry which ferential
Course	Outcome	es: At the e	end of the	course, the	e students	will be al	ole to			
CO1	have un	derstandin	g of main	topics of	Banach A	lgebras ar	nd Spectral	Theory.		
CO2	termino	logy, nota	tion and th	he basic re	sults and	concepts	of Banach	and Hilbe	ert spaces.	12.25
CO3	understa adjoint	and the co and norma	ncept of s	spectrum a rs, Gelfand	and resolv I Represei	ent, adjoi ntation, Ri	nt operato iesz-Fredho	rs, compa olm Theo	act operat ry.	ors, self-
CO4	relation	n of the sub tial equati	oject with ons)	other bran	ches of m	athematic	s (Fourier a	analysis, c	complex f	unctions,
C05	prepare ideas ar	the studer e used.	nts for read	ling the lite	erature of	a wide va	riety of sub	ojects in w	which Hilt	ert space
		Мар	ping of co	ourse outc	omes wit	h the pro	gram outc	omes `.		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C01	~	1	-	~	~	-	-		-	1
CO2	~	~	-	~	~	-	-	-	-	1
CO3	1	~	-	~	~	-	-		-	1
CO4	1	-	1	~	~	-	-		-	1
CO5	1	1	-	. ✓	~	-	-	-	-	~

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CHefel

Course Title: Theory of Linear Operators

Course Code: UC-MSM-509-18

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.
- 4. Bachman G. and Narici, L., Functional analysis, Academic Press, New York, 1998.

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Department of Mathematical Sciences LK. Gujral Punjab Technical University arthala-144603 Pointeder

UC-MSN 510-18	I-	Advan	ced Num	erical M	ethods	L	4, T-1, P-	-0	4 Credi	ts
Pre-requisi	ite: Basi	c Calculu	us and an	alysis. Ba	isic nume	erical ana	lysis			
Course Ob of advance eigenvalues application development limitations	jectives: d numer s probler s, for exa nt, analy of these	This cou- rical met ms, ordir ample in sis and ir methods.	urse is de hods for nary and science, nplemen	solving partial of engineeri tation of	provide differenti differenti ng and e numerica	a theoret types of al equati conomics al method	ical intro f probler ons arisi etc. The s keeping	duction a ns viz. 1 ng in va major fo g in mino	and appli inear sy- arious fi- ocus will l advanta	cation stems, eld of be on ages &
Course Ou	tcomes:	At the en	nd of the	course, th	ne studen	t will be a	able to	1	1:ffanon	ttunes
CO1	Apply of pro differe engine	the know oblems wential equ cering and	vledge of viz. line ation ari d econom	advanced ar systen sing in va nics etc.	l numeric ns, eiger arious fie	al method nvalues eld of app	ds in orde problems dications	for exan	ry and apple in so	partial cience,
CO2	Under	stand adv	antages	and limita	ations of	advanced	numeric	al metho	as.	
CO3	Select	and imp	lement a d nature	n appropr of the pro	iate num blem.	erical me	thod for	solving a	i given p	roblem
CO4	Use the sc	neoretical ientific li	basis of terature.	these me	thods in	order to s	tudy their	r counter	parts exis	sting in
CO5	Identi deal v	fy the ch vith analy	allenging (tically) a	g problem and find t	is in cont heir appr	inuous m opriate sc	athemations a	cs (whicl ccurately	and effi	ciently
CO6	Exten	d their k methods.	nowledg	e to do re	esearch v	vork on t	hese met	hods and	similar	type o
		Mapping	g of cour	se outcor	nes with	the prog	ram out	comes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C01	~	-	-	-		-	-	-	~	1
CO2	-	1	-	-	-	-	-		~	1
CO3	~	~	-		-	-	-	-	~	~
CO4	-	~	-	-	-	-	-	-		~
CO5	-	-	-	~	-	-	-	-	1	1
		1		1	1				1	

Scheme & Syllabus (M.Sc. Mathematics) Batch 2018 & Onwards

Head Department of Mathematical Sciences I.K. Gujral Punjab Technical University Kapurthala 144603 Pb. (India)

Course Title: Advanced Numerical Methods Course Code: UC-MSM-510-18

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.

BOOKS RECOMMENDED:

- 1. Jain, M.K., Iyengar, S.R.K. and Jain, R.K., Numerical Methods for Scientific and Engineering Computation, 5th Edition, New Age international, 2008.
- 2. Hoffman Joe D., Numerical methods for Engineers and Scientists, McGrow-Hill, 1993.
- 3. Atkinson, K.E, An Introduction to Numerical Analysis, 2nd 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.

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PHERON 2

UC-N 511	ISM-	Тој	ological	Vector Sp	aces	L-4	, T-1, P-0		4 Credit	S
Pre-req	uisite: Lin	ear Algeb	ra, Real A	nalysis, T	opology					1
Course results connect particul Course	Objective of the theo is topologic ar attention	s: The air ry of topo cal and alg n will be g s: At the e	n of this ological ve ebraic stru- iven to loo nd of the	course is t ector spac uctures. T cally conv course, the	to give an es (TVS). he main fo ex spaces e student v	As the n ocus will t (e.g. norm will be abl	of the me ame sugge be the study ned, semin	ost impor ests, this t y of TVS formed an	tant conc theory be over the d nuclear	epts and autifully reals and spaces).
CO1	understan	d the gene	eral theory	of topolo	gical vect	or spaces.		•		
CO2	learn the	basic prop	erties of t	opologica	l vector sp	aces.				
CO3	define the	e structure	of locally	-convex t	opologica	l vector sp	baces.			
CO4	understar	ding and a	analyzing	inductive	and proje	ctive limit	ts.			
CO5	understar	d the strue	cture of, F	Frechet spa	aces, Mon	tel, Schwa	artz, and n	uclear spa	ces.	
		Map	ping of co	ourse outc	comes wit	h the prop	gram outo	comes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C01		~	~	1	~	-	-	-	~	1
CO2	~	~	~	~	~	-	-		1	~
CO3	1	~	~	~	1	-	-	-	~	1
CO4	1	1	1	~	1	-	-	-	1	~
COT		1	1	1	1	-	-	-	~	~

Course Title: Topological Vector Spaces

Scheme & Syllabus (M.Sc. Mathematics) Batch 2018 & Onwards

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Head Department of Mathematical Sciences I.K. Gujral Punjab Technical University Kapurthala-144603 Pb. (India)

Course Title: Topological Vector Spaces Course Code: UC-MSM-511-18

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.

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UC-M	SM-		Fractiona	l Calculu	S	L-4	, T-1, P-0		4 Credit	8
512- Pre-requ	isite: Dif	ferential E	quations	(Ordinary	and Partia	al), Mathe	matical Me	ethods		
Course (aptly cal fractiona of fractio	Objective led the ca l different onal differ	s: The ob- lculus of c tial equation rential equ	jective of lerivatives ons and co ations	this course s and integ nsider som	se to cove grals to an ne of their	r the basic arbitrary application will be ab	cs of the fr order. The ons. Also, st	actional n introdu tudy the r	calculus, ace the co aumerical	or more ncept of solution
Course CO1	understa commoi	and the Right functions	emann-Lio	ouville fra	ectional in	tegral and	l evaluate f	ractional	integrals	of some
CO2	define derivati	the Riema ves of som	ann-Liouv ie commo	ville and n function	Caputo f	ractional	derivative	s and fi	nd the f	ractiona
CO3	state su	fficient co	nditions u	nder whic	h the fract	tional inte	grals and d	erivative	s exist	
CO4	investig	ate some a	application	ns of the f	ractional o	calculus to	the real w	orld.		
C05	solve lin	near fractio	onal differ	ential equ	ations usir	ng the Lap	lace transfo	orm and H	ourier Tr	ansform
		Map	ping of co	ourse outc	comes wit	h the pro	gram outc	omes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C01	1	-	~		1	-	-	-	-	1
CO2	~	-	~	1	~	-	-	- '	-	~
CO3	~	-	1		~	-	-	-	-	~
CO4	1	-	~	1	~	-	-	-	-	~
CO5	~	-	1		~	-	-	-	-	1

Scheme & Syllabus (M.Sc. Mathematics) Batch 2018 & Onwards

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Course Title: Fractional Calculus

Course Code: UC-MSM-512-18

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.

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Scheme of the Program:

SEMESTER FIRST

Contact Hrs. 34 Hrs.

S.No.	Course Code	Course Title	A	Load llocat	l ion	Marks Di	stribution	Total Marks	Cr
			L	T	P	Internal	External		
1.	UC-BSHM-101-19	Calculus -1	4	1	-	40	60	100	4
2.	UC-BSHM-102-19	Co-ordinate Geometry	4	1	-	40	60	100	4
3.	UC-BSHM-103-19	Programming Lab-I	-	2	4	30	20	50	2
4.*	UC-BSHP-112-19	Electricity and Magnetism	3	1	-	40	60	100	4
	UC-BSHP-113-19	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	60	40	100	2
5.**	UC-BHCL-I-101- 19	Inorganic Chemistry	3	1	-	40	60	100	4
	UC-BHCP-I-102-19	Chemistry Lab-1	-	-	4	30	20	50	2
	BBA-GE 101	Managerial Economics-1	5	. 1	0	40	60	100	6
6.	UC-BSHL-105-19	Communicative English -I	2	-	-	20	30	50	2
7.	UC-BSHL- 106A/106B-19	Punjabi Compulsory- I/ Mudhli Punjabi-I	2	-	-	20	30	50	2
	L	Tot	al		<u> </u>			1	26

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

Note 1*: Physics (UC-BSHP-112-19 & UC-BSHP-113-19) and Chemistry (UC-BHCL I-101-19 & UC-BHSP-I-102-19) are compulsory for the Students with Non-Medical background.

Note 2**: Students without Non-medical background may opt Fundamentals of Computer and IT (UGCA-1902 & UGCA-1906) and Managerial Economics-I (BBA-GE-101).

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Scheme & Syllabus (B.Sc. Hons. Mathematics) Batch 2019 & Onwards

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S.No. **Course Code** Contact Hrs. 34 Hrs. **Course Title** Load Allocation Marks Distribution Total Cr Marks UC-BSHM-201-19 1. L T P Internal External Calculus-II 2. UC-BSHM-202-19 4 1 -40 Solid Geometry 60 100 3. UC-BSHM-203-19 4 4 1 -40 Programming Lab-II 60 100 4.* UC-BSHP-124-19 4 --4 Waves and Vibrations 30 20 50 2 3 1 -40 UC-BSHP-125-19 60 100 4 Physics Lab-II 2 4 UGCA-1909 30 20 Object Oriented 50 3 Programming using 1 -40 60 100 C++ 4 Object Oriented UGCA-1910 Programming using C++ Laboratory 4 60 40 100 5.** 2 UC-BHCL-113-19 Organic Chemistry 3 1 -40 60 100 4 UC-BHCP-119-19 Chemistry Lab-II 4 BBA-GE 201-18 30 20 50 Managerial 2 5 Economics-II 1 0 40 UC-BHHL-115-19 60 6. 100 6 Communicative 2 -English -II -20 30 7. 50 UC-BHHL-2 Punjabi Compulsory-116A/116B-19 II/ Mudhli Punjabi-II 2 --20 30 50 2 Total L:Lectures

SEMESTER SECOND

55

T: Tutorial P:Practical Cr: Credits

Note 1*: Physics (UC-BSHP-112-19 & UC-BSHP-113-19) and Chemistry (UC-BHCL-113-19 & UC-BHCP-119-19) are compulsory for the Students with Non-Medical background. Note 2**: Students without Non-medical background may opt Object Oriented Programming

using C++ (UGCA-1909 & UGCA-1910) and Managerial Economics-II (BBA-GE-201) Scheme & Syllabus (B.Sc. Hons. Mathematics) Batch 2019 & Onwards

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Scheme of the Program:

SEMESTER THIRD

Contact Hrs. 34 Hrs.

S.No.	Course Code	Course Title	A	Loa	d tion	Marks Di	stribution	Total Marks	Cr
		a the state of the	L	T	P	Internal	External		
1.	UC-BSHM-301-19	Calculus -III	4	1	-	40	60	100	4
2.	UC-BSHM-302-19	Real Analysis-I	4	1	-	40	60	100	4
3.	UC-BSHM-303-19	Algebra-I	-	-	4	40	60	100	4
4.	UC-BSHM-304-19	Programming Lab-III	-		4	30	20	50	2
5.*	UC-BSHP-214-19	Elements of Modern Physics	3	1	-	40	60	100	4
	UC-BSHP-215-19	Physics Lab-III	-	-	4	30	20	50	2
	UGCA1914	Programming in Python	3	1	-	40	60	100	4
	UGCA-1917	Programming in Python Laboratory		-	4	60	40	100	2
6.**	UC-BHCL-I-204-19	Physical Chemistry	3	1	-	40	60	100	4
6777	UC-BHCP-I-208-19	Chemistry Lab-III	-	-	4	30	20	50	2
	BBA-301-18	Organizational Behavior	5	1	0	40	60	100	6
		Tota	1			I			26

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

Note 1*: Physics (UC-BSHP-214-19 & UC-BSHP-215-19) and Chemistry (UC-BHCL I-204-19 & UC-BHSP-I-208-19) are compulsory for the Students with Non-Medical background.

Note 2**: Students without Non-medical background may opt Programming in Python(UGCA-1914 & UGCA-1917) and Organizational Behavior (BBA-GE-301-18).

Scheme & Syllabus (B.Sc. Hons. Mathematics) Batch 2019 & Onwards

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SEMESTER FOURTH

Contact Hrs. 34 Hrs.

-BSHM-401-19 -BSHM-402-19 -BSHM-403-19	Vector Calculus Ordinary Differential Equations	L 4 4	1	- P	Internal 40	External 60	100	4
-BSHM-401-19 -BSHM-402-19 BSHM-403-19	Vector Calculus Ordinary Differential Equations	4	1	-	40	60	100	4
-BSHM-402-19 BSHM-403-19	Ordinary Differential Equations	4	1					
BSHM-403-19		1		-	40	60	100	4
	Linear Algebra	4	1	-	40	60	100	4
BSHM-404-19	Probability and Statistics	4	1	-	40	60	100	4
3SHM-405-19	Programming Lab-IV	-	-	4	30	20	50	2
3SHM-406-19	Project Work.	6	-	-	40	60	100	6
SHM-407-19	Skill Enhancement Course (Audit)	2	-	-	-	-	-	-
VS-101A	Environmental	2		-	40	60	100	2
	SHM-404-19 SHM-405-19 SHM-406-19 SHM-407-19 S-101A	SHM-404-19 Probability and Statistics SHM-405-19 Programming Lab-IV SHM-406-19 Project Work SHM-407-19 SHM-407-19 Skill Enhancement Course (Audit) S-101A Environmental Studies Total	SSHM-404-19 Probability and Statistics 4 SHM-405-19 Programming Lab-IV - SHM-406-19 Project Work 6 SHM-407-19 Skill Enhancement Course (Audit) 2 'S-101A Environmental Studies 2 Total Total	SSHM-404-19 Probability and Statistics 4 1 SHM-405-19 Programming Lab-IV - - SHM-406-19 Project Work 6 - SHM-406-19 Skill Enhancement Course (Audit) 2 - SHM-407-19 Skill Enhancement Studies 2 - Total Environmental Studies 2 -	SSHMI-404-19 Probability and Statistics 4 1 - SHM-405-19 Programming Lab-IV - - 4 SHM-406-19 Project Work 6 - - SHM-406-19 Skill Enhancement Course (Audit) 2 - - SHM-407-19 Skill Enhancement Course (Audit) 2 - - 'S-101A Environmental Studies 2 - -	SSHMI-404-19 Probability and Statistics 4 1 - 40 SHM-405-19 Programming Lab-IV - - 4 30 SHM-406-19 Project Work 6 - - 40 SHM-406-19 Project Work 6 - - 40 SHM-406-19 Project Work 6 - - 40 SHM-407-19 Skill Enhancement Course (Audit) 2 - - - 'S-101A Environmental Studies 2 - - 40 -	SSHM-404-19 Probability and Statistics 4 1 - 40 60 SHM-405-19 Programming Lab-IV - - 4 30 20 SHM-406-19 Project Work 6 - - 40 60 SHM-407-19 Skill Enhancement Course (Audit) 2 - - - - 'S-101A Environmental Studies 2 - - 40 60	SSHM-404-19Probability and Statistics41-4060100SHM-405-19Programming Lab-IV4302050SHM-406-19Project Work64060100SHM-407-19Skill Enhancement Course (Audit)24060100S-101AEnvironmental Studies24060100

Cr: Credits

Scheme & Syllabus (B.Sc. Hons. Mathematics) Barch 2019 & Onwards

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Semester Fifth

Contact Hour: 28

20

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S. No	Course Code	Course Title		id ocatior	n	Marks D	istribution	Total Marks	Cr
			L	Т	Р	Internal	External		
1.	UC-BSHM-501-19	Real Analysis-II	4	1	-	40	60	100	4
2.	UC-BSHM-502-19	Algebra-II	4	1	-	40	60	100	4
3.	UC-BSHM-503-19	Numerical Methods	4	1	-	40	60	100	4
4.	UC-BSHM-504-19	Partial Differential Equations	4	1	-	40	60	100	4
5.	UC-BSHM-505-19	Project Work	-	-	8	60	40	100	4

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L: Lectures

T: Tutorials

P: Practical

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Semester Sixth

Contact Hours: 25

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S. No	Course Code	Course Title	Load Allocation			Marks Di	stribution	Total Marks	Cr
		Υ	L	Т	P	Internal	External		
1.	UC-BSHM-601-19	Number Theory	4	1	-	40	60	100	4
2.	UC-BSHM-602-19	Complex Analysis	4	1	-	40	60	100	4
3.	UC-BSHM-603-19	Mechanics	4	1	-	40	60	100	4
4.	UC-BSHM-604-19	Discrete Mathematics	4	1	-	40	60	100	4
5.	UC-BSHM-605-19	Integral Equations and Integral Transforms	4	1		40	60	100	4

L: Lectures

T: Tutorials

P: Practical

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Department of Mathematical Ociences LK Guital Punjab Technical Iniversity 144603 Pt . 1

B.Sc. (Hons.) Mathematics

Course Structure and Syllabus University Campus (Based on Choice Based Credit System) 2019 onwards

Scheme & Syllabus (B.Sc. Hons. Mathematics) Batch 2019 & Onwards

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SEMESTER-I

Scheme & Syllabus (B.Sc. Hons. Mathematics) Batch 2019 & Onwards

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Fileso Department of Mathematical Sciences

I.K. Gujral Punjab Technical University Kapurthein FM603 Pb. (India)

UC-BSHM- 101-19		(Calculus-I	L	-4, T-1, P-0	4 Credits					
Pre-requisit	te: El	ementary calcult	us of senior seco	ndary level.							
Course Objectives: The objectives of this course are to make the students understand the following: 1. The fundamental concepts of differential and integral calculus.											
 The geometrical meaning of functions, limits, continuity, derivatives, mean value theorems. Applications of derivatives and sketching of curves. The definition of Integral calculus and its basic applications. The relation between derivative and the integration of a function. 											
Course Outc	Course Outcomes: At the end of the course, the students will be able to										
CO1	Unde	erstand the basic	concepts of Dif	ferential and I	ntegral Calculu	IS.					
CO2	Visualize all concepts geometrically.										
CO3	Sket	ch curves of the	functions intuiti	vely with the l	elp of Differen	ntial Calculus.					
CO4	Appl	y the knowledge	e of Differential	and Integral C	alculus.						
CO5	Unde Ma	erstand the funda	amental relation	between differ	ential and Inte	gral Calculus.					
		PSO 1	PSO 2	PSO 3	PSO 4	PSO 5					
C01		3	3	2	2	3					
CO2		3	2	2	2	3					
CO3		3	2	2	2	3					
CO4		2	3	2	2	3					
CO5 3 2 2 2											

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Course Title: Calculus-I Course Code: UC-BSHM-101-19

UNIT-I

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, The precise definition of limit (ϵ - δ definition), continuity, limit at infinity, asymptotes, continuous functions and classification of discontinuities, uniform continuity.

UNIT-II

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, higher derivatives, preliminary transformations, differentiation of determinants.

UNIT-III

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

UNIT-IV

Higher order derivatives, calculation to the nth derivative, determination of nth derivative of rational functions. The nth derivative of the products of power of sines and cosines, Leibnitz's theorem, the nth 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.

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2	2	9
		20 A B

UC-BSHN 102-19	M-	Co-ord	inate Geometry	/]	L-4, T-1, P-0 4 Cred				
Pre-requisi	ite: A b	asic knowledge	of two-dimensi	ional Cartesia	n plane.				
Course Ob major focus rigorous dis	jective s of th cussion	es: This course is course will n on their proper	is designed to in be on geometri rties and use.	ntroduce the c definition	geometry of tw of two-dimensi	o dimensions. The onal shapes and a			
Course Ou	tcomes	: At the end of	the course, the s	tudents will b	e able to				
CO1	Expla	in the different	types of plane f	igures.					
CO2	Visua	lize two-dimen	sional shapes ge	ometrically.					
CO3	Apply mathe	y the knowledge ematics.	e of geometry of	two dimensi	ons in advance o	ourses in			
CO4	Expla shape	in the Cartesian s.	and Polar coord	dinate system	s to study two d	limensional			
CO5	Study	further the geo	metry of three d	imensions.					
	Map	oping of course	outcomes with	the program	Specific outco	omes`•			
		PSO 1	PSO 2	PSO 3	PSO 4	PSO 5			
C01		1	3	2	2	3			
CO2		1	3	2	2	3			
CO3		2	2	3					
CO4		3	3	2	2	3			
CO5 1 1 2 2									

Scheme & Syllabus (B.Sc. Hons. Mathematics) Batch 2019 & Onwards

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I Head

Course Title: Co-ordinate Geometry Course Code: UC-BSHM-102-19

UNIT-I

Joint equation of pair of straight lines and angle between them, condition of parallelism and perpendicularity, joint equation of the angle bisectors, joint equation of lines joining origin to the intersection of a line and a curve.

UNIT-II

General equation of circle, circle through intersection of two lines, tangent and normal, Chord of contact, pole and polar, pair of tangents from a point, equation of chord in midpoint form, angle of intersection and orthogonality, power of a point w.r.t. circle, radical axis, co-axial family of circles, limiting points.

UNIT-III

Parabola, ellipse and hyperbola, tangent and normal, chord of contact, pole and polar of tangent from a point, equation of chord in terms of midpoint, diameter, conjugate diameters of ellipse and hyperbola, conjugate hyperbola, asymptotes of hyperbola, rectangular hyperbola.

UNIT-IV

Transformation of axes in two dimensions: shifting of origin, rotation of axes, the second degree equation $S = ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$, its invariants t, Δ and O. Reduction of the second degree equation into standard form. Identification of curves represented by S=0 (including pair of lines).Polar equations of straight lines, circles and conics. Polar equation of chords, tangent and normal.

TEXT BOOKS

1. P. K. Jain, Khalid Ahmed, A Text book of Analytical Geometry of Two Dimensions, Wiley Eastern Ltd, 1999.

RECOMMENDED BOOKS:

2. S. L. Loney, The Elements of Coordinate Geometry, Macmillian & Comp., London, 2007

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Theater 2

5	2	
1	S	
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UC-BSHI 103-19	M -	Progra	amming Lab-I		L-0, T-0, P-2	2 Credits				
Pre-requisi matrices etc	i te: K	nowledge of basi	c concepts in Ma	athematics,	such as, graphs,	functions, conics,				
Course Ob programmin and conics. two-dimens	ng t s two two ional	ves: This course imple algebraic o dimensions. The shapes and a rigo	is designed to operations on ma major focus of orous discussion	introduce atrices and this course on their pro	the basic know to visualize the e will be on geo operties and use.	ledge of computer geometry of curves metric definition of				
Course Ou	tcom	es: At the end of	the course, the st	tudents will	l be able to	•				
CO1	Explain the basic concepts of programming.									
CO2	App	ly the knowledge	of programming	g in differe	nt Matrix Operat	ions.				
CO3	Use programming in plotting and visualization of graphs of algebraic and transcendental functions.									
CO4	Obt	ain Surface of rev	volution of curve	s.						
CO5	Stuc	ly further the trac	ing of conics.							
	Ma	apping of course	outcomes with	the progra	am Specific outc	omes				
		PSO 1	PSO 2	PSO 3	B PSO 4	PSO 5				
CO1		1	3	3	3	. 3				
CO2		1	3	3	3	3				
CO3		2	2	3	3	3				

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UC-BSHM-

CO4

CO5

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Course Title: Programming Lab-I Course Code: UC-BSHM-103-19

The following programs with following methods are to be practiced to:

- i) Introduce the programming through (FORTRAN, C etc.)
- 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. V. Rajaraman, Computer Programming in Fortran 90 and 95, PHI Learning, 2004.
- 2. Ian Chivers and Jane Sleightholme, Introduction to Programming with Fortran, Springer, 4th edition, 2018.
- 3. Walter S. Brainerd, Guide to Fortran 2008 Programming, Springer Nature, 2015.

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THERR

UC-1 11	BSHP 2-19	-	netism		L-3, T	its							
Pre-re	Pre-requisite: Basic knowledge of Electricity and Magnetism at high school level.												
Cours electri	e Objecity an	ectives: 7 d magnet	The obje ism so t	ctive of hat they	the cou can use	these a	s per the	e the stu eir requi	dents to rement.	the for	mal stru	cture of	
Course Outcomes: At the end of the course, the student will be able to													
CC	CO1 Understand and describe the different concepts of electromagnetism												
CO)2	To obta condition	in the ons.	electric	and ma	agnetic	fields f	òr simp	ole conf	iguratio	ns unde	er static	
CO	3	To analy	se time	varying	electric	and ma	gnetic fi	ields.					
CO	94	To under	rstand M	laxwell'	s equati	on in di	fferent f	forms an	d differ	ent med	ia.		
CO	95	have a so higher st	olid four udies.	ndation	in funda	amentals	s require	ed to sol	ve prob	lems and	d also to	pursue	
		Μ	apping	of cour	se outc	o mes w i	ith the p	orogran	n outcor	nes			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	
CO1	3	1	2	2	2	1	2	2	2	3	2	2	
CO2	3	2	1	-	2	2	1	2	2	3	2	3	
CO3	3	2	3	-	2	1	2	1	2	3	2	3	
CO4	3	2	3	2	-	2	2	3	2	3	3	3	
CO5	2	2	3	2	-	2	2	3	2	3	3	3	

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Course Title: Electricity and Magnetism

Course Code: UC-BSHP-112-19

UNIT-I

Review of Vector Analysis: Vector algebra, scalar and vector product; Concept of Fields; scalar and vector field; gradient, divergence and curl and their physical significance; Conservative field, Line, surface and volume integral of a vector field, Gauss-divergence theorem and Stoke's theorem.

UNIT II

Electrostatics: Electrostatic field; electric flux; Gauss's law in differential and integral form; Applications of Gauss law-Electric filed due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charge sheet; Electric potential as line integral of electric field, potential due to point charge and electric dipole; calculation of electric field from potential; Poisson's equation and Laplace's equation(Cartesian coordinate); Capacitance; capacitance of a spherical conductor and cylindrical capacitor, Energy per unit volume in electrostatic field, Dielectric medium, dielectric polarization and its types, Displacement vector, Boundary conditions.

UNIT-III

Magnetostatics: Magnetic flux; magnetic flux density; Faraday's law; magnetomotive force; Biot-Savart's law and its applications-straight conductor, circular coil, divergence and curl of magnetic field; Ampere's Circuital law in differential and integral form; Magnetic vector potential; ampere's force law; magnetic vector potential; Energy stored in a magnetic field, boundary conditions on magnetic fields.

UNIT-IV

Maxwell's Equations and Electromagnetic Waves: Equation of continuity for time varying fields; Inconsistency of ampere's law; concept of sinusoidal time variations (Phasor notation); Maxwell's equations in differential and integral form, physical significance; Maxwell equations in free space, static field and in Phasor notation; Difference between displacement current and conduction current; Wave equation in free space and in homogenous medium, Concept of Poynting vector; Poynting Theorem.

RECOMMENDED BOOKS:

1.David Griffiths, Introduction to Electrodynamics, Pearson Education India Learning Private Limited; 4thEdition.

2. E.C. Jordan and K.G. Balmain, Electromagnetic waves and radiating systems, Prentice Hall

3. Kraus John D, Electromagnetics, McGraw-Hill Publisher

4. W. Saslow, Electricity, magnetism and light, Academic Press

5.A Textbook of Electricity and Magnetism, S K Sharma, Shalini Sharma, S Dinesh & Co.

6. M. N. O. Sadiku, "Elements of Electromagnetics", Oxford University Publication, 2014.

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friend
UC-11	BSHP- 3-19	Physics Lab-I						L-0, T	-0, P-4		2 Cred	its
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.												
Cours	e Outco	mes: A	t the end	d of the	course,	the stud	ent will	be able	to			
CO1		Able to	o verify t	he theore	etical con	ncepts/la	ws learn	t in theor	y courses	5.		
CO2		Traine	d in carr	ying out	precise n	neasuren	nents and	d handlin	g sensitiv	ve equipir	ment.	
CO3		Under uncert	stand t ainties a	he met ind syste	hods u ematic "	sed for 'errors''.	estima	ating ar	id deali	ng wit	h expei	rimental
CO4		Learn	to draw o	conclusic	ons from	data and	develop	skills in	experim	ental des	ign.	
CO5		Docun	nent a tec e manner	chnical re	eport whi	ich comn	nunicate	s scientif	ic inform	ation in	a clear a	nd
Mapping of course outcomes with the program outcomes												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	1	2	1	2	3	2	3
CO2	3	3	1	-	2	2	1	1	1	3 .	2	3
CO3	3	3	2	-	2	1	2	1	1	3	2	3
CO4	3	2	2	2	-	2	2	1	1	3	2	3
CO5	2	2	2	2	-	2	2	1	1	3	2	3

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Course Title: Physics Lab-I

Course Code: UC-BSHP-113-19

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; wave length, 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 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).

RECOMMENDED BOOKS:

- 1. A Text -book of Practical Physics, I. Prakash & Ramakrishna, 11thEdn, 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

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UGCA-19	02 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						

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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.

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

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- 2. Computer Fundamentals, A. Goel, 2010, PearsonEducation.
- 3. Fundamentals of Computers, P. K.Sinha& P. Sinha, 2007, BPBPublishers.
- 4. IT Tools, R.K. Jain, Khanna PublishingHouse
- 5. "IntroductiontoInformationTechnology",SatishJain,AmbrishRai&Shashi Singh, Paperback Edition, BPB Publications,2014.
- 6. "Introduction to Computers", Peter Norton
- 7. Computers Today, D. H. Sanders, McGraw Hill.
- 8. "Computers", Larry long & Nancy long, Twelfth edition, PrenticeHall.
- ProblemSolvingCasesinMicrosoftExcel,JosephBrady&EllenFMonk,Tho mson Learning
- 10. www.sakshat.ac.in
- 11. https://swayam.gov.in/course/4067-computer-fundamentals

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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 pro	cessing, Spreadsheets	and Presentation).		
CO2	To acquire knowledge on editor, spread sheet and presentation software.				
CO3	D3 The students will be able to perform documentation and accounting operations.				
CO4	Students can learn how to perform present	ation skills.			

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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.

- 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.
- 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.

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Presentation Orientation:

- 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
- This session helps students in making their presentations interactive. Topicscoveredincludes: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, DesignTemplates, Hiddenslides. Autocontentwizard, 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/postonablogandtousetorrentsforaccelerateddownloads.
 - Hands on experience in online banking and Making an online payment for any domestic bill.

RECOMMENDED BOOKS:

- 1. IT Tools, R.K. Jain, Khanna Publishing House.
- 2. Introduction to Information Technology, ITL Education Solutions limited, Pearson Education.
- 3. Introduction to information technology, Turban, Rainer and Potter, John Wiley and Sons.
- 4. ProblemSolvingCasesinMicrosoftExcel,JosephBrady&EllenFMonk,Tho mson Learning.

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Course Title: Inorganic Chemistry Course Code: UC-BSHC-101-19

UNIT-I

Atomic Structure: Bohr's theory, 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 ψ_2 . Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of *s*, *p*, *d* and *f* orbitals. Contour boundary and probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.

UNIT-II

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, Solvation energy, Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids, Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment), Effects of chemical force, melting and boiling points, solubility energetics of dissolution process.

UNIT-III

Chemical Bonding-II: Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach), Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N₂, O₂, C₂, B₂, F₂, CO, NO, and their ions; HCl,BeF₂, CO₂, (idea of s-p mixing and orbital interaction to be given). Formal charge, Valenceshell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (σ and π bond approach) and bond lengths, Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization.Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ioniccharacter from dipole moment and electronegativity difference.

UNIT-IV

Chemistry of s and p Block Elements: Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group, Allotropy and catenation, Complex formation tendency of s and p block elements, Hydrides and their classification ionic, covalent and interstitial, Basic beryllium acetate and

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nitrate. Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses, Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, Phosphorus and chlorine, Peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens.

RECOMMENDED BOOKS:

- 1. Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
- 2. Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry 3rd Ed., John Wiley Sons, N.Y. 1994.
- 3. Greenwood, N.N. & Earnshaw. Chemistry of the Elements, Butterworth-Heinemann. 1997.
- 4. Cotton, F.A. & Wilkinson, G. Advanced Inorganic Chemistry, Wiley, VCH, 1999.
- 5. Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry 4th Ed., Pearson, 2010.
- 6. Shriver & Atkins, Inorganic Chemistry 5th Ed.

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Course Title: Chemistry Lab-I Course Code: UC-BSHC-102-19

List of Experiments:

(A) Titrimetric Analysis

(i) Calibration and use of apparatus

(ii) Preparation of solutions of different Molarity/Normality of titrants

(B) 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

(C) Oxidation-Reduction Titrimetry

(i) Estimation of Fe(II) and oxalic acid using standardized KMnO4 solution.

(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.

(iii) Estimation of Fe(II) with K₂Cr₂O₇ using internal (diphenylamine, anthranilicacid) and external indicator.

Reference text:

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.

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BBA-GE10 18	1- Managerial Economics I	L-5, T-1, P-0	6 Credits			
Pre-requisit	e: Understanding of basic knowledge of Ma	nagerial Economics				
Course Objectives: The primary objective of this course is to equip students with the necessary economic concepts, principles, theory and techniques and enhance their managerial decision making to address business problems in a globalized economic environment.						
Course Out	comes: After completion of the course, the st	udents shall be able to	:			
CO1	Understand the basic concepts of managerial economics and apply the economic way of thinking to individual decisions and business decisions.					
CO2	Measure price elasticity of demand, understand the determinants of elasticity and apply the concepts of price, cross and income elasticity of demand.					
CO3	Understand and estimate production function	and Law of Diminishin	g Marginal Utility.			
CO4	Understand and explain four basic market models of perfect competition, monopoly, monopolistic competition, and oligopoly, and how price and quantity are determined in each model.					
CO5	Understand the different costs of production and how they affect short and long run decisions.					

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Course Title: Managerial Economics I

Course Code: BBA-GE101-18

UNIT-I

Introduction to Managerial Economics: Managerial Economics: Meaning, Nature, Scope & Relationship with other disciplines, Role of managerial economics in decision Making, Opportunity Cost Principle, Production Possibility Curve, Incremental Concept, Scarcity Concept.

Demand and the Firm: Demand and its Determination: Demand function; Determinants of demand; Demand elasticity – Price, Income and cross elasticity. Use of elasticity for analyzing demand, Demand estimation, Demand forecasting, Demand forecasting of new product. **Indifference Curve Analysis:** Meaning, Assumptions, Properties, Consumer Equilibrium, Importance of Indifference Analysis, Limitations of Indifference Theory

UNIT-II

Production Function: Production function Meaning, Concept of productivity and technology, Short Run and long run production function Isoquants; Least cost combination of inputs, Producer's equilibrium; Return to scale; Estimation of production function. **Theory of Cost:** Cost Concepts and Determinants of cost, short run and long run cost

theory, Modern Theory of Cost, Relationship between cost and production function

UNIT-III

Revenue Curve: Concept of Revenue, Different Types of Revenues, concept and shapes of Total Revenue, Average revenue and marginal revenue, Relationship between Total Revenue, Average revenue and marginal revenue, Elasticity of Demand and Revenue relation

Market Structure: Market Structure: Meaning, Assumptions and Equilibrium of Perfect Competition, Monopoly, Monopolistic Competition, Oligopoly: Price and output determination under collusive oligopoly, Price and output determination under non-collusive oligopoly, Price leadership model.

UNIT-IV

Pricing: Pricing practices; Commodity Pricing: Economics of advertisement costs; Types of pricing practices

Factor Pricing: Demand and supply of factor of production; Collective bargaining, Concept of rent, profit, interest- Rate of return and interest rates; Real vs. Nominal interest rates. Basic capital theory–Interest rate and return on capital. Measurement of profit.

Note: Relevant Case Studies will be discussed in class.

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RECOMMENDED BOOKS:

- 1. K.K. Dewett, Modern Economic Theory, S. Chand Publication
- 2. D.M.Mithani, Managerial Economics Theory and Applications, Himalaya Publication
- 3. Peterson and Lewis, Managerial Economic, Prentice Hall of India
- 4. Gupta, Managerial Economics, TataMcGraw Hills
- 5. Geetika, Managerial Economics, Tata McGraw Hills
- 6. D.N.Dwivedi, Managerial Economic, Vikas Publications
- 7. Froeb, Managerial Economics, Cengage Learning
- 8. Koutsoyiannis, A, Modern Micro Economics, Palgrave Macmillan Publishers, New Delhi.
- 9. Thomas Christopher R., and Maurice S. Charles, Managerial Economics Concepts and Applications, 8th Edition,
- 10. Mehta, P. L, Managerial Economics Analysis, Problems and Cases, Sultan Chand & Sons, Delhi.
- 11. Peterson and Lewis, Managerial Economics, 4th Edition, Prentice Hall of India Pvt. Ltd., New Delhi.
- 12. Shapiro, Macro Economics, Galgotia Publications.

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Pre-requisite: Basic proficiency in Communication Skills												
Course	Obje	ectives: Tl	ne main	objecti	ve of th	is cours	e is:					
	•	To help	the stu	idents b	ecome	proficie	ent in L	SRW-L	istening	g, Speal	king, Ro	eading &
		Writing	g skills				1		frall	ah lana	1000	
	•	To help	the stu	dents b	ecome t	he inde	ion ski	l users c	or Eligit	heir ner	sonal s	ocial and
	•	10 dev	ional in	teractio	ns	munica	IOII SKI	ns, nice		nen per	Soman, S	o o nar arra
		To teac	them	the app	ropriate	e langua	ge of p	rofessio	nal com	munica	tion	
		To pre	pare the	m for jo	b mark	et	0 1					
				5								
Course	Out	comes: At	the end	d of the	course,	the stud	lent wil	11				
COI		acquire b	asic pro	ficiency	y in read	ding &l	istening	g, writin	g and sj	peaking	skills	
CO2	2	be able to	unders	stand sp	oken ar	d writte	en Engl	ish lang	uage, p	articular	ly the l	anguage
		of their c	hosen to	echnical	field.							
CO3	3	be able to	o conve	rse fluei	ntly.							
CO4	•	be able to	o produ	ce on th	eir own	clear a	nd cohe	erent tex	ts.			
CO	1	become p	oroficie	nt in pro	ofession	al com	nunicat	ion, suc	h as, in	terview	s, group)
		discussions, office environments, important reading skills as well as writing skills and										
		thereby w	vill hav	e better	job pro	spects.						
											•	
		Mappi	ng of co	ourse ou	itcome	s with t	he prog	gram S	pecific	outcom	es	
	PO	1 PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C01	1	-	-	1	1	2	2	3	2	3	2	2
CO2	1	-	-	1	1	2	2	3	2	3	2	2
CO3	1	-	-	1	1	2	2	3	2	3	2	2
CO4	1	-	-	1	1	2	2	3	2	3	2	2
CO5	2	-	-	1	1	2	2	3	2	3	2	2

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Course Title: Communicative English -I Course Code: UC-BSHL-105-19

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. Apparently With No Surprise: Emily Dickinson
- 3. Fool and Flea: Jeet Thayil

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

The following stories from the above volume are prescribed:

- a. The Kabuliwallah : Rabindranath Tagore
- b. The Eyes Are Not Here: Ruskin Bond
- c. Grief: Anton Chekov

UNIT-II

Vocabulary: Word Formation Processes; Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives; Synonyms, antonyms

Grammar: Subject-verb agreement; Noun-pronoun agreement; Misplaced modifiers; Articles

Determiners; Modals; Prepositions;

UNIT-III

Reading and Understanding: Close Reading; Comprehension;

UNIT-IV

Mechanics of Writing & Speaking Skills

Essay Writing (Descriptive/Narrative/Argumentative); Business letters; Précis Writing; Self

Introductions; Group Discussion Scheme & Syllabus (B.Sc. Hons. Mathematics) Batch 2019 & Onwards

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RECOMMENDED 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, Oxford University Press. 2011.
- 6. Communication Skills, Oxford University Press. 2011.
- 7. Liz Hamp-Lyons and Ben Heasly, Study Writing, Cambridge University Press. 2006.

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UC-BSHL-	र्थनाधीलानभी (Punjabi Compulsory)-I	L-2, T-0, P-0	2 Credits					
106A-19	(in the line (i unjubi compusory) i							
Pre-requisite: Understanding of senior secondary level Punjabi								
Course Obje	ctives: The objective of the course is:							
1.To enhance	the language ability of students.		`.					
2 To enhanc	e the ability of Learning science and deve	loping science lit	eracy through local					
language tea	whing with science subjects							
language teat	ming with selence subjects.							
Course Outo	comes. At the end of the course, the student wil	ll be able to						
Course Out	comes. At the end of the course, the statent wh							
CO1	Translate and transfer/broadcast the wester	n scientific know	vledge in the local					
001	language		C					
	language.							
CO2	Translate and transfer the indigenous/tradition	nal scientific knov	vledge available in					
	local knowledge into English and other global	languages.						
	With the life of the LD 1111	l'trustum and a						
CO3	Understand the society through Punjabi langua	ige, literature and c	culture					
CO4	Learning science and in developing science lite	eracy.						
CO5	Incompany the internel communication							
005	Improve the internal communication.							

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Course Title: ਪੰਜਾਬੀਲਾਜ਼ਮੀ (Punjabi Compulsory)-I Course Code: UC-BSHL-106A-19

UNIT-I

ਕਵਿਤਾਭਾਗ:		
ਭਾਈਵੀਰਸਿੰਘ:		
ਸਮਾਂ, ਚਸ਼ਮਾ		
ਪ੍ਰੋ.ਪੂਰਨਸਿੰਘ :		
ਪੰਜਾਬਨੂੰਕੂਕਾਂਮੈਂ, ਹੱਲਵਾਹੁਣਵਾਲੇ		
ਪ੍ਰੋ.ਮੋਹਨਸਿੰਘ :		
ਮਾਂ,ਕੋਈਆਇਆਸਾਡੇਵਿਹੜੇ,ਪਿਆਰਪੰਧ		
ਅੰਮ੍ਰਿਤਾਪ੍ਰੀਤਮ:		
ਆਖਾਂਵਾਰਿਸਸ਼ਾਹਨੂੰ,ਅੰਨਦਾਤਾ		
	UNIT-II	7
ਕਹਾਣੀਭਾਗ:ਸੰਤਸਿੰਘਸੇਖੋਂ :		
ਪੇਮੀਦੇਨਿਆਣੇ		
ਸੁਜਾਨਸਿੰਘ :		
ਕੁਲਫੀ		
ਕੁਲਵੰਤਸਿੰਘਵਿਰਕ :		
ਤੂੜੀਦੀਪੰਡ		
ਗੁਰਦਿਆਲਸਿੰਘ :		
ਸਾਂਝ		
	UNIT-III	

ਪੰਜਾਬੀਦੀਆਂਉਪ-

ਭਾਸ਼ਾਤੇਲਿਪੀ, ਗੁਰਮੁਖੀਲਿਪੀਦੀਆਂਵਿਸ਼ੇਸ਼ਤਾਵਾਂ, ਗੁਰਮੁਖੀਲਿਪੀ: ਨਿਕਾਸਤੇਵਿਕਾਸ।

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ਭਾਸ਼ਾਦਾਟਕਸਾਲੀਰੂਪ,

ਭਾਸ਼ਾਵਾਂ,ਪੰਜਾਬੀਭਾਸ਼ਾ:ਨਿਕਾਸਤੇਵਿਕਾਸ।

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ਭਾਸ਼ਾਤੇਉਪ-ਭਾਸ਼ਾਵਿਚਅੰਤਰ,

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UNIT-IV

ਸੰਖੇਪਰਚਨਾ (ਪ੍ਰੈਸੀ) ਪੈਰ੍ਹਾਰਚਨਾ

ਸਰਲਅੰਗਰੇਜ਼ੀਪੈਰ੍ਹੇਦਾਪੰਜਾਬੀਅਨੁਵਾਦ

RECOMMENDED BOOKS:

1.ਸੰਪ.ਡਾ.ਮਹਿਲ ਸਿੰਘ, ਸਾਹਿਤ ਦੇ ਰੰਗ, ਰਵੀ ਸਾਹਿਤ ਪ੍ਰਕਾਸ਼ਨ, ਅੰਮ੍ਰਿਤਸਰ,2016.

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	0.0	ITTODO	2 Credits						
UC-BSHL	- ਮੁਢਲੀ ਪੰਜਾਬੀ (Mudhli Punjabi)-I	L-2, 1-0, P-0	2 Creuits						
106B-19									
Pre-requisit	Pre-requisite: Understanding of senior secondary level Punjabi								
Course Obi	ectives: The objective of the course is to:								
1.enhance th	e language ability of students.								
2.enhance th	e ability of Learning science and developing so	cience literacy thro	ugh local language						
teaching with	h science subjects.								
			•						
Course Out	comes: At the end of the course, the student wil	ll be able to							
CO1	Translate and transfer/broadcast the wester	n scientific know	ledge in the local						
	language.								
CO2	Translate and transfer the indigenous/tradition	nal scientific know	ledge available in						
	local knowledge into English and other global	languages.							
		11 1	1						
CO3	Understand the society through Punjabi langua	age, literature and o	culture.						
CO4	Learning solonge and in developing solence lit	eracy							
04	Learning science and in developing science in	cracy.							
CO5	Improve the internal communication.								
	1								

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Course Title: (Mudhli Punjabi)-I Course Code: UC-BSHL-106B-19

UNIT-I

ਪੈਂਤੀ ਅੱਖਰੀ (ਵਰਣਮਾਲਾ), ਅੱਖਰ ਕ੍ਰਮ ਮਾਤਰਾਵਾਂ : ਮੁਢਲੀ ਜਾਣ-ਪਛਾਣ ਲਗਾਖਰ :ਬਿੰਦੀ, ਟਿੱਪੀ, ਅੱਧਕ

UNIT-II

ਪੰਜਾਬੀ ਸ਼ਬਦ ਬਣਤਰ: ਮੁਢਲੀ ਜਾਣ-ਪਛਾਣ ਮੂਲ ਸ਼ਬਦ , ਅਗੇਤਰ, ਪਿਛੇਤਰ ਸਮਾਨਾਰਥਕ ਸ਼ਬਦ, ਵਿਰੋਧਾਰਥਕ ਸ਼ਬਦ ਸ਼ੁੱਧ- ਅਸ਼ੁੱਧ: ਦਿੱਤੇ ਪੈਰ੍ਹੇ ਵਿੱਚੋਂ ਅਸ਼ੁੱਧ ਸ਼ਬਦ ਨੂੰ ਸ਼ੁੱਧ ਕਰਨਾ

UNIT-III

ਹਫਤੇ ਦੇ ਸੱਤ ਦਿਨਾਂ ਦੇ ਨਾਂ ਬਾਰ੍ਹਾਂ ਮਹੀਨਿਆਂ ਦੇ ਨਾਂ ਰੁੱਤਾਂ ਦੇ ਨਾਂ ਇਕ ਸੌ ਤੱਕ ਗਿਣਤੀ ਸ਼ਬਦਾਂ ਵਿਚ

UNIT-IV

ਸਧਾਰਣ ਸ਼ਬਦਾਂ ਦਾ ਅੰਗਰੇਜ਼ੀ ਤੋਂ ਪੰਜਾਬੀ ਅਨੁਵਾਦ

ਸਧਾਰਣ ਸ਼ਬਦਾਂ ਦਾ ਪੰਜਾਬੀ ਤੋਂ ਅੰਗਰੇਜ਼ੀ ਅਨੁਵਾਦ

ਸੰਖੇਪਰਚਨਾ (ਪ੍ਰੈਸੀ)

ਪੈਰ੍ਹਾਰਚਨਾ

ਸਰਲਅੰਗਰੇਜ਼ੀਪੈਰ੍ਹੇਦਾਪੰਜਾਬੀਅਨੁਵਾਦ

Text and Reference Books

1.ਸੁਖਵਿੰਦਰ ਸਿੰਘ ਸੰਘਾ, ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਵਿਗਿਆਨ, ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਅਕਾਦਮੀ ਜਲੰਧਰ

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SEMESTER-II

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UC-BSHM- 201-19		С	alculus-II		L-4, T-1, P-0	4 Credits	
Pre-requisi	te: Ca	lculus-I				L	
 Course Objectives: The objectives of this course are to make the students understand the following: 1. The applications of differential calculus for tracing curves. 2. The concept of Integration and its definition as limit of sum and area under curve. 3. The relation between derivative and the integration of a function. 							
 The Num length 	 The concept of improper integrals. The concept of improper integrals. Numerical techniques to find approximate integrals and applications of integration for length of arc, finding area and volume. 						
Course Outo	comes	: At the end of th	e course, the stu	idents will	be able to		
CO1	Unde	erstand the tech ilus.	niques to sketc	ch a curve	using the conce	epts of differential	
CO2	Visu	alize all concepts	s of differential	calculus ge	ometrically	•	
CO3	Unde	erstand the conce	pt of Integration	ı.			
CO4	Unde	erstand the funda	mental relation	between di	fferential and Inte	egral Calculus.	
CO5	Appl volu	y the knowledge me and area of su	of integral calc urface swept by	ulus in find curve durii	ling length of arc	, area under curves,	
	Ma	pping of course	outcomes with	the progra	am Specific outc	omes	
		PSO 1	PSO 2	PSO	3 PSO 4	PSO 5	
C01		3	3	2	2	3	
CO2		3	3	2	2	3	
CO3		3	3	2	2	3	
CO4		3	3	2	2	. 3	
C05		3	3	2	2	3	

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Chiedan Department of Mathematical Sciences I.K. Gujral Punjab Technical University Kapurthala-144603 Pb. (India)

Course Title: Calculus-II Course Code: UC-BSHM-201-19

UNIT-I

Concavity and Convexity, points of inflexion, derivative of arc, radius of curvature, centre of curvature, chord of curvature, evolutes and involutes.

UNIT-II

Asymptotes, working rules of determining Asymptotes, Asymptotes in polar co-ordinates, Cusps, curve tracing (Cartesian and polar), introduction to envelopes.

UNIT-III

Anti derivative of function of real variable, Riemann sums, definite integrals and their properties, Indefinite integral and net change, the fundamental theorem of calculus, Improper Integrals: Infinite Integrals, Discontinuous intervals, comparison test for improper integrals (Scope: James Stewart; Chapter-), reduction formulae.

UNIT-IV

Approximate Integration: Midpoint rule, Trapezoidal rule, Simpson's rule; applications of integrals to find length of arc and area between curves, finding volumes, area of surface of revolution.

TEXT BOOKS

1.James Stewart, Calculus, 5th Edition, Brooks/Cole(Thomson), 2003. 2. Maurice D Weir, Frank R. Giordano and Joel Hass, Thomas' Calculus, 11th Edition, Pearson, 2008. 3. Shanti Narayan and P. K. Mittal: Differential Calculus, S. Chand

REFERENCE BOOKS

4.George B. Thomas and Ross. L. Finney: Calculus and Analytic Geometry, 9th Edition, Addison Wesley, 1998.

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UC-BSHN 202-19	M- Solid Geometry L-4, T-1, P-0 4 Credits									
Pre-requisite: Two dimensional coordinate geometry.										
Course Obj major focus rigorous dise	jective of thi cussio	es: This course s course will be n on their prope s: At the end of	is designed to in e on geometric in rties and use.	troduce the nterpretation	geometry of thre n of three-dimens	ee dimensions. The sional shapes and a				
CO1	Line									
COI	rotati	ion of axes.	e-dimensional C	artesian co	ordinate system,	shift of origin and				
CO2	Demonstrate knowledge and understanding of three dimensional shapes and their properties.									
CO3	Visualize the three dimensional shapes, for example sphere, cylinder and cone etc.									
CO4	Utilize the knowledge of geometry of three dimensions in other branches of mathematics, for example calculus and analysis.									
Mapping of course outcomes with the program Specific outcomes .										
		PSO 1	PSO 2	PSO 3	PSO 4	PSO 5				
CO1		3	3	2	2	3				
CO2	3 3 3 2 3									
CO3		1	2	3	2	3				
CO4		1	3	3	3	3				

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Course Title: Solid Geometry Course Code: UC-BSHM-202-19

UNIT-I

Lines and planes in 3-dimension, change of axes, shift of origin, rotation of axes, sphere, and section of a sphere by a plane. Sphere through a given circle. Intersection of a line and sphere.

UNIT-II

Tangent and normal, tangent plane, angle of intersection of two spheres and condition of orthogonality, power of a point w.r.t. a sphere, Radical planes, radical axis, radical centre, coaxial family of spheres, limiting points.

UNIT-III

Cylinder, Cone, homogeneous equation of second degree in x, y, z, reciprocal cone, right circular and elliptic cones, surface of revolution, enveloping cones, right circular and elliptic cylinders. Hyperbolic cylinder.

UNIT-IV

Quadratic surfaces: Ellipsoid, hyperboloid, paraboloid, quadratic cone, tangent plane and normal.

REFERENCE BOOKS

1.P. K. Jain, Khalid Ahmad, Textbook of Analytical Geometry, 3rd Edition, New Age International Publishers, 2018.

2.Shanti Narayan, P.K. Mittal, Analytical Solid Geometry, 17th Revised Edition, S. Chand & Company, 2007.

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UC-BSHN 203-19	M- Computer Algebra System: MATLAB L-0, T-0, P-2 2 Credits									
Pre-requisi matrices etc	te: Kn	owledge of basi	c concepts in M	athematics	s such as graphs, f	unctions, conics,				
Course Obj	jective	es: This course is	s designed to int	roduce a C	Computer Algebra	System: MATLAB				
which is cu	rrently	y used in scient	ific computation	ns. The m	ain focus will be	on introduction to				
basic concepts of MATLAB using simple examples.										
0		A 1 . C	d d		11.1 . 1.1 .					
Course Out	come	s: At the end of	the course, the s	tudents wi	Il be able to					
CO1	Expl	ain the basic cor	cepts of program	nming						
CO2	Visu	Visualize functions in 2-D and 3-D								
CO3	Make their own computer programs for solving problems of their interest									
CO4	Use symbolic tools of MATLAB for solving problems arising in various fields of applications									
	Ma	pping of course	outcomes with	the progr	am Specific outc	omes				
		PSO 1	PSO 2	PSO	3 PSO 4	PSO 5				
CO1		2	3	3	3	· · 3				
CO2	CO2 1 3 3 3 3									
CO3	CO3 2 2 3 3 3									
CO4	4 3 3 2 2 3									

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Course Title: Computer Algebra System: MATLAB

Course Code: UC-BSHM-203-19

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.

Reference Books.

1.D. J. Highamand 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.

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UC- 12	-BSHF 24-19	HP- 9Waves and VibrationsL-4, T-0, P-04 Cred							its			
Pre-re	equisit	te: Under	standing	, of senie	or secon	dary lev	el Phys	ics and	Mathem	atics		
Cours Diffra applic and of scienc	se Obj ction a ations. ther re ces as a	ectives: 7 and Polar Students lated par career.	The objection vization s will be ameters,	ective of among e equipp , which	f the coustudents students bed with will act	arse is to s. The S a knowle a s a st	o develo Students edge to rong ba	p basic also le measure ckgrour	understa arn abou e wavele nd if he/	anding o ut the I ength, ro she cho	of Interf ASER efractive oses to	èrence, and its e index pursue
Cours	se Out	comes: A	t the en	d of the	course,	the stud	ent will	be able	to			
CC)1	Identify related v	and illu vave pho	strate pl enomena	nysical c a	oncepts	and terr	ninolog	y used in	n optics	and oth	er
CC)2	Analyze applicati	and und	derstand	the phe	nomeno	n of inte	erference	e, and di	ffractio	n and th	eir
CC)3	Get thor and trans	ough kr smissior	nowledg n and wi	e of the 11 learn	polariz to analy	ation of ze the po	`light a olarizati	nd its cl on in op	nanges u tical sys	upon ref stems.	flection
CC)4	Understa	and the s	simple h	armonic	motion	and its	applicat	tion.			
CC)5	Describe	e the dif	ferent ty	pes of la	asers, its	princip	le, prop	erties of	laser be	eam.	
		Μ	apping	of cour	se outco	omes wi	th the p	rogram	outcon	nes .		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C01	2	1 2 1 - 1 2 1 2 3 2 2								2		
CO2	2	2 1 2 1 1 1 1 1 3 1						1				
CO3	3	2 2 2 1 1 2 1 3		3	1	1						
CO4	2	2	2	2	1	1	2	1	1	3	1	1
CO5	2	2 2 2 1 1 2 1 1 3 1 1										

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2-65

Course Title: Waves and Vibrations Course Code: UC-BSHP-124-19

UNIT I

Interference:Electromagnetic nature of light, Definition and properties of wave front, Huygens Principle, Temporal and Spatial Coherence, Division of amplitude and wave front, Young's double slit experiment, Lloyd's single mirror and Fresnel's Biprism, Interference in Thin Films, Newton's Rings and Michelson Interferometer. (11 Lectures)

UNIT-II

Diffraction and Polarization: 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; 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.

(11 Lectures)

UNIT-III

Simple Harmonic Motion: Simple harmonic motion, Energy of a SHO, Simple, Compound and Torsional pendulum, Electrical Oscillations, damped oscillations, damped harmonic oscillator – heavy, critical, and light damping, Damping coefficients, energy decay in a damped harmonic oscillator, quality factor, forced mechanical oscillators, resonance. (12 Lectures)

UNIT-IV

Laser and Application: Lasers, Spontaneous emission, Stimulated absorption, Stimulated emission, Einstein coefficients, 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.

Lectures)

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 Text Book of Optics: Subrahmaniyam N. &et al.(S. Chand Publishing) (2006).
- 4. O. Svelto, "Principles of Lasers", Springer Science & Business Media, 2010.

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UC-B: 125-	SHP- -19	Physics Lab-II L-0, T-0, P-4), P-4	2 Credits			
Pre-requisites (if any): High-school education with Physics lab as one of the subject.												
Course Objectives: The aim and objective of the Physics Lab course is to introduce the students of B. Sc. (Hons.) Physics to the formal structure of wave and vibrations and mechanics so that they can use these as per their requirement. Course Outcomes: At the end of the course, the student will be												
C01		Able to u	understa	nd the th	eoretica	l concep	ts learne	d in the	theory co	ourse,		
CO2	60. se	Trained	in carryi	ng out p	recise m	easurem	ents and	handlin	g equipn	nent.		
CO3		Learn to	draw co	nclusion	is from c	lata and	develop	skills in	experim	ental des	sign.	
CO4		Able to understand the principles of error analysis and develop skills in experimental design.										
CO5		Able to a and conc	documen sise man	it a techr ner.	nical repo	ort whic	h commı	unicates	scientifi	c inform	ation in a	a clear
		N	Aapping	g of cour	rse outco	omes wi	th the p	rogram	outcom	es		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	1	2	1	2	3	2	3
CO2	3	3	1	-	2	2	1	1	1	3 .	2	3
CO3	3	3	2	-	2	1	2	1	1	3	2	3
CO4	3	2	2	2	-	2	2	1	1	3	2	3
CO5	2	2	2	2	-	2	2	1	1	3	2	3

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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. Measurement of volume using travelling microscope. Use of Plumb line and Spirit level.
- 2. To determine the frequency of an electrically maintained tuning fork in a) Transverse mode of vibration b) Longitudinal mode of vibration.
- 3. To find out the frequency of AC mains using sonometer.
- 4. To study the characteristic of Ge-Si junction diode.
- 5. To analyze the suitability of a given Zener diode as a power regulator.
- 6. To determine the horizontal and vertical distance between two points using a Sextant.
- 7. To determine the height of an inaccessible object using a Sextant.
- 8. To study the Motion of a Spring and calculate (a) Spring Constant (b) Value of g and (c) Modulus of rigidity.
- 9. To determine the time period of a simple pendulum for different length and acceleration due to gravity.
- 10. To study the variation of time period with distance between centre of suspension and centre of gravity for a compound pendulum and to determine: (i) Radius of gyration of the bar about an axis through its C.G. and perpendicular to its length. (ii) The value of g in the laboratory.
- 11. To find the moment of inertia of an irregular body about an axis through its C.G with the torsional pendulum.
- 12. To determine the angular acceleration α , torque τ , and Moment of Inertia of flywheel.

Reference book and suggested readings:

- 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, 11thEdn, 2011, Kitab Mahal.
- 4. Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
- 5. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.

6. Practical Physics, C L Arora, S. Chand & Company Ltd.

http://www.vlab.co.in

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UGCA-19	909 Object Oriented Programming using C++	L-3, T-1, P-0	4 Credits						
Pre-requis	site: NA								
Course Ou	atcomes: At the end of the course, the student wi	ill be able to							
CO1	To learn programming from real world examples.								
CO2	To understand Object oriented approach for finding Solutions to various problems with the help of C++ language.								
CO3	To create computer based solutions to various real-world problems using C++								
CO4	To learn various concepts of object oriented approach towards problem solving								

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Course Title: Object Oriented Programming using C++ **Course Code: UGCA-1909**

UNIT-I

Principles of object oriented programming

Introduction to OOP and its basic features, Basic components of a C++, Program and program structure, Compiling and Executing C++ Program. Difference between Procedure Oriented Language(C) and Object Oriented Language. (12)

UNIT-II

Classes & Objects and Concept of Constructors

Defining classes, Defining member functions, Declaration of objects to class, Access to member variables from objects, Different forms of member functions, Access specifiers (Private, public, protected), Array of objects. Introduction to constructors, Parameterized constructors, Copy Constructor, Multiple constructors in class, Dynamic initialization of objects, Destructors.

(10)

UNIT-III

Inheritance and Operator overloading

Introduction to Inheritance, Types of inheritance: - Single inheritance, Multiple inheritance, Hybrid inheritance, Hierarchical inheritance, Multilevel inheritance, Defining operator overloading, Overloading of Unary and Binary operators, Rules for overloading operators.

(10)

UNIT-IV

Polymorphism and File Handling

Early Binding, Late Binding, Virtual Functions, pure virtual functions, Abstract Classes. Opening and Closing File, Reading and Writing a file.

(10)

Text Books:

1. Object Oriented Programming with C++, E. Balagurusami, Fourth Edition, Tata Mc-Graw Hill. 2. Object Oriented Programming in Turbo C++, Robert Lafore, Fourth Edition Galgotia Publications.

3. The C++ Programming Language, Bjarna Stroustrup, Third Edition, Addison-Wesley Publishing Company.

4. Object Oriented Programming Using C++, Salaria, R. S, Fourth Edition, Khanna Book Publishing.

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UGCA-1910	Object Oriented Programming using	L-0, T-0, P-4	2 Credits					
	C++							
Pre-requisite (If any):NA								
CO1 To learn programming from real world examples.								
CO2	To understand Object oriented approach for finding Solutions to various problems with the help of C++ language.							
CO3	To create computer based solutions to vario	us real-world proble	ems using C++					
CO4	To learn various concepts of object oriented	approach towards j	problem solving					

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L Head Department of Mathematical Sciences I.K. Gujral Punjab Technical University Kapurthala-144603 Pb. (India)
Course Title: Object Oriented Programming using C++ Laboratory

Course Code: UGCA-1910

Instructions: Develop all program in C++

Assignments:

1. Write a program to enter mark of 6 different subjects and find out the total mark.(Using cin and cout statement)

2. Write a function using reference variables as arguments to swap the values of pair of integers.

3. Write a function to find largest of three numbers.

4. Write a program to find the factorial of a number.

5. Define a class to represent a bank account which includes the following members as Data members: a) Name of the depositor b) Account Number c) Withdrawal amount d) Balance amount in the account

Member Functions:

a) To assign initial values b)To deposit an amount c) To withdraw an amount after checking the balance d) To display name and balance.

6. Write the above program for handling n number of account holders using array of objects.

7. Write a C++ program to compute area of right angle triangle, equilateral triangle, isosceles triangle using function overloading concept.

8. Consider a publishing company that markets both book and audio cassette version to its works. Create a class Publication that stores the title (a string) and price (type float) of a publication. Derive the following two classes from the above Publication class: Book which adds a page count (int) and Tape which adds a playing time in minutes(float). Each class should have get_data() function to get its data from the user at the keyboard. Write the main() function to test the Book and Tape classes by creating instances of them asking the user to fill in data with get_data() and thenndisplaying it using put data().

9. Consider an example of declaring the examination result. Design three classes student, exam and result. The student has data members such as rollno, name. Create the lass exam by inheriting the student class. The exam class adds data members representing the marks scored in 5 subjects. Derive the result from exam-class and it has own data members like total, avg.

10. Write a program for overloading of Unary ++ operator.

11. Write a program for overloading of Binary + operator.

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12. Write a program of Virtual Functions.

13. Write a program of Abstract Classes.

14. Write a program to read and write from file.

Reference Books:

1. Object Oriented Programming with C++, E. Balagurusami, Fourth Edition, Tata Mc-Graw Hill.

2. Object Oriented Programming in Turbo C++, Robert Lafore, Fourth Edition Galgotia Publications.

3. The C++ Programming Language, Bjarna Stroustrup, Third Edition, Addison- Wesley Publishing Company.

4. Object Oriented Programming Using C++, Salaria, R. S, Fourth Edition, Khanna Book Publishing.

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UC-BHCL- 113-19	L- Introduction to Organic Chemistry L-3, T-1, P-0 4 Credits											
Pre-requisite:	Pre-requisite: Knowledge of basic concepts in Mathematics, such as graphs, functions, conics, matrices etc.											
Course Object	ives:											
 To teach the basic principles, reaction mechanisms and stereochemistry of organic compounds. To impart knowledge regarding physical properties and chemical reactions of alkanes, alkenes, dienes, alkynes, arenes, alkyl and aryl halides etc. To predict and account for the most commonly encountered reaction mechanisms (substitution, addition and elimination) in organic chemistry. To teach the basic principles, reaction mechanisms and stereochemistry of organic compounds. To impart knowledge regarding physical properties and chemical reactions of alkanes, alkenes, dienes, alkynes, arenes, alkyl and aryl halides etc. To impart knowledge regarding physical properties and chemical reactions of alkanes, alkenes, dienes, alkynes, arenes, alkyl and aryl halides etc. To predict and account for the most commonly encountered reaction 												
Course Outco	mes: At the end of the course, the students wi	rganic chemistry										
CO1 U ar	nderstand the fundamental concepts of organd various effects in organic compounds.	anic chemistry i.e	structure, bonding									
CO2 To	o learn the stereochemistry viz. optical onformational isomerism of organic compound	l isomerism, ste ds.	reoisomerism and									
CO3 To	o study the various known reactive intermedia	ate in organic synth	nesis									
CO4 To th el	b learn the fundamental and advanced concep e study of reaction mechanisms in various imination reactions.	ts of reaction mec s types of substit	hanisms along with ution addition and									
CO5 To	p predict the relationships between organic ch	emical structures a	and their reactivity.									
	Mapping of course outcomes with the p	orogram outcomes	8									

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	-	2	-	3	1	-
CO2	2	-	3	-	3	3	-
CO3	3	3	4	-	3	3	-
CO4	3	4	3	4	4	5	4
CO5	2	3	4	2	4	4	4

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Course Title: Introduction to Organic Chemistry

Course Code: UC-BHCL-113-19

Unit-I

Basics of Organic Chemistry Organic Compounds:

Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyper conjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophilcity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes. (11)

Unit-II

Introduction to types of organic reactions: -

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

Unit-III

Chemistry of Aliphatic Hydrocarbons

A. Carbon-Carbon sigma bonds Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

B. **Carbon-Carbon** π - **bonds:** 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), syn and anti-hydroxylation (oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction.

(12)

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Unit-IV

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. Directing effects of the groups.

(10)

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REFERENCE BOOKS:

1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)

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

4. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994

5. Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005.

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UC-BHC 119-19	CP-Introduction to Organic ChemistryL-0, T-0, P-42 CreditsLab									
Pre-requisite: Knowledge of basic concepts in Mathematics, such as, graphs, functions, conics, matrices etc.										
Course Ob	ojectives:									
The objective of this course is to provide practical knowledge and illustrative experiments regarding qualitative analysis, isolation, and purification of organic compounds										
Course Ou	itcomes: At	the end of the	ne course, th	e students w	vill be able to	C				
CO1	To check to points.	To check the purity of organic compounds by determining the melting or boiling points.								
CO2	To develo crystalliza	To develop preparative skills for purification of organic compounds by crystallization method.								
CO3	To determ qualitative	ine the element analysis.	ent or function	onal groups p	present in org	ganic com	pound by organic			
CO4	To present procedures	their work v s.	with practica	l skills and th	ne awareness	ofhealth	and safety			
CO5	To apply r	elated expen	riments for t	heir research	n work.					
	Mapping	of course of	outcomes wi	ith the prog	ram Specifi	ic outcom	es			
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7			
CO1	2	-	2	-	3	1	-			
CO2	2 - 3 - 3 -									
CO3	3 3 4 - 3 3 -					-				
CO4	3	4	3	4	4	5	4			
CO5	2	3	4	2	4	4	4			

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Course Title: Introduction to Organic Chemistry Lab Course Code: UC-BHCP-119-19

Unit-I

Determination of melting point

Napthalene 80-82°, Benzoic acid 121.5-122°, Urea 132.5-133°, Succinic acid 184.5-185°, Cinnamic acid 132.5-133°, Salicylic acid 157.5-158°, Acetanilide 113.5-114°, m-Dinitrobenzene 90°, p-Dichlorobenzene 52°, Aspirin 135°

Determination of boiling point

Ethanol 78°, Cyclohexane 81.4°, Toluene 110.6°, Benzene 80°

Unit-II

Distillation

Simple distillation of ethanol-water mixture using water condenser Distillation of nitrobenzene and aniline using air condenser **Crystallization** Concept of induction of crystallization Phthalic acid from hot water (using fluted filter paper and stemless funnel) Acetanilide from boiling water Napthalene from ethanol Benzoic acid from water

Unit-III

Qualitative Analysis Elemental analysis nitrogen, sulphur, chlorine, bromine, iodine Functional groups -phenols, carboxylic acids

Unit-IV

-carbonyl compounds - ketones, aldehydes
-carbohydrates
-aromatic amines
-amides, ureas and anilides
-aromatic hydrocarbons and their halo- derivatives

Reference Books

1.Brian S. Furniss, Antony J. Hannaford, Peter W.G. Smith and Austin R. Tatchell, Vogel's Textbook of Practical Organic Chemistry, 5th Edition, Longman, London.

2. F.G. Mann and B. C. Saunders, Practical Organic Chemistry, Springer

3. J.T. Sharp, Practical Organic Chemistry: A student handbook of techniques.

4. Philippa B. Cranwell, Laurence M. Harwood and Cristopher J. Moody, Experimental Organic Chemistry, 3rd Edition, Wiley.

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BBA-GE 2 18	01-	Manageri	al Economi	L-5, T-1,	P-0	6 Credits					
Pre-requisite: Understanding of basic knowledge of Managerial Economics											
Course Ob measuremen understandi	ourse Objectives: This course aims to acquaint students with economy as a whole including leasurement of national income, inflation and unemployment, which an objective to inculcate nderstanding of macroeconomic environment of an economy for better decision making.										
Course Ou	tcomes:	After completi	on of the co	urse, the stud	dents shall be	able to:					
C01	Explai approa	Explain the concept of national income and its measurement using different approaches.									
CO2	Descr	ibe the underlyi	ng theories	of demand a	nd supply of r	noney in ai	n economy.				
CO3	Make descri	use of employ be and analyze	ment and the econom	national inco y in quantitat	ome statistics tive terms.	students	will be able to				
CO4	Interp	ret macroecono	mic issues l	ike money, i	nflation and u	nemploym	ent.				
C05	Identi fluctu	fy the phases ations in the ma	of the bus rket econon	iness cycle ny	and the prol	olems caus	sed by cyclical				
	Map	ping of course	outcomes v	with the prog	gram o Speci	fic utcome	S				
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7				
CO1	2	2	2	3	2	2	-				
CO2	3	3 2 2 3 3 2 3									
CO3	2	3	3	2	2	3	3				
CO4	2	2	3	3	3	2	3				
CO5	2	1	1	3	1	1	3				

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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.

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UC-BHH 115-19	L-	Communica	tive English	-II	L-2, T-0, P-0	2 C	redits			
Pre-requisi	te: Basic pr	oficiency in (Communicatio	on Skills						
Course Ob	jectives: Th	e main objec	tive of this co	urse is:		2.4				
	 To help the students become proficient in LSRW-Listening, Speaking, Reading & Writing skills 									
	• To help	the students	become the ir	ndependent	users of English	language				
	• To develop in them vital communication skills, integral to their personal, social and professional interactions									
	• To teacl	n them the ap	propriate lang	guage of pi	ofessional commu	unication				
	• To prep	are them for	job market							
Course Ou	tcomes: At	the end of the	e course, the s	student wil	1					
C01	acquire ba	sic proficien	cy in reading	&listening	, writing and spea	king skills	L			
CO2	be able to	understand s	poken and wr	itten Engli	sh language, parti	cularly the	language			
	of their ch	osen technica	al field.							
CO3	be able to	converse flue	ently.							
CO4	be able to	produce on t	heir own clea	r and cohe	rent texts.					
CO5	become pr discussion thereby w	oficient in profice environment office environment ill have bette	rofessional co ironments, im r job prospect	mmunicat portant rea s.	ion, such as, interv ading skills as wel	views, gro l as writin	up g skills and			
	Mappin	g of course o	outcomes wit	h the prog	ram Specific out	comes				
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7			
CO1	2	2	2	3	2	2	2			
CO2	3	2	2	3	2	3	3			
CO3	2	3	3	2	2	3	3			
CO4	2	2	3	3	3	2	3			
CO5	2	1	1	3	1	1	3			

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Course Title: Communicative English-II Course Code: BHHL115-19

UNIT-I

(Literature)

(C) The Poetic Palette (Orient BlackSwan, Second Edition, 2016) The following poems from this anthology are prescribed: The Soul's Prayer: Sarojini Naidu I Sit and Look Out: Walt Whitman Women's Rights: Annie Louise Walker

(D) Prose Parables (Orient Black Swan, 2013)

The following stories from the above volume are prescribed:

- a. The Doctor's Word: R.K. Narayan
- b. The Doll's House: Katherine Mansfield
- c. Dusk: H.H. Munroe (Saki)

UNIT-II

Vocabulary:

Standard abbreviations; One word substitution; Word Pairs (Homophones/Homonyms) Grammar: Sentence Structures; Use of phrases and clauses in sentences; Transformation of Sentences; Importance of proper punctuation

UNIT-III

Reading and Understanding:

Summary Paraphrasing; Analysis and Interpretation; Translation (from Hindi/Punjabi to English and vice-versa)

Close Reading; Comprehension;

UNIT-IV

Mechanics of Writing & Speaking Skills:

Report writing; Career Documents- Job applications, Resume/CV writing, Common Everyday Situations: Conversations & Dialogues, Formal Presentations

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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.

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		Constanting Constant								
UC-BHHL-1	116A	PUNJA	BI COMPU	LSORY-II	L:2, T:0, P:0	Credits:2				
		C	ਪੰਜਾਬੀ ਲਾਜ਼)	-fl-II)						
Pre-requisite	: Z	ਪੰਜਾਬੀਲਾਜ਼ਮੀ (Punjabi Compulsory)-I								
Course Obje	ctives	1. To enhance the language ability of students.								
		2. T	To enhance t	he ability of	Learning science and d	eveloping science				
literacy through local language teaching with science subjects.										
Course Outcomes: At the end of the course, the student will be able to										
C01.	Transla	te and the	ransfer/broac	lcast the west	ern scientific knowledg	e in the local				
	langua	ge.			1 1	1.1				
CO2.	Transla	ite and t	transfer the	ndigenous/tra	aditional scientific know	wiedge available				
	in local	knowle	dge into Eng	glish and othe	r global languages.					
CO3.	Underst	tand the	society thro	ugh Punjabi I	anguage, literature and	culture.				
CO4.	Learnin	ng scienc	ce and in dev	eloping scier	ice literacy.					
CO5.	Improv	e the int	ternal comm	inication.						
	Mappin	g of co	urse outcom	es with the p	rogram Specific outco	mes				
	11	0		•	0					
	PS	01	PSO2	PSO3	PSO4	PSO5				
CO1	3	3	2	2	2	2				
CO2	2	2	2	2	2	2				
CO3	2	2 2 2 2 2 2								
CO4	2	2	2	2	2	3				
CO5	2	2	3	2	2	2				

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Course Title: PUNJABI COMPULSORY-II (ਪੰਜਾਬੀ ਲਾਜ਼ਮੀ-II) Course Code: BHHL116A-19

UNIT-I ਡਾ.ਹਰਿਭਜਨ ਸਿੰਘ: ਅਪ੍ਰਮਾਣਿਕ, ਤੇਰੇ ਹਜ਼ੁਰ ਮੇਰੀ ਹਾਜ਼ਰੀ ਦੀ ਦਾਸਤਾਨ ਸ਼ਿਵ ਕਮਾਰ ਬਟਾਲਵੀ: ਕੰਡਿਆਲੀ ਥੋਰ੍ਹ, ਧਰਮੀ ਬਾਬਲ ਪਾਪ ਕਮਾਇਆ, ਰੁੱਖ ਪਾਸ: ਇਨਕਾਰ,ਸਭ ਤੋਂ ਖਤਰਨਾਕ,ਦਹਿਕਦੇ ਅੰਗਿਆਰਾਂ 'ਤੇ ਸੁਰਜੀਤ ਪਾਤਰ: ਹਣ ਘਰਾਂ ਨੂੰ ਪਰਤਣਾ, ਕੁਝ ਕਿਹਾ ਤਾਂ..., ਪਲ (8) **UNIT-II** ਕਹਾਣੀ ਭਾਗ: ਸੰਤੋਖ ਸਿੰਘ ਧੀਰ: ਕੋਈ ਇਕ ਸਵਾਰ ਪ੍ਰੇਮ ਪ੍ਰਕਾਸ਼: ਲੱਛਮੀ ਮੋਹਨ ਭੰਡਾਰੀ : ਘੋਟਣਾ ਵਰਿਆਮ ਸਿੰਘ ਸੰਧੁ : ਆਪਣਾ ਆਪਣਾ ਹਿੱਸਾ (8) **UNIT-III** ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਦੀਆਂ ਵਿਸ਼ੇਸ਼ਤਾਵਾਂ ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਉਪਰ ਪਏ ਪ੍ਰਭਾਵ (6) UNIT-IV ਰਿਪੋਰਟਿੰਗ, ਸਮਾਚਾਰ ਲਿਖਣ ਦੀ ਵਿਧੀ ਤੇ ਤੱਤ ਪੰਜਾਬੀ ਪੈਰ੍ਹੇ ਦਾ ਸਰਲ ਅੰਗਰੇਜ਼ੀ ਅਨੁਵਾਦ ਦਫਤਰੀ ਚਿੱਨੀ ਪੱਤਰ

Reference Books

ਸੰਪ.ਡਾ.ਮਹਿਲ ਸਿੰਘ, ਸਾਹਿਤ ਦੇ ਰੰਗ, ਰਵੀ ਸਾਹਿਤ ਪ੍ਰਕਾਸ਼ਨ, ਅੰਮ੍ਰਿਤਸਰ, 2016.

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UC-BHHL-1	16B	MUDH	ILI PUNJA	BI-II (ਮੁਢਲੀ	L:2, T:0, P	: :0	Credits:2				
			ਪੰਜਾਬੀ-।	I)			•				
Pre-requisite	:	ਮੁਢਲੀ ਪੰਜਾਬੀ (Mudhli Punjabi)-I									
Course Obje	ctives	1. To enhance the language ability of students.									
		2. To enhance the ability of Learning science and developing science									
			literacy thro	ough local langu	lage teaching wit	th scienc	e subjects.				
Course Outcomes: At the end of the course, the student will be able to											
CO1.	Translate and transfer/broadcast the western scientific knowledge in the local										
	langu	iguage.									
CO2 .	Trans	inslate and transfer the indigenous/traditional scientific knowledge available									
	in loc	in local knowledge into English and other global languages.									
CO3.	Unde	rstand the	e society thi	rough Punjabi l	anguage, literatu	re and cu	ulture.				
CO4.	Learn	ing scien	ce and in d	eveloping scien	ce literacy.						
CO5.	Impro	ove the in	ternal comi	nunication.							
	PSOI	l	PSO2	PSO3	PSO4	PS	05				
CO1	3		2	2	2	2	`.				
CO2	2		2	2	2	2					
CO3	2	2 2 2 2									
CO4	2		2	2	2	3					
CO5	2		3	2	2	2					

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Course Title: MUDHLI PUNJABI-II (ਮੁਢਲੀ ਪੰਜਾਬੀ-II) **Course Code: BHHL116B-19** UNIT-I ਸ਼ਬਦ ਸ਼੍ਰੇਣੀਆਂ : ਪਛਾਣ ਤੇ ਵਰਤੋਂ-ਨਾਂਵ, ਪੜਨਾਂਵ ਵਿਸ਼ੇਸ਼ਣ, ਕਿਰਿਆ ਕਿਰਿਆ ਵਿਸ਼ੇਸ਼ਣ (8) **UNIT-II** ਰੋਜ਼ਾਨਾ ਵਰਤੋਂ ਦੀ ਪੰਜਾਬੀ ਸ਼ਬਦਾਵਲੀ: ਬਾਜ਼ਾਰ, ਵਪਾਰ, ਰਿਸ਼ਤੇ-ਨਾਤੇ ਤੇ ਕਿੱਤਿਆਂ ਸਬੰਧੀ। (8)UNIT-III ਪੰਜਾਬੀ ਵਾਕ ਬਣਤਰ : ਸਧਾਰਣ ਵਾਕ ਸੰਯੁਕਤ ਵਾਕ ਮਿਸ਼ਰਤ ਵਾਕ (8)**UNIT-IV** ਸਧਾਰਣ ਵਾਕਾਂ ਦਾ ਅੰਗਰੇਜ਼ੀ ਤੋਂ ਪੰਜਾਬੀ ਅਨੁਵਾਦ ਸਧਾਰਣ ਵਾਕਾਂ ਦਾ ਪੰਜਾਬੀ ਤੋਂ ਅੰਗਰੇਜ਼ੀ ਅਨੁਵਾਦ (8) **Reference Books** 1.ਸੁਖਵਿੰਦਰ ਸਿੰਘ ਸੰਘਾ, ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਵਿਗਿਆਨ, ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਅਕਾਦਮੀ ਜਲੰਧਰ

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SEMESTER-III

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UC-BSHM	-301-19		Calculus-III		L-4, T-1, P-0	4 Credits					
Pre-requisit	Pre-requisite: - Calculus of one variable										
Course Objectives: The objectives of the course are to introduce the functions of several											
variable, the continuity, derivatives and integrals of the functions of several variables and their											
geometrical	geometrical interpretations. One of the objectives is to introduce the applicability of the calculus										
of several va	ariables to	the students			1 11 /						
Course Out	comes: A	t the end of t	the course, the stud	lents will	be able to						
C01	Underste	nd the funct	ions of several vari	ables an	d their behavior						
<u>CO1</u>	Find the	na the function	atives understand	its geom	etrical meaning a	nd understand their					
02	relation v	with total der	vivative	its geom	ethear meaning a	na unacristana then					
CO3	Find the	maxima and	minima of functio	n of seve	eral variables and	their expansion.					
CO4	Understa	nd the integr	als of the function	s of seve	ral variables and	their geometrical					
001	interpreta	interpretation									
CO5	Applicat	ions of the ca	alculus of several v	variables	in the real world.						
	Mannii	ng of course	outcomes with th	e nrogrs	am Specific outc	omes					
	mappn	ig of course	outcomes with th	e progre	im specific dute						
		PSO 1	PSO 2	PSO :	3 PSO 4	PSO 5					
CO1		3	3	-	-	3					
CO2		3	3	-	-	3					
C03		2	2			3					
03											
CO4		3	3	-	-	3					
C05	5 1 3 - 3										

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Course Title: Calculus-III

Course Code: UC-BSHM-301-19

UNIT-I

Real valued functions of several variables with emphasis on functions of two and three variables, Limits and continuity, Partial derivatives, Homogenous Functions, Euler's Theorem

UNIT-II

Total differentiation, Differentiation of composite functions, Implicit functions, Chain Rule, Jacobians, Directional Derivatives, Gradient Vectors, Tangent Planes.

UNIT-III

Saddle Points, Maxima and Minima of functions of two variables, Lagrange's multiplier method, Higher dimensional analogues of Lagrange's Mean value Theorem and Taylor's theorem for functions of two variables.

UNIT-IV

Double integration over rectangular and non-rectangular regions, change of order of integration, double integration in polar co-ordinates, triple integration over parallelepiped and other solid regions, Applications of double and triple integrals to area, volume, centre of gravity, moment of inertia etc.

RECOMMENDED BOOKS:

1. G. B. Thomas and R. L. Finney, Calculus and Analytic Geometry, 9th Edition, Addison Wesley, 1998. (Scope as in Ch.11-13)

2. Shanti Narayan and P.K. Mittal, Differential Calculus, S. Chand & Co.

3. Shanti Narayan and P.K. Mittal, Integral Calculus, S. Chand & Co.

4. T. M. Apostol, Mathematical Analysis, 2nd Edition, Narosa Publishing House, Reprint 2002.

5. J. Stewart, Multivariable Calculus, Concepts and Contexts, 2nd Ed., Brooks /Cole, Thomson Learning, USA, 2001.

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UC-BSHM	[-302-19		Algebra-I		L-4, T-1, P-0	4 Credits					
Pre-requisite: - Complex numbers, Sets, Relation and Functions											
~ ~ ~											
Course Ob	Course Objectives: This course is designed to introduce the basic notions of algebra. The major										
tocus of the course will be on: De Moivre's theorem & its applications, matrices and their use in											
system of ed	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 sol	ving probl	ems concerning	powers of complex					
	numbers	s and complex	k roots of polyno	mials etc.							
CO2	Use mat	rices in solvi	ng system of equ	ations.							
CO3	Demons	strate linear in	dependence and	dependenc	e of a set of vect	ors.					
CO4	Find inv	verse of a mat	rix using Gauss-	Jordan met	hod.						
CO5	Demonstrate the nature of solutions of polynomial equations.										
CO6	Use Cardano's method, Ferrari method and Descarte's method for finding solutions										
	ofequat	ions.									
	Manni	ng of course	outcomes with	the progra	m Specific oute	omos					
	Mappi	ing of course	outcomes with	the progra	in specific oute	omes					
		PSO 1	PSO 2	PSO 3	B PSO 4	PSO 5					
CO1		2	3	-	-	1					
CO2		2	3	-	-	1					
CO3		3	3		-	·. 1					
CO4		2	3	-	-	1					
CO5		3	3	-	-	1					
CO6		3	3	-	-	1					

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Course Title: Algebra-I Course Code: UC-BSHM-302-19

UNIT-I

Polar representation of complex numbers, nth roots of unity, De Moivre's theorem for rational indices and its applications. Linear independence and dependence of row and column vectors, elementary operations on matrices, inverse of a matrix using Gauss-Jordan method, echelon form, row rank and column rank of a matrix and their equivalence,

UNIT-II

System of linear equations (homogeneous and non-homogeneous), conditions for consistency, Polynomials, zeros of a polynomial, division algorithm, greatest common divisor, repeated roots, equal roots, fundamental theorem of algebra.

UNIT-III

Relationship between roots and the coefficients, 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-IV

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

RECOMMENDED BOOKS

1. T. Andreescu and D. Andrica, Complex Numbers from A to Z, Springer Nature, 2016

2. Shanti Narayan and P.K. Mittal, A Textbook of Matrices, S. Chand & Company, 2010.

3.S. Lipschutz and M. L. Lipson, Schaum's Outline of Linear Algebra, McGraw Hill Education, 3rd Edition, 2017.

4.A Kurosh, Higher Algebra, Moscow Mir Publisher, 1972.

5.H. W. Turnbull, Theory of Equations, Palala Press, 2018.

6.W. S. Burnside and A. W. Panton, The Theory of Equations, Vol-1, Dublin University Press, 1954.

7. Chandrika Prasad, Text Book on Algebra and Theory of Equations, Pothishala Pvt. Ltd., 2017.

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UC-BSHM 19	-303- Re	al Analysis-I	nalysis-I L-4, T-1, P-0								
Pre-requisite: Students must have the knowledge of number system, limit.											
Course Objectives: The objective of the course on Real Analysis-I is to equip the B.Sc. (Hons) students with the real line, its properties. The various concepts of sequence, infinite series. Furthermore, students will be introduced to various tests to discuss the convergence, divergence of sequences and infinite series.											
<u>C01</u>	Learn t	he basic concepts of I	Real line and its pro	perties.							
CO2	Unders	tand about bounded, i	unbounded and limi	t suprema and infi	na.						
CO3	Use of	Monotone Converger	nce theorem for the	calculation of squa	re roots.						
CO4	Be acqu	Be acquainted with knowledge of convergent and divergent sequences.									
CO5	Apply converg	the learnt tests in gence and conditional	n establishing concernence of inf	nvergence, diverg	gence, absolute						
	Mappin	g of course outcomes	s with the program	specific outcome	S						
	PSO1	PSO2	PSO3	PSO4	PSO5						
C01	2	2	2	2	2						
CO2	2	2	2	2	2						
CO3	2	2	2	2	2						
CO4	2	2 2 2 2 1									
CO5	2	2	2	2	1						

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Course Title: Real Analysis-I Course Code: UC-BSHM-303-19

UNIT-I

Review of Algebraic properties, Rational and irrational numbers, Order properties of \mathbb{R} , Absolute value of a real number, Triangle inequality, Real line, δ -neighborhood of a point in \mathbb{R} , Idea of bounded above sets, bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima, The Completeness Property of \mathbb{R} (without proof).

UNIT-II

Sequence of real number, Limit of a sequence, Uniqueness of limits, Limit theorems, Bounded sequence, Convergent sequence, Squeeze theorem, Examples of divergent sequences, Monotone sequence, Monotone convergence theorem, Calculation of square roots, Subsequences, Divergence Criteria, Monotone Subsequence Theorem (statement only), Bolzano-Weierstrass Theorem for Sequences, Cauchy sequence, Cauchy's Convergence Criterion.

UNIT-III

Infinite series, convergence and divergence of infinite series, The n^{th} term test, Harmonic series, Geometric series, Cauchy Criterion for convergence, Integral test, *p*-test, Comparison test, Limit Comparison test, Ratio test, Cauchy root test.

UNIT-IV

Absolute Convergence of infinite series, Comparison test, Root test, Ratio Test, Cauchy integral test, Kummer's test, Raabe's Test, Non-absolute convergence of infinite series, Alternating series, Leibniz test, Abel's Lemma, Abel's test, Dirichlet test.

RECOMMENDED BOOKS

- 1. R.G. Bartle and D.R. Sherbert, Introduction to Real Analysis, 3rd Edition. Singapore: John Wiley and Sons (Asia) Pvt. Ltd., 2002.
- 2. R.T. Smith, and R.B. Minton, R.B. Calculus, 4th Edition. McGraw-Hill Education, 2011.
- 3. S.R. Ghorpade and B.V. Limaye, A Course in Calculus and Real Analysis, Springer International Publishing, 2018.
- 4. T.M. Apostol, Calculus, Volume I &II, 2nd edition. New Delhi: Wiley, 1969.

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- 5. R.K. Jain and S.K. Iyengar, S.K. Advanced Engineering Mathematics, 5th Edition. New Delhi: Narosa Publication, 2011.
- 6. W.R. Wade, An Introduction to Analysis, 4th Edition. Person, 2010.

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UC- 21	BSHP 4-19	- Ele	ments o	f Mode	T-1, P-0)	4 Cred	its				
Pre-re	equisit	e: Under	standing	of senio	or secon	dary lev	el Phys	ics and l	Mathema	atics		
Course Objectives: The objective of the course is to develop basic understanding concepts of modern physics, namely to special relativity and to the quantum nature of light and energy, emphasizing whenever possible, how classical concepts have shown up to be inadequate in explaining experiments, which will act as a strong background if he/she chooses to pursue science as a career. Course Outcomes: At the end of the course, the student will be able to												
CO)1	gained a relativis	deep ur dic and c	nderstan Juantum	ding on revoluti	the mot ion in pl	ivations nysics	that hav	ve led in	the past	t century	to the
CO	2	demonst physics	trate abil problem	ity to ap s.	oply way	/e-partic	le duali	ty and u	ncertain	ty princ	iple to s	olve
CO	03	demonst	demonstrate ability to solve quantum mechanical eigenvalue equations for various operators and obtain expectation values of the corresponding observables.									
CO	94	demonstrate ability to solve 1-D quantum problems including the quantum particle in a box, a well, the simple harmonic oscillator, and the transmission and reflection of waves.										
CO	95	solve pr Avogad issues.	oblems i ro's nur	nvolvin nber, b	g the qu lack-boc	antizatio 1y radia	on of ma ition, pl	uss, char notoelec	ge, light tric effe	t, and en ect, and	ergy ind other	cluding related
		Марр	ing of co	ourse ou	itcomes	with th	ie progi	am Spe	ecific ou	tcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	1	2	1	2	3	2	2
CO2	2	2	1	2	1	1	1	2	1	3	2	1
CO3	3	2	2	2	1	1	2	2	1	3	2	1
CO4	2	2	2 2 2 1 1 2 1 1 3 1 2									
CO5	2	2	2	2	1	1	2	1	1	3	1	1

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Course Title: Elements of Modern Physics Course Code: UC-BSHP-214-19

UNIT-I

Dual Nature of Waves and Matter: 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)

UNIT-II

Quantum Mechanics: Two slit interference experiment with photons, atoms & particles; linear superposition principle as a consequence; Matter waves and wave amplitude; wave velocity and group velocity, Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of wave function, 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)

UNIT-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)

UNIT-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. Doppler effect, 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)

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Recommended Books:

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

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UC-BS 215-	SHP- 19	- Physics Lab-III L-0, T-0, P-4 2 C							2 Cre	edits		
Pre-ree	Pre-requisites (if any): High-school education with Physics lab as one of the subject.											
Course	Course Objectives: The aim and objective of the Physics Lab course is to introduce the students of B.											
Sc. (Ho	ons.) P	hysics to	the form	nal struc	ture of v	vave and	d vibratio	ons and	mechan	ics so th	at they o	can use
these as	s per th	neir requir	ement.									
Course	e Outc	omes: At	the end o	of the co	urse, the	student	will be					
CO1		Able to u	inderstar	nd the th	eoretical	concept	ts learned	d in the t	theory co	ourse.		
CO2		Trained i	in carryi	ng out pi	recise me	easurem	ents and	handling	g equipn	nent.		
CO3		Learn to	draw co	nclusion	s from d	ata and	develop	skills in	experim	ental des	sign.	
CO4		Able to	understa	and the	principle	es of en	ror analy	sis and	develop	o skills i	n exper	imental
		design.										
CO5		Able to c	locumen	t a techn	ical repo	ort whicl	h commu	inicates	scientifie	e informa	ation in a	a clear
		and conc	ise mani	ner.				0	• • • •			
		Map	ping of c	course o	utcomes	with th	e progra	am Spec	entic out	comes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C01	3	3	2	2	2	1	2	1	2	3 .	2	3
CO2	3	3	3	3	2	2	1	1	1	3	2	3
CO3	3	3	2	-	2	1	2	1	1	3	2	3
CO4	3	2	2	2	-	2	2	1	2	3	2	3
CO5	2	2	2	2	-	2	2	1	1	3	2	3

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Course Title: Physics Lab-III Course Code: UC-BSHP-215-19

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.

- 1. To determine value of Boltzmann constant using V-I characteristic of PN diode.
- 2. To show the tunneling effect in tunnel diode using I-V characteristics.
- 3. To determine work function of material of filament of directly heated vacuum diode
- 4. To determine value of Planck's constant using LEDs of at least 4 different colors.
- 5. Measurement of Planck's constant using black body radiation and photo-detector.
- 6. To determine work function of material of filament of directly heated vacuum diode.
- 7. To determine the ionization potential of mercury.
- 8. To determine the wavelength of H-alpha emission line of Hydrogen atom.
- 9. To determine the absorption lines in the rotational spectrum of Iodine vapour.
- 10. To study the diffraction patterns of single and double slits using laser source and measure its intensity variation using Photosensor and compare with incoherent source Na light.
- 11. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
- 12. To determine the value of e/m by magnetic focusing.
- 13. To experimentally demonstrate the concept of quantization of energy levels according to Bohr's model of atom using Franck-Hertz Apparatus.
- 14. To determine the wavelength of laser source using diffraction of single slit.
- 15. To determine the wavelength of laser source using diffraction of double slits.
- 16. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency.

RECOMMENDED BOOKS:

- 1. http://vlab.amrita.edu/?sub=1&brch=195
- 2. Experimental Physics M.A. Hippargi.
- 3. Experimental Physics Gadad & Hiregoudar.
- 4. Practical Physics C. L. Arora.
- 5. Advanced Practical Physics Worsnop and Flint.
- 6. Practical Physics Gupta & Kumar Vol I, Vol II

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UGCA1914	Programming in P	ython	L-3, T-1, P-0		4 Credits		
Pre-requisites (if any): NA							
Course Outcomes: At the end of the course, the student will be							
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 fi	les in Python and I	earn Object Orien	nted Program	ming Concepts.		
Mapping of course outcomes with the program Specific outcomes							
	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5		
C01	1	2	3	3	3		
CO2	1	- 1	3	3	3		
CO3	1	2	3	3	3		
CO4	1	2	3	3	·· 3		
CO5	1	1	3	3	3		

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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, PathSearching 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)

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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.

Reference 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.

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UGCA1917	Programming in Py Laboratory	thon	L-0, T-0, P-	2 Credits				
Pre-requisites (if any): NA								
Additional n	naterial required in H	ESE: - Maintain	practical note b	ook as per the i	nstructions given by			
the instructor.								
CO1	Solve simple to advan	nced problems us	ing Python lang	uage.				
CO2	Develop logic of various programming problems using numerous data types and control structures of Python.							
CO3	Implement different of	lata structures.						
CO4	Implement modules and functions.							
CO5	Design and implement the concept of object oriented programming structures.							
Mapping of course outcomes with the program Specific outcomes								
	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5			
CO1	1	2	3	3	2			
CO2	1	1	3	3	2			
CO3	1	2	3	3	2			
CO4	1	2	3	3	2			
CO5	1	1	2	3	2			

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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 13n
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. $x-x^{3}/3!+x^{5}/5!-x^{7}/7!+x^{n}/n!$
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.
21.	Determine whether a string is palindrome or not.
22.	Perform following operations on a list of numbers:
	1) Insert an element 2) delete an element 3) sort the list 4) delete entire list
23.	Display word after Sorting in alphabetical order.
24.	Perform sequential search on a list of given numbers.
25.	Perform sequential search on ordered list of given numbers.
26.	Maintain practical note book as per their serial numbers in library using Python
	dictionary.
27.	Perform following operations on dictionary

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	1) Insert 2) delete 3) change
28.	Check whether a number is in a given range using functions.
29.	Write a Python function that accepts a string and calculates number of upper case
	letters and lower case letters available in that string.
30.	To find the Max of three numbers using functions.
31.	Multiply all the numbers in a list using functions.
32.	Solve the Fibonacci sequence using recursion.
33.	Get the factorial of a non-negative integer using recursion.
34.	Write a program to create a module of factorial in Python.
35.	Design a Python class named Rectangle, constructed by a length & width, also
	design a method which will compute the area of a rectangle.
36.	Design a Python class named Circle constructed by a radius and two methods which
	will compute the area and the perimeter of a circle.
37.	Design a Python class to reverse a string 'word by word'.
38.	Write a Python program to read an entire <i>text file</i> .
39.	Design a Python program to read first n lines of a <i>text file</i> .
40.	Construct a Python program to write and append text to a file and display the text.

Text Books:

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

Reference Books:

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

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UC-BHCL-	204-19	PHYSI	CAL CHEMIS	TRY	L-3, T-1, P-0	4 Credits		
Pre-requisite: Understanding of senior secondary level Physics and Mathematics								
Course Obj	Course Objectives: This course will equip students with the necessary knowledge concerning the							
fundamental	s in the	basic areas of	physical chemis	try viz. diffei	rent states of ma	atter, solutions and		
ionic equili	orium.	The problem so	olving skills of s	students are e	expected to be enf	nanced through due		
weightage gi	ven to	numerical prob	lems in each uni	it.				
Course Out	comos:	At the end of t	he course the st	udent will be	able to			
Course Out	comes.	At the chd of t	the course, the st	udent will be				
C01	Under	stand the basic	principles and t	heories pertai	ining to different	states of matter		
CO2	Solve	various proble	ms related to pH	[
CO3	Define the various laws pertaining to gaseous state and solutions.							
CO4	Famil	iarise with the	different collig	ative propert	ties of solutions a	and the concept of		
	abnormal molecular mass							
C05	Understand the basic structure and symmetry elements in solids							
Manning of course outcomes with the program Specific outcomes								
		1 0		1.9	1			
		PSO 1	PSO 2	PSO 3	PSO 4	PSO 5		
CO1		-	3	-	-	3		
CO2		-	3	-	-	3		
C03			2			2		
03								
CO4	CO4 - 3 - 3							

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Course Tittle: Physical Chemistry Course Code: UC-BHCP-204-19

UNIT-I

Gaseous State:

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. Numericals.

UNIT-II

Liquid and Solid State

Physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity and their determination, cleansing action of detergents.

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

UNIT-III

Ionic equilibria:

Concept of Acids and Bases. Electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di-and triprotic acids.

Buffer solutions; buffer capacity, buffer range, buffer action

Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

UNIT-IV

Solutions and Colligative Properties:

Ways of expressing the concentration, lowering of vapour pressure, Raoult's Law. Colligative properties (i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

RECOMMENDED BOOKS:

1. P.W. Atkins and J. de Paula, Atkin's Physical Chemistry, Oxford University Press (2006).

2. S.H. Maron and 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 and P. Reid, Physical Chemistry 3rd Ed., Prentice-Hall (2012)

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UC-BHCL- 208-19		Chen	nistry Lab-III		L-0, T-0, P-4	2 Credits		
Pre-requisite: Understanding of senior secondary level Physics and Mathematics								
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 Out	comes	s: At the end of t	he course, the st	udent will b	e able to	` •		
C01	CO1 Understand the basic procedures for carrying out a physical chemistry practical like preparation and standardisation of solutions, handling the equipments 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 study.							
CO4	Verify various laws studied in the theory part.							
Mapping of course outcomes with the program Specific outcomes								
		PSO 1	PSO 2	PSO 3	PSO 4	PSO 5		
C01		-	3	-	-	3		
CO2	CO2 - 3				·. 3			
CO3		-	3	-	-	3		
CO4		-	3	-	-	3		
CO5	- 3 - 3							

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Subject Tittle: Chemistry Lab-III Subject Code: UC-BHCP-208-19

UNIT-I

Preparation and Standardisation 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.



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

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BBA 301-18Organizational BehaviourL-5, T-1, P-06 Credits									
Pre-requisit	Pre-requisite: Understanding of senior secondary level Physics and Mathematics								
Course O	bject	ive: This cour	se emphasizes	the impo	ortance of huma	in capital in the			
organization	ns of	today. It give	s an insight to	the stude	ents regarding inc	lividual and group			
behaviour in	n any	organization.							
Course Out	come	s. At the end of t	he course the st	udent will l	e able to				
Course Out	come	s. At the end of t	the course, the st						
CO1	Тое	explain the basics	of Orgnaization	nal behavior	ur and various chal	lenges for OB			
CO2	To i	llustrate the four	dations of Indiv	vidual Beha	viour and various	factors influencing			
	indi	vidual behaviour	viz. learning, pe	ersonality, p	erception, attitude	and motivation.			
CO3	To e	examine the dyna	mics of group d	evelopment	and group propert	ies.			
604	T	1 1 1 1	1	· · .·	1 1				
CO4	101	inderstand variou	s dimensions of	organisatio	onal culture.				
CO5	To a	nalyse the proces	ss of conflict ma	nagement a	and approaches to s	stress management.			
	Μ	apping of course	e outcomes with	n the progr	am Specific outco	omes			
		PSO 1	PSO 2	PSO 3	PSO 4	PSO 5			
CO1		-	3	-	-	3			
CO2		-	3	-	-	3			
<u> </u>									
003		-	3		-	·. 3			
CO4	No. 19	_	3		_	3			
001			5			5			
CO5		-	3	-	-	3			

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Course Title: Organizational Behaviour Course Code: BBA 301-18

UNIT-I

Introduction: Meaning of organizational behaviour and its relevance in today's business environment, contributing disciplines to Organization Behaviour, challenges and opportunities for OB.

Individual behaviour in organization: Foundations of individual behaviour, Factors influencing Individual Behaviour.

Learning: Meaning, characteristics and theories: Classical conditioning theory, operant conditioning theory, social learning theory, behaviour modification.

UNIT-II

Perception: Nature, importance, perceptual process, factors influencing perception, perceptual errors.

Attitude: Meaning, importance, components and types of work related attitude.

Personality: Meaning, determinants of personality, personality traits.

Motivation: Meaning, types of motivation, theories of work motivation given by Maslow, Herzberg, McGregor, Vroom and Porter – Lawler.

UNIT-III

Group behaviour in organization: Group dynamics, Types of groups, Group development, theories of group development, Group norms and roles, Group cohesiveness,

Work Teams: Meaning, characteristics, types of team, Creating effective team.

Leadership: nature, leadership styles, Leadership theories: trait theory and behavioural theories.

UNIT-IV

Conflict Management: Meaning, types and sources of conflict, Process of conflict management, approaches to conflict management.

Stress management: sources of stress, approaches for stress management.

Organizational culture: meaning, concept, types of culture, dimensions of organizational culture.

Recommended BOOKS:

- 1. Robbins, Organization Behaviour, Pearson Education Asia
- 2. Luthans, Organization Behaviour, Tata McGraw Hill
- 3. Newstrom, Organizational Behaviour: Human Behaviour at Work, Tata McGraw Hill
- 4. L.M. Prasad, Organisation Behaviour, Sultan Chand
- 5. Parikh, Gupta, Organisational Behaviour, Tata McGraw Hill
- 6. Aswathappa, Organization Behaviour, Himalaya.

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UC-BSHN	1-401-19 V	ector Calculus]	L-4, T-1, P-0	5 Credits		
Pre-requisi	te: Students m	ust have the knowle	edge of Scalar, Vec	tors and vector a	llgebra.		
Course Obj students with applications general cond Course Out	ectives: The o h the theoretica in real life eng cept, that is, Te comes: At the	bjective of the cour al as well as physics gineering problems. ensors. end of the course,	rse on Vector Calc al interpretations of Furthermore, stud the student will be	ulus is to equip t f scalar vector qu ents will be intro able to	the B.Sc. (Hons) antities. Their duced to more		
CO1	Learn the bas	sic concepts of Vec	tor algebra, Dot pro	oduct, Cross proc	luct.		
CO2	Learn about of	operations on vecto	rs, such as, vector t	riple product, sc	alar triple product.		
CO3	Understand t gradient, Div	he Differentiation ergence and curl.	of Vector valued	functions, Scalar	valued functions,		
CO4	Be acquainter functions. Ar	d with Line, Surfac nd, Gauss, Diverger	e and Volume integ ace and Stokes theo	grals of vector (o orem, Tensors.	r scalar) valued		
CO5	Apply the lea	rnt techniques in so	olving various prob	lems related to v	ectors.		
	Mappi	ng of course outco	omes with the prog	gram outcomes			
	PSO1	PSO2	PSO3	PSO4	PSO5		
C01	2	2	2	2	2		
CO2	2 2 2 2 2 2						
CO3	2	2	2	2	2		
CO4	2	2	2	2	1		
CO5	2	2	2	2	1		

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Course Title: Vector Calculus Course Code: UC-BSHM-401-19

UNIT-I

Vector Algebra: Dot and Cross product of two vectors, Scalar and vector product of three vectors. Scalar fields and vector fields. [Ref 2: Chapter-1B]

Introduction to Suffix notation and summation convention, Kronecker delta.

UNIT-II

Vector Differentiation: Vector functions, Differentiation of a vector function, General rules for differentiation of vector function, Chain rule, Geometric interpretation of $\frac{d\vec{r}}{dt}$, Velocity and acceleration, Scalar and vector point function. [Ref 2: Chapter-1C]

UNIT-III

Gradient, divergence and Curl: Vector Differential operator, Gradient of a scalar function, Geometric interpretation of Gradient, Directional Derivative, Properties of Gradient, Divergence of a Vector point function, Physical interpretation of Divergence, Curl of Vector point function, Physical interpretation of curl, Properties of divergence and curl, Repeated operations by V, Conservative vector field and Scalar Potential. [Ref 2: Chapter-1C]

UNIT-IV

Vector Integral Calculus: Introduction to Integration of vector functions, Line integral, Surface integral, Volume integral.

Integral Theorems: Green's theorem in the plane, Stoke's Theorem, Gauss' theorem of Divergence and their applications. [Ref 2: Chapter-1D]

RECOMMENDED BOOKS:

1. M. Spiegel, S. Lipschutz and D. Spellman, Vector Analysis and An Introduction to Tensor Analysis, 2nd Edition. U.K.: Schaum's Outline Series, McGraw Hill, 1980.

2. H. Anton and C. Rorres, Elementary Linear Algebra, New Delhi: Wiley, 2012.

3. P. C. Mathews, Vector Analysis, 2nd Indian reprint. Springer undergraduate Mathematics Series, Springer-Verlag London, 2008.

4. H. Lass, Vector and Tensor Analysis. McGraw Hill, 2007.

5. S. Narayan, Tensor Analysis. New Delhi: S. Chand, 2010.

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UC-BSHN	I- Ordinary Differential Equations L-4, T-1, P-0 4 Credits							
Pre-requisi	te: Ca	lculus						
The Object	vo of	this assume is t	introduce and	nonu diffor	untial aquations	and basis theory of		
existence ar	nd uni	aueness of solu	tions. This cou	rse further	explains the ana	lytic techniques in		
computing t	he sol	utions of variou	is ordinary diffe	rential equ	ations appearing	in various fields of		
science and	techno	ology.						
Course Outo	comes:	At the end of the	ne course, the stu	dents will	be able to	7		
CO1	Unde	erstand the basic	definitions to	know abou	ut ordinary differe	ential equations, its		
	vario	us types and the	ir solutions	une in ueei				
CO2	Visua	alize the geomet	rical meaning of	first order	r differential equat	tion.		
CO3	Unde	erstand the fund	amental concept	s about ex	istence and unique	eness of solution of		
000	initia	l value problem	umentar concept	s ubout ex	istence una uniqui	eness of solution of		
CO4	Unde	erstand the ap	plications of	differentia	l equations in	different type of		
	phen	omenon.	•			·.		
CO5	Appl	y power series r	nethod to obtain	series solu	tions of differenti	al equations		
	Maj	pping of course	outcomes with	the progr	am Specific outc	omes		
		PSO 1	PSO 2	PSO	3 PSO 4	PSO 5		
C01		2	3	-	-	3		
CO2		2	3	-	-	3		
<u> </u>		2	2					
COS		2	3	-	-	3		
CO4		2	3	-	-	3		
CO5		2	3	-	-	3		

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Department of Mathematical Sciences IIK. Gujner/Punjnet-Potmice-Winisejajty Kapurthala-144603 Pla. (India)

Course Title: Ordinary Differential Equations Course Code: UC-BSHM-402-19

UNIT-I

Basic definitions, Formulation of differential equations, order and degree of differential equation, primitives, initial value problem and solution of differential equations, First order differential equations: Linear, non-linear differential equations, Solution by variables separable, homogeneous, non-homogeneous exact equations, reducible in exact form and integrating factors, Solution of Leibnitz and Bernoulli's differential equation.

UNIT-II

Geometrical interpretation of first order differential equation, Successive approximation, Existence and uniqueness of solution of first order differential equations, Lipschitz condition, Picard's existence and uniqueness theorem.

UNIT-III

First order and higher degree equations solvable for x, y, p and Clairaut's form, Linear differential equations of first and higher order with constant coefficients, exponential decay model, lake pollution model (case study of Lake Burley Griffin), exponential growth of population (Scope as in Chapters 1, 3 of S. L. Ross).

UNIT-IV

Linear differential equations with variable coefficients, Cauchy's Euler equation and Legendre's equation, Linear independence, Linear dependence, Wronskian, Variation of parameters method.

RECOMMENDED BOOKS

- 1. S.L. Ross, Differential Equations, 3rd edition, John Wiley and Sons, 2004
- 2. W. E. Boyce and R. C. Diprima, 4th edition, Elementary differential equations and boundary value problems, John Wiley and Sons,1986.
- 3. M.D. Raisinghania, Ordinary and Partial Differential Equations, S Chand Publisher, 15th edition, 2013
- 4. E. A. Coddington, An introduction to ordinary differential equation, Prentice- Hall of India.

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UC-BSHN	IM-403-19 Linear Algebra L-4, T-1, P-0 4 Credits								
Pre-requisi	te: - Set	s, Relations an	d Functions						
Course Objectioner This course is designed to inter the basis course (Clim 1.1.1.)									
vector space	jectives:	r transformati	s designed to in	ue problem	e dasic concepts c	focus of the course			
will be on th	es, inical	l foundation o	f these concents	including	explanation through	igh examples			
	leoreriea	in foundation o	r these concepts	menualing	explanation throt	ign examples.			
Course Out	tcomes:	At the end of	the course, the s	tudents wi	ll be able to				
CO1	Deal w	ith the notions	s of vector space	s and linea	r transformations	•			
CO2	Demon	istrate matrix r	epresentation of	f linear trai	nsformation.				
CO3	Deal w	with the eigen	value and eiger	nvector pr	oblem arising in	different fields of			
	applica	tions, for inst	ance, in solution	n of system	n of linear differe	ential equations and			
	stability	y of numerical	methods etc.						
CO4	Diagon	alize a given 1	matrix using the	eigenvalue	es and eigenvecto	rs of the			
	corresp	onding matrix	•						
CO5	Demon	strate similari	ty of matrices ar	nd use of a	method to check	similarity of two			
	matrice	es.				`•			
	Mapp	ing of course	outcomes with	the progr	am Specific outc	omes			
		PSO 1	PSO 2	PSO	3 PSO 4	PSO 5			
C01		3	3	-	-	1			
CO2	3 3 - 1								
CO3		2	3	-	-	1			
CO4		2	3	-	-	1			
C05		2	3	-	-	1			

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Litedo Department of Mathematical Sciences I.K. Gujral Punjab Technical University Kapurthala-144603 Pb. (India)

Course Title: Linear Algebra Course Code: UC-BSHM-403-19

UNIT-I

Vector spaces, subspaces, span of a set, intersection and union of subspaces, direct sum of subspaces, linear dependence and independence of vectors, basis and dimension of a vector space, finite dimensional vector spaces.

UNIT-II

Linear transformations, matrices as linear transformations, kernel and image of linear transformation, rank and nullity of a linear transformation, Rank-Nullity theorem, inverse of a linear transformation,

UNIT-III

Singular and non-singular linear transformations, isomorphism, algebra of linear maps, composition of linear maps, Matrix representation of a linear transformation, properties of matrix representation, change of basis.

UNIT-IV

Polynomials of matrices, characteristic polynomial, eigenvalues and eigenvectors, properties of eigenvalues and eigenvectors, Cayley-Hamilton theorem and its applications, similarity of matrices, diagonalization of a matrix, quadratic forms, minimal polynomial.

RECOMMENDED BOOKS

1. Serge Lang, Introduction to Linear Algebra, 2nd Edition, Springer, 1997.

2. D. C. Lay, S. R. Lay, J. J. McDonald, Linear Algebra and its Applications, 5th Edition, 2014.

3. V. Krishnamurthy, V. P. Mainra, J. L. Arora, Introduction to Linear Algebra, East-West Press, 1976.

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I.K. Gujral Punjab Technical University Kapurthala-144603 Pb. (India)

UC-BSHM	-404-19 Probability and Statistics L-4, T-1, P-0 4 Credits								
Pre-requisite: - Basic statistics, Permutation & combination and the basic knowledge of									
probability at 10+2 level.									
Course Ob	Course Objectives: The objective of the course is to prepare students for big data analysis by								
introducing	basic conc	cepts of stati	stics and probabi	lity theory	along with their	r appliça	ations.		
<u> </u>		1 1 0							
Course Out	tcomes: A	t the end of	the course, the st	udents wi	ll be able to				
COI	Understa	nd the may	sures of centre	1 tondono	y the concent	like el	compass and		
COI	standard	deviation of	the data	i tendenc	y, the concepts	S TIKE SP	cewness and		
CO2	Correlate	bivariate ar	d multivariate d	ata					
CO3	Fit the cu	irve by colle	cting random da	ta and und	erstand regressi	on lines.			
CO4	Understa	nd the math	ematical definition	on of prob	ability, condition	nal proba	ability and		
	its applic	ations.		•		•			
CO5	Understa	nd the theor	etical concepts li	ke randon	n variable, proba	bility dis	stribution,		
	generatin	g functions	and their usage.						
	Mappin	ig of course	outcomes with	the progr	am Specific out	tcomes			
		PSO 1	PSO 2	PSO	3 PSO	4	PSO 5		
C01		1	3	-	-	۰.	3		
CO2		1	3	-	-		3		
CO3		2	3	-	-		3		
C04		2	2				2		
04		2	3	-	-		3		
C05		3	3	-	-		3		

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I. K. Gujral Punjab Technical University, Kapurthala

Subject Title: Probability and Statistics

Code: UC-BSHM-404-19

UNIT-I

Measure of central tendency, Measure of dispersion, Coefficient of variation, relation between measure of dispersion, Standard deviation of the combination of two groups, Moments, Skewness, Kurtosis. Correlation, Rank correlation.

UNIT-II

Curve fitting, graphical method, laws reducible to linear law, Principle of least squares, Method of least square, Fitting of $y=ax^n$, $y=ae^{bx}$, $xy^n=b$; method of group averages, fitting a parabola, method of moments, Regression, lines of regression.

UNIT-III

Definition of probability, probability and set notations, Addition law of probability, Independent events-Multiplication law of probability, Baye's theorem

UNIT-IV

Random variable, discrete probability distribution, continuous probability distribution, expectation, variance, moments, moment generating function, probability generating function.

RECOMMENDED BOOKS:

- 1. S.C. Gupta and V.K. Kapoor, Mathematical Statistics.
- 2. Olive Jean Dunn, Virginia A. Clark, Basic Statistics, John Wiley & Sons, Inc., Publication.

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I. K. Gujral Punjab Technical University, Kapurthala

EVS-101A	Environmental Studies L-2, T-0, P-0 2 Credits								
Pre-requisite	es (if any): NA								
Course Obj	ectives: The a	im and objective of	this course is to tea	ch the fundam	nental concepts of				
Environment	as a whole ald	ong with Natural Reso	ources, their types, ar	nd issues relate	ed with sustainable				
use as its con	nponents along	with social issues rela	ted with environment	•					
Course Outo	comes: At the e	end of the course, the s	tudent will be						
CO1	Understand th	ne fundamental concep	ots about Environment	t and its compo	nents.				
CO2	Know about various types of natural resources, their functions, uses, exploitation and the problems arise due to these along with suitable case studies.								
CO3	Gain knowled energy flow t	dge about working of hrough them.	various ecosystems,	their features	and functions and				
CO4	Know about I	biodiversity, its various	s forms, importance a	nd important a	reas				
	Марј	oing of course outcom	es with the program	outcomes					
	PSO1	PSO2	PSO3	PSO4	PSO5				
CO1	1	3	-	-	3				
CO2	1 2 3								
CO3	1	3	-	-	3				
CO4	1	2	-	-	3				

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Head Department of Mathematical Sciences I.K. Gujral Punjab Technical University Kapurthala-144603 Pb. (India)

Course Tittle: Environmental Studies Course Code: EVS-101A

UNIT-I

Multidisciplinary nature of environmental studies, Definition, scope and importance, Need for public awareness. (2)

UNIT-II

Natural Resources : Renewable and non-renewable resources : Natural resources and associated problems.

a) Forest resources : Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.

b) Water resources : Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.

c) Mineral resources : Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

d) Food resources : World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.

e) Energy resources : Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Case studies.

f) Land resources : Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

• Role of an individual in conservation of natural resources.

• Equitable use of resources for sustainable lifestyles.

UNIT-III

Ecosystems

- Concept of an ecosystem.
- Structure and function of an ecosystem.
- Producers, consumers and decomposers.
- Energy flow in the ecosystem.
- Ecological succession.
- · Food chains, food webs and ecological pyramids.
- Introduction, types, characteristic features, structure and function of the
- following ecosystem :-
- a. Forest ecosystem
- b. Grassland ecosystem
- c. Desert ecosystem
- d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

(8)

(10)

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UNIT-IV

Biodiversity and its conservation

- Introduction Definition : genetic, species and ecosystem diversity.
- · Biogeographical classification of India
- Value of biodiversity : consumptive use, productive use, social, ethical, aesthetic and option values
- Biodiversity at global, National and local levels.
- · India as a mega-diversity nation
- Hot-spots of biodiversity.
- Threats to biodiversity : habitat loss, poaching of wildlife, man-wildlife conflicts.
- · Endangered and endemic species of India
- Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity

(6)

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RECOMMENDED BOOKS

- 1. K.C. Aggarwal, Environmental Biology, Nidi Publishers, 2001
- 2. E.P. Odum, Fundamentals of Ecology, WB Saunders, 1971
- 3. Erach Bharucha, The Biodiversity of India, Mapin Publishers, 2003
- 4. Benny Joseph, Environmental Studies, McGraw Hills, 2015.
- 5. R Rajagopalan, Environmental Studies, Oxford Higher Education, 2016.
- 6. S.P. Misra & S.N. Pandey, Essential Environmental Studies, Ane Books Pvt. Ltd. 2016

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Interfectives Integration Pre-requisite: Differential and Integral Calculus, Basic set theory Course Objectives: The objectives of this course are to: 1. Develop understanding of abstract mathematical concepts. 2. Develop analytical and logical skills of students. 3. Introduce to students the basic theorems of real analysis 4. Prepare students for the study of advanced analysis. 5. Develop understanding of Reimann integrable functions and their Course Outcomes: At the end of the course, the students will be able to	properties.				
 Pre-requisite: Differential and Integral Calculus, Basic set theory Course Objectives: The objectives of this course are to: Develop understanding of abstract mathematical concepts. Develop analytical and logical skills of students. Introduce to students the basic theorems of real analysis Prepare students for the study of advanced analysis. Develop understanding of Reimann integrable functions and their Course Outcomes: At the end of the course, the students will be able to 	properties.				
 Course Objectives: The objectives of this course are to: Develop understanding of abstract mathematical concepts. Develop analytical and logical skills of students. Introduce to students the basic theorems of real analysis Prepare students for the study of advanced analysis. Develop understanding of Reimann integrable functions and their Course Outcomes: At the end of the course, the students will be able to 	properties.				
CO1 Understand the basic concepts of Real Analysis.					
CO2 Visualize abstract mathematical concepts					
CO3 Understand basic theorems related to real analysis.					
CO4 Understand the logical concepts and apply the knowledge to	derive the basic results.				
CO5 Understand the behavior of Reimann integrable functions.					
Mapping of course outcomes with the program outcomes	omes				
PSO 1 PSO 2 PSO 3 PS	O 4 PSO 5				
CO1 5	- 4				
CO2 5					
CO3 5					
CO4 5 3 -	- 5				
CO5 - 5 -					

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Inofer-

Course Title: Real Analysis-II

Course Code: UC-BSHM-501-18

UNIT-I

Metric spaces: open sets, closed sets, limit points, interior of a set, closed set, dense and nowhere dense sets, exterior, frontier and boundary points and their properties, balls and bounded sets, limits and continuity (Definition and basic examples only of all above concepts). Sequences in metric spaces, convergent and Cauchy sequences, Complete Metric Spaces (Scope as in ref. 6, Chapter 1, section-1.2, 1.3, 1.4 definition and examples with propositions 1.4.1, 1.4.3 and 1.4.7 / ref.5 section 8.1.10-8.1.18 and sec.8.2).

UNIT-II

Compact sets in a metric space, Heine Borel theorem, sequential compactness, Bolzano Weierstrass property, finite intersection property, continuity and compactness, separable sets, (Scope as in ref. 6, Chapter 5, Theorems 5.1.1-5.1.10, 5.1.14-5.1.15 only). Connectedness, connected subsets of reals, continuity and connectedness. (Basic definitions and fundamental theorems only: Scope as in ref. 6, Chapter 4, Theorems 4.1.3 to 4.1.11 only)

UNIT-III

Riemann Integration, Upper and Lower Darboux Sums, Riemann Sums and definition of Riemann integral through Riemann sums, Cauchy Criterions for integrability, Equivalence of two definitions. The Class of Riemann integrable functions, Properties of the Riemann integral, Fundamental theorems of Calculus. Scope as in Ref 2. Chapter 6 (Art. 32.1 to 32.9, 33.1, 33.2, 33.3, 33.4 to 33.8, 33.9, 34.1, 34.3)

UNIT-IV

Improper Integrals, Tests for Convergence of Improper Integrals, Beta and Gamma functions.

Scope as in Ref. 3 Chapter 11 and ref. 2, 8.17 to 8.20.

Text Books

- T. M. Apostol, Mathematical Analysis, 2nd Edition, Narosa Publishing House, Reprint 2002.
- 2. K.A. Ross, Elementary Analysis, The Theory of Calculus, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
- 3. S. C. Malik and Savita Arora, Mathematical Analysis, 3rd Edition, New Age International Publishers, 2008.
- 4. Shanti Narayan, A Course of Mathematical Analysis, S. Chand and Company Ltd.1984.
- 5. William F.Trench, Introduction to real Analysis, Trinity University, San Antonio, Texas, USA, (Open Book Initiative of American Institute of Mathematics)

Had 2

6. Satish Shirali, Harkishan L. Vasudeva, Metric Spaces, Springer Verlag, London, 2006.

Reference Books

- 1. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill, 2004.
- 2. Charles G. Denlinger, Elements of Real Analysis, Jones & Bartlett (Student Edition), 2011.
- 3. M. H. Protter and C. B. Morrey, A First Course in Real Analysis, 2nd Edition, Springer Verlag, Indian Reprint, 2004.
- 4. W. Rudin. Principles of Mathematical Analysis, 3rd edition. McGraw Hill, 1976.
- 5. N. L. Carothers, Real Analysis, Cambridge University Press 2000.

UC-BSM-50	02-	Algbera-II	L-	4, T-1, P-0	4 Credits		
Pre-requisit	e: Sets, Relations a	nd Functions					
Course Obj	ectives: The objecti	ves of this course	e are to:				
1. Deve 2. Deve	lop analytical and lo	ogical skills of st	udents.				
3. Introd	duce basic algebraic	structures: Grou	ips and Rings.				
4. Prepa	are students for the s	study of advance	d abstract algebr	a.			
5. Deal	with axiomatic stru	ctures occurring	in science and en	ngineering.			
Course Out	comes: At the end of	of the course, the	students will be	able to			
CO1	Deal with different	algebraic structu	ires occurring in	abstract algeb	ora.		
CO2	Analyze algebraic	structure Group	and its properties	2			
CO2 CO3	Analyze algebraic	structure Ring an	ind its properties.				
C04	Annly the know	ladas of abstr	n n	, in studyin	a advanced pure		
CU4	mathematics.	ledge of abstra	ict mathematic	s in studyin;	g advanced pure		
CO5	Apply the method example, in science	s of proofs in p e and engineering	roving theoretic g.	al results in c	other branches, for		
	Mapping of	course outcomes	s with the progr	am outcomes			
	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5		
CO1	5	-	-	-	5		
CO2	5	-	-	-	5		
CO3	CO3 5 5						
CO4	5	-	-	-	5		
CO5	5	-	-	-	5		

I Hoad 2

Course Title: Algebra-II

Course Code: UC-BSHM-502-18

UNIT-I

Binary operations, symmetries of a square, Groups, semi groups, quaternion groups, groups of integers modulo n, symmetric groups, cyclic notation for permutations, even and odd permutations, properties of permutations, elementary properties of groups.

UNIT-II

Subgroups and examples of subgroups, center of a group, centralizer, normalizer, cosets, Lagrange's theorem on finite groups, index of a subgroup, product of two subgroups, Cyclic groups and their properties.

UNIT-III

Normal subgroups, simple subgroup, quotient group, Group homomorphisms, properties of homomorphism, properties of isomorphism, First, second and third isomorphism theorems, Dihedral group, permutation groups, Cayley's theorem.

UNIT-IV

Definitions and examples of rings, properties of rings, subrings, integral domains and fields, characteristic of a ring, Ideals, sum and product of ideals.

Textbooks

- 1. V. K. Khanna, S. K. Bhambri, A Course in Abstract Algebra, 4th Ed., Vikas Publishing House, 2013.
- 2. John B. Fraleigh, Neal E. Brand, A First Course in Abstract Algebra, 8th Ed., Pearson, 2021.

Reference Books

- 1. M. Artin, Algebra, 2nd Ed., Pearson, 2011.
- 2. Joseph A. Gallian, Contemporary Abstract Algebra, 8th Ed., Cengage, 2013.

I Head

UC-BSM-5 19	503-	Num	erical Methods	I	L-4, T-1, P-0	4 Credits		
Pre-requis	ite: Dif	ferential and In	ntegral Calculus					
Course Ob 1. Intro with 2. Dev 3. Intro 4. Intro 5. Intro ordi 6. Dev in s	jective: oduce m a analyt velop an oduce m oduce m oduce inary di velop ur cience a	s: The objective numerical methically. alytical and control of the second nethods to deather the second nethods for control of the second methods to deather the second fferential equation of the second nethod of the second second second second second and engineering of the second second second second second second second second s	ves of this course nods for solving omputational skil l with nonlinear nstructing interpo- leal with numer ations. computational mag.	are to: continuous pr ls of students. equations, sys olating polync ical different athematics and	oblems which tem of linear al omials. iation, numerio l also to demon	are difficult to deal gebraic equations. cal integration and strate its importance		
Course Ou	itcomes	s: At the end o	f the course, the	students will I	be able to			
CO1	Find	approximate	numerical solution	ons of nonline	ear equations a	nd system of linear		
CO2	Deve	elop and use i est is not know	nterpolating poly n or complicated	nomials whe to deal with.	n explicit form	n of the function of		
CO3	Deal diffic	with differen cult to get exac	tiation and defired to the text of	nite integral p nese.	roblems appro	ximately when it is		
CO4	Appl	y the numeric cult to deal wit	al methods for s h them analytica	olving ordina lly.	ry differential	equations when it is		
CO5	Appl prob	y the underst lems occurring	anding of comp g in science and e	utational tech engineering.	niques in deal	ing with real world		
		Mapping of o	course outcomes	s with the pro	gram outcom	28		
		PSO 1	PSO 2	PSO 3	PSO 4	PSO 5		
C01		3	4	-	-	5		
CO2	*	3	5	-	-	5		
CO3 3 4					5			
CO4		3	4	-	-	5		
C05		05 3 3 5						

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Course Title: Numerical Methods

Course Code: UC-BSHM-503-18

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. 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, Newton's forward and backward difference interpolation formulas.

UNIT-III

Numerical differentiation: methods based on finite differences. Numerical integration: idpoint 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, Euler's method, Taylor series method, Runge-Kutta methods, linear multi-step methods: Adams-Bashforth methods and Adams-Moulton methods.

Textbooks

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

Reference 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.

1 Head

UC-BSM-5 19	4- Partial Differential Equation (PDE)			4, T-1, P-0	4 Credits			
Pre-requisi	te: Calculus of sever	ral variables and C	DE					
Course Obj 1. Intro 2. Deri 3. Find 4. Lear	ectives: The objecti duce Partial differer ve heat and wave eq the solutions of PDI n the technique of s	ves of this course ntial equations and uations. Es with boundary of eparation of varial	are to: I different me conditions. bles to solve F	thods to solve DEs and analy	it. ze the behavior.			
5. Deve Course Out	tcomes: At the end of	of the course, the s	tudents will b	e able to	oncepts.			
CO1 CO2	Solve linear partial Classify the Partial	l differential equat l differential equat	ions of both fi	irst and second	order.			
CO3	Apply problem-so analysis applied mathematical conte	lving using conc to diverse situat exts.	epts and tech tions in phy	niques from sics, engineer	PDE's and Fourier ring and in other			
CO4	Demonstrate accur applications in the	rate and efficient theory of PDE's.	use of Four	ier analysis te	chniques and their			
CO5	Solve real problem derivative equation	is by identifying th	em appropria	tely from the p	erspective of partia			
	Mapping of	course outcomes	with the prog	gram outcome	S			
	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5			
C01	5	-	•	-	5			
CO2	5	-		-	5			
CO3	5 5							
CO4	5	-	-	5				
CO5	CO5 5							

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Course Title: Partial Differential Equations (PDE) Course Code: UC-BSHM-504-18

UNIT-I

Introduction of a PDE, Surfaces and Normals, Formation of PDE, Solution of PDE of first order, Lagrange's method, Integral surfaces passing through a given curve, surfaces orthogonal to a given system of surfaces. Non-linear partial differential equation of the first order, Cauchy method of characteristics, compatible systems of first order equations, Charpit's method.

UNIT-II

Classification of a second order PDE, Elliptic equations: Derivation of Laplace equation, Boundry value problems, Method of separation of variables, Solution of Laplace equation in cylindrical and spherical coordinates.

UNIT-III

Parabolic differential equations: Occurrence of diffusion equation, Boundary conditions, Solution by separation of variables method, Solution of diffusion equation in cylindrical spherical coordinates.

UNIT-IV

Hyperbolic differential equation: Derivation of one - dimensional wave equation, vibrating string-variables separation solution, Periodic solution of one - dimensional wave equation in cylindrical and spherical polar coordinates.

Books Recommended:

- 1. K. Sankara Rao, Introduction to Partial differential Equations (Second Edition), PHI.
- 2. Walter A. Strauss, Partial differential equations An Introduction, John Wiley and Sons.
- Sneddon I. N, Elements of Partial differential equations, Dover Publications, Inc. Newyork, 2006.
- 4. Ross S. L, Differential equation. 3rd Ed., John Wiley and Sons, India, 2004.

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UC-BSHM 601-19	-	Num	ber Theory	L-4	, T-1, P-0	4 Credits	
Pre-requisite	e: Nur	nbers system an	d Basic operatio	ons on numbers.			
Course Obje 1. Introc 2. Devel Funda 3. Devel Course Oute	ectives luce the lop u ament lop the	The objective ne fundamental inderstanding al theorem of ar e skills that will	s of this course a concepts of the l of the fundam ithmetic, congru allow students t	are to: Number theory ental concepts ences etc. o apply the con- tudents will be a	of Number cepts in real lif	theory such as fe problems.	
Course Out	comes	. At the ond of t			D (D		
CO1	Unde Trian	rstand well ord gular number	dering principle	, Archimedean	Property, B	inomiai theorem,	
CO2	Desc	ribe basic prope	erties of GCD an	d LCM and hav	ing the ability	to compute them.	
CO3	Decic infini	le the primality te primes.	of a given nun	nber and be abl	e to understar	nd the concept of	
CO4	Apply	V Chinese remai	nder theorem.				
CO5	Unde	rstand the utility	of Divisibility	tests.			
	Sec.	Mapping of co	urse outcomes v	with the progra	m outcomes		
		PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
C01		3	3	2	2	3	
CO2	D2 3 2 2 3						
CO3		3	2	2	2	3	
CO4		2	3	2	2	3	
C05	1	3	2	2	2	3	

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Course Title: Number Theory

Course Code: UC-BSHM-601-19

UNIT-I

Earlier Number Theory: 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 and their solutions.

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.

RECOMMENDED BOOKS:

- 1. David M. Burton, Elementary Number Theory, 7th Ed., Tata McGraw-Hill, 2007, Print.
- 2. Neville Robinns, Beginning Number Theory, 2nd Ed., Narosa Publishing House Pvt. Ltd., 2007. Print.

1 Head Department of Mathematical Sciences I.K. Gujral Punjab Technical University Kapurthala-144603 Pb. (India)

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UC-BSM-60	-602- Complex Analysis L-4, T-1, P-0						
Pre-requisi	te: Comple	x number	s system and Cal	culus of severa	al variables.		
Course Obj 1. Intro 2. Deve func 3. Lear form 4. Deve 5. Deve Course Our	ectives: The duce the fu- elop unders tions, comp n the techn fula etc. elop the und elop the ski tcomes: At	e objecti indament tanding o blex integ nique to derstandi <u>lls that w</u> the end o	ves of this course cal ideas of the fu- of the fundamenta prals etc. and solve the problem ng to solve the problem <u>ill allow students</u> of the course, the s	are to: nctions of con I concepts of ms using Cau roblems of Co to work effect students will b	nplex variables Complex Analy chy's theorem, ntour Integration tively with the openation of the able to	sis such as analytic , Cauchy's integral on. concepts.	
C01	Understar	d Compl	ex functions, Its o	continuity and	differentiabilit	у.	
CO2	Describe such integ	basic prograls.	operties of compl	ex integration	and having the	e ability to compute	
CO3	Decide w developm	hen and ent.	where a given fu	inction is ana	ytic and be ab	le to find its series	
CO4	Apply res	idue theo	brem to compute t	he several kin	ds of real integ	rais.	
CO5	Understar Maj	nd the com pping of	course outcomes	with the pro	gram outcome	s	
	P	50 1	PSO 2	PSO 3	PSO 4	PSO 5	
C01		5	-	-	-	5	
CO2)2 5 5						
CO3	203 5 5						
CO4 5						5	
C05		5	₹	-	-	5	

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Course Title: Complex Analysis Course Code: UC-BSHM-602-18

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.

Books Recommended:

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

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UC-BSM-603-		Mechanics	· L·	-4, T-1, P-0	4 Credits		
Pre-requisi	te: Sets, Relations	and Functions					
Course Ob 1. Devi 2. Devi 3. Intro 4. Devi 5. Intro 6. Devi engi Course Ou	jectives: The objectives: The objectives: The objective objective objective of start objective o	tives of this course of concept of force tic equilibrium and of Friction, kinds of of the basic laws of ergy and its princi- g for solving real of the course, the	e are to: e, coplanar, con l the governing b f friction and its of mechanics gov ples. life mechanics students will be	current forces, laws of equilibre laws. verning the moto problems relate able to	their resultant. rium. tion of the particle. red to science and		
CO1	Understand the sy	stem of different	forces and its ef	fect on the phy	sical body.		
CO2 CO3 CO4	Understand the various concepts of statics and dynamics. Understand the various mathematical laws of mechanics dealing with the motion of the particle and the static equilibrium. Apply the knowledge of Mechanics in solving real life problems related to mechanics.						
CO5	Visualize the rea frame the mathen Mapping of	l life mechanical problems a f course outcomes	problems related long with sugges s with the prog	to science an sted solutions. ram outcomes	d engineering and		
CO5	Visualize the rea frame the mathem Mapping of PSO 1	l life mechanical problems a f course outcomes PSO 2	problems related long with sugges with the progr	to science an sted solutions. ram outcomes PSO 4	d engineering and PSO 5		
CO5 CO1	Visualize the rea frame the mathen Mapping of PSO 1 -	l life mechanical problems a f course outcomes PSO 2 5	problems related long with sugges s with the progr PSO 3 -	to science an sted solutions. ram outcomes PSO 4 -	PSO 5		
CO5 CO1 CO2	Visualize the rea frame the mathem Mapping of PSO 1 - -	l life mechanical problems al f course outcomes PSO 2 5 5 5	Problems related ong with sugges with the progr PSO 3 - -	to science an sted solutions. ram outcomes PSO 4	PSO 5 5 5		
CO5 CO1 CO2 CO3	Visualize the rea frame the mathem Mapping of PSO 1 - - 3	l life mechanical problems al foourse outcomes PSO 2 5 5 5 5 5 5	Problems related ong with sugges with the progr PSO 3 - - -	to science an sted solutions. ram outcomes PSO 4 - - -	PSO 5 5 5 5 5		
CO5 CO1 CO2 CO3 CO4	Visualize the rea frame the mathem Mapping of PSO 1 - - 3 -	l life mechanical problems al f course outcomes PSO 2 5 5 5 5 5 5 5 5	PSO 3 - - - -	to science an sted solutions. ram outcomes PSO 4	PSO 5 5 5 5 5 5 5 5		

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Course Title: Mechanics

Course Code: UC-BSHM-603-18

UNIT-I

Concept of Force and the system of forces, Resultant of the Force system, Coplanar and concurrent force system and their resultant, resolution and composition of forces, turning effect of forces, resultant of coplanar non-concurrent force system, funicular polygon, concept of equilibrium, possible displacements of a body, conditions of equilibrium for coplanar force system, body constraints and free body diagrams, reactions.

UNIT-II

Gravity and gravitational force, centre of gravity, centroid, Location of centre of gravity of solids, location of centre of gravity through method of integration, Friction, laws of friction, coefficient of friction, moment of frictional force, rough inclined plane.

UNIT-III

Motion of particles, rectilinear motion of particles, curvilinear motion of particles, kinematics of rigid bodies, Newton's laws of motion, equation of motion, linear momentum of particle, impulse and momentum, conservation of linear momentum, D'Alembert's Principle, circular motion.

UNIT-IV

Work, energy their Principles and applications to rigid bodies undergoing rectilinear and curvilinear translations. Applications of work and energy principle to bodies undergoing rotation about a fixed axis, potential energy, conservation of energy, power.

Textbooks

1. M. M. Malhotra, R. Subramanian, P. S. Gahlot, B. S. Rathore: Textbook in Applied Mechanics, New Age International, 2003.

Reference Books

- 1. Dynamics by A. S. Ramsey, Cambridge University Press.
- 2. The Elements of Statics and Dynamics: Part 2 (Dynamics) by S. L. Loney, Arihant Prakashan, Meerut.

1 Head

UC-BSHN 604-19	1-	Discrete	Mathematics	L-4,	T-1, P-0	4 Credits	
Pre-requisi	te: Nu	mbers system and	l Primality.				
Course Obj	ective	es: The objectives	of this course a	re to:			
 Intro Dev Dev 	duce t elop u elop th	the basic ideas of nderstanding of the ne skills that will a	sets, relations ar ne fundamental c allow students to	nd functions. concepts of Basi work effective	c Counting prin ly with the conc	ciples. epts.	
Course Ou	tcome	s: At the end of the	ne course, the stu	idents will be al	ole to		
CO1	Understand sets, relations, and functions.						
CO2	Describe basic properties of graph theory.						
CO3	Decide when and where a given function is one-one, onto.						
CO4	Apply logics for inferences.						
CO5	Understand the applicability of basic counting principles in daily life problems.						
		Mapping of co	ourse outcomes v	with the program	outcomes		
		PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO1		3	3	2	2	3	
CO2		3	2	2	2	3	
CO3 3		2	2	2	3		
CO4 2		3	2	2	3		
CO5 3 2 2				2	2	3	

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Course Title: Discrete Mathematics

Course Code: UC-BSHM-604-19

UNIT-I

Set Theory, Relations and Functions: Sets, Algebra of Sets, Ordered Sets, Subsets, Relations, Equivalence Relations and Partitions, Hasse diagram, Functions, Composition of Functions, One-One, onto and Inverse of a function Number of one-one functions.

UNIT-II

Basic Counting Principles and Recurrence Relations: Permutation, Combinations, Pigeonhole Principle, Inclusion-exclusion Principle, Recurrence Relations, Characteristic Equation, Homogeneous and non-homogeneous linear recurrence relations with constant coefficients, Generating Functions for some standard sequences.

UNIT-III

Graphs Theory and Basic Terminology: Simple graphs, Multiple graphs, Connected graphs, Complete graphs, Handshaking Theorem, Isomorphism of Graphs, Walks, Paths, Circuits, Eulerian and Hamiltonian Paths, Planar and Non Planar Graphs, Shortest path, Directed graphs, Travelling Salesman Problem.

UNIT-IV

Logic and Boolean algebra: Propositions, Basic logic operators, Logic equivalence involving Tautologies and Contradiction, Conditional Propositions, Quantifiers, Introduction to Boolean algebra, Laws of Boolean algebra, Boolean function, Sum of product form, Logic gates and circuits.

RECOMMENDED BOOKS:

- K. H. Rosen, Discrete Mathematics and its Applications, 6th Edition, McGraw Hill, 2007.
- 2. S. Lipschutz and M. L. Lipson. Schaum 's Outline of Discrete Mathematics, Schaum 's Outlines, 2007. Print.
- 3. B. Ram, Discrete Mathematics. Pearson Publications, 2011. Print.
- 4. C. L. Lui, Elements of Discrete Mathematics. McGraw Hill, International Edition, Computer Science Series.1986. Print.
- 5. J.P. Trembley and R.P. Manohar, Discrete Mathematical Structures with Applications to Computer Science. McGraw Hill, 1975. Print.

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UC-BSHM 605-19	- Integral E	quations and Inte Fransforms	egral L-	4, T-1, P-0	4 Credits			
Pre-requisit	e: Differential and I	ntegral Calculus						
Course Obj 1. Deve 2. Intro demo 3. Deve Course Out	ectives: The objecti- lop understanding of duce Integral Trans- onstrate their applica- elop understanding of comes: At the end of	ves of this course of Integral equation forms: Laplace of applicable math of the course, the s	are to: ns occurring in Fransform and ematics. students will be	science and e Fourier Tran able to	engineering. nsform and also to			
CO1	Understand the sig	nificance of Integ	ral equations	1 11	11			
CO2	Solve Integral equations and apply the knowledge to real world problems.							
CO3	Apply Laplace transform for solving certain differential equations.							
CO4	Apply Fourier transform for solving certain differential equations.							
CO5	Apply understandi science and engine Mapping of	ng of applicable ering. course outcomes	with the prog	ram outcome				
	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5			
CO1	3	5	-	-	5			
CO2	3	5	-	-	5			
CO3	3	5	-	-	5			
CO4	3	5	-	-	5			
CO5	3	5	-	-	5			

1 Head

Course Title: Integral Equations and Integral Transforms

Course Code: UC-BSHM-605-19

UNIT-I

Integral Equations: Definition of Integral equation, Relation between differential and Integral equations, The Green's function, Conversion of boundary value problems to integral equations using Green's function, solution of integral equations, Integral equations of convolution type, Abel's Integral equation, Integro-differential equations.

UNIT-II

Integral equations (Continue): Integral equations with separable kernels, Solution of Fredholm equations with separable kernels, Solution of Fredholm and Volterra equations by the method of successive approximations.

UNIT-III

Laplace Transform Laplace transform and inverse Laplace transform, sufficient conditions for existence of Laplace transform, linearity property, shifting property, change of scale property, Laplace transform of derivatives and integrals, differentiation of Laplace transform, integration of Laplace transform, convolution theorem, Laplace transform of periodic functions, Solution of initial value problems of ordinary differential equations by Laplace transform.

UNIT-IV

Fourier Transform Fourier transform and its inversion formula, linearity property, shifting property, Modulation theorem, Fourier transform of derivative, Fourier transform of integral, convolution, Fourier cosine transform, Fourier sine transform, Solution of some initial-boundary value partial differential equations using Fourier transform.

Textbooks

- 1. Francis B. Hildebrand, Methods of Applied Mathematics, Prentice-Hall, INC, 1965.
- 2. B. S, Grewal, Higher Engineering Mathematics, Khanna Publishers, New Delhi
- 3. R. K. Jain, S. R. K. Iyengar, Advanced Engineering Mathematics, 5th Ed., Narosa, 2019.
- 4. Baidyanath Patra, An Introduction to Integral Transforms, 1st Ed., CRC Press, 2018.

Reference Books

Lokenath Debnath, Integral Transforms and Their Applications, 3rd Ed., Chapman and

Hall/CRC, 2014.

L'Head L

B.Sc. (Hons.) Mathematics

Course Structure and Syllabus University Campus (Based on Choice Based Credit System) 2019 onwards

Scheme & Syllabus (B.Sc. Hons. Mathematics) Batch 2019 & Onwards

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DEPARTMENT OF MATHEMATICAL SCIENCES

VISION

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

MISSION

- 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.
B.Sc. (Honours Mathematics) Program

PROGRAM OBJECTIVES

Objectives of the program are to catch young and talented students, motivated 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 skillful 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 (Bachelors 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.
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						
1501							
	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.						
DSO5	Students will become more confident due to enhanced level of reasoning logics						
F303	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:

SEMESTER FIRST

Contact Hrs. 34 Hrs.

S.No.	Course Code	Course Title	Load Allocation		Marks Di	Total Marks	Cr		
			L	Т	P	Internal	External		
1.	UC-BSHM-101-19	Calculus -1	4	1	-	40	60	100	4
2.	UC-BSHM-102-19	Co-ordinate Geometry	4	1	-	40	60	100	4
3.	UC-BSHM-103-19	Programming Lab-I	-	-	4	30	20	50	2
4.*	UC-BSHP-112-19	Electricity and Magnetism	3	1	-	40	60	100	4
	UC-BSHP-113-19	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	60	40	100	2
5.**	UC-BHCL-I-101- 19	Inorganic Chemistry	3	1	-	40	60	100	4
	UC-BHCP-I-102-19	Chemistry Lab-I	-	-	4	30	20	50	2
BBA-GE 101 Managerial Economics-I		Managerial Economics-I	5	1	0	40	60	100	6
6.	UC-BSHL-105-19	Communicative English -I	2	-	-	20	30	50	2
7.	7.UC-BSHL- 106A/106B-19Punjabi Compulsory- I/ Mudhli Punjabi-I		2	-	-	20	30	50	2
	I	Tota	ıl	1	I	1		1	26

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

Note 1*: Physics (UC-BSHP-112-19 & UC-BSHP-113-19) and Chemistry (UC-BHCL I-101-19 & UC-BHSP-I-102-19) are compulsory for the Students with Non-Medical background.

Note 2**: Students without Non-medical background may opt Fundamentals of Computer and IT (UGCA-1902 & UGCA-1906) and Managerial Economics-I (BBA-GE-101).

SEMESTER SECOND

Contact Hrs. 34 Hrs.

S.No.	Course Code	Course Title	Load Allocation		Load Allocation		Marks Di	Total Marks	Cr
			L	T	P	Internal	External		
1.	UC-BSHM-201-19	Calculus-II	4	1	-	40	60	100	4
2.	UC-BSHM-202-19	Solid Geometry	4	1	-	40	60	100	4
3.	UC-BSHM-203-19	Programming Lab-II	-	-	4	30	20	50	2
4.*	UC-BSHP-124-19	Waves and Vibrations	3	1	-	40	60	100	4
	UC-BSHP-125-19	Physics Lab-II	-	4		30	20	50	2
	UGCA-1909	Object Oriented Programming using C++	3 1 -		40	40 60		4	
	UGCA-1910	Object Oriented Programming using C++ Laboratory	-	-	- 4 60		40	100	2
5.**	UC-BHCL-113-19	Organic Chemistry	3	1	-	40	60	100	4
	UC-BHCP-119-19	Chemistry Lab-II	-	4		30	20	50	2
	BBA-GE 201-18	Managerial Economics-II	5	5 1 0		40	60	100	6
6.	UC-BHHL-115-19	Communicative English -II	2	2		20	30	50	2
7.	UC-BHHL- 116A/116B-19	Punjabi Compulsory- II/ Mudhli Punjabi-II	2	-	-	20	30	50	2
		Tot	al		1	1		-	26

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

Note 1*: Physics (UC-BSHP-112-19 & UC-BSHP-113-19) and Chemistry (UC-BHCL-113-19 & UC-BHCP-119-19) are compulsory for the Students with Non-Medical background.

Note 2**: Students without Non-medical background may opt Object Oriented Programming using C++ (UGCA-1909 & UGCA-1910) and Managerial Economics-II (BBA-GE-201)

Scheme of the Program:

SEMESTER THIRD

Contact Hrs. 34 Hrs.

S.No.	Course Code	Course Title	Load Allocation		Load Marks Distribution Allocation			Load Marks Distribution Allocation		Total Marks	Cr
			L	Т	Р	Internal	External				
1.	UC-BSHM-301-19	Calculus -III	4	1	-	40	60	100	4		
2.	UC-BSHM-302-19	Real Analysis-I	4	1	-	40	60	100	4		
3.	UC-BSHM-303-19	Algebra-I	-	-	4	40	60	100	4		
4.	UC-BSHM-304-19	Programming Lab-III	-	-	4	30 20		50	2		
5.*	UC-BSHP-214-19	HP-214-19Elements of Modern Physics31-40		40	60	100	4				
	UC-BSHP-215-19	Physics Lab-III	-	-	4	30	20	50	2		
	UGCA1914	Programming in Python	3	1 - 40		40	60	100	4		
	UGCA-1917	Programming in Python Laboratory	-	-	4	60	40	100	2		
6.**	UC-BHCL-I-204-19	204-19 Physical Chemistry 3 1 -		40	60	100	4				
	UC-BHCP-I-208-19 Chemistry Lab-III -		-	4	30	20	50	2			
	BBA-301-18	Organizational Behavior	5	1	0	40	60	100	6		
	1	Tota	ıl		1	1		1	26		

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

Note 1*: Physics (UC-BSHP-214-19 & UC-BSHP-215-19) and Chemistry (UC-BHCL I-204-19 & UC-BHSP-I-208-19) are compulsory for the Students with Non-Medical background.

Note 2**: Students without Non-medical background may opt Programming in Python(UGCA-1914 & UGCA-1917) and Organizational Behavior (BBA-GE-301-18).

SEMESTER FOURTH

Contact Hrs. 34 Hrs.

S.No.	Course Code	Course Title	Load Allocation			Marks Di	Total Marks	Cr	
			L	T	P	Internal	External		
1.	UC-BSHM-401-19	Vector Calculus	4	1	-	40	60	100	4
2.	UC-BSHM-402-19	Ordinary Differential Equations	4	1	-	40	60	100	4
3.	UC-BSHM-403-19	Linear Algebra	4	1	-	40	60	100	4
4.	UC-BSHM-404-19	Probability and Statistics	4 1		-	40	60	100	4
5.	UC-BSHM-405-19	Programming Lab-IV	-	-	4	30	20	50	2
6.	UC-BSHM-406-19	Project Work	6	-	-	40	60	100	6
7.	UC-BSHM-407-19	Skill Enhancement Course (Audit)	2	-	-	-	-	-	-
8.	EVS-101A	Environmental Studies	2	-	-	40	60	100	2
		То	tal						26

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)
2	Attendance	6	MSTs, Quizes, assignments,
3	Assignments	10	-attendance, etc., constitute internal evaluation. Average of two mid semester test will be considered for evaluation.
4	End semester examination	60	External evaluation
5	Total	100	Marks may be rounded off to nearest integer.
Practic	al		
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 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 units 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 upto 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: 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.

Sec	tion: A	Marks	Cos
1		2	
2		2	
3		2	
4		2	
Sec	tion: B		
5		4	
6		4	
7		4	
Sec	tion: C		
8		8	
9		8	

Scheme & Syllabus (B.Sc. Hons. Mathematics) Batch 2019 & Onwards

Details of Course Objectives

CO1	
CO2	
CO3	
<i>CO4</i>	
C05	

I. K. Gujral Punjab Technical University, Kapurthala

SEMESTER-I

Scheme & Syllabus (B.Sc. Hons. Mathematics) Batch 2019 & Onwards

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UC-BSHN	/I-	С	alculus-I	L-4,	T-1, P-0	4 Credits		
Pre-requisi	te: Ele	mentary calculu	s of senior secor	ndary level.				
Course Objectives: The objectives of this course are to make the students understand the following: The fundamental concepts of differential and integral calculus. 								
 The relational concepts of unreferration and integral calculus. The geometrical meaning of functions, limits, continuity, derivatives, mean value theorems. Applications of derivatives and sketching of curves. The definition of Integral calculus and its basic applications. The relation between derivative and the integration of a function. 								
Course Outo	comes:	At the end of th	e course, the stu	dents will be ab	e to			
CO1	Unde	erstand the basic	concepts of Diff	erential and Inte	gral Calculus			
CO2	Visua	alize all concepts	geometrically.					
CO3	Sketo	ch curves of the f	unctions intuitiv	vely with the hel	p of Different	ial Calculus.		
CO4	Appl	y the knowledge	of Differential a	and Integral Calo	culus.			
CO5	Unde	erstand the funda	mental relation l	between differen	tial and Integ	ral Calculus.		
	Maj	pping of course	outcomes with	the program Sj	pecific outcor	nes		
		PSO 1	PSO 2	PSO 3	PSO 4	PSO 5		
CO1		3	3	2	2	3		
CO2 3 2			2	2	2	3		
CO3		3	2	2 2		3		
CO4		2	3	2	2	3		
CO5		3	2	2	2	3		

Course Title: Calculus-I Course Code: UC-BSHM-101-19

UNIT-I

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, The precise definition of limit (ϵ - δ definition), continuity, limit at infinity, asymptotes, continuous functions and classification of discontinuities, uniform continuity.

UNIT-II

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, higher derivatives, preliminary transformations, differentiation of determinants.

UNIT-III

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

UNIT-IV

Higher order derivatives, calculation to the nth derivative, determination of nth derivative of rational functions. The nth derivative of the products of power of sines and cosines, Leibnitz's theorem, the nth 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

- 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.

UC-BSHN	1-	Co-ordi	nate Geometry	1	L-4, T-1, P-0 4 Credits						
102-19											
Pre-requisi	te: A	basic knowledge	of two-dimensio	onal Cartesia	n plane.						
	• • • •	T TI · · ·	1 • 1 / •	. 1 .1		1' ' ' ' ' ' ' ' ' ' ' ' ' ' ' ' ' ' '					
Course Objectives: This course is designed to introduce the geometry of 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 Out	come	s: At the end of t	he course, the st	udents will b	be able to						
CO1	Expl	ain the different	types of plane fi	gures.							
CO2	Visu	alize two-dimens	sional shapes geo	ometrically.							
	·										
CO3	Apply the knowledge of geometry of two dimensions in advance courses in										
	math	ematics.									
CO 4	Evnl	ain the Cartesian	and Polar coord	lingte system	e to etudy two d	imensional					
04	chor			mate system	is to study two c	intensional					
	snap	58.									
CO5	Stud	y further the geor	metry of three di	mensions.							
	N.			41	· · · · · · · · · · · · · · · · · · ·						
	Ma	pping of course	outcomes with	the program	i Specific outco	omes					
		PSO 1	PSO 2	PSO 3	PSO 4	PSO 5					
		1501	150 2	1505	1504	1505					
CO1		1	3	2	2	3					
<u> </u>		1	3	2	2	3					
CO3 2 3 2 2						3					
CO4		3	3	2	2	3					

2

1

2

1

CO5

3

Course Title: Co-ordinate Geometry Course Code: UC-BSHM-102-19

UNIT-I

Joint equation of pair of straight lines and angle between them, condition of parallelism and perpendicularity, joint equation of the angle bisectors, joint equation of lines joining origin to the intersection of a line and a curve.

UNIT-II

General equation of circle, circle through intersection of two lines, tangent and normal, Chord of contact, pole and polar, pair of tangents from a point, equation of chord in midpoint form, angle of intersection and orthogonality, power of a point w.r.t. circle, radical axis, co-axial family of circles, limiting points.

UNIT-III

Parabola, ellipse and hyperbola, tangent and normal, chord of contact, pole and polar of tangent from a point, equation of chord in terms of midpoint, diameter, conjugate diameters of ellipse and hyperbola, conjugate hyperbola, asymptotes of hyperbola, rectangular hyperbola.

UNIT-IV

Transformation of axes in two dimensions: shifting of origin, rotation of axes, the second degree equation $S = ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$, its invariants *t*, Δ and *O*. Reduction of the second degree equation into standard form. Identification of curves represented by S=0 (including pair of lines).Polar equations of straight lines, circles and conics. Polar equation of chords, tangent and normal.

TEXT BOOKS

1. P. K. Jain, Khalid Ahmed, A Text book of Analytical Geometry of Two Dimensions, Wiley Eastern Ltd, 1999.

RECOMMENDED BOOKS:

2. S. L. Loney, The Elements of Coordinate Geometry, Macmillian & Comp., London, 2007

UC-BSHM-	Programming Lab-I	L-0, T-0, P-2	2 Credits
103-19			

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 Specific outcomes

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
C01	1	3	3	3	3
CO2	1	3	3	3	3
CO3	2	2	3	3	3
CO4	3	3	2	2	3
CO5	2	3	2	2	3

Course Title: Programming Lab-I Course Code: UC-BSHM-103-19

The following programs with following methods are to be practiced to:

- i) Introduce the programming through (FORTRAN, C etc.)
- 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.

- 1. V. Rajaraman, Computer Programming in Fortran 90 and 95, PHI Learning, 2004.
- 2. Ian Chivers and Jane Sleightholme, Introduction to Programming with Fortran, Springer, 4th edition, 2018.
- 3. Walter S. Brainerd, Guide to Fortran 2008 Programming, Springer Nature, 2015.

UC-I	BSHP-		Electi	ricity ar	nd Mag	netism		L-3, T	-1, P-0		4 Credi	its
112	2-19											
Pre-re	Pre-requisite: Basic knowledge of Electricity and Magnetism at high school level.											
Course Objectives: The objective of the course is to expose the students to the formal structure of												
electricity and magnetism so that they can use these as per their requirement.												
Course Outcomes: At the end of the course, the student will be able to												
CO)1	Understand and describe the different concepts of electromagnetism										
CO	2	To obtain the electric and magnetic fields for simple configurations under static conditions.										
CO	3	To analy	se time	varying	electric	and mag	gnetic f	fields.				
CO	4	To under	stand M	[axwell'	s equati	on in dif	ferent	forms an	d differe	ent medi	ia.	
CO	5	have a solid foundation in fundamentals required to solve problems and also to pursue higher studies.										
	Mapping of course outcomes with the program outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	2	2	1	2	2	2	3	2	2
CO2	3	2	1	-	2	2	1	2	2	3	2	3
CO3	3	2	3	-	2	1	2	1	2	3	2	3
CO4	3	2	3	2	-	2	2	3	2	3	3	3
CO5	2	2	3	2	-	2	2	3	2	3	3	3

Course Title: Electricity and Magnetism

Course Code: UC-BSHP-112-19

UNIT-I

Review of Vector Analysis: Vector algebra, scalar and vector product; Concept of Fields; scalar and vector field; gradient, divergence and curl and their physical significance; Conservative field, Line, surface and volume integral of a vector field, Gauss-divergence theorem and Stoke's theorem.

UNIT II

Electrostatics: Electrostatic field; electric flux; Gauss's law in differential and integral form; Applications of Gauss law-Electric filed due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charge sheet; Electric potential as line integral of electric field, potential due to point charge and electric dipole; calculation of electric field from potential; Poisson's equation and Laplace's equation(Cartesian coordinate); Capacitance; capacitance of a spherical conductor and cylindrical capacitor, Energy per unit volume in electrostatic field, Dielectric medium, dielectric polarization and its types, Displacement vector, Boundary conditions.

UNIT-III

Magnetostatics: Magnetic flux; magnetic flux density; Faraday's law; magnetomotive force; Biot-Savart's law and its applications-straight conductor, circular coil, divergence and curl of magnetic field; Ampere's Circuital law in differential and integral form; Magnetic vector potential; ampere's force law; magnetic vector potential; Energy stored in a magnetic field, boundary conditions on magnetic fields.

UNIT-IV

Maxwell's Equations and Electromagnetic Waves: Equation of continuity for time varying fields; Inconsistency of ampere's law; concept of sinusoidal time variations (Phasor notation); Maxwell's equations in differential and integral form, physical significance; Maxwell equations in free space, static field and in Phasor notation; Difference between displacement current and conduction current; Wave equation in free space and in homogenous medium, Concept of Poynting vector; Poynting Theorem.

RECOMMENDED BOOKS:

1.David Griffiths, Introduction to Electrodynamics, Pearson Education India Learning Private Limited; 4thEdition.

- 2. E.C. Jordan and K.G. Balmain, Electromagnetic waves and radiating systems, Prentice Hall
- 3. Kraus John D, Electromagnetics, McGraw-Hill Publisher
- 4. W. Saslow, Electricity, magnetism and light, Academic Press
- 5.A Textbook of Electricity and Magnetism, S K Sharma, Shalini Sharma, S Dinesh & Co.
- 6. M. N. O. Sadiku, "Elements of Electromagnetics", Oxford University Publication, 2014.

UC- 11	BSHP- 3-19	- Physics Lab-I						L-0, T-0, P-4 2 Credits					
Pre-re	equisite	(If any)	High-	school e	ducation	n							
Cours formal per the	e Obje structu eir requi	ctives: ' re of ele rement.	The aim ectromag	n and ol gnetism	bjective and phe	of the senomeno	lab cou on of w	irse is to ave opti	o introducts so that	uce the at they o	student can use	s to the these as	
Cours	e Outco	omes: A	t the end	d of the	course,	the stude	ent will	be able	to				
CO1 Able to verify the theoretical concepts/laws learnt in theory courses.													
CO2		Traine	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 c	conclusio	ons from	data and	develop	skills in	experim	ental des	ign.		
CO5		Docum	nent a tec e manner	chnical re	eport whi	ch comm	nunicate	s scientif	ic inform	ation in	a clear a	nd	
		Μ	lapping	of cour	se outco	omes wi	th the	progran	1 outcor	nes			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	
CO1	3	3	2	2	2	1	2	1	2	3	2	3	
CO2	3	3	1	-	2	2	1	1	1	3	2	3	
CO3	3	3 2 - 2 1 2 1 1 3 2									3		
CO4	3	2	2	2	-	2	2	1	1	3	2	3	
CO5	2	2	2	2	-	2	2	1	1	3	2	3	

Course Title: Physics Lab-I

Course Code: UC-BSHP-113-19

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; wave length, 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 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) .

- 1. A Text -book of Practical Physics, I. Prakash & Ramakrishna, 11thEdn, 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-19	02 Fundamentals of Computer and IT	L-3, T-1, P-0	4 Credits									
Pre-requisi	Pre-requisite: NA											
Course Out	tcomes: At the end of the course, the student v	vill 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 ar	d Presentation Grap	hics 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.

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

Scheme & Syllabus (B.Sc. Hons. Mathematics) Batch 2019 & Onwards

- 2. Computer Fundamentals, A. Goel, 2010, PearsonEducation.
- 3. Fundamentals of Computers, P. K.Sinha& P. Sinha, 2007, BPBPublishers.
- 4. IT Tools, R.K. Jain, Khanna PublishingHouse
- 5. "IntroductiontoInformationTechnology",SatishJain,AmbrishRai&Shashi Singh, Paperback Edition, BPB Publications,2014.
- 6. "Introduction to Computers", Peter Norton
- 7. Computers Today, D. H. Sanders, McGraw Hill.
- 8. "Computers", Larry long & Nancy long, Twelfth edition, PrenticeHall.
- 9. ProblemSolvingCasesinMicrosoftExcel,JosephBrady&EllenFMonk,Tho mson Learning
- 10. www.sakshat.ac.in
- 11. 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 presentat	ion 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.

- 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 formFeatures 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.

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

> Presentation Orientation:

- 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
- This session helps students in making their presentations interactive. Topicscovered includes: 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, DesignTemplates, Hiddenslides. Autocontentwizard, SlideTransition, 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/postonablogandtousetorrentsforaccelerateddownloads.
 - 3) Hands on experience in online banking and Making an online payment for any domestic bill.

- 1. IT Tools, R.K. Jain, Khanna Publishing House.
- 2. Introduction to Information Technology, ITL Education Solutions limited, Pearson Education.
- 3. Introduction to information technology, Turban, Rainer and Potter, John Wiley and Sons.
- 4. ProblemSolvingCasesinMicrosoftExcel,JosephBrady&EllenFMonk,Tho mson Learning.

Course Title: Inorganic Chemistry Course Code: UC-BSHC-101-19

UNIT-I

Atomic Structure: Bohr's theory, 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 ψ_2 . Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of *s*, *p*, *d* and *f* orbitals. Contour boundary and probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.

UNIT-II

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, Solvation energy, Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids, Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment), Effects of chemical force, melting and boiling points, solubility energetics of dissolution process.

UNIT-III

Chemical Bonding-II: Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach), Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N₂, O₂, C₂, B₂, F₂, CO, NO, and their ions; HCl,BeF₂, CO₂, (idea of s-p mixing and orbital interaction to be given). Formal charge, Valenceshell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (σ and π bond approach) and bond lengths, Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization.Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ioniccharacter from dipole moment and electronegativity difference.

UNIT-IV

Chemistry of s and p Block Elements: Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group, Allotropy and catenation, Complex formation tendency of s and p block elements, Hydrides and their classification ionic, covalent and interstitial, Basic beryllium acetate and

nitrate. Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses, Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, Phosphorus and chlorine, Peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens.

- 1. Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
- 2. Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry 3rd Ed., John Wiley Sons, N.Y. 1994.
- 3. Greenwood, N.N. & Earnshaw. Chemistry of the Elements, Butterworth-Heinemann. 1997.
- 4. Cotton, F.A. & Wilkinson, G. Advanced Inorganic Chemistry, Wiley, VCH, 1999.
- 5. Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry 4th Ed., Pearson, 2010.
- 6. Shriver & Atkins, Inorganic Chemistry 5th Ed.

Course Title: Chemistry Lab-I Course Code: UC-BSHC-102-19

List of Experiments:

(A) Titrimetric Analysis

- (i) Calibration and use of apparatus
- (ii) Preparation of solutions of different Molarity/Normality of titrants

(B) 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

(C) Oxidation-Reduction Titrimetry

- (i) Estimation of Fe(II) and oxalic acid using standardized KMnO4 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, anthranilicacid) and external indicator.

Reference text:

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.

BBA-GE10 18	01- Managerial Economics I	L-5, T-1, P-0	6 Credits									
Pre-requisi	Pre-requisite: Understanding of basic knowledge of Managerial Economics											
Course Objectives: The primary objective of this course is to equip students with the necessary economic concepts, principles, theory and techniques and enhance their managerial decision making to address business problems in a globalized economic environment.												
Course Out	Course Outcomes: After completion of the course, the students shall be able to:											
CO1	Understand the basic concepts of managerial e thinking to individual decisions and business de	conomics and apply ecisions.	the economic way of									
CO2	Measure price elasticity of demand, understan the concepts of price, cross and income elastici	d the determinants of ty of demand.	f elasticity and apply									
CO3	Understand and estimate production function a	nd Law of Diminishi	ng Marginal Utility.									
CO4	Understand and explain four basic market models of perfect competition, monopoly, monopolistic competition, and oligopoly, and how price and quantity are determined in each model.											
CO5	Understand the different costs of production decisions.	and how they affec	et short and long run									

Course Title: Managerial Economics I

Course Code: BBA-GE101-18

UNIT-I

Introduction to Managerial Economics: Managerial Economics: Meaning, Nature, Scope & Relationship with other disciplines, Role of managerial economics in decision Making, Opportunity Cost Principle, Production Possibility Curve, Incremental Concept, Scarcity Concept.

Demand and the Firm: Demand and its Determination: Demand function; Determinants of demand; Demand elasticity – Price, Income and cross elasticity. Use of elasticity for analyzing demand, Demand estimation, Demand forecasting, Demand forecasting of new product. **Indifference Curve Analysis:** Meaning, Assumptions, Properties, Consumer Equilibrium, Importance of Indifference Analysis, Limitations of Indifference Theory

UNIT-II

Production Function : Production function Meaning, Concept of productivity and technology, Short Run and long run production function Isoquants; Least cost combination of inputs, Producer's equilibrium; Return to scale; Estimation of production function. **Theory of Cost:** Cost Concepts and Determinants of cost, short run and long run cost theory, **Modern** Theory of Cost, Relationship between cost and production function

UNIT-III

Revenue Curve: Concept of Revenue, Different Types of Revenues, concept and shapes of Total Revenue, Average revenue and marginal revenue, Relationship between Total Revenue, Average revenue and marginal revenue, Elasticity of Demand and Revenue relation

Market Structure: Market Structure: Meaning, Assumptions and Equilibrium of Perfect Competition, Monopoly, Monopolistic Competition, Oligopoly: Price and output determination under collusive oligopoly, Price and output determination under non-collusive oligopoly, Price leadership model.

UNIT-IV

Pricing: Pricing practices; Commodity Pricing: Economics of advertisement costs; Types of pricing practices

Factor Pricing: Demand and supply of factor of production; Collective bargaining, Concept of rent, profit, interest- Rate of return and interest rates; Real vs. Nominal interest rates. Basic capital theory–Interest rate and return on capital. Measurement of profit. **Note:** Relevant Case Studies will be discussed in class.

- 1. K.K .Dewett, Modern Economic Theory, S. Chand Publication
- 2. D.M.Mithani, Managerial Economics Theory and Applications, Himalaya Publication
- 3. Peterson and Lewis, *Managerial Economic*, Prentice Hall of India
- 4. Gupta, Managerial Economics, TataMcGraw Hills
- 5. Geetika, Managerial Economics, Tata McGraw Hills
- 6. D.N.Dwivedi, Managerial Economic, Vikas Publications
- 7. Froeb, *Managerial Economics*, Cengage Learning
- 8. Koutsoyiannis, A, Modern Micro Economics, Palgrave Macmillan Publishers, New Delhi.
- 9. Thomas Christopher R., and Maurice S. Charles, Managerial Economics Concepts and Applications, 8th Edition,
- 10. Mehta, P. L, Managerial Economics Analysis, Problems and Cases, Sultan Chand & Sons, Delhi.
- 11. Peterson and Lewis, Managerial Economics, 4th Edition, Prentice Hall of India Pvt. Ltd., New Delhi.
- 12. Shapiro, Macro Economics, Galgotia Publications.

UC-B	SHL	-	Com	munica	tive En	glish -I		L-2,	T-0, P-	0	2 Cr	edits
Pre-rec	-19 Juisite	e: Basic p	oroficier	ncy in C	ommur	nication	Skills					
 Course Objectives: The main objective of this course is: To help the students become proficient in LSRW-Listening. Speaking. Reading & 												
Writing skills												
 To help the students become the independent users of 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 job market 												
~	<u> </u>	-	<u> </u>									
Course Outcomes: At the end of the course, the student will												
CO	L	acquire t	basic pro	oficienc	y in rea	ding &l	istening	g, writin	ig and s	peaking	skills	
CO2	2	be able to	o unders	stand sp	oken ar I field	nd writt	en Engl	ish lang	uage, p	articula	rly the l	anguage
CO.	5	be able to	o conve	rse flue	ntly.							
CO4	1	be able to	o produ	ce on th	eir own	clear a	nd cohe	erent tex	ats.			
CO		become j discussio	proficie ns, offi	nt in pro ce envir	ofession conment	al comits, impo	municat	ion, suc ading sl	ch as, in cills as v	terview vell as v	s, group writing	o skills and
		thereby v	vill have	e better	job pro	spects.		U			U	
		Mappi	ng of co	ourse ou	utcome	s with t	he prog	gram Sj	pecific	outcom	es	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	1	1	2	2	3	2	3	2	2
CO2	1	-	-	1	1	2	2	3	2	3	2	2
CO3	1	-	-	1	1	2	2	3	2	3	2	2
CO4	1	-	-	1	1	2	2	3	2	3	2	2
CO5	2	-	-	1	1	2	2	3	2	3	2	2

Course Title: Communicative English -I Course Code: UC-BSHL-105-19

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. Apparently With No Surprise: Emily Dickinson
- 3. Fool and Flea: Jeet Thayil

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

The following stories from the above volume are prescribed:

- a. The Kabuliwallah : Rabindranath Tagore
- b. The Eyes Are Not Here: Ruskin Bond
- c. Grief: Anton Chekov

UNIT-II

Vocabulary: Word Formation Processes; Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives; Synonyms, antonyms

Grammar: Subject-verb agreement; Noun-pronoun agreement; Misplaced modifiers; Articles

Determiners; Modals; Prepositions;

UNIT-III

Reading and Understanding: Close Reading; Comprehension;

UNIT-IV

Mechanics of Writing & Speaking Skills

Essay Writing (Descriptive/Narrative/Argumentative); Business letters; Précis Writing; Self

Introductions; Group Discussion Scheme & Syllabus (B.Sc. Hons. Mathematics) Batch 2019 & Onwards
RECOMMENDED 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, Oxford University Press. 2011.
- 6. Communication Skills, Oxford University Press. 2011.
- 7. Liz Hamp-Lyons and Ben Heasly, Study Writing, Cambridge University Press. 2006.

UC-BSHI 106A-19	- ਪੰਜਾਬੀਲਾਜ਼ਮੀ (Punjabi Compulsory)-I L-2, T-0, P-0 2 Credits									
Pre-requisite: Understanding of senior secondary level Punjabi										
Course Obj 1.To enhanc	Course Objectives: The objective of the course is: 1.To enhance the language ability of students.									
2.To enhand language tea	the ability of Learning science and deve ching with science subjects.	loping science lit	eracy through local							
Course Out	comes: At the end of the course, the student wil	l be able to								
CO1	Translate and transfer/broadcast the wester language.	n scientific know	vledge in the local							
CO2	Translate and transfer the indigenous/tradition local knowledge into English and other global	nal scientific know languages.	ledge available in							
CO3	Understand the society through Punjabi langua	ge, literature and c	ulture							
CO4	Learning science and in developing science lite	eracy.								
CO5	Improve the internal communication.									

Course Title: ਪੰਜਾਬੀਲਾਜ਼ਮੀ (Punjabi Compulsory)-I Course Code: UC-BSHL-106A-19

UNIT-I

ਕਵਿਤਾਭਾਗ:

ਭਾਈਵੀਰਸਿੰਘ:

ਸਮਾਂ, ਚਸ਼ਮਾ

ਪ੍ਰੋ.ਪੂਰਨਸਿੰਘ :

ਪੰਜਾਬਨੂੰਕੂਕਾਂਮੈਂ, ਹੱਲਵਾਹੁਣਵਾਲੇ

ਪ੍ਰੋ.ਮੋਹਨਸਿੰਘ :

ਮਾਂ,ਕੋਈਆਇਆਸਾਡੇਵਿਹੜੇ,ਪਿਆਰਪੰਧ

ਅੰਮ੍ਰਿਤਾਪ੍ਰੀਤਮ:

ਆਖਾਂਵਾਰਿਸਸ਼ਾਹਨੂੰ,ਅੰਨਦਾਤਾ

UNIT-II

ਕਹਾਣੀਭਾਗ:ਸੰਤਸਿੰਘਸੇਖੋਂ :

ਪੇਮੀਦੇਨਿਆਣੇ
ਸੁਜਾਨਸਿੰਘ :
ਕੁਲਫੀ
ਕੁਲਵੰਤਸਿੰਘਵਿਰਕ :
ਤੂੜੀਦੀਪੰਡ
ਗੁਰਦਿਆਲਸਿੰਘ :
ਸਾਂਝ

UNIT-III

ਭਾਸ਼ਾਦਾਟਕਸਾਲੀਰੂਪ, ਭਾਸ਼ਾਤੇਉਪ-ਭਾਸ਼ਾਵਿਚਅੰਤਰ, ਪੰਜਾਬੀਦੀਆਂਉਪ-ਭਾਸ਼ਾਵਾਂ,ਪੰਜਾਬੀਭਾਸ਼ਾ:ਨਿਕਾਸਤੇਵਿਕਾਸ। ਭਾਸ਼ਾਤੇਲਿਪੀ, ਗੁਰਮੁਖੀਲਿਪੀਦੀਆਂਵਿਸ਼ੇਸ਼ਤਾਵਾਂ, ਗੁਰਮੁਖੀਲਿਪੀ: ਨਿਕਾਸਤੇਵਿਕਾਸ।

Scheme & Syllabus (B.Sc. Hons. Mathematics) Batch 2019 & Onwards

UNIT-IV

ਸੰਖੇਪਰਚਨਾ (ਪ੍ਰੈਸੀ)

ਪੈਰ੍ਹਾਰਚਨਾ

ਸਰਲਅੰਗਰੇਜ਼ੀਪੈਰ੍ਹੇਦਾਪੰਜਾਬੀਅਨੁਵਾਦ

RECOMMENDED BOOKS:

1.ਸੰਪ.ਡਾ.ਮਹਿਲ ਸਿੰਘ, ਸਾਹਿਤ ਦੇ ਰੰਗ, ਰਵੀ ਸਾਹਿਤ ਪ੍ਰਕਾਸ਼ਨ, ਅੰਮ੍ਰਿਤਸਰ,2016.

UC-BSHI	- ਮੁਢਲੀ ਪੰਜਾਬੀ (Mudhli Punjabi)-I	ਮਢਲੀ ਪੰਜਾਬੀ (Mudhli Punjabi)-I L-2, T-0, P-0 2 Credits									
106B-19											
Pre-requisit	Pre-requisite: Understanding of senior secondary level Punjabi										
Course Obj	Course Objectives: The objective of the course is to:										
1.enhance th	e language ability of students.										
2.enhance th teaching wit	2.enhance the ability of Learning science and developing science literacy through local language teaching with science subjects.										
Course Out	comes: At the end of the course, the student wil	l be able to									
CO1	Translate and transfer/broadcast the western	n scientific know	ledge in the local								
	language.										
CO2	Translate and transfer the indigenous/tradition	al scientific know	ledge available in								
	local knowledge into English and other global	languages.									
CO3	Understand the society through Punjabi langua	ge, literature and c	ulture.								
CO4	14 Learning science and in developing science literacy.										
CO5	Improve the internal communication.										

Course Title: (Mudhli Punjabi)-I Course Code: UC-BSHL-106B-19

UNIT-I

ਪੈਂਤੀ ਅੱਖਰੀ (ਵਰਣਮਾਲਾ), ਅੱਖਰ ਕ੍ਰਮ ਮਾਤਰਾਵਾਂ : ਮੁਢਲੀ ਜਾਣ-ਪਛਾਣ ਲਗਾਖਰ :ਬਿੰਦੀ, ਟਿੱਪੀ, ਅੱਧਕ

UNIT-II

ਪੰਜਾਬੀ ਸ਼ਬਦ ਬਣਤਰ: ਮੁਢਲੀ ਜਾਣ-ਪਛਾਣ ਮੂਲ ਸ਼ਬਦ , ਅਗੇਤਰ, ਪਿਛੇਤਰ ਸਮਾਨਾਰਥਕ ਸ਼ਬਦ, ਵਿਰੋਧਾਰਥਕ ਸ਼ਬਦ ਸ਼ੁੱਧ- ਅਸ਼ੁੱਧ: ਦਿੱਤੇ ਪੈਰ੍ਹੇ ਵਿੱਚੋਂ ਅਸ਼ੁੱਧ ਸ਼ਬਦ ਨੂੰ ਸ਼ੁੱਧ ਕਰਨਾ

UNIT-III

ਹਫਤੇ ਦੇ ਸੱਤ ਦਿਨਾਂ ਦੇ ਨਾਂ ਬਾਰ੍ਹਾਂ ਮਹੀਨਿਆਂ ਦੇ ਨਾਂ ਰੁੱਤਾਂ ਦੇ ਨਾਂ ਇਕ ਸੌ ਤੱਕ ਗਿਣਤੀ ਸ਼ਬਦਾਂ ਵਿਚ UNIT-IV ਸਧਾਰਣ ਸ਼ਬਦਾਂ ਦਾ ਅੰਗਰੇਜ਼ੀ ਤੋਂ ਪੰਜਾਬੀ ਅਨੁਵਾਦ ਸਧਾਰਣ ਸ਼ਬਦਾਂ ਦਾ ਪੰਜਾਬੀ ਤੋਂ ਅੰਗਰੇਜ਼ੀ ਅਨੁਵਾਦ ਸੰਖੇਪਰਚਨਾ (ਪ੍ਰੈਸੀ) ਪੈਰ੍ਹਾਰਚਨਾ ਸਰਲਅੰਗਰੇਜ਼ੀਪੈਰ੍ਹੇਦਾਪੰਜਾਬੀਅਨੁਵਾਦ

Text and Reference Books

1.ਸੁਖਵਿੰਦਰ ਸਿੰਘ ਸੰਘਾ, ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਵਿਗਿਆਨ, ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਅਕਾਦਮੀ ਜਲੰਧਰ

I. K. Gujral Punjab Technical University, Kapurthala

SEMESTER-II

Scheme & Syllabus (B.Sc. Hons. Mathematics) Batch 2019 & Onwards

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UC-BSHM- 201-19	Calculus-II	L-4, T-1, P-0	4 Credits
Pre-requisite: (Calculus-I		

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

- 1. The applications of differential calculus for tracing curves.
- 2. The concept of Integration and its definition as limit of sum and area under curve.
- 3. The relation between derivative and the integration of a function.
- 4. The concept of improper integrals.
- 5. Numerical techniques to find approximate integrals and applications of integration for length of arc, finding area and volume.

Course Outcomes: At the end of the course, the students will be able to											
CO1	Understand the techniques to sketch a curve using the concepts of differential calculus.										
CO2	Visualize all concepts of differential calculus geometrically										
CO3	Unde	rstand the conce	pt of Integration	l.							
CO4	Unde	rstand the funda	mental relation	between differen	tial and Integral	Calculus.					
CO5	Apply the knowledge of integral calculus in finding length of arc, area under curves, volume and area of surface swept by curve during revolution.										
	Maj	oping of course	outcomes with	the program Sp	ecific outcome	5					
		PSO 1	PSO 2	PSO 3	PSO 4	PSO 5					
CO1		3	3	2	2	3					
CO2		3	3	2	2	3					
CO3		3	3	2	2	3					
CO4		3	3	2	2	3					
CO5		3	3	2	2	3					

Course Title: Calculus-II Course Code: UC-BSHM-201-19

UNIT-I

Concavity and Convexity, points of inflexion, derivative of arc, radius of curvature, centre of curvature, chord of curvature, evolutes and involutes.

UNIT-II

Asymptotes, working rules of determining Asymptotes, Asymptotes in polar co-ordinates, Cusps, curve tracing (Cartesian and polar), introduction to envelopes.

UNIT-III

Anti derivative of function of real variable, Riemann sums, definite integrals and their properties, Indefinite integral and net change, the fundamental theorem of calculus, Improper Integrals: Infinite Integrals, Discontinuous intervals, comparison test for improper integrals (Scope: James Stewart; Chapter-), reduction formulae.

UNIT-IV

Approximate Integration: Midpoint rule, Trapezoidal rule, Simpson's rule; applications of integrals to find length of arc and area between curves, finding volumes, area of surface of revolution.

TEXT BOOKS

1. James Stewart, Calculus, 5th Edition, Brooks/Cole(Thomson), 2003. 2. Maurice D Weir, Frank R. Giordano and Joel Hass, Thomas' Calculus, 11th Edition, Pearson, 2008.

3. Shanti Narayan and P. K. Mittal: Differential Calculus, S. Chand

REFERENCE BOOKS

4.George B. Thomas and Ross. L. Finney: Calculus and Analytic Geometry, 9th Edition, Addison Wesley, 1998.

UC-BSHN 202-19	M- Solid Geometry L-4, T-1, P-0 4 Credits										
Pre-requisite: Two dimensional coordinate geometry.											
Course Objectives: This course is designed to introduce the geometry of three dimensions. The											
major focus of this course will be on geometric interpretation of three-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	Use rotat	the idea of three ion of axes.	-dimensional C	artesian co	oordinate system	, shift of origin and					
CO2	Dem prop	onstrate knowled erties.	lge and underst	anding of	three dimensior	al shapes and their					
CO3	Visu	alize the three di	mensional shape	es, for exam	nple sphere, cylii	nder and cone etc.					
CO4	Utiliz math	ze the knowled ematics, for exar	ge of geometry nple calculus an	y of three d analysis.	dimensions in	other branches of					
	Ma	pping of course	outcomes with	the progra	am Specific outo	comes					
		PSO 1	PSO 2	PSO 3	3 PSO 4	PSO 5					
CO1		3	3	2	2	3					
CO2	3 3 3 2 3										
CO3		1	2	3	2	3					
CO4		1	3	3	3	3					

Course Title: Solid Geometry Course Code: UC-BSHM-202-19

UNIT-I

Lines and planes in 3-dimension, change of axes, shift of origin, rotation of axes, sphere, and section of a sphere by a plane. Sphere through a given circle. Intersection of a line and sphere.

UNIT-II

Tangent and normal, tangent plane, angle of intersection of two spheres and condition of orthogonality, power of a point w.r.t. a sphere, Radical planes, radical axis, radical centre, coaxial family of spheres, limiting points.

UNIT-III

Cylinder, Cone, homogeneous equation of second degree in x, y, z, reciprocal cone, right circular and elliptic cones, surface of revolution, enveloping cones, right circular and elliptic cylinders. Hyperbolic cylinder.

UNIT-IV

Quadratic surfaces: Ellipsoid, hyperboloid, paraboloid, quadratic cone, tangent plane and normal.

REFERENCE BOOKS

1.P. K. Jain, Khalid Ahmad, Textbook of Analytical Geometry, 3rd Edition, New Age International Publishers, 2018.

2.Shanti Narayan, P.K. Mittal, Analytical Solid Geometry, 17th Revised Edition, S. Chand & Company, 2007.

UC-BSHN	A- Computer Algebra System: MATLAB L-0, T-0, P-2 2 Credits											
203-19												
Pre-requisi	te: Ki	nowledge of basic	c concepts in Ma	athematics	such as graphs, f	functions, conics,						
matrices etc	matrices etc.											
Course Objectives: This course is designed to introduce a Computer Algebra System: MATLAB												
which is cu	which is currently used in scientific computations. The main focus will be on introduction to											
basic concep	pts of	MATLAB using	simple example	es.								
Course Out	tcome	es: At the end of t	the course, the st	tudents wi	ll be able to							
CO1	Fyn	lain the basic con	cepts of program	nming								
	ЦЛР		copts of program	lilling								
CO2	Visu	alize functions ir	n 2-D and 3-D									
CO3	Mak	e their own comp	puter programs f	for solving	problems of thei	r interest						
CO4	Use	symbolic tools of	f MATLAB for	solving pr	oblems arising in	various fields of						
	appi	ications										
	M	• 6		4	G • 6• 4							
	Ma	ipping of course	outcomes with	the progr	am Specific out	comes						
		PSO 1	PSO 2	PSO	3 PSO	4 PSO 5						
CO1		2	3	3	3	3						
CO2		1	3	3	3	3						
CO3		2	2	3	3	3						
CO4		3	3	2	2	3						

Course Title: Computer Algebra System: MATLAB

Course Code: UC-BSHM-203-19

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.

Reference Books.

1.D. J. Highamand 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.

UC-I	BSHP	-Waves and VibrationsL-4, T-0, P-04 Credits										
12	4-19											
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. The Students also learn about the LASEP and its												
applications Students will be equipped with knowledge to measure wavelength refractive index												index
and ot	her rel	lated para	ameters,	which	will act	as a str	rong bad	ckgroun	d if he/s	she cho	oses to	pursue
science	es as a	career.										
Cours	e Onto	romes: A	t the end	l of the a	course f	he stude	ent will	be able t	to			
Cours	c Out				course, t	ine study			.0			
CO	1	Identify	and illus	strate ph	ysical co	oncepts	and terr	ninolog	y used ir	n optics	and othe	er
		related v	vave phe	enomena								
CO	2	Analyze	and und	erstand	the pher	nomeno	n of inte	rference	e, and di	ffraction	n and the	eir
00	2	applicati	ons		f (1		- 4 ¹	1:-1.4	. 1 1			1
CO	3	Get thor	ougn kn mission	owledge	e of the 1 learn f	potariza o analyz	ation of the po	light ar	a its cr	anges u	ipon rei tems	lection
~~~	_					· · ·				lical sys	tems.	
CO	4	Understa	and the s	imple ha	armonic	motion	and its	applicat	ion.			
CO	5	Describe	the diff	erent typ	pes of la	sers, its	princip	le, prope	erties of	laser be	am.	
	l	Μ	apping	of cours	se outco	mes wit	th the p	rogram	outcon	nes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	1	2	1	2	3	2	2
CO2	2	2	1	2	1	1	1	1	1	3	1	1
CO3	3	2	2	2	1	1	2	1	1	3	1	1
005	3	2		2	1	1	۷	1	1	5	1	1
CO4	2	2	2	2	1	1	2	1	1	3	1	1
CO5	2	2	2	2	1	1	2	1	1	3	1	1

#### Course Title: Waves and Vibrations Course Code: UC-BSHP-124-19

#### UNIT I

Interference:Electromagnetic nature of light, Definition and properties of wave front, Huygens Principle, Temporal and Spatial Coherence, Division of amplitude and wave front, Young's double slit experiment, Lloyd's single mirror and Fresnel's Biprism, Interference in Thin Films, Newton's Rings and Michelson Interferometer. (11 Lectures)

#### **UNIT-II**

**Diffraction and Polarization:** 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; 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.

(11 Lectures)

#### **UNIT-III**

**Simple Harmonic Motion:** Simple harmonic motion, Energy of a SHO, Simple, Compound and Torsional pendulum, Electrical Oscillations, damped oscillations, damped harmonic oscillator – heavy, critical, and light damping, Damping coefficients, energy decay in a damped harmonic oscillator, quality factor, forced mechanical oscillators, resonance. (12 Lectures)

#### **UNIT-IV**

**Laser and Application:** Lasers, Spontaneous emission, Stimulated absorption, Stimulated emission, Einstein coefficients, 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.

Lectures)

#### **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 Text Book of Optics: Subrahmaniyam N. &et al.(S. Chand Publishing) (2006).
- 4. O. Svelto, "Principles of Lasers", Springer Science & Business Media, 2010.

(11)

UC-BS 125-	SHP- •19	- Physics Lab-II L-0, T-0, P-4 2 Credits							edits			
Pre-requisites (if any): High-school education with Physics lab as one of the subject.												
<b>Course Objectives:</b> The aim and objective of the Physics Lab course is to introduce the students of B. Sc. (Hons.) Physics to the formal structure of wave and vibrations and mechanics so that they can use these as per their requirement.												
Course Outcomes: At the end of the course, the student will be												
CO1		Able to u	understa	nd the th	eoretical	concept	s learned	d in the t	heory co	ourse.		
CO2		Trained	in carryi	ng out pi	recise me	easurem	ents and	handling	g equipn	nent.		
CO3		Learn to	draw co	nclusion	s from d	ata and	develop	skills in	experim	ental des	sign.	
CO4		Able to design.	understa	and the	principle	es of err	or analy	vsis and	develop	o skills i	n experi	imental
CO5		Able to a and conc	locumen ise man	t a techn ner.	ical repo	ort which	n commu	inicates	scientific	e informa	ation in a	a clear
		Ν	Aapping	g of cour	se outco	omes wit	th the pr	ogram	outcome	es		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	1	2	1	2	3	2	3
CO2	3	3	1	-	2	2	1	1	1	3	2	3
CO3	3	3	2	-	2	1	2	1	1	3	2	3
CO4	3	2	2	2	-	2	2	1	1	3	2	3
CO5	2	2	2	2	-	2	2	1	1	3	2	3

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. Measurement of volume using travelling microscope. Use of Plumb line and Spirit level.
- 2. To determine the frequency of an electrically maintained tuning fork in a) Transverse mode of vibration b) Longitudinal mode of vibration.
- 3. To find out the frequency of AC mains using sonometer.
- 4. To study the characteristic of Ge-Si junction diode.
- 5. To analyze the suitability of a given Zener diode as a power regulator.
- 6. To determine the horizontal and vertical distance between two points using a Sextant.
- 7. To determine the height of an inaccessible object using a Sextant.
- 8. To study the Motion of a Spring and calculate (a) Spring Constant (b) Value of **g** and (c) Modulus of rigidity.
- 9. To determine the time period of a simple pendulum for different length and acceleration due to gravity.
- 10. To study the variation of time period with distance between centre of suspension and centre of gravity for a compound pendulum and to determine: (i) Radius of gyration of the bar about an axis through its C.G. and perpendicular to its length. (ii) The value of g in the laboratory.
- 11. To find the moment of inertia of an irregular body about an axis through its C.G with the torsional pendulum.
- 12. To determine the angular acceleration  $\alpha$ , torque  $\tau$ , and Moment of Inertia of flywheel.

#### **Reference book and suggested readings:**

- 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, 11thEdn, 2011, Kitab Mahal.
- 4. Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
- 5. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.
- 6. Practical Physics, C L Arora, S. Chand & Company Ltd.

http://www.vlab.co.in

UGCA-19	<b>Object Oriented Programming using</b> L-3, T-1, P-0       4 Credits         C++								
Pre-requisi	Pre-requisite: NA								
Course Out	comes: At the end of the course, the student will be able to								
CO1	To learn programming from real world examples.								
CO2	To understand Object oriented approach for finding Solutions to various problems with the help of C++ language.								
CO3	To create computer based solutions to various real-world problems using C++								
CO4	To learn various concepts of object oriented approach towards problem solving								

#### Course Title: Object Oriented Programming using C++ **Course Code: UGCA-1909**

#### **UNIT-I**

#### **Principles of object oriented programming**

Introduction to OOP and its basic features, Basic components of a C++, Program and program structure, Compiling and Executing C++ Program. Difference between Procedure Oriented Language(C) and Object Oriented Language. (12)

#### **UNIT-II**

#### **Classes & Objects and Concept of Constructors**

Defining classes, Defining member functions, Declaration of objects to class, Access to member variables from objects, Different forms of member functions, Access specifiers (Private, public, protected), Array of objects. Introduction to constructors, Parameterized constructors, Copy Constructor, Multiple constructors in class, Dynamic initialization of objects, Destructors.

(10)

#### **UNIT-III**

#### **Inheritance and Operator overloading**

#### Introduction to Inheritance, Types of inheritance: - Single inheritance, Multiple inheritance, Multilevel inheritance, Hierarchical inheritance, Hvbrid inheritance, Defining operator overloading, Overloading of Unary and Binary operators, Rules for overloading operators.

(10)

(10)

#### **UNIT-IV**

Early Binding, Late Binding, Virtual Functions, pure virtual functions, Abstract Classes. Opening

#### **Polymorphism and File Handling**

and Closing File, Reading and Writing a file.

# Text Books:

1. Object Oriented Programming with C++, E. Balagurusami, Fourth Edition, Tata Mc-Graw Hill.

2. Object Oriented Programming in Turbo C++, Robert Lafore, Fourth Edition Galgotia Publications.

3. The C++ Programming Language, Bjarna Stroustrup, Third Edition, Addison-Wesley Publishing Company.

4. Object Oriented Programming Using C++, Salaria, R. S, Fourth Edition, Khanna Book Publishing.

UGCA-1910	Object Oriented Programming using	L-0, T-0, P-4	2 Credits								
	C++										
Pre-requisite (If any):NA											
CO1	CO1 To learn programming from real world examples.										
CO2	To understand Object oriented approach for with the help of C++ language.	finding Solutions t	o various problems								
CO3	To create computer based solutions to various real-world problems using C++										
CO4	To learn various concepts of object oriented	approach towards	problem solving								

#### **Course Title: Object Oriented Programming using C++ Laboratory**

#### **Course Code: UGCA-1910**

#### Instructions: Develop all program in C++

#### **Assignments:**

1. Write a program to enter mark of 6 different subjects and find out the total mark (Using cin and cout statement)

2. Write a function using reference variables as arguments to swap the values of pair of integers.

3. Write a function to find largest of three numbers.

4. Write a program to find the factorial of a number.

5. Define a class to represent a bank account which includes the following members as Data members: a) Name of the depositor b) Account Number c) Withdrawal amount d) Balance amount in the account

Member Functions:

a) To assign initial values b)To deposit an amount c) To withdraw an amount after checking the balance d) To display name and balance.

6. Write the above program for handling n number of account holders using array of objects.

7. Write a C++ program to compute area of right angle triangle, equilateral triangle, isosceles triangle using function overloading concept.

8. Consider a publishing company that markets both book and audio cassette version to its works. Create a class Publication that stores the title (a string) and price (type float) of a publication. Derive the following two classes from the above Publication class: Book which adds a page count (int) and Tape which adds a playing time in minutes(float). Each class should have get_data() function to get its data from the user at the keyboard. Write the main() function to test the Book and Tape classes by creating instances of them asking the user to fill in data with get_data() and thenndisplaying it using put_data().

9. Consider an example of declaring the examination result. Design three classes student, exam and result. The student has data members such as rollno, name. Create the lass exam by inheriting the student class. The exam class adds data members representing the marks scored in 5 subjects. Derive the result from exam-class and it has own data members like total, avg.

10. Write a program for overloading of Unary ++ operator.

11. Write a program for overloading of Binary + operator.

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- 12. Write a program of Virtual Functions.
- 13. Write a program of Abstract Classes.

14. Write a program to read and write from file.

#### **Reference Books:**

1. Object Oriented Programming with C++, E. Balagurusami, Fourth Edition, Tata Mc-Graw Hill.

2. Object Oriented Programming in Turbo C++, Robert Lafore, Fourth Edition Galgotia Publications.

3. The C++ Programming Language, Bjarna Stroustrup, Third Edition, Addison- Wesley Publishing Company.

4. Object Oriented Programming Using C++, Salaria, R. S, Fourth Edition, Khanna Book Publishing.

UC-BHC 113-19	L- Introduction to Organic Chemistry L-3, T-1, P-0 4 Credits										
Pre-requisite: Knowledge of basic concepts in Mathematics, such as graphs, functions, conics,											
matrices etc.											
Course Objectives:											
<ol> <li>To teach the basic principles, reaction mechanisms and stereochemistry of organic compounds.</li> <li>To impart knowledge regarding physical properties and chemical reactions of alkanes, alkenes, dienes, alkynes, arenes, alkyl and aryl halides etc.</li> <li>To predict and account for the most commonly encountered reaction mechanisms (substitution, addition and elimination) in organic chemistry.</li> <li>To teach the basic principles, reaction mechanisms and stereochemistry of organic compounds.</li> <li>To impart knowledge regarding physical properties and chemical reactions of alkanes, alkenes, dienes, alkynes, arenes, alkyl and aryl halides etc.</li> <li>To predict and account for the most commonly encountered reactions of alkanes, alkenes, dienes, alkynes, arenes, alkyl and aryl halides etc.</li> <li>To predict and account for the most commonly encountered reaction mechanisms (substitution, addition and elimination) in organic chemistry</li> </ol>											
Course Ou	tcomes: At	the end of th	ne course, th	e students w	ill be able to	)					
CO1	Understand and variou	d the funda is effects in (	mental cono organic com	cepts of org pounds.	anic chemis	stry i.e st	ructure, bonding				
CO2	To learn conformat	the stered ional isomer	ochemistry rism of orga	viz. optica	l isomerisi ids.	m, stered	bisomerism and				
CO3	To study t	he various k	nown reacti	ve intermedi	ate in organ	ic synthes	is				
CO4	To learn the study elimination	ne fundamer of reaction n reactions.	ntal and adva mechanisn	anced concep ans in variou	ots of reactions types of	on mechai substituti	nisms along with on addition and				
CO5	To predict	the relation	ships betwee	en organic cl	nemical stru	ctures and	l their reactivity.				
	Mapping of course outcomes with the program outcomes										
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7				
CO1	2	-	2	-	3	1	-				
CO2	2	-	3	-	3	3	-				
CO3	5	5	4	-	5	5	-				
CO4	<u> </u>	4	<u></u> З Л	4	4	<u></u> Л	4				
005	4	5	+	4	<b>T</b>	-	+				

#### **Course Title: Introduction to Organic Chemistry**

#### Course Code: UC-BHCL-113-19

#### Unit-I

#### **Basics of Organic Chemistry Organic Compounds:**

Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyper conjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophilcity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes. (11)

#### Unit-II

#### Introduction to types of organic reactions: -

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

(12)

#### Unit-III

#### **Chemistry of Aliphatic Hydrocarbons**

A. **Carbon-Carbon sigma bonds Chemistry of alkanes**: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

B. **Carbon-Carbon**  $\pi$ - **bonds:** 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), syn and anti-hydroxylation (oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction.

(12)

#### **Unit-IV**

#### 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. Directing effects of the groups.

(10)

#### **REFERENCE BOOKS:**

1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)

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

4. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994

5. Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005.

UC-BHCP- In		ntroduction	to Organic	Chemistry	L-0, T-0,	, <b>P-4</b>	2 Credits
Pre-requisite: Knowledge of basic concepts in Mathematics, such as, graphs, functions, conics, matrices etc							
Course Of	oiectives:						
The objective of this course is to provide practical knowledge and illustrative experiments regarding qualitative analysis, isolation, and purification of organic compounds							
Course Ou	itcomes: A	At the end of	the course,	the students w	ill be able to	)	
CO1	To chec points.	To check the purity of organic compounds by determining the melting or boiling points.					
CO2	To deve crystall	To develop preparative skills for purification of organic compounds by crystallization method.					
CO3	To deter qualitati	To determine the element or functional groups present in organic compound by organic qualitative analysis.					
CO4	To present their work with practical skills and the awareness of health and safety procedures.						
CO5	To apply related experiments for their research work.						
Mapping of course outcomes with the program Specific outcomes							
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	-	2	-	3	1	-
CO2	2	-	3	-	3	3	-
CO3	3	3	4	-	3	3	-
CO4	3	4	3	4	4	5	4
CO5	2	3	4	2	4	4	4

#### Course Title: Introduction to Organic Chemistry Lab Course Code: UC-BHCP-119-19

#### Unit-I

#### **Determination of melting point**

Napthalene 80-82°, Benzoic acid 121.5-122°, Urea 132.5-133°, Succinic acid 184.5-185°, Cinnamic acid 132.5-133°, Salicylic acid 157.5-158°, Acetanilide 113.5-114°, m-Dinitrobenzene 90°, p-Dichlorobenzene 52°, Aspirin 135°

#### **Determination of boiling point**

Ethanol 78°, Cyclohexane 81.4°, Toluene 110.6°, Benzene 80°

#### Unit-II

#### Distillation

Simple distillation of ethanol-water mixture using water condenser Distillation of nitrobenzene and aniline using air condenser **Crystallization** Concept of induction of crystallization Phthalic acid from hot water (using fluted filter paper and stemless funnel) Acetanilide from boiling water Napthalene from ethanol Benzoic acid from water

#### **Unit-III**

Qualitative Analysis Elemental analysis nitrogen, sulphur, chlorine, bromine, iodine Functional groups -phenols, carboxylic acids

#### Unit-IV

-carbonyl compounds - ketones, aldehydes
-carbohydrates
-aromatic amines
-amides, ureas and anilides
-aromatic hydrocarbons and their halo- derivatives

#### **Reference Books**

1.Brian S. Furniss, Antony J. Hannaford, Peter W.G. Smith and Austin R. Tatchell, Vogel's Textbook of Practical Organic Chemistry, 5th Edition, Longman, London.

2. F.G. Mann and B. C. Saunders, Practical Organic Chemistry, Springer

3. J.T. Sharp, Practical Organic Chemistry: A student handbook of techniques.

4. Philippa B. Cranwell, Laurence M. Harwood and Cristopher J. Moody, Experimental Organic Chemistry, 3rd Edition, Wiley.

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<b>BBA-GE 201-</b>		Managerial Econor			s II	L-5, T-1, P	-0	6 Credits
18								
Pre-requis	ite: U	ndersta	unding of ba	sic knowledg	e of Manag	gerial Econom	ics	
Course Of	viactiv	705• Tł	nic course a	ime to acque	aint students	with econor	nv ac a u	hole including
<b>Course Objectives:</b> This course aims to acquaint students with economy as a whole including measurement of national income inflation and unemployment which an objective to inculcate								
understand	ing of	macro	economic er	vironment o	f an econom	y for better de	ecision ma	king.
	C					•		C
Course Ou	tcome	es: Afte	er completio	on of the cour	se. the stude	ents shall be a	ble to:	
CO1	Exp	lain tl	he concept	of national	income a	nd its measu	urement u	using different
	appi	roache	S.					
CO2	Des	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	Inte	Interpret macroeconomic issues like money, inflation and unemployment.						
CO5	Identify the phases of the business cycle and the problems caused by cyclical							
	fluc	fluctuations in the market economy						
Mapping of course outcomes with the program o Specific utcomes								
	PSO	1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2		2	2	3	2	2	-
CO2	3		2	2	3	2	3	
CO3	2		3	3	2	2	3	3
CO4	2		2	3	3	3	2	3
CO5	2		1	1	3	1	1	3

#### **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.

UC-BHHL- 115-19		C	Communica	tive English	·II	L-2, T-0, P-0	2 C	redits
Pre-requisi	isite: Basic proficiency in Communication Skills							
	• .•	-						
<b>Course Objectives:</b> The main objective of this course is:								
	• To help the students become proficient in LSR w-Listening, Speaking, Reading & Writing skills							
	<ul> <li>To help the students become the independent users of English language</li> </ul>							
	• To	develo ofession	op in them v nal interaction	ital communi ons	cation skil	lls, integral to the	ir personal	, social and
	• To	teach	them the app	propriate lang	uage of pr	ofessional comm	unication	
	• To	prepar	e them for j	ob market				
Course Out	tcome	s: At th	e end of the	course. the st	udent wil	1		
2000000						-		
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 on 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								
	PSO	1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2		2	2	3	2	2	2
CO2	3		2	2	3	2	3	3
CO3	2		3	3	2	2	3	3
CO4	2		2	3	3	3	2	3
CO5	2		1	1	3	1	1	3

#### Course Title: Communicative English-II Course Code: BHHL115-19

### UNIT-I

#### (Literature)

# (C) The Poetic Palette (Orient BlackSwan, Second Edition, 2016)

The following poems from this anthology are prescribed:

- 4. The Soul's Prayer: Sarojini Naidu
- 5. I Sit and Look Out: Walt Whitman
- 6. Women's Rights: Annie Louise Walker

#### (D) Prose Parables (Orient Black Swan, 2013)

The following stories from the above volume are prescribed:

- a. The Doctor's Word: R.K. Narayan
- b. The Doll's House: Katherine Mansfield
- c. Dusk: H.H. Munroe (Saki)

#### **UNIT-II**

#### Vocabulary:

Standard abbreviations; One word substitution; Word Pairs (Homophones/Homonyms)Grammar: Sentence Structures; Use of phrases and clauses in sentences; Transformation of<br/>Sentences; Importance of proper punctuation(6)

#### **UNIT-III**

#### **Reading and Understanding:**

Summary Paraphrasing; Analysis and Interpretation; Translation (from Hindi/Punjabi to English and vice-versa)

Close Reading; Comprehension;

#### **UNIT-IV**

#### Mechanics of Writing & Speaking Skills:

Report writing; Career Documents- Job applications, Resume/CV writing, Common Everyday Situations: Conversations & Dialogues, Formal Presentations

(10)

(4)

(10)

#### **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.

UC-BHHL-116A		PUNJA	BI COMPU	ULSORY-II	L:2, T:0, P:0	Credits:2		
		(ਪੰਜਾਬੀ ਲਾਜ਼ਮੀ-II)						
Pre-requisite:		ਪੰਜਾਬੀਲਾਜ਼ਮੀ (Punjabi Compulsory)-I						
Course Obje	ctives	1. To enhance the language ability of students.						
		2. To enhance the ability of Learning science and developing science						
		literacy through local language teaching with science subjects.						
Course Outco	omes:	At the en	nd of the cou	urse, the stude	nt will be able to			
CO1.	Trans	late and t	ransfer/broa	dcast the west	ern scientific knowledg	e in the local		
	langu	age.						
CO2.	Transl	late and	transfer the	indigenous/tra	ditional scientific know	wledge available		
	in loca	al knowle	edge into En	glish and othe	r global languages.			
CO3.	Under	stand the society through Punjabi language, literature and culture.						
CO4.	Learn	ing science and in developing science literacy.						
CO5.	Impro	prove the internal communication.						
Mapping of course outcomes with the program Specific outcomes						omes		
	PS	SO1	PSO2	PSO3	PSO4	PSO5		
CO1		3	2	2	2	2		
CO2		2	2	2	2	2		
CO3		2	2	2	2	2		
CO4		2	2	2	2	3		
CO5		2	3	2	2	2		

# Course Title: PUNJABI COMPULSORY-II (ਪੰਜਾਬੀ ਲਾਜ਼ਮੀ-II) Course Code: BHHL116A-19

UNIT-I	
ਡਾ.ਹਰਿਭਜਨ ਸਿੰਘ:	
ਅਪ੍ਰਮਾਣਿਕ, ਤੇਰੇ ਹਜ਼ੂਰ ਮੇਰੀ ਹਾਜ਼ਰੀ ਦੀ ਦਾਸਤਾਨ	
ਸ਼ਿਵ ਕੁਮਾਰ ਬਟਾਲਵੀ:	
ਕੰਡਿਆਲੀ ਥੋਰ੍ਹ, ਧਰਮੀ ਬਾਬਲ ਪਾਪ ਕਮਾਇਆ, ਰੁੱਖ	
វាអ៊ុ:	
ਇਨਕਾਰ,ਸਭ ਤੋਂ ਖਤਰਨਾਕ,ਦਹਿਕਦੇ ਅੰਗਿਆਰਾਂ 'ਤੇ	
ਸੁਰਜੀਤ ਪਾਤਰ:	
ਹੁਣ ਘਰਾਂ ਨੂੰ ਪਰਤਣਾ, ਕੁਝ ਕਿਹਾ ਤਾਂ, ਪੁਲ	
TINIT'E TI	(8)
UN11-11 तनाकी ताता.	
ਸਤੋਮ ਸਿੰਘ ਸੀਰ-	
ਨੋਈ ਇਕ ਸਵਾਰ	
ਪੇਮ ਪੁਕਾਸ਼	
ਸਾ ਸਾਹਾ ਸਾਹ ਲੱਛਮੀ	
ਮੋਹਨ ਭੰਡਾਰੀ :	
ਘੋਟਣਾ	
ਵਰਿਆਮ ਸਿੰਘ ਸੰਧੂ :	
ਆਪਣਾ ਆਪਣਾ ਹਿੱਸਾ	
	(8)
UNIT-III	
ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਦੀਆਂ ਵਿਸ਼ੇਸ਼ਤਾਵਾਂ 	
ਪਜਾਬਾ ਭਾਸ਼ਾ ਉਪਰ ਪਏ ਪ੍ਰਭਾਵ	
LINIT-IV	(6)
ਰਿਪੋਰਟਿੰਗ, ਸਮਾਚਾਰ ਲਿਖਣ ਦੀ ਵਿਧੀ ਤੇ ਤੱਤ	
ਪੰਜਾਬੀ ਪੈਰੇ ਦਾ ਸਰਲ ਅੰਗਰੇਜੀ ਅਨਵਾਦ	
ਦਫਤਰੀ ਚਿੱਨੀ ਪੱਤਰ	
	(8)
	. /

# **Reference Books**

# ਸੰਪ.ਡਾ.ਮਹਿਲ ਸਿੰਘ, ਸਾਹਿਤ ਦੇ ਰੰਗ, ਰਵੀ ਸਾਹਿਤ ਪ੍ਰਕਾਸ਼ਨ, ਅੰਮ੍ਰਿਤਸਰ, 2016.

UC-BHHL-116B		MUDH	ILI PUNJA	BI-II (ਮੁਢਲੀ	L:2, T:0	, P:0	Credits:2		
			ਪੰਜਾਬੀ-Ⅱ	[)					
Pre-requisite	2:	ਮੁਢਲੀ ਪੰਜਾਬੀ (Mudhli Punjabi)-I							
Course Obje	ctives	1. To enhance the language ability of students.							
		2. To enhance the ability of Learning science and developing science							
		literacy through local language teaching with science subjects.							
Course Outc	omes:	At the e	nd of the co	urse, the stude	nt will be able	to			
CO1.	Trans	late and	transfer/bro	adcast the we	estern scientifi	ic knowle	edge in the local		
~~~	langu	age.		/					
CO2.	Trans	slate and transfer the indigenous/traditional scientific knowledge available							
~~~	in loca	Il knowledge into English and other global languages.							
CO3.	Under	rstand the society through Punjabi language, literature and culture.							
CO4.	Learn	ing science and in developing science literacy.							
<u> </u>	Improve the internal communication.								
	PSO1		PSO2	PSO3	PSO4	P	SO5		
CO1	3		2	2	2	2			
CO2	2		2	2	2	2			
CO3	2		2	2	2	2			
CO4	2		2	2	2	3			
CO5	2		3	2	2	2			

(8)

(8)

(8)

(8)

# Course Title: MUDHLI PUNJABI-II (ਮੁਢਲੀ ਪੰਜਾਬੀ-II ) Course Code: BHHL116B-19

#### UNIT-I

ਸ਼ਬਦ ਸ਼੍ਰੇਣੀਆਂ : ਪਛਾਣ ਤੇ ਵਰਤੋਂ- ਨਾਂਵ, ਪੜਨਾਂਵ ਵਿਸ਼ੇਸ਼ਣ, ਕਿਰਿਆ ਕਿਰਿਆ ਵਿਸ਼ੇਸ਼ਣ	
ਰੋਜ਼ਾਨਾ ਵਰਤੋਂ ਦੀ ਪੰਜਾਬੀ ਸ਼ਬਦਾਵਲੀ: ਬਾਜ਼ਾਰ, ਵਪਾਰ, ਰਿਸ਼ਤੇ-ਨਾਤੇ ਤੇ ਕਿੱਤਿਆਂ ਸਬੰਧੀ।	UNIT-II
ਪੰਜਾਬੀ ਵਾਕ ਬਣਤਰ : ਸਧਾਰਣ ਵਾਕ ਸੰਯੁਕਤ ਵਾਕ ਮਿਸ਼ਰਤ ਵਾਕ	UNIT-III
	UNIT-IV
ਸਧਾਰਣ ਵਾਕਾਂ ਦਾ ਅੰਗਰੇਜ਼ੀ ਤੋਂ ਪੰਜਾਬੀ ਅਨੁਵਾਦ	
ਸਧਾਰਣ ਵਾਕਾਂ ਦਾ ਪੰਜਾਬੀ ਤੋਂ ਅੰਗਰੇਜ਼ੀ ਅਨੁਵਾਦ	

# **Reference Books**

1.ਸੁਖਵਿੰਦਰ ਸਿੰਘ ਸੰਘਾ, ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਵਿਗਿਆਨ, ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਅਕਾਦਮੀ ਜਲੰਧਰ

# **SEMESTER-III**

Scheme & Syllabus (B.Sc. Hons. Mathematics) Batch 2019 & Onwards
UC-BSHM	[-301-19		Calculus-III		L-4, '	T-1, P-0	4 Credits			
Pre-requisi	te: - Calcu	lus of one va	ariable							
Course Objectives: The objectives of the course are to introduce the functions of several										
variable, the	variable, the continuity, derivatives and integrals of the functions of several variables and their									
geometrical interpretations. One of the objectives is to introduce the applicability of the calculus										
of several va	ariables to	the students	•							
Course Out	tcomes: A	t the end of t	the course, the st	udents wi	ll be abl	le to				
	0									
CO1	Understa	nd the function	ions of several v	ariables ai	nd their	behavior.				
CO2	Find the	partial deriva	atives, understan	d its geon	netrical	meaning an	nd understand their			
	relation v	with total der	ivative							
CO3	Find the	maxima and	minima of funct	tion of sev	eral var	riables and	their expansion.			
CO4	Understa	Understand the integrals of the functions of several variables and their geometrical								
	interpret	ation								
CO5	Applications of the calculus of several variables in the real world.									
	Марріі	ng of course	outcomes with	the progr	am Spe	ecific outco	omes			
		PSO 1	PSO 2	PSO	3	PSO 4	PSO 5			
CO1		3	3	-		-	3			
CO2		3	3	-		-	3			
CO3		3	3	-		-	3			
CO4		3	3	-		-	3			
CO5		1	3	-		-	3			

# **Course Title: Calculus-III**

#### Course Code: UC-BSHM-301-19

# UNIT-I

Real valued functions of several variables with emphasis on functions of two and three variables, Limits and continuity, Partial derivatives, Homogenous Functions, Euler's Theorem

# UNIT-II

Total differentiation, Differentiation of composite functions, Implicit functions, Chain Rule, Jacobians, Directional Derivatives, Gradient Vectors, Tangent Planes.

# UNIT-III

Saddle Points, Maxima and Minima of functions of two variables, Lagrange's multiplier method, Higher dimensional analogues of Lagrange's Mean value Theorem and Taylor's theorem for functions of two variables.

# UNIT-IV

Double integration over rectangular and non-rectangular regions, change of order of integration, double integration in polar co-ordinates, triple integration over parallelepiped and other solid regions, Applications of double and triple integrals to area, volume, centre of gravity, moment of inertia etc.

# **RECOMMENDED BOOKS:**

1. G. B. Thomas and R. L. Finney, Calculus and Analytic Geometry, 9th Edition, Addison Wesley, 1998. (Scope as in Ch.11-13)

- 2. Shanti Narayan and P.K. Mittal, Differential Calculus, S. Chand & Co.
- 3. Shanti Narayan and P.K. Mittal, Integral Calculus, S. Chand & Co.
- 4. T. M. Apostol, Mathematical Analysis, 2nd Edition, Narosa Publishing House, Reprint 2002.
- 5. J. Stewart, Multivariable Calculus, Concepts and Contexts, 2nd Ed., Brooks /Cole,
- Thomson Learning, USA, 2001.

UC-BSHM	[-302-19	)	Algebra-I		L-4, T-1, P-0	4 Credits			
Pre-requisi	<b>te:</b> - Coi	mplex numbers	s, Sets, Relation	and Funct	ions				
Course Obj	jectives:	This course is	s designed to int	roduce the	e basic notions of	f 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.									
<b>Course Outcomes:</b> At the end of the course, the students will be able to									
CO1	Use the	e De Moivre's	theorem for sol	lving prob	lems concerning	powers of complex			
	numbe	rs and complex	roots of polyno	mials etc.					
CO2	Use ma	atrices in solvir	ng system of equ	ations.					
CO3	Demor	istrate linear in	dependence and	dependen	ce of a set of vec	ctors.			
CO4	Find in	verse of a mat	rix using Gauss-	Jordan me	thod.				
CO5	Demonstrate the nature of solutions of polynomial equations.								
CO6	Use Cardano's method, Ferrari method and Descarte's method for finding solutions								
	of equa	ations.							
	р. Д	·		41	C <b>'</b> C'4				
	wapp	oing of course	outcomes with	the progr	am specific out	comes			
		PSO 1	PSO 2	PSO	3 PSO	4 <b>PSO 5</b>			
CO1		2	3	-	-	1			
CO2		2	3	-	-	1			
CO3		3	3	-	-	1			
CO4		2	3	-	-	1			
CO5		3	3	-	-	1			
CO6		3	3	-	-	1			

# Course Title: Algebra-I Course Code: UC-BSHM-302-19

# UNIT-I

Polar representation of complex numbers, nth roots of unity, De Moivre's theorem for rational indices and its applications. Linear independence and dependence of row and column vectors, elementary operations on matrices, inverse of a matrix using Gauss-Jordan method, echelon form, row rank and column rank of a matrix and their equivalence,

#### **UNIT-II**

System of linear equations (homogeneous and non-homogeneous), conditions for consistency, Polynomials, zeros of a polynomial, division algorithm, greatest common divisor, repeated roots, equal roots, fundamental theorem of algebra.

# UNIT-III

Relationship between roots and the coefficients, 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-IV**

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

# **RECOMMENDED BOOKS**

1. T. Andreescu and D. Andrica, Complex Numbers from A to Z, Springer Nature, 2016

2.Shanti Narayan and P.K. Mittal, A Textbook of Matrices, S. Chand & Company, 2010.

3.S. Lipschutz and M. L. Lipson, Schaum's Outline of Linear Algebra, McGraw Hill Education, 3rd Edition, 2017.

4.A Kurosh, Higher Algebra, Moscow Mir Publisher, 1972.

5.H. W. Turnbull, Theory of Equations, Palala Press, 2018.

6.W. S. Burnside and A. W. Panton, The Theory of Equations, Vol-1, Dublin University Press, 1954.

7. Chandrika Prasad, Text Book on Algebra and Theory of Equations, Pothishala Pvt. Ltd., 2017.

UC-BSHM	C-BSHM-303- Real		nalysis-I		L-4, T-1, P-0	4 Credits			
19 Pre-requisit	e: Students	s must	have the knowle	edge of number system	tem. limit.				
					,,				
Course Obj	ectives: Th	ne obje	ective of the cou	irse on Real Analy	v <b>sis-I</b> is to equip t	he B.Sc. (Hons)			
students wit	students with the real line, its properties. The various concepts of sequence, infinite series.								
Furthermore	, students v	vill be	introduced to va	arious tests to discu	iss the convergenc	e, divergence of			
Course Out	$\frac{10 \text{ mmme s}}{10 \text{ comes} \cdot \Delta t}$	the en	d of the course t	he student will be	able to				
	comes. At		d of the course, t	the student will be a					
CO1	Learn	the bas	sic concepts of R	eal line and its pro	perties.				
CO2	Unders	stand a	about bounded, u	nbounded and limi	t suprema and infin	na.			
CO3	Use of	Mono	otone Convergen	ce theorem for the	calculation of squa	re roots.			
CO4	Be acq	Be acquainted with knowledge of convergent and divergent sequences.							
CO5	Apply	Apply the learnt tests in establishing convergence, divergence, absolute							
	conver	gence	and conditional	convergence of inf	inite series.				
	Mappin	g of c	ourse outcomes	with the program	specific outcome	S			
	PSO1		PSO2	PSO3	PSO4	PSO5			
CO1	2		2	2	2	2			
CO2	2		2	2	2	2			
	_		_	_	_	_			
CO3	2		2	2	2	2			
						1			
CO4	2		2	2	2				
CO5	2		2	2	2	1			

#### Course Title: Real Analysis-I Course Code: UC-BSHM-303-19

#### UNIT-I

Review of Algebraic properties, Rational and irrational numbers, Order properties of  $\mathbb{R}$ , Absolute value of a real number, Triangle inequality, Real line,  $\delta$ -neighborhood of a point in  $\mathbb{R}$ , Idea of bounded above sets, bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima, The Completeness Property of  $\mathbb{R}$  (without proof).

#### **UNIT-II**

Sequence of real number, Limit of a sequence, Uniqueness of limits, Limit theorems, Bounded sequence, Convergent sequence, Squeeze theorem, Examples of divergent sequences, Monotone sequence, Monotone convergence theorem, Calculation of square roots, Subsequences, Divergence Criteria, Monotone Subsequence Theorem (statement only), Bolzano-Weierstrass Theorem for Sequences, Cauchy's Convergence Criterion.

#### UNIT-III

Infinite series, convergence and divergence of infinite series, The  $n^{th}$  term test, Harmonic series, Geometric series, Cauchy Criterion for convergence, Integral test, *p*-test, Comparison test, Limit Comparison test, Ratio test, Cauchy root test.

#### **UNIT-IV**

Absolute Convergence of infinite series, Comparison test, Root test, Ratio Test, Cauchy integral test, Kummer's test, Raabe's Test, Non-absolute convergence of infinite series, Alternating series, Leibniz test, Abel's Lemma, Abel's test, Dirichlet test.

#### **RECOMMENDED BOOKS**

- 1. R.G. Bartle and D.R. Sherbert, Introduction to Real Analysis, 3rd Edition. Singapore: John Wiley and Sons (Asia) Pvt. Ltd., 2002.
- 2. R.T. Smith, and R.B. Minton, R.B. Calculus, 4th Edition. McGraw-Hill Education, 2011.
- 3. S.R. Ghorpade and B.V. Limaye, A Course in Calculus and Real Analysis, Springer International Publishing, 2018.
- 4. T.M. Apostol, Calculus, Volume I &II, 2nd edition. New Delhi: Wiley, 1969.
- 5. R.K. Jain and S.K. Iyengar, S.K. Advanced Engineering Mathematics, 5th Edition. New Delhi: Narosa Publication, 2011.
- 6. W.R. Wade, An Introduction to Analysis, 4th Edition. Person, 2010.

UC-I	C-BSHP-Elements of Modern PhysicsL-3, T-1, P-04 Credits						its						
214 D	4-19		. 1	· 1'	<u> </u>		1 1	1 D1	1.1	<i>I</i> (1			
Pre-ree	re-requisite. Onderstanding of senior secondary lever r hysics and mathematics												
Course Objectives: The objective of the course is to develop basic understanding concepts of													
moderr	modern physics, namely to special relativity and to the quantum nature of light and energy,												
emphas	emphasizing whenever possible, how classical concepts have shown up to be inadequate in												
explain	explaining experiments, which will act as a strong background if he/she chooses to pursue science												
as a car	reer.												
Course	e Out	com	es: A	t the end	d of the	course, t	the stude	ent will	be able	to			
CO	1	gai	ned a	deep un	derstand	ling on	the moti	vations	that hav	e led in	the past	century	to the
		rela	tivist	ic and q	uantum	revoluti	on in pł	iysics			1	J	
CO	2	den	nonsti	ate abil	ity to ap	ply wav	e-partic	le dualit	y and u	ncertain	ty princi	iple to s	olve
GO	•	phy	sics p	oroblem	<u>s.</u>	1		1 .	1 •	1			
CO	3	den	nonsti	ate abil	ity to so	Ive quar	ntum me	chanica	l eigenv	alue equ	lations i	or vario	us
<u> </u>	4	ope		s and ob	tain exp	ectation	values	of the co	orrespon	lung ob	servable	2S.	tiala in
	4	den	lonsu		ity to so	1 - 1 - 1 - D	quantu	in probi			ne quan	tum par	
		a b	ox, a	well, th	ie simpl	e narmo	onic osc	illator, a	and the	transmis	ssion an	d reflec	tion of
		way	ves.										
CO	5	solv	ve pro	blems i	nvolving	g the qua	antizatio	on of ma	ss, char	ge, light	, and en	ergy inc	luding
		Ave	ogadr	o's nun	nber, bl	ack-bod	ly radia	tion, pł	notoelec	tric effe	ect, and	other	related
		issu	ies.				•						
		•	<b>r</b> •	e			•41 41		0	• 6•	4		
		N	lappi	ng of co	ourse ou	tcomes	with th	e progr	am Spe	cific ou	tcomes		
	PO1	. ]	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1		2	1	-	1	2	1	2	3	2	2
	-			-						-			-
CO2	2	2		1	2	1	1	1	2	1	3	2	1
CO3	3	2		2	2	1	1	2	2	1	3	2	1
CO4	2	2		2	2	1	1	2	1	1	3	1	2
CO5	2	2		2	2	1	1	2	1	1	3	1	1

# Course Title: Elements of Modern Physics Course Code: UC-BSHP-214-19

#### UNIT-I

**Dual Nature of Waves and Matter:** 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)

# UNIT-II

**Quantum Mechanics:** Two slit interference experiment with photons, atoms & particles; linear superposition principle as a consequence; Matter waves and wave amplitude; wave velocity and group velocity, Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of wave function, 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.

#### **UNIT-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.

UNIT-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. Doppler effect, 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)

Lecture (10)

Lecture (10)

#### **Recommended Books:**

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

UC-BS	SHP-	<b>Physics</b>	Lab-III			]	L-0, T-0	, P-4		2 Cre	edits	
215-	-19											
-												
Pre-re	<b>Pre-requisites (if any):</b> High-school education with Physics lab as one of the subject.											
<b>Course Objectives:</b> The aim and objective of the Physics Lab course is to introduce the students of B.												
Sc. (He	Sc. (Hons.) Physics to the formal structure of wave and vibrations and mechanics so that they can use											
these a	these as per their requirement.											
Course	Course Outcomes: At the end of the course, the student will be											
CO1		Able to u	indersta	nd the th	eoretical	concept	ts learned	d in the	theory co	ourse.		
CO2		Trained i	in carryi	ng out pi	recise me	easurem	ents and	handlin	g equipn	nent.		
CO3		Learn to	draw co	nclusion	s from d	ata and	develop	skills in	experim	ental des	sign.	
<b>CO4</b>		Able to	understa	and the	principle	es of err	or analy	vsis and	develop	o skills i	n experi	imental
		design.										
CO5		Able to c	locumen	t a techn	ical repo	ort which	n commu	inicates	scientific	c informa	ation in a	a clear
		and conc	ise man	ner.								
		Map	ping of c	ourse o	utcomes	with th	e progra	am Spee	cific out	comes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	1	2	1	2	3	2	3
CO2	3	3	3	3	2	2	1	1	1	3	2	3
<b>CO3</b>	3	3	2	-	2	1	2	1	1	3	2	3
CO4	3	2	2	2	-	2	2	1	2	3	2	3
CO5	2	2	2	2	-	2	2	1	1	3	2	3

# Course Title: Physics Lab-III Course Code: UC-BSHP-215-19

# 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.

- 1. To determine value of Boltzmann constant using V-I characteristic of PN diode.
- 2. To show the tunneling effect in tunnel diode using I-V characteristics.
- 3. To determine work function of material of filament of directly heated vacuum diode
- 4. To determine value of Planck's constant using LEDs of at least 4 different colors.
- 5. Measurement of Planck's constant using black body radiation and photo-detector.
- 6. To determine work function of material of filament of directly heated vacuum diode.
- 7. To determine the ionization potential of mercury.
- 8. To determine the wavelength of H-alpha emission line of Hydrogen atom.
- 9. To determine the absorption lines in the rotational spectrum of Iodine vapour.
- 10. To study the diffraction patterns of single and double slits using laser source and measure its intensity variation using Photosensor and compare with incoherent source Na light.
- 11. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
- 12. To determine the value of e/m by magnetic focusing.
- 13. To experimentally demonstrate the concept of quantization of energy levels according to Bohr's model of atom using Franck-Hertz Apparatus.
- 14. To determine the wavelength of laser source using diffraction of single slit.
- 15. To determine the wavelength of laser source using diffraction of double slits.
- 16. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency.

# **RECOMMENDED BOOKS:**

- 1. <u>http://vlab.amrita.edu/?sub=1&brch=195</u>
- 2. Experimental Physics M.A. Hippargi.
- 3. Experimental Physics Gadad & Hiregoudar.
- 4. Practical Physics C. L. Arora.
- 5. Advanced Practical Physics Worsnop and Flint.
- 6. Practical Physics Gupta & Kumar Vol I, Vol II

UGCA1914	Progr	amming in Pyt	thon	L-3, T-1, P-0	2	l Credits	
Pre-requisite	es (if an	y): NA		I			
Course Outc	omes: A	At the end of the	e course, the stude	ent will be			
CO1	Famili	iar with Python	environment, data	a types, operators	s used in Pytho	n.	
CO2	Comp	are and contrast	t Python with othe	er programming l	anguages.		
CO3	Learn	the use of contr	rol structures and	numerous native	data types wit	h their methods.	
CO4	Design	n user defined f	unctions, modules	s, and packages a	nd exception h	andling methods.	
CO5	Create and handle files in Python and learn Object Oriented Programming Concepts.						
	Ma	apping of cours	se outcomes with	the program S	pecific outcom	nes	
		PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO1		1	2	3	3	3	
CO2		1	1	3	3	3	
CO3		1	2	3	3	3	
CO4		1	2	3	3	3	
CO5	<b>CO5</b> 1 1 3 3						

# **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.

# **Reference 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.

<b>UGCA1917</b>	Programming in P	thon	L-0, T-0, P-4		2 Credits				
	Laboratory								
Pre-requisite	es (if any): NA			<u> </u>					
Additional material required in ESE: - Maintain practical note book as per the instructions given by									
the instructor.									
CO1	Solve simple to adva	anced problems us	ing Python langu	lage.					
CO2	Develop logic of var	ious programming	g problems using	numerous data	types and control				
	structures of Python								
CO3	Implement different	data structures.							
CO4	Implement modules	and functions.							
CO5	Design and impleme	ent the concept of	object oriented p	rogramming str	uctures.				
	Mapping of cou	rse outcomes wit	h the program S	pecific outcom	les				
	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5				
CO1	1	2	3	3	2				
CO2	1	1	3	3	2				
CO3	1	2	3	3	2				
<b>CO4</b> 1 2 3					2				
CO5	1	1	2	3	2				

# 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 13n
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.
21.	Determine whether a string is palindrome or not.
22.	Perform following operations on a list of numbers:
	1) Insert an element 2) delete an element 3) sort the list 4) delete entire list
23.	Display word after Sorting in alphabetical order.
24.	Perform sequential search on a list of given numbers.
25.	Perform sequential search on ordered list of given numbers.
26.	Maintain practical note book as per their serial numbers in library using Python
	dictionary.
27.	Perform following operations on dictionary

Scheme & Syllabus (B.Sc. Hons. Mathematics) Batch 2019 & Onwards

	1) Insert 2) delete 3) change
28.	Check whether a number is in a given range using functions.
29.	Write a Python function that accepts a string and calculates number of upper case
	letters and lower case letters available in that string.
30.	To find the Max of three numbers using functions.
31.	Multiply all the numbers in a list using functions.
32.	Solve the Fibonacci sequence using recursion.
33.	Get the factorial of a non-negative integer using recursion.
34.	Write a program to create a module of factorial in Python.
35.	Design a Python class named Rectangle, constructed by a length & width, also
	design a method which will compute the area of a rectangle.
36.	Design a Python class named <i>Circle</i> constructed by a radius and two methods which
	will compute the area and the perimeter of a circle.
37.	Design a Python class to reverse a string 'word by word'.
38.	Write a Python program to read an entire <i>text file</i> .
39.	Design a Python program to read first n lines of a <i>text file</i> .
40.	Construct a Python program to write and append text to a file and display the text.

# **Text Books:**

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

# **Reference Books:**

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

UC-BHCL-	204-19	PHYSI	CAL CHEMIS	ΓRY	L-3, T-1, P-0	4 Credits			
Pre-requisite: Understanding of senior secondary level Physics and Mathematics									
Course Obj	Course Objectives: This course will equip students with the necessary knowledge concerning the								
fundamental	s in the	basic areas of	physical chemis	try viz. diff	erent states of r	natter, solutions and			
ionic equili	brium. 🕻	The problem so	lving skills of s	tudents are	expected to be e	nhanced through due			
weightage g	iven to 1	numerical prob	lems in each uni	t.					
<b>Course Out</b>	comes:	At the end of t	he course, the st	udent will b	be able to				
CO1	Understand the basic principles and theories pertaining to different states of matter								
CO2	Solve	various problei	ns related to pH						
CO3	Define	e the various lav	ws pertaining to	gaseous sta	te and solutions.				
CO4	Famili	arise with the	different collig	ative prope	erties of solutions	and the concept of			
001	abnori	nal molecular i	nass	and prope					
C05	Under	stand the basic	structure and sv	mmetrv ele	ments in solids				
005	Onder	stand the basic	structure and sy	innieti y ele	ments in sonds				
	•								
	Mar	oping of course	e outcomes with	the progr	am Specific outc	omes			
				ľ	•				
		PSO 1	PSO 2	PSO 3	PSO 4	PSO 5			
CO1		-	3	-	-	3			
			2			2			
002									

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CO3

**CO4** 

CO5

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# Course Tittle: Physical Chemistry Course Code: UC-BHCP-204-19

# UNIT-I

#### **Gaseous State:**

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. Numericals.

# **UNIT-II**

# Liquid and Solid State

Physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity and their determination, cleansing action of detergents.

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

#### UNIT-III

#### Ionic equilibria:

Concept of Acids and Bases. Electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di-and triprotic acids.

Buffer solutions; buffer capacity, buffer range, buffer action

Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

# UNIT-IV

#### **Solutions and Colligative Properties:**

Ways of expressing the concentration, lowering of vapour pressure, Raoult's Law. Colligative properties (i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

# **RECOMMENDED BOOKS:**

1. P.W. Atkins and J. de Paula, Atkin's Physical Chemistry, Oxford University Press (2006).

2. S.H. Maron and 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 and P. Reid, Physical Chemistry 3rd Ed., Prentice-Hall (2012)

#### Scheme & Syllabus (B.Sc. Hons. Mathematics) Batch 2019 & Onwards

UC-BHCI 208-19	<b></b>	Chen	nistry Lab-III		L-0, T-0, P-4	2 Credits			
Pre-requisite: Understanding of senior secondary level Physics and Mathematics									
<b>Course Objectives:</b> 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 Out	come	s: At the end of the	he course, the stu	udent will I	be able to				
CO1	Understand the basic procedures for carrying out a physical chemistry practical like preparation and standardisation of solutions, handling the equipments and measuring with precision.								
CO2	Corr expe	elate the theoreti erimental error.	cal and practical	aspects an	d know about the	limits of the			
CO3	Dete	ermine the various	physical parame	eters for the	various problems	under study.			
CO4	Ver	ify various laws	studied in the the	eory part.					
Mapping of course outcomes with the program Specific outcomes									
		PSO 1	PSO 2	PSO 3	B PSO 4	PSO 5			
CO1		-	3	-	-	3			
CO2	<b>XO2</b> - 3					3			
CO3		-	3	-	-	3			
CO4		-	3	-	-	3			

3

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CO5

3

# Subject Tittle: Chemistry Lab-III Subject Code: UC-BHCP-208-19

# UNIT-I

Preparation and Standardisation 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

6 Organi	zational Behavio	ur	L-5, T-1, P-0	6 Credits				
: Understanding of	senior secondary	level Physic	s and Mathematics					
Course Objective: This course emphasizes the importance of human capital in the								
organizations of today. It gives an insight to the students regarding individual and group								
behaviour in any organization.								
	<u>C (1 (1 (</u>	1 4 111	11 /					
omes: At the end of	t the course, the st	udent will b	e able to					
To explain the basi	cs of Orgnaization	al behaviou	r and various challe	nges for OB				
To illustrate the fo	undations of Indiv	vidual Beha	viour and various fa	ctors influencing				
individual behavior	ır viz. learning, pe	ersonality, p	erception, attitude a	nd motivation.				
	0,1	J / 1	1 /					
To examine the dy	namics of group de	evelopment	and group properties	s.				
-		-						
To understand varie	ous dimensions of	organisatio	nal culture.					
To analyze the prov	pass of conflict ma	nagamant a	nd annroaches to str	ass management				
To analyse the proc		inagement a	ind approaches to sub	ess management.				
Manning of cou	rse outcomes with	n the nrogr	am Specific outcom	IES				
mapping or cou	ise outcomes with	r the progra	um opeeme outeom					
PSO 1	PSO 2	PSO 3	PSO 4	PSO 5				
-	3	-	-	3				
-	3	-	-	3				
	2			2				
- 3 - 3								
	3	_		3				
-	5	-	-	5				
_	3	_	_	3				
	i Understanding of jective: This cors s of today. It given any organization. omes: At the end of To explain the basi To illustrate the for individual behaviou To examine the dyn To understand varied To analyse the proof Mapping of course PSO 1 - - - - - - - - - - -	S       Organizational Benavio         : Understanding of senior secondary         jective: This course emphasizes         s of today. It gives an insight to         any organization.         omes: At the end of the course, the st         To explain the basics of Orgnaization         To illustrate the foundations of Individual behaviour viz. learning, per         To examine the dynamics of group de         To understand various dimensions of         To analyse the process of conflict mat         Mapping of course outcomes with         -       3         -       3         -       3         -       3         -       3         -       3	i Understanding of senior secondary level Physic         jective: This course emphasizes the impose of today. It gives an insight to the stude any organization.         omes: At the end of the course, the student will be the total of the course, the student will be total behaviour.         To explain the basics of Orgnaizational behaviou.         To illustrate the foundations of Individual Behaviour.         To examine the dynamics of group development.         To understand various dimensions of organisation.         To analyse the process of conflict management at the program of course outcomes with the program of the progr	S       Organizational Benaviolit       [12-3, 1-4, 1-0]         : Understanding of senior secondary level Physics and Mathematics         jective: This course emphasizes the importance of human s of today. It gives an insight to the students regarding indiv any organization.         omes: At the end of the course, the student will be able to         To explain the basics of Orgnaizational behaviour and various challe         To illustrate the foundations of Individual Behaviour and various challe         To examine the dynamics of group development and group propertie         To understand various dimensions of organisational culture.         To analyse the process of conflict management and approaches to str         Mapping of course outcomes with the program Specific outcom         PSO 1       PSO 2       PSO 3       PSO 4         -       3       -       -         -       3       -       -         -       3       -       -				

# Course Title: Organizational Behaviour Course Code: BBA 301-18

# UNIT-I

**Introduction**: Meaning of organizational behaviour and its relevance in today's business environment, contributing disciplines to Organization Behaviour, challenges and opportunities for OB.

**Individual behaviour in organization**: Foundations of individual behaviour, Factors influencing Individual Behaviour.

**Learning**: Meaning, characteristics and theories: Classical conditioning theory, operant conditioning theory, social learning theory, behaviour modification.

# UNIT-II

**Perception:** Nature, importance, perceptual process, factors influencing perception, perceptual errors.

Attitude: Meaning, importance, components and types of work related attitude.

Personality: Meaning, determinants of personality, personality traits.

**Motivation:** Meaning, types of motivation, theories of work motivation given by Maslow, Herzberg, McGregor, Vroom and Porter – Lawler.

#### **UNIT-III**

Group behaviour in organization: Group dynamics, Types of groups, Group development,

theories of group development, Group norms and roles, Group cohesiveness,

Work Teams: Meaning, characteristics, types of team, Creating effective team.

Leadership: nature, leadership styles, Leadership theories: trait theory and behavioural theories.

# UNIT-IV

**Conflict Management:** Meaning, types and sources of conflict, Process of conflict management, approaches to conflict management.

Stress management: sources of stress, approaches for stress management.

Organizational culture: meaning, concept, types of culture, dimensions of organizational culture.

#### **Recommended BOOKS:**

- 1. Robbins, Organization Behaviour, Pearson Education Asia
- 2. Luthans, Organization Behaviour, Tata McGraw Hill
- 3. Newstrom, Organizational Behaviour: Human Behaviour at Work, Tata McGraw Hill
- 4. L.M. Prasad, Organisation Behaviour, Sultan Chand
- 5. Parikh, Gupta, Organisational Behaviour, Tata McGraw Hill
- 6. Aswathappa, Organization Behaviour, Himalaya.

I. K. Gujral Punjab Technical University, Kapurthala

# **SEMESTER-IV**

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UC-BSHN	1-401-19	Vector Calculus		L-4, T-1, P-0	5 Credits				
<b>Pre-requisite:</b> Students must have the knowledge of Scalar, Vectors and vector algebra.									
<b>Course Objectives:</b> The objective of the course on <b>Vector Calculus</b> is to equip the B.Sc. (Hons) students with the theoretical as well as physical interpretations of scalar vector quantities. Their applications in real life engineering problems. Furthermore, students will be introduced to more general concept, that is, Tensors.									
Course Out	comes: At t	he end of the course,	the student will b	be able to					
CO1	Learn the b	basic concepts of Vect	tor algebra, Dot p	product, Cross pro	duct.				
CO2	Learn abou	t operations on vecto	rs, such as, vecto	r triple product, so	calar triple product.				
CO3	Understand the Differentiation of Vector valued functions, Scalar valued functions, gradient, Divergence and curl.								
CO4	Be acquainted with Line, Surface and Volume integrals of vector (or scalar) valued functions. And, Gauss, Divergence and Stokes theorem, Tensors.								
CO5	Apply the learnt techniques in solving various problems related to vectors.								
	Map	ping of course outco	omes with the pr	ogram outcomes					
	PSO1	PSO2	PSO3	PSO4	PSO5				
CO1	2 2 2 2 2 2								
CO2	2	2	2	2	2				
CO3	2	2	2	2	2				
CO4	2	2	2	2	1				
CO5	2	2	2	2	1				

#### Course Title: Vector Calculus Course Code: UC-BSHM-401-19

#### UNIT-I

Vector Algebra: Dot and Cross product of two vectors, Scalar and vector product of three vectors. Scalar fields and vector fields. [Ref 2: Chapter-1B] Introduction to Suffix notation and summation convention, Kronecker delta.

#### **UNIT-II**

Vector Differentiation: Vector functions, Differentiation of a vector function, General rules for differentiation of vector function, Chain rule, Geometric interpretation of  $\frac{d\vec{r}}{dt}$ , Velocity and acceleration, Scalar and vector point function. [Ref 2: Chapter-1C]

#### UNIT-III

Gradient, divergence and Curl: Vector Differential operator, Gradient of a scalar function, Geometric interpretation of Gradient, Directional Derivative, Properties of Gradient, Divergence of a Vector point function, Physical interpretation of Divergence, Curl of Vector point function, Physical interpretation of curl, Properties of divergence and curl, Repeated operations by  $\nabla$ , Conservative vector field and Scalar Potential. [Ref 2: Chapter-1C]

#### **UNIT-IV**

Vector Integral Calculus: Introduction to Integration of vector functions, Line integral, Surface integral, Volume integral.

Integral Theorems: Green's theorem in the plane, Stoke's Theorem, Gauss' theorem of Divergence and their applications. [Ref 2: Chapter-1D]

#### **RECOMMENDED BOOKS:**

1. M. Spiegel, S. Lipschutz and D. Spellman, Vector Analysis and An Introduction to Tensor Analysis, 2nd Edition. U.K.: Schaum's Outline Series, McGraw Hill, 1980.

2. H. Anton and C. Rorres, Elementary Linear Algebra, New Delhi: Wiley, 2012.

3. P. C. Mathews, Vector Analysis, 2nd Indian reprint. Springer undergraduate Mathematics Series, Springer-Verlag London, 2008.

4. H. Lass, Vector and Tensor Analysis. McGraw Hill, 2007.

5. S. Narayan, Tensor Analysis. New Delhi: S. Chand, 2010.

UC-BSHM- 402-19		Ordinary Di	fferential Equat	tions L	-4, T-1, P-0	4 Credits			
Pre-requisite: Calculus									
The Objective of this course is to introduce ordinary differential equations and basic theory of existence and uniqueness of solutions. This course further explains the analytic techniques in computing the solutions of various ordinary differential equations appearing in various fields of science and technology.									
CO1	CO1 Understand the basic definitions to know about ordinary differential equations, its various types and their solutions								
CO2	Visua	alize the geometr	rical meaning of	first order dif	ferential equat	ion.			
CO3	Understand the fundamental concepts about existence and uniqueness of solution of initial value problem								
CO4	Understand the applications of differential equations in different type of phenomenon.								
CO5	Appl	y power series m	nethod to obtain	series solution	ns of differenti	al equations			
	Map	oping of course	outcomes with	the program	Specific outco	omes			
		PSO 1	PSO 2	PSO 3	PSO 4	PSO 5			
CO1		2	3	-	-	3			
CO2	2 2 3 - 3								
CO3	<b>3</b> 2 3 - 3								
CO4		2	3	-	-	3			
CO5	2 3 - 3								

# Course Title: Ordinary Differential Equations Course Code: UC-BSHM-402-19

#### UNIT-I

Basic definitions, Formulation of differential equations, order and degree of differential equation, primitives, initial value problem and solution of differential equations, First order differential equations: Linear, non-linear differential equations, Solution by variables separable, homogeneous, non-homogeneous exact equations, reducible in exact form and integrating factors, Solution of Leibnitz and Bernoulli's differential equation.

#### **UNIT-II**

Geometrical interpretation of first order differential equation, Successive approximation, Existence and uniqueness of solution of first order differential equations, Lipschitz condition, Picard's existence and uniqueness theorem.

#### **UNIT-III**

First order and higher degree equations solvable for x, y, p and Clairaut's form, Linear differential equations of first and higher order with constant coefficients, exponential decay model, lake pollution model (case study of Lake Burley Griffin), exponential growth of population (Scope as in Chapters 1, 3 of S. L. Ross).

#### **UNIT-IV**

Linear differential equations with variable coefficients, Cauchy's Euler equation and Legendre's equation, Linear independence, Linear dependence, Wronskian, Variation of parameters method.

#### **RECOMMENDED BOOKS**

- 1. S.L. Ross, Differential Equations, 3rd edition, John Wiley and Sons, 2004
- 2. W. E. Boyce and R. C. Diprima, 4th edition, Elementary differential equations and boundary value problems, John Wiley and Sons,1986.
- 3. M.D. Raisinghania, Ordinary and Partial Differential Equations, S Chand Publisher, 15th edition, 2013
- 4. E. A. Coddington, An introduction to ordinary differential equation, Prentice- Hall of India.

UC-BSHN	<b>A-403-</b> 1	19 I	Linear Algebra	gebra L-4, T-1, 1				-1, P-0 4 Credits		
<b>Pre-requisite:</b> - Sets, Relations and Functions										
<b>Course Objectives:</b> This course is designed to introduce the basic concepts of linear algebra <i>viz</i> .										
vector space	vector spaces, linear transformation and eigenvalue problem etc. The main focus of the course									
will be on th	neoretic	al foundation of	t these concepts	including	explar	nation throug	gh ez	xamples.		
<b>Course Outcomes:</b> At the end of the course, the students will be able to										
CO1	Deal v	with the notions	of vector spaces	s and linea	r trans	formations.				
CO2	Demo	nstrate matrix r	epresentation of	linear tran	nsform	ation.				
CO3	Deal	with the eigen	value and eiger	nvector pr	oblem	arising in	diffe	erent fields of		
	applic	ations, for insta	ance, in solution	of system	n of li	near differer	ntial	equations and		
	stabili	ty of numerical	methods etc.							
CO4	Diagonalize a given matrix using the eigenvalues and eigenvectors of the									
	corres	ponding matrix		U		e				
C05										
05	Demo		y of matrices an	d use of a	metho	d to check s	111111	arity of two		
	matric									
		• 6			C	• 6• 4				
	Мар	ping of course	outcomes with	the progr	am Sp	ecific outco	mes	5		
		PSO 1	PSO 2	PSO	3	PSO 4		PSO 5		
CO1		3	3	-		-		1		
CO2	3 3 - 1									
CO3		2	3	-		-		1		
004		2	2					1		
04		2	3	-		-		1		
CO5		2	3	-		-		1		
				1						

#### Course Title: Linear Algebra Course Code: UC-BSHM-403-19

#### UNIT-I

Vector spaces, subspaces, span of a set, intersection and union of subspaces, direct sum of subspaces, linear dependence and independence of vectors, basis and dimension of a vector space, finite dimensional vector spaces.

#### **UNIT-II**

Linear transformations, matrices as linear transformations, kernel and image of linear transformation, rank and nullity of a linear transformation, Rank-Nullity theorem, inverse of a linear transformation,

#### **UNIT-III**

Singular and non-singular linear transformations, isomorphism, algebra of linear maps, composition of linear maps, Matrix representation of a linear transformation, properties of matrix representation, change of basis.

#### **UNIT-IV**

Polynomials of matrices, characteristic polynomial, eigenvalues and eigenvectors, properties of eigenvalues and eigenvectors, Cayley-Hamilton theorem and its applications, similarity of matrices, diagonalization of a matrix, quadratic forms, minimal polynomial.

#### **RECOMMENDED BOOKS**

1. Serge Lang, Introduction to Linear Algebra, 2nd Edition, Springer, 1997.

2. D. C. Lay, S. R. Lay, J. J. McDonald, Linear Algebra and its Applications, 5th Edition, 2014.

3. V. Krishnamurthy, V. P. Mainra, J. L. Arora, Introduction to Linear Algebra, East-West Press, 1976.

UC-BSHM	[-404-19	Proba	bility and Statis	tics	L-4, '	Т-1, Р-0	4 Credits			
Pre-requisite: - Basic statistics, Permutation & combination and the basic knowledge of										
probability at 10+2 level.										
Course Objectives: The objective of the course is to prepare students for big data analysis by										
introducing basic concepts of statistics and probability theory along with their applications.										
Course Out	tcomes: A	At the end of t	he course, the st	udents wi	ll be ab	le to				
CO1	Understa	and the mea	sures of central	l tendenc	y, the	concepts li	ke skewness and			
	standard	deviation of	the data.							
CO2	Correlat	e bivariate an	d multivariate da	ata.						
CO3	Fit the c	urve by colle	cting random dat	a and und	lerstand	regression	ines.			
CO4	Understand the mathematical definition of probability, conditional probability and									
	its applications.									
CO5	Understand the theoretical concepts like random variable, probability distribution,									
	generating functions and their usage.									
	Mappi	ng of course	outcomes with	the progr	am Spe	ecific outcom	mes			
	I									
		PSO 1	PSO 2	PSO	3	PSO 4	PSO 5			
CO1		1	3	-		-	3			
CO2		1	3	-		_	3			
CO3	<b>CO3</b> 2 3 - 3						3			
<b>CO4</b> 2 3 -					-	3				
CO5		3	3	-		-	3			

#### **Subject Title: Probability and Statistics**

# Code: UC-BSHM-404-19

#### UNIT-I

Measure of central tendency, Measure of dispersion, Coefficient of variation, relation between measure of dispersion, Standard deviation of the combination of two groups, Moments, Skewness, Kurtosis. Correlation, Rank correlation.

#### **UNIT-II**

Curve fitting, graphical method, laws reducible to linear law, Principle of least squares, Method of least square, Fitting of  $y=ax^n$ ,  $y=ae^{bx}$ ,  $xy^n=b$ ; method of group averages, fitting a parabola, method of moments, Regression, lines of regression.

#### **UNIT-III**

Definition of probability, probability and set notations, Addition law of probability, Independent events-Multiplication law of probability, Baye's theorem

#### **UNIT-IV**

Random variable, discrete probability distribution, continuous probability distribution, expectation, variance, moments, moment generating function, probability generating function.

#### **RECOMMENDED BOOKS:**

1. S.C. Gupta and V.K. Kapoor, Mathematical Statistics.

2. Olive Jean Dunn, Virginia A. Clark, Basic Statistics, John Wiley & Sons, Inc., Publication.

<b>EVS-101A</b>	Environmental StudiesL-2, T-0, P-02 Credits									
Pre-requisites (if any): NA										
Course Objectives: The aim and objective of this course is to teach the fundamental concepts of										
Environment as a whole along with Natural Resources, their types, and issues related with sustainable										
use as its components along with social issues related with environment.										
Course Outcomes: At the end of the course, the student will be										
CO1	Understand th	ne fundamental conc	cepts about Environ	nent and its compo	nents.					
CO2	Know about various types of natural resources, their functions, uses, exploitation and the problems arise due to these along with suitable case studies.									
CO3	Gain knowledge about working of various ecosystems, their features and functions and energy flow through them.									
CO4	Know about biodiversity, its various forms, importance and important areas									
	Mapping of course outcomes with the program outcomes									
	PSO1 PSO2 PSO3 PSO4 PSO5									
CO1	1 3 - 3									
CO2	1 2 - 3									
CO3	3 - 3									
CO4	1 2 - 3									

# Course Tittle: Environmental Studies Course Code: EVS-101A

# UNIT-I

Multidisciplinary nature of environmental studies, Definition, scope and importance, Need for public awareness. (2)

#### **UNIT-II**

Natural Resources : Renewable and non-renewable resources : Natural resources and associated problems.

a) Forest resources : Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.

b) Water resources : Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.

c) Mineral resources : Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

d) Food resources : World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.

e) Energy resources : Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Case studies.

f) Land resources : Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

• Role of an individual in conservation of natural resources.

• Equitable use of resources for sustainable lifestyles.

#### (10)

#### UNIT-III

Ecosystems

- Concept of an ecosystem.
- Structure and function of an ecosystem.
- Producers, consumers and decomposers.
- Energy flow in the ecosystem.
- Ecological succession.
- Food chains, food webs and ecological pyramids.
- Introduction, types, characteristic features, structure and function of the

following ecosystem :-

- a. Forest ecosystem
- b. Grassland ecosystem
- c. Desert ecosystem
- d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

(8)

Scheme & Syllabus B.Sc. (Hons.) Mathematics Batch 2019 & Onwards

#### **UNIT-IV**

Biodiversity and its conservation

- Introduction Definition : genetic, species and ecosystem diversity.
- Biogeographical classification of India
- Value of biodiversity : consumptive use, productive use, social, ethical, aesthetic and option values
- Biodiversity at global, National and local levels.
- India as a mega-diversity nation
- Hot-spots of biodiversity.
- Threats to biodiversity : habitat loss, poaching of wildlife, man-wildlife conflicts.
- Endangered and endemic species of India
- Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity

#### (6)

# **RECOMMENDED BOOKS**

- 1. K.C. Aggarwal, Environmental Biology, Nidi Publishers, 2001
- 2. E.P. Odum, Fundamentals of Ecology, WB Saunders, 1971
- 3. Erach Bharucha, The Biodiversity of India, Mapin Publishers, 2003
- 4. Benny Joseph, Environmental Studies, McGraw Hills, 2015.
- 5. R Rajagopalan, Environmental Studies, Oxford Higher Education, 2016.
- 6. S.P. Misra & S.N. Pandey, Essential Environmental Studies, Ane Books Pvt. Ltd. 2016

# **Semester Fifth**

# Contact Hour: 28

S. No	Course Code	Course Title				Marks Distribution		Total	Cr
			Allocation					Marks	
			L	Т	Р	Internal	External		
1.	UC-BSHM-501-19	Real Analysis-II	4	1	-	40	60	100	4
2.	UC-BSHM-502-19	Algebra-II	4	1	-	40	60	100	4
3.	UC-BSHM-503-19	Numerical Methods	4	1	-	40	60	100	4
4.	UC-BSHM-504-19	Partial Differential	4	1	-	40	60	100	4
		Equations							
5.	UC-BSHM-505-19	Project Work	-	-	8	60	40	100	4

L: Lectures T: Tutorials P: Practical
# Semester Sixth

# **Contact Hours: 25**

S. No	Course Code	Course Title	Load		Marks Distribution		Total	Cr	
			Alloc	ation				Marks	
			L	Т	Р	Internal	External		
1.	UC-BSHM-601-19	Number Theory	4	1	-	40	60	100	4
2.	UC-BSHM-602-19	Complex Analysis	4	1	-	40	60	100	4
3.	UC-BSHM-603-19	Mechanics	4	1	-	40	60	100	4
4.	UC-BSHM-604-19	Discrete Mathematics	4	1	-	40	60	100	4
5.	UC-BSHM-605-19	Integral Equations and	4 1 -		40	60	100	4	
		Integral Transforms							

L: Lectures

T: Tutorials

P: Practical

UC-BSM-5 19	01- R Metric	eal Analysis-II: Spaces and Rein	lann	4, T-1, P-0	4 Credits				
	mugration								
Pre-requisite: Differential and Integral Calculus, Basic set theory									
<ul> <li>Course Objectives: The objectives of this course are to:</li> <li>1. Develop understanding of abstract mathematical concepts.</li> <li>2. Develop analytical and logical skills of students.</li> <li>3. Introduce to students the basic theorems of real analysis</li> <li>4. Prepare students for the study of advanced analysis.</li> <li>5. Develop understanding of Reimann integrable functions and their properties.</li> </ul>									
CO1	Understand the ba	sic concepts of R	eal Analysis.						
CO2	Visualize abstract	mathematical cor	ncepts						
CO3	Understand basic	theorems related t	o real analysis.						
CO4	Understand the lo	gical concepts and	l apply the kno	wledge to deriv	e the basic results.				
CO5	Understand the behavior of Reimann integrable functions.								
	Mapping of	course outcomes	s with the prog	ram outcomes	3				
	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5				
C01	5	-	-	-	4				
CO2	5	-	-	-	-				
CO3 5 -		-	-	-					
CO4	5	3	-	-	5				
CO5	-	5	-	-	4				

# Course Title: Real Analysis-II

# Course Code: UC-BSHM-501-18

# UNIT-I

Metric spaces: open sets, closed sets, limit points, interior of a set, closed set, dense and nowhere dense sets, exterior, frontier and boundary points and their properties, balls and bounded sets, limits and continuity (Definition and basic examples only of all above concepts). Sequences in metric spaces, convergent and Cauchy sequences, Complete Metric Spaces (Scope as in ref. 6, Chapter 1, section-1.2, 1.3, 1.4 definition and examples with propositions 1.4.1, 1.4.3 and 1.4.7 / ref.5 section 8.1.10-8.1.18 and sec.8.2).

# **UNIT-II**

Compact sets in a metric space, Heine Borel theorem, sequential compactness, Bolzano Weierstrass property, finite intersection property, continuity and compactness, separable sets, (Scope as in ref. 6, Chapter 5, Theorems 5.1.1-5.1.10, 5.1.14-5.1.15 only). Connectedness, connected subsets of reals, continuity and connectedness. (Basic definitions and fundamental theorems only: Scope as in ref. 6, Chapter 4, Theorems 4.1.3 to 4.1.11 only)

## **UNIT-III**

Riemann Integration, Upper and Lower Darboux Sums, Riemann Sums and definition of Riemann integral through Riemann sums, Cauchy Criterions for integrability, Equivalence of two definitions. The Class of Riemann integrable functions, Properties of the Riemann integral, Fundamental theorems of Calculus. Scope as in Ref 2. Chapter 6 (Art. 32.1 to 32.9, 33.1, 33.2, 33.3, 33.4 to 33.8, 33.9, 34.1, 34.3)

## **UNIT-IV**

Improper Integrals, Tests for Convergence of Improper Integrals, Beta and Gamma functions.

Scope as in Ref. 3 Chapter 11 and ref. 2, 8.17 to 8.20.

# **Text Books**

- 1. T. M. Apostol, Mathematical Analysis, 2nd Edition, Narosa Publishing House, Reprint 2002.
- 2. K.A. Ross, Elementary Analysis, The Theory of Calculus, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
- 3. S. C. Malik and Savita Arora, Mathematical Analysis, 3rd Edition, New Age International Publishers, 2008.
- 4. Shanti Narayan, A Course of Mathematical Analysis, S. Chand and Company Ltd.1984.
- 5. William F.Trench, Introduction to real Analysis, Trinity University, San Antonio, Texas, USA, (Open Book Initiative of American Institute of Mathematics)

6. Satish Shirali, Harkishan L. Vasudeva, Metric Spaces, Springer Verlag, London, 2006.

- 1. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill, 2004.
- 2. Charles G. Denlinger, Elements of Real Analysis, Jones & Bartlett (Student Edition), 2011.
- 3. M. H. Protter and C. B. Morrey, A First Course in Real Analysis, 2nd Edition, Springer Verlag, Indian Reprint, 2004.
- 4. W. Rudin. Principles of Mathematical Analysis, 3rd edition. McGraw Hill, 1976.
- 5. N. L. Carothers, Real Analysis, Cambridge University Press 2000.

UC-BSM-5(	)2-	Algbera-II	L-	4, T-1, P-0	4 Credits					
Pre-requisite: Sets, Relations and Functions										
Course Objectives: The objectives of this course are to:										
1. Deve	<ol> <li>Develop understanding of axiomatic algebraic structures.</li> <li>Develop understanding of axiomatic algebraic structures.</li> </ol>									
2. Deve	<ol> <li>Develop analytical and logical skills of students.</li> <li>Introduce basic algebraic structures: Groups and Pings</li> </ol>									
4. Prepa	the students for the	study of advance	d abstract algebr	a						
5. Deal	with axiomatic stru	ictures occurring	in science and er	ngineering.						
Course Out	comes: At the end	of the course, the	students will be	able to						
CO1	Deal with differen	t algebraic structu	res occurring in	abstract algebra						
CO2	Analyze algebraic	structure Group a	and its properties	•						
CO3	Analyze algebraic	structure Ring an	d its properties.							
CO4	Apply the knowledge of abstract mathematics in studying advanced pure mathematics.									
CO5	Apply the methods of proofs in proving theoretical results in other branches, for example, in science and engineering									
	Mapping of	course outcomes	s with the progr	am outcomes						
	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5					
CO1	5	-	-	-	5					
CO2 5				-	5					
CO3 5				-	5					
CO4	5	-	-	-	5					
CO5	5	-	-	-	5					

# **Course Title: Algebra-II**

## Course Code: UC-BSHM-502-18

# UNIT-I

Binary operations, symmetries of a square, Groups, semi groups, quaternion groups, groups of integers modulo n, symmetric groups, cyclic notation for permutations, even and odd permutations, properties of permutations, elementary properties of groups.

# **UNIT-II**

Subgroups and examples of subgroups, center of a group, centralizer, normalizer, cosets, Lagrange's theorem on finite groups, index of a subgroup, product of two subgroups, Cyclic groups and their properties.

#### **UNIT-III**

Normal subgroups, simple subgroup, quotient group, Group homomorphisms, properties of homomorphism, properties of isomorphism, First, second and third isomorphism theorems, Dihedral group, permutation groups, Cayley's theorem.

## **UNIT-IV**

Definitions and examples of rings, properties of rings, subrings, integral domains and fields, characteristic of a ring, Ideals, sum and product of ideals.

# Textbooks

- 1. V. K. Khanna, S. K. Bhambri, A Course in Abstract Algebra, 4th Ed., Vikas Publishing House, 2013.
- John B. Fraleigh, Neal E. Brand, A First Course in Abstract Algebra, 8th Ed., Pearson, 2021.

- 1. M. Artin, Algebra, 2nd Ed., Pearson, 2011.
- 2. Joseph A. Gallian, Contemporary Abstract Algebra, 8th Ed., Cengage, 2013.

UC-BSM-5	03-	Nun	nerical Methods		L-4, T-1, P-0	4 Credits			
19									
Pre-requisite: Differential and Integral Calculus									
<ul> <li>Course Objectives: The objectives of this course are to: <ol> <li>Introduce numerical methods for solving continuous problems which are difficult to deal with analytically.</li> <li>Develop analytical and computational skills of students.</li> <li>Introduce methods to deal with nonlinear equations, system of linear algebraic equations.</li> <li>Introduce methods for constructing interpolating polynomials.</li> <li>Introduce methods to deal with numerical differentiation, numerical integration and ordinary differential equations.</li> <li>Develop understating of computational mathematics and also to demonstrate its importance in science and engineering.</li> </ol> </li> </ul>									
Course Out	com	les: At the end o	of the course, the	students wi	II be able to				
C01	Fin alg	d approximate a	numerical solution	ons of nonli	inear equations an	nd system of linear			
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	Ap pro	ply the understand	anding of compu- tin science and e	utational teo ngineering.	chniques in dealing	ng with real world			
	<b>P</b> ¹⁰	Mapping of o	course outcomes	with the p	rogram outcome	S			
		PSO 1	PSO 2	PSO 3	PSO 4	PSO 5			
C01		3	4	-	-	5			
CO2	3 5 - 5								
CO3	3 4 - 5								
CO4		3	4	-	-	5			
CO5		3	3	-	-	5			

## **Course Title: Numerical Methods**

## Course Code: UC-BSHM-503-18

# 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. 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, Newton's forward and backward difference interpolation formulas.

#### **UNIT-III**

Numerical differentiation: methods based on finite differences. Numerical integration: idpoint 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, Euler's method, Taylor series method, Runge-Kutta methods, linear multi-step methods: Adams-Bashforth methods and Adams-Moulton methods.

## Textbooks

- 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.

- 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.

UC-BSM-5	04- Partial Diffe	erential Equation	n (PDE)	L-4, T-1, P-0	4 Credits					
19										
Pre-requisit	<b>Pre-requisite:</b> Calculus of several variables and ODE									
Course Obi	<b>Course Objectives:</b> The objectives of this course are to:									
1. Intro	1. Introduce Partial differential equations and different methods to solve it.									
2. Deriv	ve heat and wave eq	uations.								
3. Find	the solutions of PD	Es with boundary	conditions.	o DDEc and analy	za tha babayiar					
5. Deve	lon the skills that w	vill allow students	to work effe	ectively with the c	concepts					
Course Out	comes: At the end of	of the course, the	students wil	l be able to						
		,								
CO1	Solve linear partial	l differential equa	tions of both	n first and second	order.					
CO2	Classify the Partial	differential equa	tions.							
CO3	Apply problem-so	lving using con	cepts and te	chniques from I	PDE's and Fourier					
	analysis applied	to diverse situa	ations in p	hysics, engineer	ing and in other					
CO4	Demonstrate accu	exis.	t use of Fo	urier englycic te	chniques and their					
04	applications in the	theory of PDE's.		uner analysis te	chiliques and their					
CO5	Solve real problem	s by identifying t	hem appropr	riately from the pe	erspective of partial					
	derivative equation	) <i>j j j</i>	11 1	<b>y</b> 1	1 1					
	Mapping of	course outcomes	with the pr	ogram outcomes	5					
	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5					
COI	5	-	-	-	5					
CO2	5	-	-	-	5					
CO3	5	-			5					
CO4	5	-	-	-	5					
CO5	5	-	-	-	5					

# Course Title: Partial Differential Equations (PDE) Course Code: UC-BSHM-504-18

# UNIT-I

Introduction of a PDE, Surfaces and Normals, Formation of PDE, Solution of PDE of first order, Lagrange's method, Integral surfaces passing through a given curve, surfaces orthogonal to a given system of surfaces. Non-linear partial differential equation of the first order, Cauchy method of characteristics, compatible systems of first order equations, Charpit's method.

## **UNIT-II**

Classification of a second order PDE, Elliptic equations: Derivation of Laplace equation, Boundry value problems, Method of separation of variables, Solution of Laplace equation in cylindrical and spherical coordinates.

#### **UNIT-III**

Parabolic differential equations: Occurrence of diffusion equation, Boundary conditions, Solution by separation of variables method, Solution of diffusion equation in cylindrical spherical coordinates.

#### **UNIT-IV**

Hyperbolic differential equation: Derivation of one - dimensional wave equation, vibrating string-variables separation solution, Periodic solution of one - dimensional wave equation in cylindrical and spherical polar coordinates.

## **Books Recommended:**

- 1. K. Sankara Rao, Introduction to Partial differential Equations (Second Edition), PHI.
- 2. Walter A. Strauss, Partial differential equations An Introduction, John Wiley and Sons.
- Sneddon I. N, Elements of Partial differential equations, Dover Publications, Inc. Newyork, 2006.
- 4. Ross S. L, Differential equation. 3rd Ed., John Wiley and Sons, India, 2004.

UC-BSHN 601-19	1-	Num	ber Theory	L-4	, T-1, P-0	4 Credits			
Pre-requisite: Numbers system and Basic operations on numbers.									
Course Objectives: The objectives of this course are to:									
<ol> <li>Intro</li> <li>Deve</li> <li>Fund</li> <li>Deve</li> </ol>	duce t elop u lament elop th	he fundamental of understanding of tal theorem of ar e skills that will	concepts of the l of the fundam ithmetic, congru allow students t	Number theory ental concepts ences etc. o apply the con	of Number	r theory such as			
Course Out	comes	s: At the end of t	he course, the st	udents will be a	ble to				
CO1	Unde Trian	erstand well ord	lering principle	, Archimedean	Property, B	inomial theorem,			
CO2	Describe basic properties of GCD and LCM and having the ability to compute them.								
CO3	Decide the primality of a given number and be able to understand the concept of infinite primes.								
CO4	Appl	y Chinese remain	nder theorem.						
CO5	Unde	erstand the utility	of Divisibility t	ests.					
		Mapping of cou	irse outcomes v	vith the progra	m outcomes				
		PSO 1	PSO 2	PSO 3	PSO 4	PSO 5			
CO1		3	3	2	2	3			
CO2	CO2         3         2         2         2         3								
CO3		3	2	2	2	3			
CO4		2	3	2	2	3			
CO5	CO5         3         2         2         2         3								

## **Course Title: Number Theory**

## Course Code: UC-BSHM-601-19

## UNIT-I

**Earlier Number Theory:** 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 and their solutions.

#### **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.

# **RECOMMENDED BOOKS:**

- 1. David M. Burton, Elementary Number Theory, 7th Ed., Tata McGraw-Hill, 2007, Print.
- Neville Robinns, Beginning Number Theory, 2nd Ed., Narosa Publishing House Pvt. Ltd., 2007. Print.

UC-BSM-60	02- Co	Complex Analysis			4 Credits					
Pre-requisit	Pre-requisite: Complex numbers system and Calculus of several variables.									
<ul> <li>Course Objectives: The objectives of this course are to: <ol> <li>Introduce the fundamental ideas of the functions of complex variables</li> <li>Develop understanding of the fundamental concepts of Complex Analysis such as analytic functions, complex integrals etc. and</li> <li>Learn the technique to solve the problems using Cauchy's theorem, Cauchy's integral</li> </ol> </li> </ul>										
formula etc. 4. Develop the understanding to solve the problems of Contour Integration. 5. Develop the skills that will allow students to work effectively with the concepts. <b>Course Outcomes:</b> At the end of the course, the students will be able to										
CO1 CO2	Understand Complex functions, Its continuity and differentiability. Describe basic properties of complex integration and having the ability to compute									
CO3	such integrals. Decide when and where a given function is analytic and be able to find its series development									
CO4	Apply residue the	eorem to compute	the several kind	ls of real integr	als.					
005	Mapping o	f course outcome	s with the prog	gram outcomes						
	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5					
CO1	5	-	-	-	5					
CO2 5				5						
CO3 5 -		-	-	5						
CO4 5		-	-	-	5					
CO5	5	-	-	-	5					

# Course Title: Complex Analysis Course Code: UC-BSHM-602-18

# 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.

#### **Books Recommended:**

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

UC-BSM-603-		Mechanics	]	L-4, T-1, P-0	4 Credits					
19 Pro-roquisito:	Pre-requisite: Sets Relations and Functions									
re-requisite. Sets, relations and Functions										
Course Object	<b>Course Objectives:</b> The objectives of this course are to:									
1. Develop	o understanding c	of concept of forc	e, coplanar, co	oncurrent forces	, their resultant.					
2. Develop	o concept of statio	equilibrium and	l the governing	g laws of equilit	orium.					
3. Introduc	ce the concept of	Friction, kinds of	f friction and i	ts laws.						
4. Develop	o understanding o	f the basic laws c	of mechanics g	overning the mo	otion of the particle.					
5. Introduc	the law of ener	gy and its princip	ples.		. 1					
6. Develop	o understanding	for solving real	life mechanic	s problems rela	ited to science and					
enginee	ring.	£ (1		1-1- 4-						
Course Outcol	nes: At the end of	of the course, the	students will t	be able to						
CO1 U	nderstand the sys	tem of different f	forces and its e	ffect on the phy	usical body					
	inderstand the sys			field of the phy	sicul obuy.					
<b>CO2</b> U	nderstand the var	ious concepts of	statics and dyi	namics.						
<b>CO3</b> U	nderstand the var	ious mathematic	al laws of med	chanics dealing	with the motion of					
th	e particle and the	static equilibriu	m.							
CO4 A	pply the knowled	ge of Mechanics	in solving real	life problems re	elated to mechanics.					
<b>CO5</b> V	involiza the real	lifa machanical r		d to coionaa a	nd anginaaring and					
CU5 V	ame the mathema	tical problems al	ong with sugg	ested solutions	nu engineering anu					
110	Manning of a	rourse outcomes	with the pro-	ram outcome	3					
	mapping of v				5					
	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5					
CO1	-	5	-	-	5					
~~~										
CO2	-	5	-	-	5					
				5						
	5	5	_	_	5					
CO4	-	5	-	-	5					
005	3	5	-	-	5					

Course Title: Mechanics

Course Code: UC-BSHM-603-18

UNIT-I

Concept of Force and the system of forces, Resultant of the Force system, Coplanar and concurrent force system and their resultant, resolution and composition of forces, turning effect of forces, resultant of coplanar non-concurrent force system, funicular polygon, concept of equilibrium, possible displacements of a body, conditions of equilibrium for coplanar force system, body constraints and free body diagrams, reactions.

UNIT-II

Gravity and gravitational force, centre of gravity, centroid, Location of centre of gravity of solids, location of centre of gravity through method of integration, Friction, laws of friction, coefficient of friction, moment of frictional force, rough inclined plane.

UNIT-III

Motion of particles, rectilinear motion of particles, curvilinear motion of particles, kinematics of rigid bodies, Newton's laws of motion, equation of motion, linear momentum of particle, impulse and momentum, conservation of linear momentum, D'Alembert's Principle, circular motion.

UNIT-IV

Work, energy their Principles and applications to rigid bodies undergoing rectilinear and curvilinear translations. Applications of work and energy principle to bodies undergoing rotation about a fixed axis, potential energy, conservation of energy, power.

Textbooks

1. M. M. Malhotra, R. Subramanian, P. S. Gahlot, B. S. Rathore: Textbook in Applied Mechanics, New Age International, 2003.

- 1. Dynamics by A. S. Ramsey, Cambridge University Press.
- 2. The Elements of Statics and Dynamics: Part 2 (Dynamics) by S. L. Loney, Arihant Prakashan, Meerut.

UC-BSHM- 604-19		Discret	e Mathematics	L-4,	T-1, P-0	4 Credits				
Pre-requisi	Pre-requisite: Numbers system and Primality.									
Course Obj	Course Objectives: The objectives of this course are to:									
 Introduce the basic ideas of sets, relations and functions. Develop understanding of the fundamental concepts of Basic Counting principles. Develop the skills that will allow students to work effectively with the concepts. 										
Course Out	tcomes	s: At the end of t	he course, the st	udents will be al	ole to					
CO1	Unde	erstand sets, relat	ions, and function	ons.						
CO2	Desc	ribe basic proper	ties of graph the	eory.						
CO3	Decie	de when and whe	ere a given funct	ion is one-one, o	onto.					
CO4	Appl	y logics for infer	rences.							
CO5	Unde	erstand the applic	cability of basic	counting princip	les in daily life	problems.				
		Mapping of co	ourse outcomes v	with the program	outcomes					
		PSO 1	PSO 2	PSO 3	PSO 4	PSO 5				
CO1		3	3	2	2	3				
CO2	CO2 3 2 2 2 3									
CO3	CO3 3 2 2 2 3									
CO4		2	3	2	2	3				
CO5		3	2	2	2	3				

Course Title: Discrete Mathematics

Course Code: UC-BSHM-604-19

UNIT- I

Set Theory, Relations and Functions: Sets, Algebra of Sets, Ordered Sets, Subsets, Relations, Equivalence Relations and Partitions, Hasse diagram, Functions, Composition of Functions, One-One, onto and Inverse of a function Number of one-one functions.

UNIT-II

Basic Counting Principles and Recurrence Relations: Permutation, Combinations, Pigeonhole Principle, Inclusion-exclusion Principle, Recurrence Relations, Characteristic Equation, Homogeneous and non-homogeneous linear recurrence relations with constant coefficients, Generating Functions for some standard sequences.

UNIT-III

Graphs Theory and Basic Terminology: Simple graphs, Multiple graphs, Connected graphs, Complete graphs, Handshaking Theorem, Isomorphism of Graphs, Walks, Paths, Circuits, Eulerian and Hamiltonian Paths, Planar and Non Planar Graphs, Shortest path, Directed graphs, Travelling Salesman Problem.

UNIT-IV

Logic and Boolean algebra: Propositions, Basic logic operators, Logic equivalence involving Tautologies and Contradiction, Conditional Propositions, Quantifiers, Introduction to Boolean algebra, Laws of Boolean algebra, Boolean function, Sum of product form, Logic gates and circuits.

RECOMMENDED BOOKS:

- 1. K. H. Rosen, Discrete Mathematics and its Applications, 6th Edition, McGraw Hill, 2007.
- 2. S. Lipschutz and M. L. Lipson. Schaum 's Outline of Discrete Mathematics, Schaum 's Outlines, 2007. Print.
- 3. B. Ram, Discrete Mathematics. Pearson Publications, 2011. Print.
- 4. C. L. Lui, Elements of Discrete Mathematics. McGraw Hill, International Edition, Computer Science Series.1986. Print.
- 5. J.P. Trembley and R.P. Manohar, Discrete Mathematical Structures with Applications to Computer Science. McGraw Hill, 1975. Print.

UC-BSHN 605-19	1-	Integral E	quations and In Transforms	L-4, T-1, P-0	4 Credits					
Pre-requisit	te: D	ifferential and I	ntegral Calculus							
Course Objectives: The objectives of this course are to:										
1. Deve	elop u	understanding o	f Integral equation	ons occurrin	g in science and e	engineering.				
2. Intro	duce	Integral Trans	forms: Laplace	Transform	and Fourier Tran	nsform and also to				
demo	onstra	ate their applica	tions.							
3. Deve	elop u	inderstanding o	f applicable math	nematics.						
Course Out	come	es: At the end o	f the course, the	students wi	ll be able to					
CO1	Und	lerstand the sign	nificance of Integ	gral equation	ns					
CO2	Solv	ve Integral equa	tions and apply t	he knowled	ge to real world p	roblems.				
CO3	App	bly Laplace tran	sform for solving	g certain dif	ferential equation	s.				
CO4	App	ly Fourier trans	form for solving	certain diff	ferential equations	5 .				
CO5	App	oly understandi	ng of applicable	mathematic	es for solving pro	blems occurring in				
	scie	nce and engined	ering.			C				
		Mapping of c	course outcomes	with the p	rogram outcome	s				
		PSO 1	PSO 2	PSO 3	PSO 4	PSO 5				
CO1		3	5	-	-	5				
CO2	2 3		5	-	-	5				
CO3		3	5	-	-	5				
CO4		3	5	-	-	5				
C05		2	E							
05		3	5	-	-	5				

Course Title: Integral Equations and Integral Transforms

Course Code: UC-BSHM-605-19

UNIT-I

Integral Equations: Definition of Integral equation, Relation between differential and Integral equations, The Green's function, Conversion of boundary value problems to integral equations using Green's function, solution of integral equations, Integral equations of convolution type, Abel's Integral equation, Integro-differential equations.

UNIT-II

Integral equations (Continue): Integral equations with separable kernels, Solution of Fredholm equations with separable kernels, Solution of Fredholm and Volterra equations by the method of successive approximations.

UNIT-III

Laplace Transform Laplace transform and inverse Laplace transform, sufficient conditions for existence of Laplace transform, linearity property, shifting property, change of scale property, Laplace transform of derivatives and integrals, differentiation of Laplace transform, integration of Laplace transform, convolution theorem, Laplace transform of periodic functions, Solution of initial value problems of ordinary differential equations by Laplace transform.

UNIT-IV

Fourier Transform Fourier transform and its inversion formula, linearity property, shifting property, Modulation theorem, Fourier transform of derivative, Fourier transform of integral, convolution, Fourier cosine transform, Fourier sine transform, Solution of some initial-boundary value partial differential equations using Fourier transform.

Textbooks

- 1. Francis B. Hildebrand, Methods of Applied Mathematics, Prentice-Hall, INC, 1965.
- 2. B. S, Grewal, Higher Engineering Mathematics, Khanna Publishers, New Delhi
- 3. R. K. Jain, S. R. K. Iyengar, Advanced Engineering Mathematics, 5th Ed., Narosa, 2019.
- 4. Baidyanath Patra, An Introduction to Integral Transforms, 1st Ed., CRC Press, 2018.

Reference Books

Lokenath Debnath, Integral Transforms and Their Applications, 3rd Ed., Chapman and

Hall/CRC, 2014.