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

Math-1263
Dated-16/07/19

To

Assistant Registrar (Academic)
Chaudhary Devi Lal University
Sirsa

17/7/2019

580
17/07/19

Dy. Supdt (Acad)

Subject: **Regarding Revised Syllabus.**

Madam,

Please find enclosed herewith the copy of the revised syllabus of the following papers duly approved in 25th Academic Council meeting held on 12.02.2019 vide resolution no. 17 (copy enclosed) to be implemented from session 2019-20 on the recommendation of PGBOS & R in Mathematics:

M. Sc. Mathematics (2-year) Programme

Semester	Course Code	Course Name
I	MTHCC-2101	Abstract Algebra
I	MTHCC-2104	Complex Analysis
I	MTHCC-2105	Ordinary Differential Equations
II	MTHCC-2201	Advanced Abstract Algebra
II	MTHCC-2202	Measure & Integration Theory
II	MTHCC-2203	Mechanics of Solids
II	MTHCC-2204	System of Differential Equations
II	MTHCE-2206	Methods of Applied Mathematics
III	MTHCC-2302	Fluid Mechanics
III	MTHCE-2303	Integral Equations
III	MTHCE-2304	Mathematical Statistics
III	MTHCE-2305	Advanced Complex Analysis
III	MTHCE-2306	Advanced Mechanics of Solids
IV	MTHCE-2404	Mathematical Aspect of Seismology
IV	MTHCE-2406	Advanced Fluid Mechanics

Pl. check & report

17/07/19

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M. Sc. Mathematics (5-year integrated programme)

Semester	Course Code	Course Name
VII	MTHCC-5701	Abstract Algebra
VII	MTHCC-5704	Complex Analysis
VII	MTHCC-5705	Ordinary Differentia; Equations
VIII	MTHCC-5801	Advanced Abstract Algebra
VIII	MTHCC-5802	Measure & Integration Theory
VIII	MTHCC-5803	Mechanics of Solids
VIII	MTHCC-5804	System of Differential Equations
VIII	MTHCE-5806	Methods of Applied Mathematics
IX	MTHCC-5902	Fluid Mechanics
IX	MTHCE-5903	Integral Equations
IX	MTHCE-5904	Mathematical Statistics
IX	MTHCE-5905	Advanced Complex Analysis
IX	MTHCE-5906	Advanced Mechanics of Solids
X	MTHCE-5004	Mathematical Aspect of Seismology
X	MTHCE-5006	Advanced Fluid Mechanics

Soft Copy has already been sent through E-mail.

This is for information and further necessary action.

16/7/19

Chairperson

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15. Noted the action taken by the Vice-Chancellor under Section 11 (6) of the University Act, 2003 on 03.08.2018 regarding approval of the Scheme and Syllabus of M.A. (Psychology) (2 year course) under CBCS, Semester 3rd and 4th w.e.f. Session 2018-19, M.A. (History) (2 year course) CBCS, Semester 3rd and 4th w.e.f. the academic year 2018-19, M.A. (Economics) (2 year) Programme under CBCS, Semester 3rd and 4th w.e.f. 2018-19 and M.A. Hons in Economics (5 year) Integrated Programme under CBCS, Semester 9th and 10th w.e.f. 2018-19.

Further, resolved to approve the minor modifications in the scheme of examinations of M.A, 1st Semester and 2nd semester under CBCS, already approved in PGBOS&R in Psychology in its meeting held on 12.07.2017.

16. Noted the action taken by the Vice-Chancellor under Section 11 (6) of the University Act, 2003 on 25.07.2018 regarding approval of the Scheme and Syllabus of MPA (Music-Vocal/Instrumental) 3rd Semester under CBCS w.e.f. 2018-19.

17. Noted the action taken by the Vice-Chancellor under Section 11 (6) of the University Act, 2003 on 03.08.2018 regarding approval of the Scheme and Syllabus of M.Sc. Mathematics 2 year programme under CBCS, Semester 3rd and 4th w.e.f. Session 2018-19 & M.Sc. Mathematics 5 year programme under CBCS, Semester 9th and 10th w.e.f. Session 2018-19.

Further, resolved to approve the change in syllabus made by the department of Mathematics, which has already been approved by the PGBOS&R in its meeting held on 24.01.2019 w.e.f. Session 2019-20 as the constitution of the faculty is under process.

18. Noted the action taken by the Vice-Chancellor under Section 11 (6) of the University Act, 2003 on 13.09.2018 regarding approval of the Scheme and Syllabus for level-1 course of Compulsory Computer Education for BA/B.Sc (except for B. Sc. Computer Science/BSc I.T./BCA/B.Com. vocational- Computer Application)

19. Noted the action taken by the Vice-Chancellor on 22.08.2018 under Section 11 (6) of the University Act, 2003 regarding approval of the Scheme and Syllabus of M.A. (English) 3rd and 4th Semester under CBCS w.e.f. July 2018, Amendments in syllabus of M.A. (English) 1st Semester effective since July 2017 (2017-19), 2nd Semester under CBCS effective from January 2018 (2017-19), M.A. (Hindi) 3rd Semester under CBCS w.e.f. July 2018, M.A. (Hindi) 1st Semester minor change/ amendments in the syllabus w.e.f 2017 onwards, M.A. (Punjabi) under CBCS add on course/Open Elective at UG level w.e.f. 2018-19.

20. Noted the action taken by the Vice-Chancellor on 03.08.2018 under section 11(6) of the University Act, 2003 regarding approval of the Scheme and Syllabus of MBA-2 Year 1st Semester to 4th Semester, MBA-2 Year (Hons.) 1st Semester to 4th Semester and M. Phil (Management) 1st Semester to 2nd Semester w.e.f. Academic Session 2018-19.

Department of Mathematics
Chaudhary Devi Lal University
Sirsa

Revised Syllabus

Effective from Session 2019-20

M.Sc. Mathematics – 5 year Programme

MTHCC–5701: Abstract Algebra

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

Marks (Total): 100
Time: 03 Hours
Total Credit: 04

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short 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 one question from each unit including compulsory question.

Unit: 1

Automorphisms and Inner automorphisms of a group G. The groups Aut(G) and Inn(G). Automorphism group of a cyclic group. Normalizer and Centralizer of a non-empty subset of a group G. Conjugate elements and conjugacy classes. Class equation of a finite group G and its applications. Derived group (or a commutator subgroup) of a group G. perfect groups. Simplicity of the Alternating group A_n ($n \geq 5$). Zassenhaus's Lemma. Normal and Composition series of a group G. Scheier's refinement theorem. Jordan Holder theorem. Composition series of groups of order p^n and of finite Abelian groups. Caunchy theorem for finite groups. p-groups. Finite Abelian groups. Sylow p-subgroups. Sylow's Ist, IInd and IIIrd theorems. Application of Sylow theorems.

Unit: 2

Commutators identities. Commutator subgroups. Three subgroups Lemma of P.Hall. Central series of a group G. Nilpotent groups. Centre of a nilpotent group. Subgroups and factor subgroups of nilpotent groups. Finite nilpotent groups. Upper and lower central series of a group G and their properties. Subgroups of finitely generated nilpotent groups. Sylow-subgroups of nilpotent groups. Solvable groups. Derived series of a group G.

Unit: 3

Modules, submodules and quotient modules. Module generated by a non-empty subset of an R-module. Finitely generated modules and cyclic modules. Idempotents. Homomorphism of R-modules. Fundamental theorem of homomorphism of R-modules. Direct sum of modules. Endomorphism Simple modules and completely reducible modules (semi-simple modules). Finitely generated free modules. Rank of a finitely generated free module. Submodules of free modules of finite rank over a PID.

Unit: 4

Endomorphism ring of a finite direct sum of modules. Finitely generated modules. Ascending and descending chains of sub modules of an R-module. Ascending and Descending chain conditions (A.C.C. and D.C.C.). Noetherian modules and Noetherian rings. Finitely co-generated modules. Artinian modules and Artinian rings. Nilpotent elements of a ring R. Nil and nilpotent ideals. Hilbert Basis Theorem. Structure theorem for finite Boolean rings. Wedeerburn-Artin theorem and its consequences. Uniform modules. Primary modules.

Recommended Books:

1. I.S. Luthar and I.B.S. Passi; Algebra Vol. 1 Groups (Narosa publication House)
2. P.B. Bhattacharya S.R. Jain and S.R. Nagpal; Basic Abstract Algebra
3. I.D. Macdonald; Theory of Groups
4. Vivek Sahai and Vikas Bist; Algebra (Narosa publication House)
5. Surjit Singh and Quazi Zameeruddin; Modern Algebra (Vikas Publishing House 1990)
6. W.R. Scott; Group Theory.

Revised syllabus approved in 25th Academic Council meeting held on 12.02.19 vide resolution no. 17.
To be implemented from session 2019-20.

MTHCC–5704: Complex Analysis

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

Marks (Total): 100
Time: 03 Hours
Total Credit: 04

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short 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 one question from each unit including compulsory question.

Unit: 1

Analytic functions, Harmonic functions, Path in a region, Smooth path, p. w. smooth path, Contour, Simply connected region, Multiply connected region, Complex integration, Antiderivatives, Cauchy-Goursat theorem, Cauchy-Goursat theorem for simply connected and multiply connected domains.

Unit: 2

Cauchy integral formula, Extension of Cauchy integral formula for multiply connected domain, Higher order derivatives of Cauchy integral formula, Morera's theorem, Liouville's theorem, Fundamental theorem of algebra, Cauchy inequality, Maximum modulus principle, Gauss mean value theorem, Poisson integral formula.

Unit: 3

Branches of many valued functions with special reference to arg z, Log z, z^a, Bilinear transformations, Their Properties and classification, Definition and examples of Conformal mapping.
Taylor series, Laurent series, Power series and its convergence, Radius of convergence, Sum of power series, Differentiability of sum function of power series.

Unit: 4

Singularity and its classification, Residues, Cauchy residue theorem, Residues at poles, Zeros of analytic functions, Cassorati-Weierstrass theorem, Evaluation of improper integrals, Meromorphic functions, The Argument principle, Rouche's theorem.

Books Recommended:

1. J. W. Brown and R. V. Churchill; Complex Variables and Applications, McGraw Hill, 1996.
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. H. A. Priestly; Introduction to Complex Analysis, Clarendon Press, Oxford, 1990.

Revised syllabus approved in 25th Academic Council meeting held on 12.02.19 vide resolution no. 17.
To be implemented from session 2019-20.

MTHCC–5705: Ordinary Differential Equations

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

Marks (Total): 100
Time: 03 Hours
Total Credit: 04

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short 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 one question from each unit including compulsory question.

Unit: 1

Preliminaries: Initial value problem and equivalent integral equation, ε-approximate solution, equicontinuous set of functions.Basic theorems: Ascoli- Arzela theorem, Cauchy–Peano existence theorem and its corollary. Gronwall's inequality.
Lipschitz condition.Picard-Lindelöf existence and uniqueness theorem for $\frac{dy}{dt} = f(t, y)$. Solution of initial value problem by Picard's method.

Unit: 2

Higher order equations: Linear differential equation (LDE) of order n; Linear combinations, Linear dependence and linear independence of solutions. Wronskian theory: Definition, necessary and sufficient condition for linear dependence and linear independence of solutions of homogeneous LDE. Abel's Identity, Fundamental set.Reduction of order.
Non-homogeneous LDE.Variation of parameters.Adjoint equations, Lagrange's Identity, Green's formula.Linear equation of order n with constant coefficients.

Unit: 3

Linear second order equations: Preliminaries, self adjoint equation of second order, basic facts.Superposition Principle.Riccati's equation.Prüffer transformation.Zero of a solution.Abel's formula.Common zeros of solutions and their linear dependence.
Sturm theory: Sturm separation theorem, Sturm fundamental comparison theorem and their corollaries.Oscillatory and non-oscillatory equations.

Unit: 4

Second order boundary value problems(BVP): Linear problems; periodic boundary conditions, regular linear BVP, singular linear BVP; non-linear BVP. Sturm-Liouville BVP: definitions, eigen values and eigen functions. Orthogonality of functions, orthogonality of eigen functions corresponding to distinct eigen values.Green's function. Applications of Green's function for solving boundary value problems.

Recommended books:

1. E.A. Coddington and N. Levinson, Theory of Ordinary Differential Equations, Tata McGraw-Hill , 2000
2. S.L. Ross, Differential Equations, John Wiley & Sons
3. P. Hartman, Ordinary Differential Equations, John Wiley & Sons NY, 1971.
4. G. Birkhoff and G.C. Rota, Ordinary Differential Equations, John Wiley & Sons, 1978.
5. G.F. Simmons, Differential Equations, Tata McGraw-Hill , 1993.
6. I.G. Petrovski, Ordinary Differential Equations, Prentice-Hall, 1966.
7. D. Somasundaram, Ordinary Differential Equations, A first Course, Narosa Pub., 2001.
8. Mohan C Joshi, Ordinary Differential Equations, Modern Perspective, Narosa Publishing House, 2006

MTHCC–5801: Advanced Abstract Algebra

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

Marks (Total): 100
Time: 03 Hours
Total Credit: 04

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short 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 one question from each unit including compulsory question.

Unit: 1

Characteristic of a ring with unity. Prime fields Z/pZ and Q. Characterization of prime fields. Field extensions. Degree of an extension. Algebraic and transcendental elements. Simple field extensions. Minimal polynomial of an algebraic element. Conjugate elements. Algebraic extensions. Finitely generated algebraic extensions. Algebraic closure and algebraically closed fields. Splitting fields.

Unit: 2

Finite fields. Roots of unity, Cyclotomic polynomials and their irreducibility over Q. Normal extensions. Finite normal extensions as Splitting fields. Separable elements, separable polynomials and separable extensions. Perfect fields.
(Scope of the course as given in the book at Sr. No. 2).

Unit: 3

Galois extensions. Galois theory, Automorphism of fields. Fundamental theorem of Galois theory. Klein's 4-group and Diheadral group. Galois groups of polynomials. Fundamental theorem of Algebra. Radicals extensions. Galois radical extensions. Cyclic extensions. Solvability of polynomials by radicals over Q. Construction with ruler and compass only. (Scope of the course as given in the book at Sr. No. 2).

Unit: 4

Similar linear transformations. Invariant subspaces of vector spaces. Reduction of a linear transformation to triangular form. Nilpotent transformations. Index of nilpotency of a nilpotent transformation. Cyclic subspace with respect to a nilpotent transformation. Uniqueness of the invariants of a nilpotent transformation. Primary decomposition theorem. Jordan blocks and Jordan canonical forms. Cyclic module relative to a linear transformation. (Sections 6.4 to 6.7 of Topics in Algebra by I.N. Herstein).

Recommended Books:

1 I.N. Herstein; Topics in Algebra (Wiley Eastern Ltd.)
2 P.B. Bhattacharya S.R. Jain and S.R. Nagpal; Basic Abstract Algebra, (Cambridge University Press 1995)
3 Vivek Sahai and Vikas Bist; Algebra (Narosa publication House)
4 Surjit Singh and Quazi Zameeruddin; Modern Algebra (Vikas Publishing House 1990)
5 Patrick Morandi; Field and Galois Theory (Springer 1996).

Revised syllabus approved in 25th Academic Council meeting held on 12.02.19 vide resolution no. 17.
To be implemented from session 2019-20.

MTHCC–5802: Measure and Integration theory

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

Marks (Total): 100
Time: 03 Hours
Total Credit: 04

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short 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 one question from each unit including compulsory question.

Unit: 1

Lebesgue outer measure, elementary properties of outer measure, Measurable sets and their properties, Lebesgue measure of sets of real numbers, algebra of measurable sets, Borel sets and their measurability, characterization of measurable sets in terms of open, closed, $F\sigma$ and G_δ sets, existence of a non-measurable set.

Unit: 2

Lebesgue measurable functions and their properties, the almost everywhere concept , characteristic functions, simple functions, approximation of measurable functions by sequences of simple functions, measurable functions as nearly continuous functions. Lusin's theorem, almost uniform convergence, Egoroff's theorem, convergence in measure, F. Riesz theorem that every sequence which is convergent in measure has an almost everywhere convergent subsequence.

Unit: 3

The Lebesgue Integral: Shortcomings of Riemann integral, Lebesgue integral of a bounded function over a set of finite measure and its properties, Lebsegue integral as a generalization of the Riemann integral, Bounded convergence theorem, Lebesgue theorem regarding points of discontinuities of Riemann integrable functions.
Integral of a non negative function, Fatou's lemma, Monotone convergence theorem, the general Lebesgue integral, Lebesgue convergence theorem.

Unit: 4

Differentiation and Integration: Differentiation of monotone functions, Vitali's covering lemma,Lebesgue differentiation theorem, functions of bounded variation and their representation as difference of monotone functions. Differentiation of an integral, absolutely continuous functions.

Reference Books:

1. H. L. Royden , Real Analysis, 3rd Edition Prentice Hall of India, 1999.
2. G.de Barra, Measure theory and integration, Willey Eastern Ltd., 1981.
3. P.R.Halmos, Measure Theory, Van Nostrans, Princeton, 1950.
4. I.P.Natanson, Theory of functions of a real variable, Vol. I, Frederick Ungar Publishing Co., 1961.
5. R.G.Bartle, The elements of integration, John Wiley & Sons, Inc.New York, 1966.
6. K.R.Parthsarthy, Introduction to Probability and measure, Macmillan Company of India Ltd., Delhi, 1977.
7. P.K. Jain and V.P. Gupta, Lebesgue measure and integration, New age International (P) Ltd., Publishers, New Delhi, 1986.

MTHCC–5803: Mechanics of Solids

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

Marks (Total): 100
Time: 03 Hours
Total Credit: 04

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short 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 one question from each unit including compulsory question.

Unit: 1

Coordinate-transformation, Cartesian Tensor of different order, Properties of tensors, Isotropic tensors of different orders and relation between them, Symmetric and skew symmetric tensors, Tensor invariants, Eigen-values and eigen-vectors of a tensor.
Scalar, vector, tensor functions, Comma notation, Gradient, divergence and curl of a vector / tensor field.

Unit: 2

Affine transformation, 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, Stress, Stress Vector, Stress tensor.

Unit: 3

Equations of equilibrium, Transformation of coordinates, Stress quadric of Cauchy, Principal stresses and invariants, Maximum normal and shear stresses, Mohr's circles, Examples of stress, Generalised Hooks Law, Anisotropic symmetries, Homogeneous isotropic elastic medium.

Unit: 4

Elastic moduli for isotropic media, Equilibrium and dynamical equations for an isotropic elastic media, Strain energy function and its connection with Hooke's Law, Beltrami-Michell compatibility conditions and equations, Saint- Venant' s principle.

Recommended Books:

1. I.S. Sokolnikoff, Mathematical Theory of Elasticity, Tata-McGraw Hill Publishing Company Ltd., New Delhi, 1977.
2. D.S. Chandrasekharaiah and L. Debnath, Continuum Mechanics, Academic Press, 1994
3. A.E.H. Love, A Treatise on the Mathematical Theory of Elasticity, Dover Publications, New York.
4. Y.C. Fung. Foundations of Solid Mechanics, Prentice Hall, New Delhi, 1965.
5. Shanti Narayan, Text Book of Cartesian Tensors, S. Chand & Co., 1950.
6. S. Timeshenko and N. Goodier, Theory of Elasticity, McGraw Hill, New York, 1970.
7. I.H. Shames, Introduction to Solid Mechanics, Prentice Hall, New Delhi, 1975

Revised syllabus approved in 25th Academic Council meeting held on 12.02.19 vide resolution no. 17.
To be implemented from session 2019-20.

MTHCC–5804: System of Differential Equations

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

Marks (Total): 100
Time: 03 Hours
Total Credit: 04

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short 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 one question from each unit including compulsory question.

Unit: 1

Linear differential systems: Definitions and notations. Linear homogeneous systems; Existence and uniqueness theorem. Fundamental set and fundamental matrix of a homogeneous system. Wronskian of a system. Abel-Liouville formula. Adjoint systems, Reduction to smaller homogeneous systems.

Unit: 2

System of differential equations. Differential equation of order n and its equivalent system of differential equations. Existence theorem for solution of system of differential equations. Systems with constant coefficients, method of variation of constants for a non-homogeneous system. Periodic system. Floquet theory for periodic systems.

Unit: 3

Autonomous systems: the phase plane, paths and critical points, types of critical points; Node, Center, Saddle point, Spiral point. Stability of critical points. Critical points and paths of linear systems: basic theorems and their applications. Critical points and paths of quasilinear systems.

Unit: 4

Stability of solution of system of equations with constant coefficients, linear equation with constant coefficients. Liapunov stability. Stability of quasi linear systems.
Limit cycles and periodic solutions: limit cycle, existence and non-existence of limit cycles, Benedixson's non-existence theorem. Half-path or Semiorbit, Limit set, Poincare-Benedixson theorem (statement only).

Recommended books:

1. E.A. Coddington and N. Levinson, Theory of Ordinary Differential Equations, Tata McGraw-Hill, 2000.
2. S.L. Ross, Differential Equations, John Wiley & Sons
3. S.G. Deo, V. Lakshmikantham and V. Raghavendra, Textbook of Ordinary Differential Equations, Tata McGraw-Hill , 2006.
4. Mohan C Joshi, Ordinary Differential Equations, Modern Perspective, Narosa Publishing House, 2006.
5. P. Hartman, Ordinary Differential Equations, John Wiley & Sons NY, 1971.
6. G. Birkhoff and G.C. Rota, Ordinary Differential Equations, John Wiley & Sons, 1978.
7. G.F. Simmons, Differential Equations, Tata McGraw-Hill , 1993.
8. I.G. Petrovski, Ordinary Differential Equations, Prentice-Hall, 1966.
9. D. Somasundaram, Ordinary Differential Equations, A first Course, Narosa Pub., 2001.

Revised syllabus approved in 25th Academic Council meeting held on 12.02.19 vide resolution no. 17.
To be implemented from session 2019-20.

MTHCE-5806: Methods of Applied Mathematics

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

Marks (Total): 100
Time: 03 Hours
Total Credit: 04

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short 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 one question from each unit including compulsory question.

Unit: 1

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, Contravariant and Co-variant components of a vector, Metric coefficients & the volume element.

Unit: 2

Fourier Transform: Definition and properties, Fourier transform of some elementary functions, Fourier transform of derivatives, Parseval's identity for Fourier transform, evaluation of integrals, convolution theorem, Finite Fourier sine transform, finite Fourier cosine transform, Application of Fourier transform to solve ordinary and partial differential equation.

Unit: 3

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.

Unit: 4

Motivating problems of calculus of variations, shortest distance, minimum surface of revolution, Branchistochrone 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, conditional extremum under geometric constraints and under integral constraints. Ritz, Galerkin and Kantorovich methods.

Books Recommended:

1. I. N. Sneddon; The Use of Integral Transforms.
2. W. W. Bell; Special Functions for Scientists and Engineers.
3. Schaum's Series; Vector Analysis.
4. Lokenath Debnath; Integral Transforms and their Applications, CRC Press, Inc.
5. J. M. Gelfand and S. V. Fomin, Calculus of Variations, Prentice Hall, New Jersy, 1963.
6. Weinstock, Calculus of Variations, McGraw Hill.

Revised syllabus approved in 25th Academic Council meeting held on 12.02.19 vide resolution no. 17.
To be implemented from session 2019-20.

MTHCC–5902: Fluid Mechanics

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

Marks (Total): 100
Time: 03 Hours
Total Credit: 04

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short 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 one question from each unit including compulsory question.

Unit: 1

Kinematics - Velocity at a point of a fluid, Eulerian and Lagrangian methods, Stream lines, path lines and streak lines, Velocity potential, Irrotational and rotational motions, Vorticity and circulation, Equation of continuity, Boundary surfaces, Acceleration at a point of a fluid, Components of acceleration in cylindrical and spherical polar co-ordiantes.

Unit: 2

Pressure at a point of a moving fluid, Euler equation of motion, Equations of motion in cylindrical and spherical polar co-ordinates, Bernoulli equation, Impulsive motion, Kelvin circulation theorem, Vorticity equation, Energy equation for incompressible flow, Kinetic energy of irrotational flow, Kelvin minimum energy theorem, Kinetic energy of infinite fluid, Uniqueness theorems.

Unit: 3

Axially symmetric flows, Liquid streaming part a fixed sphere, Motion of a sphere through a liquid at rest at infinity, Equation of motion of a sphere, Kinetic energy generated by impulsive motion, Motion of two concentric spheres, Three-dimensional sources, sinks and doublets, Images of sources, sinks and doublets in rigid impermeable infinite plane and in impermeable spherical surface.

Unit: 4

Two dimensional motion, Use of cylindrical polar co-ordinates, Stream function. Axisymmetric flow, Stoke stream function, Stoke stream function of basic flows, Irrotational motion in two- dimensions, Complex velocity potential, Milne-Thomson circle theorem, Two-dimensional sources, sinks, doublets and their images, Blasius theorem.

Books Recommended:

1. F. Chorlton, Text-book of Fluid Dynamics, C.B.S. Publishers, Delhi, 1985.
2. Michael E.O. Neill and F. Chorlton, Ideal and Incompressible Fluid Dynamics, John Wiley & Sons, 1986.
3. S. W. Yuan, Foundations of Fluid Mechanics, Prentice Hall of India Ltd., New Delhi, 1976.
4. G.K. Batchelor, An Introduciton to Fluid Mechanics, Foundation Books, New Delhi, 1994.
5. R.K. Rathy. An Introduction to Fluid Dynamics, Oxford and IBH Publishing Company, New Delhi. 1976.
6. W.H. Besant and A.S. Ramsey, A Treatise on Hydromechanics, Part-II, CBS Publishers, Delhi, 1988.

Revised syllabus approved in 25th Academic Council meeting held on 12.02.19 vide resolution no. 17.
To be implemented from session 2019-20.

MTHCE–5903: Integral Equations

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

Marks (Total): 100
Time: 03 Hours
Total Credit: 04

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short 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 one question from each unit including compulsory question.

Unit: 1.
Linear Integral equations, Some basic identities, Initial value problems reduced to Volterra integral equations, Methods of successive substitution and successive approximation to solve Volterra integral equations of second kind, Iterated kernels and Neumann series for Volterra equations. Resolvent kernel as a series. Laplace transform method for a difference kernel. Solution of a Volterra integral equation of the first kind.

Unit: 2.
Boundary value problems reduced to Fredholm integral equations, Methods of successive approximation and successive substitution to solve Fredholm equations of second kind, Iterated kernels and Neumann series for Fredholm equations. Resolvent kernel as a sum of series. Fredholm resolvent kernel as a ratio of two series. Fredholm equations with separable kernels. Approximation of a kernel by a separable kernel, Fredholm Alternative, Non homonogenous Fredholm equations with degenerate kernels.

Unit: 3.
Singular integral equation, solution of Abel integral equation, solution of general form of Abel integral equation, Cauchy principal value for integrals: Cauchy's general and principal values,Holder condition, singular integrals,Plemelj formulas, Poincare-Bertrand transformation formula.Solution of Cauchy-Type singular integral equation, closed contour, unclosed contours and Riemann- Hilbert problem.Hilbert kernel, Hilbert formula, solution of Hilbert-type singular integral equation of first and second kind.

Unit: 4.
Green function, Use of method of variation of parameters to construct the Green function for a nonhomogeneous linear second order boundary value problem, Basic four properties of the Green function, Alternate procedure for construction of the Green function by using its basic four properties. Reduction of a boundary value problem to a Fredholm integral equation with kernel as Green function.

Books Recommended:

1. R.P. Kanwal, Linear Integral Equations, Theory and Techniques, Academic Press, New York.
2. M.D. Raishinghania, Integral Equations and Boundary value problems, S. Chand and Company Pvt. Ltd. 2007.
3. S.G. Mikhlin, Linear Integral Equations (translated from Russian) Hindustan Book Agency, 1960.
4. A.J. Jerri,Introduction to Integral Equations with Applications, AWiley- Interscience Publication, 1999.
5. W.V. Lovitt, Linear Integral Equations, McGraw Hill, NewYork.

Revised syllabus approved in 25th Academic Council meeting held on 12.02.19 vide resolution no. 17.
To be implemented from session 2019-20.

MTHCE–5904: Mathematical Statistics

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

Marks (Total): 100
Time: 03 Hours
Total Credit: 04

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short 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 one question from each unit including compulsory question.

Unit – 1

Probability: Definition and various approaches of probability, Addition theorem, Boole inequality, Conditional probability and multiplication theorem, Independent events, Mutual and pairwise independence of events, Bayes theorem and its applications.

Unit – 2

Random variable and probability functions: Definition and properties of random variables, Discrete and continuous random variables, Probability mass and density functions, Distribution function. Concepts of bivariate random variable: joint, marginal and conditional distributions. Mathematical expectation: Definition and its properties. Variance, Covariance, Moment generating function-Definitions and their properties.

Unit – 3

Discrete distributions: Uniform, Bernoulli, Binomial, Poisson and Geometric distributions with their properties.
Continuous distributions: Uniform, Exponential and Normal distributions with their properties.

Unit – 4

Testing of hypothesis: Parameter and statistic, Sampling distribution and standard error of estimate, Null and alternative hypotheses, Simple and composite hypotheses, Critical region, Level of significance, One tailed and two tailed tests, Two types of errors. Tests of significance: Large sample tests for single mean, Single proportion, Difference between two means and two proportions.

Books recommended:

1. V. Hogg and T. Craig, Introduction to Mathematical Statistics, 7th addition, Pearson Education Limited-2014
2. A.M. Mood, F.A. Graybill, and D.C. Boes, Introduction to the Theory of Statistics, Mc Graw Hill Book Company.
3. J.E. Freund, Mathematical Statistics, Prentice Hall of India.
4. M. Speigel, Probability and Statistics, Schaum Outline Series.
5. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, S. Chand Pub., New Delhi.

MTHCE–5905: Advanced Complex Analysis

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

Marks (Total): 100
Time: 03 Hours
Total Credit: 04

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short 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 one question from each unit including compulsory question.

Unit: 1.
The space of continuous functions $C(G,\Omega)$, Arzela-Ascoli theorem, Spaces of analytic functions, Hurwitz's theorem, Montel's theorem. Spaces of meromorphic functions, Riemann mapping theorem, infinite products, Weierstrass factorization theorem, Factorization of sine function.

Unit: 2.
Gamma function and its properties, functional equation for gamma function, Bohr-Mollerup theorem, Reimann-zeta function, Riemann's functional equation, Euler's theorem. Runge's theorem, Mittag-Leffler's theorem.

Unit: 3.
Analytic continuation, Uniqueness of direct analytic continuation, Uniqueness of analytic continuation along a curve, Power series method of analytic continuation, Schwarz reflection principle. Monodromy theorem and its consequences, Basic properties of harmonic functions, Harmonic functions on a disk, Poisson's Kernel. Dirichlet problem for a unit disk.

Unit: 4..
Harnack's inequality, Harnack's theorem. Dirichlet problem for a region, Green's function, Canonical product, Jensen's formula, Poisson –Jensen formula. Hadamard's three circles theorem, The genus and order of an entire function, Hadamard's factorization theorem.
The range of an analytic function: Bloch's theorem, Little-Picard theorem, Schottky's theorem, Montel-Carathedory theorem, Great Picard theorem

Books Recommended:

1. Conway, J.B., Functions of One complex variables Narosa Publishing, 2000.
2. Ahlfors, L.V., Complex Analysis. McGraw-Hill Book Company, 1979.
3. Churchill, R.V. and Brown, J.W., Complex Variables and Applications McGraw Hill Publishing Company, 1990.
4. Priestly, H.A., Introduction to Complex Analysis Claredon Press, Orford, 1990.
5. Mark J.Ablewitz and A.S.Fokas, Complex Variables : Introduction & Applications, Cambridge University Press, South Asian Edition, 1998.
6. E.C.Titchmarsn, The Theory of Functions, Oxford University Press, London.
7. S.Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, 1997.

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To be implemented from session 2019-20.

MTHCE–5906: Advanced Mechanics of Solids

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

Marks (Total): 100
Time: 03 Hours
Total Credit: 04

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short 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 one question from each unit including compulsory question.

Unit: 1.
Two dimensional problems: Plane strain deformation, State of Plane stress. Generalized plane stress, Airy stress function for plane strain problem, General solution of biharmonic equation, Stresses and displacements in terms of complex potentials, Deformation of a thick-walled elastic tube under external and internal pressures.

Unit: 2.
Extension: Extension of beams by longitudinal forces, beams stretched by its own weight.
Torsion: Torsion of a circular cylindrical beam, Torsional rigidity, Torsion and stress functions, Lines of shearing stress, Torsion of a beam of arbitrary cross-section and its special cases for circular, elliptic and equilateral triangular cross-sections, Circular grooves in a circular beam.

Unit: 3.
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.

Unit: 4.
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.

Books Recommended:

1. I.S. Sokolnikoff, Mathematical Theory of Elasticity, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1977.
2. Teodar M. Atanackovic and Ardeshiv Guran, *Theory of Elasticity for Scientists and Engineers*, Birkhausev, Boston, 2000.
3. A.K. Mal & S.J. Singh, *Deformation of Elastic Solids*, Prentice Hall, New Jersey, 1991.
4. W. Flugge, Viscoelasticity, Springer Verlag.
5. A.S. Saada, *Elasticity-Theory and Applications*, Pergamon Press, New York, 1973.
6. Y.C. Fung. Foundations of Solid Mechanics, Prentice Hall, New Delhi, 1965.
7. D.S. Chandrasekharaiah and L. Debnath, Continuum Mechanics, Academic Press, 1994.

Revised syllabus approved in 25th Academic Council meeting held on 12.02.19 vide resolution no. 17.
To be implemented from session 2019-20.

MTHCE–5004: Mathematical Aspect of Seismology

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

Marks (Total): 100
Time: 03 Hours
Total Credit: 04

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short 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 one question from each unit including compulsory question.

Unit: 1.

Waves, General form of progressive waves, Harmonic waves, Plane waves, the wave equation, Principle of superposition. Progressive types solutions of wave equation, Stationary type solutions of wave equation in Cartesian, Cylindrical and Spherical coordinates systems, Equation of telegraphy, Exponential form of harmonic waves. D' Alembert's formula, Inhomogeneous wave equation.

Unit: 2.

Spherical waves, Expansion of a spherical wave into plane waves, Sommerfield's integral, Dispersion, Group velocity, relation between phase velocity and group velocity.
Introduction to Seismology: Earthquakes, Location of earthquakes, Causes of Earthquakes, Observation of Earthquakes, Aftershocks and Foreshocks, Earthquake magnitude, Seismic moment, Energy released by earthquakes, Interior structure of the Earth.

Unit: 3.

Reduction of equation of motion to wave equations, P and S waves and their characteristics, Polarization of plane P and S waves, Snell's law of reflection and refraction, Reflection of plane P and SV waves at a free surface, Partition of reflected energy, Reflection at critical angles, Reflection and refraction of plane P, SV and SH waves at an interface, Special cases of Liquid-Liquid interface, Liquid-Solid interface and Solid-Solid interface.

Unit: 4.

Two dimensional Lamb's problems in an isotropic elastic solid, Area sources and Line Sources in an unlimited elastic solid, normal force acts on the surface of a semi-infinite elastic solid, tangential forces acting on the surface of a semi-infinite elastic solid, Surface waves, Rayleigh waves, Love waves and Stoneley waves.

Books Recommended:

1. C.A. Coulson and A. Jefferey, Waves, Longman, New York, 1977.
2. M. Bath, Mathematical Aspects of Seismology, Elsevier Publishing Company, 1968.
3. W.M. Ewing, W.S. Jardetzky and F. Press, Elastic Waves in Layered Media, McGraw Hill Book Company, 1957.
4. C.M.R. Fowler, The Solid Earth, Cambridge University Press, 1990
5. P.M. Shearer, Introduction to Seismology, Cambridge University Press, (UK) 1999.
6. Seth Stein and Michael Wysession, An Introduction to Seismology, Earthquakes and Earth Structure, Blackwell Publishing Ltd., 2003.
7. Bullen, K.E. and B.A. Bolt, An Introduction to the Theory of Seismology, Cambridge Universty Press, 1985.

MTHCE–5006: Advanced Fluid Mechanics

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

Marks (Total): 100
Time: 03 Hours
Total Credit: 04

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short 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 one question from each unit including compulsory question.

Unit: 1

Vorticity in two dimensions, Circular and rectilinear vortices, Vortex doublet, Images, Motion due to vortices, Single and double infinite rows of vortices, Karman vortex sheet.
Newton's Law of viscosity, Newtonian and non-Newtonian fluids, Stress components in a real fluid, State of stress at a point, Nature of stresses, transformation of stress components, Relation between Cartesian components of stress.

Unit: 2

Translational motion of fluid element, Rates of strain. Transformation of rates of strain, Principal stress & strain rate, Relation between stresses and rates of strain. The co-efficient of viscosity and laminar flow.
Navier-Stoke equations of motion. Equations of motion in cylindrical and spherical polar co-ordinates. Diffusion of vorticity. Energy dissipation due to viscosity.

Unit: 3

Plane Poiseuille and Couette flows between two parallel plates. Theory of lubrication. Hagen Poiseuille flow. Steady flow between co-axial circular cylinders and concentric rotating cylinders. Flow through tubes of uniform elliptic and equilateral triangular cross-section. Unsteady flow over a flat plate. Steady flow past a fixed sphere. Flow in convergent and divergent channels.

Unit: 4

Dynamical similarity, Inspection analysis, Non-dimensional numbers, Dimensional analysis. Buckingham pi-theorem and its application, Physical importance of non-dimensional parameters.
Prandtl boundary layer, Boundary layer equation in two-dimensions, The boundary layer on a flat plate (Blasius solution), Characteristic boundary layer parameters, Karman integral conditions, Karman-Pohlhausen method.

Books Recommended:

1. W.H. Besant and A.S. Ramsey, A Treatise on Hydromechanics, Part-II, CBS Publishers, Delhi, 1988.
2. F. Chorlton, Text-book of Fluid Dynamics, C.B.S. Publishers, Delhi, 1985.
3. Michael E.O. Neill and F. Chorlton, Ideal and Incompressible Fluid Dynamics, John Wiley & Sons, 1986.
4. S. W. Yuan, Foundations of Fluid Mechanics, Prentice Hall of India Ltd., New Delhi, 1976.
5. G.K. Batchelor, An Introduciton to Fluid Mechanics, Foundation Books, New Delhi, 1994.
6. H. Schlichting, Boundary Layer Theory, McGraw Hill Book Company, New York, 1979.
7. R.K. Rathy. An Introduction to Fluid Dynamics, Oxford and IBH Publishing Company, New Delhi. 1976.
8. A.D. Young, Boundary Layers, AIAA Education Series, Washington DC, 1989.

Revised syllabus approved in 25th Academic Council meeting held on 12.02.19 vide resolution no. 17.
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Department of Mathematics
Chaudhary Devi Lal University
Sirsa

Revised Syllabus

Effective from Session 2019-20

M.Sc. Mathematics – 2 year Programme

MTHCC–2101: Abstract Algebra

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

Marks (Total): 100
Time: 03 Hours
Total Credit: 04

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short 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 one question from each unit including compulsory question.

Unit: 1

Automorphisms and Inner automorphisms of a group G. The groups Aut(G) and Inn(G). Automorphism group of a cyclic group. Normalizer and Centralizer of a non-empty subset of a group G. Conjugate elements and conjugacy classes. Class equation of a finite group G and its applications. Derived group (or a commutator subgroup) of a group G. perfect groups. Simplicity of the Alternating group A_n ($n \geq 5$). Zassenhaus's Lemma. Normal and Composition series of a group G. Scheier's refinement theorem. Jordan Holder theorem. Composition series of groups of order p^n and of finite Abelian groups. Caunchy theorem for finite groups. p-groups. Finite Abelian groups. Sylow p-subgroups. Sylow's Ist, IInd and IIIrd theorems. Application of Sylow theorems.

Unit: 2

Commutators identities. Commutator subgroups. Three subgroups Lemma of P.Hall. Central series of a group G. Nilpotent groups. Centre of a nilpotent group. Subgroups and factor subgroups of nilpotent groups. Finite nilpotent groups. Upper and lower central series of a group G and their properties. Subgroups of finitely generated nilpotent groups. Sylow-subgroups of nilpotent groups. Solvable groups. Derived series of a group G.

Unit: 3

Modules, submodules and quotient modules. Module generated by a non-empty subset of an R-module. Finitely generated modules and cyclic modules. Idempotents. Homomorphism of R-modules. Fundamental theorem of homomorphism of R-modules. Direct sum of modules. Endomorphism Simple modules and completely reducible modules (semi-simple modules). Finitely generated free modules. Rank of a finitely generated free module. Submodules of free modules of finite rank over a PID.

Unit: 4

Endomorphism ring of a finite direct sum of modules. Finitely generated modules. Ascending and descending chains of sub modules of an R-module. Ascending and Descending chain conditions (A.C.C. and D.C.C.). Noetherian modules and Noetherian rings. Finitely co-generated modules. Artinian modules and Artinian rings. Nilpotent elements of a ring R. Nil and nilpotent ideals. Hilbert Basis Theorem. Structure theorem for finite Boolean rings. Wedeerburn-Artin theorem and its consequences. Uniform modules. Primary modules.

Recommended Books:

1. I.S. Luthar and I.B.S. Passi; Algebra Vol. 1 Groups (Narosa publication House)
2. P.B. Bhattacharya S.R. Jain and S.R. Nagpal; Basic Abstract Algebra
3. I.D. Macdonald; Theory of Groups
4. Vivek Sahai and Vikas Bist; Algebra (Narosa publication House)
5. Surjit Singh and Quazi Zameeruddin; Modern Algebra (Vikas Publishing House 1990)
6. W.R. Scott; Group Theory.

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To be implemented from session 2019-20.

MTHCC–2104: Complex Analysis

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

Marks (Total): 100
Time: 03 Hours
Total Credit: 04

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short 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 one question from each unit including compulsory question.

Unit: 1

Analytic functions, Harmonic functions, Path in a region, Smooth path, p. w. smooth path, Contour, Simply connected region, Multiply connected region, Complex integration, Antiderivatives, Cauchy-Goursat theorem, Cauchy-Goursat theorem for simply connected and multiply connected domains.

Unit: 2

Cauchy integral formula, Extension of Cauchy integral formula for multiply connected domain, Higher order derivatives of Cauchy integral formula, Morera's theorem, Liouville's theorem, Fundamental theorem of algebra, Cauchy inequality, Maximum modulus principle, Gauss mean value theorem, Poisson integral formula.

Unit: 3

Branches of many valued functions with special reference to arg z, Log z, z^a, Bilinear transformations, Their Properties and classification, Definition and examples of Conformal mapping.
Taylor series, Laurent series, Power series and its convergence, Radius of convergence, Sum of power series, Differentiability of sum function of power series.

Unit: 4

Singularity and its classification, Residues, Cauchy residue theorem, Residues at poles, Zeros of analytic functions, Cassorati-Weierstrass theorem, Evaluation of improper integrals, Meromorphic functions, The Argument principle, Rouche's theorem.

Books Recommended:

1. J. W. Brown and R. V. Churchill; Complex Variables and Applications, McGraw Hill, 1996.
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. H. A. Priestly; Introduction to Complex Analysis, Clarendon Press, Oxford, 1990.

MTHCC–2105: Ordinary Differential Equations

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

Marks (Total): 100
Time: 03 Hours
Total Credit: 04

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short 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 one question from each unit including compulsory question.

Unit: 1

Preliminaries: Initial value problem and equivalent integral equation, ε-approximate solution, equicontinuous set of functions.Basic theorems: Ascoli- Arzela theorem, Cauchy–Peano existence theorem and its corollary. Gronwall's inequality.

Lipschitz condition.Picard-Lindelöf existence and uniqueness theorem for $\frac{dy}{dt} = f(t, y)$. Solution of initial value problem by Picard's method.

Unit: 2

Higher order equations: Linear differential equation (LDE) of order n; Linear combinations, Linear dependence and linear independence of solutions. Wronskian theory: Definition, necessary and sufficient condition for linear dependence and linear independence of solutions of homogeneous LDE. Abel's Identity, Fundamental set.Reduction of order.

Non-homogeneous LDE.Variation of parameters.Adjoint equations, Lagrange's Identity, Green's formula.Linear equation of order n with constant coefficients.

Unit: 3

Linear second order equations: Preliminaries, self adjoint equation of second order, basic facts.Superposition Principle.Riccati's equation.Prüffer transformation.Zero of a solution.Abel's formula.Common zeros of solutions and their linear dependence.

Sturm theory: Sturm separation theorem, Sturm fundamental comparison theorem and their corollaries.Oscillatory and non-oscillatory equations.

Unit: 4

Second order boundary value problems(BVP): Linear problems; periodic boundary conditions, regular linear BVP, singular linear BVP; non-linear BVP. Sturm-Liouville BVP: definitions, eigen values and eigen functions. Orthogonality of functions, orthogonality of eigen functions corresponding to distinct eigen values.Green's function. Applications of Green's function for solving boundary value problems.

Recommended books:

1. E.A. Coddington and N. Levinson, Theory of Ordinary Differential Equations, Tata McGraw-Hill , 2000
2. S.L. Ross, Differential Equations, John Wiley & Sons
3. P. Hartman, Ordinary Differential Equations, John Wiley & Sons NY, 1971.
4. G. Birkhoff and G.C. Rota, Ordinary Differential Equations, John Wiley & Sons, 1978.
5. G.F. Simmons, Differential Equations, Tata McGraw-Hill , 1993.
6. I.G. Petrovski, Ordinary Differential Equations, Prentice-Hall, 1966.
7. D. Somasundaram, Ordinary Differential Equations, A first Course, Narosa Pub., 2001.
8. Mohan C Joshi, Ordinary Differential Equations, Modern Perspective, Narosa Publishing House, 2006

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To be implemented from session 2019-20.

MTHCC–2201: Advanced Abstract Algebra

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

Marks (Total): 100
Time: 03 Hours
Total Credit: 04

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short 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 one question from each unit including compulsory question.

Unit: 1

Characteristic of a ring with unity. Prime fields Z/pZ and Q. Characterization of prime fields. Field extensions. Degree of an extension. Algebraic and transcendental elements. Simple field extensions. Minimal polynomial of an algebraic element. Conjugate elements. Algebraic extensions. Finitely generated algebraic extensions. Algebraic closure and algebraically closed fields. Splitting fields.

Unit: 2

Finite fields. Roots of unity, Cyclotomic polynomials and their irreducibility over Q. Normal extensions. Finite normal extensions as Splitting fields. Separable elements, separable polynomials and separable extensions. Perfect fields.
(Scope of the course as given in the book at Sr. No. 2).

Unit: 3

Galois extensions. Galois theory, Automorphism of fields. Fundamental theorem of Galois theory. Klein's 4-group and Diheadral group. Galois groups of polynomials. Fundamental theorem of Algebra. Radicals extensions. Galois radical extensions. Cyclic extensions. Solvability of polynomials by radicals over Q. Construction with ruler and compass only. (Scope of the course as given in the book at Sr. No. 2).

Unit: 4

Similar linear transformations. Invariant subspaces of vector spaces. Reduction of a linear transformation to triangular form. Nilpotent transformations. Index of nilpotency of a nilpotent transformation. Cyclic subspace with respect to a nilpotent transformation. Uniqueness of the invariants of a nilpotent transformation. Primary decomposition theorem. Jordan blocks and Jordan canonical forms. Cyclic module relative to a linear transformation. (Sections 6.4 to 6.7 of Topics in Algebra by I.N. Herstein).

Recommended Books:

1 I.N. Herstein; Topics in Algebra (Wiley Eastern Ltd.)
2 P.B. Bhattacharya S.R. Jain and S.R. Nagpal; Basic Abstract Algebra, (Cambridge University Press 1995)
3 Vivek Sahai and Vikas Bist; Algebra (Narosa publication House)
4 Surjit Singh and Quazi Zameeruddin; Modern Algebra (Vikas Publishing House 1990)
5 Patrick Morandi; Field and Galois Theory (Springer 1996).

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To be implemented from session 2019-20.

MTHCC–2202: Measure and Integration theory

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

Marks (Total): 100
Time: 03 Hours
Total Credit: 04

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short 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 one question from each unit including compulsory question.

Unit: 1

Lebesgue outer measure, elementary properties of outer measure, Measurable sets and their properties, Lebesgue measure of sets of real numbers, algebra of measurable sets, Borel sets and their measurability, characterization of measurable sets in terms of open, closed, $F\sigma$ and G_δ sets, existence of a non-measurable set.

Unit: 2

Lebesgue measurable functions and their properties, the almost everywhere concept , characteristic functions, simple functions, approximation of measurable functions by sequences of simple functions, measurable functions as nearly continuous functions. Lusin's theorem, almost uniform convergence, Egoroff's theorem, convergence in measure, F. Riesz theorem that every sequence which is convergent in measure has an almost everywhere convergent subsequence.

Unit: 3

The Lebesgue Integral: Shortcomings of Riemann integral, Lebesgue integral of a bounded function over a set of finite measure and its properties, Lebsegue integral as a generalization of the Riemann integral, Bounded convergence theorem, Lebesgue theorem regarding points of discontinuities of Riemann integrable functions.
Integral of a non negative function, Fatou's lemma, Monotone convergence theorem, the general Lebesgue integral, Lebesgue convergence theorem.

Unit: 4

Differentiation and Integration: Differentiation of monotone functions, Vitali's covering lemma,Lebesgue differentiation theorem, functions of bounded variation and their representation as difference of monotone functions. Differentiation of an integral, absolutely continuous functions.

Reference Books:

1. H. L. Royden , Real Analysis, 3rd Edition Prentice Hall of India, 1999.
2. G.de Barra, Measure theory and integration, Willey Eastern Ltd., 1981.
3. P.R.Halmos, Measure Theory, Van Nostrans, Princeton, 1950.
4. I.P.Natanson, Theory of functions of a real variable, Vol. I, Frederick Ungar Publishing Co., 1961.
5. R.G.Bartle, The elements of integration, John Wiley & Sons, Inc.New York, 1966.
6. K.R.Parthsarthy, Introduction to Probability and measure, Macmillan Company of India Ltd., Delhi, 1977.
7. P.K. Jain and V.P. Gupta, Lebesgue measure and integration, New age International (P) Ltd., Publishers, New Delhi, 1986.

MTHCC–2203: Mechanics of Solids

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

Marks (Total): 100
Time: 03 Hours
Total Credit: 04

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short 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 one question from each unit including compulsory question.

Unit: 1

Coordinate-transformation, Cartesian Tensor of different order, Properties of tensors, Isotropic tensors of different orders and relation between them, Symmetric and skew symmetric tensors, Tensor invariants, Eigen-values and eigen-vectors of a tensor.
Scalar, vector, tensor functions, Comma notation, Gradient, divergence and curl of a vector / tensor field.

Unit: 2

Affine transformation, 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, Stress, Stress Vector, Stress tensor.

Unit: 3

Equations of equilibrium, Transformation of coordinates, Stress quadric of Cauchy, Principal stresses and invariants, Maximum normal and shear stresses, Mohr's circles, Examples of stress, Generalised Hooks Law, Anisotropic symmetries, Homogeneous isotropic elastic medium.

Unit: 4

Elastic moduli for isotropic media, Equilibrium and dynamical equations for an isotropic elastic media, Strain energy function and its connection with Hooke's Law, Beltrami-Michell compatibility conditions and equations, Saint- Venant' s principle.

Recommended Books:

1. I.S. Sokolnikoff, Mathematical Theory of Elasticity, Tata-McGraw Hill Publishing Company Ltd., New Delhi, 1977.
2. D.S. Chandrasekharaiah and L. Debnath, Continuum Mechanics, Academic Press, 1994
3. A.E.H. Love, A Treatise on the Mathematical Theory of Elasticity, Dover Publications, New York.
4. Y.C. Fung. Foundations of Solid Mechanics, Prentice Hall, New Delhi, 1965.
5. Shanti Narayan, Text Book of Cartesian Tensors, S. Chand & Co., 1950.
6. S. Timeshenko and N. Goodier, Theory of Elasticity, McGraw Hill, New York, 1970.
7. I.H. Shames, Introduction to Solid Mechanics, Prentice Hall, New Delhi, 1975

Revised syllabus approved in 25th Academic Council meeting held on 12.02.19 vide resolution no. 17.
To be implemented from session 2019-20.

MTHCC–2204: System of Differential Equations

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

Marks (Total): 100
Time: 03 Hours
Total Credit: 04

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short 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 one question from each unit including compulsory question.

Unit: 1

Linear differential systems: Definitions and notations. Linear homogeneous systems; Existence and uniqueness theorem. Fundamental set and fundamental matrix of a homogeneous system. Wronskian of a system. Abel-Liouville formula. Adjoint systems, Reduction to smaller homogeneous systems.

Unit: 2

System of differential equations. Differential equation of order n and its equivalent system of differential equations. Existence theorem for solution of system of differential equations. Systems with constant coefficients, method of variation of constants for a non-homogeneous system. Periodic system. Floquet theory for periodic systems.

Unit: 3

Autonomous systems: the phase plane, paths and critical points, types of critical points; Node, Center, Saddle point, Spiral point. Stability of critical points. Critical points and paths of linear systems: basic theorems and their applications. Critical points and paths of quasilinear systems.

Unit: 4

Stability of solution of system of equations with constant coefficients, linear equation with constant coefficients. Liapunov stability. Stability of quasi linear systems.
Limit cycles and periodic solutions: limit cycle, existence and non-existence of limit cycles, Benedixson's non-existence theorem. Half-path or Semiorbit, Limit set, Poincare-Benedixson theorem (statement only).

Recommended books:

1. E.A. Coddington and N. Levinson, Theory of Ordinary Differential Equations, Tata McGraw-Hill, 2000.
2. S.L. Ross, Differential Equations, John Wiley & Sons
3. S.G. Deo, V. Lakshmikantham and V. Raghavendra, Textbook of Ordinary Differential Equations, Tata McGraw-Hill , 2006.
4. Mohan C Joshi, Ordinary Differential Equations, Modern Perspective, Narosa Publishing House, 2006.
5. P. Hartman, Ordinary Differential Equations, John Wiley & Sons NY, 1971.
6. G. Birkhoff and G.C. Rota, Ordinary Differential Equations, John Wiley & Sons, 1978.
7. G.F. Simmons, Differential Equations, Tata McGraw-Hill , 1993.
8. I.G. Petrovski, Ordinary Differential Equations, Prentice-Hall, 1966.
9. D. Somasundaram, Ordinary Differential Equations, A first Course, Narosa Pub., 2001.

MTHCE-2206: Methods of Applied Mathematics

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

Marks (Total): 100
Time: 03 Hours
Total Credit: 04

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short 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 one question from each unit including compulsory question.

Unit: 1

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, Contravariant and Co-variant components of a vector, Metric coefficients & the volume element.

Unit: 2

Fourier Transform: Definition and properties, Fourier transform of some elementary functions, Fourier transform of derivatives, Parseval's identity for Fourier transform, evaluation of integrals, convolution theorem, Finite Fourier sine transform, finite Fourier cosine transform, Application of Fourier transform to solve ordinary and partial differential equation.

Unit: 3

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.

Unit: 4

Motivating problems of calculus of variations, shortest distance, minimum surface of revolution, Branchistochrone 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, conditional extremum under geometric constraints and under integral constraints. Ritz, Galerkin and Kantorovich methods.

Books Recommended:

1. I. N. Sneddon; The Use of Integral Transforms.
2. W. W. Bell; Special Functions for Scientists and Engineers.
3. Schaum's Series; Vector Analysis.
4. Lokenath Debnath; Integral Transforms and their Applications, CRC Press, Inc.
5. J. M. Gelfand and S. V. Fomin, Calculus of Variations, Prentice Hall, New Jersy, 1963.
6. Weinstock, Calculus of Variations, McGraw Hill.

MTHCC–2302: Fluid Mechanics

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

Marks (Total): 100
Time: 03 Hours
Total Credit: 04

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short 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 one question from each unit including compulsory question.

Unit: 1

Kinematics - Velocity at a point of a fluid, Eulerian and Lagrangian methods, Stream lines, path lines and streak lines, Velocity potential, Irrotational and rotational motions, Vorticity and circulation, Equation of continuity, Boundary surfaces, Acceleration at a point of a fluid, Components of acceleration in cylindrical and spherical polar co-ordiantes.

Unit: 2

Pressure at a point of a moving fluid, Euler equation of motion, Equations of motion in cylindrical and spherical polar co-ordinates, Bernoulli equation, Impulsive motion, Kelvin circulation theorem, Vorticity equation, Energy equation for incompressible flow, Kinetic energy of irrotational flow, Kelvin minimum energy theorem, Kinetic energy of infinite fluid, Uniqueness theorems.

Unit: 3

Axially symmetric flows, Liquid streaming part a fixed sphere, Motion of a sphere through a liquid at rest at infinity, Equation of motion of a sphere, Kinetic energy generated by impulsive motion, Motion of two concentric spheres, Three-dimensional sources, sinks and doublets, Images of sources, sinks and doublets in rigid impermeable infinite plane and in impermeable spherical surface.

Unit: 4

Two dimensional motion, Use of cylindrical polar co-ordinates, Stream function. Axisymmetric flow, Stoke stream function, Stoke stream function of basic flows, Irrotational motion in two- dimensions, Complex velocity potential, Milne-Thomson circle theorem, Two-dimensional sources, sinks, doublets and their images, Blasius theorem.

Books Recommended:

1. F. Chorlton, Text-book of Fluid Dynamics, C.B.S. Publishers, Delhi, 1985.
2. Michael E.O. Neill and F. Chorlton, Ideal and Incompressible Fluid Dynamics, John Wiley & Sons, 1986.
3. S. W. Yuan, Foundations of Fluid Mechanics, Prentice Hall of India Ltd., New Delhi, 1976.
4. G.K. Batchelor, An Introduciton to Fluid Mechanics, Foundation Books, New Delhi, 1994.
5. R.K. Rathy. An Introduction to Fluid Dynamics, Oxford and IBH Publishing Company, New Delhi. 1976.
6. W.H. Besant and A.S. Ramsey, A Treatise on Hydromechanics, Part-II, CBS Publishers, Delhi, 1988.

Revised syllabus approved in 25th Academic Council meeting held on 12.02.19 vide resolution no. 17.
To be implemented from session 2019-20.

MTHCE–2303: Integral Equations

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

Marks (Total): 100
Time: 03 Hours
Total Credit: 04

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short 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 one question from each unit including compulsory question.

Unit: 1.
Linear Integral equations, Some basic identities, Initial value problems reduced to Volterra integral equations, Methods of successive substitution and successive approximation to solve Volterra integral equations of second kind, Iterated kernels and Neumann series for Volterra equations. Resolvent kernel as a series. Laplace transform method for a difference kernel. Solution of a Volterra integral equation of the first kind.

Unit: 2.
Boundary value problems reduced to Fredholm integral equations, Methods of successive approximation and successive substitution to solve Fredholm equations of second kind, Iterated kernels and Neumann series for Fredholm equations. Resolvent kernel as a sum of series. Fredholm resolvent kernel as a ratio of two series. Fredholm equations with separable kernels. Approximation of a kernel by a separable kernel, Fredholm Alternative, Non homonogenous Fredholm equations with degenerate kernels.

Unit: 3.
Singular integral equation, solution of Abel integral equation, solution of general form of Abel integral equation, Cauchy principal value for integrals: Cauchy's general and principal values,Holder condition, singular integrals,Plemelj formulas, Poincare-Bertrand transformation formula.Solution of Cauchy-Type singular integral equation, closed contour, unclosed contours and Riemann- Hilbert problem.Hilbert kernel, Hilbert formula, solution of Hilbert-type singular integral equation of first and second kind.

Unit: 4.
Green function, Use of method of variation of parameters to construct the Green function for a nonhomogeneous linear second order boundary value problem, Basic four properties of the Green function, Alternate procedure for construction of the Green function by using its basic four properties. Reduction of a boundary value problem to a Fredholm integral equation with kernel as Green function.

Books Recommended:

1. R.P. Kanwal, Linear Integral Equations, Theory and Techniques, Academic Press, New York.
2. M.D. Raishinghania, Integral Equations and Boundary value problems, S. Chand and Company Pvt. Ltd. 2007.
3. S.G. Mikhlin, Linear Integral Equations (translated from Russian) Hindustan Book Agency, 1960.
4. A.J. Jerri,Introduction to Integral Equations with Applications, AWiley- Interscience Publication, 1999.
5. W.V. Lovitt, Linear Integral Equations, McGraw Hill, NewYork.

Revised syllabus approved in 25th Academic Council meeting held on 12.02.19 vide resolution no. 17.
To be implemented from session 2019-20.

MTHCE–2304: Mathematical Statistics

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

Marks (Total): 100
Time: 03 Hours
Total Credit: 04

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short 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 one question from each unit including compulsory question.

Unit – 1

Probability: Definition and various approaches of probability, Addition theorem, Boole inequality, Conditional probability and multiplication theorem, Independent events, Mutual and pairwise independence of events, Bayes theorem and its applications.

Unit – 2

Random variable and probability functions: Definition and properties of random variables, Discrete and continuous random variables, Probability mass and density functions, Distribution function. Concepts of bivariate random variable: joint, marginal and conditional distributions. Mathematical expectation: Definition and its properties. Variance, Covariance, Moment generating function-Definitions and their properties.

Unit – 3

Discrete distributions: Uniform, Bernoulli, Binomial, Poisson and Geometric distributions with their properties.
Continuous distributions: Uniform, Exponential and Normal distributions with their properties.

Unit – 4

Testing of hypothesis: Parameter and statistic, Sampling distribution and standard error of estimate, Null and alternative hypotheses, Simple and composite hypotheses, Critical region, Level of significance, One tailed and two tailed tests, Two types of errors. Tests of significance: Large sample tests for single mean, Single proportion, Difference between two means and two proportions.

Books recommended:

1. V. Hogg and T. Craig, Introduction to Mathematical Statistics, 7th addition, Pearson Education Limited-2014
2. A.M. Mood, F.A. Graybill, and D.C. Boes, Introduction to the Theory of Statistics, Mc Graw Hill Book Company.
3. J.E. Freund, Mathematical Statistics, Prentice Hall of India.
4. M. Speigel, Probability and Statistics, Schaum Outline Series.
5. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, S. Chand Pub., New Delhi.

MTHCE–2305: Advanced Complex Analysis

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

Marks (Total): 100
Time: 03 Hours
Total Credit: 04

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short 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 one question from each unit including compulsory question.

Unit: 1.
The space of continuous functions $C(G,\Omega)$, Arzela-Ascoli theorem, Spaces of analytic functions, Hurwitz's theorem, Montel's theorem. Spaces of meromorphic functions, Riemann mapping theorem, infinite products, Weierstrass factorization theorem, Factorization of sine function.

Unit: 2.
Gamma function and its properties, functional equation for gamma function, Bohr-Mollerup theorem, Reimann-zeta function, Riemann's functional equation, Euler's theorem. Runge's theorem, Mittag-Leffler's theorem.

Unit: 3.
Analytic continuation, Uniqueness of direct analytic continuation, Uniqueness of analytic continuation along a curve, Power series method of analytic continuation, Schwarz reflection principle. Monodromy theorem and its consequences, Basic properties of harmonic functions, Harmonic functions on a disk, Poisson's Kernel. Dirichlet problem for a unit disk.

Unit: 4.
Harnack's inequality, Harnack's theorem. Dirichlet problem for a region, Green's function, Canonical product, Jensen's formula, Poisson –Jensen formula. Hadamard's three circles theorem, The genus and order of an entire function, Hadamard's factorization theorem.
The range of an analytic function: Bloch's theorem, Little-Picard theorem, Schottky's theorem, Montel-Carathedory theorem, Great Picard theorem

Books Recommended:

1. Conway, J.B., Functions of One complex variables Narosa Publishing, 2000.
2. Ahlfors, L.V., Complex Analysis. McGraw-Hill Book Company, 1979.
3. Churchill, R.V. and Brown, J.W., Complex Variables and Applications McGraw Hill Publishing Company, 1990.
4. Priestly, H.A., Introduction to Complex Analysis Claredon Press, Orford, 1990.
5. Mark J.Ablewitz and A.S.Fokas, Complex Variables : Introduction & Applications, Cambridge University Press, South Asian Edition, 1998.
6. E.C.Titchmarsn, The Theory of Functions, Oxford University Press, London.
7. S.Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, 1997.

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MTHCE–2306: Advanced Mechanics of Solids

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

Marks (Total): 100
Time: 03 Hours
Total Credit: 04

Note -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short 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 one question from each unit including compulsory question.

Unit: 1.
Two dimensional problems: Plane strain deformation, State of Plane stress. Generalized plane stress, Airy stress function for plane strain problem, General solution of biharmonic equation, Stresses and displacements in terms of complex potentials, Deformation of a thick-walled elastic tube under external and internal pressures.

Unit: 2.
Extension: Extension of beams by longitudinal forces, beams stretched by its own weight.
Torsion: Torsion of a circular cylindrical beam, Torsional rigidity, Torsion and stress functions, Lines of shearing stress, Torsion of a beam of arbitrary cross-section and its special cases for circular, elliptic and equilateral triangular cross-sections, Circular grooves in a circular beam.

Unit: 3.
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.

Unit: 4.
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.

Books Recommended:

1. I.S. Sokolnikoff, Mathematical Theory of Elasticity, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1977.
2. Teodar M. Atanackovic and Ardeshiv Guran, *Theory of Elasticity for Scientists and Engineers*, Birkhausev, Boston, 2000.
3. A.K. Mal & S.J. Singh, *Deformation of Elastic Solids*, Prentice Hall, New Jersey, 1991.
4. W. Flugge, Viscoelasticity, Springer Verlag.
5. A.S. Saada, *Elasticity-Theory and Applications*, Pergamon Press, New York, 1973.
6. Y.C. Fung. Foundations of Solid Mechanics, Prentice Hall, New Delhi, 1965.
7. D.S. Chandrasekharaiah and L. Debnath, Continuum Mechanics, Academic Press, 1994.

MTHCE–2404: Mathematical Aspect of Seismology

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

Marks (Total): 100
Time: 03 Hours
Total Credit: 04

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short 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 one question from each unit including compulsory question.

Unit: 1.

Waves, General form of progressive waves, Harmonic waves, Plane waves, the wave equation, Principle of superposition. Progressive types solutions of wave equation, Stationary type solutions of wave equation in Cartesian, Cylindrical and Spherical coordinates systems, Equation of telegraphy, Exponential form of harmonic waves. D` Alembert`s formula, Inhomogeneous wave equation.

Unit: 2.

Spherical waves, Expansion of a spherical wave into plane waves, Sommerfield's integral, Dispersion, Group velocity, relation between phase velocity and group velocity.
Introduction to Seismology: Earthquakes, Location of earthquakes, Causes of Earthquakes, Observation of Earthquakes, Aftershocks and Foreshocks, Earthquake magnitude, Seismic moment, Energy released by earthquakes, Interior structure of the Earth.

Unit: 3.

Reduction of equation of motion to wave equations, P and S waves and their characteristics, Polarization of plane P and S waves, Snell's law of reflection and refraction, Reflection of plane P and SV waves at a free surface, Partition of reflected energy, Reflection at critical angles, Reflection and refraction of plane P, SV and SH waves at an interface, Special cases of Liquid-Liquid interface, Liquid-Solid interface and Solid-Solid interface.

Unit: 4.

Two dimensional Lamb`s problems in an isotropic elastic solid, Area sources and Line Sources in an unlimited elastic solid, normal force acts on the surface of a semi-infinite elastic solid, tangential forces acting on the surface of a semi-infinite elastic solid, Surface waves, Rayleigh waves, Love waves and Stoneley waves.

Books Recommended:

1. C.A. Coulson and A. Jefferey, Waves, Longman, New York, 1977.
2. M. Bath, Mathematical Aspects of Seismology, Elsevier Publishing Company, 1968.
3. W.M. Ewing, W.S. Jardetzky and F. Press, Elastic Waves in Layered Media, McGraw Hill Book Company, 1957.
4. C.M.R. Fowler, The Solid Earth, Cambridge University Press, 1990
5. P.M. Shearer, Introduction to Seismology, Cambridge University Press, (UK) 1999.
6. Seth Stein and Michael Wysession, An Introduction to Seismology, Earthquakes and Earth Structure, Blackwell Publishing Ltd., 2003.
7. Bullen, K.E. and B.A. Bolt, An Introduction to the Theory of Seismology, Cambridge Universty Press, 1985.

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MTHCE–2406: Advanced Fluid Mechanics

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

Marks (Total): 100
Time: 03 Hours
Total Credit: 04

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short 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 one question from each unit including compulsory question.

Unit: 1

Vorticity in two dimensions, Circular and rectilinear vortices, Vortex doublet, Images, Motion due to vortices, Single and double infinite rows of vortices, Karman vortex sheet.
Newton's Law of viscosity, Newtonian and non-Newtonian fluids, Stress components in a real fluid, State of stress at a point, Nature of stresses, transformation of stress components, Relation between Cartesian components of stress.

Unit: 2

Translational motion of fluid element, Rates of strain. Transformation of rates of strain, Principal stress & strain rate, Relation between stresses and rates of strain. The co-efficient of viscosity and laminar flow.
Navier-Stoke equations of motion. Equations of motion in cylindrical and spherical polar co-ordinates. Diffusion of vorticity. Energy dissipation due to viscosity.

Unit: 3

Plane Poiseuille and Couette flows between two parallel plates. Theory of lubrication. Hagen Poiseuille flow. Steady flow between co-axial circular cylinders and concentric rotating cylinders. Flow through tubes of uniform elliptic and equilateral triangular cross-section. Unsteady flow over a flat plate. Steady flow past a fixed sphere. Flow in convergent and divergent channels.

Unit: 4

Dynamical similarity, Inspection analysis, Non-dimensional numbers, Dimensional analysis. Buckingham pi-theorem and its application, Physical importance of non-dimensional parameters.
Prandtl boundary layer, Boundary layer equation in two-dimensions, The boundary layer on a flat plate (Blasius solution), Characteristic boundary layer parameters, Karman integral conditions, Karman-Pohlhausen method.

Books Recommended:

1. W.H. Besant and A.S. Ramsey, A Treatise on Hydromechanics, Part-II, CBS Publishers, Delhi, 1988.
2. F. Chorlton, Text-book of Fluid Dynamics, C.B.S. Publishers, Delhi, 1985.
3. Michael E.O. Neill and F. Chorlton, Ideal and Incompressible Fluid Dynamics, John Wiley & Sons, 1986.
4. S. W. Yuan, Foundations of Fluid Mechanics, Prentice Hall of India Ltd., New Delhi, 1976.
5. G.K. Batchelor, An Introduciton to Fluid Mechanics, Foundation Books, New Delhi, 1994.
6. H. Schlichting, Boundary Layer Theory, McGraw Hill Book Company, New York, 1979.
7. R.K. Rathy. An Introduction to Fluid Dynamics, Oxford and IBH Publishing Company, New Delhi. 1976.
8. A.D. Young, Boundary Layers, AIAA Education Series, Washington DC, 1989.