Learning Outcomes based Curriculum Framework (LOCF)

For

Ph. D. Course Work in Mathematics
(w.e.f. session 2021-2022)

Department of Mathematics
Chaudhary Devi Lal University
Sirsa-125055
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1. About the Department

The Department of Mathematics is one of the three departments under the Faculty of Physical Sciences of Chaudhary Devi Lal University, Sirsa. The department came into existence in the year 2003 with the introduction of M.Sc. (Mathematics) programme. Since its inception, the department has been sharing the vision of the University in striving for excellence in research and teaching activities. Presently, the department is offering M.Sc. (Mathematics)-2 year programme under regular scheme and M.Sc. (Mathematics) under Lateral entry scheme of M.Sc. (Mathematics)-5 year Integrated programme under self-finance scheme, along with the Ph.D. program in Mathematics. The programmes in Mathematics are designed to equip the students with advanced level of training in Mathematics as well as sufficient exposure to computer fundamentals and programming. The department is well known for its excellence in teaching and research in Mathematics. The department is working with the zeal to achieve the highest standards of excellence in teaching and research in the fields related to Mathematics by promoting the applications of Mathematics to solve out real life problems using advanced techniques.

2. Learning Outcomes based Curriculum Framework

The Choice Based Credit Scheme has evolved into learning outcome based curriculum framework and provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill-based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Grading system provides uniformity in the evaluation and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations which enables the student to move across institutions of higher learning. The uniformity in evaluation system also enables the potential employers in assessing the performance of the candidates.

2.1 Objectives of the Programme

To undergo research in different areas of Mathematical Sciences; especially in Applied Mathematics to solve real life mathematical problems of different fields of study and to fulfil the industrial requirements.

2.2. Programme Outcomes (POs)

After completing the programme, the scholars have:

PO1	Knowledge with Learning Aptitude	Capability of applying comprehensive disciplinary knowledge with research aptitude acquired during other programme of study for conducting research/innovation/discovery work.
PO2	Research & Problem Solving Aptitude	Capability to raise/ask relevant/appropriate questions for identifying, formulating and analysing the research problems and applying knowledge/skill for trying to solve them with philosophical aptitude.
PO3	Investigation of Problems	Ability to gain and apply research based knowledge to provide fresh interpretation/analysis of results with conclusions/new findings.
PO4	Individual & Team Work	Capability to learn and work effectively as an individual, and asa member or group leader in diverse nature of groups with multidisciplinary approach.
PO5	Communication & Society	Ability to communicate effectively on research/scientific topics with the scientific community and with society at large relevant to professional scientific practices.
PO6	Ethics in Research	Capability to identify and apply ethical issues related to one's work, avoid unethical behaviour such as fabrication of data, committing plagiarism and unbiased truthful actions in all aspects of work in the research.
PO7	Modern Tool Usage	Ability to apply techniques, skill and modern tools for scientific practices
PO8	Project Management	Ability to demonstrate knowledge and understanding of the scientific principles and apply these to manage projects.

2.3 Programme Specific Outcomes (PSOs)

Students would be able to:

PSO1	Investigate emerging areas of research in mathematical sciences and study the research problems in the context of latest issues in the field
PSO2	Review research literature, identify, formulate and solve mathematical models for the real life problems, carrying out computation and data analyses using computer software packages.
PSO3	Apply knowledge of research methodology and its various tools for arriving at substantiated conclusions of the research problems.
PSO4	Attain in-depth knowledge in the field of specialization and ability to conduct research which results in strengthening the discipline and its teaching.

3 Programme Structure

Table 1: Courses and Credit Scheme

Ph. D. Course Work in Mathematics
(w.e.f. session 2021-22)

Paper no.	Paper Code	Nomenclature of the Paper	Hrs per week	Credits	Marks (Theory)	Marks (Internal Assessment)	Total Marks
Paper-I	PhD/Maths/SEC 1	Research Methodology	04	04	70	30	100
Paper-II	PhD/Maths/CC 1	Advanced Mathematical Methods	04	04	70	30	100
Paper-III	Any one of the following papers:						
	PhD/Maths/DSC 1	Mechanics of Continuous Media	04	04	70	30	100
	PhD/Maths/DSC 2	Advanced Solid Mechanics	04	04	70	30	100
Paper-IV	PhD/RPE 4	Research and Publication Ethics*	02	02	30	20	50

- **SEC**: Skill Enhancement Course, **CC**: Core Course, **DSC**: Discipline Specific Elective Course

* **To be completed MOOCs available on SWAYAM Portal and mandatory to complete it before submission of Ph.D. thesis by the Student.**

Paper-I
PhD/Maths/SEC I : Research Methodology

Marks (Theory): 70 Marks (Internal Assessment): 30 Marks (Total): 100
Credits: 04 Time: 03 Hours

Note: *The question paper will consist of nine questions carrying equal marks.*
Question no. 1 will be compulsory consisting of seven short answer questions (2-marks each) covering the whole syllabus.
In addition, eight more questions will be set unit-wise comprising two questions from each of the four units.
The students shall be required to attempt five questions in all, selecting on question from each unit and the compulsory question.

Course Outcomes: This course will enable the students to:

1. Understand meaning, objective and significance of research, research methods, formulation of research problem, meaning and need for research design.
2. Understand history and basic anatomy of computers, MS office, word basics, Mail merge.
3. Understand Excel Basics, Data Sort and Power Point Basics.
4. Understand scientific thesis writing and preparing manuscript for publication.

Syllabus

Unit: I

Introduction and definition: Meaning of research, objectives of research, types of research, research approaches, significance of research, research methods versus methodology, research and scientific method, research process, criteria of good research, problems encountered by researchers in India; Definition, necessity and techniques of defining research problem; Meaning and need for research design, features of a good design.

(*Relevant chapters/portions from the Book by C. R. Kothari)*

Unit: II

Basic Computer Applications - I: Introduction, History and Basics Anatomy of computers; MS Office 2007, Word Basics, Mail Merge.

(*Relevant chapters/portions from the Book by S. Saxena)*

Unit: III

Basic Computer Applications - II: Excel Basics, Data Sort, Power Point Basics.

(*Relevant chapters/portions from the Book by S. Saxena)*

Unit: IV

Scientific Thesis writing and Communications: Writing – introduction; Review of literature; Abstract, Summary and synopsis; Discussion; Reference citing and listing; Preparing manuscript for publication.

(Relevant chapters/portions from the Book by N. Gurumani)

Books Recommended:

1. Gurumani, N. (2010), Scientific Thesis Writing and Paper Presentation, MJP Publishers
2. Kothari, C.R. (2010), Research Methodology (Methods and Techniques), New Age International Publishers.
3. Saxena, S. (2010), A first course in Computer, Vikas Publishing house Pvt. Ltd.

Paper-II

PhD/Maths/CC I: Advanced Mathematical Methods

Marks (Theory): 70 Marks (Internal Assessment): 30 Marks (Total): 100

Time: 03 Hours

Credits: 04

Note: *The question paper will consist of nine questions carrying equal marks.*
Question no. 1 will be compulsory consisting of seven short answer questions (2-marks each) covering the whole syllabus.
In addition, eight more questions will be set unit-wise comprising two questions from each of the four units.
The students shall be required to attempt five questions in all, selecting on question from each unit and the compulsory question.

Course Outcomes: This course will enable the students to:

1. Understand Bessel functions of first and second kind, Hankel functions, modified Bessel functions, Spherical Bessel functions and their recurrence relations.
2. Understand Fourier series, Fourier integral, complex Fourier integral, Fourier transform and application of Fourier transform to boundary value problem.
3. Understand Dirac delta function $\delta(x)$ and its properties, Fourier series solution of the wave equation.
4. Understand Hankel transforms and its properties, application of Hankel transform to Boundary value problem.

Syllabus

Unit-I

Bessel's equation and its solution, Bessel functions of the first and second kind, Hankel functions, Recurrence relations for Hankel functions, Equations reducible to Bessel's equation, Modified Bessel functions, Recurrence relations and integral representations for the modified Bessel functions, Kelvin's functions, Spherical Bessel functions.

Unit-II

Fourier series: Euler's formulae, Fourier series of a function, even and odd functions, cosine and sine series, half range series, Parseval's formula, complex Fourier series, practical harmonic analysis, Fourier integral, Fourier cosine and sine integrals, Complex Fourier integral and the Fourier transform, Application of Fourier transform to boundary value problem.

Unit-III

Dirac delta function $\delta(x)$, Heaviside's unit step function and relation between them, Integral representation of delta function, Properties of Dirac delta function.

Fourier series solutions of the Wave Equation: Vibrating string with zero initial velocity, Vibrating string with given initial velocity and zero initial displacement, Vibrating string with initial displacement and velocity.

Unit-IV

Hankel transforms, Definition, Elementary properties, Basic operational properties, Inversion theorem, Hankel transform of derivatives and some elementary functions, Relation between Fourier and Hankel transforms, Application of Hankel transform to Boundary Value Problem.

Books Recommended:

1. W.W. Bell; Special functions for Scientist and Engineers, D. VAN Nostrand Company Ltd.
2. Lokenath Debnath; Integral Transforms and their Applications, CRC Press.
3. Peter V. O'Neil; Advanced Engineering Mathematics, An International Thomson Publishing Company.
4. B. S. Grewal; Higher Engineering Mathematics, Khanna Publishers, New Delhi.

Paper-III

PhD/Maths/DSC I : Mechanics of Continuous Media

Marks (Theory): 70 Marks (Internal Assessment): 30 Marks (Total): 100

Credits: 04 Time: 03 Hours

Note: *The question paper will consist of nine questions carrying equal marks.*
Question no. 1 will be compulsory consisting of seven short answer questions (2-marks each) covering the whole syllabus.
In addition, eight more questions will be set unit-wise comprising two questions from each of the four units.
The students shall be required to attempt five questions in all, selecting on question from each unit and the compulsory question.

Course Outcomes: This course will enable the students to:

1. Understand elasticity problems of potential and different type of problem of continuous media.
2. Understand Maxwell & Kelvin models of viscoelasticity, analysis of stress and strain.
3. Understand about Earthquakes, P and S waves and their characteristics and Polarization.
4. Understand about surface waves, Snell's law of reflection and refraction of P, SV and SH waves.

Syllabus

Unit: I

Elasticity problems of potential: The Homogenous Equations of Elasticity and the particular solutions, The Scalar and vector potential, Lame's strain potential, The Galerkin Vector, Love's Strain Function, Kelvin and Cerrate's problems, The Neuber-Popkovich Representation, Boussinseq's problem.

Unit: II

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

Unit: III

Introduction to Seismology: Earthquakes, Location of earthquakes, Causes of Earthquakes, Observation of Earthquakes, Aftershocks and Foreshocks, Earthquakes magnitude, Interior structure of the Earth.

Reduction of equation of motion to wave equations, P and S waves and their characteristics, Polarization of plane P and S waves.

Unit: IV

Surface waves – Rayleigh waves, Love waves and Stoneley waves.

Snell's law of reflection and refraction, reflection of plane P, SV and SH waves at a free surface, reflection at critical angles, reflection and refraction of plane SH and P wave at a solid-solid interface.

Books Recommended:

1. A. S. Saada; Elasticity Theory and Applications, Pergamon Press. Inc., 1974, Relevant portion of Chapter-IX and X.
2. W. Flugge, Viscoelasticity, Springer Verlag.
3. Seth Stein and Michael Wysession; An Introduction to Seismology, Earthquakes and Earth Structure, Blackwell Publishing Ltd., 2003.
4. Thorne Lay and Torey C. Wallace; Modern Global Seismology, Academic Press, 1995.
5. Peter M. Shearer; Introduction to Seismology, Cambridge University Press, 1999.
6. W. M. Ewing, W. S. Jardetzki and F. Press; Elastic Waves in Layered Media, McGraw Hill Book Co. New York.

Paper-III

PhD/Maths/DSC 2 : Advanced Solid Mechanics

Marks (Theory): 70 Marks (Internal Assessment): 30 Marks (Total): 100
Credits: 04 Time: 03 Hours

Note: *The question paper will consist of nine questions carrying equal marks. Question no. 1 will be compulsory consisting of seven short answer questions (2-marks each) covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising two questions from each of the four units. The students shall be required to attempt five questions in all, selecting on question from each unit and the compulsory question.*

Course Outcomes: This course will enable the students to:

1. Understand Hollow Cylinder and Hollow Spheres with internal and external pressures, thermal stresses for a solid and hollow sphere.
2. Understand Plane Gravity Waves, Stationary Waves, Circular Waves in shallow water and deep water.
3. Learn about Basic theory of Plasticity, Torsion, compression and bending of beams.
4. Understand the concept of plane problems of Plasticity and fully Plastic stress distribution.

Syllabus

Unit: I

Thick Cylinder and Spheres: Hollow Cylinder with Internal and External Pressures with Free and Fixed ends, Hollow Spheres subjected to Internal and External Pressures.

Thermal Stresses in Long Cylinders: The Cylinder is not free to deform longitudinally in case of Solid and hollow Cylinder, Thermal Stresses for a Solid and Hollow Sphere.

Unit: II

Plane Gravity Waves in Deep Water, Plane Gravity Waves in Shallow Water and Moderate Deep Water, Standing or Stationary Waves, Standing Waves in Deep Water, Path of the particles in Deep Water, Shallow Water, Moderate Deep Water and in Stationary Waves, The concept of Group Velocity, Waves at the common surface of two Liquids, Circular Waves.

Unit: III

Theory of Plasticity: The Stress and Strain Deviations, Yield conditions, Stress-strain Relations, The solution of Plastic-elastic problems, Compression of a Rectangular beam, Pure Bending of a Rectangular Beam, Plastic-elastic Torsion of a Beam, circular cross-section, Residual stresses in case of Pure Bending of Rectangular Beam and the Torsion of a circular Beam.

Unit: IV

Plane problems of Plasticity: Plane Stress, Plane Strain, Expansion of a thick-walled cylinder, Cylindrical Cavity-symmetric and unsymmetrical Loading, Fully Plastic stress Distribution – compression of a Plastic slab between Parallel plates.

Books Recommended:

1. O. Hoffman and G. Sachs; Introduction to theory of Plasticity for Engineers, McGraw Hill Book Co., 1953.
2. D. E. R. Godfrey; Theory of Elasticity and Plasticity for Engineers, Thames and Hudson, London, 1959, Relevant portions of chapters X, XI and XII.
3. A. Sommerfield; Mechanics of Deformable Bodies, Vol.-1, Academic Press, Relevant portions of Chapter-V.
4. Y. C. Fung; Foundations of Solid Mechanics, Prentice Hall of India Pvt. Ltd., New Delhi, 1969.
5. T. M. Atanackovic and A. Guran; Theory of Elasticity for Scientists and Engineers, Birkhauser, Boston, 1999.
6. A. S. Saada; Elasticity Theory and Applications, Pergamon Press. Inc., 1974, Relevant portion of Chapter-IX and X.

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