CHAUDHARY DEVI LAL UNIVERSITY, SIRSA
(Establishment by the State Legislature Act 9 of 2003)
DEPARTMENT OF MATHEMATICS

Scheme of Examination

Ph. D. Course Work in Mathematics
(w.e.f. session 2020-21)

Paper no.	Paper Code	Nomenclature of the Paper	Hrs per week	Credits	Marks (Theory)	Marks (Internal Assessment)	Total Marks
Paper-I	DMRM-01	Research Methodology	04	04	70	30	100
Paper-II	DMDC-02	Advanced Mathematical Methods	04	04	70	30	100
Paper-III	DMDE-03; Any one of the following papers:						
	Option-i	Mechanics of Continuous Media	04	04	70	30	100
	Option-ii	Advanced Solid Mechanics	04	04	70	30	100
Paper-IV	RPE-04	Research and Publication Ethics	02	02	30	20	50

Paper-I
DMRM - 01: 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. I 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.

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 Basis 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
DMDC - 02: Advanced Mathematical Methods

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. I 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.

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
DMDE - 03 (Option-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. I 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.

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
DMDE - 03 (Option-ii): 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. I 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.

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.