ASSAM UNIVERSITY: SILCHAR

Department of Mathematics

School of Physical Sciences (CBCS (AUS))

Structure of PG(M.Sc.) Syllabus in Mathematics

(To be implemented from Academic Session 2010-2011)

SEMESTER-II

Paper No.	Paper Name	Marks					L	P	T	C
		Internal		External		Total				
		M	P. M.	M	P.M.					
M201	Topology	25	10	75	30	100	4		1	5
M202	Classical Mechanics	25	10	75	30	100	4		1	5
M203	Discrete Mathematics	25	10	75	30	100	4		1	5
M204	Real Analysis-II	25	10	75	30	100	4		1	5
M205 (Theory)	Partial Differential Equations (Theory)	25	10	45	18	70+30	4		1	5
M205 (Practical-II)	Practical-II (External) MATLAB/Mathematica/ MAPLE etc.			30(5+5+20) (Practical Notebook + viva-voce + Experiment)	12	100		3		
	Total	125	50	375	150	500	20	03	5	25

SEMESTER-III

Paper No.	Paper Name	Marks					L	P	T	C
		Internal		External		Total				
		M	P. M.	M	P.M.					
M301	Linear Algebra	25	10	75	30	100	4		1	5
M302	Fluid Mechanics	25	10	75	30	100	4		1	5
M303	Complex Analysis	25	10	75	30	100	4		1	5
M304	Operations Research	25	10	75	30	100	4		1	5
M305 (Theory)	Mathematical Modelling	25	10	45	18	70+30	4		1	5
M305 (Practical-III)	Practical-III (External) MATLAB/Mathematica/ MAPLE etc.			30(5+5+20) (Practical Notebook + viva-voce + Experiment)	12	100		3		
	Total	125	50	375	150	500	20	03	5	25

SEMESTER-IV

Paper No.	Paper Name	Marks					L	P	T	C
		Internal		External		Total				
		M	P. M.	M	P.M.					
M401	Functional Analysis	25	10	75	30	100	4		1	5
M402	Relativity	25	10	75	30	100	4		1	5
M403	Calculus of Variations & Integral Equations	25	10	75	30	100	4		1	5
M404	**Optional (An y One)**	25	10	75	30	100	4		1	5
	a) Fuzzy mathematics									
	b) Differential geometry									
	c) Computational fluid Dynamics (CFD)									
	d) Advanced Operations Research									
	e) Number Theory									
	f) Data structure and Algorithm									
	g) Algebraic topology									
	h) Operator Theory									
	i) Rings and modules									
	j) Groups and Representations									
M405	Project	25	10	75	30	100	4	3	1	
	Total	125	50	375	150	500	20	03	5	25
	GRAND TOTAL	500		1500		2000				

** L= Lecture P= Practical T=Tutorial/Seminar etc. C= Credit, M = Marks, P.M. = Pass Marks

Duration 1 hour in L,P & T Class

Mathematics (AUS)
Course No. M-201
Topology
(Each Unit Carries 15(fifteen) Marks)

Full Marks: 75
Pass marks: 30

Unit-I

Topological spaces and open sets, examples, basis and sub basis and their characterization, examples, subspace topology, closed sets, limit points, closure, derived sets, boundary, interiors, exterior, Hausdorff space, Continuous functions and their characterization, homeomorphism.

Unit-II

Pasting lemma and applications, box and product topology, quotient spaces and constructions (involving topological group action), Connected space and related results, path-connectedness, local connectedness, total disconnectedness, examples and related results.

Unit-III

Compactness, local compactness, one-point compactification, limit point compact, tube lemma, sequentially compact, countably compact, Tychonoff's theorem, compactness in metric spaces, sequential compactness, bounded sets and compactness, Lebesgue covering lemma.

Unit-IV

More about metric topology, separation and countability axioms, Urysohn's lemma, Tietze's extension theorem, Urysohn's metrization theorem.

Unit-V

Homotopy, path-homotopy, fundamental groups, fundamental group of the circle and simple applications, contractibility, simple connectivity, vector fields and simple applications.

Recommended Texts:

1) Munkers, J. R., Topology, Pearson Prentice Hall.
2) Armstrong, M.A., Basic Topology, Springer International Publishers.
3) Pervin, W.J., Foundations in General Topology, Academic Press.

References:

1) Kelly, J.L., General Topology, Springer International Publishers.
2) Dugundji, J., Topology, UBS Publishers.
3) Simmons, G.F., Topology and Modern Analysis, McGraw Hill.

Mathematics (AUS)
Course No. M-202
Classical Mechanics
(Each Unit Carries 15(fifteen) Marks)

Full Marks: 75
Pass marks: 30

UNIT – I

Generalised coordinates, holonomic & non-holonomic systems, constraints, D'Alembert's principle Lagrange's equations, Calculus of variations, Euler-Lagrange equation, application of calculus of variations in dynamical problems.

UNIT –II

Hamilton's principle Lagrange's equations from Hamilton's principle, extension of Hamilton's principle to non-conservative and non-holonomic systems, conservation theorems and symmetry properties.

UNIT –III

Two dimensional motion of rigid bodies, Euler's dynamical equations of motion for a rigid body, Motion of a rigid body about an axis, motion about revolving axis, Eulerian angles, Euler's theorem on the motion of a rigid body, infinitesimal rotations, rate of change of a vector, Coriolis force, Euler's equations of motion, force free motion of a rigid body.

UNIT –IV

Hamilton canonical equations, Hamilton's equations of motion, conservation theorems and physical significance of Hamiltonian, Hamilton's equations from variatioinal principle, principle of least action.

UNIT –V

Equations of canonical transformation, integral invariants of Poincare, Lagrange and Poisson brackets as canonical invariants, equations of motion in Poisson bracket notation.

Recommended Texts:

1. Classical Mechanics – Goldstein, H; Addison Wisley pub. Co. (1968)
2. Introduction to Classical Mechanics – R.G. Takwala & P.S. Puranik.
3. Classical Mechanics – N.C. Rana & P.S. Joag.
4. Classical Mechanics of particle & Rigid bodies – K.C. Gupta
5. Classical Mechanics – B.D. Gupta & S. Prakash

References:

1. Classical Mechanics – E.A. Desloge
2. New Foundations for Classical Mechanics – D. Hestenes.
3. Classical Mechanics – T.W.B. Kibble
4. Classical Mechanics – A course of lectures – A.I. Roy Choudhury.
5. Classical Mechanics – J.W. Leech.
6. Classical Dynamics – A Modern Approach – E.C.G. Sudarshan & N. Mukunda.

Mathematics (AUS)
Course No. M-203
Discrete Mathematics
(Each Unit Carries 15(fifteen) Marks)

Full Marks: 75
Pass marks: 30

UNIT – I

Divisibility, greatest common division, least common multiple, prime numbers, fundamental theorem of arithmetic, Euler's Phi function, Diophantine equations ax+by = c, congruences and elementary properties, residue systems, theorems of Euler, Fermat and Wilson, chinese remainder theorem, polynomial congruences; applications.

UNIT – II

Primitive roots and indices, quadratic residues, Legendre symbol, Jacobi symbol, law of quadratic reciprocity, arithmetic functions, multiplicative arithmetic functions, Mobius inversion formula; applications.

UNIT – III

Graph, Subgraph, Varities of graphs, degree and incidence, isormorphism, intersection graph, operations on graph, walks and connectedness, trees, Forest, spanning trees, cycles and cocycles.

UNIT – IV

Traversability : Eulerian and Hamiltomian graphs, plane and planner graphs, Kuratowski's theorem.

UNIT – V

Poset and lattices, Boolean lattices and Boolean algebras, Boolean functions, applications, basics of automata theory.

Recommended texts:

1. Burton, D.M. : Elementary Number Theory (universal Book Stall)
2. Niven,l I.H.S. Zuckerman, H.L. Montgomery. An Introduction to the Theory of Numbers (John Wiley LPE)
3. Harary, F. : Graph Theory (Narosa Publishing House)
4. Liu, C.L.: Elements Discrete Maths (Tata McGraw – Hill)

References :

1. Ireland, K&Rosen, M., A classical Introduction to Modern Number Theory. (Springer LPE)
2. West : Introduction to Graph Theory (Prentice Hall of India)
3. B. Kolman, Busby, R.C. & S. Ross : Discrete Mathematical Structures (Prentice – Hall of India)

Mathematics (AUS)
Course No. M-204
Real Analysis-II
(Each Unit Carries 15(fifteen) Marks)

Full Marks: 75
Pass marks: 30

Unit-I

Metric space (definition, examples open and closed sets, diameter of a subset etc.), sequences in metric spaces, complete metric space, complete metric space, completion of metric space, Cantor's intersection theorem and applications, Baire's category theorem and applications, Banach's fixed point theorem and applications, continuous functions, normed linear spaces (definition, P^n and spaces of continuous functions as examples only)

Unit-II

(Brief review of differentiability, elementary properties, mean-valued theorem of functions of one variable), directional derivatives, derivatives of functions of several variables and their inter-relationship, Jacobian matrix, chain rule, mean-valued theorem for function of several variables, higher order partial derivatives, equality of mixed partial derivatives, Schwarz lemma, Taylor's theorem, extremum problems with and without constraints of real-valued functions of several variables.

Unit-III

Rings and σ-ring of sets, algebra and σ-algebra of sets, set functions, Lebesgue outer and inner measures, Lebesgue measurable sets (including Borel sets and Cantor sets), construction of non-measurable sets, measurable function, Cantor function and its properties.

Unit-IV

(Brief review of Riemann integral and its drawbacks), Riemann integral in terms step function, simple functions, Lebesgue integral of a bounded function over a set of finite measure, relation between Riemann and Lebesgue integral, Lebesgue integral of non-negative functions, general Lebesgue integral (definition, example and simple properties).

Unit-V

Convergence theorems in Lebesgue intregations:Lebesgue monotone, bounded and dominated convergence theorems, Fatou's lemma, fundamental theorem of calculus in Lebesgue integration, improper Riemann integral and its relation with Lebesgue integration, drawbacks of Lebesgue integral and further developments.

Recommended Texts:

1. Sohrab, Houshang H. : Basic Real Analysis (Birkhäuser(2003), Indian reprint(2006))
2. Apostol, Tom : Mathematical Analysis (Narosa Publishing House)(1997)
3. Royden, H.L., Real Analysis (Macmillan Publishing company, 3rd edition)

References:

1. Rudin, Walter : Principles of Mathematical Analysis (McGraw-Hill, third Edition)
2. Simmons,G.F., Introduction to Topology and Modern Analysis (McGraw-Hill Book Company, 3rd edition)
3. Bartle, Robert G. : A Modern theory of integrations (American mathematical Society, GSM, Vol.32)

Mathematics (AUS)
Course No. M-205
Partial Differential Equations (Theory)
(Each Unit Carries 9(nine) Marks)

Full Marks: 45
Pass marks: 18

Unit-I

First order partial differential equations (linear and nonlinear) and their solutions by inspection, Lagrange's and Charpit's methods, characteristic curves and characteristic surfaces, linear PDE with constant coefficient-homogeneous equation to find CF & PI; non-homogenous linear equation with constant coefficients-reducible & irreducible cases & equation reducible to linear homogeneous form.

Unit-II

Second order PDE with variable coefficients: Introduction, Monges method for solving the equations of the form : $\mathbf{Rr + Ss + Tt + U (rt - s^2) = V (x,y)}$, reduction of $\mathbf{Rr+Ss+Tt+f(x,y,z,p,q)=0}$ to canonical forms, method of variation of parameter.

Unit-III

Application of PDE in Physical Problems : (a) Laplace equations (upto two dimensions) – occurrence & solution in different coordinate systems, boundary value problems, separation of variables.

(b) The wave equation- occurrence, solution of one-dimensional wave equation; the Riemann – Volterra solution, vibrating membranes, transverse vibrations of a stretching string.

(c)The diffusion equation- occurrence and elementary solution, heat equation in one dimension, separation of variables, the use of integral transforms (separation of variables for heat equation).

Unit-IV

Integral transform methods (Laplace and Fourier transforms) to solve conditional PDE, Browmwitch integral.

Unit- V

Numerical Methods :

Numerical solutions of elliptic, parabolic and hyperbolic PDEs (2 independent variable case) by finite difference method, Liebmanns iterative method for elliptic equations, Bender- Schmidt method, Crank- Nicholson method for solving parabolic equation.

Recommended Texts:

1. Partial Differential Differential Equation : E. T. Copson, Oxford University Press
2. Numerical Methods : Vedamurthy and Iyenger (VPH Pub.)
3. Differential Equation by Piaggio(CBS. Publ.)
4. Theory of differential equation – Fersyth
5. Partial Diff. Equations : P. Prasad & R. Ravindran (New Age)

References:

1. Elements of PDE : I. N. Sneddon (Oxford Univ. Press)
2. An Elementary course in Partial Differential Equation : T Amarnath, narosa Pub.
3. Numeric al Solution of Differential Equation : M.K. Jain, New Age Pub.
4. Method of Mathematical Physics – Magenal & Murphy
5. Applied Mathematics for Engineers & Physicist: Pipes & Harvill.
6. Schaum's outline of theory and problems of Diff. Equation. Metric Units : Frank Ayres.
7. Partial Differential equations : Epstein.

Mathematics (AUS)
Course No. M-205
Partial Differential Equations (Practical-II)

Full Marks: 30
Pass marks: 12

Distribution of marks:

i) Practical Note Book	: 05
ii) Viva-voce	: 05
iii) Experiments (two experiments/ problems Having 10 marks each)	: 20
Total	: 30

For Practical (Course and software)

i) Problems may be considered for solving with the help of knowledge in M-205(Theory)

ii) MATLAB/ Mathematica / MAPLE are to be used.

Mathematics (AUS)
Course No. M-301
Linear Algebra
(Each Unit Carries 15(fifteen) Marks)

Full Marks: 75
Pass marks: 30

UNIT-I

(Brief review of vector spaces), Linear Transformations, Rank Plus Nullity Theorem, Representation of Linear transformations by Matrices, Change of Basis Matrices, Algebra of Linear Transformations, Algebra isomorphism between the algebra of Linear Transformations and Algebra of Matrices Change of Bases for Linear Transformations, Equivalence of Matrices, Similarity of Matrices, Quotient spaces, Isomorphism Theorems, Linear Functionals, Dual Space, dual Bases, Annihilators.

UNIT-II

Characteristic roots, Characteristic vectors, Characteristic Polynomials, relation between characteristic polynomial and Minimal Polynomial of an Operator, Eigenvalues, Cayley-Hamilton Theorem (proof to be given later), Diagonalizablility, necessary and sufficient condition for diagonalizability, Projections and their relation with direct sum decomposition of vector spaces, Invariant Subspaces, Direct sum Decompositions, Invariant Direct Sums, The Primary Decomposition Theorem, Geometric and Algebraic multiplicities.

UNIT-III

Cyclic subspaces, companion matrices, a proof of Cayley-Hamilton theorem, Triangulability, Canonical forms of nilpotent transformations, Diagonal Forms, Triangular Forms, Rational Canonical Forms.

UNIT-IV

Trace and Transpose, Inner product spaces, Linear functionals and Adjoints, Orthogonality, Orthonormality, Projection Theorem, Gram-Schmidt Orthogonalization, Orthonormal Basis, Riesz Representation Theorem, Adjoint of Operators, Orthogonal Diagonalizability, Self-Adjoint Operators, Unitary and Normal Operators, Orthogonal Diagonalization, Orthogonal Projection.

UNIT-V

Bilinear Forms, Correspondence between bilinear forms and matrices, Rank of a Bilinear Form, non-degenerate bilinear form, Quadratic forms, reduction and classification of quadratic forms, Symmetric and Skew-symmetric bilinear forms.

Recommended Texts:

1. Herstein, I.N. : Topics in Algebra,Wiley Eastern Limited/New Age International Second Edition.
2. Hoffman and Kunze: Linear Algebra, (Prentice Hall of India Private Limited Second Edition/ Third Edition)
3. Roman, Steven : Advanced Linear Algebra, Graduate Texts in Mathematics 135,Springer- Verlag (1992)

References :

1. Bhattacharjee, Jain & Nagpaul : First Course in Linear Algebra,New Age International.
2. Halmos, Paul R. : Finite-Dimensional Vector Spaces, Sringer.

Mathematics (AUS)
Course No. M-302
Fluid Mechanics
(Each Unit Carries 15(fifteen) Marks)

Full Marks: 75
Pass marks: 30

UNIT – I

Governing equations of fluid motion : Lagrangian and Eulerian Methods of description, Stream line, path line, Vorticity and circulation, Equation of continuity in Fluid Motion (in Lagrangian and Eulerian Methods). Equivalence of the two forms of equations of continuity, Boundary conditions, Euler's equations of motion, for perfect fluids, integrals of Euler's equations of motion. Lagrange's equations of motion, Cauchy's integrals, Equation of Energy.

UNIT – II

Motion in two dimensions : Two-dimensional motions, stream function, complex potential, source, sink and doublet; Image, Image in two-dimensions ; Images of a source with regard to a plane, a circle and a sphere; Image of a doublet, Milne-Thomson' circle theorem, Theorem of Blasius.

UNIT – III

Motions in three-dimensions : (a) Uniform motion of a sphere in a liquid, axisymmetric motion
(b) Vortex Motion : Helmholtz' properties of varities, velocity in a vortex field, Motion of a circular vortex, Infinite rows of vortices, Karman's vortex street.

UNIT – IV

Viscous fluids : Navier – Stokes equations for viscous flows-some solutions, diffusion of vorticity, Dissipation of energy, Reynolds Number, Steady motion of a viscous fluid between two parallel plates, steady flow through circular cylindrical pipe and annulus.

UNIT – V

Boundary layer theory : - Dynamical similarity, Parandtl's boundary layer equations in two dimensions, Blasius solution. Boundary layer thickness. Displacement thickness, Karman integral equations.

Recommended Texts :

1. Text book of Fluid Dynamics – F. Chorlton. (Van Nostrand Reinhold Co)
2. Fluid Dynamics – D.E. Rutherford. (oliver & Boyd)
3. Theoretical Hydrodynamics – L.M. Milne – Thomson.
4. A treatise of Hydromechanics – by W.H. Besant and A.S. Ramsey.
5. Ideal and Incompressible Fluid Dynamics – M.E. D'Neill and F. Chorlton

Reference :

1. Hydrodynamics – Shantiswarup (Krishna Prakashan)
2. Theoratical Hydrodynamics – Bansilal
3. Hydrodynamics – H. Lamb
4. Modern Fluid Dynamics : N. Curle & H.J. Davies (Van Nostrand Reinhold Co,)
5. Principles of Ideal Fluid Aerodynamics : Karmacheti & Krishna Murti (John Wiley & Sons)

Mathematics (AUS)
Course No. M-303
Complex Analysis
(Each Unit Carries 15(fifteen) Marks)

Full Marks: 75
Pass marks: 30

UNIT- I

Extended Complex Plane, Stereographic projections, arguments, complex logarithms, Power series, Holomorphic and Analytic Functions, Cauchy-Riemann equations, the exponential functions, the logarithmic functions, complex trigonometric functions.

UNIT- II

Line integrals, differential forms, homotopy and simple connectivity, winding number, Cauchy's theorem, Goursat's theorem, Cauchy's integral formula, Power series expansion of holomorphic functions, Morera's theorem, Cauchy's inequalities, Liouville's theorem, Fundamental theorem of algebra, cycles and homology.

UNIT- III

Counting zeros of holomorphic function, open mapping theorem, Maximum modulus principle, Schwarz's lemma, singularities and their classification, Laurent series expansions, Casorati-Weierstrass's theorem, meromorphic functions.

UNIT- IV

Residues, residue theorem, Evaluation of definite integrals, Argument principle, Rouche's theorem, harmonic conjugates, Poisson's formula.

UNIT- V

Examples of images of regions under elementary holomorphic functions, conformal maps, Mobius transformation, cross-ratio, orientation and symmetry principles

Recommended Texts:

1. Gilman, Jane P., Kra, Irwin & Rodriguez, Rubi E. : Complex Analysis, In the Spirit of Lipman Bers, GMT 245, Springer - Verlag
2. Conway, John B.: Functions of One Complex Variable, Second Edition, Narosa Publishing House.

References :

1. Cartan, H. : Elementary Theory of Analytic Functions of One or Several Complex Variable, Dover Publishing House
2. Shastri, Anant R. : An Introduction to Complex Analysis, Macmillan India Limited.
3. Ahlfors, L.V. : Complex Analysis, McGraw-Hill Book Co.
4. Choudhary,B. : The Elements of Complex Analysis, New Age International (P) Limited, Publishers
5. Ponnusamy, S : Foundations of Complex Analysis, Narosa Publishing House.

Mathematics (AUS)
Course No. M-304
Operations Research
(Each Unit Carries 15(fifteen) Marks)

Full Marks: 75
Pass marks: 30

Unit-I

Revised Simplex Method, Parametric Linear Programming, Linear Fractional Programming, Duality Theorem, Dual Simplex Methods, Post-Optimal Analysis.

Unit-II

Sequencing Problem- Processing n-job through two machines, three machines, k-machines, processing of 2 job through k-machines, Variation in assignment problems, Transhipment problem, Introduction to Non-Linear Programming.

Unit-III

Integer programming problems, Gomory's all integer cutting plane method, Gomory's mixed integer cutting plane method, Branch and bound technique, game theory, games without saddle point, mixed strategy, algebraic method, graphical method, dominance property, solution of a game by L.P. method.

Unit-IV

Deterministic Inventory control Models-advantage of carrying inventory, techniques of inventory control for economic lot size models with constant demand/different rates of demand in different cycles finite replenishment rate ; deterministic inventory models with short ages, techniques of inventory control with shortages for economic lot size models with constant demand and variable order cycle time/constant demand and fixed reorder cycle time/finite replenishment rate, EOQ models with quantity discounts.

Unit-V

Replacement problems, Replacement of items when value of money remains constant/changes with constant rate, replacement of items that fails completely, group replacement policy, project management. PERT and CPM techniques, activities, Network diagram, forward pass method, float of activity and event, critical path.

Recommended Texts:

1. Wagner, H.M.: Principles of Operations Research (Prentice Hall)
2. Sharma. J.K. : Operations Research : Theory and Application (Mcmillan)
3. Man Mohan, Gupta, P.K., Swarup Kanti : Operation Research (S. Chand & Sons).
4. Taha, H.A, Operation Research : An Introduction (Prentice Hall)
5. S. D. Sharma : Operations Research (Kedar Nath Ram Nath)

References:

1. Mustafi C.R.: Operations Research – Methods & Practice (New Age Int)
2. Shenoy, L.V.: Linear Programming : Methods Applications.
3. Mittal K.V. : Optimization Methods : In O.R. and systems Analysis (New Age Int.)
4. Vohra, N.D. : Quantitative Techniques in Management, (Tata McGraw Hill)

Mathematics (AUS)
Course No. M-305
Mathematical Modelling (Theory)
(Each Unit Carries 9(nine) Marks)

Full Marks: 45
Pass marks: 18

Unit-I

Mathematical modelling – introduction, techniques, classifications, some illustrations :mathematical modelling through geometry/algebra/trigonometry/calculus, mathematical modelling through ODE of first order: linear growth and decay model, non-linear growth and decay model, compartment models mathematical modelling of dynamics, geometrical problem.

Unit-II

Mathematical modeling through systems of ordinary differential equations of first order: in population dynamics, epidemics, economics, medicine, dynamics, mathematical modelling through ODE of second order : of planetary motions and motion of satellites, modelling through linear ordinary differential equations of second order in electrical circuits, catenary.

Unit-III

Mathematical modelling through difference equations with constant coefficients : in population dynamics and genetics, mathematical modelling through PDE : mass-balance equations, momentum balance equations, variational principles, model for traffic on a highway.

Unit-IV

Mathematical modelling through graphs : in terms of directed graphs in terms of signed graphs, in terms of weighted diagraphs and in terms of unoriented graphs.

Unit-V

Mathematical modelling through linear programming : of different industrial oriented problems, mathematical modelling through calculus of variations : on geometrical problems, problems of mechanics/bioeconomics.

Recommended Texts:

1. Kapur, J.N. : Mathematical modelling (New Age International)
2. Burghes, D.N. : Mathematical modelling in social, management and life sciences (Ellios Horwood and John Wiley)
3. Giordano, F.R.: and Weir, M.D. : A first course in Mathematical Modelling (Brooks Cole)
4. Kapur, J.N. : Insight into mathematical modeling (Indian National Science academy)

References:

1. Bellomo and Preziosi, Modelling Mathematical methods and Scientific computation (CRC)

Mathematics (AUS)
Course No. M-305
Mathematical Modelling (Practical-III)

Full Marks: 30
Pass marks: 12

Distribution of marks:

i) Practical Note Book	: 05
ii) Viva-voce	: 05
iii) Experiments (two experiments/ problems Having 10 marks each)	: 20
Total	: 30

For Practical (Course and software)

i) Problems may be considered for solving with the help of knowledge in M-205(Theory)

ii) MATLAB/ Mathematica / MAPLE are to be used.

Mathematics (AUS)
Course No. M-401
Functional Analysis
(Each Unit Carries 15(fifteen) Marks)

Full Marks: 75
Pass marks: 30

UNIT- I

Normed linear spaces and Banach spaces, completion of normed linear spaces, finite-dimensional normed linear spaces and subspaces, equivalent norms, compactness and finite dimension, Linear operators, Inverse operators, Bounded and continuous linear operators, finite-dimensional domain and boundedness of operators .

UNIT- II

Norm of a bounded linear linear operator, Bounded linear extension, Linear functionals, continuity and boundedness of linear functionals, algebraic dual and algebraic reflexivity, normed linear space of bounded linear operators, topological dual space and examples.

UNIT- III

Inner product spaces, Hilbert spaces, properties of inner product spaces, orthogonal complements and direct sums, orthonormal sets and sequences, series related to orthonormal sequences and sets, total orthonormal sets and sequences, Parseval's identity, examples of total orthonormal sets, presentation of functionals on Hilbert spaces, Riesz representation theorem, Hilbert-adjoint operators, self-adjoint, unitary and normal operators.

UNIT- IV

Zorn's lemma, Hahn-Banach theorem, Hahn-Banach theorem for complex linear spaces and normed linear spaces, consequences of Hahn-Banach theorems, natural embedding into second topological dual spaces, topological reflexive spaces, topological reflexive spaces and separability and other related results.

UNIT- V

Adjoint of a bounded linear operator, uniform Boundedness theorem, open mapping theorem, closed graph theorem and their applications.

Recommended Text :

1. Kreyszig, Erwin: Introductory Functional Analysis With Applications, John Wiley & Sons.

References :

1. Bachman, George; and Narici, Lawrence : Functional Analysis, Dover Publications, Inc.
2. Simmons, G.F. : Introduction to Topology and Modern Analysis, McGraw- Hills.
3. Lahiri, B.K. : Elements of Functional Analysis, World Press, Kolkata
4. Jain, P.K; Ahuja, O.P.; and Ahmed, K : Functional Analysis, New Age International

Mathematics (AUS)
Course No. M-402
Relativity
(Each Unit Carries 15(fifteen) Marks)

Full Marks: 75
Pass marks: 30

UNIT – I

Inertial frame, Galilean transformations, Postulates of special theory of Relativity, Lorentz transformations, Fitzgerald contraction, Time dilation, Relativistic formulae for composition of velocities, transformation of Lorentz contraction factor, Lorentz transformation actotation. variation of mass with velocity, equivalence of mass and energy transformation formulae for mass, momentum and energy problems, Minkowski space.

UNIT – II

Summation convention, dummy and free suffix, Kroneeker delta, definition of tensor, Invariance of tensor equation, covariant and contravariant tensors, addition, subtraction, outer product, Inner product of tensors, line element, The fundamental tensor in cartesian, cylindrical and spherical co-ordinates, Christoffel symbols of the first and second kind, transformation of Christoffel symbols, formula for second-order partial derivative in terms of Christoffel symbols.

UNIT – III

The covariant derivative of a covariant vector, contravariant vector a mixed tensor of second order, rule of covariant differentiation, velocity gradient tensor in cylindrical and spherical co-ordinates. curvature tensor, Riemmann – Christoffel tensor, Riccei tensor, equation of geodesic, geodesic co-ordinates, bianchi identities, Einstein tensor.

UNIT – IV

The electromagnetic field equations of Maxwell, invariance of Maxwell's equations, Biot-Savart law, Faraday's law, transformation of electric and magnetic field components, electromagnetic wave equation, principles of covariance and equivalence, energy momentum tensor, field equations of general relativity, inertial and gravitational mass, Poisson's equation as approximation.

UNIT – V

Schwarzschild's exterior solution, planetary orbits, advance of perihelion, gravitational shift of spectral lines, schwarzschild's interior solution, bending of light, cosmological models, Einstein's model, De-sitters model, comparison of the models the big bang models, the expanding universe.

Recommended texts :

1. Introduction to special Relativity – Robert Resnick (New Age)
2. Special Relativity – A.P. French (ELBS/Van Nostrand Reinhold (UN)
3. Introduction to the Theory of Relativity – P.G. Bergman (Prentice Hall)
4. Theory of Relativity (Special and General) – M. Ray (S. Chand & Co. Delhi)
5. The Mathematical Theory of Relativity – A.S. Eddington.
6. The Theory of Relativity – C. Moller.

Reference :

1. Relavivistic Mechanics – Satya Prash (Pragati Prakashan Meerut; U.P)
2. Tensors – S. Spain
3. An Introduction to The Special Theory of Relativity – R. Latz (Van Nostran ,Princeton, N.J.)
4. The Theory of Relativity –R.K. Pathria (Hindustan Publishing Co., Delhi)
5. Relativity, Thermodynamics and Cosmology – R.C. Tolman
6. Tensor Analysis – Barry Spain

Mathematics (AUS)
Course No. M-403
Calculus of Variations and Integral Equations
(Each Unit Carries 15(fifteen) Marks)

Full Marks: 75
Pass marks: 30

Unit-I

Functionals, linear functional, fundamental lemma of calculus of variations. simple variational problems. the variation of Functional, extremum of functional, necessary condition for extremum, Euler's equation and applications, Euler's equation of several variables, invariance of Euler's equation, isometric problems, brachistochrone problem.

Unit-II

Generalization of Euler's equations (n- dependent functions, higher order derivatives), variational problems with subsidiary conditions, method of variational techniques to solve IVP and BVP, derivation of basic formula, eigen value problems, variational theory of eigen values, extremum properties of eigen values and some important consequences, variational problems leading to an integral equation.

Unit-III

Integral equation : Differentiation of a function under an integral sign- reduction of differential equations to integral equations, classification of linear integral equations, solution of non-homogenous Volterra's integral equations by the method of successive substitution and successive approximation of some relevant kernels-Volterra integral equations of first & second kind.

Unit-IV

Solution of Fredholm integral equations of first & second kind by the method of successive substitution and successive approximation, Fredholm first theorem, unique solution of the non-homogenous Fredholm integral equation- symmetric kernel, orthogonality of fundamental functions, eigen value of symmetric kernel, real characteristic constants - expansion of a symmetric kernel in eigen functions, Greens functions – construction of Greens function.

Unit-V

Integro-Differential equations: Fredholm-integro-differential equations, direct computation method, adomain decomposition method, converting to Fredholm-integral equations .
Volterra-Integro-Differential equations: The series solution method, decomposition method, converting to Volterra integral equations.
Introduction to non-linear integral equations of Volterra and Fredholm types and simple problems.

Recommended Texts:

1. Calculus of variations, I.M.Gelfanf and S.V. Fomin, Dover.
2. Integral Equations, Shanti Swarup, Krishna Prakashan Media

References:

1. Calculus of variations with Applications, A.S. Gupta,PHI(2004)
2. A First Course in Integral Equations, Abdul-Mazid Wazwaz
3. R. P. Kanwal: Linear Integral Equations, Academic press, New York (1998)
4. S. G. Mikhlin: Linear Integral Equations (translated from Russian) Hudson Book Agency (1980)

5. D. Porter and D. S. G. Stirling: Integral equations, Cambridge University Press (1998)

Mathematics (AUS)

Course No. M-404 (a)

Fuzzy Mathematics (OPTIONAL)

(Each Unit Carries 15(fifteen) Marks)

Full Marks: 75

Pass marks: 30

Unit-I

Introduction, Basic concept of fuzzy sets, operations on fuzzy sets, α - cut (level subset) and its properties, convex fuzzy sets, scalar cardinality of a fuzzy set.

Unit-II

Image and inverse image of fuzzy sets under a function, extension principles of fuzzy sets, fuzzy relations, fuzzy similarity and compatibility relations, ordering, morphism, fuzzy relation equation.

Unit-III

Fuzzy numbers, linguistic variables, arithmetic operations on intervals, arithmetic operations on fuzzy numbers, lattice of fuzzy numbers, fuzzy equations.

Unit-IV

Classical logic (an overview), fuzzy propositions, fuzzy quantifiers, linguistic hedges, inferences from conditional, quantified fuzzy propositions.

Unit-V

Belief and plausibility measures, probability, possibility and necessity measures, uncertainty and information.

Recommended Texts:

1. G. J. Klir, U. S. Clair and B. Yuan, Fuzzy Set Theory: Foundation and Applications (Prentice Hall, 1997)

References:

1. H. J. Zimmermann: Fuzzy Set Theory and its Applications, 3rd edition (Kluwer Academic, 1992)
2. G. J. Klir and T.A.Folger : Fuzzy sets, Uncertainty and Information (Prentice Hall,2005)

Mathematics (AUS)
Course No. M-404 (b)
Differential Geometry(OPTIONAL)
(Each Unit Carries 15(fifteen) Marks)

Full Marks: 75
Pass marks: 30

Unit-I

Curves with Torsion : Space curves, their curvature and torsion, Fundamental theorem of space curves, tangent, principal normal, curvature, bi-normal, torsion, Serret-Frenet formulae, locus of center of curvature, examples I , spherical curvature, locus of center of spherical curvature, theorem of curve determined by its intrinsic equations, helices, spherical indicatrix of tangent etc., involutes, evolutes, Betrand curves, examples II.

Unit-II

Envelopes & Developable Surfaces : Surface, tangent plane, normal; one-parameter family of surfaces; envelope, characteristics, edge of regression; developable surfaces; osculating developable; polar developable, rectifying developable; two parameter family of surfaces, envelope, characteristic points., examples III.

Unit – III

Curvilinear co-ordinates on a surface, fundamental magnitudes, curves on surfaces, first and second fundamental forms, Gaussian curvature, curvilinear coordinates : first order magnitudes ; directions of a surface, the second order magnitudes, derivatives of **N**, curvature of normal section, Mausnier's theorem.

Unit – IV

Curves on a surface and lines of curvature : Principal directions and curvatures, first and second curvatures, Euler's theorem, Dupin's indicatrix, the surface X=f(x,y), surface of revolution, examples of asymptotic lines, curvature and torsion.

Unit – V

Geodesics , Fundamental equations of surface theory, Geodesic property, equation of geodesics, surface of revolution, torsion of a geodesic.

Recommended Texts:

1. Weather burn ,C.E.: Differential Geometry of three Dimensions –(Cambridge University Press)
2. Bansi Lal : Three Dimentional Differential Geometry – (S. Chand)
3. An Introduction to differential Geometry – T.J. Willmore. (Oxford University Press)

Reference :

1. Guggenheimer ,H. : Differential Geometry – (McGraw Hill)

Mathematics (AUS)
Course No. M-404 (c)
Computational Fluid Dynamics (CFD) (OPTIONAL)
(Each Unit Carries 15(fifteen) Marks)

Full Marks: 75
Pass marks: 30

Unit-I

Irrotational flow, Potential function, Full potential equation, 2-D incompressible fluid flow, Stream function, conservation principles, Steady and unsteady fluid flow, vortex motion, vorticity equation, vorticity transport equations, viscous fluid flow, boundary layer approximation to viscus fluid motions.

Unit-II

Nature of problems, Finite difference formulations for elliptic problems. Simple, general and higher order derivative, mixed derivatives. Higher order accuracy schemes, accuracy of F.D. solutions. Iterative solution method, FD methods for 2-D and 3-D elliptic BVP with 2^{nd} and 4^{th} order and their application. FD approximations to Poisson's equation in cylindrical and spherical co-ordinates, Alternation direction method.

Unit-III

Two and three level explicit and implicit F.D. approximations to parabolic equations. Stability analysis (matrix and Von-Neumann method). The method of factorization, fractional step methods, solution of 1-D non-linear parabolic equations. compatibility, consistency and convergence of the difference method, FD approximations to heat conduction equation in cylindrical and spherical co-ordinates.

Unit-IV

Explicit and implicit schemes, Von-Neumann stability analysis, Multi step methods, solution of 1-D non-linear hyperbolic problems, solution of non-linear wave equation, explicit and implicit schemes for Bunger's equation.

Unit-V

Finite element formulations, the construction of finite elements, convergence rates for FEM, stability of FEM, Galerpin's method, elementary ideas of finite volume method, one-dimensional computations by FVM, conversion of FVM to FDM, simple problem.

Recommended Texts:

1. C.A.J. Eletcher: Computational techniques for Fluid Dynamics, Vol-1 and 2 (Springer-Verleg, 1992)
2. C.Y. Chow, Introduction to Computation Fluid Dynamics (John Willey 1979)
3. D.A. Anderson, J.C. Tasnechill, R.H. Pletcher: Computational Fluid Dynamics and Heat Transformation , (McGraw Hill, 1984)

References:

1. T.J. Chung : Computational Fluid Dynamics (Cambridge University Press)
2. R. Peyret and T.D. Taylor : Computational Fluid Dynamics (Springer-Verleg)
3. P. Wesseling : Principles of Computational Fluid Dynamics (Springer-Verleg,2000)

Mathematics (AUS)
Course No. M-404 (d)
Advanced Operations Research(OPTIONAL)
(Each Unit Carries 15(fifteen) Marks)

Full Marks: 75
Pass marks: 30

Unit-I

Basic concept of probability and probability distributions- Binomial- Poission- Negative Exponential –Normal –Emperical distributions, Generation of random numbers – Expectation of a random variable, mean and variance of a random variable and joint Random variables.
Simulation – Definition and types of simulation, limitation of simulation technique, Monte-Carlo simulation, application of simulation.

Unit-II

Goal programming – introduction, formulation of linear goal programming problem, solution of goal programming by graphical method, simplex method, classical optimisation, different methods.

Unit-III

Queuing theory: Introduction, queuing system, classification of queuing models, Markov chain, brand switching models, transient and steady state, dynamic programming.

Unit-IV

Probabilistic inventory control models : Instantaneous demand inventory control models without setup cost – different models with uncertain demand for single period, optimal order point – marginal analysis approach, with shortages and discrete replenishment, with shortages and continuous replenishment, Re-order lead time; continuous demand inventory control models without setup cost – different models with discrete replenishment with continuous replenishment; instantaneous demand inventory control models with setup cost and with continuous replenishment.

Unit-V

Decision analysis : Introduction, decision making environment, decision under uncertainty, decision under risk, decision – tree analysis.
Information theory : Introduction, entropy as a measure of uncertainty, properties of entropy function, communication system, channel probabilities, joint and conditional entropies, mutual information , encoding.

Recommended Texts:

1. Wagner, H.M, : Principles of Operations Research (Prentice Hall)
2. Sharma, J.K., : Operations Research : Theory and Application (Mcmillan)
3. Man Mohan, Gupta, P.K., Swarup Kanti : Operations Research (S. Chand & Sons)
4. Taha, H. A. : Operations Research: An Introduction (Prentice Hall)

References:

1. Mustafi C.R. : Operations Research – Methods & Practice (New Age Int.)
2. Shenoy, L.V. : Linear Progarmming : Methods and Applications(New Age Int.)
3. Mittal, K.V. : Optimization Methods : In O.R. and System Analysis (New Age Int.)
4. Vhora, N.D. : Quantitative Techniques in Management (Tata McGraw Hill)

Mathematics (AUS)
Course No. M-404 (e)
Number Theory(OPTIONAL)
(Each Unit Carries 15(fifteen) Marks)

Full Marks: 75
Pass marks: 30

UNIT- I

Direct and inverse problems, Finite arithmetic progressions, inverse problem for distinct summands, small sumsets, applications.

UNIT- II

Addition in groups, e-transform, Cauchy-Davenport theorem, Erdos-Ginzburg-Ziv theorem, Vosper's theorem, Application, Exponential sum, Frieman-Vosper theorem,Erdos-Heilbronn conjecture, Multidimensional ballot numbers, Polynomial method, Erdos-Heilbronn via polynomials, applications.

UNIT-III

Addition theorems of Number theory, asymptotic density and theorems of Ostmann and Kneser, Kneser's theorem for groups, applications.

UNIT- IV

Difference sets in abelian groups, necessary conditions for the existence of difference sets, decomposition theorems.

UNIT-V

Small sumsets and hyperplanes, Linearly independent hyperplanes, Blocks and related results, Lattices and determinants, Convex bodies and Minkowski's first theorem,Applications,Successive minima and Minkowski's second theorem,bases for sublattices,Torsion-free abelian groups.

Recommended Texts :

1. Nathanson, Melvyn B.: Additive Number Theory, Graduate Texts in Mathematics 165,Springer.
2. Mann, Henry B. : Addition Theorems, Interscience Tracts in Pure and Applied Mathematics, Number 18, Intersience Publishers.

References:

1. Nathanson, Melvyn B. : Elementary Methods in Number Theory, Graduate texts in Mathematics 195, Springer

Mathematics (AUS)
Course No. M-404 (f)
Data Structure and Algorithm(OPTIONAL)
(Each Unit Carries 15(fifteen) Marks)

Full Marks: 75
Pass marks: 30

UNIT – I

Arrays and Sequential Representations – Ordered lists-Stacks and Queues-Evaluation of Expressions-Multiple stacks and queues-singly Linked Lists-Linked Stacks and Queues-Polynomial Addition-Doubly Linked Lists and Dynamic Storage Management-Strings – a case study.

UNIT – II

Trees-Binary tree representations-Tree traversal-Threaded binary trees-Binary tree representation of trees-Set representations-decision trees-Game Trees and counting Binary Trees-Graphs and Representations-Traversals, connected components and spanning trees-Shortest paths and transitive closure-activity Networks-Topological sort and critical paths.

UNIT – III

A logarithms-conventions-writing Structured programs-Analyzing algorithms-Sorting-Heapsort-Binary search-Finding the maximum and minimum-Mergesort-Quicksort-Selection Sort.

UNIT – IV

GREEDY METHOD : The general method-optimal storage on tapes-knapsack problem-job sequencing with deadlines-optimal merge patterns-minimum spanning trees-single source shortest paths.

UNIT – V

BACKTRACKING : The general method-the 8-Queens problem-sum of subsent-graph coloring-Hamiltonian cycles-knapsack problem. BRANCH AND BOUND. The general method 0/1 Knapsack problem-Travelling sales-person-Efficiency considerations.

Recommended Texts :

1. Fundamentals of Data Structure-Ellis Hiorowitz and Satraj Sahani Chapters
2. Fundamentals of Computer Algorithms-Ellis Horowitz and Sartaj (Sahni Galgotia Publications)

Reference Book:

Data Structures - LIPSCHUTA, Schaum’s Outline Series (Tata McGraw Hill)

Mathematics (AUS)
Course No. M-404 (g)
Algebraic Topology(OPTIONAL)
(Each Unit Carries 15(fifteen) Marks)

Full Marks: 75
Pass marks: 30

Unit-I

Homotopy of paths, fundamental groups, fundamental group functor, homotopy of maps, homotopy equivalence, contractible and simply connected spaces, fundamental groups of the circle, torus etc., degree of maps of the circle.

Unit-II

Van-Kempen's theorem, application to cell complexes, calculation of fundamental groups of Σ^n, $n > 1$, fundamental group of topological group, Brouwer's fixed point theorem, fundamental theorem of algebra, vector fields, Frobenius theorem on eigen values of a 3×3 matrix.

Unit-III

Covering space, unique lifting theorem, path-lifting theorem, covering homotopy theorem, application, universal covering and its existence.

Unit-IV

Simplicial and singular homology, reduced homology, Eilenberg- Steenrod axioms(without proof), relation between π_1 and $\mathbf{H_1}$, relative homology.

Unit-V

Calculation of homology of Σ^n, Brouwer's fixed point theorem for $f : \Sigma^n \to \Sigma^n$, $(n > 2)$ and its applications to spheres and vector fields, Meyer – Vietoris sequences and its application.

Recommended Texts:

1. M.J. Greenberg & J. R. Harper : A First Course in Algebraic Topology (Second Edition), Addition-Wesley Publishing Co., 1997.
2. Czes Kosnioski : A First Course in Algebraic Topology, Cambridge University Press (1980)

References:

1. Allen Hatcher : Algebraic topology , Cambridge University Press (2002)
2. William S. Massey : A Basic Course in Algebraic Topology, Springer (Indian Edition)
3. J.K. Munkres : A First Course in Topology, Second Edition, Prentice-Hall of India Ltd, new Delhi.

Mathematics (AUS)
Course No. M-404 (h)
Operator Theory(OPTIONAL)
(Each Unit Carries 15(fifteen) Marks)

Full Marks: 75
Pass marks: 30

UNIT – I

Banach algebras, inverse of an element, Spectrum and Resolvent, Compact linear operators on normed linear spaces. The ideal of compact operators, the separability of the range and spectral properties of a compact linear operator, operator equations involving compact linear operators.

UNIT – II

Fredholm Type Theorems, the Fredhalm Alternative, Spectral properties of bounded selfadjoint linear operators. Positive operators. Square roots of a positive operator. Projection operators. Spectral families. Spectral family of a bounded self-adjoint linear operators.

UNIT – III

Extension of the spectral theorem to continuous functions. Properties of the spectral family of a bounded self-adjoint linear operator. Unbounded linear operators and their Hilbert-adjoint operators. Symmetric and self adjoint linear operators. Closed linear operators closable operators and their closures.

UNIT – IV

Spectral properties of self-adjoint linear operators. Spectral representation of unitary and selfadjoint linear operators. Multiplication operator and differentiation operator. Functional calculus and spectral mapping theorem for analytic function. The Riesz decomposition theorem.

UNIT-V

Semigroups of bounded linear operators. Exponential growth property and the resolvent, generation of semigroups, dissipative semigroups and compact semigroups. Elementary examples of semigroups : Cauchy problem.

Recommended Text :

1. Introductory Functional Analysis with Applications, John Filey and Sons, 1978. E. Kreyszig
2. Invarian subspaces, By H. Rajdavi and P. Rosenmthal, Springer-Verlag, 1973(Chapter 2).
3. Applied Functional Analysis, by A.V. Balakrishnan, Springer-Verlag, second edition 1981

References:

1. Elements of Functional Analysis by B.K. Lahiri, World Press, Kolkata.
2. Functional Analysis by B.V. Limayce, New Age Int.
3. Linear Operators, Pt-I & II : N. Dunford and J.P. Schwartz, Intesciences Publishers.
4. Introduction to Functional Analysis by A.E. Taylor & D.C. Ley, John Wiley and Sons, 1980.

Mathematics (AUS)
Course No. M-404 (i)
Rings and Modules(OPTIONAL)
(Each Unit Carries 15(fifteen) Marks)

Full Marks: 75
Pass marks: 30

UNIT – I

Rings, homomorphism, ideals and quotient rings (preview only), zero divisors, nilpotent elements, units, prime ideals, Nil radical and Jacobson radical, operations on ideals, extraction and contraction of ideals.

UNIT – II

Module and module homomorphism, sub-modules and quotient modules, operations on sub-modules, direct sum and product, finitely generated modules, exact sequences.

UNIT – III

Primitive rings, completely reducible rings and modules, artinian and nonertherian rings and modules, Hilbert basis theorem, primary ideals, primary decomposition.

UNIT – IV

Rings and modules of fractions, localization, free modules, injective and projective modules.

UNIT-V

More module theory, Nakayama's lemma, modules over PID.

Recommended Text :

1. M.F. Atiyah and I.G. Macdonald: Introduction to Commutative Algebra (Addison-Wesely Publishing Company)
2. R.Y. Sharp : Steps in Commutative Algebra (Cambridge university Press)

References:

1. J. Lambek: Lectures in Rings and Modules (Chelsea Publishing Company)
2. I.T. Adamson : Rings and Modules (Academic Press)

Mathematics (AUS)
Course No. M-404 (j)
Groups and Representations (OPTIONAL)
(Each Unit Carries 15(fifteen) Marks)

Full Marks: 75
Pass marks: 30

UNIT – I

(Brief review of basic concepts of group theory), isomorphism theorems, group presentations, symmetric groups, dihedral groups, general linear groups, group actions, Sylow's theorems.

UNIT – II

Minimal and maximal normal subgroups, automorphism groups, commutators, composition series, solvable groups, Jordan-Hölder theorem, nilpotent groups, supersolvable groups, Fitting and Frattini subgroups.

UNIT – III

Semidirect product, central product, wreath product, p-groups, extra-special p-groups, complements of subgroups, the Schur- Zassenhaus theorem.

UNIT – IV

Modules and representations, Maschke's theorem, Wedderburn theory.

UNIT-V

Characters, character table, theorems of Burnside and Hall, induced characters.

Recommended Text :

1. **J. L. Alperin & Rowen B. Bell,** Gropus and Representations, GTM 162, Springer (1995)

References:

1. Derik J. S. Robinson, A course in the theory of Groups, GTM 80, Springer (1996)
2. David S. Dummit & Richard M. Foote, Abstract Algebra, John Wiley & Sons, Inc (1999)
3. Joseph J. Rotman, An Introduction to the Theory of Groups, third edition, Allyn & Bacon, Inc (1984)
4. M. J. Collins, Representations and characters of finite groups, Cambridge studies in advanced mathematics 22, Cambridge University Press (1990)

Mathematics (AUS)
Course No. M-405
Project

Full Marks: 75
Pass marks: 30

Modalities:

i) Topics & Supervisors may be decided in the Department.
ii) Concerned Project Supervisor may conduct Lecture / Tutorial / Practical Classes.
iii) Library work and interaction in the Department or outside may be assigned by the Supervisor.
iv) For Internal Evaluation : Tests / Seminars may be conducted by the Supervisor.
v) For External Evaluation : Project Dissertation may be conducted by an External examiner.
vi) Projected is to be completed and submitted to the Department within the stipulated time.

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