MAHARSHI DAYANAND UNIVERSITY, ROHTAK
DEPARTMENT OF MATHEMATICS

Scheme of Examination-Semester System
for
M.Sc. Mathematics with Computer Science(Semester-III & IV)

(w.e.f. Session 2014-2015)

SEMESTER-III

Paper Code	Title of the Paper	Internal-Assessment Marks	Theory Marks	Practicals Marks	Total Marks
12MMCS-301	Functional Analysis-I	20	80	-	100
12MMCS-302	Partial Differential Equations and Mechanics	20	80	-	100
12MMCS-303	Complex Analysis-I	20	80	-	100
12MMCS-304	(i) Mathematical Statistics (ii) Advanced Discrete Mathematics-I	20	80	-	100
12MMCS-305	Object Oriented Programming with C++	20	80	-	100
12MMCS-306	Database Management System	20	80	-	100
12MMCS-307	Practicals	20	-	80	100
Total Marks Semester-III					700
Total Marks Semester-II					700
Total Marks Semester-I					700
GRAND TOTAL					2100

Note 1: The marks of internal assessment of each paper shall be split as under :

A) One class test of 10 marks. The class test will be held in the middle of the semester.

B)	Assignment & Presentation	:	5 marks
C)	Attendance	:	5 marks
	65% but upto 75%	:	1 marks
	More than 75% but upto 85%	:	2 marks
	More than 85% but upto 90%	:	3 marks
	More than 90% but upto 95%	:	4 marks
	Above 95%	:	5 marks

Note 2: The syllabus of each paper will be divided into **four** units of **two** questions each. The question paper will consist of **five** units. Each of the first four units will contain two questions and the students shall be asked to attempt **one** question from each unit. Unit five of each question paper shall contain **eight to ten** short answer type questions without any internal choice and it shall be covering the entire syllabus. As such unit five shall be **compulsory**.

Note 3: As per UGC recommendations, the teaching program shall be supplemented by tutorials and problem solving sessions for each theory paper. For this purpose, tutorial classes shall be held for each theory paper in groups of 8 students for half-hour per week.

Note 4: Optional papers can be offered subject to availability of requisite resources/ faculty.

Syllabus- 3rd SEMESTER

12MMCS 301 : Functional Analysis-I

Max. Marks : 80 **Time : 3 Hours**

Unit -I (2 Questions)

Normed linear spaces, Metric on normed linear spaces, Completion of a normed space, Banach spaces, subspace of a Banach space, Holder's and Minkowski's inequality, Completeness of quotient spaces of normed linear spaces. Completeness of l_p, L^p, R^n, C^n and C[a,b]. Incomplete normed spaces.

Unit -II (2 Questions)

Finite dimensional normed linear spaces and Subspaces, Bounded linear transformation, Equivalent formulation of continuity, Spaces of bounded linear transformations, Continuous linear functional, Conjugate spaces, Hahn-Banach extension theorem (Real and Complex form).

Unit -III (2 Questions)

Riesz Representation theorem for bounded linear functionals on L^p and C[a,b]. Second conjugate spaces, Reflexive space, Uniform boundedness principle and its consequences, Open mapping theorem and its application projections, Closed Graph theorem.

Unit -IV (2 Questions)

Equivalent norms, Weak and Strong convergence, their equivalence in finite dimensional spaces. Weak sequential compactness, Solvability of linear equations in Banach spaces.

Compact operator and its relation with continuous operator. Compactness of linear transformation on a finite dimensional space, properties of compact operators, compactness of the limit of the sequence of compact operators, the closed range theorem.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended

1. H.L. Royden, Real Analysis, MacMillan Publishing Co., Inc., New York, 4th Edition, 1993.
2. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley.
3. George F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1963.
4. A. H. Siddiqi, Khalil Ahmad and P. Manchanda, Introduction to Functional Analysis with Applications.

12MMCS 302 : Partial Differential Equations and Mechanics

Max. Marks : 80 **Time : 3 Hours**

Unit – I(2 Questions)

Method of separation of variables to solve B.V.P. associated with one dimensional heat equation. Solution of two dimensional heat equation and two dimensional Laplace equation. Steady state temperature in a rectangular plate, in the circular disc, in a semi-infinite plate. The head equation in semi-infinite and infinite regions. Temperature distribution in square plate and infinite cylinder. Solution of three dimensional Laplace equation in Cartesian, cylindrical and spherical coordinates. Dirichlets problem for a solid sphere. (Relevant topics from the books by O'Neil)

Unit -II(2 Questions)

Method of separation of variables to solve B.V.P. associated with motion of a vibrating string. Solution of wave equation for Semi-infinite and infinite

strings. Solution of wave equation in two dimensions. Solution of three dimensional wave equation in Cartesian, cylindrical and spherical coordinates. Laplace transform solution of P.V.P.. Fourier transform solution of B.V.P. (Relevant topics from the books by O'Neil)

Unit-III(2 Questions)

Kinematics of a rigid body rotating about a fixed point, Euler's theorem, general rigid body motion as a screw motion, moving coordinate system - rectilinear moving frame, rotating frame of reference, rotating earth. Two- dimensional rigid body dynamics – problems illustrating the laws of motion and impulsive motion. (Relevant topics from the book of Chorlton).

Unit -IV(2 Questions)

Moments and products of inertia, angular momentum of a rigid body, principal axes and principal moment of inertia of a rigid body, kinetic energy of a rigid body rotating about a fixed point, momental ellipsoid and equimomental systems, coplanar mass distributions, general motion of a rigid body. (Relevant topics from the book of Chorlton).

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended

1. Sneddon, I.N. — Elements of Partial Differential Equations, McGraw Hill, New York.
2. O'Neil, Peter V. — Advanced Engineering Mathematics, ITP.
3. F. Chorlton — Textbook of Dynamics, CBS Publishers, New Delhi.
4. H.F. Weinberger — A First Course in Partial Differential Equations, John Wiley & Sons, 1965.

5. M.D. Raisinghania Advanced Differential equations, S. Chand & Co.

12MMCS 303 : Complex Analysis-I

Max. Marks : 80 **Time : 3 hours**

Unit -I(2 Questions)

Function of a complex variable, continuity, differentiability. Analytic functions and their properties, Cauchy-Riemann equations in Cartesian and polar coordinates. Power series, Radius of convergence, Differentiability of sum function of a power series. Branches of many valued functions with special reference to arg z, log z and z^a.

Unit -II(2 Questions)

Path in a region, Contour, Simply and multiply connected regions, Complex integration. Cauchy theorem. Cauchy's integral formula. Poisson's integral formula. Higher order derivatives. Complex integral as a function of its upper limit, Morera's theorem. Cauchy's inequality. Liouville's theorem. The fundamental theorem of algebra. Taylor's theorem.

Unit -III(2 Questions)

Zeros of an analytic function, Laurent's series. Isolated singularities. Cassorati- Weierstrass theorem, Limit point of zeros and poles.

Maximum modulus principle, Minimum modulus principle. Schwarz lemma. Meromorphic functions. The argument principle. Rouche's theorem, Inverse function theorem.

Unit - IV(2 Questions)

Calculus of residues. Cauchy's residue theorem. Evaluation of integrals.

Bilinear transformations, their properties and classifications. Definitions and examples of Conformal mappings.

Space of analytic functions and their completeness, Hurwitz's theorem. Montel's theorem. Riemann mapping theorem.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended

1. H.A. Priestly, Introduction to Complex Analysis, Clarendon Press, Oxford, 1990.
2. J.B. Conway, Functions of one Complex variable, Springer-Verlag, International student-Edition, Narosa Publishing House, 1980.
3. Liang-shin Hann & Bernand Epstein, Classical Complex Analysis, Jones and Bartlett Publishers International, London, 1996.
4. E.T. Copson, An Introduction to the Theory of Functions of a Complex Variable, Oxford University Press, London.
5. E.C. Titchmarsh, The Theory of Functions, Oxford University Press, London.
6. L.V. Ahlfors, Complex Analysis, McGraw Hill, 1979.
7. S. Lang, Complex Analysis, Addison Wesley, 1977.
8. Mark J. Ablowitz and A.S. Fokas, Complex Variables : Introduction and Applications, Cambridge University Press, South Asian Edition, 1998.
8. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, 1997.
9. Ruel V. Churchill and James Ward Brown, Complex Variables and Applications, McGraw-Hill Publishing Company.

12MMCS 304 (Option (i)) : Mathematical Statistics

Max. Marks : 80 **Time :3 Hours**

Unit - I (2 Questions)

Probability: Definition of probability-classical, relative frequency, statistical and axiomatic approach, Addition theorem, Boole's inequality, Conditional probability and multiplication theorem, Independent events, Mutual and pairwise independence of events, Bayes' theorem and its applications.

Unit - II (2 Questions)

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- Definition and their properties. Chebychev's inequality.

Unit - III (2 Questions)

Discrete distributions: Uniform, Bernoulli, binomial, Poisson and geometric distributions with their properties.

Continuous distributions: Uniform, Exponential and Normal distributions with their properties.Central Limit Theorem (Statement only).

Unit - IV (2 Questions)

Statistical estimation: Parameter and statistic, sampling distribution and standard error of estimate. Point and interval estimation, Unbiasedness, Efficiency.

Testing of Hypothesis: 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;

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books recommended :

1. Mood, A.M., Graybill, F.A. and Boes, D.C., Mc Graw Hill Book Company.
2. Freund,J.E., Mathematical Statistics, Prentice Hall of India.
3. Gupta S.C. and Kapoor V.K., Fundamentals of Mathematical Statistics, S. Chand Pub., New Delhi.
4. Speigel, M., Probability and Statistics, Schaum Outline Series.

12MMCS 304 (Option (ii)) : Advanced Discrete Mathematics –I

Max. Marks : 80 **Time :3 Hours**

Unit - I(2 Questions)

Graph Theory – Definitions and basic concepts, special graphs, Sub graphs, isomorphism of graphs, Walks, Paths and Circuits, Eulerian Paths and Circuits, Hamiltonian Circuits, matrix representation of graphs, Planar graphs, Colouring of Graph.

Unit -II (2 Questions)

Directed Graphs, Trees, Isomorphism of Trees, Representation of Algebraic Expressions by Binary Trees, Spanning Tree of a Graph, Shortest Path Problem, Minimal spanning Trees, Cut Sets, Tree Searching..

Unit -III (2 Questions)

Introductory Computability Theory - Finite state machines and their transition table diagrams, equivalence of finite state machines, reduced machines, homomorphism, finite automata acceptors, non-deterministic finite automata and equivalence of its power to that of deterministic finite automata Moore and Mealy machines.

Unit -IV (2 Questions)

Grammars and Languages – Phrase-structure grammar rewriting rules, derivations, sentential forms, Language generated by a grammar, regular, context-free and context sensitive grammars and languages, regular sets, regular expressions and pumping lemma, Kleene's theorem.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions

without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended

1. J.P. Tremblay & R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, McGraw-Hill Book Co., 1997.
2. J.L. Gersting, Mathematical Structures for Computer Science, (3rd edition), Computer Science Press, New York.
3. Seymour Lipschutz, Finite Mathematics (International edition 1983), McGraw-Hill Book Company, New York.
4. C.L. Liu, Elements of Discrete Mathematics, McGraw-Hilll Book Co.
5. Babu Ram, Discrete Mathematics, Vinayak Publishers and Distributors, Delhi, 2004.

12MMCS 305 : Object Oriented Programming with C++

Max. Marks : 80 **Time :3 Hours**

Section I (2 Questions)

Basic concepts of Object-Oriented Programming (OOP). Advantages and applications of OOP. Object-oriented languages. Introduction to C++. Structure of a C++ program. Creating the source files. Compiling and linking.

C++ programming basics: Input/Output, Data types, Operators, Expressions, Control structures, Library functions.

Section II (2 Questions)

Functions in C++ : Passing arguments to and returning values from functions, Inline functions, Default arguments, Function overloading.

Classes and objects : Specifying and using class and object, Arrays within a class, Arrays of objects, Object as a function arguments, Friendly functions, Pointers to members.

Section III (2 Questions)

Constructors and destructors. Operator overloading and type conversions.

Inheritance : Derived class and their constructs, Overriding member functions, class hierarchies, Public and private inheritance levels.

Polymorphism, Pointers to objects, this pointer, Pointers to derived classes, virtual functions.

Section IV (2 Questions)

Streams, stream classes, Unformatted Input/Output operations, Formatted console Input/Output operations, Managing output with manipulators.

Classes for file stream operations, Opening and Closing a file. File pointers and their manipulations, Random access. Error handling during file operations, Command-line arguments. Exceptional handling.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended :

1. I.S. Robert Lafore, Waite's Group Object Oriented Programming using C++, Galgotia Pub.
2. E. Balagrusamy, Object Oriented Programming with C++, 2nd Edition, Tata Mc Graw Hill Pub. Co.
3. Byron, S. Gottfried, Object Oriented Programming using C++, Schaum's Outline Series, Tata Mc Graw Hill Pub. Co.
4. J.N. Barakaki, Object Oriented Programming using C++, Prentic Hall of India, 1996.

12MMCS 306 : Database Management System

Max. Marks : 80 **Time :3 Hours**

Section I (2 Questions)

Terminologies of database, Drawbacks of conventional file systems, Data administrator (Role and functions), characteristics of databases. Data redundancy, data integrity, data independence. DBMS and its functions. Advantages and disadvantages of database.

Section II (2 Questions)

Three levels of the architecture: External level, conceptual level and internal level, Mappings and schemas, Client/Server architecture, Distributed processing.

Section III (2 Questions)

Data model, Relational data model, Hierarchical data model, Network data model. Relational model, Basic structure, terminology.

Section IV (2 Questions)

Normalization, First Normal Form, Second Normal Form, Third Normal Form, BCNF, Relational algebra and Relational Calculus, The SQL language.

Use of DBMS Package ORACLE/MS-ACCESS.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended

1. C.J. Date, Sixth Ed., An Introduction to Database System, Addison-Wesley Publishing Co.

2. Ullman, Jeffery D., Principles of Database System, Computer Science Press.
3. James Martin, Principles of Database Management System, Prentice Hall of India Pvt. Ltd.
4. Desai, Bipin C., Introduction to Data base Systems, Galgotia Publ.
5. Whittington, R.P., Data Base Systems Engineering, Clavendon Press.
6. Kroenke, D.M., Database Processing : Fundamental Design, Implementation, 2nd Edn. Galgotia Publ. Pvt. Ltd.
7. Wiederhold, Database Design, McGraw Hill Book Comp.

12MMCS 307 : Practicals

Max. Marks : 80
Time : 4 Hours

The practical will be based on the Papers 12MMCS-305 and 12MMCS-306

i) Viva-voce and practical record : 30 marks

ii) Written practical work : 50 marks

The examiner shall set a question paper consisting of 4 questions and the examinees will be required to attempt any two. They will write the programs in Answer-books and will run the same on computers and they will take printouts of programs and output.

SEMESTER-IV

Paper Code	Title of the Paper	Internal-Assessment Marks	Theory Marks	Practicals Marks	Total Marks
12MMCS-401	Functional Analysis-II	20	80	-	100
12MMCS-402	Classical Mechanics	20	80	-	100
12MMCS-403	Complex Analysis-II	20	80	-	100
12MMCS-404	(i) Operations Research (ii) Advanced Discrete Mathematics-II	20	80	-	100
12MMCS-405	Programming in Visual Basic	20	80	-	100
12MMCS-406	Software Engineering	20	80	-	100
12MMCS-407	Practicals	20	-	80	100
Total Marks Semester-IV					700
Total Marks Semester-III					700
Total Marks Semester-II					700
Total Marks Semester-I					700
GRAND TOTAL					2800

Note 1: The marks of internal assessment of each paper shall be split as under :

A) One class test of 10 marks. The class test will be held in the middle of the semester.

B) Assignment & Presentation : 5 marks

C) Attendance : 5 marks

65% but upto 75% : 1 marks

More than 75% but upto 85% : 2 marks

More than 85% but upto 90% : 3 marks

More than 90% but upto 95% : 4 marks

Above 95% : 5 marks

Note 2: The syllabus of each paper will be divided into **four** units of **two** questions each. The question paper will consist of **five** units. Each of the first four units will contain two questions and the students shall be asked to attempt **one** question from each unit. Unit five of each question paper shall contain **eight to ten** short answer type questions without any internal choice and it shall be covering the entire syllabus. As such unit five shall be **compulsory**.

Note 3: As per UGC recommendations, the teaching program shall be supplemented by tutorials and problem solving sessions for each theory paper. For this purpose, tutorial classes shall be held for each theory paper in groups of 8 students for half-hour per week.

Note 4: Optional papers can be offered subject to availability of requisite resources/ faculty.

Syllabus- 4th SEMESTER

12MMCS 401 : Functional Analysis –II

Max. Marks : 80 **Time : 3 Hours**

Unit-I (2 Questions)

Signed measure, Hahn decomposition theorem, Jordan decomposition theorem, Mutually signed measure, Radon – Nikodyn theorem Lebesgue decomposition, Lebesgue - Stieltjes integral, Product measures, Fubini's theorem.

Unit-II (2 Questions)

Baire sets, Baire measure, continuous functions with compact support, Regularity of measures on locally compact spaces, Riesz-Markoff theorem.

Hilbert Spaces: Inner product spaces, Hilbert spaces, Schwarz's inequality, Hilbert space as normed linear space.

Unit-III (2 Questions)

Convex sets in Hilbert spaces, Projection theorem. Orthonormal sets, Bessel's inequality, Parseval's identity, conjugate of a Hilbert space, Riesz representation theorem in Hilbert spaces.

Unit-IV (2 Questions)

Adjoint of an operator on a Hilbert space, Reflexivity of Hilbert space, Self-adjoint operators, Positive and projection operators, Normal and unitary operators, Projections on Hilbert space, Spectral theorem on finite dimensional space.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions

without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended

1. H.L. Royden, Real Analysis, MacMillan Publishing Co., Inc., New York, 4th Edition, 1993.
2. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley.
3. S.K. Berberian, Measure and Integration, Chelsea Publishing Company, New York, 1965.
4. G. Bachman and L. Narici, Functional Analysis, Academic Press, 1966.
5. George F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1963.

12MMCS 402 : Classical Mechanics

Max. Marks : 80 **Time : 3 hours**

Unit –I(2 Question)

Free & constrained systems, constraints and their classification, holonomic and non-holonomic systems, degree of freedom and generalized coordinates, virtual displacement and virtual work, statement of principle of virtual work (PVW), possible velocity and possible acceleration, D' Alembert's principle,

Lagrangian Formulation : Ideal constraints**,** general equation of dynamics for ideal constraints, Lagrange's equations of the first kind.

Unit –II(2 Question)

Independent coordinates and generalized forces, Lagrange's equations of the second kind, generalized velocities and accelerations. Uniqueness of solution, variation of total energy for conservative fields.

Lagrange's variable and Lagrangian function L(t, q_i, $\dot{q}_i$), Lagrange's equations for potential forces, generalized momenta p_i , Hamiltonian variable and Hamiltonian function H(t, q_i, p_i), Donkin's theorem, ignorable coordinates.

Unit -III(2 Question)

Hamilton canonical equations, Routh variables and Routh function R, Routh's equations, Poisson Brackets and their simple properties, Poisson's identity, Jacobi – Poisson theorem.

Hamilton action and Hamilton's principle, Poincare – Carton integral invariant, Whittaker's equations, Jacobi's equations, Lagrangian action and the principle of least action.

Unit -IV(2 Question)

Canonical transformation, necessary and sufficient condition for a canonical transformation, univalent Canonical transformation, free canonical transformation, Hamilton-Jacobi equation, Jacobi theorem, method of separation of variables in HJ equation, Lagrange brackets, necessary and sufficient conditions of canonical character of a transformation in terms of Lagrange brackets, Jacobian matrix of a canonical transformation, conditions of canonicity of a transformation in terms of Poison brackets, invariance of Poisson Brackets under canonical transformation.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended

1. F. Gantmacher — Lectures in Analytic Mechanics, MIR Publishers, Moscow, 1975.

2.	P.V. Panat	Classical Mechanics, Narosa Publishing House, New Delhi, 2005.
3.	N.C. Rana and P.S. Joag	Classical Mechanics, Tata McGraw-Hill, New Delhi, 1991.
4.	Louis N. Hand and Janet D. Finch	Analytical Mechanics, CUP, 1998.
5.	K. Sankra Rao	Classical Mechanics, Prentice Hall of India, 2005.
6.	M.R. Speigal	Theoretical Mechanics, Schaum Outline Series.

12MMCS 403 : Complex Analysis-II

Max. Marks : 80 **Time : 3 hours**

Unit - I(2 Question)

Integral Functions. Factorization of an integral function. Weierstrass' factorisation theorem. Factorization of sine function. Gamma function and its properties. Stirling formula. Integral version of gamma function. Riemann Zeta function. Riemann's functional equation. Runge's theorem. Mittag-Leffler's theorem.

Unit - II(2 Question)

Analytic Continuation. Natural Boundary. Uniqueness of direct analytic continuation. Uniqueness of analytic continuation along a curve. Power series method of analytic continuation. Schwarz Reflection principle. Germ of an analytic function.

Monodromy theorem and its consequences. Harmonic functions on a disk. Poisson kernel. The Dirichlet problem for a unit disc.

Unit - III(2 Question)

Harnack's inequality. Harnack's theorem. Dirichlet's region. Green's function. Canonical product. Jensen's formula. Poisson-Jensen formula.

Hadamard's three circles theorem. Growth and order of an entire function. An estimate of number of zeros. Exponent of Convergence. Borel's theorem. Hadamard's factorization theorem.

Unit -IV(2 Question)

The range of an analytic function. Bloch's theorem. Schottky's theorem. Little Picard theorem. Montel Caratheodory theorem. Great Picard theorem. Univalent functions. Bieberbach's conjecture(Statement only) and the "1/4 theorem" .

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended

1. H.A. Priestly, Introduction to Complex Analysis, Clarendon Press, Oxford, 1990.
2. J.B. Conway, Functions of one Complex variable, Springer-Verlag, International student-Edition, Narosa Publishing House, 1980.
3. Liang-shin Hann & Bernand Epstein, Classical Complex Analysis, Jones and Bartlett Publishers International, London, 1996.
4. E.T. Copson, An Introduction to the Theory of Functions of a Complex Variable, Oxford University Press, London.
5. E.C. Titchmarsh, The Theory of Functions, Oxford University Press, London.
6. L.V. Ahlfors, Complex Analysis, McGraw Hill, 1979.
7. S. Lang, Complex Analysis, Addison Wesley, 1977.
8. Mark J. Ablowitz and A.S. Fokas, Complex Variables : Introduction and Applications, Cambridge University Press, South Asian Edition, 1998.

9. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, 1997.

12MMCS 404 (Option (i)) : Operations Research Techniques
Max. Marks : 80 **Time : 3 hours**

Unit - I (2 Questions)

Operations Research: Origin, definition, methodology and scope.
Linear Programming: Formulation and solution of linear programming problems by graphical and simplex methods, Big - M and two phase methods, Duality in linear programming.

Unit - II (2 Questions)

Transportation Problems: Basic feasible solutions, optimum solution by stepping stone and modified distribution methods, unbalanced and degenerate problems, transhipment problem. Assignment problems: Solution by Hungarian method, unbalanced problem, case of maximization, travelling salesman and crew assignment problems.

Unit - III (2 Questions)

Queuing models: Basic components of a queuing system, General birth-death equations, steady-state solution of Markovian queuing models with single and multiple servers (M/M/1. M/M/C, M/M/1/k, M/MC/k)
Inventory control models: Economic order quantity(EOQ) model with uniform demand and with different rates of demands in different cycles, EOQ when shortages are allowed, EOQ with uniform replenishment, Inventory control with price breaks.

Unit - IV (2 Questions)

Game Theory : Two person zero sum game, Game with saddle points, the rule of dominance; Algebric, graphical and linear programming methods for solving mixed strategy games. Sequencing problems: Processing of n jobs through 2 machines, n jobs through 3 machines, 2 jobs through m machines, n jobs through m machines.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books recommended :

1. Taha, H.A., Operation Research-An introducton, Printice Hall of India.
2. Gupta, P.K. and Hira, D.S., Operations Research, S. Chand & Co.
3. Sharma, S.D., Operation Research, Kedar Nath Ram Nath Publications.
4. Sharma, J.K., Mathematical Model in Operation Research, Tata McGraw Hill.

12MMCS 404 (Option (ii)) : Advanced Discrete Mathematics -II

Max. Marks : 80 **Time :3 Hours**

Unit- I (2 Questions)

Formal Logic – Statements. Symbolic Representation and Tautologies. Quantifier, Predicates and Validity. Propositional Logic.

Unit -II (2 Questions)

Semigroups & Monoids-Definitions and Examples of Semigroups and Monoids (including those pertaining to concatenation operation). Homomorphism of semigroups and monoids. Congruence relation and Quotient Semigroups. Subsemigroup and submonoids. Direct products. Basic Homomorphism Theorem. Pigeonhole principle, principle of inclusion and exclusion, derangements.

Unit -III (2 Questions)

Lattices- Lattices as partially ordered sets. Their properties. Lattices as Algebraic systems. Sublattices, Direct products, and Homomorphisms. Some Special Lattices e.g., Complete. Complemented and Distributive Lattices. Join-irreducible elements. Atoms and Minterms.

Unit -IV (2 Questions)

Boolean Algebras – Boolean Algebras as Lattices. Various Boolean Identities. The switching Algebra example. Subalgebras, Direct Products and Homomorphisms. Boolean Forms and Their Equivalence. Minterm Boolean Forms, Sum of Products Canonical Forms. Minimization of Boolean Functions. Applications of Boolean Algebra to Switching Theory (using AND, OR & NOT gates). The Karnaugh Map method.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended

1. J.P. Tremblay & R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, McGraw-Hill Book Co., 1997.
2. J.L. Gersting, Mathematical Structures for Computer Science, (3rd edition), Computer Science Press, New York.
3. Seymour Lipschutz, Finite Mathematics (International edition 1983), McGraw-Hill Book Company, New York.
4. C.L. Liu, Elements of Discrete Mathematics, McGraw-Hilll Book Co.
5. Babu Ram, Discrete Mathematics, Vinayak Publishers and Distributors, Delhi, 2004.

12MMCS 405 : Programming in Visual Basic

Max. Marks : 80 **Time :3 Hours**

Section I (2 Questions)

Visual Basic : Introduction, Analyzing, Controls and Properties, Coding, Control structures : Decision & Loops, Control Array, Arrays

Section II (2 Questions)

Text Boxes, Command Buttons, Additional Controls – List Box, Option Buttons, Frames, Check Boxes, Scroll Bars, Timer Control,

Section III (2 Questions)

Menus: Menu Editor, Menu controls, Dialog Boxes, Procedures and Functions, Using Debugging Windows, Database Programming,

Section IV (2 Questions)

Crystal Reports. Simple Active X controls. Library Functions: String, Numeric, Time-related & Misc. Functions

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended

1. Reselman & Other, Using Visual Basic 6, Prentice Hall of India.
2. Donald & Oancea, Visual Basic 6 from Scratch, Prentice- Hall of India.
3. Noel Jerke, Visual Basic 6, Tata Mc-Graw Hill
4. Days Maver, Teach Yourself More VB in 21 days, Techmedia.

12MMCS 406 : Software Engineering

Max. Marks : 80 **Time :3 Hours**

Section I (2 Questions)

Introduction : The Software crisis, Software Engineering Problem, Software Engineering Approach, software process & its characteristics, Goals of software engineering, Software metrics and their importance,

Software Development Process: A Process Step Specification, Waterfall model, Prototyping, Iterative Enhancement, Spiral model and their comparisons.

Section II (2 Questions)

Software Requirements Analysis and Specifications, Planning a Software Project: Cost Estimation, COCOMO Model, Project Scheduling, Quality assurance Plans, Project Monitoring Plans, Risk Management

Section III (2 Questions)

Software Design : Function oriented design - principles, modeule level concepts, Design notation, structured design methodologies, Object-Oriented Design – concept, notations, methodologies. Detailed Design

Section IV (2 Questions)

Coding, Testing techniques- Testing fundamental, test case design, functional testing, Structural testing, Test Plans, Unit Testing, Integration Testing, System Testing, Acceptance Testing.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectively and the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended :

1. S. Roser Pressman, Software Engineering, A Practitioners Approach, Mc-Graw Hill Book Co.
2. N.S. Gill, Software Engineering, Khanna Pub. Co., New Delhi.
3. Pankaj Jalote, An Integrated Approach to Software Engineering, Narosa Pub.
4. K.K. Aggarwal and Yogesh Singh, Software Engineering, New Age Publishers, New Delhi.
5. M.L. Shooman, Software Engineering, Tata McGraw Hill.

12MMCS-407 : Practicals

Max. Marks : 80
Time : 4 Hours

The practical will be based on the Paper 12MMCS-405

i) Viva-voce and practical record : 30 marks

ii) Written practical work : 50 marks

The examiner shall set a question paper consisting of 4 questions and the examinees will be required to attempt any two. They will write the programs in Answer-books and will run the same on computers and they will take printouts of programs and output.