PANJAB UNIVERSITY, CHANDIGARH-160014 (INDIA)
(Estd. under the Panjab University Act VII of 1947—enacted by the Govt. of India)

FACULTY OF SCIENCE

SYLLABi

FOR

M.Sc. MATHEMATICS
PARTS I & II EXAMINATIONS, 2011

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APPLICABILITY OF REGULATIONS FOR THE TIME BEING IN FORCE

Notwithstanding the integrated nature of a course spread over more than one academic year, the regulations in force at the time a student joins a course shall hold good only for the examinations held during or at the end of the academic year. Nothing in these regulations shall be deemed to debar the University from amending the regulations subsequently and the amended regulations, if any, shall apply to all students whether old or new.
GUIDELINES FOR CONTINUOUS INTERNAL ASSESSMENT (20%) FOR REGULAR
STUDENTS OF POST-GRADUATE COURSES of Mathematics (Annual System)
(Effective from the First Year Admissions for the Academic Session 2004-2005)

1. Mode of testing and evaluation for Continuous Internal Assessment:

(i) Terminal Evaluation : 80 %
(ii) Continuous Assessment : 20 %
(iii) Continuous Assessment may include written assignment, snap tests, participation in
discussions in the class, term papers, attendance etc.
(iv) In order to incorporate an element of Continuous Internal Assessment of students, the
Colleges/Departments will conduct one written test as quantified below:
   (a) Three mid-term examinations of 40 marks each, with two best results : 80 marks
   (b) Two snap tests of 5 marks each : 10 marks
   (c) Attendance : 10 marks

Total : 100 marks reduced to 20

2. Weightage of 2 marks for attendance component out of 20 marks for Continuous Assessment shall be
available only to those students who attend 75% and more of classroom lectures/seminars/
workshops. The break–up of marks for attendance component for theory papers shall be as under:

<table>
<thead>
<tr>
<th>Attendance Component</th>
<th>Mark/s for Theory Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) 75 % and above upto 85 %</td>
<td>: 1</td>
</tr>
<tr>
<td>(b) Above 85 %</td>
<td>: 2</td>
</tr>
</tbody>
</table>

3. It shall **not be compulsory** to pass in Continuous Internal Assessment. Thus, whatever marks are
secured by a student out of 20% marks, will be carried forward and added to his/her score out of
80 % i.e. the remaining marks allocated to the particular subject and, thus, he/she shall have to secure
pass marks both in the University examinations as well as total of Internal Continuous Assessment
and University examinations.

4. Continuous Internal Assessment awards from the affiliated Colleges/Departments must be sent to the
Controller of Examinations, by name, **two weeks before** the commencement of the particular
examination on the praforma obtainable from the Examination Branch.

SPECIAL NOTES:

(i) Each theory question paper will be set out of marks allotted to each theory paper and 20 % marks
of the maximum marks of each theory paper will be internal assessment.

(ii) For private candidates, who have not been assessed earlier for internal assessment, the marks
secured by them in theory paper will proportionately be increased to maximum marks of the paper
in lieu of internal assessment.

(iii) In the case of Postgraduate Courses in the Faculties (Arts, Science, Languages, Education, Design
& Fine Arts, and Business Management & Commerce) falling under the purview of Academic
Council) where such a provision of Internal Assessment/Continuous Assessment already exists, the
same will continue as before.

(iv) The marks obtained by a candidate in Continuous Internal Assessment in Postgraduate Classes
from the admissions of 2004 will be shown separately in the Detail Marks Card (D.M.C.).
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(ANNUAL SYSTEM)

A candidate has to take following 5 courses:

Math 601 : Real Analysis
Math 602 : Algebra
Math 603 : Differential Equations and Mechanics
Math 604 : Complex Analysis
Math 605 : Number Theory

MATH 601 : REAL ANALYSIS

Total marks : 100
Theory : 80 Marks
Internal Assessment : 20 Marks
Time : 3 Hours

Note : 1. The question paper will consist of 9 questions. All questions carry equal marks.
2. Three questions will be set from each Unit i.e. Unit I, II & III.
3. The students will attempt at least one question from each Unit and 5 questions in total.

UNIT-I


(iv) Differentiation : Differentiation of vector-valued functions.
UNIT-II


(vii) *Functions of Several Variables*: The space of linear transformations on $\mathbb{R}^n$ to $\mathbb{R}^m$ as a metric space. Differentiation of a vector-valued function of several variables. The Inverse function theorem. The implicit function theorem.

UNIT-III


(x)  *Differentiation and Integration*: Differentiation of monotone functions. Differentiation of an integral. Absolute continuity.

Scope:

(i) For items (i) to (vii) as in relevant sections of Chapters 2 to 7 and Chapter 9 of the Book at Sr. No. 7 in the list of references.

(ii) For items (viii) to (x) as in relevant sections of Chapters 3 to 5 of the book at Sr. No. 6 of references.

References:


**MATH 602 : ALGEBRA**

Total marks : 100
Theory : 80 Marks
Internal Assessment : 20 Marks
Time : 3 Hours

**Note:**
1. The question paper will consist of 9 questions. All questions carry equal marks.
2. Three questions will be set from each Unit i.e. Unit-I, II & III.
3. The students will attempt at least one question from each Unit and 5 questions in total.

**UNIT-I : GROUP THEORY**

Review of basic concepts of groups with emphasis on exercises. Symmetries of a square, Symmetry Groups, Symmetry group of a figure in \( \mathbb{R}^n \). Classification of finite group of rotations of \( \mathbb{R}^3 \). Permutation groups, Even and Odd permutations, Conjugacy classes of permutations, Alternating groups, Cayley’s Theorem. Direct products, Fundamental Theorem for finite abelian groups. Finite Simple groups.

[Scope as in Chapters 1-11 and 24, 25 & 27 of Contemporary Abstract Algebra by J.A. Gallian]

Simplicity of \( A_n \), \( n \geq 4 \). Solvable groups, Normal and Subnormal series, composition series, Survey of some finite groups, Groups of order \( p^2 \), \( pq \) (\( P \) and \( q \) primes).

[Scope as in Chapters 2 (Section 3), 5 & 6 of Modern Algebra by Surjeet Singh and Qazi Zameerudin, Eighth Edition, 2006].

**UNIT-II : RING THEORY**

Review of basic concepts of rings with emphasis on exercises. Examples of rings including polynomial rings, formal power series rings, matrix rings. Factorization Theory in Integral Domains, Divisibility, Unique Factorization Domain (UFD), Principal Ideal Domain (PID), Euclidien Domain (ED) and their relationships. The ring of Guassian Integers, LCM and GCD of elements in Commutative Rings, Primitive Polynomials, Unique Factorization in \( \mathbb{R}[x] \).

Noetherian and Artinian Rings, Examples and Counter-Examples, Artinian Rings without zero-divisors, Nil Ideals in Artinian Rings, Hilbert Basis Theorem.
UNIT-III : VECTOR SPACES AND MODULES

Modules, Difference between Modules and Vector Spaces, Module Homomorphisms, Quotient Module, Completely reducible or Semisimple Modules, Free Modules, Representation and Rank of Linear mappings, Smith Normal Form over a PID, Finitely generated modules over a PID, Rational Canonical Form, Applications to finitely generated abelian groups.

References:


MATH 603 : DIFFERENTIAL EQUATIONS AND MECHANICS

Total marks : 100
Theory : 80 Marks
Internal Assessment : 20 Marks
Time : 3 Hours

Note: 1. The question paper will consist of 9 questions. All questions carry equal marks.
2. Syllabus is divided into three Units. 4 questions from Unit-I, 2 questions from Unit-II and 3 questions from Unit-III will be set.
3. The students will attempt 5 questions selecting at least 1 from each Unit.

M. Sc. (PASS COURSE) IN MATHEMATICS PART-I SYLLABUS

UNIT-I

Differential Equations :

Existence and uniqueness of solution of first order equations. Boundary value problems and Strum-Liouville theory. ODE in more than 2 variables.


UNIT-II

Vectors :


UNIT-III

Mechanics :


References :

7. Schaum Series : Vector Analysis.
MATH 604: COMPLEX ANALYSIS

Total marks : 100
Theory : 80 Marks
Internal Assessment : 20 Marks
Time : 3 Hours

Note : 1. The question paper will consist of 9 questions. All questions carry equal marks.
2. Three questions will be set from each Unit.
3. The students will attempt at least one question from each Unit and 5 questions in total.

UNIT-I

Complex plane, geometric representation of complex numbers, joint equation of circle and straight line, stereographic projection and the spherical representation of the extended complex plane. Topology on the complex plane, connected and simply connected sets. Complex valued functions and their continuity. Curves, connectivity through polygonal lines. Analytic functions, Cauchy-Riemann equations, Harmonic functions and Harmonic conjugates. Power series, exponential and trigonometric functions, arg z, log z, a^z and their continuous branches.

[Scope as in “Theory of Functions of a Complex Variable” by Shanti Narain, Chapter 1, 2, §39-44 and §47-50, 53, 54 of Chapter 4, §59-64 of Chapter 5, §79-88 of Chapter 6].

Complex Integration, Line integral, Cauchy’s theorem for a rectangle, Cauchy’s theorem in a disc, index of a point with respect to a closed curve, Cauchy’s integral formula, Higher derivatives, Morrera’s theorem, Liouville’s theorem, Fundamental theorem of Algebra, Maximum Modules principle, Schwarz Lemma.

[Scope as in “Complex Analysis” by D. V. Ahlfors, Chapter 4, §1, 2 and the book “Theory of Functions Complex Variable” by Shanti Narain, §117-118 of Chapter 9].

UNIT-II


[Scope as in “Complex Analysis” by D. V. Ahlfors, §4.1 to 4.5 and §5.1 of Chapter 4 and in “Theory of Functions Complex Variable” by Shanti Narain, §111-113 of Chapter 9, §120-126 of Chapter 10, §130-136 of Chapter 11, §65-67 of Chapter 5 and Chapter 7].

UNIT-III

Zeros and poles of meromorphic functions, Rouche’s theorem, Argument Principle. Infinite products, Weierstrass theorem, Mittaglefffer’s theorem, Canonical product, Analytic Continuation through power series (basic ideas), Natural boundary, the Gamma function and Riemann Zeta function.
References:


MATH 605 : NUMBER THEORY

Total marks : 100
Theory : 80 Marks
Internal Assessment : 20 Marks
Time : 3 Hours

Note : 1. The question paper will consist of 9 questions. All questions carry equal marks.
2. Three questions will be set from each unit.
3. The students will attempt at least one question from each Unit and 5 questions in total.

UNIT-I
Divisibility, Greatest common divisor, Euclidean Algorithm, The Fundamental Theorem of arithmetic, congruences, Special divisibility tests, Chinese remainder theorem, Fermat’s little theorem, Wilson’s theorem, residue classes and reduced residue classes, Euler’s theorem, An Application to cryptography, Arithmetic functions \( \phi(n) \), \( d(n) \), \( \sigma(n) \), \( \mu(n) \), Mobius inversion Formula, the greatest integer function, perfect numbers, Mersenne primes and Fermat numbers, primitive roots and indices.

[Scope as in Chapters 2-8, 10 of ‘Elementary Number Theory’, 2nd Edition, by David M. Burton.]

UNIT-II
Quadratic residues, Legendre symbol, Quadratic reciprocity law, Jacobi symbol, Binary quadratic forms and their reduction, sums of two and four squares, positive definite binary quadratic forms, Diophantine equations \( ax + by = c \), \( x^2+y^2=z^2 \), \( x^4+y^4=z^2 \). Farey sequences, Continued fractions, Approximation of reals by rationals, Pell’s equations, Minkowski’s theorem in Geometry of Numbers and its applications.


UNIT-III

[Scope as in Chapters 3 & 4 of ‘Introduction to Analytic Number Theory’ by T. M. Apostol].

References:
5. Hardy & Wright : Number Theory (Oxford Univ. Press).
OUTLINES OF TESTS, SYLLABI AND COURSES OF READING FOR M.Sc. (PASS COURSE) IN MATHEMATICS PART II EXAMINATION, 2011

Outlines of Tests

Note: 1. Course No. MATH-617 and MATH-618 are compulsory.
      2. Out of remaining courses, a student can opt any three from the following:

List of Courses:

<table>
<thead>
<tr>
<th>Math Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 617</td>
<td>Field Theory and Linear Algebra (Compulsory Course)</td>
</tr>
<tr>
<td>Math 618</td>
<td>Topology and Functional Analysis (Compulsory Course)</td>
</tr>
<tr>
<td>Math 661</td>
<td>Probability and Mathematical Statistics</td>
</tr>
<tr>
<td>Math 672</td>
<td>Computational Techniques</td>
</tr>
<tr>
<td>Math 673</td>
<td>Tensors and Differential Geometry</td>
</tr>
<tr>
<td>Math 674</td>
<td>Tensors, Elasticity and Elastic Waves</td>
</tr>
<tr>
<td>Math 675</td>
<td>Special Functions and Integral Transform</td>
</tr>
<tr>
<td>Math 676</td>
<td>Fluid Mechanics</td>
</tr>
<tr>
<td>Math 678</td>
<td>Linear and Non-Linear Programming</td>
</tr>
<tr>
<td>Math 680</td>
<td>Geometry of Numbers</td>
</tr>
</tbody>
</table>

MATH 617: FIELD THEORY AND LINEAR ALGEBRA (Compulsory Course)

Total marks: 100
Theory: 80 Marks
Internal Assessment: 20 Marks
Time: 3 Hours

Note: 1. Nine questions will be set in total - four from Unit I and five from Unit II. All questions carry equal marks.
      2. The students will be required to attempt 5 questions, selecting at least two from each unit.

UNIT-I

UNIT-II

Definition and examples of vector spaces (over arbitrary fields), subspaces, direct sum of subspaces, linear dependence and independence, basis and dimensions, linear transformations, quotient spaces, algebra of linear transformations, linear functions, dual spaces, matrix representation of a linear transformation, rank and nullity of a linear transformation, invariant subspaces.

Characteristic and minimal polynomials and eigenvalues and eigenvectors of a linear transformation, diagonalization and triangularization of a matrix, Jordan and Rational canonical forms, bilinear forms, symmetric bilinear forms, Sylvester’s theorem, quadratic forms, Hermitian forms, Inner product spaces, Gram-Schmidt orthonormalization process.

References:

2. S. Singh and Q. Zameeruddin: Modern Algebra (Delhi, Vikas).
3. I. N. Herstein: Topics in Algebra (Delhi, Vikas).
4. V. Bist and V. Sahai: Linear Algebra (Narosa, Delhi).
5. Stewart: Galois Theory, Chapman & Hall.
7. Steven Roman: Field Theory, Springer Verlag.

MATH 618: TOPOLOGY AND FUNCTIONAL ANALYSIS (Compulsory Course)

Total marks: 100
Theory: 80 Marks
Internal Assessment: 20 Marks
Time: 3 Hours

Note: 1. Nine questions will be set in total – five from Unit I and four from Unit II. All questions carry equal marks.
2. Each student will attempt 5 questions, selecting at least two from each Unit.

UNIT–I

Topology:

Topological Spaces, bases for a topology, the order topology, the product topology on $X \times Y$, the subspace topology, closed sets and limit points continuous functions, the product topology, the metric topology, the quotient topology.


Connected spaces, connected subspaces of the real line, components and local connectedness, compact spaces, compact spaces of the real line, limit point compactness, local compactness, nets.

The countability axioms, the separation axioms, normal spaces, the Urysohn Lemmas, the Urysohn Metrization Theorem, the Tietze Extension Theorem, the Tychonoff Theorem.


M. Sc. (PASS COURSE) IN MATHEMATICS PART-II SYLLABUS

UNIT–II

Banach Spaces with examples of $L^p([a,b])$ and $C([a,b])$, Hahn Banach theorem, open mapping theorem, closed graph theorem, Baire Category theorem, Banach Steinhaus theorem (uniform boundedness principle), Boundedness and continuity of linear transformation, Dual Spaces, embedding in second dual.


Hilbert space, orthonormal basis, Bessel’s inequality, Riesz Fischer theorem, Parseval’s identity, bounded Linear functionals; projections, Riesz Representation theorem, adjoint operators, self adjoint, normal, unitary and isometric operators.


References :

6. Thron, W.J : Topological Structures, N.Y. Holt (Scope as in Chapters IV to XV, Chapter XVI : def. 16.4 and results including Tychonoff’s Theorem and Chapter XVIII of the reference 4).

MATH 661 : PROBABILITY AND MATHEMATICAL STATISTICS

Total marks : 100
Theory : 80 Marks
Internal Assessment : 20 Marks
Time : 3 Hours
UNIT–I

Chebyshev’s inequality, weak law of large numbers, De-Moivre—Laplace and Lindeberg—Levy Central Limit theorems.


[Scope as in :

1. Chapters 1, 2 (Sections 2.1 to 2.4), 3, 4 (excluding Sections 4.6, 4.10) and 5 (Sections 5.2 and 5.4 only) of the book ‘Introduction to Mathematical Statistics’ by R.V. Hogg and A.T. Craig (MacMillan, 2002).
2. Chapters 1-6, 8 (Sections 8.9, 8.13, 8.20 only), 9, 10 (excluding 10.9, 10.11, 10.12) of the book ‘Fundamental of Statistics’ by A.M. Goon and Others, Vol. I, 7th Edition (1998).

UNIT–II

Testing of Hypotheses, uniformly most powerful tests, likelihood ratio tests. t, Chi-square and F-distribution. Tests of significance based on t, Chi-square and F. Analysis of variance.

[Scope as in Chapters 6, 7 (excluding Sections 7.7, 7.8, 7.9), 8 (Section 8.2 only), 9 (excluding Sections 9.4, 9.5), 10 (Sections 10.2 and 10.5 only) of the book ‘Introduction to Mathematical Statistics’ by R.V. Hogg and A.T. Craig (Macmillan, 2002).

References :

UNIT-I
UNIT-II


MATH 672 : COMPUTATIONAL TECHNIQUES

Total Marks : 100

Computational Techniques (Theory)

Theory : 60 Marks
(4 Hours per week)
Internal Assessment : 15 Marks

Note :
1. Nine questions will be set in total – four from Unit I and five from Unit II.
2. The students will be required to attempt 5 questions, selecting at least two from each unit.
3. Use of calculator is allowed for numerical work.

UNIT–I


Programming in FORTRAN 77 : Character set, constants, variables, Arithmetic expressions, Format specification, READ, WRITE statements, unformatted I/O Statements, GOTO, IF, IF-THEN-ELSE, DO loops, CONTINUE Statement, Data statement, Arrays and subscripted variables, Function Subprogram and Subroutine, Simple programs.

Programming in C : Historical development of C, Character set, Constants, Variables, Hierarchy of Operations, if and if-else statements, Logical and Conditional Operators, while, do-while and for Loops, Break and Continue statements, Functions, Recursion and Introduction to pointers, Simple programs.

UNIT–II

Solution of Non-Linear Equations : Functional iteration, Bisection, Secant, Regula-Falsi, Newton-Raphson and Bairstow’s methods, Rate of convergence of these methods, Solution of linear system of equations : Gauss elimination, Gauss Seidal and Triangularization methods, Condition of convergence of these methods.


Computational Techniques (Practical)

Total marks : 25
Practical : 20 Marks
(3 Hours per week)
Internal Assessment : 05 Marks

Writing programs in FORTRAN and C for the problems based on the methods studied in theory paper and to run the program on PC.

Practical examination shall be conducted by the department/college concerned as per the following distribution of marks:

Writing one program of FORTRAN or C and running it on PC = 10 marks
Practical Record = 05 marks
Viva-Voce = 05 marks
Internal Assessment = 05 marks

References:

4. C. Xavier : FORTRAN 77 and Numerical Methods, New Age Int. Ltd.
5. C. Xavier : C Language and Numerical Methods, New Age Int. Ltd.

MATH 673: TENSORS AND DIFFERENTIAL GEOMETRY

Total marks : 100
Theory : 80 Marks
Internal Assessment : 20 Marks
Time : 3 Hours

Note:
1. Nine questions will be set in total - five from Unit I and four from Unit II. All questions carry equal marks.
2. The students will be required to attempt 5 questions, selecting at least two from each unit.

UNIT-I

Tensors: Notations and Summation Convention, Transformation Law for vectors, Cartesian tensors, Algebra of Cartesian tensors, Differentiation of Cartesian tensors, The metric tensor, Transformation of
curvilinear co-ordinates, General tensors, Contravariant, Covariant derivative of a vector, Physical components, Christoffel symbol, Relation with the metric tensor, Covariant derivative of a tensor, Riemann –Christoffel curvature tensor.

M. Sc. (PASS COURSE) IN MATHEMATICS PART-II SYLLABUS

Curve with Torsion : Tangent, Principal normal, Curvature, Binomial, Torsion, Serret-Frenet formulae, Locus of Center of curvature, Circle of curvature, torsion of a curve, Involutes, Evolutes and Bertrand curves.

Envelopes and Developable Surfaces : Surfaces, Tangent plane, normal, Envelop, Edge of regression, Developable surfaces, Curvilinear co-ordinates on a surface : Fundamental Magnitude.

UNIT-II

Curve on a Surface : Principal directions and curvature, First and second curvature, Euler’s theorem, Normal curvature, Mean curvature, Umblic points, Conjugate directions and asymptotic lines, Principal directions and principal curvature, Line of curvature and evolute of a surface.


References :

MATH 674 : TENSORS, ELASTICITY AND ELASTIC WAVES

Total marks : 100
Theory : 80 Marks
Internal Assessment : 20 Marks
Time : 3 Hours

Note : 1. Nine questions will be set in total - five from Unit I and four from Unit II. All questions carry equal marks.
2. The students will be required to attempt 5 questions, selecting at least two from each unit.

UNIT-I

Tensors : Summation convention, Coordinate transformation, Cartesian tensors of different orders, Sum, product and quotient laws, Contraction, Symmetric and skew symmetric tensors, Relation between
alternate and Kronecker tensors, Eigen values and Eigen vectors of a tensor of order two, Three scalar invariants of a tensor of order two, Eigen vectors and values of symmetric tensors, Orthogonality of Eigen vectors and reality of Eigen values, Gradient, Divergence and Curl in tensor notations, Gauss divergence theorem.

**Analysis of Strain** : Affine transformation, infinitesimal affine transformation, Geometrical interpretation of component of strain, Strain quadric of Cauchy, Principal Strains and Invariants, General infinitesimal deformation, Example of Strain, Equations of Compatibility, Finite deformations.

**Analysis of Stress** : Stress tensor, Equation of equilibrium, Stress quadric of Cauchy, Principal stress and invariants, Maximum normal and shear stress, Plane Stress, Generalized plane stress, Airy stress function, General solution of biharmonic equation, Stresses and displacements in terms of complex potentials, Simple problems.

**UNIT-II**

**Equations of Elasticity** : Generalized Hook’s Law, Homogeneous isotropic media, Equilibrium and dynamical equations for isotropic media, Strain energy function, Uniqueness of solution, Beltrami-Michell Compatibility equations, Saint Venant’s Principal.

**Elastic Waves** : Wave propagation in isotropic elastic solid medium, Waves of dilation and distortion, Rayleigh waves, Love waves, Reflection of P, SV and SH-waves from free surface of a half-space.

**References**:


**MATH 675 : SPECIAL FUNCTIONS AND INTEGRAL TRANSFORM**

<table>
<thead>
<tr>
<th>Total marks</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory</td>
<td>80 Marks</td>
</tr>
<tr>
<td>Internal Assessment</td>
<td>20 Marks</td>
</tr>
<tr>
<td>Time</td>
<td>3 Hours</td>
</tr>
</tbody>
</table>

**Note** : 1. Nine questions will be set in total - five from Unit I and four from Unit II. All questions
carry equal marks.
2. The students will be required to attempt 5 questions, selecting at least two from each unit.

UNIT-I

Bessel Functions : Bessel equation and its solution in series, Bessel function, Generating function, Recurrence relations, Integral representation of \( J_n(x) \), Addition formulae for \( J_n(x) \), Orthogonality of Bessel functions, Expression of a function in a series of Bessel Functions, Behaviour of \( J_n(x) \) for large values of \( x \).

Legendre Functions : Legendre equation, Legendre polynomials and Legendre functions, Rodrigue’s formula, Generating functions, Recurrence relations, Orthogonality of Legendre Polynomials, Definite integral representation of \( P_n(x) \), Expansion of a function in a series of Legendre polynomials, Behaviour of \( P_n(x) \) for large values of \( x \).

Dirac Delta Functions : Definition of delta function and its properties, Derivative of delta function, Heaviside unit step function and its relation with delta function.

UNIT-II


References:

2. Sen, B. : Treaties on Special Functions for Scientist and Engineers.

MATH 676 : FLUID MECHANICS

Total marks : 100
Theory : 80 Marks
Internal Assessment : 20 Marks
Time : 3 Hours

Note : 1. Nine questions will be set in total – five from Unit I and four from Unit II. All questions carry equal marks.
2. The students will be required to attempt 5 questions, selecting at least two from each Unit.

UNIT–I
Real fluids and ideal fluids, velocity of fluid at a point, streamlines, pathlines, streaklines, velocity potential, vorticity vector, local and particle rate of change, equation of continuity, irrotational and rotational motion, acceleration of fluid, conditions at rigid boundary.

Euler’s equation of motion, Bernoulli’s equation, Potential theorems, axially symmetric flows, impulsive motion, Kelvin’s Theorem of circulation, equation of vorticity.

Some three dimensional flows, sources, sinks and doublets, images in rigid planes, images in solid sphere. Stoke’s stream function.

Two Dimensional Flows : Complex velocity potential, Milne Thomson Circle Theorem, Theorem of Blasius, Vortex rows, Karman vortex street.

[Scope of Unit I is as given in the relevant chapters of the book ‘Text Book of Fluid Dynamics’ by Chorlton, F., 1st Edition].

UNIT–II
Viscous Flows : Stress components, Stress and strain terror, Coefficient of viscosity and Laminar flow, Plane Poiseuille flows and Couette flow. Flow through tubes of uniform cross section in the form of circle, Ellipse, equilateral triangle, annulus, under constant pressure gradient.

Diffusion of Vorticity. Energy dissipation due to viscosity, steady flow past a fixed sphere, dimensional analysis, Reynold numbers, Prandtl’s boundary layer. Boundary layer equation in two dimensions, Karman integral equation.

[Scope as given in the relevant Chapters of the book ‘Text Book of Fluid Dynamics’ by Chorlton, F., 1st Edition].

Elements of wave motion; waves in fluids : Surface gravity waves, group velocity, energy of propagations, path of particles, waves at interface of two liquids.


References :

MATH 678 : LINEAR AND NON-LINEAR PROGRAMMING

Total marks : 100
Theory : 80 Marks
Internal Assessment : 20 Marks
Time : 3 Hours

Note:
1. Nine questions will be set in total – five from Unit I and four from Unit II. All questions carry equal marks.
2. The students will be required to attempt 5 questions, selecting at least two from each unit.

UNIT–I


Parametric programming, Revised Simplex method, Transportation Problems, U-V method, assignment problems, Integer Programming, Gomary’s algorithm, Branch & Bound Technique.

[Scope as in Chapters 2 to 5; Chapter 7 (Sections 7-1 to 7-7), Chapter 8 (Sections 8-1 to 8-7, Sections 8-9, 8-10), Chapter 9 (Sections 9-1 to 9-6, Sections 9-10 to 9-12) of the book ‘Linear Programming’ by G. Hadley, Narosa Publishing House, 6th edition, 1995, Chapters 6, 7, 9 (Sections 9.3 & 9.4), Chapter 11 of the book ‘Operations Research’ by Kanti Swarup, P.K. Gupta & Man Mohan, Sultan Chand & Sons, New Delhi, 9th edition, 2001].

UNIT–II

Game Theory - Two-person, Zero-sum Games with mixed strategies, graphical solution, solution by Linear Programming.

[Scope as in Chapter 17 (Sections 17.1 to 17.9) of the book ‘Operations Research’ by Kanti Swarup, P.K. Gupta & Man Mohan, Sultan Chand & Sons, New Delhi, 9th edition, 2001].


References:

UNIT–I
Convex sets, Minkowski's Fundamental theorem and its applications and generalizations, Hermite's Theorem on minima of quadratic forms, statement of Minkowski's 2nd theorem, Mahler's compactness theorem, critical determinants, critical lattices, packings.

UNIT–II
Covering constants, Lattice and non-lattice covering for n-dimensional convex bodies, Minima of indefinite binary quadratic forms, homogeneous and non-homogeneous minima of indefinite quadratic forms.

References:
2. Lekkerkerker, C.C. and Gruber, P. : Geometry of Numbers.