Scheme and Syllabi

for

Dual Degree B.Sc. (Hons.) Mathematics – M.Sc. Mathematics

(3+2 Years Programme)

Under Choice Based Credit System

(w.e.f. 2016-17)

DEPARTMENT OF MATHEMATICS

GURU JAMBHESHWAR UNIVERSITY OF SCIENCE & TECHNOLOGY

HISAR – 125001, HARYANA

Scheme and Syllabi of Programme for

Dual Degree B.Sc. (Hons.) Mathematics – M.Sc. Mathematics

under Choice Based Credit System

(w.e.f. 2016-2017)

Semester - I

Course Opted	Paper Code	Nomenclature	Credit	Hours/ Week	Marks		
					External	Internal	Total
Ability Enhancement Compulsory Course-I	BXL 101	English	2	2	70	30	100
Ability Enhancement Compulsory Course-II	BXL 102	Environmental Sciences	2	2	70	30	100
Bridge Course-I	BML 101	Elementary Mathematics - I	4	4	70	30	100
Core Course-I	BML 102	Mathematics - I: Basic Algebra	4	4	70	30	100
Generic Elective-I	BPL 101	Physics - I: Mechanics (Batch 2016 only)	4	4	70	30	100
	BPL 101	Physics - I: Mechanics (Batch 2017 and 2018 only)	4	4	70	30	100
	BPL 101	Physics - I: Mechanics (Batch 2019 onwards)	4	4	70	30	100
Generic Elective-II	BCL 101	Chemistry - I	4	4	70	30	100
Generic Elective-III	BBL 101	Elementary Biology - I (Fundamentals of Biology) (Batch 2016-2019)	4	4	70	30	100
	BBL 101	Elementary Biology - I (Fundamentals of Biology) (Batch 2020 onwards)	4	4	70	30	100

Generic Elective Practical-I	BPP 101	Physics Lab - I (Batch 2016-2018)	2	4	70	30	100
	BPP 101	Physics Lab - I (Batch 2019 onwards)	2	4	70	30	100
Generic Elective Practical-II	BCP 101	Chemistry Lab - I	2	4	70	30	100
Generic Elective Practical-III	BBP 101	Biology Lab - I (Batch 2016-2019)	2	4	70	30	100
	BBP 101	Biology Lab - I (Batch 2020 onwards)	2	4	70	30	100
		Total	**26**	**32**	**630**	**270**	**900**

Note:

(i) Students, who have not studied Mathematics at 10+1 and 10+2 level, will opt the paper Elementary Mathematics-I (BML-101) and students, who have studied Mathematics at 10+1 and 10+2 level, will opt the paper Elementary Biology-I (BBL-101) & Mathematics - I (BML-102).

(ii) Paper code BML 101 is offered by the Dept. of Mathematics for the students of other Departments.

(iii) Semesters I and II will be common for all the four programmes.

Semester - II

Course Opted	Paper Code	Nomenclature	Credit	Hours/ Week	Max. Marks		
					External	Internal	Total
Ability Enhancement Compulsory Course-III	BXL 201	Hindi	2	2	70	30	100
Bridge Course-II	BML 201	Elementary Mathematics - II	4	4	70	30	100
Core Course-II	BML 202	Mathematics - II: Calculus	4	4	70	30	100
Generic Elective-IV	BPL 201	Physics – II: Waves and Optics (Batch 2016 only)	4	4	70	30	100
	BPL 201	Physics – II: Waves and Optics (Batch 2017 and 2018 only)	4	4	70	30	100
	BPL 201	Physics – II: Heat and Thermodynamics (Batch 2019 onwards)	4	4	70	30	100
Generic Elective-V	BCL 201	Chemistry – II	4	4	70	30	100
Generic Elective- VI	BBL 201	Elementary Biology - II (Cell Biology) (Batch 2016-2019)	4	4	70	30	100
	BBL 201	Elementary Biology - II (Cell Biology) (Batch 2020 onwards)	4	4	70	30	100
Generic Elective-VII	BXL 202	Computer Science	2	2	70	30	100
Generic Elective Practical- IV	BPP 201	Physics Lab – II (Batch 2016 only)	2	4	70	30	100
	BPP 201	Physics Lab – II (Batch 2017 and 2018 only)	2	4	70	30	100
	BPP 201	Physics Lab – II (Batch 2019 onwards)	2	4	70	30	100

Generic Elective Practical- V	BCP 201	Chemistry Lab – II	2	4	70	30	100
Generic Elective Practical- VI	BXP 201	Computer Science-Lab	2	4	70	30	100
		Total	**26**	**32**	**630**	**270**	**900**

Note:

(i) Students, who have not studied Mathematics at 10+1 and 10+2 level, will opt the paper Elementary Mathematics - II (BML-201) and students, who have studied Mathematics at 10+1 and 10+2 level, will opt the paper Elementary Biology - II (BBL-201) & Mathematics - II (BML-202).

(ii) Paper code BML 201 is offered by the Dept. of Mathematics for the students of other Departments.

Semester - III

Course Opted	Paper Code	Nomenclature	Credit	Hours/ Week	Max. Marks		
					External	Internal	Total
Core Course- III	BML 301	Number Theory and Trigonometry	5	5	70	30	100
Core Course- IV	BML 302	Ordinary Differential Equations	5	5	70	30	100
Core Course- V	BML 303	Advanced Calculus	5	5	70	30	100
Core Course- VI	BML 304	Vector Calculus	5	5	70	30	100
Core Course- VII	BML 305	Mathematical Statistics	5	5	70	30	100
Skill Enhancement Course- I	BML 306	Special Functions-I	2	2	36	14	50
		Total	**27**	**27**	**386**	**164**	**550**

Semester - IV

Course Opted	Paper Code	Nomenclature	Credit	Hours/ Week	Max. Marks		
					External	Internal	Total
Core Course -VIII	BML 401	Solid Geometry	5	5	70	30	100
Core Course- IX	BML 402	Transform Techniques	5	5	70	30	100
Core Course- X	BML 403	Elementary Partial Differential Equations	5	5	70	30	100
Core Course- XI	BML 404	Statics	5	5	70	30	100
Core Course- XII	BML 405	Operations Research-I	5	5	70	30	100
Skill Enhancement Course- II	BML406	Special Functions-II	2	2	36	14	50
		Total	**27**	**27**	**386**	**164**	**550**

Semester - V

Course Opted	Paper Code	Nomenclature	Credit	Hours/ Week	Max. Marks		
					External	Internal	Total
Core Course- XIII	BML 501	Real Analysis	5	5	70	30	100
Core Course- XIV	BML 502	Groups and Rings	5	5	70	30	100
Core Course- XV	BML 503	Programming in C & Numerical Methods	5	5	70	30	100
Core Course Practical- XV	BMP 504	Programming in C & Numerical Methods - Lab	2	4	35	15	50
Discipline Specific Elective- I	BML 505	Sequences and Series	5	5	70	30	100
Discipline Specific Elective- II	BML 506	Operations Research-II	5	5	70	30	100
		Total	**27**	**29**	**385**	**165**	**550**

Semester - VI

Course Opted	Paper Code	Nomenclature	Credit	Hours/ Week	Max. Marks		
					External	Internal	Total
Core Course- XVI	BML 601	Real and Complex Analysis	5	5	70	30	100
Core Course- XVII	BML 602	Linear Algebra	5	5	70	30	100
Core Course- XVIII	BML 603	Numerical Analysis	5	5	70	30	100
Core Course Practical- XVIII	BMP 604	Numerical Analysis - Lab	2	4	35	15	50
Discipline Specific Elective- III	BML 605	Dynamics	5	5	70	30	100
Discipline Specific Elective - IV	BML 606	Mathematical Modeling	5	5	70	30	100
		Total	**27**	**29**	**385**	**165**	**550**

Semester - VII

Paper Code	Nomenclature	Credit	Hours/ Week	Max. Marks		
				External	Internal	Total
MML 711	Abstract Algebra-I	5	5	70	30	100
MML 712	Real Analysis	5	5	70	30	100
MML 713	Mechanics	5	5	70	30	100
MML 714	Advanced Differential Equations	5	5	70	30	100
MML 715	Complex Analysis-I	5	5	70	30	100
MML 716	Programming with Fortran (Theory)	5	5	70	30	100
MMP 717	Programming with Fortran (Practical)	1.5	3	70	30	100
	Total	**31.5**	**33**	**490**	**210**	**700**

Semester - VIII

Paper Code	Nomenclature	Credit	Hours/ Week	Max. Marks		
				External	Internal	Total
MML 721	Abstract Algebra-II	5	5	70	30	100
MML 722	Measure & Integration Theory	5	5	70	30	100
MML 723	Advanced Mathematical Statistics	5	5	70	30	100
MML 724	Differential Equations and Calculus of Variations	5	5	70	30	100
MML 725	Complex Analysis-II	5	5	70	30	100
MML 726	Advanced Numerical Methods	5	5	70	30	100
MMP 727	Computing Lab – MatLab	1.5	3	70	30	100
	Total	**31.5**	**33**	**490**	**210**	**700**

Semester - IX

Paper Code	Nomenclature	Credit	Hours/ Week	Max. Marks		
				External	Internal	Total
MML 831	Topology	5	5	70	30	100
MML 832	Partial Differential Equations	5	5	70	30	100
MML 833	Mechanics of Solids-I	5	5	70	30	100
MMP 834	Computing Lab-II MATLAB Programming & Applications	1.5	3	70	30	100
-----	Programme Elective-1	5	5	70	30	100
-----	Programme Elective-2	5	5	70	30	100
-----	Open Elective (To be opted from other Discipline(s)/Departments)	4	4	70	30	100
Total		**30.5**	**32**	**490**	**210**	**700**

***Programme Electives**

Paper Code	Nomenclature	Credit	Hours/ Week	Max. Marks		
				External	Internal	Total
MML 835	Analytic Number Theory	5	5	70	30	100
MML 836	Fluid Mechanics	5	5	70	30	100
MML 837	Advanced Discrete Mathematics	5	5	70	30	100
MML 838	Difference Equations	5	5	70	30	100

Open Elective offered by Department of Mathematics for other Discipline(s)/Departments						
Paper Code	**Nomenclature**	**Credit**	**Hours/ Week**	**Max. Marks**		
				External	**Internal**	**Total**
MOL 851	Mathematical Methods	4	4	70	30	100

* Programme/ open electives can be offered subject to availability of requisite resources/ faculty in the department.

Semester - X

Paper Code	Nomenclature	Credit	Hours/ Week	Max. Marks		
				External	Internal	Total
MML 841	Functional Analysis	5	5	70	30	100
MML 842	Differential Geometry	5	5	70	30	100
MML 843	Mechanics of Solids-II	5	5	70	30	100
-----	Programme Elective-3	5	5	70	30	100
-----	Programme Elective-4	5	5	70	30	100
MMP 848	Computing Lab-III	1.5	3	70	30	100
	Total	**26.5**	**28**	**420**	**180**	**600**

***Programme Electives**

Paper Code	Nomenclature	Credit	Hours/ Week	Max. Marks		
				External	Internal	Total
MML 844	Integral Equations	5	5	70	30	100
MML 845	Advanced Fluid Mechanics	5	5	70	30	100
MML 846	Bio-Mechanics	5	5	70	30	100
MML 847	Algebraic Coding Theory	5	5	70	30	100

* Programme/ open electives can be offered subject to availability of requisite resources/ faculty in the department.

Semester - I

Course Opted	Paper Code	Nomenclature	Credit	Hours/ Week	Marks		
					External	Internal	Total
Ability Enhancement Compulsory Course-I	BXL 101	English	2	2	70	30	100
Ability Enhancement Compulsory Course-II	BXL 102	Environmental Sciences	2	2	70	30	100
Bridge Course-I	BML 101	Elementary Mathematics - I	4	4	70	30	100
Core Course-I	BML 102	Mathematics - I: Basic Algebra	4	4	70	30	100
Generic Elective-I	BPL 101	Physics - I: Mechanics (Batch 2016 only)	4	4	70	30	100
	BPL 101	Physics - I: Mechanics (Batch 2017 and 2018 only)	4	4	70	30	100
	BPL 101	Physics - I: Mechanics (Batch 2019 onwards)	4	4	70	30	100
Generic Elective-II	BCL 101	Chemistry - I	4	4	70	30	100
Generic Elective-III	BBL 101	Elementary Biology - I (Fundamentals of Biology) (Batch 2016-2019)	4	4	70	30	100
	BBL 101	Elementary Biology - I (Fundamentals of Biology) (Batch 2020 onwards)	4	4	70	30	100
Generic Elective Practical-I	BPP 101	Physics Lab - I (Batch 2016-2018)	2	4	70	30	100
	BPP 101	Physics Lab - I (Batch 2019 onwards)	2	4	70	30	100

Generic Elective Practical-II	BCP 101	Chemistry Lab - I	2	4	70	30	100
Generic Elective Practical-III	BBP 101	Biology Lab - I (Batch 2016-2019)	2	4	70	30	100
	BBP 101	Biology Lab - I (Batch 2020 onwards)	2	4	70	30	100
		Total	**26**	**32**	**630**	**270**	**900**

Note:

(i) Students, who have not studied Mathematics at 10+1 and 10+2 level, will opt the paper Elementary Mathematics-I (BML-101) and students, who have studied Mathematics at 10+1 and 10+2 level, will opt the paper Elementary Biology-I (BBL-101) & Mathematics - I (BML-102).

(ii) Paper code BML 101 is offered by the Dept. of Mathematics for the students of other Departments.

(iii) Semesters I and II will be common for all the four programmes.

BXL 101: English

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: The examiner is requested to set nine questions in all, selecting two questions from each unit and one compulsory question (Question No.1 based on entire syllabus will consist of seven short answer type questions each of two marks). The candidate is required to attempt five questions in all selecting one from each unit and the compulsory Question No.1.

Unit-I

Syntax **7Hrs**

Sentence structures, Verb patterns and their usage

Unit-II

Phonetics **8Hrs**

Basic Concepts – Vowels, Consonants, Phonemes, Syllables; Articulation of Speech Sounds – Place and Manner of Articulation; Transcription of words and simple sentences, using International Phonetic Alphabet.

Unit-III

Comprehension **7Hrs**

Listening and Reading comprehension – Note taking, Reviewing, Summarizing, Interpreting, Paraphrasing and Précis Writing.

Unit-IV

Composition **8Hrs**

Descriptive, Explanatory, Analytical and Argumentative Writing - description of simple objects like instruments, appliances, places, persons, principles; description and explanation of processes and operations; analysis and arguments in the form of debate and group discussion.

BOOKS SUGGESTED:

1. Roy A. & Sharma P.L. English for Students of Science, Orient Longman.
2. Spoken English for India by R.K. Bansal and J.B. Harrison, Orient Longman.
3. Tickoo M.L. & Subramanian A.E. Intermediate Grammar, Usage and Composition, Orient Longman.
4. Pink M.A. & Thomas S.E. English Grammar, Composition and Correspondence, S. Chand and Sons Pvt. Ltd., Delhi.
5. Thomson & Martinet A Practical English Grammar, OUP, Delhi.
6. Hornby A.S Guide to Patterns and Usage in English, OUP, Delhi.
7. Balasubramanian T. A Textbook of English Phonetics for Indian Students, MacMillan, Chennai.
8. O‟ Connor J.D. Better English Pronunciation, Cambridge Univ. Press, London.
9. McCarthy English Vocabulary in Use, Foundation Books (Cambridge University Press), Delhi.
10. Buck, Assessing Listening, Foundation Books (Cambridge University Press), Delhi.

BXL 102: Environmental Sciences

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: The examiner is requested to set nine questions in all, selecting two questions from each unit and one compulsory question (Question No.1 based on entire syllabus will consist of seven short answer type questions each of two marks). The candidate is required to attempt five questions in all selecting one from each unit and the compulsory Question No.1.

Unit-I

The Multidisciplinary nature of environmental studies 8Hrs

Definition, scope and importance, Need for public awareness. Natural resources: Renewable and non-renewable resources. Natural resources and associated problems.

a) Forest resources: Use and over-exploitation, deforestration

b) Water resources: Use and over-utilization of surface and ground water, floods and drought.

c) Mineral resources: Use and exploitation, environmental effects of extrading.

d) Food resources: World food problems, changes caused by agriculture, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity.

e) Energy Resources: Growing energy needs, renewable and non renewable energy sources use of alternative energy sources.

f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification

Unit-II

Ecosystems 7Hrs

Concept of an ecosystem, Structure and function of an ecosystem, Procedures, consumers and decomposers, Energy flow in the ecosystem, Ecological succession & Food chains, food webs and ecological pyramids.

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 megadiversity nation.

Unit-III

Environmental Pollution 7Hrs

Definition, Causes, effects and control measures of: - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution & Nuclear hazards. Solid waste Management: Causes, effects and control measures of urban and industrial wastes.

Unit-IV

Social Issues and the Environment **8Hrs**

From Unsustainable to sustainable development, urban problems related to energy, Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, Wasteland reclamation, Consumerism and waste products, environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environment legislation & Public awareness.

BOOKS SUGGESTED:

1. De A. K. Environmental Chemistry, Wiley Eastern Ltd, 1999.
2. Bharucha E. Text book of Environmental studies, University press, Hydrabad 2005.
3. Cunningham W P., Cooper T H. Gorhani E. Hepworth M T, Environmental Enclopedia, Jaico publication House, Mumbai, 2001.
4. Miller T G. Environmental Science Wadsworth publishing corp, 2000.

BML101: Elementary Mathematics - I

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section – I

Sets, Relations and Functions: Sets and their Representations, The Empty Set, Finite and Infinite Sets, Equal Sets, Subsets, Universal Set, Venn Diagrams, Operations on Sets, Complement of a Set, Practical Problems on Union and Intersection of Two Sets, Cartesian Product of Sets, Relations, Functions.
Sequences and Series: Sequences, Series, Arithmetic Progression (A.P.), Geometric Progression (G.P.), Relationship Between A.M. and G.M.

Section – II

Straight Lines: Introduction, Slope of a Line, Various Forms of the Equation of a Line, General Equation of a Line, Distance of a Point From a Line.
Trigonometric Functions: Angles, Trigonometric Functions, Trigonometric Functions of Sum and Difference of Two Angles, Trigonometric Equations.

Section – III

Permutations and Combinations: Fundamental Principle of Counting, Permutations, Combinations.
Binomial Theorem: Introduction, Binomial Theorem for Positive Integral Indices, General and Middle Terms.

Section – IV

Linear Inequalities: Inequalities, Algebraic Solutions of Linear Inequalities in One Variable and their Graphical Representation, Graphical Solution of Linear Inequalities in Two Variables, Solution of System of Linear Inequalities in Two Variables.

Probability: Introduction, Random Experiments, Event, Axiomatic Approach to Probability, Addition Theorems on Probability, Conditional Probability, Multiplicative Law of Probability.

Books Recommended:

1. Mathematics Text Book for Class XI, National Council of Educational Research and Training.
2. R.S. Verma and K.S. Sukla, Text Book on Trigonometry, Pothishala Pvt. Ltd, Allahabad.
3. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, S. Chand & Sons.
4. Ivo Duntsch and Gunther Gediga, Set, Relations, Functions, Methodos Publishers.

BML102: Mathematics - I: Basic Algebra

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section – I

Symmetric, Skew-symmetric, Hermitian and skew Hermitian matrices. Elementary operations on matrices. Rank of a matrices. Inverse of a matrix. Linear dependence and independence of rows and columns of matrices. Row rank and column rank of a matrix. Eigenvalues, eigenvectors and the characteristic equation of a matrix. Minimal polynomial of a matrix. Cayley Hamilton theorem and its use in finding the inverse of a matrix.

Section – II

Applications of matrices to a system of linear (both homogeneous and non–homogeneous) equations. Theorems on consistency of a system of linear equations. Unitary and Orthogonal Matrices, Bilinear and Quadratic forms.

Section – III

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

Section – IV

Nature of the roots of an equation, Descarte's rule of signs. Solutions of cubic equations (Cardon's method). Biquadratic equations and their solutions.

Books Recommended:

1. H.S. Hall and S.R. Knight, Higher Algebra, H.M. Publications 1994.
2. Shanti Narayan, A Text Books of Matrices.
3. Chandrika Prasad, Text Book on Algebra and Theory of Equations. Pothishala Private Ltd., Allahabad.

BPL 101: PHYSICS - I: Mechanics
(Batch 2016 only)

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: The question paper will consist of nine questions in all. Question no. 1 will contain seven short answer type questions without any internal choice covering the entire syllabus and shall be compulsory. The remaining eight questions will be set from the four units with two questions from each unit. Candidate is required to attempt five questions in all with one compulsory question and one question from each unit.

UNIT – 1

Fundamentals of Dynamics: Reference frames. Inertial frames; Review of Newton's Laws of Motion. Galilean transformations; Galilean invariance. Momentum of variable mass system: motion of rocket. Motion of a projectile in Uniform gravitational field Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse.

Work and Energy: Work and Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by non-conservative forces. Law of conservation of Energy.

Collisions: Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames.

UNIT - 2

Rotational Dynamics: Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation.

Elasticity: Relation between Elastic constants. Twisting torque on a Cylinder or Wire.

Fluid Motion: Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube.

UNIT – 3

Gravitation and Central Force Motion: Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere.

Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS).

Oscillations: SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor.

UNIT - 4

Non-Inertial Systems: Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems.

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

Reference Books:

1. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
2. Mechanics, Berkeley Physics, vol.1, C. Kittel, W. Knight, et.al. 2007, Tata McGraw-Hill.
3. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
4. Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
5. Feynman Lectures, Vol. I, R.P. Feynman, R.B. Leighton, M. Sands, 2008, Pearson Education
6. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
7. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

Additional Books for Reference

1) Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
2) University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley
3) Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A. Serway, 2010, Cengage Learning
4) Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

BPL 101: PHYSICS - I: MECHANICS
(Batch 2017 and 2018 only)

Marks (Theory) : 70 **Credits : 4 (60 lectures)**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: The question paper will consist of nine questions in all. Question no. 1 will contain seven short answer type questions without any internal choice covering the entire syllabus and shall be compulsory. The remaining eight questions will be set from the four units with two questions from each unit. Candidate is required to attempt five questions in all with one compulsory question and one question from each unit.

Course Objective: The objective of this course is to teach the students fundamentals of Newtonian Mechanics, rigid body dynamic, concept of inverse square force and the special theory of relativity.

Unit – I

Fundamentals of Dynamics: Reference frames, Inertial and non-inertial frames of references, Conservative and non-conservative forces, Fictitious forces, Concept of potential energy, Energy diagram. Stable and unstable equilibrium, Elastic potential energy, Force as gradient of potential energy, Work & Potential energy, Impulse, Centre of Mass for a system of particles, Motion of centre of mass, Expression for kinetic energy, Linear momentum and angular momentum for a system of particles in terms of centre of mass values.
Collisions: Elastic and inelastic collisions between particles, Centre of Mass and Laboratory frames.

Unit - II

Equation of motion of a rigid body, Rotational motion of a rogid body in general and that of plane lamina, Rotaion of angular momentum vector about a fixed axis, Angular momentum and kinetic energy of a rigid body about principal axis, Torque, Principle of conservation of angular momentum, Moment of Inertia, Calculation of moment of inertia for rectangular, cylindrical and spherical bodies, Kinetic energy of rotation, Motion involving both translation and rotation.

Unit – III

Inverse Square Law Force: Forces in nature (qualitative), Central forces, Law of gravitation, Gravitational potential energy, Inertial and gravitational mass, Potential energy and force between a point mass and spherical shell, a point mass and solid sphere, gravitational and electrostatic self energy, two body problem and concept of reduced mass, Motion of a body under central force, Equation of orbit in inverse-square force field, Kepler's laws and their derivation, Deduction of Newton's law of gravitation from Kepler's laws.

Unit – IV

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

Reference Books:

1. An introduction to Mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
2. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000.
3. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.

BPL 101: PHYSICS - I: MECHANICS
(Batch 2019 onwards)

Marks (Theory) : 70 **Credits : 4 (60 lectures)**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: The objective of this course is to teach the students fundamentals of Newtonian Mechanics, rigid body dynamic, concept of inverse square force and the special theory of relativity.

Unit – I

Fundamentals of Dynamics: Reference frames, Inertial and non-inertial frames of references, Conservative and non-conservative forces, Fictitious forces, Concept of potential energy, Energy diagram. Stable and unstable equilibrium, Elastic potential energy, Force as gradient of potential energy, Work & Potential energy, Impulse, Centre of Mass for a system of particles, Motion of centre of mass (discrete and continuous), Expression for kinetic energy, Linear momentum and angular momentum for a system of particles in terms of centre of mass values.
Collisions: Elastic and inelastic collisions between particles, Centre of Mass and Laboratory frames.

Unit - II

Rotational Dynamics: Equation of motion of a rigid body, Rotational motion of a rigid body in general and that of plane lamina, Rotation of angular momentum vector about a fixed axis, Angular momentum and kinetic energy of a rigid body about principal axis, Torque, Principle of conservation of angular momentum, Moment of Inertia (discrete and continuous), Calculation of moment of inertia for rectangular, cylindrical and spherical bodies, Kinetic energy of rotation, Motion involving both translation and rotation, elementary Gyroscope.

Unit – III

Inverse Square Law Force: Forces in nature (qualitative), Central forces, Law of gravitation, Gravitational potential energy, Inertial and gravitational mass, Potential energy and force between a point mass and spherical shell, a point mass and solid sphere, gravitational and electrostatic self energy, two body problem and concept of reduced mass, Motion of a body under central force, Equation of orbit in inverse-square force field, satellite in Circular orbit & Geosynchronous orbits, Basic idea of GPS (Global Positioning System).

Unit – IV

Special Theory of Relativity: Michelson-Morley Experiment and its outcome, Galilean transformation (velocity, acceleration) and its inadequacy, Postulates of Special Theory of Relativity, Lorentz Transformations, simultaneity, Lorentz contraction, Time dilation, Relativistic transformation of velocity, frequency and wave number, Relativistic addition of velocities, Variation of mass with velocity, Massless Particles, Mass-energy Equivalence, Relativistic Doppler effect, Relativistic Kinematics (decay, inelastic collision, Compton effect), Transformation of Energy and Momentum and force, Four Vectors.

Reference Books:

1. An introduction to Mechanics, D. Kleppner, R.J. Kolenkow, 2007, McGraw-Hill.
2. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2012.
3. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
4. University Physics, F.W. Seers, M. W. Zemansky, H. D. Young, Addison-Wesley Pub. Co.
5. Fundamentals of Physics, Halliday, & Walker, Resnick John Wiley & Sons, Inc.

BCL 101: CHEMISTRY- I

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: The examiner is requested to set nine questions in all, selecting two questions from each unit and one compulsory question (Question No.1 based on entire syllabus will consist of seven short answer type questions each of two marks). The candidate is required to attempt five questions in all selecting one from each unit and the compulsory Question No.1.

UNIT-I

Chemical Thermodynamics **15 Hrs**

Objectives and limitations of Chemical Thermodynamics, state functions, thermodynamic equilibrium, work, heat, internal energy, enthalpy. First Law of Thermodynamics: First law of thermodynamics for open, closed and isolated systems. Reversible isothermal and adiabatic expansion/compression of an ideal gas. Irreversible isothermal and adiabatic expansion. Enthalpy change and its measurement, standard heats of formation and absolute enthalpies. Kirchoff's equation.

Second and Third Law: Various statements of the second law of thermodynamics. Efficiency of a cyclic process (Carnot's cycle). Entropy: Entropy changes of an ideal gas with changes in P, V, and T. Free energy and work functions. Gibbs-Helmholtz Equation, Criteria of spontaneity in terms of changes in free energy. Introduction to Third law of thermodynamics.

UNIT-II

Conductance and Electrochemistry **15 Hrs**

Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions.

Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance to measure degree of dissociation of weak electrolytes.

Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half cell potentials, application of electrolysis in metallurgy and industry. Chemical cells with examples; Standard electrode (reduction) potential.

UNIT-III

Fundamentals of Organic Chemistry **15 Hrs**

Electronic Displacements: Inductive Effect, Electrometric Effect, Resonance and Hyperconjugation.

Cleavage of Bonds: Hemolysis and Heterolysis.

Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles.

Reactive Intermediates: Carbocations, Carbanions and free radicals.

Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values.

UNIT-IV

Stereochemistry **8Hrs**

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

Chemistry of Biomolecules **7Hrs**

Occurrence, classification of Carbohydrates. Amino acids, peptides and their classification. α-Amino Acids. Zwitterions, pK_a values, isoelectric point, components of nucleic acids, nucleosides and nucleotides.

BOOKS SUGGESTED:

1. Atkins, P.W. & Paula, J. *Physical Chemistry,* 10th Ed., Oxford University Press, 2014.
2. Castellan, G.W., Physical Chemistry, Narosa Publishers
3. Morrison, R. N. & Boyd, R. N. *Organic Chemistry,* Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Finar, I. L. *Organic Chemistry (Volume 1),* Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Finar, I. L. *Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products),* Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Eliel, E. L. & Wilen, S. H. *Stereochemistry of Organic Compounds,* Wiley: London, 1994.
7. Kalsi, P. S. *Stereochemistry Conformation and Mechanism,* New Age International, 2005.
8. McMurry, J.E. *Fundamentals of Organic Chemistry,* 7th Ed. Cengage Learning India Edition, 2013.

BBL 101: Elementary Biology - I (Fundamentals of Biology)
(Batch 2016-2019)

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four section (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section - I

Introduction to concepts of biology
Themes in the study of biology; A closer look at ecosystem; A closer look at cell; The process of Science; Biology and everyday life
Evolutionary history of biological diversity
Early earth and the origin of life; Major events in the history of life; Mechanism of Macroevolution; Phylogeny and the tree of life

Section - II

Classifying the diversity of life
Kingdoms of Life –Prokaryotes, Eukaryotes, Archaea
Darwinian view of life and origin of species
Darwin's theory of evolution; The evolution of populations; Concepts of species; Mechanism of speciation
Genetic approach to Biology
Patterns of inheritance and question of biology; Variation on Mendel's Law; The molecular basis of genetic information; The flow of genetic information from DNA to RNA to protein; Genetic Variation; Methodologies used to study genes and gene activities; Developmental noise; Detecting macromolecules of genetics; Model organisms for the genetic analysis; Distinction between Phenotype and Genotype.

Section - III

Chemistry of life
The constituents of matter; Structure of an atom; The energy level of electron; The formation and function of molecules depend on chemical bonding between atoms; Chemical reaction make or break chemical bonds
Water and life
The water molecule is polar; Properties of water; Ionization of water
Carbon and life
Organic chemistry-the study of carbon compounds; what makes carbon special? Properties of organic compounds

Section – IV

Structure and function of biomolecules
Most macromolecules are Polymers; Carbohydrates act as fuel and building materials; Lipids are group of hydrophobic molecules; Protein have diverse structures and functions; Nucleic acids store and transmit hereditary information

SUGGESTED READING/BOOKS

1. Campbell, N.A. and Reece, J. B. (2008) Biology 8th edition, Pearson Benjamin Cummings, San Francisco.
2. Raven, P.H et al (2006) Biology 7th edition Tata McGraw Hill Publications, New Delhi
3. Griffiths, A.J.F et al (2008) Introduction to Genetic Analysis, 9th edition, W.H. Freeman & Co. NY

BBL 101: Elementary Biology - I (Fundamentals of Biology)
(Batch 2020 onwards)

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objectives of this course are to sensitize the students to the fact that as we go down the scale of magnitude from cells to organelles to molecules, the understanding of various biological processes. The course shall make the students aware of various theories of origin of life and evolution	***After successful completion of this course, students should be able to: -*** ***1. Learn about biomolecule, prokaryotic and eukaryotic cell and cell organelles, cell membrane and transport across the membrane, cell division*** ***2. Understand origin of life and various theories of evolution and documentary evidence***

UNIT-I [15 Lectures]

Molecules of Life: pH and Buffers in Biology. Chemistry of water. Chemical Bonding and various types of bonds, Carbohydrate: Sugars and polysaccharides. Lipids: Fat, phospholipids and steroids. Proteins: polypeptides, protein confirmation and function. Nucleic acids as information molecules. DNA and RNA.

UNIT-II [15 Lectures]

Cell Structure and Cell Processes: Prokaryotic cells and eukaryotic cells Organelles of eukaryotic cell: Nucleus, endoplasmic reticulum, Golgi apparatus, vesicles, peroxisomes, Mitochondria and Plastid. The evolution of eukaryotic organelles.

UNIT-III [15 Lectures]

Membranes as Fluid Layers of Lipid: The phospholipids bilayer. The fluid mosaic model. Model Membranes Membrane proteins. Passive transport across membranes: Diffusion, facilitated diffusion, Osmosis. Active transport

UNIT-IV [15 Lectures]

Origin of Life and Evolution: Different theories of origin of life, Experimental evidences supporting different theories. Lamarck, Darwinism and other theories of evolution, Documentary evidences supporting different evolution theories.

Recommended Textbooks and References:

1. *Campbell, N.A. & Reece, J. B. Biology (12th Ed.). Pearson Benjamin Cummings, San Francisco. 2020.*
2. *Raven, P., Johnson, G., Mason, K., Losos, J. & Duncan, T. Biology (12th Ed.) Tata McGraw Hill Publications, New York. US. 2020.*

BPP 101: Physics Lab – I
(Batch 2016-2018)

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

(Credits: 02)

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
2. To study the random error in observations.
3. To determine the height of a building using a Sextant.
4. To study the Motion of Spring and calculate (a) Spring constant, (b) **g** and (c) Modulus of rigidity.
5. To determine the Moment of Inertia of a Flywheel.
6. To determine **g** and velocity for a freely falling body using Digital Timing Technique;
7. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
8. To determine the Young's Modulus of a Wire by Optical Lever Method.
9. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
10. To determine the elastic Constants of a wire by Searle's method.
11. To determine the value of g using Bar Pendulum.
12. To determine the value of g using Kater's Pendulum.

Reference Books

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

BPP 101: PHYSICS LAB – I
(Batch 2019 onwards)

Marks (Theory) : 70 **Credits: 2**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note:

1. ***Each student should perform at-least eight experiments.***
2. ***The students are required to calculate the error involved in a particular experiment.***
3. ***List of experiments may vary.***

List of Experiments:

1. Measurements of length (or diameter) using Vernier calliper, screw gauge and travelling microscope.
2. To determine the height of a building using a Sextant.
3. To study the Motion of Spring and calculate (a) Spring constant, (b) **g** and (c) Modulus of rigidity.
4. To determine the Moment of Inertia of a Flywheel.
5. To determine **g** and velocity for a freely falling body using Digital Timing Technique;
6. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
7. To determine the Young's Modulus of a Wire by Optical Lever Method.
8. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
9. To determine the elastic Constants of a wire by Searle's method.
10. To determine the value of g using Bar Pendulum.
11. To determine the value of g using Kater's Pendulum.

Reference Books

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

BCP 101: CHEMISTRY LAB - I

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

1. Preparation of reference solutions.
2. Redox titrations: Determination of Fe^{2+}, $C_2O_4^{2-}$ (using $KMnO_4$, $K_2Cr_2O_7$)
3. Iodometic titrations: Determination of Cu^{2+} (using standard hypo solution).
4. To determine the surface tension of at least two liquids using stalagmometer by drop no. and drop weight methods (Use of organic solvents excluded).
5. To study the effect of surfactant on surface tension of water.
6. To determine the viscosity of at least two liquids by using Ostwald's viscometer (use of organic solvents excluded).
7. To study the process of (i) sublimation (ii) Crystallization of camphor and phthalic acid
8. Preparation and purification through crystallization or distillation and ascertaining their purity through melting point or boiling point
   (i) Iodoform from ethanol (or acetone)
   (ii) p-Bromoacetanilide from acetanilide

BOOKS SUGGESTED:

1. Vogel A. I., Tatchell A.R., Furnis B.S., Hannaford A.J., Smith P.W.G.,Vogel's Text Book of Practical Organic Chemistry, 5th Edn., Pubs: ELBS, 1989.
2. Pavia D.L., Lampanana G.M., Kriz G.S. Jr., Introduction to Organic Laboratory Techniques, 3rd Edn., Pubs: Thomson Brooks/Cole,2005.
3. Mann F.G., Saunders. P.C., Practical Organic Chemistry, Pubs: Green & Co. Ltd., London, 1978.
4. Svehla, G., Vogel's Qualitative Inorganic Analysis (revised); 7th edition, Pubs: Orient Longman, 1996.
5. Bassett, J., Denney, R.C., Jeffery, G.H., Mendham, J., Vogel's Textbook of Quantitative Inorganic Analysis (revised); 4th edition, Pubs: Orient Longman, 1978.
6. Yadav J. B., Advanced Practical physical Chemistry

BBP 101: BIOLOGY LAB - I
(Batch 2016-2019)

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

PRACTICALS

1. To learn a) use of microscope b) principles of fixation and staining.
2. Preparation of Normal, molar and standard solutions, phosphate buffers, serial dilutions
3. Use of micropipettes
4. Measurement of cell size by cytometry
5. To perform gram staining of bacteria.
6. To study the cytochemical distribution of nucleic acids and mucopolysaccharides with in cells/tissues from permanent slides.
7. To perform quantitative estimation of protein using the Lowry's method. Determine the concentration of the unknown sample using the standard curve plotted.
8. To study of plasmolysis & deplamolysis of *Rhoeo* leaf.
9. To study prokaryotic cells, Bacteria/fungi and eukaryotic cells.
10. To prepare squash from root tip of Aliumcepa & study various stages of mitosis.

SUGGESTED BOOKS:

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASMPress & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.
5. Campbell, N.A. and Reece, J. B. (2008) Biology 8th edition, Pearson Benjamin Cummings, San Francisco.
6. Raven, P.H et al (2006) Biology 7th edition Tata McGraw Hill Publications, New Delhi
7. Griffiths, A.J.F et al (2008) Introduction to Genetic Analysis, 9th edition, W.H. Freeman & Co. NY

BBP 101: Biology Lab - I
(Batch 2020 onwards)

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**4 H**

Course Objectives	Student Learning Outcomes
The objectives of this laboratory course are to develop an understanding about structural aspects of prokaryotic and eukaryotic cell and its inner components. ***It will also insight into the anatomy of stem, leaf and root***	***After successful completion of this course, students should be able to: -*** ***1. Perform fixation, staining and visualize various stages of cell division*** ***2. To analyse the anatomy of stem, root and leaf*** ***3. To understand the structure of eukaryotic and prokaryotic cell***

List of Experiments:

1. To learn a) use of microscope b) principles of fixation and staining.
2. Preparation of Normal, molar and standard solutions, phosphate buffers, serial dilutions
3. Use of micropipettes
4. Measurement of cell size by cytometry
5. To perform gram staining of bacteria.
6. To study the cytochemical distribution of nucleic acids and mucopolysaccharides with in cells/tissues from permanent slides.
7. To study of plasmolysis and deplasmolysis of *Rhoeo* leaf.
8. To study prokaryotic cells, Bacteria/fungi and eukaryotic cells.
9. To prepare squash from root tip of *Allium cepa* and study various stages of mitosis.
10. To prepare the slide and study for various stages of meiosis.
11. To identify the blood cell types in human blood smear.
12. To prepare Buccal smear for Identification of Barr Body.
13. To prepare microscope slide for dicot leaf section.
14. To prepare permanent slide of plant stem/root/leaf.
15. Preparation of nuclear, mitochondrial & cytoplasmic fractions.

Recommended Textbooks and References:

1. *Karp, G., Iwasa, J. & Marshall, W. Karp's Cell and Molecular Biology (9th Ed.). John Wiley & Sons. 2020.*
2. *De Robertis, E.D.P. and De Robertis, E.M.F. Cell and Molecular Biology (8th Ed.). Lippincott Williams and Wilkins, Philadelphia. 2017.*
3. *Cooper, G. M. The Cell: A Molecular Approach (8th Ed.). Oxford University Press. ASMPress & Sunderland, Washington, D.C.; Sinauer Associates, MA. 2018.*
4. *Becker, W. M., Kleinsmith, L. J., Hardin. J. & Bertoni, G. P. The World of the Cell (8th Ed.). Pearson Benjamin Cummings Publishing, San Francisco. 2016.*
5. *Campbell, N.A. and Reece, J. B. Biology (12th Ed.). Pearson Benjamin Cummings, San Francisco. 2020.*
6. *Raven, P., Johnson, G., Mason, K., Losos., J. & Duncan, T. Biology (12th Ed.) Tata McGraw Hill Publications, New York. US. 2020.*
7. *Griffiths, A.J.F., Doebley, J., & Peichel, C. An Introduction to Genetic Analysis (12th Ed.). W.H. Freeman & Co. NY. 2020*
8. *Choinski J.S. Dimaculangan, D. and Barwick J.* Molecular and Cell Biology Laboratory Manual. Indo- American Books. 2005

Semester - II

Course Opted	Paper Code	Nomenclature	Credit	Hours/ Week	Max. Marks		
					External	Internal	Total
Ability Enhancement Compulsory Course-III	BXL 201	Hindi	2	2	70	30	100
Bridge Course-II	BML 201	Elementary Mathematics - II	4	4	70	30	100
Core Course-II	BML 202	Mathematics - II: Calculus	4	4	70	30	100
Generic Elective-IV	BPL 201	Physics – II: Waves and Optics (Batch 2016 only)	4	4	70	30	100
	BPL 201	Physics – II: Waves and Optics (Batch 2017 and 2018 only)	4	4	70	30	100
	BPL 201	Physics – II: Heat and Thermodynamics (Batch 2019 onwards)	4	4	70	30	100
Generic Elective-V	BCL 201	Chemistry – II	4	4	70	30	100
Generic Elective- VI	BBL 201	Elementary Biology - II (Cell Biology) (Batch 2016-2019)	4	4	70	30	100
	BBL 201	Elementary Biology - II (Cell Biology) (Batch 2020 onwards)	4	4	70	30	100
Generic Elective-VII	BXL 202	Computer Science	2	2	70	30	100
Generic Elective Practical- IV	BPP 201	Physics Lab – II (Batch 2016 only)	2	4	70	30	100
	BPP 201	Physics Lab – II (Batch 2017 and 2018 only)	2	4	70	30	100
	BPP 201	Physics Lab – II (Batch 2019 onwards)	2	4	70	30	100

Generic Elective Practical- V	BCP 201	Chemistry Lab – II	2	4	70	30	100
Generic Elective Practical- VI	BXP 201	Computer Science-Lab	2	4	70	30	100
		Total	**26**	**32**	**630**	**270**	**900**

Note:

(i) Students, who have not studied Mathematics at 10+1 and 10+2 level, will opt the paper Elementary Mathematics - II (BML-201) and students, who have studied Mathematics at 10+1 and 10+2 level, will opt the paper Elementary Biology - II (BBL-201) & Mathematics - II (BML-202).

(ii) Paper code BML 201 is offered by the Dept. of Mathematics for the students of other Departments.

BXL 201: Hindi

बी.एक्स.एल–201: हिन्दी

कुल अंक: 70 क्रैडिट –2

आंतरिक मूल्यांकन–30 समय–3 घण्टे

खण्ड (क)

निर्धारित कवि

1 कबीरदास 2 सूरदास

3 मीराबाई 4 रसखान

खण्ड (ख)

हिन्दी साहित्य का इतिहास भक्तिकाल: पाठ्यक्रम में निर्धारित आलोचनात्मक प्रश्न–

1 सन्तकाव्य की प्रवृतियाँ 2 सूफी काव्य की प्रवृतियाँ

3 कृष्ण काव्य की प्रवृतियाँ 4 राम काव्य की प्रवृतियाँ

5 भक्तिकाल का: स्वर्णयुग

खण्ड (ग)

अलंकार–अनुप्रास, श्लेष, यमक, उपमा, रूपक, अतिश्योक्ति, मानवीकरण, अन्योक्ति, समासोक्ति आदि।

खण्ड (घ)

मुहावरे एवं लोकोक्तियाँ।

खण्ड(क) के लिए निर्धारित पाठ्यपुस्तक–मध्यकालीन काव्य–कुंज : सं. डॉ रामसजन पाण्डेय प्रकाशन:खादूश्याम प्रकाशन, 1276/5 पीर जी मोहल्ला, प्रताप टाकीज, रोहतक।

निर्देश:– सभी प्रश्न अनिवार्य हैं।

1. खण्ड (क) में निर्धारित पाठ्यपुस्तक में से व्याख्या के लिए चार अवतरण पूछे जाएँगे, जिनमें से परीक्षार्थी को किन्हीं दो की सप्रसंग व्याख्या करनी होगी। प्रत्येक व्याख्या 6 अंक की होगी। पूरा प्रश्न 12 अंक का होगा।
2. खण्ड (क) में निर्धारित कवियों में से किन्ही दो कवियों के साहित्यिक परिचय पूछे जाएँगे, जिनमें से किसी एक कवि का साहित्यिक परिचय लिखना होगा। यह प्रश्न 8 अंक का होगा।

3. खण्ड (क) में पाठ्यपुस्तक से निर्धारित आलोचनात्मक प्रश्नों में से दो प्रश्न पूछे जाएँगे, जिनमें से परीक्षार्थी को एक प्रश्न का उत्तर देना होगा। यह प्रश्न 10 अंक का होगा।

4. खण्ड(ख) में निर्धारित आलोचनात्मक प्रश्नों में से दो प्रश्न पूछे जाएँ गे , जिनमें से किसी एक का उत्तर देना होगा। यह प्रश्न 10 अंक का होगा।

5. खण्ड(ख) से 12 अति लघूत्तरात्मक प्रश्न पूछे जाँएगे। प्रत्येक प्रश्न एक–एक अंक का होगा। पूरा प्रश्न 12 अंक का होगा।

6.खण्ड (ग) में निर्धारित अलंकारों में से दो अलंकार पूछे जाएँगे,जिनमें से एक अलंकार उदाहरणो सहित लिखना होगा। जो 8 अंक का होगा।

7. खण्ड (घ) से दस मुहावरों और लोकोक्तियों में से किन्ही पांच मुहावरों का अर्थ एंव वाक्य प्रयोग लिखना होगा। जो 10 अंक का होगा।

BML201: Elementary Mathematics - II

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section – I

Matrix Algebra: Introduction, types of matrices, addition and multiplication of matrix, transpose of matrix, concept of elementary row and column operations. Determinant and its properties, minors, cofactors. Application of determinants in finding area of triangle. Adjoint and inverse of square matrix. Solution of homogeneous and non-homogeneous linear equations and condition for solution.

Section – II

Differential Calculus: Differentiation of standard functions including function of a function (Chain rule). Differentiation of implicit functions, logarithmic differentiation, parametric differentiation, elements of successive differentiation.
Integral Calculus: Integration as inverse of differentiation, indefinite integrals of standard forms, integration by parts, partial fractions and substitution. Formal evaluation of definite integrals.

Section – III

Ordinary Differential Equations: Definition and formation of ordinary differential equations, equations of first order and first degree, variable separable, homogeneous equations, linear equations (Leibnitz form) and differential equations reducible to these types, Linear differential equation of order greater than one with constant coefficients, complementary function and particular integrals.

Section – IV

Partial Differential Equations: Introduction and formation of P.D.E., solution of P.D.E., linear equation of first order (Lagrange's Equation), Non-Linear Equation of first order.
Vector Calculus: Differentiation of vectors, scalar and vector point functions, gradient of scalar field and directional derivative, divergence and curl of vector field and their physical interpretation.

Books Recommended:

1. Shanti Narayan : Differential and Integral Calculus, S. Chand.
2. S.L. Ross, : Differential Equations, John Wiley and sons inc., Ny, 1984.
3. Shanti Narayan : A Textbook of Matrices, S. Chand.
4. Ian N. Snnedon : Elements of Partial Differential Equations, McGraw Hill.
5. Murray R. Spiegal : Vector Analysis Schaum Publishing Company, New York

BML202: Mathematics - II: Calculus

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section – I

Definition of the limit of a function. Basic properties of limits, Continuous functions and classification of discontinuities. Differentiability. Successive differentiation. Leibnitz theorem. Maclaurin and Taylor series expansions.

Section – II

Asymptotes in Cartesian coordinates, intersection of curve and its asymptotes, asymptotes in polar coordinates. Curvature, radius of curvature for Cartesian curves, parametric curves, polar curves. Newton's method. Radius of curvature for pedal curves. Tangential polar equations. Centre of curvature. Circle of curvature. Chord of curvature, evolutes. Tests for concavity and convexity. Points of inflexion. Multiple points. Cusps, nodes & conjugate points. Type of cusps.

Section – III

Tracing of curves in Cartesian, parametric and polar co-ordinates. Reduction formulae. Rectification, intrinsic equations of curve.

Section – IV

Quadrature (area) Sectorial area. Area bounded by closed curves. Volumes and surfaces of solids of revolution. Theorems of Pappu's and Guilden.

Books Recommended:

1. Differential and Integral Calculus, Shanti Narayan.
2. Murray R. Spiegel, Theory and Problems of Advanced Calculus. Schaun's Outline series. Schaum Publishing Co., New York.
3. N. Piskunov, Differential and Integral Calculus. Peace Publishers, Moscow.
4. Gorakh Prasad, Differential Calculus. Pothishasla Pvt. Ltd., Allahabad.
5. Gorakh Prasad, Integral Calculus. Pothishala Pvt. Ltd., Allahabad.

BPL 201: PHYSICS – II: Waves and Optics
(Batch 2016 only)

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: The question paper will consist of nine questions in all. Question no. 1 will contain seven short answer type questions without any internal choice covering the entire syllabus and shall be compulsory. The remaining eight questions will be set from the four units with two questions from each unit. Candidate is required to attempt five questions in all with one compulsory question and one question from each unit.

UNIT - I

Superposition of Collinear Harmonic oscillations: Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats). Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences.
Superposition of two perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses.
Wave Motion: Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves: Ripple and Gravity Waves.

UNIT - II

Velocity of Waves: Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction.
Superposition of Two Harmonic Waves: Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes with respect to Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment. Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes. Superposition of N Harmonic Waves.
Wave Optics: Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence.

UNIT - III

Diffraction: Kirchhoff's Integral Theorem, Fresnel-Kirchhoff's Integral formula. (Qualitative discussion only)
Fraunhofer diffraction: Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating.
Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire.

UNIT -IV

Interference: Division of amplitude and wave front. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index.

Interferometer: Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes. Fabry-Perot interferometer.

Holography: Principle of Holography. Recording and Reconstruction Method. Theory of Holography as Interference between two Plane Waves. Point source holograms.

Reference Books

1. Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
2. Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
3. Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
4. Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
5. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
6. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
7. Fundamental of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, 2011, R. Chand Publications.

BPL 201: PHYSICS - II: WAVES AND OPTICS
(Batch 2017 and 2018 only)

Marks (Theory) : 70 **Credits : 4 (60 lectures)**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: The question paper will consist of nine questions in all. Question no. 1 will contain seven short answer type questions without any internal choice covering the entire syllabus and shall be compulsory. The remaining eight questions will be set from the four units with two questions from each unit. Candidate is required to attempt five questions in all with one compulsory question and one question from each unit.

Course objective: The objective of this course is to introduce the basics of oscillatory motion, wave motion, and phenomena of light interference and diffraction.

UNIT – I

Oscillations: SHM: Simple Harmonic Oscillations, Differential equation of SHM and its solution. Simple pendulum and compound pendulum, Superposition of Collinear Harmonic oscillations: Linearity and Superposition Principle, Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats), Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences.

Superposition of two perpendicular Harmonic Oscillations: Graphical and Analytical Methods, Lissajous Figures with equal and unequal frequency and their uses.

UNIT - II

Wave Motion: Wave Equation, Solution of wave equation, Particle and Wave Velocities, Intensity of Wave.

Transverse Waves: The string as a force oscillator**,** Velocity of Transverse Vibrations of Stretched Strings, Reflections and transmission of waves on a string at a boundary, Reflections and transmission of Energy.

Longitudinal Waves: Velocity of Longitudinal Waves in a Fluid in a Pipe, Newton's Formula for Velocity of Sound, Laplace's Correction, Reflections and transmission of sound waves at a boundary, Reflections and transmission of sound intensity, Energy distribution in sound waves, Phase and Group Velocities

UNIT – III

Wave Optics: Definition and properties of wave front, Huygens Principle, Concept of Temporal and Spatial Coherence and its experimental measurements.

Intereference: Intereference, Division of amplitude and wave front, Newton's rings, Youngs's double slit experiment, Fresnel's biprism, Interference in thin film, Michelson's interferometer and its appilication in measuring the wavelength of unknown sources and wavelength difference.

UNIT - IV

Fraunhofer diffraction: Single slit, Double slit multiple slits and Circular aperture, Various kind of diffraction grating, Resolving power of grating, Rayleigh Criteria of the limit of resolution and Resolving Power of an optical instruments.

Fresnel Diffraction: Fresnel's Assumptions, Fresnel's Half-Period Zones for Plane Wave, Rectilinear Propagation of Light, Theory of a Zone Plate and its application, Multiple Foci of a Zone Plate, Qualitative description for Fresnel diffraction pattern of a straight edge, a slit and a wire.

Reference Books

1. Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
2. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
3. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.

BPL 201: Physics - II (Heat and Thermodynamics)
(Batch 2019 onwards)

Marks (Theory): 70 **Credits: 4 (60 lectures)**
Marks (Internal Assessment): 30 **Time: 3 hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective*: The course on thermal physics is framed with the objective that students are able to understand basic concepts of thermos-dynamical systems. Students will be able to understand heart, work, temperature, entropy and the laws of thermodynamics. Behavior of real gases as thermos-dynamical systems has also been included.*

UNIT - I

Zeroth and First Law of Thermodynamics: Extensive and intensive thermodynamic variables, Thermodynamic equilibrium, zeroth law and Concept of Temperature, Work and heat, State functions, First law of thermodynamics, Internal energy, Applications of first law, General relation between C_p and C_v, Work done during isothermal and adiabatic processes.
Second Law of Thermodynamics: Reversible and Irreversible process with examples, Conversion of Work into Heat and Heat into Work, Heat Engines, Carnot's Cycle, Carnot engine & its efficiency, Refrigerator & coefficient of performance, 2^{nd} Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their equivalence, Carnot's Theorem.

UNIT-II

Entropy and Third law of Thermodynamics: Concept of entropy, Clausius theorem, Clausius Inequality, Second Law of Thermodynamics in terms of Entropy, Entropy of a Perfect Gas and Universe, Entropy Changes in Reversible and Irreversible Processes, Principle of Increase of Entropy, Third Law of Thermodynamics, Unattainability of absolute zero, T-S Diagrams, Phase Change, Classification of Phase Changes.

UNIT-III

Thermodynamic Potentials: Extensive and Intensive Thermodynamic Variables; Internal Energy; Definition, importance, properties and applications of Chemical Potential, Enthalpy, Gibbs function and Helmholtz function.
Maxwell's Thermodynamic Relations: Derivations of Maxwell's Relations and their applications: (1) Clausius- Clapeyron equation (2) C_p - C_v value, (3) Energy equations (4) Change of temperature during adiabatic process.

UNIT-IV

Real gases: Behavior of Real Gases, Deviations from the Ideal Gas Equation. The Virial Equation, Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas, Boyle Temperature, Van-der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves, P-V Diagrams, Joule's Experiment, Free Adiabatic Expansion of a Perfect Gas.
Thermo-electricity: Seeback effect, Paltier effect, Thomson effect and their explanations.

Reference Books:

1. A Treatise on Heat: Meghnad Saha and B.N. Srivastava, Indian Press
2. Thermal Physics: S. Garg, R. Bansal and Ghosh, Tata McGraw-Hill
3. Concepts in Thermal Physics: S.J. Blundell and K.M. Blundell, Oxford University Press
4. Heat and Thermodynamics: An Intermediate Textbook by M. W. Zemansky and R. Dittman, McGraw-Hill.

BCL 201: CHEMISTRY - II

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: The examiner is requested to set nine questions in all, selecting two questions from each unit and one compulsory question (Question No.1 based on entire syllabus will consist of seven short answer type questions each of two marks). The candidate is required to attempt five questions in all selecting one from each unit and the compulsory Question No.1.

UNIT-I

Chemical Bonding and Molecular Structure **15 Hrs**

Introduction to Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, polarizing power and polarizability

Introduction to Covalent bonding: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.

Ionic Solids: Factors affecting the formation of ionic solids, concept of close packing, radius ratio rule and coordination number. Calculation of limiting radius ratio for tetrahedral and octahedral sites. Structures of some common ionic solids NaCl, ZnS (zinc blende and wurtzite).

UNIT-II

Acids and Bases **8 Hrs**

Brönsted–Lowry concept, conjugate acids and bases, relative strengths of acids and bases, effects of substituent and solvent, differentiating and levelling solvents. Lewis acid-base concept, classification of Lewis acids and bases, Lux-Flood concept and solvent system concept. Hard and soft acids and bases (HSAB concept), applications of HSAB process.

Basic Coordination Chemistry **7Hrs**

Coordinate Bond. Werner's coordination theory, ligands, chelates. Nomenclature of coordination compounds. Stereochemistry of different coordination numbers, isomerism. Valence-bond and crystal field theories of bonding in complexes. Explanation of properties such as geometry colour and magnetism.

UNIT-III

Chemical Kinetics And Catalysis **15 Hrs**

Rates of reactions, rate constant, order and molecularity of reactions. Differential rate law and integrated rate expressions for zero, first, second and third order reactions. Half-life time of a reaction. Methods for determining order of reaction. Effect of temperature on reaction rate and the concept of activation energy.

Catalysis: Homogeneous catalysis, Acid-base catalysis and enzyme catalysis. Heterogeneous catalysis.

UNIT-IV

Basics of spectroscopy **15 Hrs**

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law. Electromagnetic radiations, Introduction to ultraviolet, visible and infrared spectroscopy, electronic transitions, λ_{max} & ε_{max}, chromophore, auxochrome, bathochromic, hypsochromic shifts. Infrared radiation and types of molecular vibrations, functional group and fingerprint region.

BOOKS SUGGESTED:

1. Cotton F.A. and Wilkinson G., Murillo C.A., Bochmann M., Advanced Inorg. Chemistry, 6th Edition, Pubs: John Wiley & Sons. Inc., 1999.
2. Lee J.D., Concise Inorganic Chemistry, 4th edition, Pubs: ELBS, 1991.
3. Huheey J.E., Keiter E.A., Keiter R.L., Inorganic Chemistry: Principles of Structures and Reactivity; 4th Edition, Pubs: Harper Collins, 1993.
4. Greenwood N.N. and Earnshaw A., Chemistry of the Elements, 2nd edition., Pubs: Butterworth/Heinemann, 1997.
5. Douglas B., Daniel D. Mc and Alexander J., Concepts of Models of Inorganic Chemistry, Pubs: John Wiley, 1987.
6. Puri B.R., Sharma L. R. and Pathania M. S., Principles of Physical Chemistry, Pubs: Vishal Publishing Company, 2003.
7. Laidler K. J Chemical Kinetics, McGraw Hill.
8. Castellan G.W. Physical Chemistry, Narosa Publishers
9. Kemp W. Organic Spectroscopy

BBL 201: ELEMENTARY BIOLOGY – II (CELL BIOLOGY)
(Batch 2016-2019)

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section – I

Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, cell fractionation.

Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport.

Section – II

Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments.

Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions including role in protein secretion.

Section - III

Lysosomes: Vacuoles and micro bodies: Structure and functions

Ribosomes: Structures and function including role in protein synthesis.

Mitochondria: Structure and function, Genomes, biogenesis.

Chloroplasts: Structure and function, genomes, biogenesis

Nucleus: Structure and function, chromosomes and their structure.

Section – IV

Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction.

Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.

SUGGESTED READING/BOOKS

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASMPress & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

BBL 201: ELEMENTARY BIOLOGY - II (CELL BIOLOGY)
(Batch 2020 onwards)

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objective of the course is to help the students to learn and develop an understanding of a cell as basic unit of life. This course is design to make them able to understand the construction of a cell, functions of cellular organelles and how a cell carries out and regulate cellular functions	**After successful completion of this course, students should be able to: -** ***1. Understand fundamental principles of cell biology such as difference between prokaryotic and eukaryotic cells, their structure and composition, microscopic and cytochemical techniques to study them.*** ***2. Understand how cells grow, divide, survive, die and regulate these important processes.*** ***3. Understand the process of cell signaling and its role in cellular functions.*** ***4. Gain an insight of how defects in functioning of cell organelles and regulation of cellular processes can develop into diseases.***

UNIT I [15 Lectures]

Cell: Introduction and classification of organisms by cell structure, cytosol, Compartmentalization of eukaryotic cells, Cell fractionation.
Cell Membrane and Permeability: Chemical components and organization of biological membranes, Fluid Mosaic Model, Membrane as a dynamic entity, Cell recognition and membrane transport.

UNIT II [15 Lectures]

Endo Membranous System and Cytoskeleton: Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions including role in protein secretion. Lysosomes: Vacuoles and micro bodies, Structure and function of microtubules, Microfilaments, Intermediate filaments.

UNIT III [15 Lectures]

Mitochondria and Chloroplast, Nucleus and Ribosome: Mitochondria: Structure and function, genomes, biogenesis. Chloroplasts: Structure and function, genomes, biogenesis. Nucleus: Structure and function, chromosomes and their structure and functions. Ribosomes: Structures and function including role in protein synthesis.

UNIT IV [15 Lectures]

Cell Division: Mitosis, Meiosis, Cell cycle and its regulation

Signal transduction: Cell Signaling through GPCR and Role of secondary messenger: cAMP and Protein Kinase.

Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.

Recommended Textbooks and References:

1. *Karp, G., Iwasa, J. & Marshall, W. Karp's Cell and Molecular Biology (9th Ed.). John Wiley & Sons. 2020.*
2. *Alberts, B., Johnson, A.D., Lewis, J., Morgan, D., Raff, M., Roberts, K., & Walter, P. Molecular Biology of the cell (6th Ed.). Garland Science. 2014.*
3. *Cooper, G. M. The Cell: A Molecular Approach (8th Ed.). Oxford University Press. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA. 2018.*
4. *Becker, W. M., Kleinsmith, L. J., Hardin. J. & Bertoni, G. P. The World of the Cell (8th Ed.). Pearson Benjamin Cummings Publishing, San Francisco. 2016.*
5. *Campbell, N.A. and Reece, J. B. Biology (12th Ed.). Pearson Benjamin Cummings, San Francisco. 2020.*

BXL 202: Computer Science

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: *The examiner is requested to set nine questions in all, selecting two questions from each unit and one compulsory question (Question No.1 based on entire syllabus will consist of seven short answer type questions each of two marks). The candidate is required to attempt five questions in all selecting one from each unit and the compulsory Question No.1.*

Unit-I

An Overview of Computer System **8Hrs**

Anatomy of a digital Computer, Memory Units, Main and Auxiliary Storage Devices, Input Devices, Output Devices, Classification of Computers. Radix number system: Decimal, Binary, Octal, Hexadecimal numbers and their inter-conversions; Representation of information inside the computers.

Unit-II

Operating System Basics **7Hrs**

The user Interface, Running Programmes, Managing files, Introduction to PC operating Systems: Unix/Linux, DOS, Windows 2000.

Unit-III

Internet basics **7Hrs**

Introduction to the basic concepts of Networks and Data Communications, How Internet works, Major features of internet, Emails, FTP, Using the internet.

Unit-IV

Programming Languages **8Hrs**

Machine-, Assembly-, High Level- Language, Assembler, Compiler, Interpreter, debuggers, Programming fundamentals: problem definition, algorithms, flow charts and their symbols, introduction to compiler, interpreter, assembler, linker and loader and their inter relationship.

BOOKS SUGGESTED:

1. Goel A., Computer Fundamentals, Pearson Education, 2010.
2. Aksoy P. & DeNardis L., Introduction to Information Technology, Cengage Learning, 2006
3. Sinha P. K. & Sinha P. Fundamentals of Computers, BPB Publishers, 2007

BPP 201: Physics Lab – II
(Batch 2016 only)

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

(Credits: 02)

1. To determine the frequency of an electric tuning fork by Melde's experiment and verify λ2 /T law.
2. To investigate the motion of coupled oscillators.
3. To study Lissajous Figures.
4. Familiarization with: Schuster`s focusing; determination of angle of prism.
5. To determine refractive index of the Material of a prism using sodium source.
6. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
7. To determine the wavelength of sodium source using Michelson's interferometer.
8. To determine wavelength of sodium light using Fresnel Biprism.
9. To determine wavelength of sodium light using Newton's Rings.
10. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
11. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
12. To determine dispersive power and resolving power of a plane diffraction grating.

Reference Books

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

BPP 201: PHYSICS LAB – II
(Batch 2017 and 2018 only)

Marks (Theory) : 70 **Credits: 2**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

1. To determine the frequency of an electric tuning fork by Melde's experiment.
2. To study Lissajous Figures.
3. To determine refractive index of the Material of a prism using sodium source.
4. To determine the dispersive power of the material of a prism using mercury source.
5. To determine the wavelength of sodium source using Michelson's interferometer.
6. To determine wavelength of sodium light using Fresnel Biprism.
7. To determine wavelength of sodium light using Newton's Rings.
8. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
9. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
10. To determine dispersive power and resolving power of a plane diffraction grating.

Reference Books

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

BPP 201: PHYSICS LAB – II
(Batch 2019 onwards)

Marks (External) : 70 **Credits : 2**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note:

1. ***Each student should perform at-least eight experiments.***
2. ***The students are required to calculate the error involved in a particular experiment.***
3. ***List of experiments may vary.***

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List of Experiments:

1. To determine Mechanical Equivalent of Heat, J. by Callender and Barne's constant flow method.
2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
3. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
5. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
6. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.
7. To calibrate a thermocouple to measure temperature in a specified Range using (1) Null Method, (2) Direct measurement using Op-Amp difference amplifier and to determine Neutral Temperature.
8. Study of Electrochemical Equivalent of Hydrogen using Voltmeter
9. Study of Newton's Law of cooling.
10. Determination of specific heat of Solids

Reference Books

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

BCP 201: CHEMISTRY LAB - II

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

1. Complexometric titrations: Determination of Mg^{2+}, Zn^{2+} by EDTA.
2. Paper Chromatography: Qualitative Analysis of any one of the following Inorganic cations and anions by paper chromatography (Pb^{2+}, Cu^{2+}, Ca^{2+}, Ni^{2+}, Cl^- , Br^- , I^- and PO_4^{3-} and NO_3^-).
3. To determine the specific refractivity of at least two liquids.
4. Determine rate constant of acid catalyzed hydrolysis of methyl acetate.
5. Determination of conductance of electrolytes
6. The preliminary examination of physical and chemical characteristics (physical state, colour, odour and ignition test), extra element detection (N, S, Cl, Br and I).

BOOKS SUGGESTED:

1. Vogel A. I., Tatchell A.R., Furnis B.S., Hannaford A.J., Smith P.W.G.,Vogel's Text Book of Practical Organic Chemistry, 5th Edn., Pubs: ELBS, 1989.
2. Pavia D.L., Lampanana G.M., Kriz G.S. Jr., Introduction to Organic Laboratory Techniques, 3rd Edn., Pubs: Thomson Brooks/Cole, 2005.
3. Mann F.G., Saunders. P.C., Practical Organic Chemistry, Pubs: Green & Co. Ltd., London, 1978.
4. Svehla, G., Vogel's Qualitative Inorganic Analysis (revised); 7th edition, Pubs: Orient Longman, 1996.
5. Bassett, J., Denney, R.C., Jeffery, G.H., Mendham, J., Vogel's Textbook of Quantitative Inorganic Analysis (revised); 4th edition, Pubs: Orient Longman, 1978.
6. Das R.C. & Behra B. Experimental Physical Chemistry, McGraw Hill.
7. Shoemaker & Gailand Experiments in Physical Chemistry, McGraw Hill.
8. Yadav J. B. Advanced Practical physical Chemistry

BXP 201: Computer Science Lab

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

C Programming language: C fundamentals, formatted input/ output, expressions, selection statements, loops and their applications; Basic types, arrays, functions, including recursive functions, program organization: local and external variables and scope; pointers & arrays

Representative programming in C

1. Write a program to find the largest of three numbers. (if-then-else)
2. Write a program to find the largest number out of ten numbers (for-statement)
3. Write a program to find the average mail height & average female heights in the class (input is in form of sex code, height).
4. Write a program to find roots of quadratic equation using functions and switch statements.
5. Write a program to multiply two matrices

BOOKS SUGGESTED:

1. Kanetkar Y. Let Us C, BPB publication

Semester - III

Course Opted	Paper Code	Nomenclature	Credit	Hours/ Week	Max. Marks		
					External	Internal	Total
Core Course- III	BML 301	Number Theory and Trigonometry	5	5	70	30	100
Core Course- IV	BML 302	Ordinary Differential Equations	5	5	70	30	100
Core Course- V	BML 303	Advanced Calculus	5	5	70	30	100
Core Course- VI	BML 304	Vector Calculus	5	5	70	30	100
Core Course- VII	BML 305	Mathematical Statistics	5	5	70	30	100
Skill Enhancement Course- I	BML 306	Special Functions-I	2	2	36	14	50
		Total	**27**	**27**	**386**	**164**	**550**

BML301: Number Theory and Trigonometry

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section – I

Divisibility, G.C.D. (greatest common divisors), L.C.M. (least common multiple)

Primes, Fundamental Theorem of Arithemetic. Linear Congruences, Fermat's theorem. Wilson's theorem and its converse. Linear Diophanatine equations in two variables

Section – II

Complete residue system and reduced residue system modulo m. Euler's ϕ function Euler's generalization of Fermat's theorem. Chinese Remainder Theorem. Quadratic residues. Legendre symbols. Lemma of Gauss; Gauss reciprocity law. Greatest integer function [x]. The number of divisors and the sum of divisors of a natural number n (The functions d(n) and σ(n)). Moebius function and Moebius inversion formula.

Section - III

De Moivre's Theorem and its Applications. Expansion of trigonometrical functions. Direct circular and hyperbolic functions and their properties.

Section – IV

Inverse circular and hyperbolic functions and their properties. Logarithm of a complex quantity. Gregory's series. Summation of Trigonometry series.

Books Recommended:

1. S.L. Loney, Plane Trigonometry Part – II, Macmillan and Company, London.
2. R.S. Verma and K.S. Sukla, Text Book on Trigonometry, Pothishala Pvt. Ltd. Allahabad.
3. Ivan Ninen and H.S. Zuckerman, An Introduction to the Theory of Numbers.

BML302: Ordinary Differential Equations

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section – I

Geometrical meaning of a differential equation. Exact differential equations, integrating factors. First order higher degree equations solvable for *x,y,p* Lagrange's equations, Clairaut's equations. Equation reducible to Clairaut's form. Singular solutions.

Section – II

Orthogonal trajectories: in Cartesian coordinates and polar coordinates. Self orthogonal family of curves. Linear differential equations with constant coefficients. Homogeneous linear ordinary differential equations. Equations reducible to homogeneous

Section – III

Linear differential equations of second order: Reduction to normal form. Transformation of the equation by changing the dependent variable/ the independent variable. Solution by operators of non-homogeneous linear differential equations. Reduction of order of a differential equation. Method of variations of parameters. Method of undetermined coefficients.

Section – IV

Ordinary simultaneous differential equations. Solution of simultaneous differential equations involving operators *(d/dx)* or *(d/dt)* etc. Simultaneous equation of the form $dx/P = dy/Q = dz/R$. Total differential equations. Condition for $Pdx + Qdy + Rdz = 0$ to be exact. General method of solving $Pdx + Qdy + Rdz = 0$ by taking one variable constant. Method of auxiliary equations.

Books Recommended:

1. D.A. Murray, Introductory Course in Differential Equations. Orient Longaman (India). 1967
2. A.R. Forsyth, A Treatise on Differential Equations, Macmillan and Co. Ltd., London
3. E.A. Codington, Introduction to Differential Equations.
4. S.L. Ross, Differential Equations, John Wiley & Sons
5. B. Rai & D.P. Chaudhary, Ordinary Differential Equations, Narosa Publishing House Pvt. Ltd.

BML303: Advanced Calculus

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section – I

Continuity, Sequential Continuity, properties of continuous functions, Uniform continuity, chain rule of differentiability. Mean value theorems; Rolle's Theorem and Lagrange's mean value theorem and their geometrical interpretations. Taylor's Theorem with various forms of remainders, Darboux intermediate value theorem for derivatives, Indeterminate forms.

Section – II

Limit and continuity of real valued functions of two variables. Partial differentiation. Total Differentials; Composite functions & implicit functions. Change of variables. Homogenous functions & Euler's theorem on homogeneous functions. Taylor's theorem for functions of two variables.

Section – III

Differentiability of real valued functions of two variables. Schwarz and Young's theorems. Implicit function theorem. Maxima, Minima and saddle points of two variables. Lagrange's method of multipliers.

Section – IV

Curves: Tangents, Principal normals, Binormals, Serret-Frenet formulae. Locus of the centre of curvature, Spherical curvature, Locus of centre of Spherical curvature, Involutes, evolutes, Bertrand Curves. Surfaces: Tangent planes, one parameter family of surfaces, Envelopes.

Books Recommended:

1. C.E. Weatherburn , Differential Geometry of three dimensions, Radhe Publishing House, Calcutta
2. Gabriel Klaumber, Mathematical analysis, Marcel Dekkar, Inc., New York, 1975
3. R.R. Goldberg , Real Analysis, Oxford & I.B.H. Publishing Co., New Delhi, 1970
4. Gorakh Prasad, Differential Calculus, Pothishala Pvt. Ltd., Allahabad
5. S.C. Malik , Mathematical Analysis, Wiley Eastern Ltd., Allahabad.
6. Shanti Narayan, A Course in Mathemtical Analysis, S. Chand and company, New Delhi
7. Murray, R. Spiegel, Theory and Problems of Advanced Calculus, Schaum Publishing co., New York

BML304: Vector Calculus

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section – I

Scalar and vector product of three vectors, product of four vectors. Reciprocal vectors. Vector differentiation. Scalar Valued point functions, vector valued point functions, derivative along a curve, directional derivatives

Section – II

Gradient of a scalar point function, geometrical interpretation of grad Φ, character of gradient as a point function. Divergence and curl of vector point function, characters of Div $\vec{f}$ and Curl $\vec{f}$ as point function, examples. Gradient, divergence and curl of sums and product and their related vector identities. Laplacian operator.

Section – III

Orthogonal curvilinear coordinates Conditions for orthogonality fundamental triad of mutually orthogonal unit vectors. Gradient, Divergence, Curl and Laplacian operators in terms of orthogonal curvilinear coordinates, Cylindrical co-ordinates and Spherical co-ordinates.

Section – IV

Vector integration; Line integral, Surface integral, Volume integral. Theorems of Gauss, Green & Stokes and problems based on these theorems.

Books Recommended:

1. Murrary R. Spiegal, Theory and Problems of Advanced Calculus, Schaum Publishing Company, New York.
2. Murrary R. Spiegal, Vector Analysis, Schaum Publishing Company, New York.
3. N. Saran and S.N. Nigam, Introduction to Vector Analysis, Pothishala Pvt. Ltd., Allahabad.
4. Shanti Narayna, A Text Book of Vector Calculus. S. Chand & Co., New Delhi.

BML305: Mathematical Statistics

Marks (Theory): 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section – I

Measures of Central Tendency and Location: Mean, median, mode, geometric mean, harmonic mean, partition values.
Measures of Dispersion: Absolute and relative measures of range, quartile deviation, mean deviation, standard deviation (σ), coefficient of variation.

Section – II

Moments, Skewness and Kurtosis: Moments about mean and about any point and derivation of their relationships, effect of change of origin and scale on moments, Sheppard's correction for moments (without derivation), Charlier's checks, Concepts of Skewness and Kurtosis.

Section –III

Basic concepts in Probability, Bayes' theorem and its applications.
Random Variable and Probability Functions: Definition and properties of random variables, discrete and continuous random variable, probability mass and density functions, distribution function.

Section – IV

Correlation for Bivariate Data: Concept and types of correlation, Scatter diagram, Karl Pearson Coefficient (r) of correlation and rank correlation coefficient.
Linear Regression: Concept of regression, principle of least squares and fitting of straight line, derivation of two lines of regression, properties of regression coefficients, standard error of estimate obtained from regression line, correlation coefficient between observed and estimated values. Angle between two lines of regression. Difference between correlation and regression.

Books Suggested:

1. A.M. Mood, F.A. Graybill and D.C. Boes, Introduction to the theory of Statistics, McGraw Hill, 1974.
2. Baisnab and M. Jas, Element of Probability and Statistics, Tata McGraw Hill.
3. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 2002.
4. P.L. Meyer, Introductory Probability and Statistical Applications, Addison-Wesley Publishing Company, 1970.

BML306: Special Functions-I

Marks (Theory): 36 **Marks (Total): 50**
Marks (Internal Assessment) : 14 **Time : 2 Hrs**

Note: Attempt three questions in all. The question paper will consist of **two** sections. **Question No. 1** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the two sections (**I-II**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section – I

Series solution of differential equations – Power series method, Definitions of Beta and Gamma functions. Bessel equation and its solution: Bessel functions and their properties-Convergence, recurrence, Relations and generating functions, Orthogonality of Bessel functions.

Section – II

Legendre and Hermite differentials equations and their solutions: Legendre and Hermite functions and their properties-Recurrence Relations and generating functions. Orhogonality of Legendre and Hermite polynomials. Rodrigues' Formula for Legendre & Hermite Polynomials, Laplace Integral Representation of Legendre polynomial.

Books Recommended:

1. Erwin Kreyszing, Advanced Engineering Mathematics, John Wiley & Sons, Inc., New York, 1999
2. A.R. Forsyth, A Treatise on Differential Equations, Macmillan and Co. Ltd.
3. I.N. Sneddon, Special Functions of Mathematical Physics & Chemistry. Oliver and Boyd: Interscience Publishers.
4. W.W. Bell, Special Functions for Scientists and Engineers.

Semester - IV

Course Opted	Paper Code	Nomenclature	Credit	Hours/ Week	Max. Marks		
					External	Internal	Total
Core Course -VIII	BML 401	Solid Geometry	5	5	70	30	100
Core Course- IX	BML 402	Transform Techniques	5	5	70	30	100
Core Course- X	BML 403	Elementary Partial Differential Equations	5	5	70	30	100
Core Course- XI	BML 404	Statics	5	5	70	30	100
Core Course- XII	BML 405	Operations Research-I	5	5	70	30	100
Skill Enhancement Course- II	BML406	Special Functions-II	2	2	36	14	50
		Total	**27**	**27**	**386**	**164**	**550**

BML401: Solid Geometry

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section – I

General equation of second degree. Tracing of conics. Tangent at any point to the conic, chord of contact, pole of line to the conic, director circle of conic. System of conics. Confocal conics. Polar equation of a conic, tangent and normal to the conic.

Section – II

Sphere: Plane section of a sphere. Sphere through a given circle. Intersection of two spheres, radical plane of two spheres. Co-axal system of spheres
Cones. Right circular cone, enveloping cone and reciprocal cone.
Cylinder: Right circular cylinder and enveloping cylinder.

Section – III

Central Conicoids: Equation of tangent plane. Director sphere. Normal to the conicoids. Polar plane of a point. Enveloping cone of a coincoid. Enveloping cylinder of a coincoid.

Section – IV

Paraboloids: Circular section, Plane sections of conicoids.
Generating lines. Confocal conicoid. Reduction of second degree equations.

Books Recommended:

1. R.J.T. Bill, Elementary Treatise on Coordinary Geometry of Three Dimensions, MacMillan India Ltd. 1994.
2. P.K. Jain and Khalil Ahmad: A Textbook of Analytical Geometry of Three Dimensions, Wiley Eastern Ltd. 1999.

BML402: Transform Techniques

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section – I

Laplace Transform: – Existence theorem for Laplace transforms, Linearity of the Laplace transforms, Shifting theorems, Laplace transforms of derivatives and integrals, Differentiation and integration of Laplace transforms, Convolution theorem, Inverse Laplace transforms, convolution theorem, Inverse Laplace transforms of derivatives and integrals, solution of ordinary differential equations using Laplace transform.

Section – II

Finite Laplace transformation: Definition and Properties, shifting and scaling theorem. **Fourier transforms:** Linearity property, Shifting, Modulation, Convolution Theorem, Fourier Transform of Derivatives, Relations between Fourier transform and Laplace transform, Parseval's identity for Fourier transforms, solution of differential Equations using Fourier Transforms.

Section – III

Mellin Transform: Definition and Properties of Mellin transform, shifting and scaling properties, Mellin transform of derivaties and integral.

Z-Tranform: Z-Tranform and inverse Z-Tranform of elementary function, shifting theorem, Convolution theorem, initial and final value theorem.

Section – IV

Hankel Tranform: Basic properties of Hankel transform, Basic Operational properties, Hankel transform of derivatives and some elementary functions, Relation between Fourier and Hankel transform with application to boundary value problem and PDE.

Books Recommended:

1. Erwin Kreyszing, Advanced Engineering Mathematics, John Wiley & Sons, Inc., New York, 1999.
2. A.R. Forsyth, A Treatise on Differential Equations, Macmillan and Co. Ltd.
3. I.N. Sneddon, The use of integral transform, McGraw Hill, 1972
4. Murray R. Spiegel, Laplace transform, Schaum's Series.

BML403: Elementary Partial Differential Equations

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section – I

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

Section – II

Linear partial differential equations of second and higher orders, Linear and non-linear homogeneous and non-homogeneous equations with constant coefficients, Partial differential equation with variable coefficients reducible to equations with constant coefficients, their complimentary functions and particular integrals, Equations reducible to linear equations with constant coefficients.

Section – III

Classification of linear partial differential equations of second order, hyperbolic, parabolic and elliptic types, Reduction of second order linear partial differential equations to Canonical (Normal) forms and their solutions, Solution of linear hyperbolic equations, Monge's method for partial differential equations of second order.

Section – IV

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

Books Recommended:

1. D.A. Murray, Introductory Course on Differential Equations, Orient Longman, (India), 1967
2. Erwin Kreyszing, Advanced Engineering Mathematics, John Wiley & Sons, Inc., New York, 1999
3. A.R. Forsyth, A Treatise on Differential Equations, Macmillan and Co. Ltd.
4. Ian N. Sneddon, Elements of Partial Differential Equations, McGraw Hill Book Company, 1988
5. Frank Ayres, Theory and Problems of Differential Equations, McGraw Hill Book Company, 1972
6. J.N. Sharma and Kehar Singh, Partial Differential Equations

BML404: Statics

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section – I

Composition and resolution of forces. Parallel forces. Moments and Couples.

Section – II

Analytical conditions of equilibrium of coplanar forces. Friction. Centre of Gravity.

Section – III

Virtual work. Forces in three dimensions. Poinsots central axis.

Section – IV

Wrenches. Null lines and planes. Stable and unstable equilibrium.

Books Recommended:

1. S.L. Loney, Statics, Macmillan Company, London
2. R.S. Verma, A Text Book on Statics, Pothishala Pvt. Ltd., Allahabad

BML405: Operations Research-I

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section- I

Definition, scope, methodology and applications of OR. Types of OR models.

Concept of optimization, Linear Programming: Introduction, Formulation of a Linear Programming Problem (LPP), Requirements for an LPP, Advantages and limitations of LP. Graphical solution: Multiple, unbounded and infeasible solutions.

Section-II

Principle of simplex method: standard form, basic solution, basic feasible solution.

Computational Aspect of Simplex Method: Cases of unique feasible solution, no feasible solution, multiple solution and unbounded solution and degeneracy. Two Phase and Big- M methods.

Section-III

Duality in LPP, primal-dual relationship. Transportation Problem: Methods for finding basic feasible solution of a transportation problem, Modified distribution method for finding the optimum solution, Unbalanced and degenerate transportation problems, transhipment problem, maximization in a transportation problem.

Section-IV

Assignment Problem: Solution by Hungarian method, Unbalanced assignment problem, maximization in an assignment problem, Crew assignment and Travelling salesman problem.

Game Theory: Two person zero sum game, Game with saddle points, the rule of dominance; Algebraic, graphical and linear programming methods for solving mixed strategy games.

Books Recommended

1. J.K. Sharma, Mathematical Model in Operations Research, Tata McGraw Hill.
2. H.A. Taha, Operations Research – An Introduction.
3. Kanti Swarup, P.K. Gupta, and Manmohan, Operations Research.
4. P.K. Gupta and D.S. Hira, Operations Research, S. Chand & Co.
5. S.I. Gass, Linear Programming (3rd Edition), McGraw Hill, New York, 1985.
6. S.D. Sharma, Operations Research.
7. N.S. Kambo, Mathematical Programming.
8. G. Hadley, Linear Programming, Narosa Publishing House, 1987.

BML406: Special Functions-II

Marks (Theory) : 36 **Marks (Total) : 50**
Marks (Internal Assessment) : 14 **Time : 2 Hrs**

Note: Attempt three questions in all. The question paper will consist of **two** sections. **Question No. 1** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the two sections (**I-II**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section-I

Laguerre Polynomials: Laguerre's equation and its solution, generating function, alternative expression for the Laguerre polynomials, explicit expressions and special values of the Laguerre polynomials, orthogonality properties of Laguerre polynomials, relation between Laguerre polynomials and their derivatives, recurrence relations, associated Laguerre polynomials, properties of the associated Laguerre polynomials.

Section-II

Hypergeometric functions: The hypergeometric series, an integral formula for the hypergeometric series, the hypergeometric equation, linear relation between the solutions of the hypergeometric equation, relation of contiguity, the confluent hypergeometric function, generalized hypergeometric series.

Books Recommended:

1. W.W. Bell, Special Functions for Scientists and Engineers, D. Van Nostrand Company Ltd., London 1968
2. I.N. Sneddon, Special Functions of Mathematical Physics and Chemistry, Interscience Publishers, Inc., New York, 1961.

Semester - V

Course Opted	Paper Code	Nomenclature	Credit	Hours/ Week	Max. Marks		
					External	Internal	Total
Core Course- XIII	BML 501	Real Analysis	5	5	70	30	100
Core Course- XIV	BML 502	Groups and Rings	5	5	70	30	100
Core Course- XV	BML 503	Programming in C & Numerical Methods	5	5	70	30	100
Core Course Practical- XV	BMP 504	Programming in C & Numerical Methods - Lab	2	4	35	15	50
Discipline Specific Elective- I	BML 505	Sequences and Series	5	5	70	30	100
Discipline Specific Elective- II	BML 506	Operations Research-II	5	5	70	30	100
		Total	**27**	**29**	**385**	**165**	**550**

BML501: Real Analysis

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs.**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section – I

Riemann integral, Integrability of continuous and monotonic functions, The Fundamental theorem of integral calculus. Mean value theorems of integral calculus.

Section – II

Improper integrals and their convergence, Comparison tests, Abel's and Dirichlet's tests, Frullani's integral, Integral as a function of a parameter. Continuity, Differentiability and integrability of an integral of a function of a parameter.

Section – III

Definition and examples of metric spaces, neighborhoods, limit points, interior points, open and closed sets, closure and interior, boundary points, subspace of a metric space, equivalent metrics, Cauchy sequences, completeness, Cantor's intersection theorem, Baire's category theorem, contraction Principle

Section – IV

Continuous functions, uniform continuity, compactness for metric spaces, sequential compactness, Bolzano-Weierstrass property, total boundedness, finite intersection property, continuity in relation with compactness, connectedness , components, continuity in relation with connectedness.

Books Recommended:

1. P.K. Jain and Khalil Ahmad, Metric Spaces, 2nd Ed., Narosa, 2004
2. Babu Ram, Metric Spaces, Vinayaka Publication
3. T.M. Apostol: Mathematical Analysis, Narosa Publishing House, New Delhi, 1985
4. R.R. Goldberg, Real Analysis, Oxford & IBH publishing Co., New Delhi, 1970
5. D. Somasundaram and B. Choudhary, A First Course in Mathematical Analysis, Narosa Publishing House, New Delhi, 1997
6. Shanti Narayan, A Course of Mathematical Analysis, S. Chand & Co., New Delhi
7. E.T. Copson, Metric Spaces, Cambridge University Press, 1968.
8. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill, 1963.

BML502: Groups and Rings

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section – I

Definition of a group with example and simple properties of groups, Subgroups and Subgroup criteria, Generation of groups, cyclic groups, Cosets, Left and right cosets, Index of a sub-group Coset decomposition, Largrage's theorem and its consequences, Normal subgroups, Quotient groups,

Section – II

Homoomorphisms, isomophisms, automorphisms and inner automorphisms of a group. Automorphisms of cyclic groups, Permutations groups. Even and odd permutations. Alternating groups, Cayley's theorem, Center of a group and derived group of a group.

Section – III

Introduction to rings, subrings, integral domains and fields, Characteristics of a ring. Ring homomorphisms, ideals (principle, prime and Maximal) and Quotient rings, Field of quotients of an integral domain.

Section – IV

Euclidean rings, Polynomial rings, Polynomials over the rational field, The Eisenstein's criterion, Polynomial rings over commutative rings, Unique factorization domain, R unique factorization domain implies so is $R[X_1, X_2, \ldots\ldots X_n]$

Books Recommended:

1. I.N. Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975
2. P.B. Bhattacharya, S.K. Jain and S.R. Nagpal, Basic Abstract Algebra (2^{nd} edition).
3. Vivek Sahai and Vikas Bist, Algebra, Narosa Publishing House.
4. I.S. Luther and I.B.S. Passi, Algebra, Vol.-II, Narosa Publishing House.

BML503: Programming in C & Numerical Methods

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section – I

Programmer's model of a computer, Algorithms, Flow charts, Data types, Operators and expressions, Input / Output functions.

Section – II

Decisions control structure: Decision statements, Logical and conditional statements, Implementation of Loops, Switch Statement & Case control structures. Functions, Preprocessors and Arrays.

Section – III

Strings: Character Data Type, Standard String handling Functions, Arithmetic Operations on Characters. Structures: Definition, using Structures, use of Structures in Arrays and Arrays in Structures. Pointers: Solution of Algebraic and Transcendental equations: Bisection method, Regula-Falsi method, Secant method, Newton-Raphson's method. Newton's iterative method for finding pth root of a number.

Section – IV

Simultaneous linear algebraic equations: Gauss-elimination method, Gauss-Jordan method, Triangularization method (LU decomposition method). Crout's method, Cholesky Decomposition method. Iterative method, Jacobi's method, Gauss-Seidal's method, Relaxation method.

Books Recommended:

1. B.W. Kernighan and D.M. Ritchie, The C Programming Language, 2nd Edition
2. V. Rajaraman, Programming in C, Prentice Hall of India, 1994
3. Byron S. Gottfried, Theory and Problems of Programming with C, Tata McGraw-Hill Publishing Co. Ltd., 1998
4. Babu Ram, Numerical Methods, Pearson Publication.
5. M.K. Jain, S.R.K. Iyengar, R.K. Jain, Numerical Method, Problems and Solutions, New Age International (P) Ltd., 1996
6. M.K. Jain, S.R.K. Iyengar, R.K. Jain, Numerical Method for Scientific and Engineering Computation, New Age International (P) Ltd., 1999
7. E. Balagurusamy, Programming in ANSI C, Tata McGraw-Hill Publishing Co. Ltd.

BMP504: Programming in C & Numerical Methods – Lab

Marks (Practical) : 35 **Marks (Total) : 50**
Marks (Internal Assessment) : 15

There will be a separate practical paper based on the theory paper BML 503.

BML505: Sequences and Series

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section – I

Boundedness of the set of real numbers; least upper bound, greatest lower bound of a set, neighborhoods, interior points, isolated points, limit points, open sets, closed set, interior of a set, closure of a set in real numbers and their properties. Bolzano-Weiestrass theorem, Open covers, Compact sets and Heine-Borel Theorem.

Section – II

Sequence: Real Sequences and their convergence, Theorem on limits of sequence, Bounded and monotonic sequences, Cauchy's sequence, Cauchy general principle of convergence, Subsequences, Subsequential limits.

Infinite series: Convergence and divergence of Infinite Series, Comparison Tests of positive terms Infinite series, Cauchy's general principle of Convergence of series, Convergence and divergence of geometric series, Hyper Harmonic series or p-series.

Section – III

Infinite series: D-Alembert's ratio test, Raabe's test, Logarithmic test, de Morgan and Bertrand's test, Cauchy's nth root test, Gauss Test, Cauchy's integral test, Cauchy's condensation test.

Section – IV

Alternating series, Leibnitz's test, absolute and conditional convergence, Arbitrary series: abel's lemma, Abel's test, Dirichlet's test, Insertion and removal of parenthesis, re-arrangement of terms in a series, Dirichlet's theorem, Riemann's Re-arrangement theorem, Pringsheim's theorem (statement only), Multiplication of series, Cauchy product of series, (definitions and examples only) Convergence and absolute convergence of infinite products.

Books Recommended:

1. R.R. Goldberg , Real Analysis, Oxford & I.B.H. Publishing Co., New Delhi, 1970
2. S.C. Malik, Mathematical Analysis, Wiley Eastern Ltd., Allahabad.
3. Shanti Narayan, A Course in Mathematical Analysis, S. Chand and Company, New Delhi
4. Murray, R. Spiegel, Theory and Problems of Advanced Calculus, Schaum Publishing Co., New York
5. T.M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 1985
6. Earl D. Rainville, Infinite Series, The Macmillan Co., New York

BML506: Operations Research-II

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section- I

Inventory Control: introduction of inventory, factors affecting inventory, Inventory models, Deterministic models: Economic order quantity model when shortages are allowed/not allowed, price discounts model, multi-item inventory models.

Section-II

Queuing Theory : Basic characteristics of queuing system, Birth-death equations, Steady state solution of Markovian queuing models with single and multiple servers with infinite capacity (M/M/1 and M/M/c), and with limited capacity (M/M/1/K and M/M/c/K).

Section-III

Sequencing problems: Processing of n jobs through 2 machines, n jobs through 3 machines, 2 jobs through m machines, n jobs through m machines.

Replacement problems: Replacement of items whose running cost increases with time, Replacement policies for the items that fail completely - Individual and the group replacement policies.

Section-IV

PERT and CPM: Introduction of PERT and CPM, Earliest and latest times, Determination of critical path and various types of floats, Probablistic and cost considerations in project scheduling

Books Recommended:

1. J.K. Sharma, Mathematical Model in Operations Research, Tata McGraw Hill.
2. H.A. Taha, Operations Research – An Introduction.
3. Kanti Swarup, Gupta, P.K. and Manmohan. Operations Research.
4. P.K. Gupta and D.S Hira, Operations Research, S. Chand & Co.
5. S.D. Sharma, Introduction to Operations Research.

Semester - VI

Course Opted	Paper Code	Nomenclature	Credit	Hours/ Week	Max. Marks		
					External	Internal	Total
Core Course- XVI	BML 601	Real and Complex Analysis	5	5	70	30	100
Core Course- XVII	BML 602	Linear Algebra	5	5	70	30	100
Core Course- XVIII	BML 603	Numerical Analysis	5	5	70	30	100
Core Course Practical- XVIII	BMP 604	Numerical Analysis - Lab	2	4	35	15	50
Discipline Specific Elective- III	BML 605	Dynamics	5	5	70	30	100
Discipline Specific Elective - IV	BML 606	Mathematical Modeling	5	5	70	30	100
		Total	**27**	**29**	**385**	**165**	**550**

BML601: Real and Complex Analysis

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section – I

Jacobians, Beta and Gama functions, Double and Triple integrals, Dirichlets integrals, change of order of integration in double integrals.

Section – II

Fourier's series: Fourier expansion of piecewise monotonic functions, Properties of Fourier Co-efficients, Dirichlet's conditions, Parseval's identity for Fourier series, Fourier series for even and odd functions, Half range series, Change of Intervals.

Section – III

Extended Complex Plane, Stereographic projection of complex numbers, continuity and differentiability of complex functions, Analytic functions, Cauchy-Riemann equations. Harmonic functions.

Section – IV

Mappings by elementary functions: Translation, rotation, Magnification and Inversion. Conformal Mappings, Mobius transformations. Fixed pints, Cross ratio, Inverse Points and critical mappings.

Books Recommended:

1. T.M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 1985
2. R.R. Goldberg, Real analysis, Oxford & IBH publishing Co., New Delhi, 1970
3. D. Somasundaram and B. Choudhary, A First Course in Mathematical Analysis, Narosa Publishing House, New Delhi, 1997
4. Shanti Narayan, A Course of Mathematical Analysis, S. Chand & Co., New Delhi
5. R.V. Churchill and J.W. Brown, Complex Variables and Applications, 5th Edition, McGraw-Hill, New York, 1990
6. Shanti Narayan, Theory of Functions of a Complex Variable, S. Chand & Co., New Delhi.

BML602: Linear Algebra

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section – I

Vector spaces, subspaces, Sum and Direct sum of subspaces, Linear span, Linearly Independent and dependent subsets of a vector space. Finitely generated vector space, Existence theorem for basis of a finitely generated vector space, Finite dimensional vector spaces, Invariance of the number of elements of bases sets, Dimensions, Quotient space and its dimension.

Section – II

Homomorphism and isomorphism of vector spaces, Linear transformations and linear forms on vector spaces, Vector space of all the linear transformations Dual Spaces, Bidual spaces, annihilator of subspaces of finite dimensional vector spaces, Null Space, Range space of a linear transformation, Rank and Nullity Theorem,

Section – III

Algebra of Linear Transformation, Minimal Polynomial of a linear transformation, Singular and non-singular linear transformations, Matrix of a linear Transformation, Change of basis, Eigen values and Eigen vectors of linear transformations.

Section – IV

Inner product spaces, Cauchy-Schwarz inequality, Orthogonal vectors, Orthogonal complements, Orthogonal sets and Basis, Bessel's inequality for finite dimensional vector spaces, Gram-Schmidt, Orthogonalization process, Adjoint of a linear transformation and its properties, Unitary linear transformations.

Books Recommended:

1. I.N. Herstein: Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975
2. P.B. Bhattacharya, S.K. Jain and S.R. Nagpal, Basic Abstract Algebra (2^{nd} edition).
3. Vivek Sahai and Vikas Bist, Algebra, Narosa Publishing House.
4. I.S. Luther and I.B.S. Passi, Algebra, Vol.-II, Narosa Publishing House.

BML603: Numerical Analysis

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section – I

Finite Differences operators and their relations. Finding the missing terms and effect of error in a difference tabular values, Interpolation with equal intervals: Newton's forward and Newton's backward interpolation formulae. Interpolation with unequal intervals: Newton's divided difference, Lagrange's Interpolation formulae.

Section – II

Central Differences: Gauss forward and Gauss's backward interpolation formulae, Sterling, Bessel Formula. Eigen Value Problems: Power method, Jacobi's method, Given's method, House-Holder's method, QR method, Lanczos method.

Section – III

Numerical Differentiation: Derivative of a function using interpolation formulae as studied in Sections–I & II. Numerical Integration: Newton-Cote's Quadrature formula, Trapezoidal rule, Simpson's one- third and three-eighth rule, Gauss Quadrature formula.

Section – IV

Difference equation: Formation of difference equation, Linear difference equation, Difference equation reducible to linear form. Numerical solution of ordinary differential equations: Single step methods-Picard's method. Taylor's series method, Euler's method, Runge-Kutta Methods. Multiple step methods; Predictor-corrector method, Modified Euler's method, Milne-Simpson's method.

Books Recommended:

1. Babu Ram, Numerical Methods: Pearson Publication.
2. R.S. Gupta, Elements of Numerical Analysis, Macmillan's India 2010.
3. M. K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Method, Problems and Solutions, New Age International (P) Ltd., 1996
4. M. K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Method for Scientific and Engineering Computation, New Age International (P) Ltd., 1999
5. C. E. Froberg, Introduction to Numerical Analysis (2^{nd} Edition).
6. Melvin J. Maaron, Numerical Analysis- A Practical Approach, Macmillan Publishing Co., Inc., New York
7. R.Y. Rubnistein, Simulation and the Monte Carlo Methods, John Wiley, 1981

BMP604: Numerical Analysis - Lab

Marks (Practical) : 35 **Marks (Total) : 50**
Marks (Internal Assessment) : 15

There will be a separate practical paper consisting of implementation of numerical methods in C Programming Language, studied in the theory paper BML 603.

BML605: Dynamics

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section – I

Velocity and acceleration along radial, transverse, tangential and normal directions. Relative velocity and acceleration. Simple harmonic motion. Elastic strings.

Section – II

Mass, Momentum and Force. Newton's laws of motion. Work, Power and Energy. Definitions of Conservative forces and Impulsive forces.

Section – III

Motion on smooth and rough plane curves. Projectile motion of a particle in a plane. Vector angular velocity.

Section – IV

General motion of a rigid body. Central Orbits, Kepler laws of motion. Motion of a particle in three dimensions. Acceleration in terms of different co-ordinate systems.

Books Recommended:

1. S.L. Loney, An Elementary Treatise on the Dynamics of a Particle and a Rigid Bodies, Cambridge University Press, 1956
2. F. Chorlton, Dynamics, CBS Publishers, New Delhi
3. A.S. Ramsey, Dynamics Part-1&2, CBS Publisher & Distributors.

BML606: Mathematical Modeling

Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Section – I

The process of Applied Mathematics: Mathematical modeling, need, techniques, classification and illustrative.

Section – II

Mathematical modeling through ordinary differential equation of first order. Mathematical modeling in population dynamics, mathematical modeling of epidemic and compartment models through system of ordinary differential equations.

Section – III

Mathematical modeling in economics, in medicine, Arms race, Battle, international trade and dynamics through ordinary differential equations. Mathematical modeling through ordinary differential equation of record order.

Section – IV

Mathematical modeling through difference equations: need, basic theory, economics and finance, population dynamics and Genetics, probability theory and examples.

Books Recommended:

1. J.N. Kapur: Mathematical modeling, Wiley Eastern limited, 1990.
2. J.N. Kapur, Mathematical Models in Biology and Medicine, Affiliated East-West Press (P) Ltd.
3. D.N. Burghes and A.D. Wood, Mathematical Models in the Social, Management and Life Science, John Wiley & Sons.
4. J.G. Andrews & R.R. Mclone, Mathematical Modeling, Butterworths (Pub.) Inc.

Scheme and Syllabi of Programme for

Dual Degree B.Sc. (Hons.) Mathematics – M.Sc. Mathematics

under Choice Based Credit System

(7^{th} to 10^{th} Semester)

(w.e.f. 2016-2017)

Semester - VII

Paper Code	Nomenclature	Credit	Hours/ Week	Max. Marks		
				External	Internal	Total
MML 711	Abstract Algebra-I	5	5	70	30	100
MML 712	Real Analysis	5	5	70	30	100
MML 713	Mechanics	5	5	70	30	100
MML 714	Advanced Differential Equations	5	5	70	30	100
MML 715	Complex Analysis-I	5	5	70	30	100
MML 716	Programming with Fortran (Theory)	5	5	70	30	100
MMP 717	Programming with Fortran (Practical)	1.5	3	70	30	100
	Total	**31.5**	**33**	**490**	**210**	**700**

Semester-VII

MML 711: Abstract Algebra-I **Marks for Major Test (External): 70**

5 Credits (5-0-0) **Marks for Internal Exam: 30**

Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks and will be distributed over the whole syllabus. The candidate is required to attempt five questions selecting one from each unit and the compulsory question.

Objectives: To familiarize students with some properties of groups and fields which have many applications in Coding Theory.

Unit - I

Review of Groups and Subgroups, Conjugate elements, Class Equation, Internal and External direct product of finite groups, Theory of finite p-groups, Cauchy theorem for finite abelian and non-abelian groups, Sylow's theory and its applications.

Unit - II

Zassenhaus's lemma, Normal and Subnormal series. Scheiers Theorem, Composition Series. Jordan-Holder theorem. Commutators and their properties. Three subgroup lemma of P.Hall.

Unit - III

Central series. Nilpotent groups. Upper and lower central series and their properties. Invariant (normal) and chief series. Solvable groups. Derived series. Field theory. Prime fields.

Unit - IV

Extension fields. Algebraic and transcendental extensions. Algebraically closed field. Conjugate elements. Splitting fields. Normal extensions. Multiple roots. Finite fields. Separable and inseparable extensions. Perfect fields.

Suggested Readings

1. I.N. Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.
2. P.B. Bhattacharya, S.K. Jain and S.R. Nag Paul, Basic Abstract Algebra (2nd Edition), Cambridge University Press, Indian Edition, 1997.
3. S. Singh and Q. Zameeruddin, Modern Algebra, Vikas Publishing House (2006).
4. I.D. Macdonald, Theory of Groups, Oxford University Press (Clarendon Press) 1968
5. I.S. Luther and I.B.S. Passi, Algebra, Vol. I-Groups, Vol.II-Rings, Narosa Publishing House (Vol. I-1996, Vol. II-1999).

Semester-VII

MML712: REAL ANALYSIS **Marks for Major Test (External): 70**

5 Credits (5-0-0) **Internal Assessment: 30**

Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks and will be distributed over the whole syllabus. The candidate is required to attempt five questions selecting one from each unit and the compulsory question.

Objectives: To acquaint the students with the topics of Riemann-Stieltjes integral, sequence and series of functions, power series, functions of several variables and with the basic concepts of measurability of sets.

Unit – I

Finite countable and uncountable sets, Real number system as a complete ordered field, lim sup and lim inf of set of real numbers and examples.

Function of bounded variation: definition and examples. Properties of function of bounded variation. Variation function, variation function of continuous function. Jordan Decomposition Theorem, Vector valued function of bounded variation.

Unit – II

Definition and existence of Riemann-Stieltjes integral, properties of the integral, integration and differentiation, the fundamental theorem of Calculus, integration of vector-valued functions, rectifiable curves.

Unit - III

Sequences and series of functions, point-wise and uniform convergence, Cauchy criterion for uniform convergence, Weierstrass M-test, Abel's and Dirichlet's tests for uniform convergence, uniform convergence and continuity, uniform convergence and Riemann-Stieltjes integration, uniform convergence and differentiation, Weierstrass approximation theorem, Power series, uniqueness theorem for power series, Abel's theorems.

Unit - IV

Functions of several variables, linear transformations, derivatives in an open subset of R^{η}, chain rule, partial derivatives, interchange of the order of differentiation, derivatives of higher orders, Taylor's theorem, Inverse function theorem, Implicit function theorem, Jacobians, extremum problems with constraints, Lagrange's multiplier method.

Suggested Readings

1. W. Rudin, Principles of Mathematical Analysis (3rd edition) McGraw-Hill, Kogakusha, 1976, International student edition.
2. T.M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 1985.
3. R.R. Goldberg, Methods of Real Analysis, John Wiley and Sons, Inc., New York, 1976.
4. H.L. Royden, Real Analysis, Macmillan Pub. Co. Inc. 4th Edition, New York, 1993.
5. SC Malik and Savita Arora, Mathematical New Age International (P) Limited Published, New Delhi, 2012 (Fourth Edition).

Semester-VII

MML713: MECHANICS **Marks for Major Test (External): 70**

5 Credits (5-0-0) **Internal Assessment: 30**

Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks and will be distributed over the whole syllabus. The candidate is required to attempt five questions selecting one from each unit and the compulsory question.

Objectives: To familiarize students with the basic concepts of moment of inertia; representation of the equations of motion for mechanical systems using the Lagrangian and Hamiltonian formulations of classical mechanics.

Unit - I

Moments and products of Inertia, Theorems of parallel and perpendicular axes, principal axes, the momental ellipsoid, Equimomental systems, Coplanar distributions. Generalized cooordinates. Euler's dynamical equations for the motion of a rigid body about a fixed point, Further properties of Rigid body motion under no forces.

Unit - II

Holonomic and Non-holonomic systems. Scleronomic and Rheonomic systems. Lagrange's equations for a holonomic system. Lagrange's equations for a conservative and impulsive forces. Kinetic energy as quadratic function of velocities. Generalized potential, Energy equation for conservative fields. Hamilton's variables. Donkin's theorem. Hamilton canonical equations. Cyclic coordinates. Routh's equations. Poisson's Bracket. Poisson's Identity. Jacobi-Poisson Theorem.

Unit - III

Hamilton's Principle. Principle of least action. Poincare Cartan Integral invariant. Whittaker's equations. Jacobi's equations. Hamilton-Jacobi equation. Jacobi theorem. Method of separation of variables. Lagrange Brackets. Condition of canonical character of a transformation in terms of Lagrange brackets and Poisson brackets. Invariance of Lagrange brackets and Poisson brackets under canonical transformations.

Unit - IV

Gravitation: Attraction and potential of rod, disc, spherical shells and sphere. Laplace and Poisson equations. Work done by self-attracting systems. Distributions for a given potential. Equipotential surfaces. Surface and solid harmonics. Surface density in terms of surface harmonics.

Suggested Readings

1. F. Chorlton, A Text Book of Dynamics, CBS Publishers & Dist., New Delhi.
2. F. Gantmacher, Lectures in Analytic Mechanics, MIR Publishers, Moscow.
3. A.S. Ramsey, Newtonian Gravitation, The English Language Book Society and the Cambridge University Press.
4. Louis N. Hand and Janet D. Finch, Analytical Mechanics, Cambridge University Press.

Semester-VII
MML714: ADVANCED DIFFERENTIAL EQUATIONS

Marks for Major Test (External): 70
5 Credits (5-0-0) **Internal Assessment: 30**
Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks and will be distributed over the whole syllabus. The candidate is required to attempt five questions selecting one from each unit and the compulsory question.

Objectives: To acquaint the students with existence and uniqueness of solutions of initial value problems, continuation of solutions, differential inequalities, eigenvalues, eigenfunctions and with Sturm-Liouville boundary value problems.

Unit - I

Existence of solutions, Functions of two variables, Initial-value problem and the equivalent integral equation, ε-approximate solution, Cauchy-Euler construction of an ε-approximate solution, Equicontinuous family of functions, Ascoli-Arzela theorem, Cauchy-Peano existence theorem. Uniqueness of solutions, Lipschitz condition **and determination of Lipschitz constant, Successive approximations,** Picard-Lindelof theorem for local existence and uniqueness of solutions, solution of initial-value problems by Picard method, **Non-local existence of solutions.**

Unit - II

Approximate methods of solving first-order equations: Power Series Methods, Numerical Methods. Continuation of solutions, Maximum interval of existence, Extension theorem, Dependence of solutions on initial conditions and function. Matrix method for homogeneous first order systems, nth order equation**: Existence and uniqueness of solutions.**

Unit - III

Total differential equations: Condition of integrability, Methods of Solution. Gronwall's differential inequality, Comparison theorems involving differential inequalities. **Eigenvalues and eigenfunctions: computation of eigenvalues and eigenvectors, Geometrical representation, properties and some theorems, Repeated eigenvalues, complex eigenvalues, Independence of eigenvectors, Diagonalization, Application of eigenvalues and eigenvectors: Matrix powers, solving a system of Ist order linear differential equations, homogeneous linear system (IVP).**

Unit – IV

Second order linear equations, Self adjoint form, Superposition principle, Lagrange's identity, Green's function, Zeros of solutions, **Abel's formula,** Sturm's separation and comparison theorems. Oscillatory and nonoscillatory equations, Riccati's equation and its solution, Pruffer transformation, **Boundary-value problems, Sturm-Liouville systems: Applications, Eigen values and eigen functions., Orthogonality of eigen functions, Properties of eigen values, Orthonormal systems, Expansion of a function in a series of orthonormal functions.**

Suggested Readings

1. E.A. Coddington and N. Levinson. Theory of Ordinary Differential Equations, McGraw Hill, NY, 1955.
2. G. Birkhoff and Rota, G.C. Ordinary Differential Equations, John Wiley and sons inc., NY, 1978.
3. S.L. Ross. Differential Equations, John Wiley and sons inc., NY, 1984.
4. Boyce, W.E. and Diprima, R.c. Elementary Differential Equations and Boundary Value Problems, John Wiley and sons Inc., NY, 1986.
5. D. Somasundaram. Ordinary Differential Equations, A First Course, Narosa Publishing House, 2010.
6. Gene H. Golub and Charles F. Van Loan, Matrix Computations (4th Edition) Johns Hopkins University Press, Baltimore, Maryland, 2013.

Semester-VII

MML715: COMPLEX ANALYSIS-I **Marks for Major Test (External): 70**

5 Credits (5-0-0) **Internal Assessment: 30**

Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks and will be distributed over the whole syllabus. The candidate is required to attempt five questions selecting one from each unit and the compulsory question.

Objectives: To familiarize with the analytic and meromorphic functions and their applications.

Unit-I

Power series as an analytic function, Complex Integration, Winding number or index of a curve, Antiderivatives, Cauchy-Goursat Theorem, Simply and Multiply connected domains, Cauchy's Integral formula, Extension of Cauchy's Integral formula, Higher Order derivatives, Cauchy's inequality.

Unit- II

Morera's theorem, Liouville's theorem, The fundamental theorem of Algebra, Introduction of analytic continuation, Maximum Modulus Principle, Minimum Modulus Principle, Schwarz lemma, Schwarz Reflection principle, Gauss Mean-Value Theorem, Poisson's formula, Taylor's Series, Laurent's Series.

Unit-III

Singularities, Meromorphic functions, Residues, Cauchy's residue theorem, Evaluation of Integrals, Argument principle, Rouche's theorem, Mittag Leffler's expansion theorem.

Unit-IV

Many valued functions, Branch point and Branch cut, Single valued branches for multi valid functions, Branches of many valued functions with special reference to arg z, Log z, z^a. Bilinear transformations, their properties and classification, Conformal self maps of Disk on half planes.

Suggested Readings

1. H.A. Priestly, Introduction to Complex Analysis, Clarendon Press, Oxford, 1990.
2. J.B. Conway, Functions of one Complex variable, Springer-Verlag, International student-Edition, Narosa Publishing House, 1980.
3. L.V. Ahlfors, Complex Analysis, McGraw-Hill, 1979.
4. Mark J. Ablowitz and A.S. Fokas, Complex Variables: Introduction and Applications, Cambridge University Press, South Asian Edition, 1998.
5. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, 1997.
6. J.W. Brown and R.V. Churchill, Complex Variables and Applications, McGraw HilI, 1996.

Semester-VII
MML716: PROGRAMMING WITH FORTRAN (THEORY)

Marks for Major Test (External): 70
5 Credits (5-0-0) **Internal Assessment: 30**
Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks and will be distributed over the whole syllabus. The candidate is required to attempt five questions selecting one from each unit and the compulsory question.

Objectives: To familiarize the students with the basics of computer and programming concepts of scientific language Fortran 90/95.

Unit-I

Computer Programming in Fortran 90/95: Numerical constants and variables, arithmetic expressions; implicit declaration, named constants, input/output; List directed input/output statements, Format specifications .Declarations including KIND specifications

Unit-II

Logical expressions and control flow; conditional flow; IF structure, Block DO loop Counted controlled Loops. arrays; input/output of arrays, arrays with variable size using ALLOCATABLE statement, arrays handling functions, multidimensional arrays

Unit-III

Strings, declaration of character variables, character handling functions, operators on strings, Functions; subroutines; Procedures with array arguments

Unit-IV

Derived types Using Derived types in arrays Processing files, Sequential file, Direct Access file; creating a sequential file, Use of complex variables Pointers and their applications

References

1. V. Rajaraman: Computer Programming in FORTRAN 90 and 95, Prentice-Hall of India Pvt. Ltd., New Delhi.
2. J.F. Kerrigan: Migrating to FORTRAN 90, Orielly Associates, CA, USA.
3. M. Metcalf and J. Reid: FORTRAN 90/95 Explained, OUP, oxford, UK.

Semester-VII
MMP717: Programming with Fortran (Practical)
Marks (External Assessment) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**
(1.5 Credits)

Note: The question paper will consist of **Three** programmes. The students are required to solve two programmes practically.

List of programmes:

1. Find Area of Circle
2. Find Area of Triangle
3. Generate Fibonacci Series
4. Find the roots of a quadratic Equation using arithmetic if statement
5. Sum of Sine Series using Block Do loop
6. Sum of Cosine Series using Block Do loop
7. Given no is Prime or not
8. Prime no. Generation
9. Bubble Sorting of an array
10. To calculate N! using Function
11. Calculation of mean and standard deviation
12. Fitting of a straight line=A+BX
13. Find Sum & product of two complex numbers
14. Matrix addition & subtraction using ALLOCATABLE STATEMENT
15. To arrange the name of cities alphabetically
16. To find correlation co-efficient and regression lines
17. Matrix Multiplication using subroutine
18. Transpose of a matrix using matrix handling functions
19. Given year is leap or not using else if statement

References

1. V. Rajaraman: Computer Programming in FORTRAN 90 and 95, Prentice-Hall of India Pvt. Ltd., New Delhi.
2. J.F. Kerrigan: Migrating to FORTRAN 90, Orielly Associates, CA, USA.
3. M. Metcalf and J. Reid: FORTRAN 90/95 Explained, OUP, oxford, UK.

Semester - VIII

Paper Code	Nomenclature	Credit	Hours/ Week	Max. Marks		
				External	Internal	Total
MML 721	Abstract Algebra-II	5	5	70	30	100
MML 722	Measure & Integration Theory	5	5	70	30	100
MML 723	Advanced Mathematical Statistics	5	5	70	30	100
MML 724	Differential Equations and Calculus of Variations	5	5	70	30	100
MML 725	Complex Analysis-II	5	5	70	30	100
MML 726	Advanced Numerical Methods	5	5	70	30	100
MMP 727	Computing Lab – MatLab	1.5	3	70	30	100
	Total	**31.5**	**33**	**490**	**210**	**700**

Semester-VIII

MML 721: ABSTRACT ALGEBRA-II **Marks for Major Test (External): 70**

5 Credits (5-0-0) **Internal Assessment: 30**

Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks and will be distributed over the whole syllabus. The candidate is required to attempt five questions selecting one from each unit and the compulsory question.

Objectives: To familiarize students with some properties of rings and modules.

Unit-I

Modules, submodules and quotient modules, Modules generated by a non-empty subset of an R-module. Homomorphisms of R-modules. Cyclic modules. Free modules. Simple modules. Semi-simple modules. Schur's Lemma. Ascending and descending chains of submodules of an R-module. Ascending and Descending chain conditions. Noetherian and Artinian modules and rings. Hilbert basis Theorem

Unit-II

Wedderburn-Artin theorem. Uniform modules, primary modules, and Noether-Lasker theorem. Smith normal form over a principal ideal domain and rank. Fundamental structure theorem for finitely generated abelian groups and its application to finitely generated Abelian groups.

. Unit III

Characteristic roots of a linear transformation. Canonical Forms- Similarity of linear transformations. Invariant subspaces. Reduction to triangular form. Nilpotent transformations. Index of nilpotency. Invariants of a nilpotent transformation. Cyclic subspaces with respect to a nilpotent transformation. Uniqueness of the invariants of a nilpotent transformation.

Unit IV

The primary decomposition theorem. Jordan blocks and Jordon forms. Cyclic modules relative to a linear transformation. Companion matrix of a polynomial f(x). Rational canonical form. Generalized canonical forms.

Suggested Readings

1. I.N. Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.
2. P.B. Bhattacharya, S.K. Jain and S.R. Nag Paul, Basic Abstract Algebra (2^{nd} Edition), Cambridge University Press, Indian Edition, 1997.
3. N. Jacobson, Basic Algebra, Vols. I & II, W.H. Freeman, 1980.
4. I.S. Luther and I.B.S. Passi, Algebra, Vol. I-Groups, Vol.II-Rings, Narosa Publishing House (Vol. I-1996. Vol. II-1999).

Semester-VIII
MML722: MEASURE & INTEGRATION THEORY

Marks for Major Test (External): 70
5 Credits (5-0-0) **Internal Assessment: 30**
Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks and will be distributed over the whole syllabus. The candidate is required to attempt five questions selecting one from each unit and the compulsory question.

Objectives: To acquaint the students with the topics of measurable functions, Lebesgue integral, Differentiation of monotonic functions and L^p spaces.

Unit – 1

Set functions, intuitive idea of measure, elementary properties of measure, measurable sets and their fundamental properties, Lebesgue measure of sets of real numbers, algebra of measurable sets, Borel sets, equivalent formulation of measurable sets in terms of open, closed, F_σ and G_δ sets, non measurable sets.

Unit-II

Measurable functions and their equivalent formulations, Properties of measurable functions. Approximation of measurable functions by sequences of simple functions, Measurable functions as nearly continuous functions, Egoroffs theorem, Lusin's theorem, Convergence in measure and F. Riesz theorem for convergence in measure, Almost uniform convergence.

Unit-III

Shortcomings of Riemann Integral. Lebesque Integral of a bounded function over a set of finite measure and its properties, Lebesgue integral as a generalization of Riemann integral, Bounded convergence theorem, Lebesgue theorem regarding points of discontinuities of Riemann integrable functions, Integral of non-negative functions, Fatou's Lemma, Monotone convergence theorem, General Lebesgue Integral, Lebesgue convergence theorem.

Unit-IV

Vitali's covering Lemma, Differentiation of monotonic functions, Differentiation of Indefinite integral. Fundamental Theorem of Calculus. Absolutely continuous functions and their properties.

Suggested Readings

1. G. De Barra, Measure Theory and Integration, Weiley Eastern Limited, 1981.
2. P.K. Jain and V.P. Gupta, Lebesgue Measure and Integration, New Age International (P) Limited Published, New Delhi, 1986 (Reprint 2000).
3. H.L. Royden, Real Analysis, Macmillan Pub. Co. Inc. 4th Edition, New York, 1993.
4. R. G. Bartle, The elements of Integration and Lebesgue Measure, John Wiley and Sons, 1995.
5. Walter Rudin, Principles of Mathematical Analysis (3rd edition) McGraw-Hill, Kogakusha, 1976, International student edition.

Semester-VIII
MML723: ADVANCED MATHEMATICAL STATISTICS

Marks for Major Test (External): 70
5 Credits (5-0-0) **Internal Assessment: 30**
Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks and will be distributed over the whole syllabus. The candidate is required to attempt five questions selecting one from each unit and the compulsory question.

Objectives: To familiarize the students with basics of probability, different probability distributions, multiple correlation and sampling distributions.

Unit – I

Sample Space, Random variable, discrete and continuous random variables, probability mass and density functions, distribution function, Joint, marginal and conditional distributions. Mathematical Expectation and its properties. Variance, Moments, Moment generating function, cumulant generating function.

Unit – II

Discrete distributions: Binomial, Poisson and geometric distributions with their properties. Continuous distributions: Uniform and Normal distributions and their properties.

Unit - III

Gamma and Exponential distributions and their properties. Chebychev's inequality, Central Limit Theorem. Weak Law of Large Numbers. Multiple Regression, Partial and Multiple Correlation

Unit – IV

Sampling distribution: t- distribution, Chi-square distribution, F- distribution**.** Testing of Hypothesis: Parameter and statistic, Simple and composite hypotheses, Null and alternative hypotheses, Critical Region, Level of significance, One tailed and two tailed tests, types of errors.

Suggested Readings

1. A.M. Mood, Graybill F.A. and Boes D.C., Introduction to the theory of Statistics, McGraw Hill Book Company, 2001.
2. J.E. Freund, Mathematical Statistics, Prentice Hall of India, 2014.
3. M. Speigel, Probability and Statistics, Schaum Outline Series.
4. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, S. Chand Pub., New Delhi, 2014.
5. H.C. Taneja, Statistical Methods for Engineering & Sciences, I. K. International, 2009.
6. Gun A.M, Gupta M.K, Dasgupta , Fundamental of Statistics Vol. 1 & 2, World Press, 2016
7. V. Hogg and T. Craig, Introduction to Mathematical Statistics, 7th Edition, Pearson Education Limited, 2014

Semester-VIII

MML724 DIFFERENTIAL EQUATIONS AND CALCULUS OF VARIATIONS

Marks for Major Test (External): 70

5 Credits (5-0-0) **Internal Assessment: 30**

Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1).The compulsory question will consist of seven short answer type questions, each of two marks and will be distributed over the whole syllabus. The candidate is required to attempt five questions selecting one from each unit and the compulsory question.

Objectives: To familiarize the students with linear systems, adjoint systems, non-linear systems and with some motivating problems of calculus of variation.

Unit - I

Linear differential equations, Matrix exponentials, Logarithm of a non-singular matrix, Linear systems, fundamental set, fundamental matrix of a homogeneous system **and its properties,** Wronskian **theory and its applications: relation with linearly independent and dependent vector functions,** Abel - Liouville formula, Adjoint system **and its fundamental matrix**, **Reduction of the order of 2nd order HLD Equation and its generalization to nth order HLD Equation with applications,** Reduction of the order of a homogeneous system.

Unit - II

Linear Systems with constant coefficients, Method of variation of constants for a non-homogeneous system **and its applications,** Periodic solutions, Floquet theory for periodic systems, **Representation Theorem,** Linear differential equations of order n, **Abel's identity, More Wronskian theory, Linear independence and dependence of solutions of an nth order equation, Linear operator,** Lagrange's identity, Green's formula, **Method of variation of parameter for 2^{nd} order NHLD Equation and its generalization to nth order Non-homogeneous LD Equation with applications**.

Unit – III

Nonlinear differential equations, Plane autonomous systems and their critical points, Classification of critical points-rotation points, foci, nodes, saddle points. Stability, Asymptotical stability and unstability of critical points, C**ritical points and paths of linear systems, Application to dynamics,** Almost linear systems, Perturbations, Simple critical points, Dependence on a parameter, Liapunov function, **Basic theorems for non-linear systems**, Liapunov's method to determine stability and **asymptotic stability** for nonlinear systems, Limit cycles **and periodic solutions, Existence and non existence of limit cycles,** Bendixson non-existence theorem, Statement of Poincare-Bendixson theorem, Index of a critical point, H**alf-path, Limit set of an orbit.**

Unit – IV

Functional, Motivating problems of calculus of variations, **Euler's equation for one dependent function and its first order derivative,** Shortest distance, Minimum surface of revolution, **Natural boundary conditions,** Brachistochrone problem, Isoperimetric problem, Geodesic, Fundamental lemma of calculus of variations, Euler's equation for one dependent function and its generalization to 'n' dependent functions and to higher order derivatives, **Variational problems in parametric form, Invariance of Euler's equation under co-ordinate transformation, Lagrange multipliers**, Conditional extremum under geometric constraints and under integral constraints.

Suggested Readings

1. E.A. Coddington and N. Levinson. Theory of Ordinary Differential Equations, McGraw Hill, NY, 1955.
2. G. Birkhoff and Rota, G.C. Ordinary Differential Equations, John Wiley and sons inc., NY, 1978.
3. S.L. Ross. Differential Equations, John Wiley and sons inc., NY, 1984.
4. J.M. Gelfand and Fomin, S.V., Calculus of Variations, Prentice Hall, Englewood, Cliffs, New Jersy, 1963.

5. Boyce, W.E. and Diprima, R.C., Elementary Differential Equations and Boundary Value Problems, John Wiley and sons Inc., NY, 1986.
6. D. Somasundaram. Ordinary Differential Equations, A First Course, Narosa Publishing House, 2010.
7. S G. Deo, V. Lakshmikantham and V. Raghavendra, Textbook of Ordinary Differential Equations, Tata McGraw-Hill, 2006.

Semester-VIII
MML725: Complex Analysis-II
Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**
5 Credits (5-0-0)

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Objectives: To familiarize the concepts of analytic continuation, properties of entire functions and conformal mapping.

Unit - I

Analytic Continuation; Spaces of Analytic functions, Hurwitz's theorem, Montel's theorem, Uniqueness of direct analytic continuation, Uniqueness of analytic continuation along a curve, power series method of analytic continuation. Monodromy theorem and its consequences.

Unit – II

Conformal mapping: Normal families of Analytics Functions, Riemann's mapping theorem, Harmonic function on a disk, Harnack's inequality and theorem, The Schwarz-Christoffel formula, Dirichlet problem. Green's function., Univalent functions in the unit disk, Bieberbach's conjecture (Statement only) and the Koebe- Bieberbach's 1/4 theorem.

Unit – III

Entire function; Infinite product, convergence theorems for numerical infinite products, zeros of entire function, Weierstrass' factorisation theorem, Exponent of Convergence of the zeros of an entire function, Genus, Exponential Degree, Order and Type of an entire function, Hadamard's factorization theorem, Hadamard's three circles theorem, Borel's theorem, The range of an analytic function, Bloch's theorem. The Little Picard theorem, Schottky's theorem, Montel Caratheodory and the Great Picard theorem.

Unit - IV

Meromorphic Function; Gamma function and its properties-Euler formula, Reflection formula, Gauss formula, Riemann Zeta function, Analytic continuation of Zeta function-Riemann's functional equation. Runge's theorem, Jensen's formula, Poisson-Jensen formula. Order and type of a meromorphic function.

Suggested Readings

1. H.A. Priestly, Introduction to Complex Analysis, Clarendon Press, Oxford, 1990.
2. J.B. Conway, Functions of one Complex variable, Springer-Verlag, International student Edition, Narosa Publishing House, 1980.
3. L.V. Ahlfors, Complex Analysis, McGraw-Hill, 1979.
4. Mario O. Gonzalez, Complex Analysis, Marcel Dekker, Inc. New York, 1991.
5. Mark J. Ablowitz and A.S. Fokas, Complex Variables: Introduction and Applications, Cambridge University Press, South Asian Edition, 1998.
6. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, 1997.
7. J.W. Brown and R.V. Churchill, Complex Variables and Applications, McGraw Hill, 1996.

Semester-VIII
MML726: Advanced Numerical Methods (5.0 Credit)
Marks (Theory) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Objectives: The course on Advanced Numerical Methods deals with advance topics on interpolations, solution of system of linear and non-linear equations, solution of initial value problems and boundary value problems.

Unit-I

Interpolation and Approximation

Interpolation: Introduction of Gauss' Central Difference Formulae, Stirling's Formula, Bessel's Formula without proof, Everett's Formula, Relation between Bessel's and Everett's Formulae. Hermite's Interpolation Formula, Divided Differences and Their Properties, Newton's General Interpolation Formula, Interpolation by Iteration, Inverse Interpolation, Double Interpolation.
Approximation: Norms of functions – Best Approximations: Least squares polynomial approximation– Approximation with Chebyshev polynomials – Piecewise Linear & Cubic Spline approximation.

Unit-II

Numerical Differentiation and Integration

Numerical Differentiation: Errors in Numerical Differentiation, Cubic Splines Method, Differentiation Formulae with Function Values, Maximum and Minimum Values of a Tabulated Function.
Numerical Integration: Boole's and Weddle's rules, use of Cubic splines, Romberg integration, Newton-Cotes integration formula, Euler-Maclaurin formula, Adaptive Quadrature method. Gaussian integration, Numerical evaluation of Singular integrals, Numerical evaluation of double and triple integrals with constant and variable limits and its application, Solution of integral equations.

Unit-III

Iterative Methods for Linear and Nonlinear System

Iterative Method for System of Linear Equations: General iterative method. Jacobi and Gauss-Seidel method. Relaxation method. Necessary and sufficient conditions for convergence. Speed of convergence. S.O.R. and S.U.R. methods. Determination of eigenvalue by iterative methods. Ill conditioned system. Solution of tridiagonal system,
Iterative Method for System of Non-linear Equations: Complex root of non-linear equation, solution of simultaneous non-linear equations.

Unit-IV

Numerical solution of ordinary differential equations

Initial value problems: Runge Kutta methods of fourth order, Multistep method- The Adams-Moulton method, stability, Convergence and Truncation error for the above methods. Milne's method, Cubic spline method, Simultaneous and higher order equations,
Boundary Value Problems: Second order finite difference, Shooting method and Cubic spline methods, Numerov's method, Mixed BVPs.

Suggested Readings:

1. C.F. Gerald and P.O. Wheatley: Applied Numerical Methods, Low- priced edition, Pearson Education Asia (2002), Sixth Edition.
2. D. Kincaid and W. Cheney, Numerical Analysis: Mathematics of Scientific Computing, 3rd Edn., AMS (2002).
3. D.V. Griffiths and I.M. Smith, Numerical Methods for Engineers, Blackwell Scientific Publications (1991).

4. John H Mathews, Numerical Methods for Mathematics, Science and Engineering, Prentice Hall of India (1994).
5. K. E. Atkinson, Introduction to Numerical Analysis, 2nd Edn., John Wiley (1989).
6. M.K. Jain: Numerical Solution of Differential Equations, 4th Edition, New Age (2018).
7. M.K. Jain, S.R.K. Iyengar, R.K.Jain, Numerical Methods for Scientific and Engineering, Computation, 7th Edition, New Age (2019).

Semester-VIII
MMP727: Computing Lab - MatLab (1.5 Credits)
Marks (External Assessment) : 70 **Marks (Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Objectives: The course on Matlab deals with topics on Matlab tools, operations with arrays, programming with inbuilt functions of Matlab, use of Matlab as symbolic calculation of function expression.

MATLAB Basics: working in the command window, Arithmetic Operations, Elementary Math Built-in Functions, Variable names, script files, Matrices and Arrays, Input to a Script file, Output commands-The `disp` Command, The *`fprintf`* Command, the `save` and `load` commands, Importing and Exporting data. two-dimensional plots, formatting a plot. Multiple plots on the same page.

Operations with Arrays: Creating, Concatenating, and Expanding Matrices, Removing Rows or Columns from a Matrix, Reshaping and Rearranging Arrays, Multidimensional Arrays, Array Indexing, Mathematical Operations with Arrays, Systems of Linear Equations and solutions.

Programming in MATLAB: Relational and logical operators, Conditional statements : `if-end`,`if-else-end`, `if-elseif-else-end` Structures. The `switch-case` Statement. **LOOPS:** `for-end`, `while-end` loops, Nested loops and nested conditional statements, the `break` and `continue` commands. Creating a function file, local and global variables.

Symbolic math: Symbolic objects and symbolic expressions, Creating symbolic objects, creating symbolic expressions, the `findsym` command and the default symbolic variable, Changing the form of an existing symbolic expression.

Suggested Readings:

1. Amos Gilat: MATLAB® An Introduction with Applications, Fourth Edition, JOHN WILEY & SONS, INC, 2011.
2. Stephen J. Chapman, MATLAB® Programming for Engineers, Fourth Edition, Thomson, 2008.
3. *MATLAB® Mathematics,* www.mathworks.com.
4. Dingyü Xue and Yang Quan Chen, Solving Applied Mathematical Problems With Matlab®, Chapman & Hall/CRC, 2009.
5. Moler C B. Numerical computing with MATLAB. MathWorks Inc, 2004

Semester - IX

Paper Code	Nomenclature	Credit	Hours/ Week	Max. Marks		
				External	Internal	Total
MML 831	Topology	5	5	70	30	100
MML 832	Partial Differential Equations	5	5	70	30	100
MML 833	Mechanics of Solids-I	5	5	70	30	100
MMP 834	Computing Lab-II MATLAB Programming & Applications	1.5	3	70	30	100
-----	Programme Elective-1	5	5	70	30	100
-----	Programme Elective-2	5	5	70	30	100
-----	Open Elective (To be opted from other Discipline(s)/Departments)	4	4	70	30	100
	Total	**30.5**	**32**	**490**	**210**	**700**

***Programme Electives**

Paper Code	Nomenclature	Credit	Hours/ Week	Max. Marks		
				External	Internal	Total
MML 835	Analytic Number Theory	5	5	70	30	100
MML 836	Fluid Mechanics	5	5	70	30	100
MML 837	Advanced Discrete Mathematics	5	5	70	30	100
MML 838	Difference Equations	5	5	70	30	100

Open Elective offered by Department of Mathematics for other Discipline(s)/Departments						
Paper Code	**Nomenclature**	**Credit**	**Hours/ Week**	**Max. Marks**		
				External	**Internal**	**Total**
MOL 851	Mathematical Methods	4	4	70	30	100

* Programme/ open electives can be offered subject to availability of requisite resources/ faculty in the department.

Semester- IX
MML831: TOPOLOGY

Marks for Major Test (External): 70
5 Credits (5-0-0) **Internal Assessment: 30**
Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks and will be distributed over the whole syllabus. The candidate is required to attempt five questions selecting one from each unit and the compulsory question.

Objectives: To familiarize the students with basics of a topological space, compactness, connectedness, separation axioms and product spaces.

Unit - I

Definition and examples of topological spaces. Closed sets. Closure. Dense subsets. Neighbourhoods. Interior, exterior and boundary points of a set. Accumulation points and derived sets. Bases and sub-bases. Subspaces and relative topology. Alternate methods of defining a topology in terms of Kuratowski Closure Operator and Neighbourhood Systems.

Unit - II

Continuous functions and homeomorphism. Compactness. Continuous functions and compact sets. Basic properties of compactness. Compactness and finite intersection property. Sequentially and countably compact sets. Local compactness. Compactness in metric spaces. Equivalence of compactness, countable compactness and sequential compactness in metric spaces.

Unit - III

Connected spaces. Connectedness on the real line. Components. Locally connected spaces. First and Second Countable spaces. Lindelof ’s theorem. Separable spaces. Second Countability and Separability.

Unit - IV

Separation axioms. T_0, T_1, and T_2 spaces. Their characterization and basic properties. Regular and normal spaces. Urysohn's Lemma. T_3 and T_4 spaces. Complete regularity and Complete normality. $T_{3½}$ and T_5 spaces. Product topological spaces, Projection mapping.

Suggested Readings

1. W.J. Pervin, Foundations of General Topology, Academic Press Inc. New York, 1964.
2. J.L. Kelley, General Topology, Van Nostrand, Reinhold Co., New York, 1995.
3. James R. Munkres, Topology, A First Course, Prentice Hall of India Pvt. Ltd., New Delhi, 2000.
4. George F. Simmons, Introduction to Topology and Modem Analysis, McGraw-Hill Book Company, 1963.
5. J. Dugundji, Topology, Allyn and Bacon, 1966 (Reprinted in India by Prentice Hall of India Pvt. Ltd.).
6. K.D. Joshi, Introduction to General Topology, Wiley Eastern Ltd., 1983.

Semester- IX
MML 832: PARTIAL DIFFERENTIAL EQUATIONS

Marks for Major Test (External): 70
5 Credits (5-0-0) **Internal Assessment: 30**
Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks and will be distributed over the whole syllabus. The candidate is required to attempt five questions selecting one from each unit and the compulsory question.

Objectives: To familiarize the students with linear and non-linear partial differential equations in R^n and various methods to obtain the solution of partial differential equations.

Unit - I

Partial Differential Equations of k^{th} order: Definition, Example and classification, Transport Equation-Initial value Problem. Nonhomogeneous Equation. Poisson Equation and its solution, Laplace's Equation-Fundamental Solution, Mean Value Formulas, **Properties of Harmonic Functions**: Strong Maximum Principle, local estimates of derivatives, uniqueness, Liouville theorem, Harnack's inequality etc. Energy Methods, Dirichlet principle

Unit - II

Green's Function: representation formula, symmetry of Green's function, Green's function for a half-space, Unit ball, Ball of radius r,
Heat Equation-Fundamental Solution, Solution of initial value problem, Non Homogeneous Equation, Mean Value Formula, uniqueness

Unit – III

Wave Equation- D. Alembert's formula and its applications, Solution by Spherical Means, Euler Darboux equation, Poisson's formula, Kirchhoff's formula, Non-homogeneous wave Equations, Energy Methods. Uniqueness of Solution Domain of Dependence of Solution.
Nonlinear First Order PDE-Complete Integrals, Envelopes, Characteristics, Hamilton-Jacobi Equations

Unit – IV

Representation of Solutions-Separation of Variables, Similarity Solutions (Plane and Travelling Waves, Solitons, Similarity under Scaling), Fourier and Laplace Transform, Hopf-Cole Transform, Hodograph and Legendre Transforms, Potential Functions.

Suggested Readings

1. L.C. Evans, Partial Differential Equations, Graduate Studies in Mathematics, Volume 19. AMS, 1998.
2. Sneddon I. N., Elements of Partial Differential Equations, McGraw Hill International

Semester- IX
MML833: MECHANICS OF SOLIDS-I

Marks for Major Test (External): 70
5 Credits (5-0-0) **Internal Assessment: 30**
Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks and will be distributed over the whole syllabus. The candidate is required to attempt five questions selecting one from each unit and the compulsory question.

Objectives: To familiarize students with basics of Cartesian Tensor, theory of elasticity including strain/displacement relations, equilibrium and constitutive equations, Hooke's law to develop stress-strain relationships for different types of materials, basic properties of materials to solve problems related to isotropic elasticity.

Unit - I

Cartesian Tensor: Coordinate transformation, Cartesian Tensor of different order, Sum or difference and product of two tensors. Contraction theorem, Quotient law, Symmetric & Skewsymmetric tensors, Kronecker tensor, alternate tensor and relation between them, Scalar invariant of second order tensor, Eigen values & vectors of a symmetric second order tensor, Gradient, divergence & curl of a tensor field.

Unit - II

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. Saint- Venant's equations of Compatibility.

Analysis of Stress: Stress tensor. Equations of equilibrium. Transformation of coordinates.

Unit - III

Stress quadric of Cauchy. Principal stress and invariants. Maximum normal and shear stresses. Equations of Elasticity: Generalised Hooke's law. Homogeneous isotropic media.

Unit - IV

Elastic moduli for isotropic media, Equilibrium and dynamic equations for an isotropic elastic solid. Strain energy function and its connection with Hooke's law. BeItrami-MicheII compatibility equations. Saint- Venant' s principle.

Suggested Readings

1. I.S. Sokolnikoff, Mathematical Theory of Elasticity, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1977.
2. Shanti Narayan, Text Book of Cartesian Tensors, S. Chand & Co., 1950.
3. S. Timoshenko and N. Goodier, Theory of Elasticity, McGraw Hill, New York, 1970.
4. A.E.H. Love, A Treatise on the Mathematical Theory of Elasticity Dover Publications, New York.
5. Y.C. Fung. Foundations of Solid Mechanics, Prentice Hall, New Delhi.

Semester- IX
MMP834: Computing Lab-II (MATLAB Programming & Applications)

External Assessment: 70
1.5 Credits (0-0-3) **Internal Assessment: 30**
Time: 3 Hours **Total Marks: 100**

Objectives: The objective of the course is to familiarize the students with the working of the MATLAB software.

User-Defined Functions and Function Files: Main Features of a Function file, Saving a Function File, Using a User-Defined Function, Comparison between Script Files and Function Files, **Anonymous and Inline Functions**: Anonymous Functions, Inline Functions. **Function:** Using Function Handles for Passing a Function into a Function, Using a Function Name for Passing a Function into a Function. Subfunctions, Nested Functions.

Polynomials: Value of a Polynomial, Roots of a Polynomial, Addition, Multiplication and Division of Polynomials, Derivatives of Polynomials. Curve Fitting with Polynomials, The polyfit Function, Curve Fitting with Functions other than Polynomials.

Applications in Numerical Analysis: Solution of an Equation with one Variable, Minimum or a Maximum of a Function, Numerical Integration, Ordinary Differential Equations.

Three Dimensional Plots: Line Plots, Mesh and Surface Plots, Plots with Special Graphics, The View Command.

Symbolic Math: Solving Algebraic Equations, Differentiation, Integration, Solving an Ordinary Differential Equation, Plotting Symbolic Expressions, Numerical Calculations with Symbolic Expressions.

Numerical Methods - Interpolation: Lagrange′s interpolation formula, Newton Gregory forward interpolation formula, Newton Gregory backward interpolation formula. **Solution of a system of Linear Equations: (Unique solution case only)**: Gauss – Elimination Method, Gauss – Jordan Method. **Solution of Ordinary Differential Equations:** Euler's Method, Euler′s Modified Method, Runge Kutta Second and Fourth order Method.

Suggested Books:

1. Amos Gilat, MATLAB- An Introduction with Applications, Fourth Edition, 2011, John Wiley & Sons, Inc.
2. www.mathworks.com, MATLAB Programming Fundamentals, The MathWorks, Inc.
3. Stephen J. Chapman, MATLAB Programming for Engineers, Fourth Edition, 2008, Thomson Learning.
4. Dingyü Xue and Yang Quan Chen, Solving Applied Mathematical Problems with MATLAB, 2009, Chapman & Hall/CRC.

Semester- IX
MML835: ANALYTIC NUMBER THEORY

Marks for External Exam : 70
5 Credits (5-0-0) **Internal Assessment: 30**
Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks and will be distributed over the whole syllabus. The candidate is required to attempt five questions selecting one from each unit and the compulsory question.

Objectives: To study some important results of number theory.

Unit - I

Primes in certain arithmetical progressions. Fermat numbers and Mersenne numbers. Approximation of irrational numbers by rationals. Hurwitz's theorem, irrationality of e and π.

Unit - II

System of linear congruences Chinese Remainder Theorem. Quadratic residues and non-residues. Legendre's Symbol. Gauss Lemma and its applications. Quadratic Law of Reciprocity jacobi's Symbol.

Unit - III

Riemann Zeta Function $\xi(s)$ and its convergence. Application in prime numbers. $\xi(s)$ as Euler's product. Evaluation of $\xi(2)$ and $\xi(2k)$. Dirichlet series with simple properties. Dirichlet series as analytic function and its derivative. Eulers products. Introduction to modular forms.

Unit - IV

Euler's summation formula and some elementary asymptotic formula. Average order of the arithmetical functions $d(n)$, $\sigma_\alpha a(n)$, $\phi(n)$, $\mu(n)$ and $\Lambda(n)$. Partial sums of a Dirichlet product and their application to $\mu(n)$ and $\Lambda(n)$. Chebyshev's functions $\Psi(x)$ and $\nu(x)$ and relation between $\nu(x)$ and $\pi(x)$. Shapiro's Tauberian theorem and its applications. Partial sums of the Mobius function. Selberg's asymptotic formula.

Suggested Readings

1. T.M. Apostol. Introduction to Analytic number theory (Narosa Publishing House 1980).
2. T.M. Apostol. Modular functions and Dirichlet series in Number Theory (Springer-Verlag 1976).
3. J.P. Serre. A Course in Arithmetic G.T.M. Vol.7 (Springer Verlag 1973).

Semester- IX
MML836: FLUID MECHANICS

Marks for Major Test (External): 70
5 Credits (5-0-0) **Internal Assessment: 30**
Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks and will be distributed over the whole syllabus. The candidate is required to attempt five questions selecting one from each unit and the compulsory question.

Objectives: The objective of this paper is to make the students familiar with concepts of fluid mechanics and the properties of an ideal fluid flow past a rigid body.

Unit - I

Basics of Fluid Kinematics: General consideration of fluid, Lagrangian and Eulerian approach, Substantial derivative, Stream lines, Path lines, Streak lines, Divergence of a flow field, Translation, deformation and rotation of fluid element, Irrotational and rotational motions. Vortex lines, Reynolds Transport Theorem, Equation of Continuity. Euler's equation of motion, Bernoulli's theorem, Kelvin's circulation theorem, Vorticity equation.

Unit - II

Energy equation for an incompressible flow. Boundary conditions, Kinetic energy of liquid, Axially symmetric flows, Motion of a sphere through a liquid at rest at infinity, Liquid streaming past a fixed sphere, Force on a sphere, Equation of motion of a sphere.

Unit - III

Vorticity and Rotation, The Velocity potential φ, Stream functions ψ, Stokes stream functions. Uniform flow, Sources, Sinks and doublets, Images in a rigid impermeable infinite plane and in impermeable spherical surfaces, Conformal mapping, Milne-Thomson Circle theorem, Application to fluid mechanics, Blasius theorem, Joukovskii transformation, Joukovskii Aerofoils.

Unit - IV

Two-dimensional irrotational motion produced by motion of circular, co-axial and elliptic cylinders in an infinite mass of liquid, Vortex motion and its elementary properties, Kelvin's proof of permanence, motion due to rectilinear vortices.

Suggested Readings

1. W.H. Besaint and A.S. Ramsey, A Treatise on Hydromechanics, Part II, CBS Publishers, Delhi, 1988.
2. F. Chorlton, Textbook of Fluid Dynamics, C.B.S. Publishers, Delhi, 1985.
3. S.W. Yuan, Foundations of Fluid Mechanics, Prentice Hall of India Private Limited, New Delhi, 1976.
4. M.E.O'Neil and F. Chorlton, Ideal and Incompressible Fluid Dynamics, John Wiley & Sons.
5. Y.A. Cengel and JM Cimbala, Fluid Mechanics: Fundamentals and Applications, 3rd Ed, McGraw Hill, 2014.

Semester- IX
MML837: ADVANCED DISCRETE MATHEMATICS

Marks for Major Test (External): 70
5 Credits (5-0-0) **Internal Assessment: 30**
Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks and will be distributed over the whole syllabus. The candidate is required to attempt five questions selecting one from each unit and the compulsory question.

Objectives: To study some important results of discrete mathematics with their applications.

Unit - I

Formal Logic: Propositions, Logical operations, Symbolic Representation, Tautologies and Contradictions, Logical Equivalence, Laws of algebra of Propositions, Conditional and Biconditional Propositions, Propositional Functions, Quantifiers, Negation of Quantified Statements. Lattices: Lattices as partially ordered sets, their properties, Lattices as Algebraic system, Sublattices, Direct product of lattices, Lattice isomorphism, Some special Lattices, e.g., Complete Lattices, Bounded Lattices, Complemented Lattices and Distributive Lattices.

Unit - II

Boolean Algebra: Definition and examples, Boolean Algebra as Lattices, Various Boolean Identities, The Switching Algebra example, Sub- Boolean Algebra, Direct product of Boolean Algebras, Boolean homomorphism, Join - irreducible elements, Atoms (Minterms), Boolean Forms and their Equivalence, Minterm Boolean Forms, Sum-of-Products Canonical Forms, Boolean Function, Minimization of Boolean Functions using Algebraic method and Karnaugh map, Logic Gates and Circuits, Applications of Boolean Algebra to Switching Circuit Theory (using AND, OR and NOT gates).

Unit - III

Graph Theory: Definitions and Basic concepts, Regular graph, Complete and Complete Bipartite Graphs, Subgraphs and Induced Subgraphs, Walks, Paths and Circuits, Connected and disconnected graphs, Connected components of a graph, Planar Graphs and their properties, Euler's Formula for Connected Planar Graph, Kuratowski's two graphs.

Unit - IV

Euler paths and circuits, Euler graphs, Euler's theorem on the existence of Eulerian paths and circuits, Konigsberg's seven bridges problem, Fleury's algorithm for finding Euler circuit, Weighted Undirected Graphs, Matrix Representation of Graphs, Directed Graphs, Indegree and outdegree of a vertex, Strongly connected graphs, Warshall's Algorithm. Trees: Definition and their properties, Directed trees, Rooted trees, Binary trees, Spanning tree of a Graph, Minimal spanning tree, Prim algorithm and Kruskal's algorithm for finding minimal spanning tree for a weighted graph, Tree searching, Different methods of searching a tree.

Suggested Readings

1. J.P. Tremblay and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, McGraw Hill Book Co., 1997.
2. Seymour Lipschutz, Finite Mathematics (International edition 1983), McGraw Hill Book Company, New York.
3. C.L. Liu, Elements of Discrete Mathematics, McGraw Hill Book Co., 1985.
4. N. Deo, Graph Theory with Applications to Engineering and Computer Science, Prentice Hall of India, 1974.
5. Babu Ram, Discrete Mathematics, Pearson Education Publishers, 2011

Semester- IX
MML838: DIFFERENCE EQUATIONS

Marks for Major Test (External): 70
5 Credits (5-0-0) **Internal Assessment: 30**
Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks and will be distributed over the whole syllabus. The candidate is required to attempt five questions selecting one from each unit and the compulsory question.

Objectives: To familiarize the students with difference equations, stability theory and asymptotic methods.

Unit - I

Introduction, Difference Calculus-The Difference Operator, Summation, Generating functions and approximate summation.

Unit - II

Linear Difference Equations-First order equations, General results for linear equations. Equations with constant coefficients. Applications. Equations with variable coefficients. Nonlinear equations that can be linearized. The z- Transform.

Unit - III

Stability Theory - Initial value problems for linear systems. Stability of linear systems. Stability of nonlinear systems, Chaotic behaviour.

Unit - IV

Asymptotic methods-Introduction. Asymptotic analysis of sums. Linear equations. Nonlinear equations. The self-adjoint second order linear equation. Introduction. Sturmian Theory. Green's functions, Disconjugacy. The Riccati Equations. Oscillation.

Suggested Readings

1. Walter G. Kelley and Allan C. Peterson-Difference Equations. An Introduction with Applications. Academic Press Inc., Harcourt Brace Joranovich Publishers, 1991.
2. Calvin Ahlbrandt and Allan C. Peterson. Discrete Hamiltonian Systems, Difference Equations, Continued Fractions and Riccati Equations. Kluwer, Boston, 1996.

Open Elective paper offered by Dept. of Mathematics
for other Discipline(s)/Departments
(Odd Semester)
(To be opted by the students of other Discipline(s)/Departments)

Semester- IX
MOL851: MATHEMATICAL METHODS

Marks for Major Test (External): 70
4 Credits (4-0-0) **Internal Assessment: 30**
Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks and will be distributed over the whole syllabus. The candidate is required to attempt five questions selecting one from each unit and the compulsory question.

Objectives: To familiarize the students with basics of Fourier Transforms and its applications, Curvilinear Co-ordinates, probability distributions, simple correlation and multiple correlation.

Unit - I

Curvilinear Co-ordinates: Co-ordinate transformation, Orthogonal Co-ordinates, Change of Co-ordinates, Cartesian, Cylindrical and spherical co-ordinates, expressions for velocity and accelerations, ds, dv and ds^2 in orthogonal co-ordinates, Areas, Volumes & surface areas in Cartesian, Cylindrical & spherical co-ordinates in a few simple cases, Grad, div, Curl, Laplacian in orthogonal Co-ordinates.

Unit – II

Fourier Transforms - Definition and properties, Fourier transform of some elementary functions, convolution theorem, Application of Fourier transforms to solve ordinary & partial differential equations.

Unit - III

Sample spaces, random variables, Mathematical expectation and moments, Binomial, Poisson and Geometric distributions.

Unit - IV

Exponential, Normal and Gamma distributions. Correlation & Regression, Multiple Regression, Partial and Multiple Correlation.

Suggested Readings

1. Sneddon, I. N., The Use of Integral Transforms.
2. Schaum's Series, Vector Analysis.
3. Gupta, S.C. and Kapoor, V.K., Fundamentals of Mathematical Statistics

Semester - X

Paper Code	Nomenclature	Credit	Hours/ Week	Max. Marks		
				External	Internal	Total
MML 841	Functional Analysis	5	5	70	30	100
MML 842	Differential Geometry	5	5	70	30	100
MML 843	Mechanics of Solids-II	5	5	70	30	100
-----	Programme Elective-3	5	5	70	30	100
-----	Programme Elective-4	5	5	70	30	100
MMP 848	Computing Lab-III	1.5	3	70	30	100
	Total	**26.5**	**28**	**420**	**180**	**600**

***Programme Electives**

Paper Code	Nomenclature	Credit	Hours/ Week	Max. Marks		
				External	Internal	Total
MML 844	Integral Equations	5	5	70	30	100
MML 845	Advanced Fluid Mechanics	5	5	70	30	100
MML 846	Bio-Mechanics	5	5	70	30	100
MML 847	Algebraic Coding Theory	5	5	70	30	100

* Programme/ open electives can be offered subject to availability of requisite resources/ faculty in the department.

Semester- X
MML841: FUNCTIONAL ANALYSIS

Marks for Major Test (External): 70
5 Credits (5-0-0) **Internal Assessment: 30**
Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks and will be distributed over the whole syllabus. The candidate is required to attempt five questions selecting one from each unit and the compulsory question.

Objective: To familiarize the students with the topics of Normed linear spaces, Conjugate spaces, Equivalent norms and Inner product spaces.

Unit-1

Normed linear spaces, metric on normed linear spaces, Holder's and Minkowski's inequality, completeness of quotient spaces of normed linear spaces. Completeness of l_P, L^P, R^η, C^η and C[a, b]. Bounded linear transformation. Equivalent formulation of continuity. Spaces of bounded linear transformation. Continuous linear functional, conjugate spaces.

Unit-1I

Hahn Banach extension theorem (Real and Complex form), Riesz Representation theorem for bounded linear functionals on L^P and C[a, b]. Second Conjugate spaces, Reflexive spaces, uniform boundedness principle and its consequence, open mapping theorem and its application, projections, closed graph theorem.

Unit-III

Equivalent norms, weak and strong convergence, their equivalence in finite dimensional spaces. Compact operators and its relation with continuous operators, compactness of linear transformation on a finite dimensional space, properties of compact operators, compactness of the limit of the sequence of compact operators.

Unit-IV

Inner product spaces, Hilbert spaces, Schwarz's inequality, Hilbert space as normed linear space, convex sets in Hilbert spaces. Projection theorem, orthonormal sets, Bessel's inequality, Parseval's identity, Conjugate of a Hilbert space. The Adjoint of an operator, Self-adjoint operator, Positive operator, Normal Operator, Normal operator and Unitary operator. Reflexivity of Hilbert space, Finite Dimensional Spectral Theory.

Suggested Readings

1. H.L. Royden, Real Analysis Macmillian Publishing Co., Inc, New York 4th Edition 1993.
2. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley & Sons, New York, 1978.
3. A.E. Taylor, Introduction to Functional Analysis, John Wiley and Sons, New York, 1958.
4. K. Yosida, Functional Analysis, 3rd edition Springer Verlag, New York, 1971.
5. Walter Rudin, Functional Analysis, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1973.

Semester- X
MML 842: DIFFERENTIAL GEOMETRY

Marks for Major Test (External): 70
5 Credits (5-0-0) **Internal Assessment: 30**
Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks and will be distributed over the whole syllabus. The candidate is required to attempt five questions selecting one from each unit and the compulsory question.

Objectives: To apply the concepts and techniques of differential geometry of curves and surfaces; understand the curvature and torsion of a space curve and how to analyze and solve problems, First and Second fundamental forms of a surface; compute the mean and Gauss curvature of a surface; find geodesics on a given surface and its torsion.

Unit - I

Curves with torsion: Tangent, Principal Normal, Curvature, Binormal, Torsion, Serret Frenet formulae.

Unit - II

Locus of centre of Curvature, Locus of centre of Spherical Curvature, Surfaces, Tangent plane, Normal, Envelope, Characteristics, Edge of regression.

Unit - III

Curvilinear Co-ordinates, First order magnitudes, Directions on a surface, The Normal, Second order magnitudes, Derivative of unit normal.

Unit - IV

Principal directions and curvatures, First and Second curvatures, Geodesic property, Equations of geodesics, Surface of revolution, Torsion of a geodesic.

Suggested Readings

1. C.E. Weatherburn, Differential Geometry of Three Dimensions
2. M. Lipschultz, Differential Geometry, Schaum Outlines

Semester- X
MML843: MECHANICS OF SOLIDS-II

Marks for Major Test (External): 70
5 Credits (5-0-0) **Internal Assessment: 30**
Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks and will be distributed over the whole syllabus. The candidate is required to attempt five questions selecting one from each unit and the compulsory question.

Objectives: To familiarize the students with Two-dimensional elastostistic, problems, fundamentals of Viscoelasticity, Torsion of cylindrical bars, propagation of waves in an elastic solids and variational methods used in deformation of elastic materials.

Unit - I

Two-dimensional Problems: Plane stress. Generalized plane stress. Airy stress function. General solution of Biharmonic equation. Stresses and displacements in terms of complex potentials. The structure of functions of $\phi(z)$ and $\psi(z)$. First and second boundary value problems in plane elasticity, Thick-walled tube under external and internal pressures.

Unit - II

Viscoelasticity: Spring & Dashpot, Maxwell & Kelvin Models, Three parameter solid, Correspondence principle & its application to the Deformation of a viscoelastic Thick-walled tube in Plane strain.

Unit - III

Torsion: Torsion of cylindrical bars. Tortional rigidity. Torsion and stress functions. Lines of shearing stress. Simple problems related to circle, ellipse and equilateral triangle.

Waves: Propagation of waves in an isotropic elastic solid medium. Waves of dilatation and distortion. Plane waves. Elastic surface waves such as Rayleigh and Love waves.

Unit - IV

Variational methods - Theorems of minimum potential energy. Theorems of minimum complementary energy. Reciprocal theorem of Betti and Rayleigh. Deflection of elastic string and elastic membrane. Solution of Euler's equation by Ritz, Galerkin and Kantorovich methods.

Suggested Readings

1. I.S. Sokolnikoff, Mathematical Theory of Elasticity, Tata McGraw Hill Publishing Company Ltd., New Delhi.
2. Y.C. Fung, Foundations of Solid Mechanics, Prentice Hall, New Delhi.
3. S. Timoshenko and N. Goodier, Theory of Elasticity, McGraw Hill, New York.
4. W. Flugge, Viscoelasticity, Springer Verlag.
5. Martin H. Sadd., Elasticity Theory, Applications and Numerics AP (Elsevier).

Semester- X
MML844: INTEGRAL EQUATIONS

Marks for Major Test (External): 70
5 Credits (5-0-0) **Internal Assessment: 30**
Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks and will be distributed over the whole syllabus. The candidate is required to attempt five questions selecting one from each unit and the compulsory question.

Objectives: To familiarize the students with the concepts of integral equations and various methods for the solutions of different type of integral equations.

Unit – I

Definition of Integral Equations and their classification. Relation between integral and differential equations Fredholm integral equations of second kind with separable kernels. Eigen Values and Eigen functions. Reduction to a system of algebraic equations. An approximate Method. Method of successive approximations. Iterative scheme. Condition of convergence and uniqueness of series solution. Resolvent kernel and its results. Fredholm theorems.

Unit - II

Solution of Volterra's integral equations by iterative scheme. Successive approximation. Resolvent kernel. Integral transform methods: Fourier transform, Laplace transform, Convolution integral, Application to Volterra integral equations with Convolution type kernels, Abel's equations.

Unit - III

Symmetric kernel. Complex Hilbert space. Orthonormal system of functions, Fundamental properties of eigen values and eigen functions for symmetric kernels. Expansion in eigen function and bilinear form, Hilbert Schmidt theorem, Solution of integral equations with symmetric kernels

Unit - IV

Singular Integral Equations - Inversion formula for singular integral equation with kernel of type (h(s) - h(t) - a, 0< a <1). Dirac Delta Function. Green's function approach to reduce boundary value problems of a self-adjoint differential equation with homogeneous boundary conditions to integral equation forms. Auxiliary problem satisfied by Green's function. Modified Green's function.

Suggested Readings

1. R.P. Kanwal, Linear Integral Equation. Theory and Techniques, Academic Press, New York, 1971.
2. S.G. Mikhlin, Linear Integral Equations (translated from Russian), Hindustan Book Agency, 1960.
3. Abdul J. Jerri, Introduction to Integral Equations with Applications.
4. Hildebrand. F.B. - Methods of Applied Mathematics

Semester- X
MML845: ADVANCED FLUID MECHANICS

Marks for Major Test (External): 70
5 Credits (5-0-0) **Internal Assessment: 30**
Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks and will be distributed over the whole syllabus. The candidate is required to attempt five questions selecting one from each unit and the compulsory question.

Objectives: The objectives of this paper is to make familiar with the flow properties of real fluids and their applications in science and technology.

Unit – I

Stress components in a real fluid, stress tensor, Symmetry of the stress tensor, Stresses in a fluid at rest, Relations between rectangular components of stress in transformed coordinate system, Connection between stresses and velocity gradients. Viscous fluid, Navier-Stokes equations of motion. Laminar Flows, Exact solution of Navier-Stokes equations: Couette flows and Generalized Couette flow between two parallel plates, Plane Poiseuille flow, Hagen-Poiseuille flow.

Unit – II

Flow through tubes of uniform cross section in the form of circle, annulus, ellipse and equilateral triangle under constant pressure gradient. Unsteady flow over a flat plate: Stokes First & second Problem. Dynamical similarity: Dimensional Analysis and Buckingham π-theorem. Reynolds number, Wever Number, Mach Number, Froude Number, Eckert Number, Application of pi-theorem to viscous and compressible fluid flow.

Unit – III

Boundary Layer Flow: Prandtl's boundary layer approximation, boundary layer thickness, displacement thickness, momentum thickness, boundary layer equations in two-dimensions, Flat Plate Boundary Layer-Blasius solution, Karman integral equations. Boundary Layers with Pressure Gradients: Separation of boundary layer.

Unit – IV

Compressible flow: Stagnation properties. Wave motion in a gas: Speed of Sound, Equation of motion of a gas, Variation of fluid velocity with flow area, Subsonic, Sonic and Supersonic flows of a gas. Isentropic gas flows: Property relations for isentropic flow of ideal gases, Flow through a nozzle; Converging Nozzles, Converging–Diverging Nozzles.

Suggested Readings

1. F. Chorlton, Textbook of Fluid Dynamics, C.B.S. Publishers, Delhi, 1985.
2. H. Schlichting, Boundary Layer Theory, McGraw Hill Book Company, New York, 1979.
3. A.D. Young, Boundary Layers, AIAA Education Series, Washington DC, 1989.
4. S.W. Yuan, Foundations of Fluid Mechanics, Prentice Hall of India Private Limited, New Delhi, 1976.
5. Y.A. Cengel and JM Cimbala, Fluid Mechanics: Fundamentals and Applications, 3rd Ed, McGraw Hill, 2014.

Semester- X
MML846: BIO-MECHANICS

Marks for Major Test (External): 70
5 Credits (5-0-0) **Internal Assessment: 30**
Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks and will be distributed over the whole syllabus. The candidate is required to attempt five questions selecting one from each unit and the compulsory question.

Objectives: The objective of this paper is to motivate students towards applications of mathematics in life sciences.

Unit-I

Newton's equations of motion. Continuum approach. Segmental Movement and Vibrations: Strain energy and influence coefficients, normal modes of vibration, decoupling of equations of motion, muscle forces, segmental movement and vibrations, systems with damping and fluid dynamic loads, decoupling equations of system with damping.

Unit-II

Fluid Dynamic Forces Acting on Moving Bodies: Flow around bluff bodies, steady-state aeroelastic problems, transient fluid dynamic, forces due to unsteady motion, circulation around a wing, circulation and vorticity in the wake, lift and drag on a finite wing.

Flying and Swimming: Forward flight of birds and insects, aquatic animal propulsion, stokeslet and dipole in a viscous fluid, resistive-force theory of flagellar propulsion, theories of fish swimming, cell movement.

Unit-III

Blood Flow in Heart, Lung, Arteries, and Veins: The geometry of the circulation system, field equations and boundary conditions, blood flow in heart and through heart valves, coupling of left ventricle to aorta and right ventricle to pulmonary artery, pulsatile flow in arteries, steady laminar flow in an elastic tube and velocity profiles, systemic blood pressure, flow in collapsible tubes.

Micro and Macrocirculation: Major features of microcirculation, the rheological properties of blood, general equations describing flow in microvessels, pulmonary capillary blood flow,

Unit-IV

Respiratory Gas Flow: Gas flow in the airway, interaction between convection and diffusion, ventilation-perfusion ratio, pulmonary function tests, dynamics of the ventilation system,

Equation of motion in Lagrangian description, work and strain energy, calculation of stresses from the strain energy function, rotation and strain.

Stress, Strain, and Stability of Organs: Shock loading and structural response, vibration and the amplification spectrum of dynamic structural response, impact and elastic waves, tolerance of organs to impact loads.

Suggested Readings

1. Y.C. Fung, Biomechanics- Motion, Flow, Stress, and Growth, Springer-Verlag, New York Inc., 1990.
2. N. Ozkaya and M. Nordin-Fundamentals of Biomechanics-Equilibrium, Motion and Deformation, springer-verlag, 2nd edition 1999.
3. C. Ross Ethier and Craig A. Simmons- Introductory Biomechanics From Cells to Organisms, Cambridge University Press, 2007

Semester- X
MML847: ALGEBRAIC CODING THEORY

Marks for Major Test (External): 70
5 Credits (5-0-0) **Internal Assessment: 30**
Time: 3 Hours **Total Marks: 100**

Note: The examiner is requested to set nine questions in all taking two questions from each unit and one compulsory question (Question No. 1). The compulsory question will consist of seven short answer type questions, each of two marks and will be distributed over the whole syllabus. The candidate is required to attempt five questions selecting one from each unit and the compulsory question.

Objectives: To familiarize the students with basic concepts of codes.

Unit - I

The Communication channel. The Coding Problem. Types of Codes. Block Codes. Error Detecting and Error-Correcting Codes. Linear Codes. The Hamming Metric. Description of Linear Block Codes by Matrices. Dual Codes.

Unit – II

Standard Array. Syndrome. Step-by-Step Decoding Modular Representation. Error-Correction Capabilities of Linear Codes. Bounds on Minimum Distance for Block Codes. Plotkin Bound. Hamming Sphere packing Bound. Varshamov-Gilbert-Sacks Bound. Bounds for Burst-Error Detecting and Correcting Codes.

Unit - III

Important Linear Block Codes. Hamming Codes. Golay Codes. Perfect Codes. Quasi - perfect Codes. Reed-Muller Codes. Codes derived from Hadmard Matrices. Product Codes. The Algebra of Polynomial residue Classes.

Unit - IV

Galois Fields. Multiplicative group of a Galois field. Cyclic Codes. Cyclic Codes as Ideals. Matrix Description of Cyclic Codes. Hamming and Golay Codes as Cyclic Codes. Error Detection with Cyclic Codes. Error Correction procedure for Short Cyclic Codes. Short-ended Cyclic Codes. Pseudo Cyclic Codes. Code Symmetry.

Suggested Readings

1. Raymond Hill, A first Course in coding theory, oxford university 1986.
2. E.R. Berlekamp, Algebraic Coding Theory, McGraw Hill Inc., 1968.
3. F.J. MacWilliams and N.J.A. Sloane, Theory of Error Correcting Codes, North Holland Publishing Company 1977.

Semester- X
MMP848: COMPUTING LAB-III

External Assessment: 70
1.5 Credits (0-0-3) **Internal Assessment: 30**
Time: 3 Hours **Total Marks: 100**

Objectives: The objective of the course is to familiarize the students with the working of the LATEX software.

Overview, Special Characters, Text, Making Tables, Bibliography with Bibtex, Math Mode, Equations and arrays, Specific operators of Mathematics and structure formations – Derivatives, Integrals, del operator, product and sum operator. Making special parts, Format for technical writing – Article, Report. Cover page, Abstract, other front matter, Back matter, graphics, Importing pictures.

Suggested Readings

1. Harvey J. Greenberg, A Simplified Introduction to Latex.
2. Latex Companion, 2nd Edition, Frank Mittelbach, Michel Goossem, Johannes Braams, David Carlisle, Chris Rowley.
3. Guide to Latex, Helmut Kopka and Patrick W. Daly.